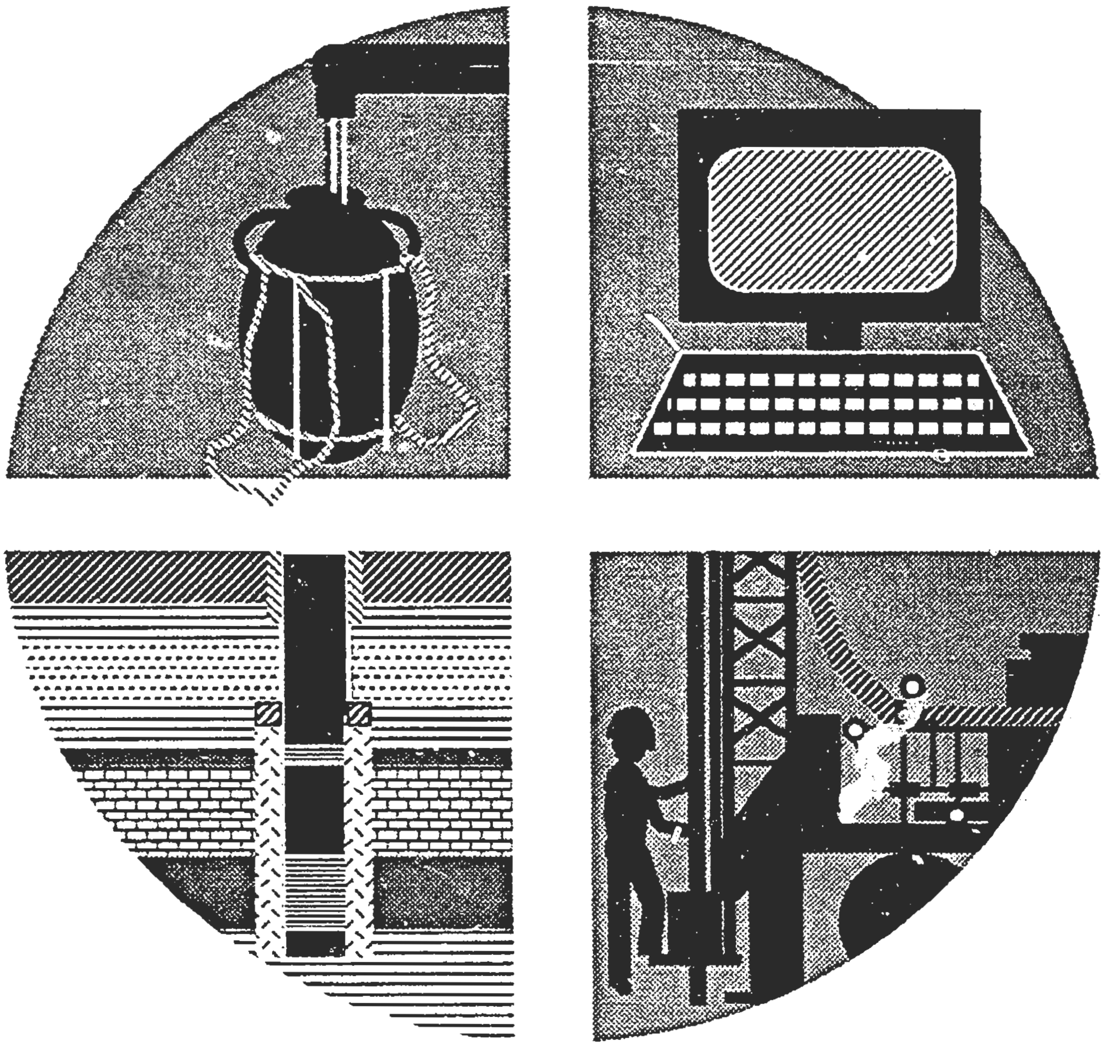
SOMALI DEMOCRATIC REPUBLIC

MINISTRY OF MINERALS AND WATER RESOURCES
WATER DEVELOPMENT AGENCY

Comprehensive Groundwater Development Project



Volume II

General Activities

End of Project Report

LOUIS BERGER INTERNATIONAL, Inc.

ROSCOE MOSS Co.

E N D   O F   P R O J E C T   R E P O R T

C O M P R E H E N S I V E   G R O U N D W A T E R
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G E N E R A L   A C T I V I T I E S

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MINISTRY OF MINERALS AND WATER RESOURCES
SOMALI DEMOCRATIC REPUBLIC.

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VOLUME II

GENERAL ACTIVITIES

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GENERAL ABBREVIATIONS

BRADP	Bay Region Agricultural Development Project.
BR	Bay Region
CAPP	Community Assessment and Participation Program
CGDP	Comprehensive Groundwater Development Project.
CRDP	Central Range Development Program.
CR	Central Rangelands.
EPR	End of Project Report.
FAO	Food and Agricultural Organization.
GDRS	Government of Democratic Republic, Somalia.
HTS	Hunting Technical Services, Ltd.
LBII	Louis Berger International, Inc.,
MES	Monitoring and Evaluation System
MMWR	Ministry of Minerals and Water Resources.
NRA	National Range Agency
NWC	National Water Committee
NWDC	National Water Data Center.
OJT	On the Job Training
PU	Planning Unit.
RLA	Range and Livestock Association
RMC	Roscoe Moss Company.
RMR	Resource Management and Research.
TVAPP	Tuulo Village Assessment and Participation Program
UNCHR	United Nations High Commission for Refugees.
UNDP	United Nations Development Program.
USAID	United States Agency for International Development.
USDA	United States Department of Agriculture.
WDA	Water Development Agency.

MATHEMATICAL/CHEMICAL ABBREVIATIONS

m	meters
cm	centimeters
mm	millimeters
m/s	meters per second
m^2/min	meters squared per minute
m^3/hr	cubic meters per hour
m^2/d	meters squared per day a reduction of meters cubed/day/meter.
m^3/min	meters cubed per minute
m/km	meters per kilometer
km^2	square kilometers
km/hr	kilometers per hour
mph	miles per hour
T	transmissivity (see Glossary of Terms)
Q	signifies discharge in m^3/d unless otherwise noted.
t	time in minutes

EC	electrical conductivity
pH	negative logarithm of hydrogen ion concentration.
mg/l	milligrams per liter
^oC	degree centigrade
TDS	total dissolved solids

PVC	polyvinyl cholride

VOLUME II
GENERAL ACTIVITIES

1.0 INTRODUCTION

This End of Project Report (EPR) summarizes the results of five years of intensive effort to investigate and to develop the groundwater resource potential of Somalia. The scarcity of dependable water supplies for the rural population and for their livestock is one of the most serious constraints to the economic development of the country. The Government of the Democratic Republic of Somalia (GDRS), in recognition of this problem, and in cooperation with the United States Agency for International Development (USAID), established and funded the Comprehensive Groundwater Development Project (CGDP).

This project was administered through the Water Development Agency (WDA) of the Ministry of Minerals and Water Resources (MMWR), and was provided technical assistance by the firm of Louis Berger International, Inc., in association with the Roscoe Moss Company (hereinafter referred to as LBII/RM).

In addition to developing water supplies in the designated priority areas of the Bay, Hiran, Galgudud, and Mudug Regions (Figure 2.1.1), the overall purpose of the CGDP was to strengthen the WDA's capability to construct, operate, and maintain rural water supply systems. As a further inducement to accomplish these goals, the CGDP was designed to be integrated with two existing USAID projects, the Bay Region Agricultural Development Project (BRADP) and the Central Rangelands Development Project (CRDP).

Exploration and exploitation of the groundwater resources were made possible through the provision by USAID of required equipment and materials, and by the requirement for the training of WDA personnel in the use and maintenance of this equipment. In an effort to insure that water supply facilities would be properly received and maintained, a socioeconomic program was included in the project to monitor impacts and to foster community participation.

1.1 Organization of Report

This report has been prepared in five volumes with the intent of providing the set of documents that cover the main goals and accomplishments of the project. An Executive Summary was prepared as Volume I for those readers only interested in an overview of the project. Volume II describes the General Activities that include accomplishments toward institutional support, the monitoring and evaluation system, cost analyses,

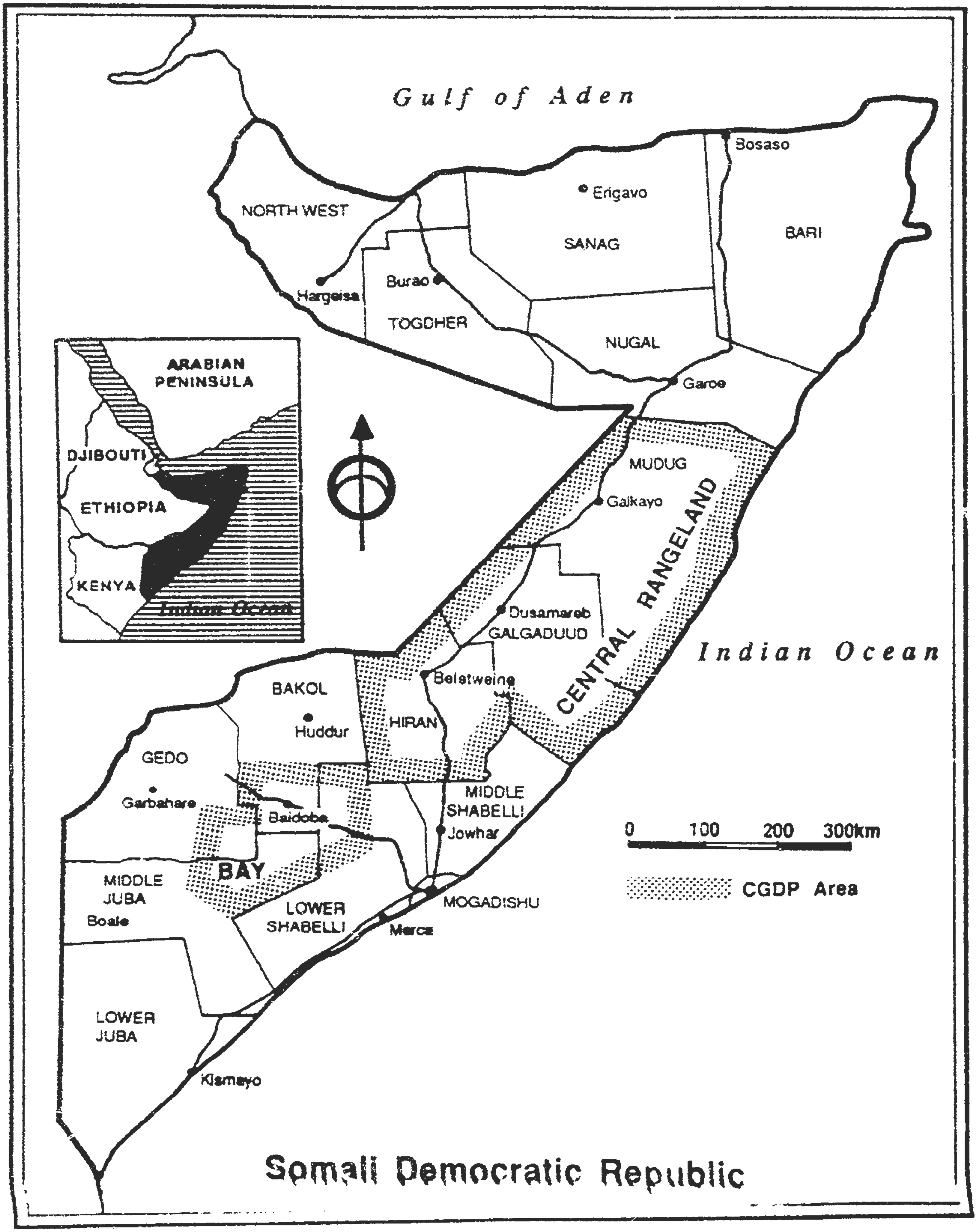


Figure 2.1.1. BAY, HIRAN, GALGADUD AND MUDUG REGIONS

and private sector development. The results of the exploration and exploitation work are presented in Volume III, entitled Hydrogeology. All basic data related to the General Activities are included in Volume IV, and all hydrogeologic basic data are included in Volume V.

1.2 Previous Reports

Numerous reports were prepared by the technical assistance team of LBII/RM. The interested reader is advised to refer to those reports for a more comprehensive review of work completed. An effort has been made, however, to incorporate the key findings of these earlier works into this End of Project Report. A brief description of these earlier reports is presented below. Copies of all reports were given to both the WDA and USAID. The reports are identifiable by title and year, and in those cases where an individual team member prepared the report, by author, year and title.

Pape, M, 1982, Preliminary Analysis of the Potential Environmental Impacts of the Comprehensive Groundwater Development Project.

This report was prepared in the early stages of the project to determine if any serious unforeseen environmental impacts would result from the project. Other than potential rural road damage, and possible deterioration of grazing conditions, no negative impacts were cited. These were felt to be minor in relation to the overall benefit of the water supply system. Other problems mentioned were potential aquifer contamination by the introduction of materials in the well, land subsidence, and social impacts.

Pape, M, 1982, Preliminary Economic Analysis of the Comprehensive Groundwater Development Project.

A preliminary economic analysis was conducted, with the main objective of identifying methodologies for collecting and analyzing cost and benefit data. These methodologies were subsequently utilized by other team members.

Roark, P.D., 1982, Phase I Socioeconomic Report.

This report provided critical review and discussion of reports and socioeconomic data for the Bay Region. It consisted of a summary of relevant data and a presentation of:

- The administrative structure of the Bay Region;
- Local water management systems;
- Pastoral management practices, and;
- The role of women in the Bay Region Communities.

The report also outlines a rationale and methodology for the collection and utilization of socioeconomic data for site selection, community participation, and socioeconomic planning and evaluation.

Exploratory Report for the Bay Region, 1983.

This report describes the results of a 25-borehole exploratory drilling program conducted in the Bay Region in conjunction with available data collection efforts. Pumping tests, water quality analysis, and drilling technology were discussed. In addition, a summary of the preceding socioeconomic study, which emphasized the need for "socio-technical integration", was presented. This document served as a guide for subsequent project activities. The report includes the basic data developed during this exploratory phase.

Schwarz, R.A., 1983. The Somalia Groundwater Development Project: The Community Participation Process, Monitoring, Evaluation and Training.

This is a report of a two month effort to assess and expand the village participation and data collection activities initiated in 1982 by Dr. Paula Roark. The first section includes a network plan in which drilling and construction are integrated into a schedule of village participation and data collection activities. The plan organized the activities into three stages:

- Community assessment and orientation
- Construction (drilling, installation of the pump, and construction of civil works)
- Operations and maintenance (includes management of the water system and evaluation schedule).

This plan is accompanied by a ten page chart which details the objectives, actions, and resources required to implement each event in the network plan. Monitoring activities are integrated into each stage of the program.

The second section of the report outlines data requirements at each stage, and the relationship between this information and decision-making. It identifies information needed to evaluate the effects of the water system on village populations and the environment.

The final section describes the program organized by the consultant to train members of the BRADP staff to implement village participation and monitoring activities. It covers content, methods, and coordination between the CGDP and other projects.

Brandon, Carter, 1984, Economic Evaluation of the Comprehensive Groundwater Development Project.

An economic evaluation was undertaken after two years into the well construction activities of the project. The intention of the study was to advance the knowledge of the costs and benefits of the project. A definitive evaluation of benefits was not possible because of insufficient end user data. The report covered three major activities that included an analysis of:

1. The full costs of the groundwater development program,
2. The projected benefits, and
3. The long-term operating and maintenance costs.

Although the resulting costs appeared high, close analysis of assumptions made and items included indicate that given the same logistical and material costs, the well costs would be comparable to those almost anywhere.

Updated analyses, and details of the computer model now available to obtain the data, are included in this report. End user data is still sparse, and economic evaluation of benefits is difficult, however, some projections were made.

Final Report, Phase I, 1984

The final report prepared at the end of the first phase of the project, July 1984, summarizes project activities from July, 1981, when the project was initiated. This report consisted of three volumes; volume one described general activities, volume two presented findings of the hydrogeologic investigation, and volume three contained appendices of basic data.

The general activities volume was quite comprehensive; however, an update of general activities is presented in this volume. Many of the findings presented in the hydrology volume have been revised in this report on the basis of new information. All of the data contained in the third volume, appendices, are included in this report in either Volume IV or V.

Interim Report, 1985.

Upon completion of three years work, the project was re-evaluated and extended for two more years. The single volume Interim Report describes work completed after the first year of this extension, namely from July 1984 through July 1985. Basic data collected during that period was included, in addition to discussions on the progress and problems of all project activities.

Preliminary Executive Summary Water Development Industries, 1985

In recognition of the water resource demands in Somalia, a study of the industries that provide services and/or materials for water development was made a part of the CGDP. The main objective of this study was to determine the extent to which the private sector could provide drilling, pump installation, equipment, materials and consulting services to the development of water supplies. The executive summary was prepared in anticipation of seminars that were to be conducted with government and industry in regard to the study.

Somalia's Water Resource Development Industry, 1986

This report presents the findings of the status of industries related to water development in Somalia. In addition to data collected with respect to these industries, recommendations of methods for increasing private sector involvement are provided. A summary of this work is presented in Section 6, Volume II of this report. The interested reader is encouraged to review the original document for details.

There were numerous other reports prepared in conjunction with the project that included monthly reports, work plans, and project papers. Because these were primarily for administrative purposes they have not been discussed here.

2.0 INSTITUTIONAL SUPPORT

One of the major goals of the CGDP was to provide institutional support to the WDA in the way of equipment, training, planning, and well maintenance. The WDA is the implementation arm of the MMWR for the development of water resources. The WDA is responsible for constructing the wells allocated by the National Water Committee, and for operating and maintaining the wells. When the CGDP was initiated, the capability to meet the demand of WDA was limited by the availability of adequate equipment and by lack of trained drillers and professional staff. By combining the resources of the CGDP, the BRADP, and the CRDP, equipment and materials were made available to begin a program toward meeting water development demands.

2.1 Equipment and Material Support

Equipment for carrying out the goals of the CGDP consisted of three Ingersol Rand TH-60 drill rigs with a full complement of parts and drilling bits. In addition to the drill rigs, a large number of support vehicles were provided that included; tanker trucks, crane trucks, flatbed trucks, pump rigs, geophysical logging trucks, crew cab pickup trucks, mechanics trucks, welders, generators and workshop equipment.

Materials purchased for the project included; bentonite, drilling mud, drilling foam, steel and PVC casing, and an assortment of lumber, galvanized pipe and fittings for civil works construction. Perhaps to be included with the materials list are the large amount of tools for the workshops in Mogadishu and Baidoa. These included all mechanics tools and pipe cutting and threading tools.

The total capital investment of equipment and materials for the project was in excess of ten million dollars. This does not include diesel fuel, which was provided when local sources were not available, and equipment purchased by BRADP and CRDP projects.

2.1.1 Bay Region Agricultural Development Project (BRADP)

The BRADP purchased the following equipment that was utilized in the construction of water wells in the Bay Region:

1. An A frame single axle flatbed truck
2. A four wheel drive pump installation rig
3. A single axle tanker truck for fuel
4. A tandem axle flatbed truck with knuckle crane
5. Two, single axle tanker trucks used for water hauling

These vehicles will be retained by the BRADP upon termination of the CGDP. Maintenance and parts on these vehicles were provided by the CGDP during the drilling program in the Bay Region. Some parts, provided with the initial vehicle orders, were sent to the BRADP warehouse for future use.

In addition to the vehicles, the BRADP purchased casing and pumps for use in the wells. Two thousand nine hundred forty two meters of casing of various diameters, forty Mono/Lister diesel pumps, twenty Robbins and Meyers hand pumps, thirty Mono hand pumps and a Wind Baron Windmill were provided. Parts for the diesel pumps are stored by the WDA for future maintenance.

2.1.2 Central Rangelands Development Project (CRDP)

The CRDP purchased the following equipment that was utilized in the construction of water wells in the Hiran, Mudug, and Galgadud Regions:

1. An A frame single axle flatbed truck
2. Two tandem axle flatbed trucks with knuckle crane
3. Two single axle tanker trucks
4. A four wheel drive pump installation rig.

These vehicles will be retained by the CRDP upon termination of the CGDP. Some parts were sent to the CRDP warehouse when the vehicles first arrived in country, however most parts, and all maintenance, have been provided by the CGDP during the drilling program.

In addition to the vehicles, the CRDP purchased a number of drill bits, 1440 meters of various diameter steel casing, ten Robbins and Meyers hand pumps, and ten Mono/Lister diesel pumps. Parts for the pumps are stored by the WDA for maintenance.

2.2 Training Programs

One of the objectives of the CGDP was to provide training to WDA and MMWR personnel in the various activities associated with water development programs. Intensive training was provided during the three year first phase of the project. In addition to classroom and on-the-job training in Somalia, university degree programs, and short term training programs were provided in the USA. A comprehensive discussion of this training is provided in the phase one Final Report by LBII (1985).

During the second phase of the project, hands-on training was emphasized, although short term training in the US for hydrogeologist was continued. All levels from drivers to hydrogeologist were given more independence in their activities.

At the completion of the first phase of the project it was concluded that additional emphasis should be given to hydrogeologists. In recognition of this need, they were made to work more closely with the consultant's hydrogeologists on all aspects of the work, and additional classroom training was provided on a limited bais. Light and heavy duty vehicle mechanics were also felt to be in need of extended training. This was found to be difficult because of the turnover of personnel. As quickly as someone attained any proficiency as a mechanic he would leave the employ of WDA for a higher paying position.

Training in all positions was generally handicapped by three factors; limited to nonexistent ability to speak or read English, lack of employment incentives, and lack of decision making experience. The language problem, although considerable, was manageable by working through those that did have a knowledge of English. This caused delays and mistakes, but did not totally prevent the transfer of information.

The lack of incentives was more critical in the sense that it resulted in absenteesim from the project, and an absence of a work ethic. When people are having to live on what they can generate day to day, it is impossible to interest them in the advantages they will have in the future from the training being given.

The third problem, although not serious to the execution of project objectives, was of concern for the continuation of water development efforts. This is the lack of decision-making ability, that expresses itself in unnecessary delays. A history of not being allowed to make decisions is no doubt responsible for the lack of ability.

The training provided during the extension period of the project is discussed in the sections that follow. Some of the discussion is taken from the LBII Interim Report (1985) which summarized training from July 1984 to July 1985.

During the second phase of the project, a greater effort has been made by the consultant's staff to give counterparts more opportunity for judgement and decision making. Although some improvement was noted, this problem will continue to be a factor in the efficient operation of a water development activity.

Manuals have been written for nearly every aspect of the work to be done by WDA, and these have, with the exception of the manual on geophysics, been translated into Somali. Although interpretations may differ among Somali readers, an effort was made to use the most accepted terminology. These manuals will be available in the WDA library for use by all personnel.

Training during the project has been provided to six main groups, namely hydrogeologist, chemists, drillers, pump installers, mechanics and planners.

2.2.1 Hydrogeologists

The number of hydrogeologists that have received training over the life of the project is difficult to determine. Many that were assigned did not participate, and many that participated did so only occasionally. Not counting those individuals sent to the U.S. for university training, it is estimated that fifteen have received some classroom and on-the-job training (OJT).

Classroom training consisted of slide presentations, and of one-on-one sessions with the consultant's hydrogeologists on specific subjects. Training covered exploration, siting, drilling supervision, pump testing, and pump test data evaluation. When possible, the hydrogeologists were rotated amongst drilling and pump rigs to provide the OJT needed. A manual for hydrogeologists was prepared that included a discussion of these various topics.

Exploration was limited to a review of hydrogeologic conditions at sites selected by the BRADP, and CRDP projects. Counterparts were taught to seek existing data in the WDA files, and to use topographic maps and aerial photos for interpretation of hydrogeologic conditions.

Well siting was done in the company of the consultant's hydrogeologist, counterparts were taught to look for the physical conditions that verified topographic and aerial photo data. Conditions that could contribute to contamination were identified at each site. Other well site considerations included the location of civil works structures in relation to the well and to the village, and the desires of the people in the village.

Drilling supervision by hydrogeologists is a task that will require some time before being accepted by the drillers. Hydrogeologists tend to be younger than many of the drillers and consequently the drillers challenge their decisions. Training in drilling supervision was oriented toward the taking of good formation samples, and toward being able to advise the driller on depths to be drilled and on zones to be screened and developed.

Pump testing and pump test data evaluation were by necessity taught in the field and on a one-on-one basis. A classroom discussion of the results and the significance of the data was given to show the relationship between individual well tests and the respective geologic areas. Those individuals who had the opportunity to attend the U.S. Geological Survey short course on groundwater tend to do well on data collection and interpretation. Additional training and experience is needed by all hydrogeologists in this effort.

There are at this time five hydrogeologists, and five assistant hydrogeologists in country with sufficient training to be of service to the WDA drilling operations. Three hydrogeologist are completing their degree programs at the University of Arizona, and are expected to return soon. Several of these individuals have requested enrollment in a groundwater correspondence course offered by Wright State University.

2.2.2 Chemists

Training of personnel at the MMWR laboratory faced the same problems as all groups namely, lack of attendance and lack of incentive to participate in training activities. The laboratory had a staff of twenty-five, but only one was a professional chemist. The few who attended on a regular basis had been previously trained in basic analytical work, and were able to perform some geochemical analyses under supervision, but were not able to perform routine water analyses.

With the initiation of the CGDP, five professional chemists and two laboratory technicians were recruited. All the professional chemists and one laboratory technician have received, or are receiving, training in the U.S. Two of the chemists are still in the U.S., two have been released, and three are still working at the laboratory. Those individuals staying with the program have received OJT for water chemistry, microbiology field tests, water quality data interpretation and report writing.

Prior to introducing analytical water analysis techniques, forms for receiving samples and for registering results were developed. These forms have been made a part of the established laboratory procedure for water analyses. Figures 2.2.1 and 2.2.2 are examples of these forms.

Training was given in the preparation of analytical routines for water sample analyses after the methods were standardized by the consultants' chemist. Standardization consisted of developing techniques compatible with the laboratory equipment, extremes in water quality and available reagents. Seventeen parameters were standardized that included: EC, TDS, pH, Ca, Mg, TH, Na, K, Cl, SO_4, HCO_3, NO_3, R, WH_4, Fe, and Si. Of these, routine analyses were developed for eleven

Water Sample Register

Location	Well No.	Sample No.	Sampling Date	Received Date	Collector	Source*

* **HDW** - Hand Dug Well
  DW - Drilled Well
  S - Spring

Figure 2.2.1 WATER SAMPLE REGISTER FORM

Analytical Results

Sample No.	EC	pH	TDS mg/1	Alk. mg/1	SO_4 mg/1	Cl mg/1	Ca mg/1	Mg mg/1	Na mg/1	K mg/1

Figure 2.2.2 ANALYTICAL RESULTS FORM

that included; EC, TDS, pH, Ca, Mg, TH, Na, Cl, SO_4, and HCO_3. After establishing routines for these eleven parameters and conducting a number of analyses, it was found that accuracy of results was poor. Training was then directed toward increased accuracy of the established routines.

One of the major concerns regarding water quality is the presence or absence of bacterial organisims. Tests for bacteria procedure had to either be completed in the field or the samples had to be preserved and transported to the lab for subsequent analysis. Two of the laboratory technicians were trained in analytical field methods to test for fecal coliforms and fecal streptococcus. They were able to conduct the sampling and testing independent of the Consultants' chemist.

The final stage of training for chemists consisted of water quality data interpretation and report writing. As a result of this effort a manual was prepared, and five preliminary reports on the quality of water in the Bay Region and in the Central Rangelands were completed.

After the first six months of the project extension period, the consultants' direct involvement in technical assistance to the laboratory was terminated. This was due to the realization that the individuals trained were capable of continuing the analytical work under the direction of their own professional chemist.

2.2.3 Drillers

Attendance on site by the drillers, assistant drillers and rig hands was comparatively good throughout the life of the project. On-the-job training was better received than classroom or seminar type training provided early in the project. During the extension period, with the exception of slide programs and a classroom discussion on the Ingersoll-Rand parts manual, all training was OJT.

The phase one Final Report discusses in detail the classroom, and seminar training provided during that period. A variety of visual aids were used in the presentation of all activities required to be performed by the drilling staff. The OJT subjects covered during the latter part of phase one and throughout the extension period consisted of materials and equipment organization, drilling procedures, casing installation, and well development.

One of the more important aspects of a drilling program is the proper preparation before mobilization. Historically this has been the decision of a few individuals within WDA, and has been the weak link in efficiency of operations. Training was provided during this project to all drillers, in this aspect of operations. The training manual prepared for drillers emphasizes the need to be organized prior to leaving for the field.

Drilling procedures in any one area of the country tend to be similar. For this reason, drilling foremen were shifted between the three rigs to learn different drilling techniques. Those having experience with mud rotary operations were shifted to the rigs using air hammer techniques and vice versa.

Drillers working on mud rotary rigs were trained in the use of different mud viscosities and in the recovery of lost circulation. Recovery of lost circulation became an extremely important factor in wells in the Central Rangelands. Drillers working on air rotary rigs learned air hammer techniques with the use of drilling foam. Cable tool rig training was less intensive because WDA personnel were fairly well experienced with this method. The cable tool equipment had been in country for some time, and the crew assigned this rig were established in their habits. Attempts were made to demonstrate how drilling could proceed at a faster rate, however, this effort was not well received.

A major handicap that existed throughout the project was the lack of qualified welders on the rigs. On most privately owned drilling rigs, the chief driller and usually one other person are experienced welders. Unfortunately, for reasons unknown to the Consultants' staff, welding was not regarded as a respected profession. Through the efforts of the project, this stigma was to a large extent removed. Most drillers and/or assistant drillers became receptive to training in the basics of arc welding.

Coincident with training in the art of welding, was the training provided in the installation of casing. This involved insuring that casing lengths were properly measured and recorded, and that casing lengths were correctly aligned prior to welding.

Before any potentially producing borehole can be considered a well, it must be adequately developed. Development is used here to mean the removal of the mud cake from the walls of the borehole and in particular the area opposite the water producing zone. In the case of holes drilled with air or by cable tool methods, development means the removal of fines. Although equipment for rigorous well development was not available, drillers were trained to thoroughly clean the hole by either circulating clean water and/or by blowing with air. Additional air compressors, air jetting tools, and chemicals were not available nor deemed necessary in most cases.

In addition to rotating drillers through different techniques, drillers were moved up to increase the number of individuals capable of supervising and maintaining well drilling operations. Those individuals being displaced were moved into other training functions such as yard foreman, supervisors, drivers and mechanics. Although driver and mechanic functions appeared to be a demotion, it was an effort to make the drilling foreman more knowledgeable of overall operations. Many head drillers, for example, were not able to drive the drilling rigs nor understand what or how to repair mechanical failures, all functions an experienced driller should be capable of doing.

At the end of the project, twelve men could be considered head drillers, and an additional twelve could at least operate the drilling rig. The number of experienced drilling personnel wihin the WDA was definitely increased during the life of the project.

2.2.4 Civil Works Constructors

Civil works construction was turned over to the BRADP and CRDP projects shortly after the commencement of the extension period. Prior to this time, the consultant provided a civil engineer who worked with a civil engineer from WDA, and a staff of technical, skilled, and unskilled workers. Both classroom and on-the-job training were provided in the evaluation, design and construction pertaining to springs, cisterns, wars (reservoirs), storage tanks, watering troughs, and distribution systems. Training covered all aspects from site evaluation and surveying through block making and construction. Although relieved of duties with this project, these trained individuals are continuing their work with the WDA.

2.2.5 Pump Installers

Original classroom training for pump installers covered a broad range of topics that included discussions of aquifers, pump selection, pump controls, generators, and pump repair. Training in these subjects was presented by the consultant's staff, consisting of a pump installer, electrician, and a senior hydrogeologist.

After the arrival of hand pumps and diesel pumps in 1983, those individuals assigned to work as pump installers were given continuous OJT. This included training on installation, repair, and pump testing. By the end of the project, two crews were established that could operate relatively independently of consultant supervision. They were able to construct the concrete pump base, set submersible pumps for testing, and install Mono diesel and hand pumps.

One windmill was installed with consultant supervision, but it is anticipated that counterparts trained would be capable of installing others. The main problem with the pump installation crew, as with all counterparts, is their lack of ability to plan their activities and to make on site decisions as needed to complete the work. Definite improvement in this capability was made, and four of them are very close to being self sufficient in these matters.

2.2.6 Mechanics

Of all the training programs provided during the period of this project, the training of mechanics was the most difficult. This resulted from several factors; the individuals assigned generally had minimal knowledge of English; the individuals assigned had little or no previous experience; and after they had acquired reasonable expertise they would leave the project.

The training centered around the establishment of good preventative maintenance programs that included scheduled times for all vehicles and rigs to be serviced. In addition, training was given on major repair of engines, transmissions, and drive systems as required.

Training of mechanics could be considered fairly successful with the exceptions of the previously mentioned difficulties. The problem of minimal English capability arises, not only in the transfer of knowledge, but in the ability of counterparts to read vehicle maintenance manuals and to obtain appropriate parts from the warehouse. As has been mentioned in regard to other training efforts, the lack of diagnostic and decision-making capability also limits the effectiveness of any training provided. These abilities will only come with time and experience.

2.2.7 Community Participation Staff

The idea of community participation in site selection, construction and management was introduced into the project during the start-up period (1982). Although the initial effort was judged successful by the technical staff, outside observers and evaluation teams, no WDA personnel were provided to coordinate and implement community participation activities on a full or even half-time basis. Training activities in this area were, therefore, directed towards WDA technical staff, and planners and personnel of other agencies who, albeit on a very limited basis, would be able to encourage and support the involvement of villagers in project activities.

In 1982 WDA hydrogeologists and drilling staff were trained to implement the Tuulo Village Assessment and Participation Process (TVAPP). The consultant's sociologist was assisted by an experienced extension agent from the Bay Region Agricultural Development Project (BRADP). The training included lectures and discussions on objectives and methods, and visits to project villages.

The Consultant's sociologist, assisted by the BRADP advisor/interpreter, accompanied WDA and CGDP technical personnel to villages identified as potential drilling sites. Community meetings were conducted to explain the project and to collect data on socioeconomic conditions using a village self-assessment approach. Technical staff observed and participated in these activities under consultant supervision.

The primary thrust of village participation activities during the first year was to design and to test the TVAPP strategy. While training was a secondary issue the effort successfully demonstrated the value of the TVAPP approach to many technical personnel. Several continued to implement portions of it during site selection and drilling activities.

Between 8 and 12 staff persons received the equivalent of 3 to 4 weeks of training in community participation, an estimated 35 person weeks of training.

The TVAPP strategy is labor intensive and requires frequent visits during the first year of site selection, drilling, and construction activities. The lack of WDA staff to implement the community participation program led to a recommendation to train members of the newly organized monitoring and evaluation unit of the Bay Region Agricultural Development Project (BRADP). This was implemented in May and June of 1983 by LBII's development anthropologist.

In June 1983, four enumerators attached to the monitoring and evaluation unit of the BRADP received twelve days of training. The enumerators were young high school graduates, 20-25 years old, who had no formal training in community development, social science, or monitoring and evaluation. Their lack of prior training, and the fact that the BRADP had not yet established an information system, meant that training had to be conducted at an introductory level. The program focused on an explanation of basic concepts and research methods. The training introduced the enumerators to the CGDP, and to the integration of the village participatory approach. It included the development of skills to guide local participation and to monitor and evaluate project events.

(i) Coordination with Somalia Development Agencies and the Wyoming Social Science Team

The University of Wyoming undertook a contract to train the BRADP monitoring and evaluation staff and to conduct a baseline socioeconomic study of the region. Their training had just begun when the consultant's development anthropologist arrived to organize their training for the CGDP village participation program (TVAPP). Although the presence of the Wyoming Team limited the consultant's access to BRADP personnel, the training was coordinated and implemented with the support and participation of senior staff from the Wyoming Team, BRADP, and the National Monitoring and Evaluation Facility (NMEF).

(ii) Training Methods and Contents

Lectures of short duration (15-20 minutes), were used to present information. Most classroom activity involved students responding to questions and discussions. Students were given outside reading assignments on water supply projects, and self-help and monitoring and evaluation techniques, to prepare them for four days of data collection in the villages. Classes preceding village visits covered explanations of research methods and data collection instruments. Classes following field visits began with a critical analysis of the experience and a revision of research instruments. Field trips combined exposure to community participation activities, and training in mapping, observation, interviews, and the administration of questionnaires. The content of the program included:

- A review of the groundwater development project and its evaluation.
- The community participation approach (basic concepts and their application to the CGDP).
- A summary of technical components (hydrogeological survey, drilling, construction, operations and maintenance).
- Types of project monitoring and evaluation.
- Research methods and their application to project monitoring and evaluation.
- Village visits in which community meetings and research activities were combined.

The information was presented within the general integrated framework outlined in the village water development network plan (Schwarz 1983).

(iii) Limitations and Results of the Training

The enumerators who participated cannot be considered fully "trained" in either community participation or monitoring and evaluation. Even a minimal program requires two to three months of intensive classroom and field work activities, followed by professionally supervised research and periodic seminars. The Wyoming program increased the conceptual and methodological skills of these enumerators, but they still require additional training in community participation, and monitoring and evaluation of water projects.

The BRADP enumerators trained in 1983 participated in the Wyoming socioeconomic research project for about 15 months and then went to the University of Wyoming for advanced studies. They made no contribution to the CGDP Project and as of January 1986 have still not returned to the Bay Region.

(iv) Recommendations

The idea to train and utilize the services of the BRADP monitoring and evaluation staff was a good one. While the expected involvement of BRADP staff was not realized, the shift in responsibility for civil works to that organization in 1985 should be a strong incentive for them to cooperate with WDA.

The WDA Planning Unit should develop effective cooperative ties to implementing agencies and train BRADP, CRDP, and other project staff, to plan, monitor, and evaluate village water supply systems. In order for WDA to realize the benefits of such training, however, the agency will have to closely supervise, and provide additional on-the-job training to, field staff of other agencies. This, in turn, requires that WDA organize a Planning Unit with sufficient professional and field staff to conduct training and supervisory activities.

2.2.8 Planners

The establishment of a Planning Department within the WDA was initiated during phase one of the project. The difficulty of forming a Department under current government rules and regulations, however, prevented this from occuring during the life of the project. As an alternative, a Planning Unit was formed within WDA to initiate the task of collecting and evaluating socioeconomic data that was felt to be pertinent to any future water development activities. Four individuals from within the WDA administrative and hydrogeology staff were assigned to this Unit. The training provided to these individuals consisted of: computer training on the Compaq and IBM PC computers; collection and evaluation of socioeconomic data; and evaluation of data needs for planning purposes. Computer training has consisted of spreadsheet analysis, database management, word processing and graphics.

The individuals trained will be expected to interface with the personnel from the newly formed National Water Data Center. This group will be collecting, organizing, and storing data on ground water resources throughout the country.

In July and August 1985, training sessions were conducted for three members of the Planning Unit. Because only the head of the unit had prior training and experience in planning and data collection, the program was conducted at an introductory level. Total training output is estimated to be about 14 person weeks and includes time spent in field trips.

(i) Training Methods and Contents

Short lectures (15-20 minutes) were presented on most topics, and were followed by discussions which dealt with case material on conditions in the Bay Region. Readings were assigned, and the trainees had exercises to complete as preparation for class participation. Two field trips were conducted as part of the training on monitoring and evaluation; the first lasted six days, and the second, four days. Topics covered in classroom and field training included:

- Basic concepts of planning, monitoring and evaluation, and their interrelationship.
- Data sources and levels of analysis.
- The analysis of socioeconomic data using case material from the Bay Region.
- The design of a management information system for the Planning Unit.
- The community participation strategy.
- The design and utilization of monitoring observation forms and questionnaires.

The field trips included visits to eight villages in the Bay Region. Technical data on the water supply system and pump operations were collected, and interviews were held with members of village water committees, pump operators and other local residents.

(ii) Results and Limitations

The training was able to provide the inexperienced staff members with a needed orientation to the basic concepts and methods of planning, monitoring and evaluation. The trainers accompanied Planning Unit staff on field trips and helped them develop a systematic approach to observation and interviewing. Monitoring activities continued on a limited scale following the training, and the results were viewed as satisfactory. The major training limitations were the trainees' lack of educational and job experience in development and socioeconomic analysis, and the relatively short training period.

(iii) Recommendations

The small size and dispersion of Planning Unit personnel makes it difficult to suggest immediate training measures which could improve their effectiveness. The principal problem is that the WDA has been unable to retain the professional and field personnel described in the project extension document. In view of this situation, and the fact that WDA will continue to have financial and manpower constraints, we recommend the following actions:

1. Support for short and long term overseas training of WDA technical and planning staff in the following areas:

   - Planning and Project design.
   - Program Management, including the design of management and project information systems (which includes monitoring and evaluation).
   - Human resource development focusing on the design and implementation of training programs.

2. One long term (one to two year) position for a planner/trainer to assist WDA planners. This individual should be an experienced planner able to organize and conduct training programs on planning methods, information systems, and management techniques. He/She should spend about half-time in training activities. The remaining time should be used to organize the Planning Unit and to provide technical assistance to WDA staff involved in program planning and monitoring. This will provide continuity between LBII's current effort and any future activities by WDA directed towards the establishment of a viable Planning Unit.

3. Several short term technical assistants (12-20 person months) to supplement and support activities organized by the long term advisor.

A more detailed plan for the future training requirements of the Planning Unit is discussed in Section 2.3.7.

2.2.9 Other Training

In addition to the specific categories of training previously described, training was given to drivers, crane operators, backhoe operators, samplers and warehousemen. All drilling operations require a large number of support vehicles that include flatbed trucks, water and fuel trucks, and service trucks. Drivers of these vehicles were taught basic maintenance procedures, tire repair, safety, and backing with the use of mirrors.

Integral to the support of the drilling operations are the crane truck operators. They received training in the operation of the crane, and in the proper use of lifting slings for the loading and unloading of casing, cement, bentonite, and a myriad of equipment not normally handled by manpower alone. Learning to secure loads for transport was also a major part of the OJT received.

Although not utilized extensively, the backhoe/front-end loader tractor is a part of the drilling operation support equipment. Two individuals were taught how to utilize the backhoe for the construction of mud pits, and how to use the front-end loader for loading sand and stone during construction of pump bases. This piece of equipment may be utilized more in the future for construction of surface catchments and berkeds.

Warehousemen were trained in the procedures for receiving and distributing parts and equipment. Some difficulty still exists for these individuals with reading parts manuals in English. The future maintenance and operation of equipment purchased for this project will rely heavily on the warehousemen's ability to maintain a supply of needed parts.

2.2.10 Manuals

In an effort to provide the Somali counterparts with guidelines for continuation of operations upon completion of the CGDP, nine manuals have been prepared. These nine manuals are:

1. Hydrogeologist Manual
2. Pump Testing
3. Water Quality
4. Downhole Geophysical Logging
5. Well Drilling Operations and Preventive Maintenance
6. Evaluation, Rehabilitation and Abandonment of Water Source Points.
7. Pump Rig Operation and Well Maintenance
8. Light Duty Vehicle Preventive Maintenance
9. Warehouse Procedure

All manuals were prepared in English, with Somali translations being provided for most. Some manuals, those that included materials prepared by manufacturers and those intended for the professional staff, were not translated. The contents of the manuals are self explanatory and need no further discussion. The manuals will be made a part of the WDA library, and will hopefully be utilized by existing and future personnel.

2.2.11 Recommended Future Training

It is hoped that, upon termination of the CGDP, those individuals who received training will be sufficiently motivated and provided enough incentives to continue their learning, and will assist those employees who have not been exposed to the project. In the interest of insuring continuity of effort, appropriate training programs for the various disciplines should be developed. These programs should be short term and preferably be given in Somalia. The problems and conditions existing in-country should serve as the basis for any additional training. All too often, training received in other countries has limited application when trainees return. Conditions in-country are different, and the high-technology equipment on which they have trained is often lacking.

Areas in which additional training for current employees should be considered include; hydrogeologic report preparation, driver education, welding, pump maintenance and repair, and English language. Hydrogeologic report preparation should be taught to those hydrogeologists that have a good grasp of the overall tasks performed in groundwater investigations. Nearly all publications in Somalia pertaining to groundwater have been prepared by outside consultants. Personnel of WDA should learn how to conduct regional hydrogeologic investigations and how to prepare meaningful reports. With the current available database, regional reports, or other divisional unit reports, should be prepared. These reports should be made available to other agencies and to the general public when large water-using projects are under consideration.

Driver education courses, both classroom and practical, are especially important for those individuals driving heavy duty trucks and the drilling rigs. The large number of vehicle repairs could be significantly reduced by improved driving standards. Transmissions, brakes, tires, etc. could be saved from excessive wear and failure if trained drivers were assigned to the vehicles. This training should extend to preventive maintenance.

Welding techniques should be provided to all drillers and to the mechanics. Some training in welding techniques was given during the CGDP, however, lack of time and other difficulties prevented a more intensive program. Welding, and associated cutting and bending techniques are an integral part of most drilling operations and of many mechanical repair tasks. If welding is provided in the curriculum of the local trade or technical school programs, arrangements should be made for drillers and mechanics to attend. Drillers with good welding techniques will save many hours of lost time that result from casing failures and related problems.

Because most of the pump work associated with the CGDP involved installation of new pumps, there were limited opportunities to provide training in the maintenance and repair of pumps. An in-country training program that deals with practical problems and with troubleshooting techniques would be most beneficial.

English-language training should be made a continuous program for all project counterparts. All equipment and vehicles provided are American-made, and all operations and maintenance manuals are written in English. Unfortunately, not all counterparts provided have sufficient working knowledge of English to allow them to research parts and supplies in the manufacturers' manuals. Nearly all counterparts, however, express a desire to learn English.

2.3. Planning Unit

Assistance in the establishment of a Planning Department within WDA was a major feature of the institutional support objectives of the project extension phase of the CGDP. During the first three years of the project, considerable progress had been made towards establishing a site selection and community participation process. This process involved baseline data collection features. Two economic analyses of the project were also completed. The main objective of the Planning Department, in addition to other elements described in detail below, was to institutionalize and build upon this work.

Presidential approval was required to formally establish a new department within WDA, and while this was pending, WDA decided to create a Planning Unit. The Unit was formed at the beginning of 1985, and technical assistance to the Unit was provided from March of that year.

This section of the report outlines the initial objectives of the Planning Unit, and the assumptions on which they were formulated. As the work of the Unit progressed, initial assumptions proved incorrect, in particular with regard to the resources available to the Unit. As a result, the original objectives were modified to reflect the realistic capabilities of the Unit.

The actual achievements of the Unit are documented below. In addition, a five-year strategy to develop a viable Planning Department for WDA is outlined which takes into account planning activities proposed for other branches of the MMWR.

2.3.1. Initial Objective of the Planning Unit

The initial objective of the Planning Unit was to "...integrate technical, sociological, and maintenance plans...not only on the selection of well sites, but also on the use of WDA resources (financial, human, and material) in order to help improve overall WDA operations." (USAID Project Paper, 1984).

This objective was further categorized into four functions as described below:

1. Planning. With an emphasis on site selection procedures, the Planning Unit would:
   a) coordinate all available social and technical information, and,
   b) develop drilling and maintenance programs.

2. Economic analysis. The economic analysis would focus on costs of all WDA operations, user revenues, and project benefits. Specifically, this required:

   a) building upon the economic analyses already completed to develop a comprehensive model for the economic costing of groundwater development for future use by WDA,
   b) monitoring the collection of user fees, ascertaining the extent to which WDA activities are, or could be, self-financing, and studying alternative fee structures and methods of collection,
   c) monitoring project benefits, and carrying out economic analyses of the impacts of well installation in terms of observable indicators.

3. Sociological evaluation. This would entail the collection of baseline and long-term data on the social impact of well installation, assessing the social feasibility of proposed projects, and establishing community participation. Specifically, this required:
   a) further development of the process introduced during the first phase of the project, whereby community participation in site selection, construction, operation, and maintenance is encouraged, and baseline data is collected,
   b) designing and implementing procedures for monitoring and evaluating well usage, socioeconomic impacts, and community participation,
   c) supporting community water committees not only in well maintenance responsibilities, but also towards other improvements in social services associated with the use of potable water.

4. Policy studies. Using data obtained from carrying out the above functions, the Planning Unit would study feasible WDA policy options, with particular reference to:
   a) community responsibilities for operation and maintenance,
   b) control and methods of revenue collection,

c) water pricing structure.

In addition, the Planning Unit was to cooperate with the National Water Data Centre (NWDC). This was to have been set up within the Ministry of Minerals and Water Resources with USAID and UNDP/FAO assistance. The NWDC is charged with the collection and utilization of all water resource data in Somalia with a view to developing water sector development plans for the National Water Committee. Sharing some of the facilities of the NWDC, the WDA Planning Unit was to take responsibility for the collection of data relating to all boreholes in Somalia.

2.3.2. Assumed Resources of the Planning Unit - Conditions Precedent

The Planning Unit was to be staffed from within WDA, with technical assistance provided by LBII on a full-time and visiting consultancy basis. In addition to coordinating the work to be undertaken with the NWDC, certain resources of that unit were to be made available to the Planning Unit.

2.3.2.1. Assumed Resources Provided by WDA

WDA undertook to provide the following full time staff for the Planning Unit:-

1 Chief Planner
1 Assistant Planner/Economist
1 Economist
1 Sociologist
[illegible] Field Assistants - sociology
2 Secretaries/Computer Operators

Of these positions, only one was filled at the start of 1985: a qualified member of the WDA staff was in place as head of the Planning Unit.

2.3.2.2. Assumed Resources Provided by LBII

It was agreed in the final project document that LBII would provide the following technical assistance to the Planning Unit:-

Economist (9 months)
Sociologist (6 months)
Water Resource Planner (short-term, up to 3 months)

This was subsequently ammended in the approved project extension work plan to the following:-

Economist (12 months)
Sociologist (3 months)

Water Resource Planner/Computer Instructor (3 months)

A micro-computer was also to be purchased for the Unit, together with the required software.

2.3.2.3. Assumed Resources Provided by the NWDC.

Among the personnel to be provided to the NWDC were four UNDP volunteers (hydrogelogists) and a librarian/computer operator to process the collected data. These personnel were to be equipped with three four-wheel drive vehicles, hydrogeologic field equipment, and satellite locators. The precise allocation of their time to be spent in assisting the WDA Planning Unit in its part of the data collection task was to be determined.

2.3.3. Actual Resources of the Planning Unit.

The actual resources available to the Planning Unit fell far short of those anticipated. For various reasons, WDA was unable to provide the numbers nor the quality of staff originally planned. The National Water Data Centre did not become a reality until the final months of the project. The objectives and expected accomplishments of the Planning Unit were therefore extensively modified during the course of the project.

2.3.3.1. Actual Resources Provided by WDA.

The qualified person identified and appointed as head of the Planning Unit left WDA's employment in September 1985. He had worked with the full-time LBII consultant economist for only six months.

Two other employees were drafted from other departments of WDA in April 1985, one a teacher, the other a chemist. The former was moved to other duties within WDA by November 1985; the latter proved the only full-time assistant to the Planning Unit for the whole of the project extension period.

A qualified hydrogeologist joined the Unit in August of 1985 after his return from short-course training in the United States, and was appointed as head of the Unit to replace the individual who left. After a brief success, however, this person was increasingly required by WDA for hydrogeologic tasks, and by December 1985 was only available to the Planning Unit on a part-time, and largely unpredictable, basis.

2.3.3.2. Actual Resources Provided by LBII.

LBII provided a full-time economist/planner from March 1985 until the end of April 1986, a total of thirteen man-months. The Unit was also supported by an LBII water resource planner/computer expert for one month in June/July 1985.

The Consultants' anthropologist first visited the Unit for six weeks in July/August 1985 to set up systems for monitoring well sites and to train the staff. He returned with an assistant for the two months of February and March 1986, a total socioeconomic consultancy support of five and a half man-months.

An IBM micro-computer was made available to the Unit in April 1985. Suitable office facilities were prepared by the end of May, and the computer installed. Through an agreement with USAID, a second micro-computer was purchased to support the Private Sector Study undertaken by LBII. This second micro-computer was moved to the Planning Unit in August 1985. The configuration of the micro-computers, their performance, and a description of the software provided, is discussed below in Section 2.3.6.

2.3.3.3. Actual Resources Provided by the NWDC.

As of the date of writing, the NWDC had not yet been established. It follows, therefore, that none of the expected resources, nor the cooperation planned, have materialised.

2.3.4. Modification of Objectives.

The most significant factor which caused modification of the original objectives was the acute shortage of qualified staff available to the Planning Unit. The lack of field staff forced changes in the sociological evaluation component as early as July 1985. The full range of other objectives continued to be addressed until the end of 1985, by which time staff consisted of one person. It appeared highly unlikely that the situation would be improved before the end of the project, and extremely unlikely beyond project termination. The modified objectives are described below:

1. Planning. By 1984, the site selection and community participation process established during the first phase of the project had ceased to function. In reality, site selection, both for the project and for the WDA, became a purely technical activity, based on the analysis of hydrogeological data. For the CGDP, the area in which the well was to be located had been designated by the staff of BRADP or CRDP. For WDA, the area of the site is specified by the National Water Committee, or by the ministry or agency which is contracting with WDA to construct the well.

   In view of the shortage of staff, the objectives of the Planning Unit shifted away from routine implementation of the site selection process. The objective became to test and modify the original community participation element of this process as a "package", to be implemented by any project or agency with the necessary staff and facilities. This is more correctly categorised as socioeconomic monitoring and evaluation, described below.

The revised planning objective consisted of maintaining a database of all available social and technical information as a resource both for the various technical departments of WDA, and for program planners of other agencies. Planning the effective utilization of project and WDA resources, and drilling and maintenance programs, would remain a major objective of the Unit.

One aspect of the planning responsibility of the WDA Planning Unit was to monitor existing facilities. This involved monitoring the physical installation at well sites, both for repairs and maintenance purposes, and to gauge the acceptability to the community of the facilities provided.

2. Economic analysis. It was realised that the extent to which monitoring of benefits and impacts could be carried out would be severely limited by staff shortages. Furthermore, it was argued that because neither the project, nor WDA, were responsible for site selection, they should not be responsible, on a routine basis, for monitoring and evaluation of benefits and impacts. These evaluations, where the wells constructed are part of a broader program of rural development implemented by another agency, should be carried out as part of the overall monitoring and evaluation effort of those agencies. Under this category, the focus of the Planning Unit would therefore be upon cost analysis.

3. Socioeconomic monitoring and evaluation. The same rationale applies to the monitoring and evaluation of social impact as to economic impact, and the two are interdependent. It would not be realistic to expect the WDA Planning Unit to be able to monitor and evaluate the socioeconomic impact of a large number of the wells constructed throughout Somalia. Nor, in most cases, would it be appropriate. This function, then, was seen more clearly as a research function of WDA. The objective became to provide "packaged" systems for:

   a) the community participation process, and,
   b) socioeconomic monitoring and evaluation,

   which could be adopted by any other agency concerned to measure the impact of well installation. The WDA Planning Unit, so far as its facilities allowed, would be responsible for carrying out selective studies using, and further developing, these packages. The areas of concentration, as in the original objectives, were on the impact of well construction, on the feasibilty and benefits of supporting community water committees and of community participation in general.

4. Policy studies. Objectives for policy studies were not changed, but broadened, as described above, to become a major set of objectives for the Unit.

Because the NWDC did not become a reality, the field work planned as part of the effort to create a groundwater database was not possible. The objective of the Planning Unit then became to create a computerised database from the groundwater data available to the project and to WDA.

2.3.5. Actual Achievements.

Some of the revised objectives were achieved, others not at all, and still others to a limited degree. Computer systems and databases have been set up and are in use, the "packaged" systems have been created, new data has been collected and analysed, and a number of local staff have been trained. The actual achievements are described by category below:

1. Planning.

Attempts to establish planning schedules for all WDA resources did not prove possible. This required that WDA department managers and regional directors provide a regular flow of information to the Planning Unit on inventories, staffing, and budgets. Two questionnaires were circulated for this purpose, however, the information was not forthcoming. Without a detailed knowledge of the resources available and the maintenance commitments, it was not possible to devise drilling and maintenance programs.

All water quality data collected during the project has been set up as a computer database, together with most of the data on the boreholes drilled by the project.

A technical monitoring system was designed and, given the limited staff resources of the Planning Unit, successfully field tested at sites in the Bay Region and the Central Range. This is described in further detail in Section 3.0.

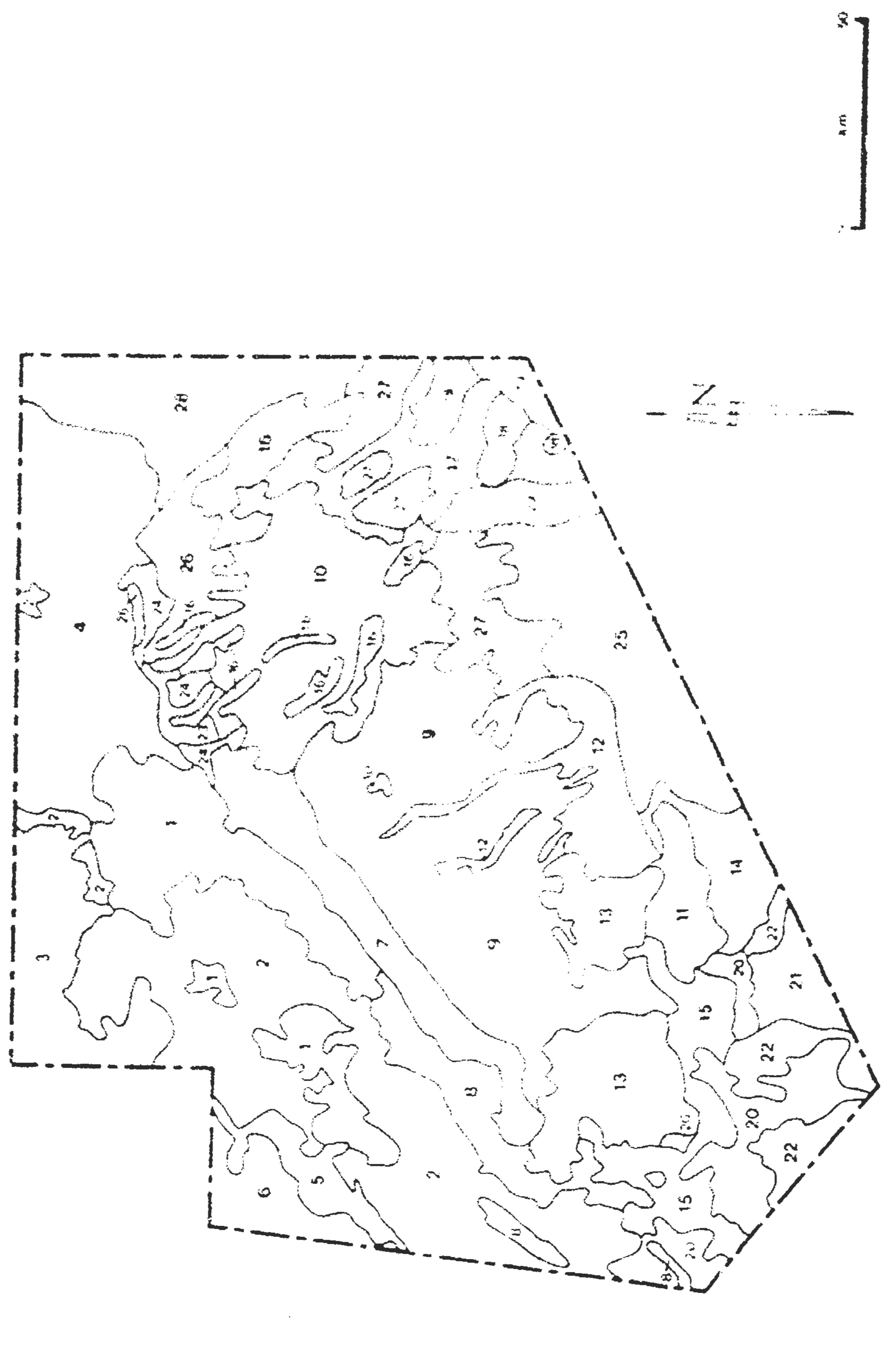
A computerized mapping system was developed whereby statistical data from surveys completed in Somalia can be used to determine population and water demand patterns for the Bay Region.

The system was first set up using data taken from a survey by Hunting Technical Services, 1982. This survey "mapped" the region into twenty nine "strata", each stratum representing an area which was found to be statistically homogeneous. The original map is reproduced in Figure 2.2.3. The data was then transcribed to a computer spreadsheet, with each entry representing the stratum code for a five kilometer square. The resulting "map" is shown in Figure 2.2.4. "Cells" containing zeroes are those which lie outside the Bay Region. The co-ordinates used are the UTM grid zone designations in kilometers: this system was found to be easier to work with than the conventional hours-minutes-seconds system. Statistics for the densities of houses and animals were then entered for all stratum codes. From these, the actual number of houses and animals for each 25 sq.km. grid can be shown in place of the stratum code.

When more extensive data became available from the Southern Rangelands Survey, 1985, the system was revised to a 16 sq.km. grid. This survey used 176 stratum codes, and produced statistics for both the wet and dry seasons. A new "map" was created from this data. The system was also redesigned to allow the co-ordinates of specific sites to be input, and for these to be "plotted" on a blank map. An example is shown in Figure 2.2.5.

Not only the populations of cattle can be shown, as in Figure 2.2.6., but using the human population figures computed from the density of houses, and the populations of all types of animals, various estimates of the demand for water throughout the region can be calculated. Figure 2.2.7. shows the pattern of demand using high estimates of consumption: each figure represents the total estimated demand per day within a 16 sq.km. area, in cubic meters, during the dry season. Using low estimates of per capita consumption, the demand throughout the region is shown in Figure 2.2.8.

A more specific profile of an area can be extracted as shown in Figure 2.2.9. The location of the village in this example, Tur Demerre, is shown in Figure 2.2.10 to be part of a narrow belt of stratum 44 stretching from the northeast. Strata 44 and 45 are to the northwest: stratum 61, and beyond it, 71, are to the



Source: Hunting Technical Services, 1982. P.74

Figure 2.2.3 AERIAL CENSUS STRATA, BAY REGION

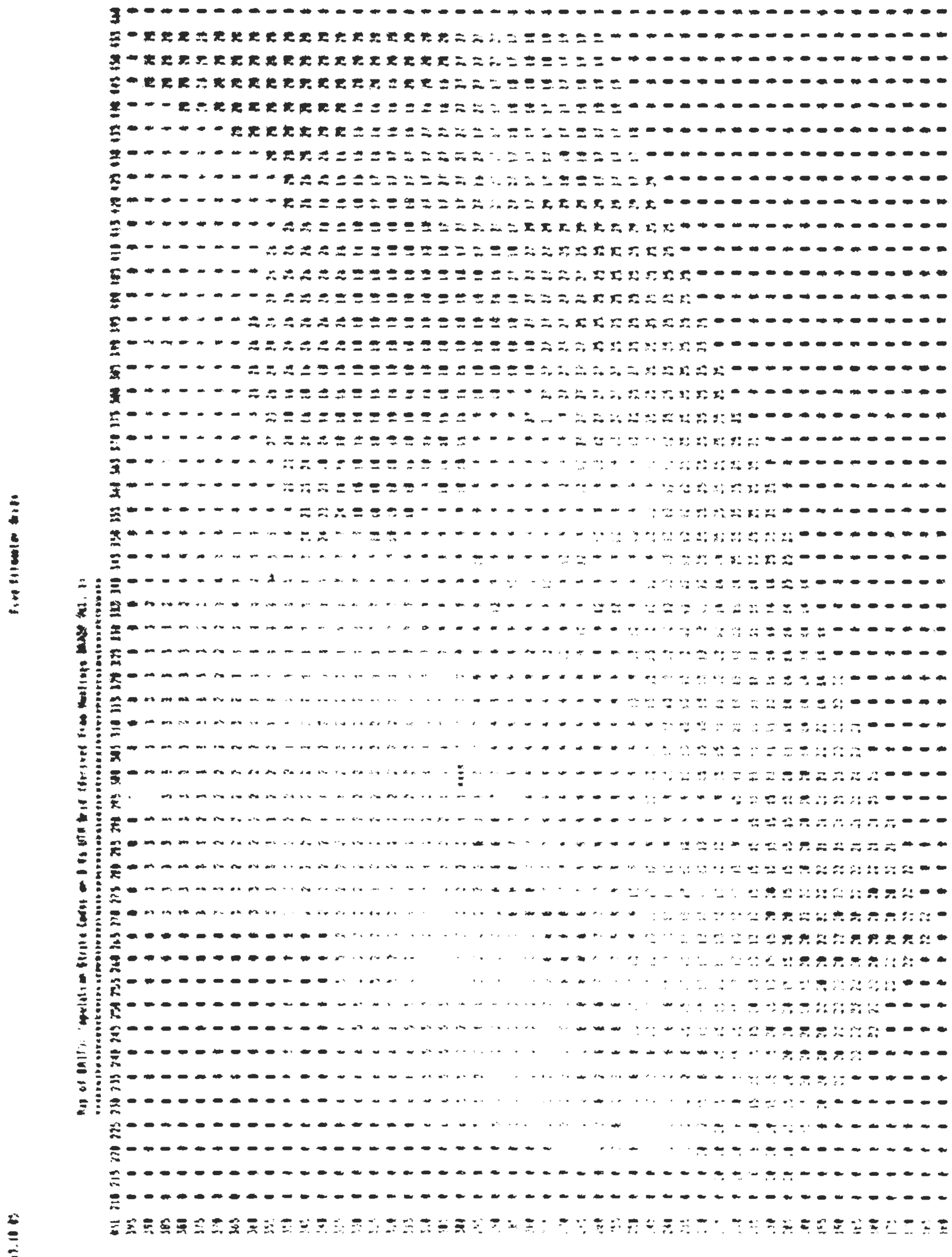


Figure 2.2.4 MAP OF STRATA CODES FOR THE BAY REGION

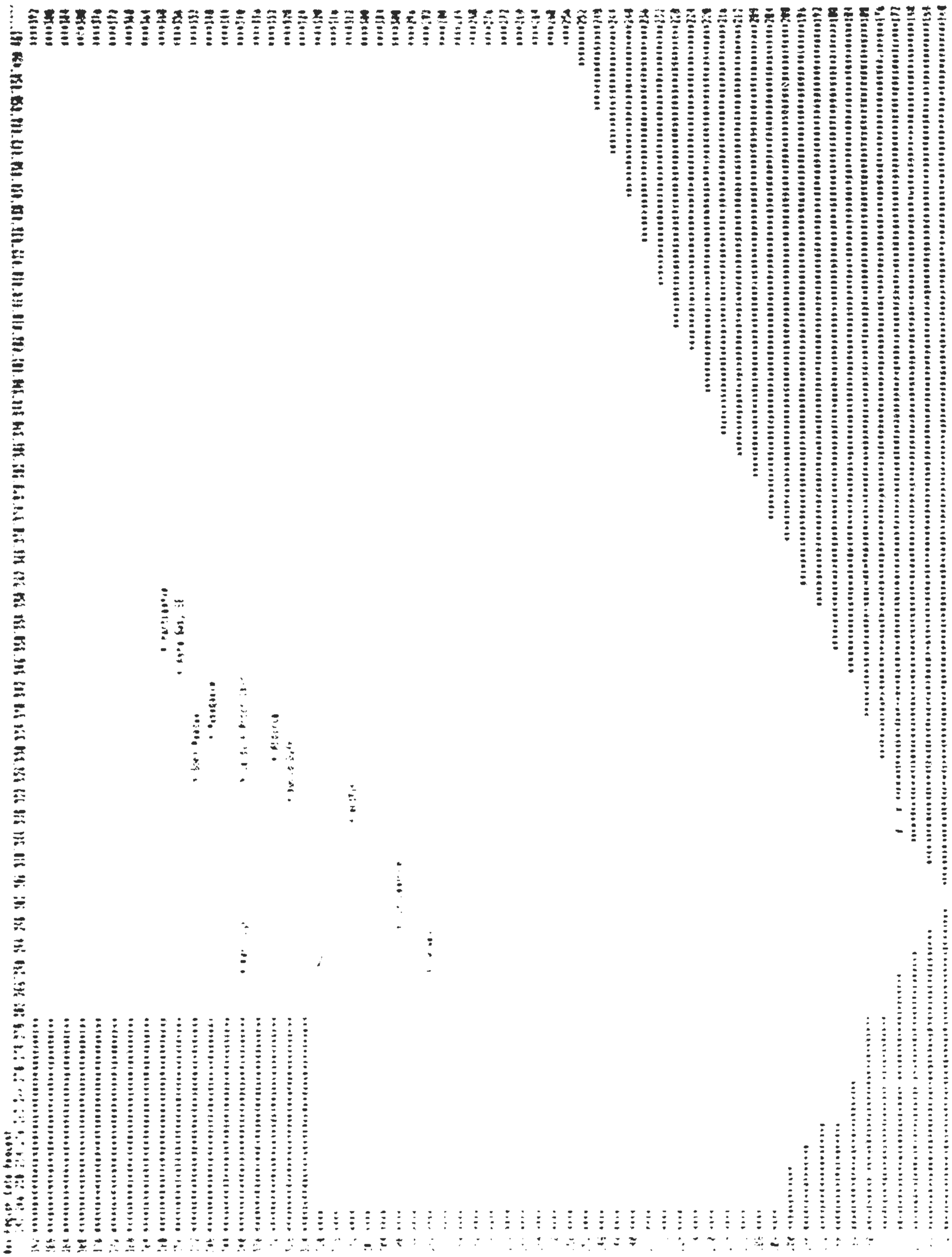


Figure 2.2.5 MAP OF PROPOSED DRILLING SITES, BAY REGION, OCTOBER 1985.

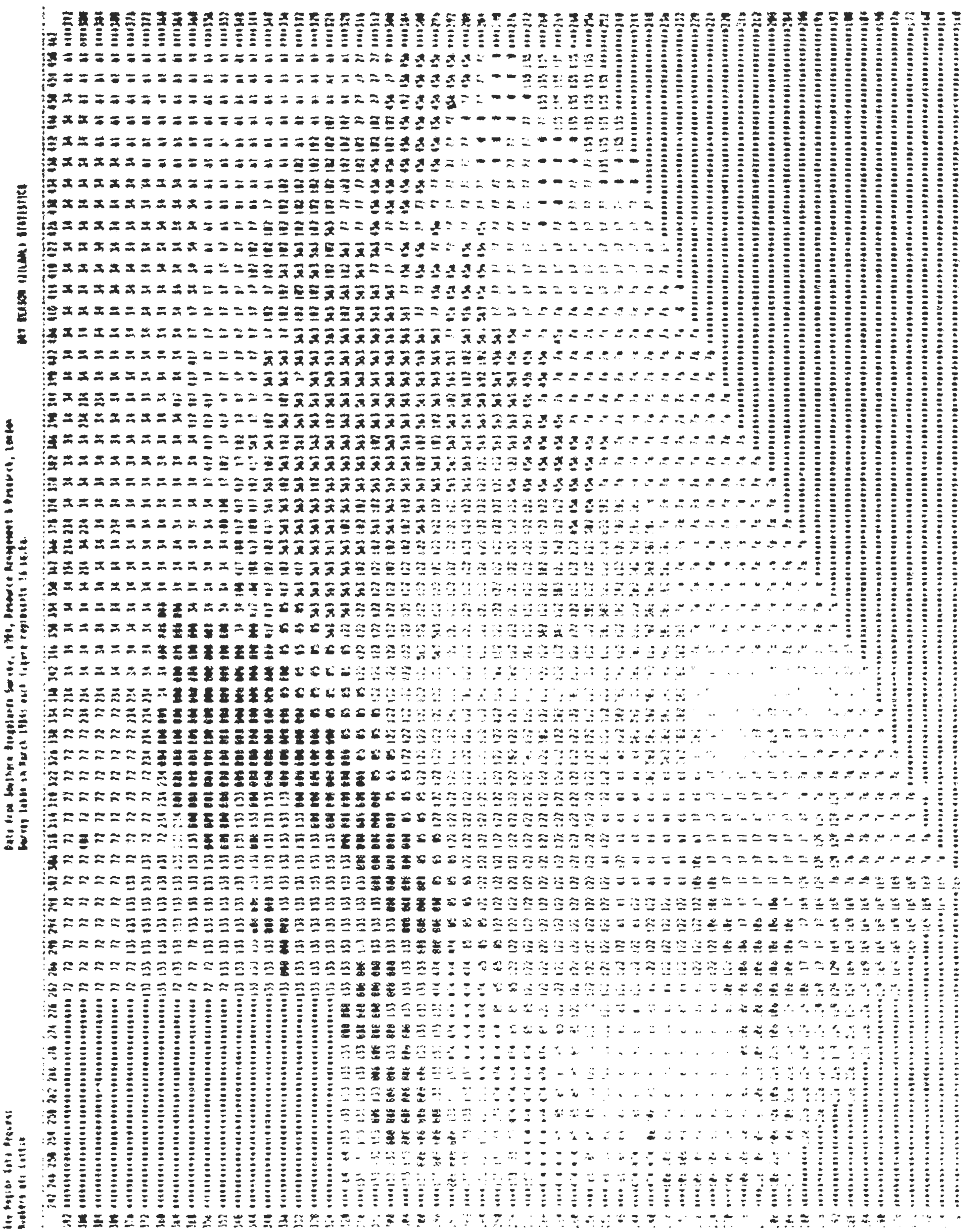


Figure 2.2.6 DISTRIBUTION OF CATTLE IN BAY REGION, DRY SEASON 1984.

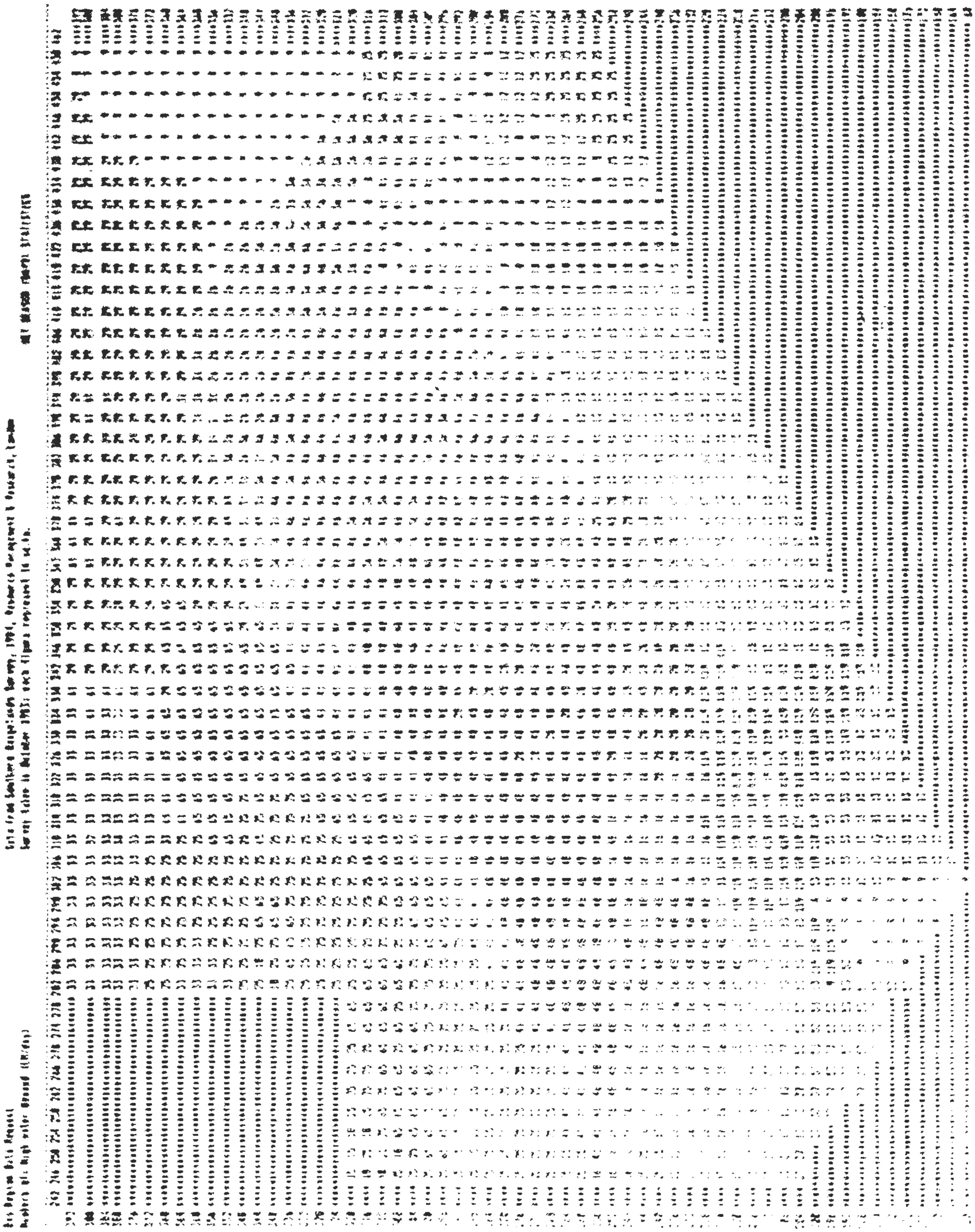


Figure 2.2.7 WATER DEMAND ESTIMATES (HIGH), BAY REGION, DRY SEASON.

Figure 2.2.8 WATER DEMAND ESTIMATES (LOW), BAY REGION, DRY SEASON.

Bay Region Data Request — Area: Tur Damerre
Location (Long. degs: 43 long. mins: 16 long. secs: 12; Lat. degs: 2 lat. mins: 43 lat. secs: 6) — UTM Location
Data from Southern Rangelands Survey, 1988, Resource Management & Research, Limited — DRY SEASON VARIANCE STATISTICS

UTM E: 296 N: 358 Stratum: 45	/km	#		/km	%
Cattle	8.3	133	Rob No	2.4	39
Sheep	2.8	47	Fir No	0.3	6
Goats	12.	152	Cropland	31	6
Camels	7.4	123			
All wall	6.6	1	People value	29	
Wet bals	0	0			
Dry bals	9.9	1	Water Ground		
Wet war	0	0	Low		9
Dry war	0.0	1	High		22

[illegible] (remaining UTM blocks, Stratum 44–45: Cattle, Sheep, Goats, Camels, All wall, Wet bals, Dry bals, Wet war, Dry war; Rob No, Fir No, Cropland, People value, Water Ground, Low, High — values [illegible])

Figure 2.2.9 AREA PROFILE, TUR DAMERRE, BAY REGION, DRY SEASON.

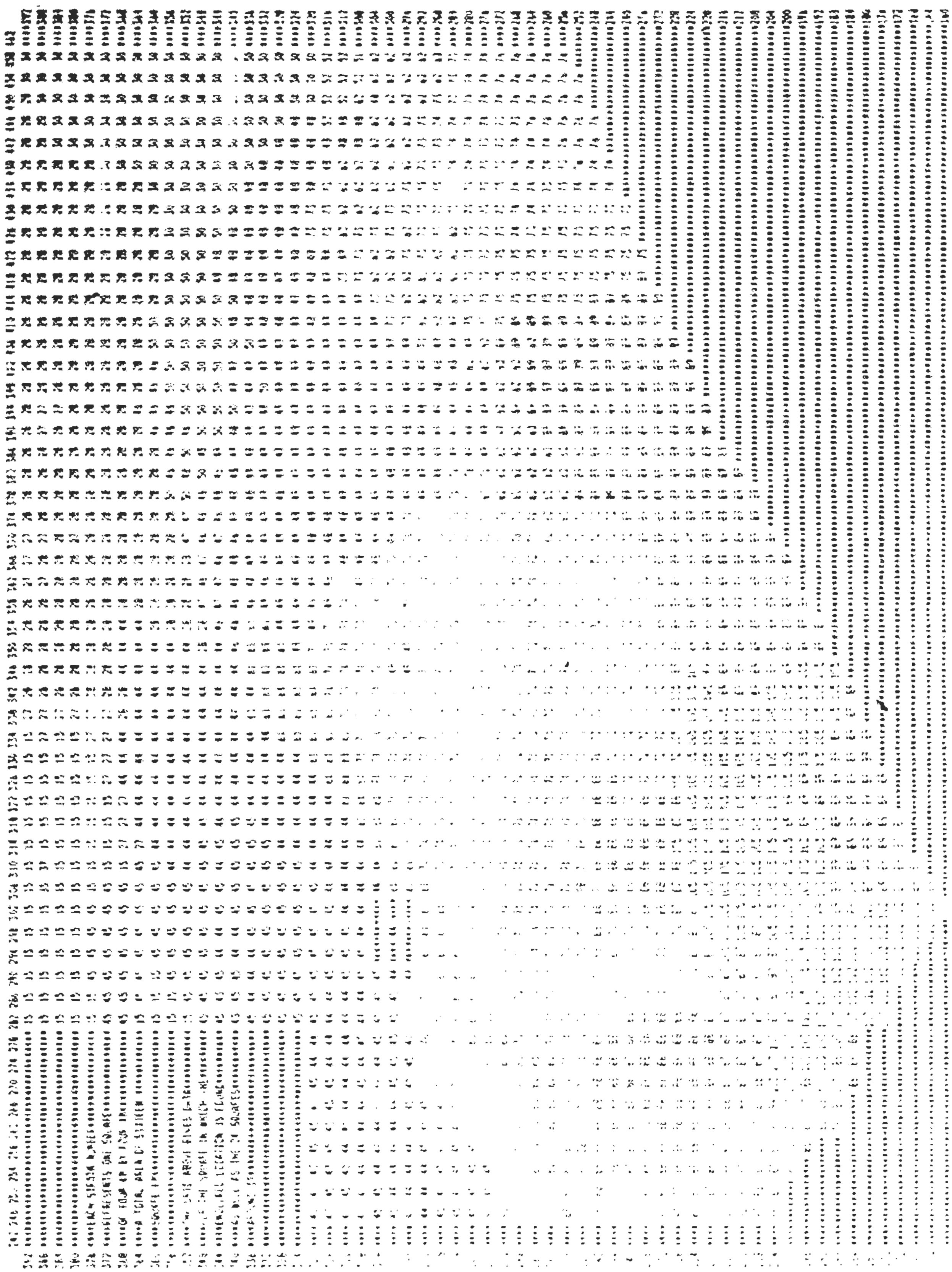


Figure 2.2.10 LOCATION OF PROFILE, TUR DAMERRE, BAY REGION.

southeast: an area of stratum 71 lies to the southwest. This data is indicative only, and it is not predicted that precisely 1,760 people will be found in the 16 sq.km. area around Tur Demerre. The data is helpful in giving a profile of the site, and the density of the populations surrounding it.

Finally, some indication of the movement of animals and people can be gained between the dry season and the wet season. The animal movement patterns are, in fact, quite complex in the region, but the total estimated increase in water demand during the dry season is shown in Figure 2.2.11. A broad evacuation takes place throughout the region: figures in brackets denote reduced demand. The area represented by "*" denotes reduced demand in excess of 99 cubic meters per day. Only the belt in the northwest sector, running from northeast to southwest, shows a significant increase in demand. This is the area in which most of the project wells have been constructed. Closer examination is obviously required to determine the availability of grazing areas throughout the region during the dry season, and to what extent access to these areas is restricted by the lack of water.

Because the resources of the Planning Unit were limited, only data for the Bay Region has been entered, but the system serves as a model for covering the whole of Somalia, for which statistical data is available. In fact, assistance has been given to U.N.I.C.E.F. staff, who, using this model, are setting up data for the Northeast of Somalia, and possibly for the whole country.

2. Economic analysis.

A set of computerized costing models has been developed to determine the cost of well construction, operation, and maintenance. These models are presented in, and form the basis of, Section 4.0 of this volume of the report. The models incorporate over three hundred variables, and show the detailed cost of a well construction program, the foreign exchange and local currency components of total cost, the manpower, and the vehicle and equipment budgets for the proposed program. The model can be manipulated to reflect the costs and resource requirements for a program anywhere in Somalia.

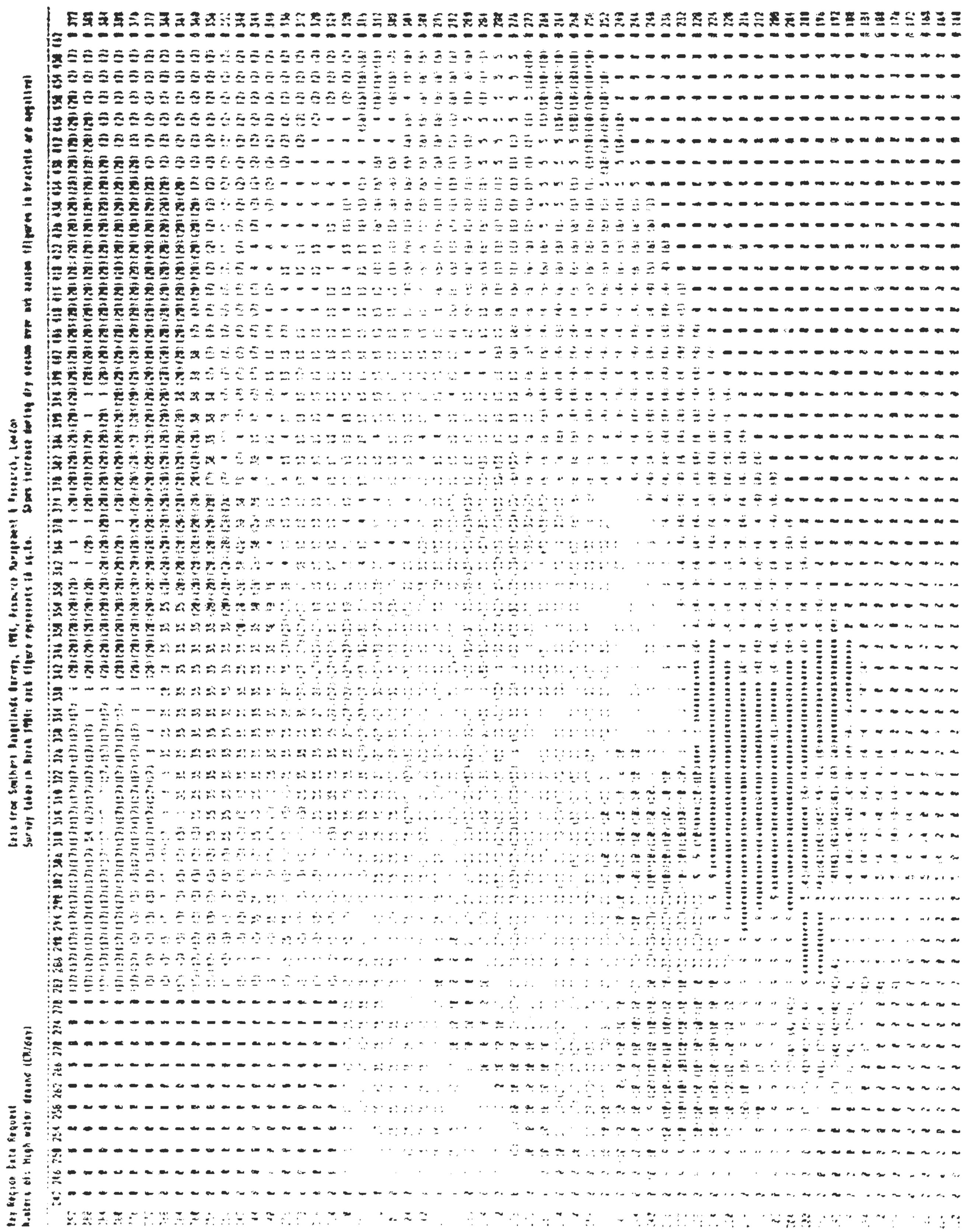


Figure 2.2 11 HIGH ESTIMATES OF INCREASED DEMAND IN DRY SEASON OVER WET SEASON, BAY REGION.

Similar costing models were to have been set up for the other activities of WDA, namely the building of surface water catchment facilities, and the installation of urban water supply systems. Unfortunately, the limited manpower available to the Planning Unit, and the lack of good cost data, prevented this from being completed. This should be a priority of WDA for the future, so that the relative costs of alternative methods of providing water can be compared. The comprehensive model designed for well construction should serve as a blueprint for this exercise.

For the same reasons that prevented resource planning schedules being established throughout the regions, it was not possible to study in any depth the revenue collection procedures of WDA. A Revenue Accounting Manual (Coopers and Lybrand, 1984), is already in existence which has not been properly implemented. Comments on the actual and potential pricing structure are derived from the economic analysis, and are presented in Section 4.0 of this volume of the report. Observations from the Bay Region on the practice of fee collection within the community around well sites are discussed in Section 3.0.

3. Socioeconomic monitoring and evaluation.

   A socioeconomic impact monitoring and evaluation system was designed and also field tested in the Bay Region. This is described in Section 3.0 of this volume of the report, where the limited data available from the surveys carried out is also discussed.

4. Policy studies.

   The policy study objectives were very much a concern in designing the monitoring and evaluation systems which were tested and are presented in this report. From the limited data collected, policy options are discussed as follows:

   1) water pricing economics in Section 4.3,
   2) the potential for community participation in operation and maintenance in Section 2.5,
   3) control and methods of revenue collection, in Section 3.8.

The Planning Unit has entered all borehole data from the 1973 UNDP/FAO study into a computerised database. Additionally, this initial well inventory includes all data from the wells completed by the CGDP, and available data from other projects in Somalia. Much of this data is now out of date, but because the NWDC has not yet materialised, and because cooperation from the WDA regional offices was not forthcoming, systematic verification has not been possible. The database has been prepared for eventual handover to the NWDC.

The above brief descriptions represent the accomplishments of the Planning Unit with respect to the original objectives, as modified in the light of the resources actually available. During the course of the final year of the project extension period, other tasks were undertaken by the Unit. These included the establishment of a stores inventory system, preparation of a budgetary procedures manual, technical assistance to other sections of the project, and training to local LBII staff.

Stores Inventory System. In preparation for eventual handover to WDA, the complete project stores inventory was set up as a computer database. A comprehensive suite of programs allows this database to be regularly updated with issues and new deliveries. In retrospect, it is now clear that such a system would have been extremely useful to the project from its inception, to better keep track of what was already on order, and facilitate tighter inventory control and planning. The packaged system was written using dBase III™. The system is transferrable to other ministries and agencies of the government which are equipped with computer facilities.

A very simple vehicle and equipment inventory system has also been set up. This will facilitate final handover to WDA, and the planning of future maintenance and replacement schedules.

Budgetary Procedures Manual. A manual of recommended budgetary procedures has been produced for WDA. Rather than a specification of the detailed procedures necessary for the handling of cash, this manual sets out the formats and timetables necessary to prepare estimates, and to account for expenditures, throughout the agency. WDA finances are derived from a number of sources, and programs and projects must be accounted for in forms which cut across the administrative structures. This manual presents a format of accounting and a system of reporting which will permit WDA to deal with this complexity.

Other Technical Systems. In response to the needs of the hydrogeology section of the project, other computerised systems have been developed that include the analysis of data on well testing and water quality.

Well testing. A spreadsheet has been set up to allow the input of aquifer test data. From this, transmissivity is automatically calculated. An example of this is shown in Figure 2.2.12.

Water quality. From the database of water quality data, Stiff Diagrams can be produced automatically by the computer. An example is shown in Figure 2.2.13.

Additional Training Provided. Informal training has been provided for a number of direct-hire LBII staff of the project. Three staff have been trained in the use of the micro-computer, specifically in the use of the word-processing packages. Two of these staff have been successfully trained in basic spreadsheet and database operation. Whether these staff will be employed by WDA after the completion of the CGDP is not yet clear: in broad terms, however, it can be claimed that their acquired skills will be of value to Somalia.

2.3.6. Micro-computer Installation.

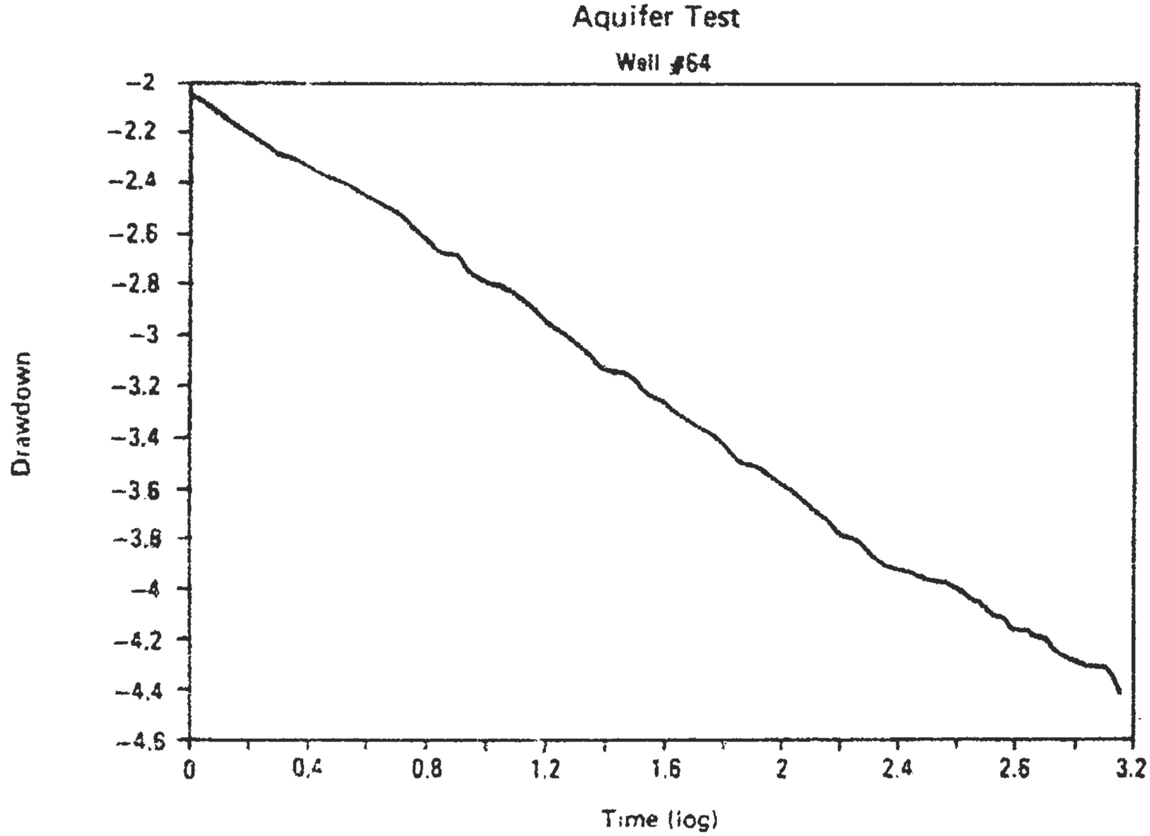
The Planning Unit was supplied with the following micro-computer equipment:

1 COMPAQ portable computer with 640k bytes of memory, equipped with two diskette drives, and one Epson FX-100+ dot matrix printer. The system is entirely IBM-compatible. This system was available from May 1985.

1 IBM PC-XT with 640k bytes of memory, equipped with one diskette drive and one 10 megabyte fixed disk, and a second Epson FX-100+ printer. This system was available from August 1985.

The equipment generally performed well, except for some initial problems with the system-board of the IBM PC-XT. These were eventually resolved by replacement of the board under the guarantee, and the problems did not recur. The Unit was supplied with a spare system- board, and a spare disk-drive unit for use in either of the two machines. These were not used as of the end of the project period.

The main problems experienced were in the electrical supply system, and in maintaining a dust free, temperature controlled, environment. An air-conditioned office proved to be absolutely necessary, and the room which housed the computer equipment was sealed as far as possible against dust. The very dusty environment of Mogadishu, and the relatively high winds prevailing for much of the year, meant that regular cleaning was necessary.



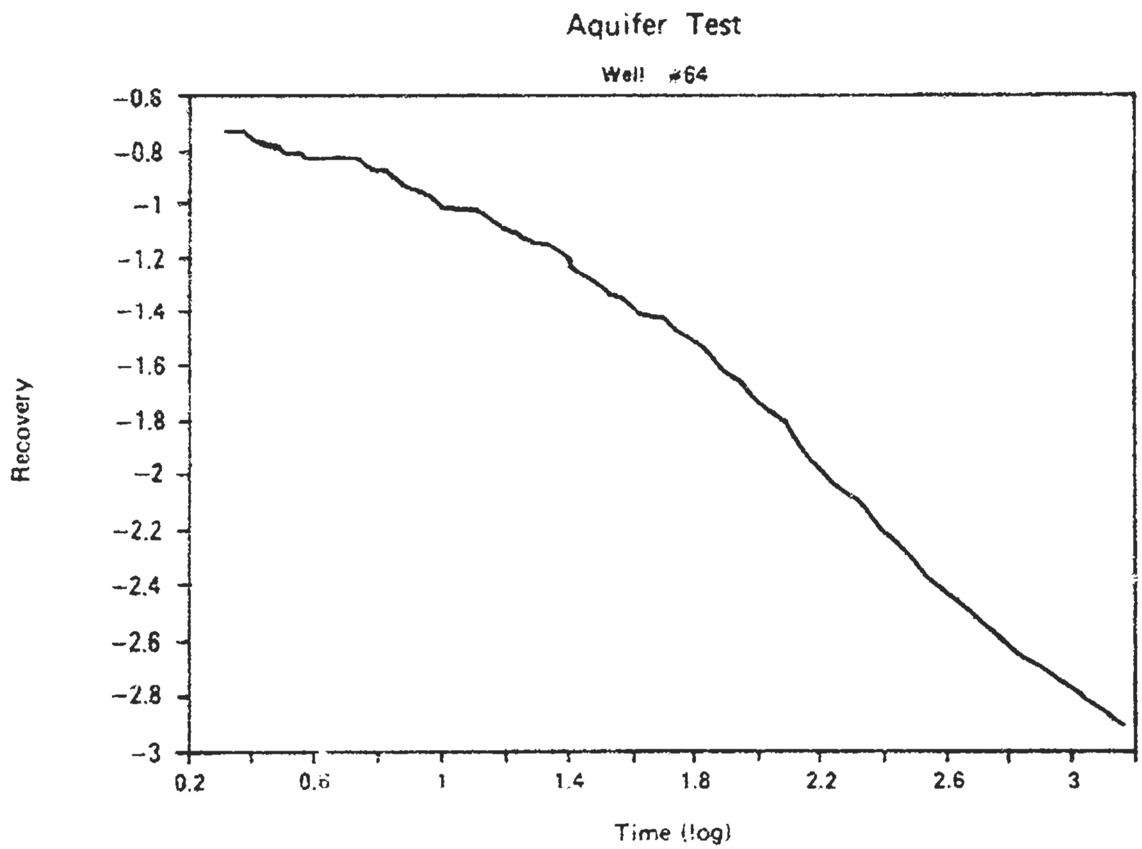
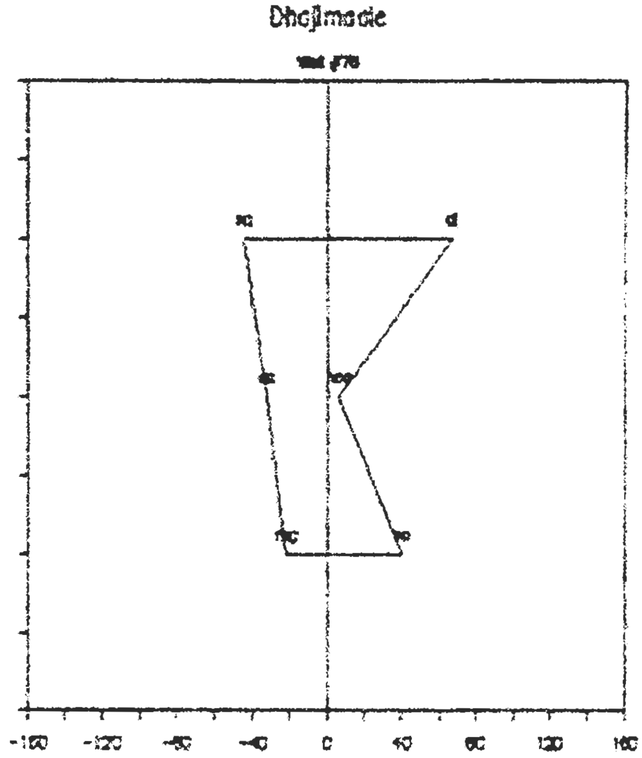


Figure 2.2.12 EXAMPLE OF WELL TESTING ANALYSIS.



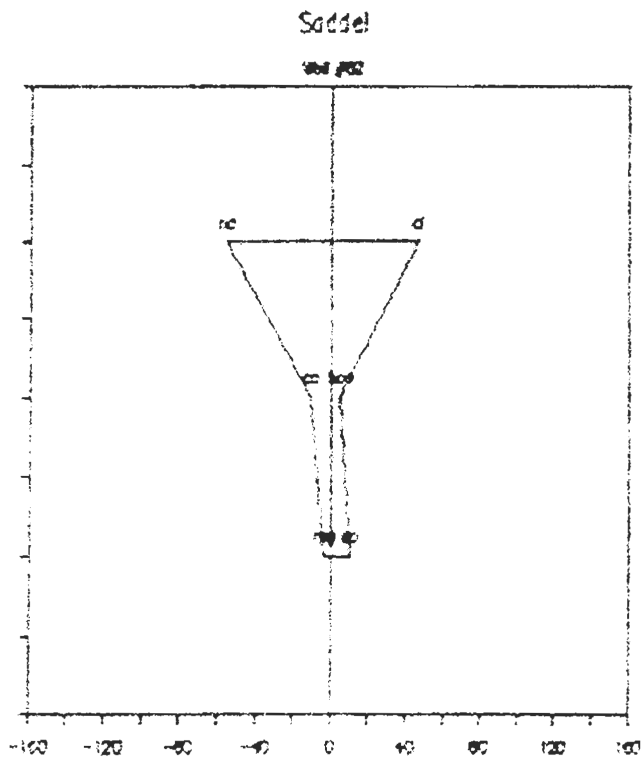


Figure 2.2.13 EXAMPLE OF COMPUTERIZED STIFF DIAGRAM.

The electrical supply system was supported by a MAYDAY 60+3H™ Uninterruptable Power Supply (UPS) providing 300va of output. This provided a back-up in the case of power failure of up to 30 minutes. The mains supply was controlled by a 2kva automatic voltage regulator, a critical requirement. Two voltage surge trip-switches were also inserted into the system for added protection.

The main power supply proved unreliable for much of the year, and frequently fell below the required voltage level of 220v. This proved less of a problem for the computer systems (because of the UPS) than in keeping the air conditioning system operating. These problems were resolved by installing a diesel generator for emergency use.

The software provided consisted of the following:

SSI "Wordperfect™": this proved useful both as a comprehensive word processing package, and as an introductory training package for staff.

Lotus "Symphony™": the spreadsheet, word processing, database, and graphics facilities were all used extensively by the Unit.

Ashton-Tate "dBase III™": this proved useful in setting up large databases, specifically the project stores system and the well inventory. Had more data been collected, more extensive use would have been made of this package.

The Planning Unit was adequately equipped to deal with most of its tasks using only the above software packages. In addition, the Unit was supplied with "IBM Professional Fortran™", and with "SPSS-PC™", neither of which packages were extensively used. Breakthrough Software's "Timeline™" project planning software was also used, and promised considerable potential had it been used from the beginning of the project, or had greater cooperation been forthcoming from the regional offices of WDA.

2.3.7. Recommendations for the Future of the Planning Unit

The WDA has a critical need for a Planning Unit with the capacity to monitor operations and evaluate program results. In retrospect, this need should have been addressed in the original project paper. The difficulties encountered during the past twelve months indicate that it will take several years of training and technical assistance to establish and operationalize a viable Planning Unit. The section below outlines a list of objectives, activities and resources required to accomplish this goal. The proposal is the result of a cooperative effort among the LBII technical assistance team and WDA staff who have been involved in the development of the Planning Unit.

A redefinition of the present and possible future roles of the WDA is discussed in Section 6.0. This proposal relates to that discussion. The WDA needs to monitor operations and evaluate program results regardless of the extent to which functions within the water industry are transferred to the private sector.

2.3.7.1. The Institutional Context and Assumptions

The Ministry of Mineral and Water Resources will soon establish a National Water Data Resource Center (NWDC) which will have data collection and planning functions. The activities of the NWDC may lead to modifications in the role of the WDA Planning Unit and the relationship between them awaits clarification. The proposal for the Planning Unit assumes that it will continue to collect borehole data, monitor the operation of WDA wells and evaluate their impact on rural populations. It also assumes that WDA will promote and support community participation in well development and management.

The program assumes that the WDA will recruit and/or reassign staff with adequate qualifications to the Planning Unit. Insofar as possible, these individuals should be identified prior to signing a project agreement. The proposal takes into account the fact that some of the individuals may resign or be transferred to other WDA departments but it is essential that most of those who receive training remain with the Planning Unit for several years.

All training is scheduled to take place in-country, with extensive use of long-term and short-term consultant trainers. In many cases, the objective is to develop the ability of Somali staff to train others.

2.3.7.2. Objectives and Activities.

The recommended principal objectives and activities of the Planning Unit are generally consistent with those stated in the 1985-1986 Project Extension Work Plan. They are:

(1) WDA Resource Management. This involves monitoring WDA activities and planning the most efficient use of WDA resources, including manpower, vehicles, and equipment. This requires the establishment of management information systems in all WDA operational units. It also involves the co-ordination of Planning Unit data collection and reporting functions with those of other agencies and

programs with water development components.

(2) Economic Analyses of WDA Activities. The analysis of water development including the cost of: drilling; construction, and; the operation and maintenance of water distribution systems. The objectives are to provide data for more efficient resource planning and to analyze the relative efficiency of pumping operations at different well sites.

(3) Technical Monitoring and Evaluation. The collection and analysis of data on: the design of water supply structures; pumping operations; water use; the management of community water systems and; WDA support services.

(4) Socioeconomic Monitoring and Evaluation. The collection of community baseline data and periodic monitoring and evaluation of changes related to water development. Areas of study include: population, physical infrastructure, crop and livestock production and services.

(5) Community Participation. The organization and support of local institutions to participate in the development and management of WDA wells.

(6) Policy Studies. The Planning Unit should be in a position to advise the Government on all aspects of rural water development in Somalia. Information from the evaluations will be analyzed in relation to policy issues such as: the role of community groups in water development, and the ownership and management of wells; pricing and revenue collection; fuel supply and maintenance and repair services.

(7) Water Resource Data. In co-operation with the NWDC, the Planning Unit will have on-going data collection responsibilities and will contribute to the national water resource database.

(8) Training. The Planning Unit will also be responsible for training members of WDA departments and the extension and evaluation staff of other agencies in: community participation strategies and methods to monitor and evaluate water development programs.

2.3.7.3. Staff Requirements

In order to accomplish the objectives and carry out the functions listed above, the Planning Unit will need a five person professional staff, one or two field staff in each region and administrative personnel. In addition, senior WDA regional officials should be trained to function as regional planning officers although they will continue to have other technical and/or administrative duties. Because the transfer of personnel, resignations and leaves for overseas training, are frequent, we recommend that at least two individuals be trained for each position. This will assure that the Planning Unit is adequately staffed at the end of the three year period. Below is a list of positions needed for the Planning Unit. The number to the left indicates the number of positions for the category being described; the number in parentheses indicates the number of people to be trained for the position.

1 (2) Head of the Planning Unit: Water resource planner. Civil engineer or hydrogeologist preferred, but an economist or information system specialist with extensive experience in water development is acceptable.

1 (2) Economist: knowledge of cost accounting, micro- and macro-economic theory and project appraisal techniques.

1 (2) Social Scientist: social anthropologist, preferably with experience in applied anthropology, community development and/or monitoring and evaluation.

1 (2) Micro-computer expert/statistician: knowledge of database management required.

1 (2) Training Specialist: formal training and curriculum development skills plus experience in the organization and implementation of training programs.

6-10 (12-15) Field staff: graduate of a technical school or university; specific area of training is less important than general intelligence and willingness to spend long periods of time in villages.

2 (3-4) Secretaries/data entry officers

2-4 Drivers

It is assumed that the staff will be recruited locally, or found within the existing WDA workforce. It is further assumed that none of the staff except drivers will have the full range of skills needed when recruited, but that they will have the educational background, motivation and aptitude to complete the training programs.

2.3.7.4. Training Requirements

All training will be carried out in Somalia by a combination of long-term counterpart instruction, and short-term intensive training courses delivered by WDA and expatriate professional staff. The short-term intensive courses will be in the following disciplines: water resource planning, economics, social sciences, training methods, and computer operations. Training programs will be scheduled throughout the three year period so that WDA personnel will have sufficient time to apply what they learn before moving on to more complex analytical and methodological problems. Senior staff in each position will also participate in the organization and implementation of training programs for field and regional staff of WDA and other agencies.

Implementation of the technical assistance-training program will require the following expatriate participation.

36 months Rural Development Planning Specialist, with knowledge of water resource development, full time counterpart, three years.

18 months Economist, costing and project appraisal expert, one year full time, three months in each of the following two years.

18 months Social anthropologist, one year full time plus three months in each of the following two years.

12 months Computer Specialist, six months in year one and three months in each of the following years.

36 months Trainer, full time for three years.

Total 120 person-months.

2.3.7.5. Other Requirements.

It is assumed that the computer hardware and software currently installed at the Planning Unit will remain there. This includes the peripheral equipment such as the transformers, uninterruptible power supply, and diesel generator presently in place. Two complete additional systems are recommended along with software programs and a recurrent budget for consumable items such as stationery, printer ribbons, and replacement diskettes. One photocopying machine with reduction and enlargement features is also needed.

Office space is required to accommodate between 10 and 15 people. A minimum of two rooms must be air conditioned and dust proof. One room should be large enough to serve as a classroom for at least ten people. Three offices currently used by the CGDP could be assigned to the Planning Unit and would be adequate to meet the space needs for the first few years.

Six four wheel drive vehicles will be needed. Two or three should be pick-ups with removeable camping units and will be assigned to regional offices. Camping equipment will be needed for the field staff.

2.3.7.6. Work Plan

A three year work plan is set out below. Emphasis in the first year will be on direct training for the Planning Unit staff, and upon establishing training courses to be provided by the Unit for other staff. Training courses will be designed for the following staff:

Regional Planning Officers. It is proposed that the eventual requirements will include the appointment of a Regional Planning Officer to each of the WDA regional headquarters. These are not to be new staff positions, however. Existing full time WDA hydrogeologists and engineers who have major technical and/or administrative responsibilities at regional offices will assume additional regional water development planning responsibilities. They will be responsible for co-ordinating the planning effort in the region, using visiting Planning Unit field staff, existing WDA region headquarters staff, and staff of other ministries or agencies operating in the region, to carry out many of the required monitoring and evaluation tasks. The appointment and training of Regional Planning Officers throughout the country would follow the plan set out below:

Year	1	2	3	4	5
Regional Planning Officers appointed and trained	2	4	4	4	4

Other WDA staff. The planning function will be a co-operative effort within the WDA. To this end, other staff within WDA, both at headquarters and at regional levels, will be required to participate in data collection for monitoring and evaluation.

Extension and monitoring and evaluation staff of other Ministries and agencies. These will include, the staff of the NMEF Unit of the Ministry of National Planning, BRADP and CRDP.

The objectives for each of the first three years are:

Year 1: Recruitment and intensive training of senior staff of the Planning Unit - planner, economists, sociologists, trainers.

Recruitment and training of computer technicians/statisticians.

Recruitment and training of Planning Unit field staff.

Training program established for Regional Planning Officers

Implementation of monitoring and evaluation program (Section 3.0) in a representative sample of villages in two regions. This should be integrated into the staff training courses.

Training program established for other WDA staff, including pump operators

Training program established for field staff of other Ministries/agencies

Two Regional Planning Officers selected. Initial training courses delivered.

Baseline surveys carried out in a sample of villages in two regions. Additional baseline data collected from secondary sources.

Detailed work plan for year two established.

Year 2: Intensive training for Planning Unit professional staff completed; training continues on a short-course basis.

Monitoring and evaluation systems revised and implemented.

Community participation program (CAPP, Section 2.5) revised and implemented.

Four Regional Planning Officers appointed and trained.

Training programs delivered to other WDA staff and to field staff of other Ministries/agencies.

Baseline surveys extended to key villages in four additional regions.

Detailed work plan for year three established.

Year 3: Refinement of all training programs.

Extension of selection and training of Regional Planning Officers, training of other staff, installation of monitoring and evaluation systems, and collection of baseline data, to four additional regions.

Detailed work plans for years four and five established.

2.3.7.7. Results After Five Years

At the end of the five-year period, a fully staffed Planning Unit will be in existence, supported by a network of Regional Planning Officers, capable of fulfilling on a continuing basis all of the objectives set out at Section 2.3.7.2. In addition, other WDA staff and staff of other Ministries/agencies will have been trained to participate in these efforts, and also to undertake similar work for their own Ministries/agencies. Furthermore, the Planning Unit will posess the proven skills to conduct ongoing courses for other staff of the GDRS.

2.4 Well Site Maintenance

All too often the maintenance of a well site is totally ignored or only given token treatment. It is not until the well no longer produces, or major leaks occur in the distribution system, that anyone takes notice. Oil seeping into a well, pollution from animals, and corrosion and deterioration of distribution systems are unfortunately common occurences.

Well site maintenance consists of two distinct categories, well maintenance, and distribution system maintenance. Not all wells completed during the course of the project have distribution systems. Those wells completed with hand pumps, with few exceptions in the form of 2" black PVC pipe, do not have distribution systems. Manuals were prepared English and in Somali to describe specific requirements.

2.4.1 Well Maintenance

Regardless of how completed, handpump or diesel pump, maintenance of the well itself is of primary importance. As mentioned above, manuals have been prepared to describe in detail the specific requirements for each system. The reason for inclusion of any discussion here is to emphasize the importance of these activities. On a routine basis, well maintenance should at minimum consist of measuring the static water level and of collecting samples on a monthly basis. This data will serve as an early warning of potential problems. In addition periodic checks of yield should be made. If the discharge capacity is dropping off, it is an indication that either the well is becoming incrusted or the pump is malfunctioning. Procedures are given in the manuals for more complete evaluation of problems. However, without maintenance of records proper assessment cannot be made.

2.4.2 Distribution System Maintenance

The distribution systems are those associated with wells equipped with diesel pumps, and include all of the civil works. In particular this refers to the storage tank, watering troughs, domestic distribution facility, and all of the related piping.

Very few of the storage tanks currently in place are equipped with covers. This allows algae to grow and blowing sand to accumulate in the tank. Both cause plugging in the outlet pipe. The obvious solution is constructing covers for these tanks, however, until such time as this work is completed regular cleaning will be required.

The animal water troughs, which cannot be covered, experience similar problems. These are more easily cleaned, but need to be maintained. An additional problem associated with the animal troughs is the erosion and undercutting of the concrete apron around the trough. Crushed rock emplaced around the trough would help to solve this problem; however, crushed rock is not always readily available. The caretaker of the well should be responsible for getting assistance to help keep this area properly graded.

Leaky taps, plugged drains, stagnant puddled water, and broken concrete are typical conditions associated with neglected maintenance of domestic water points. These problems need to be dealt with at the village level, and as quickly as is feasible. Lack of attention ultimately results in total failure of the system.

Because of the high total dissolved solids in much of the groundwaters of Somalia, encrusting and/or corrosive conditions exists. This causes plugging or leaking of valves and piping associated with the distribution system. If monitored on a regular basis, replacements can be made that will avoid a total shutdown of the water system. Spares will need to be stocked and personnel within the village trained to deal with the problem.

2.5. Community Participation and Water Committees

The original project paper (1979) discussed the need for studies to identify local leadership patterns and for actions to "encourage" local participation in different phases of the project. It did not, however, propose a significant role for villagers nor did it allocate funds to develop and support local water management institutions. The low level of concern for the sociological dimension of the project is reflected in the technical assistance schedule in which only 1.2 of the 62.5 person years (1.8 %) was allocated to social issues, primarily data collection and analysis.

The CGDP Inception Report (1981) redesigned the sociological component and included among its objectives the development of a process to involve villagers in planning and the supervision of well operations.It also called for a study to establish socioeconomic criteria for the selection of drilling sites. The first LBII sociological consultant report (Roark 1982) addressed both of these issues and outlines a strategy --the Tuulo Village Assessment and Participation Process (TVAPP)-- to involve local residents in data collection, construction, well financing and management. The TVAPP was implemented in twelve villages with the help of CGDP technical staff and an extension agent employed by the Bay Region Agricultural Development Project (BRADP). The approach and initial results are documented in the LBII Groundwater Development Exploratory Report (January 1983).

Assessments of the TVAPP component conducted by an LBII anthropologist (Schwarz 1983) and a USAID evaluation team (Gunn 1983) concluded that the strategy was basically sound and had been favorably received by villagers. They suggested modifications and strongly recommended that the TVAPP be given increased support. Two LBII reports (Schwarz 1983; Farrah, Roark and Sartana 1983) outlined in detail the activities and resources needed to sustain and expand community participation. These proposals were not, however, implemented due to the lack of support from WDA, USAID and the Wyoming Bay Region socio-economic research team. None of these agencies followed through on their committments to provide trained personnel to conduct village meetings and monitor field activities. The result was that from mid-1983 through 1984 TVAPP activities were limited to occasional village meetings conducted by hydrologists, drillers and engineers who were familiar with the approach and sympathetic with its objectives.

The CGDP Supplement Project Paper (1984) gave considerable support to the local participation program and its personnel requirements. The following statements were included in the Major Conditions Precedent and Covenants section:

> The Grantee shall agree to...
>
> > Pursue solutions to the problems of hiring and retaining qualified individuals in key positions in the Water

Development Agency.

Promote and facilitate community participation in rural water system design, operation and maintanence, to increase the longevity and efficiency of these systems (USAID 1984.p.vi).

The document draws on the recommendations of previous consultant reports and outlines procedures to promote village involvement (Ibid: Annex J, p.1 of 7). Responsibility for these activities was assigned to the new Planning Unit of WDA which was to hire a full time Somali sociologist and four sociological field assistants (Ibid: Annex G). The work program for the Planning Unit included:

- The implementation of community meetings and training for villagers to enable them to sustain local participation in data collection, construction and maintenance.

- Support to village water committees to help them promote and organize community participation in the operation and maintenance of the water supply system.

- The establishment of linkages between villagers and social service agencies in areas such as health, education and economic development.

This program was carried out on a very reduced scale by Planning Unit staff and short term LBII social scientists. They met with village water committees during monitoring visits but were not able to adequately implement the three community participation program components. The reason for this failure was that the covenants agreed to by the GOS were not respected: no Somali sociologist was employed and field staff were not hired. By November 1985, only one individual with no background in social science or community development, was available for field activities.

Effective implementation of community participation activities was also hampered by long delays in the arrival of equipment, pumps, pipes and other construction materials. Villagers whose expectations had been raised and who had made substantial contributions of labor, animals and cash were often forced to wait for more than a year to have a pump installed. Similar delays occurred in the construction of water distribution systems and some villages still lack completed storage tanks and troughs. These delays and the lack of WDA support for community participation in well management have had a negative effect on local institutional development.

In spite of the failure to strengthen and expand community participation in 1985 and 1986, village committees established during the early years of the project continued to function and play an active role in the management and maintenance of water supply systems constructed by the CGDP. Limited monitoring and evaluation of results led to the modification of the preliminary TVAPP approach and the design for the Community Assessment and Participation Program (CAPP).

2.5.1. The Community Assessment and Participation Program (CAPP)

This section briefly describes the community participation strategy developed by LBII and implemented during 1982, 1983 and, on a very limited scale, from 1984 through 1986. Additional information on rationale, content and preliminary results can be found in other LBII reports that include: Roark (1982), LBII (1983 Exploratory Report, section 6.0), Schwarz (1983), USAID CGDP Supplement PP (1984: Annex J), the LBII Final Report (1985: part 5). The Roark (1982) and LBII (1983) documents fully describe the process of community participation in site selection, village self-assessments and the organization of project water committees. The Schwarz (1983) document includes an integrated program of community participation, construction, monitoring and evaluation which form the basis of the CAPP. It describes in detail, the stages and activities summarized below.

(1) Purpose and Rationale

The goal of the CAPP is the same as that of the CGDP: to strengthen the capacity of WDA to install, operate and maintain rural water supply systems. It focuses on the rural populations and the development of their ability to contribute to the design, construction and management of water supply systems. The approach calls for close cooperation among technical personnel, community participation specialists and village leaders. It involves integrated planning and the coordination of technical and sociological activities from the design stage through the operations and maintenance period.

The program is based on principles of social and technological change and the analysis of water development projects in other countries. The major premise is that the successful adoption of a new technology, particularly a complex water system, requires organizational change in the client community. At the project level, this requires a plan to explain and generate support for the new technology and a series of meetings to guide villager participation at various stages of project implementation.

(2) Development of the Community Participation Approach.

Several activities were carried out as part of the program to develop an integrated approach to technological and social change. They included socioeconomic background surveys, the study of traditional systems of water management and the establishment of socioeconomic site selection criteria. These are summarized in Section 3.0 of this report and detailed in the LBII Exploratory Report (1983: Section 6.0) and in Schwarz (1983). One major finding was that most Bay Region villages had already established water committees to manage local reservoirs (wars or uars). The major challenge, therefore, was the adaptation of the traditional system of community control to the new diesel pump technology and to the 10 to 30 small, permanent and transient villages located within a five kilometer radius of the drilling site.

2.5.2. Major Components of the CAPP Strategy

The program and network plan shown in Figure 2.2.14 identifies the stages and principle events of a strategy to integrate community participation into a comprehensive technical and administrative framework for groundwater development. Athough the program was developed and tested in the Bay Region, the strategy can readily be adapted to other types of water development projects in other regions.

The CAPP organizes water development into four stages each of which includes technical activities and village participation. The stages are:

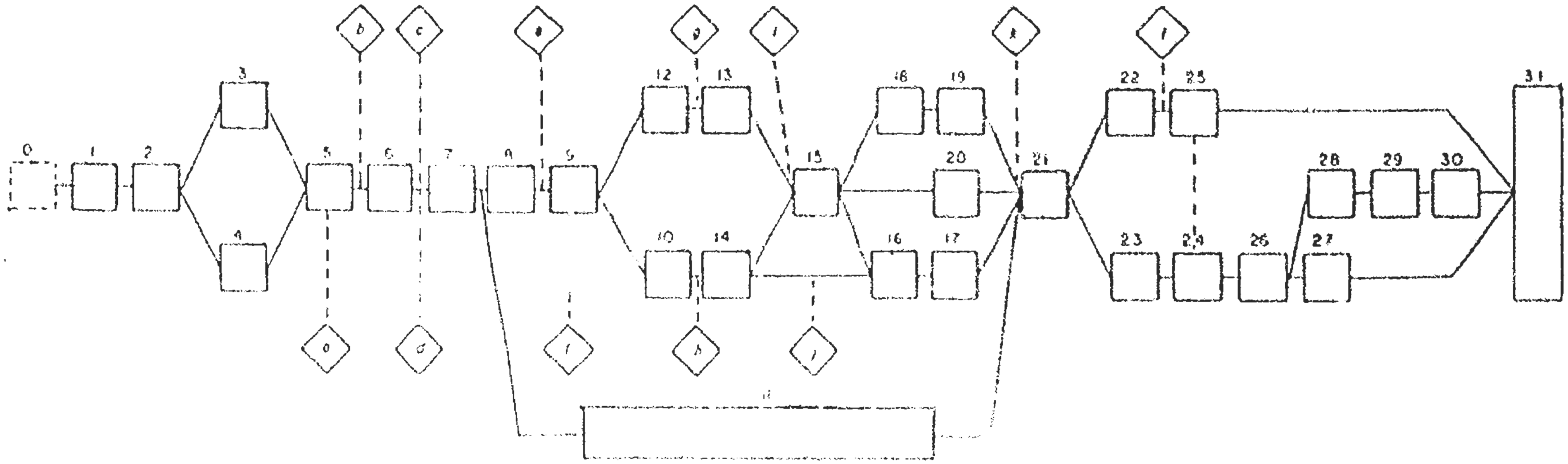
(1) Community Orientation and Assessment
(2) Drilling of Boreholes
(3) Construction of Civil Works and Pump Installation
(4) Operations and Maintenance.

Community contributions to the water development program have included information on local conditions, labor and materials for construction, the payment of user fees and the enforcement of management rules.

2.5.3. The Community Orientation and Assessment Stage

The objectives of this stage are: to determine if the residents and village leaders are sufficiently interested and able to support the project and; to form a committee to coordinate local participation. Events include several meetings with residents, village leaders and local government officials, and the collection of baseline socioeconomic data. Two methods are used to obtain information:

(1) Joint village assessments conducted by the population, and;



THE COMMUNITY ASSESSMENT AND PARTICIPATION PROGRAM (CAPP)*

COMMUNITY ORIENTATION AND ASSESSMENT STAGE	DRILLING STAGE	CONSTRUCTION STAGE	OPERATIONS AND MAINTENANCE STAGE	
Duration: 4-6 weeks	8-14 weeks	4-22 weeks	22-48 weeks	Continuous
0. Site Selection	7. Third Community Meeting (Select of Drilling Site)	15. Construction of Water Distribution System Begins	22. Well Operation and Maintenance	
1. Community Organization Meeting Organized	8. Drill Site Prepared	16. Pump Installed	23. Project Monitoring (First year)	28. Annual Joint Project Evaluation
2. Community Orientation Meeting	9. Well Drilled	17. Pump Operators Trained	24. Project Assessment Meetings	29. Preparation of Annual Work Plan
3. Socioeconomic Background Survey	10. Pump Test	18. Sixth Community Meeting (Water Management Plan)	25. Well Operations and Maintenance	30. Implementation of Annual Work Plan
4. Joint Village Assessment	11. Monitor Construction Activities (Ex. Gates)	19. NIA Approval of the Water Management Plan	26. Evaluation Plans Developed	31. Periodic Impact Evaluations
5. Project Zone Baseline Profile	12. Fourth Community Meeting	20. Construction of Distribution System Completed	27. End of Year Impact Evaluation	
6. Second Community Meeting	13. Fifth Community Meeting	21. Inauguration of Branch to Water System		
Waiting Period: 1-13 weeks	14. Preparation of Portfolio			

* This Plan focuses on community participation and evaluation. It is NOT a detailed plan for all technical and construction activities.

COMPLEMENTARY EVENTS ◇

a) Share findings with NIA technical staff.
b) Advise village of visit.
c) Determine when drill rig is available.
d) Waiting period 1 - 13 weeks.
e) Drill rig to site.
f) Test water quality.
g) Well submitted and community meeting.
h) Construction materials to site.
i) Construction materials to site.
j) Pump to site.
k) Inauguration ceremony organized.
l) Health, education and other development activities organized.

Figure 2.2.14 NETWORK PLAN: CGDP INTEGRATED APPROACH TO CONSTRUCTION PARTICIPATION, MONITORING AND EVALUATION.

(2) Socioeconomic background surveys based on the analysis of available records supplemented by rapid reconnaissance field work.

These events are organized by a Community Participation Coordinator (CPC), WDA technical personnel, the extension staff of local development agencies and local government officials.

2.5.4. The Drilling Stage

The objective of this stage is to complete the preparation of the borehole for pump installation. It involves community participation in: the selection of the drilling site; the nomination of candidates for pump operator training; road repair or construction and; the preparation of the site. Two meetings are held with residents and water committee members to explain and to coordinate contributions which include local labor and materials. WDA inputs include technical supervision, a team of trained drillers and a drill rig. The monitoring of village participation begins during this stage.

2.5.5. The Construction Stage

The objective of this stage is to complete the water supply system. This includes the installation of the diesel or hand pump and the construction of civil works; the storage tank, troughs and taps. Residents from villages in the target zone contribute labor and local construction materials. They are also asked to provide food for sale to the workers and in fact, often donate large quantities of animals and staples to the drilling and construction crews. Other activities include a community meeting to prepare a water system management plan and WDA training for pump operators and assistants.

2.5.6. The Operations and Maintenance Stage

The final stage involves the operation and management of the water distribution system. Responsibility for maintenance is divided between WDA and the community water committee according to the water management plan agreed on during the previous stage. Major activities include the operation of the pump, the procurement of fuel, oil and filter changes, the collection of user fees and the recording of technical and economic data. In principle, fuel, spare parts and repairs is supplied by WDA. In practice, WDA is often unable to meet these obligations in a timely manner. While current regulations do not sanction the use of alternative sources for these goods and services, villagers frequently use them to prevent interruptions in pump operations.

Monitoring and periodic evaluations organized at the national and regional levels are among the activities scheduled for this stage. While the overall framework for these is presented in this report (Section 3.0) , it should be adapted to fit socioeconomic and institutional contexts in each region. This requires cooperation between the WDA Planning Unit and agencies such as the new National Water Data Resource Center, the Monitoring and Evaluation Unit of the Ministry of National Planning (NMEF), the Bay Regional Agricultural Development Project (BRADP) and the Central Rangelands Development Project (CRDP). Each well site target zone should be monitored several times during the first year of operations. At the end of the first year, management activities and socioeconomic impact should be evaluated. The program also calls for long term evaluation studies which include the intensive analysis of socioeconomic and ecological impacts on a representative sample of communities.

2.5.7. Results: Community Water Committees

Water committees have been established in twelve project communities in the Bay Region. Eight of these were organized in a fairly consistent series of two or three meetings directed by an LBII or Somali social scientist or BRADP extension agent. Additional meetings in these and other villages were organized by Somali and expatriate engineers and technicians who were trained in the participatory approach. Community meetings and data collection began in 8-12 other villages, but these activities were discontinued when tests revealed the quantity of water was insufficient or excessively saline.

Committee responsibilities are similar to those required to manage the village reservoirs (wars) but WDA retains authority to make the key decisions in regard to fees, fuel supply, maintenance and repair. The committees effectively organized local contributions during the assessment, drilling and construction stages. Their participation in the management of operations, however, has not met their expectations. In spite of frequent recommendations to increase WDA support to these committees and to strengthen their management role, little progress has been made during the past eighteen months toward achieving these objectives.

Some community leaders feel that WDA has not kept agreements made at the start of the project in regard to their participation in decision-making and management. They point specifically to issues such as the setting of water fees, the procurement of fuel and other supplies, and maintenance and repair services all of which remain fully under WDA control.

2.5.8. Results: Community Participation

Community residents made substantial contributions during all stages of the project. They include:

- Information on socioeconomic conditions, well operations and project effects.
- Labor and materials for drilling, construction and some maintenance operations.
- Food and cash contributions during drilling and construction.
- Payment of user fees on a regular basis after pump operations begin.
- Coordination and supervision of villager contributions.
- Control of animals around the civil works and cleaning of the storage tank.
- Procurement of diesel fuel from WDA and other sources.

An illustrative list of some of these contributions is presented in the tables below. They cover labor inputs and gifts of cash, animals and staples to work crews for drilling, pump tests and construction.

Table 2.2.1: Community Contribution to Drilling Crews

	# village in sample	Average cash payment (So.Sh.)	Cash value of animals (So.Sh.)	Average cash value (So.Sh.)
CAPP*	14	8,000	19,000	27,000
Non-CAPP	7	3,300	5,000	8,300

* Communities in which some meetings were held to promote local participation and organize well committees.

The table above shows that communities where there was some effort by social scientists and/or technical staff trained to promote participation, the level of contributions in this phase of construction was more than three times higher than in those where the CAPP approach was not used. Data available for four villages in which civil works were constructed reveals a similar pattern and level of contributions.

Table 2.2.2 Community labor inputs during drilling and construction stages (CAPP villages)

	Labour Inputs (person days)			
	Drilling and pump testing	Civil Works construction	TOTAL DAYS	Cash Value*
Average/ village	565	1,238	1,803	324,540
TOTAL four villages	2,260	4,952	7,212	1,298,160

* So.Sh. The cash value of labor is calculated at So.Sh.85 per day for salary and So.Sh.95 per diem costs, total So.Sh.180 per day per laborer. This is the minimum paid by WDA/CGDP to Somali workers.

The table above indicates that in communities in which the CAPP strategy was used, villagers contributed 1,803 person days of labor which has a value of approximately 325,000 Somali Shillings or $4000 dollars.

In general, village leaders in the Bay Region have demonstrated a high level of interest and ability to promote and manage water development. The concept of shared responsibility among residents of different villages is well established in the region and the contribution of goods and services has been relatively high. The social science activities supported by the CGDP have demonstrated the viability of community participation and produced an integrated program (the CAPP) to guide this component. With adequate logistical and manpower support from WDA, the CAPP strategy could facilitate the expansion of water resource development and reduce capital and administrative expenditures.

2.5.9. Community Participation Issues in the Central Rangelands

The socioeconomic and development contexts in the Central Rangelands are significantly different from those found in the Bay Region. Population density is smaller, the number of animals per household is much larger (about ten times greater) and the principle mode of production is pastoral. The NRA and the CRDP have a strong informal education-extension program which focuses on the creation of Range and Livestock Associations (RLA's) at the <u>deegan</u> level. The major issues in this region are:

(1) The participation of the RLA's in the drilling, construction and management of the water development program and;

(2) The institutional support available to promote and sustain their participation once the system is constructed.

The RLA's are still new organizations and while they are based on social and geographical conditions, they are composed of many groups spread out over a large area. Because the management of a diesel powered pump and civil works is somewhat complex and has a high potential for generating conflict, a serious question remains as to the appropriateness of local control of these systems by the embryonic RLA's. Additional long term research is needed to adapt the CAPP to extension activities in the CRL, particularly in regard to the role of RLA's in water management.

WDA community participation and monitoring field staff should be assigned to work with the NRA in this region and adapt the CAPP strategy to conditions within each deegan. A regional policy and program will probably take several years to develop. As an interim measure, WDA can recruit and train pump operators from the deegan but should probably retain operational control until a sound alternative strategy is developed.

2.5.10. Recommendations

The program for the Planning Unit outlined in the 1984 CGDP Supplement and the 1985-86 Project Extension Work Plan was essentially a good one. If WDA had provided adequate resources, the CAPP could have been implemented in all project villages. The following activities and inputs are needed to develop an effective program of community participation.

The WDA Planning Unit

(1) A sociologist with training and/or experience in community development.

(2) A senior level staff person in each region who could coordinate community participation and the monitoring and evaluation activities of planning unit field staff. This individual would also draw on the resources of extension and evaluation personnel of other development programs and agencies in each region (i.e. BRADP and the CRDP).

(3) Field staff permanently assigned to each region who would conduct CAPP activities and provide support to water committees. They would work closely with extension personnel from other agencies and could also monitor

project effects.

(4) A senior level training expert who could train WDA staff and personnel from other projects who work directly with villagers. This would include hydrologists, drillers, civil works technicians and evaluation personnel.

Changes in Policies

(1) The role and responsibilities of community water committees need to be clarified and integrated into the WDA administrative framework. In the Bay Region, it seems that the committees are willing and able to assume greater responsibility for financial and operational management.

(2) Current regulations prohibit water committees from purchasing fuel, spare parts and repair services on the open market. Villagers are often forced to circumvent these restrictions in order to maintain pump operations. The elimination of these rules and WDA action to encourage private sector participation would allow the committees room for negotiation, and would increase their management role. Specific areas include fuel supply, pump maintenance and repairs. As an immediate, interim measure, WDA might allow community water committees to withold ten percent of the revenues collected for emergency fuel purchases and repairs.

Donor support and contributions

The relative success of the CAPP indicates it is an activity worthy of continued support. Donors including the World Bank and USAID should allocate between five and ten percent of water development funds to community participation and to monitoring and evaluation activities. The immediate priority is for the recruitment and training of Somali staff to implement these program components. In addition, three to five years of expatriate technical assistance is needed to develop these programs and manage them while counterparts are in training and for a year or two following their return.

2.6 Water Quality Laboratory

One of the major functions of the CGDP, in addition to exploration and exploitation of wells, has been the training of chemists and the upgrading of the water quality laboratory located within the MMWR compound. The need for an efficient, and qualified laboratory to function in conjunction with a water resource development program is crucial, not only during the development stages, but also for the maintenance and operation of safe-water supply systems.

The personnel, facilities and operations of the laboratory must be maintained to insure a successful water resource program. Weaknesses in any one of these factors should be cause for concern.

2.6.1 Laboratory Personnel

The chemical laboratory located in the MMWR facilities initially had a staff of twenty-five persons. Only one of the staff was a professional chemist. The remainder of the staff consisted of laboratory technicians and cleaners. Attendance of personnel at the lab experiences the same problems as discussed with respect to other professional and technical staff; low wages and lack of incentives. The few who maintained an interest were trained in basic analytical work and were able to perform various analyses under supervision.

Five professional chemists and two laboratory technicians were recruited during the early stages of the project. All the professional chemists and one laboratory technician have received or are receiving training in the U.S. Two are still in the U.S., two have been dismissed, one has transferred to the hydrogeology staff, one has transferred to the Planning Unit, and one provides intermittent service to the lab.

All those participating received on-the-job training in-country in water chemistry, microbiological field tests, interpretation of water-quality data, and in report writing. Seminars have been given in water chemistry and microbiology.

2.6.2 Laboratory Facilities

The MMWR laboratories are the only major laboratory facility outside of those associated with the National University of Somalia. The potential exists therefore of making the lab a self-sustaining unit. Prior to establishing this level of operation, considerable work must be done on the building and work areas; electrical and plumbing repairs are most important. A reliable source of water to the laboratory for preparation of distilled water and for the cleaning of glassware must be installed.

Power will be a continual problem, and the laboratory should have back-up power generation equipment to insure that analyses once started, can be completed uninterrupted. Voltage-regulator equipment to prevent electrical spikes or voltage drops is also essential, as analytical instrumentation will not produce valid results if not able to function properly. Unfortunately, some lab data are of questionable accuracy because of these problems.

A laboratory chemist was brought in to provide recommendations for equipment and furniture that would upgrade the laboratory. Because of the logistics of procurement, these items were not in country prior to departure of the consultant's staff.

In addition to the infrastructure improvements cited above, the laboratory must have a qualified stores manager. Many of the analytical chemicals and reagents in stock are old and of questionable value, and other reagents are lacking. A proper inventory and control system needs to be installed and maintained.

2.6.3 Laboratory Operations

Three different laboratory data forms were introduced. One form to acknowledge receipt of the sample, another for listing the analytical results, and the third for the well file at the LBI office.

Forms for water-sample registration and analytical results were introduced together with chemical routines. Before an analytical method was used it was standardized, i.e. the method was modified to local conditions (available chemicals and glassware), and tested for analytical interferences. The standardization was done by the consultant's professional chemist. When the method was satisfactory, the laboratory attendants were instructed in its use and the method established as part of the chemical routine for water analysis.

During the past year the laboratory has analyzed 39 samples; 19 are samples collected from newly constructed wells, 13 are from wells set up for continual monitoring, and 7 are from other wells or springs. Lack of power, lack of analytical chemicals, and absence of laboratory attendants, have caused periodic delays and interruptions of results, however, the lab continues to function.

2.7 Electronic and Geophysical Lab

When the CGDP was initiated, a considerable amount of electronic equipment was provided. In addition to the chemical laboratory equipment already here, down hole geophysical logging tools, surface geophysical equipment, satellite navigators, mobile radios, windmill monitoring equipment, and an assortment of hydrogeologic and automotive test equipment was provided. In an effort to insure that this equipment was operational, an electronics laboratory was established with a full time electronics engineer. Upon termination of that position in July of 1984, service to this equipment was provided on a periodic, as-needed basis.

In January of 1986, an electronics expert was brought in to conduct repairs and to provide additional training to counterparts. Unfortunately, only one WDA employee attended, and he remained for only one day. The prospects of the lab being functional upon termination of the project is nil.

It is the consultant's recommendation that the WDA enter into a service contract with an electronics firm to periodically provide repair service and training until such time as these services can be accomplished in-country. This service should be provided a minimum of every six months.

3.0. THE MONITORING AND EVALUATION SYSTEM (MES)

The original Project Paper (1979) called for the collection and analysis of sociological and economic data needed for site selection and impact evaluations. The Inception Report (1981) expanded this concept and identified specific topics to be investigated. These included the development of monitoring and evaluation procedures and the collection of data on water utilization patterns and traditional water management practices. Preliminary field studies were carried out by LBII staff and the results reported in Roark (1982), the Exploratory Report (LBII 1983) and Schwarz (1983).

Schwarz (1983) outlined a program for monitoring and evaluation linked to construction and community participation activities. It included baseline socioeconomic and water point surveys and the identification of topics and key questions for later stages. Because no WDA staff was available to conduct these surveys, four members of the BRADP monitoring unit were trained by the LBII anthropologist. Immediately following their training, however, the BRADP personnel began work with the Wyoming University Socioeconomic Study team. In spite of an informal agreement between LBII and the Wyoming team to have BRADP staff conduct community meetings and baseline surveys, the expected cooperation never materialized. The BRADP staff worked full time with the Wyoming project and repeated attempts by LBII and USAID to obtain access to baseline data collected by the Wyoming Socioeconomic Team have been unsuccessful. In 1984 Roark, Sartana and Farrah (1984) scheduled a series of monitoring field trips but this too was not implemented due to the lack of available staff.

The major problems with the preliminary studies and MES programs completed by the consultants (Roark 1982, LBII 1983 and Schwarz 1983) were identified by the investigators themselves and repeated in the USAID Evaluation (1984). They were:

(1) The volume of information collected was not sufficient;

(2) The validity and reliability of the data was not up to scientific standards because it was based primarily on community self-assessments; and

(3) The time and manpower needed to develop and implement a program to monitor effects and evaluate impacts was not sufficient to do an adequate job.

The CGDP Project Paper Supplement (1984) and the 1985-86 Extension Work Plan (LBII 1984) addressed these issues in the proposed sociological evaluation program to be assigned to the new Planning Unit. It called for the design and implementation of monitoring and evaluation procedures and specified major topics to be investigated. The Project Paper (1984) stated that the Planning Unit would include two full time economists, a sociologist and four sociological field assistants to carry out community participation and monitoring and evaluation activities. It also called for twelve months of expatriate technical assistance in social science but this was later reduced to six months.

Unfortunately, WDA was not able to recruit a Somali sociologist and between May and October 1985 the Planning Unit consisted of one qualified economist and two assistants with academic backgrounds and job experience unrelated to water development or research. They received several weeks of training in planning and evaluation, but by November 1985 two of them, including the economist, had left the Planning Unit for other positions. Since then, the Planning Unit has had only one staff person to carry out the full range of activities including the implementation of the MES program.

In view of the manpower constraints, the objective to fully develop and operationalize a monitoring and evaluation program was revised. Priority was given instead to the design of a system for monitoring and evaluation. This included the preparation and testing of survey forms, schedules for data collection and reporting, and guidelines for data entry and analysis.

The technical assistance team was also able to monitor conditions and assess the impact of the drilled wells in sixteen communities. Seven visits, lasting from four to ten days each, were made to villages in the Bay and Central Rangeland Regions. Five were directed in the field by LBII consultants and two were carried out independently by a member of the Planning Unit. Two members of the BRADP Monitoring Unit also participated in the March 1986 evaluation survey. The field trips produced a substantial amount of data on well operations, water use, and socioeconomic conditions, and led to major revisions of the survey instruments and reporting schedules.

Considerable attention was also given to methodological issues and two BRADP, and one WDA, staff person now have satisfactory basic skills in the administration of questionnaires, interviewing and technical observation. They are also able to tabulate several types of survey data. None of the current staff of the WDA Planning Unit, BRADP or the CRDP Extension Unit are sufficiently trained or have enough experience to manage and implement the proposed MES system. They require a substantial amount of additional training in theory, research methods, elementary statistics, computer operations, data management and analysis. Recommendations to develop the capacity of the Planning Unit to plan and conduct monitoring and evaluation activities are presented in Section 2.3.7.

This section of the report describes, in some detail, the Monitoring and Evaluation System that has been developed, and the preliminary results of surveys conducted. It is written in such a way as to be used as a manual by the Planning Unit when a suitably qualified staff is recruited. The system, though primarily concerned with the assessment of water systems in communities with drilled wells, could readily be adapted to other water supply facilities. Copies, and outline descriptions, of the questionnaires, are contained in the Appendices in Volume IV of this report.

Prior to presenting the MES program and results, a review of socioeconomic conditions, primarily in the Bay Region, is provided for background purposes. Part of the discussion focuses on the organization of traditional water management groups. The information is based on investigations supported by the CGDP project (Roark 1982 and 1983; Schwarz 1983) and recent studies conducted by Hunting Technical Services, Ltd. (1982, 1983), Boston University (1983), Putnam (1982, 1985), the University of Wyoming (1984), Watson and Niimo (1982) and the Central Rangelands Development Project.

3.1. Socioeconomic Conditions: Bay Region

The Bay Region is inhabited primarily by people who identify themselves as Rahanweyn (a gathering together of many things). They are one of the six major social groups (clan families) in Somalia and are further subdivided into several types of smaller units based on patrilineal descent (tracing of ancestors through the male line). The majority of residents in the region practice a mode of production known as agro-pastoralism which involves cultivation and livestock herding. In most villages there are some families who have none or very few animals and can thus be classified as farmers. Pastoralists live in villages throughout the densely populated farming areas but most reside and graze their animals in the lower rainfall districts of Buur Acaba and Dinsoor.

3.1.1. Climate and Ecology

The Bay Region has an arid to semi-arid climate. The mean annual temperature is 26.3^{o}C., with an annual variation of about 2^{o}C. The mean annual rainfall varies from about 313 mm to 589 mm per year. It is a drought prone region and crop failures occur once every three to four years. Grain production will suffer some reduction because of low rainfall one of every two years (Hunting 1982).

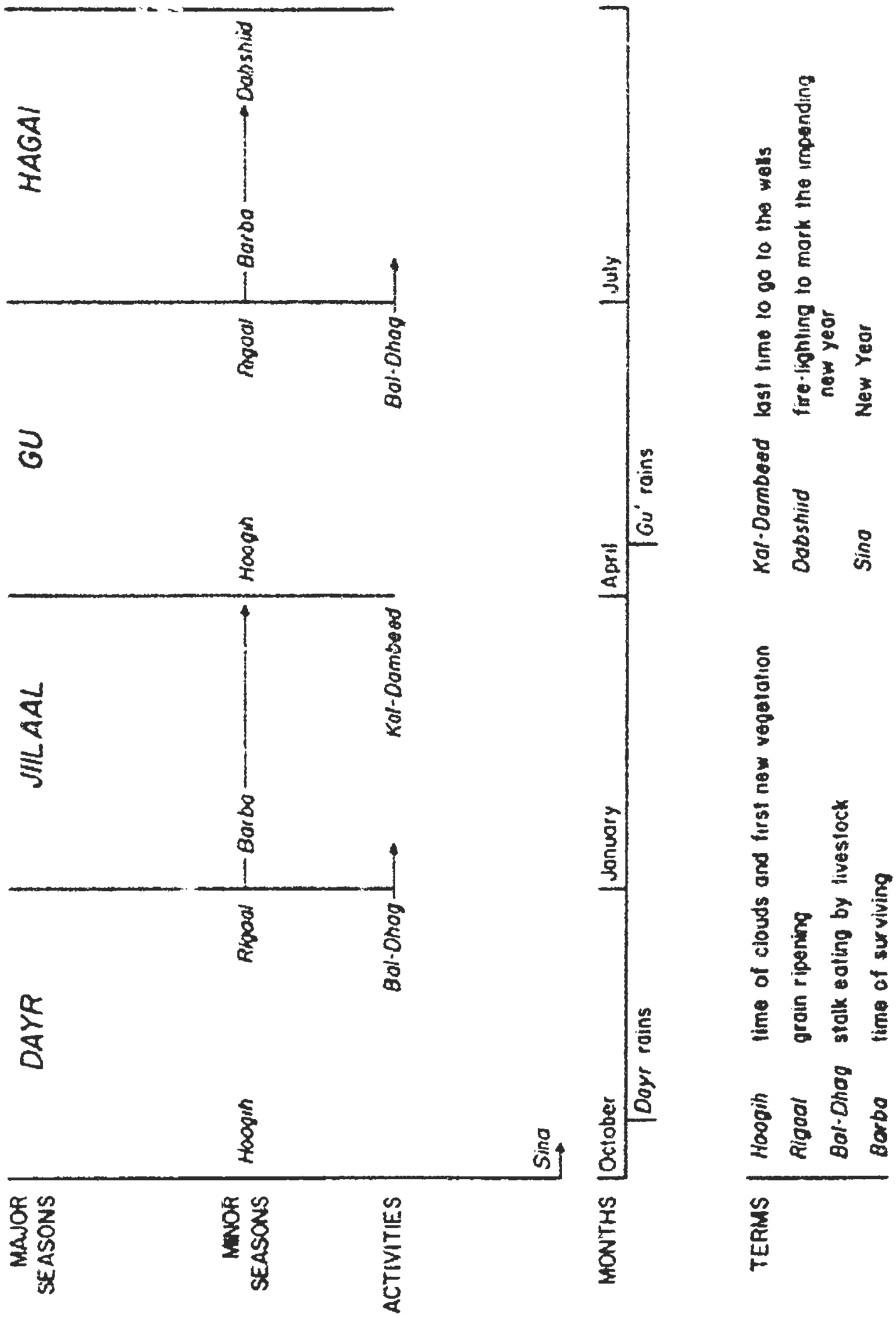
The traditional calendar divides the year into four seasons and begins in early October with the arrival of the dayr rains (Figure 2.3.1). Each season lasts approximately three months. The hottest, driest season occurs between January and April and is referred to as Jilaal. This is a time when water sources begin to dry up and when the animals have eaten stalks remaining in the ground after the harvest. Many families, and sometimes entire villages are forced to abandon the region during this season in search of water and pasture for livestock.

The Hunting report (1982) identified 25 geomorphic strata and grouped these into five main geomorphic units. The soils used most extensively for cultivation are referred to as arable soils and include the dark brown, clay type and a lighter one found mostly in the heavily farmed areas north of Baidoa.

The Bay Region is estimated to have approximately 4.0 million hectares of land. The region is considered to have good potential for agricultural intensification and expansion, and has the highest number of livestock c. any region in Somalia (Hunting 1982).

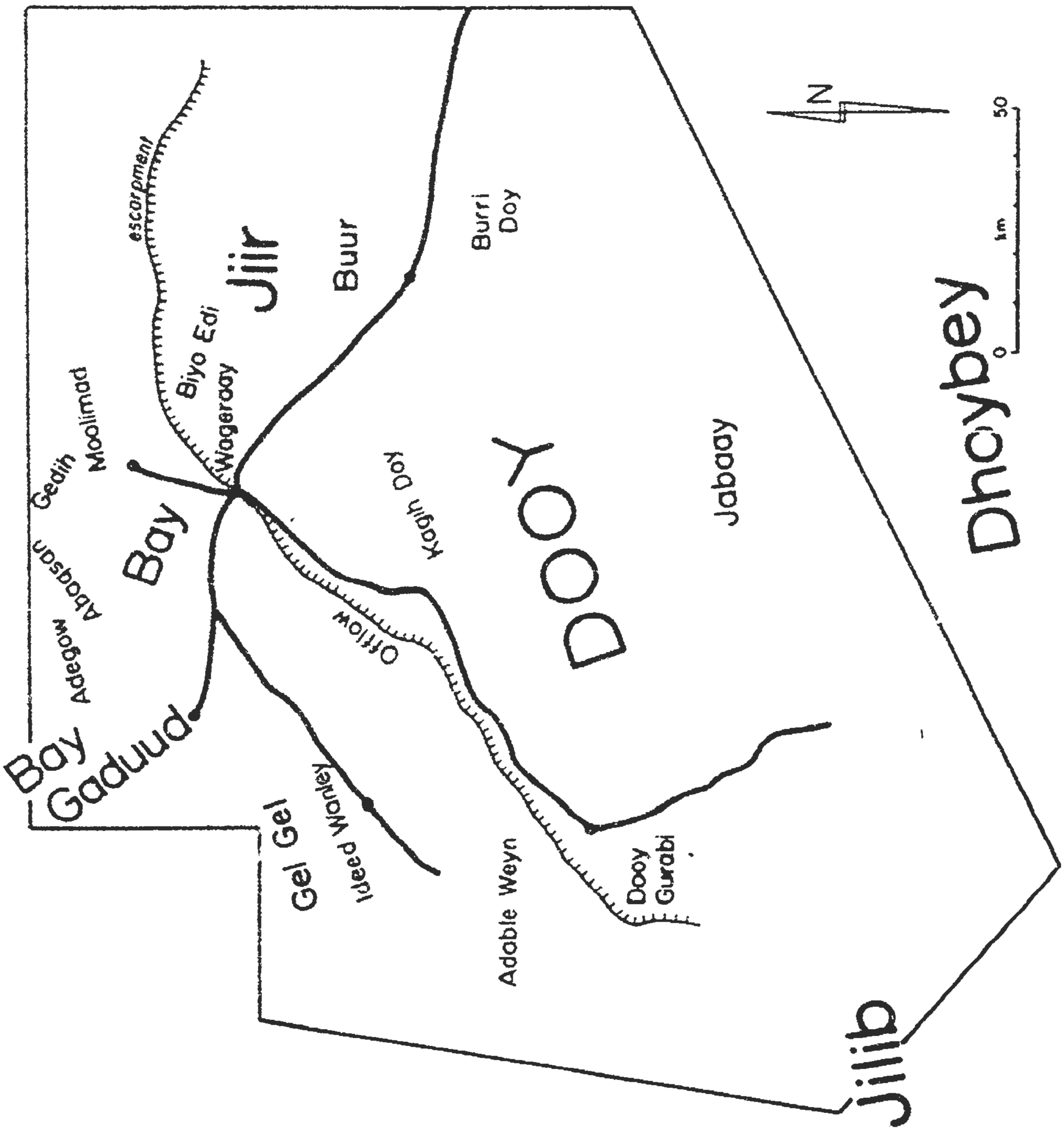
The people of the Bay Region have their own system of classifying their environment which is based on a combination of ecological factors and patterns of land use. The most important areas identified by the inhabitants of the Bay Region are the Dooy, Jabaay, Dhoybe', Jirr and Moolimad (Figure 2.3.2). These areas are related to the north/south movement of livestock and, at different times of the year are used for grazing. Bay, Buur and Ooflow refer to areas of high population density and extensive cultivation (Wyoming 1984, Vol.I:74).

The Bay Region has extensive grazing areas and soils which are suitable for cultivation. The major constraint to increased animal and grain production is the lack of a reliable supply of water (Hunting 1983: V.4:2). Rainfall is the most important source of water, and in addition to its direct effect on crops and surface water, it replenishes underground sources which feed wells, springs and village reservoirs. The Hunting report estimates there may be up to 10,000 hand dug wells in the Bay Region and these are a crucial, and often the only source of water for many villagers and animals during the hot, dry season between January and April. These wells are, however, found only in a few areas where water of adequate quality is available at a relatively shallow depth (Hunting 1983). The normal pattern is to have many hand dug wells concentrated in one location, although they are used by families spread over a wide area. The water survey conducted by the Wyoming team(1984) found hand dug wells in only 12 of the 80 villages they surveyed.



AFTER UNIVERSITY OF WYOMING, 1984.

Figure 2.3.1 ONE - YEAR SEASONAL CALENDAR OF THE RAHANWEYN.



AFTER UNIVERSITY OF WYOMING, 1984.

Figure 2.3.2 MAP OF COMMON NAMES OF AREAS OF THE BAY REGION.

The village reservoirs or collection ponds (<u>war</u>, <u>waro</u>, or <u>uars</u>) are large, hand dug pits which store up to 1500 cubic meters of water and average about 800 cubic meters. There are from 40 to 50 government-built <u>wars</u> with capacities ranging from 5000 to 20,000 cubic meters. The total number of <u>wars</u> in the Bay Region is estimated to be 9000 (Watson and Nimmo 1982). Most villages have access to one or more <u>wars</u>. The number, size, and reliabilty of these reservoirs when near a village to a large determines its population throughout the year. According to the Socioeconomic Study of the Bay Region, 94 percent of the villages have access to at least one <u>war</u> and 70 percent have access to two or more (Wyoming, 1984). Only one village in four has a reservoir which provides a reliable supply of water throughout the year. Table 2.3.1 indicates the reliablity of the supply of water in village reservoirs in the Bay Region.

Table 2.3.1. Reliability of Village Reservoirs*

Reliability level	Seasons when <u>war</u> normally has water: Dayr/rain	Jilaal/dry	Gu/rain	Hagai/rain	Number	Percent
High	x	x	x	x	20	25%
Moderate	x		x	x	32	40%
Low	x		x		28	35%
TOTALS					80	100%

* Based on data from the Socioeconomic Baseline Study of the Bay Region (Wyoming 1984:Vol I:83-84).

During years with long dry periods, reservoirs in many of the villages with normally reliable supplies will also become dry. During the dry seasons, in villages with old WDA and new CGDP wells, people and livestock come from villages 5, 10 and sometimes more than 20 kilometers away to collect water. These facilities are also used by nomads. During the wet seasons, both drilled wells and <u>wars</u> are used primarily by residents of nearby villages. Convenience, and the fact that residents do not pay for water from their <u>wars</u>, substantially limits the use of drilled wells when adequate supplies are available elsewhere.

3.1.2. Administrative Divisions

The Bay Region is divided into four districts: Baidoa (Baydhabo); Kansax (Qansax) Dheere; Buur Acaba (Buur Xakaba) and; Dinsoor (Diinsoor). Districts are divided into Beels which are the adminstrative centers for groups of villages (<u>tuulos</u>) and hamlets (<u>buulos</u>). In practice, this formal hierarchy is subject to local variation and the term "village" will be used to refer to both of the smaller residential clusters, the tuulos and buulos. There are 55 beels in the Bay Region and approximately 1500 villages. The general characteristics of villages in the Bay Region are:

(i) All villages have a water source which provides a reliable supply for domestic and animal consumption for at least half of the year (the two rainy seasons). During these seasons the villagers remain stationary, cultivate farms and graze and water livestock locally.

(ii) Almost all villages (94 percent) have a <u>war</u> which is locally managed by a water committee. In some areas there is a second level of water management which includes representatives from 5 to 15 village committees.

(iii) Villages are close together and the target zone for the CDGP project wells frequently include several administrative subdivisions. The target zone of one well site northwest of Baidoa, an area enclosed by a five to six kilometer radius, was found to crosscut the boundaries of two beels, seven tuulos and at least twelve buulos. The villages within this zone are, for CGDP purposes, considered as members of the well site "community" without further reference to other administrative affiliations.

(iv) During the dry, Jilaal season only about 25 percent of the villages have an adequate supply of water. Many of the inhabitants and sometimes entire villages are forced to move closer to a permanent watering point within the Bay Region. Some residents will lead livestock to other regions such as the Lower Shabelli.

3.1.3. Population

The rural population of the Bay Region (minus the towns of Baidoa, Kansax Dheere, Bour Acaba and Dinsoor) is approximately 432,000. There are 55 beels and about 1500 villages in the region. Most villages have between 30 and 65 households (<u>goys</u>) and most households have between five and seven members (average 5.8). The average village size is 305 people and most have between 200 and 400 residents (Univ. of Wyoming, 1984).

The target zones for the CGDP project, an area enclosed by a five to six kilometer radius from the well site, include between 7 and 15 villages (average: 10). Most target zone communities have between 300 and 600 households and between 2000 and 4000 people.

3.1.4. Agriculture and Livestock

The dominant system of production in the Bay Region is agro-pastoralism and nearly all of the region's population derives its livelihood from a mixture of agricultural and pastoral activities. While there are nomadic groups who derive their livelihood from the sale of animals and animal products, few agriculturalist derive their livelihood exclusively from crop production or related activities. Most families own some livestock, although one study (Wyoming 1984) reported that 20 percent of the households sampled had none. Livestock statistics are difficult to collect, however, because of the fluid nature of the system and because people are reluctant to reveal accurate numbers on their livestock holdings. The number of livestock in the Bay Region based on estimates made from aerial surveys (Watson and Nimmo 1982) are: 320,000 camels, 370,000 cattle and, 390,000 goats and sheep.

The region is also characterized by movements of nomads through it, some of whom are related to the permanent resident and others who are considered "guest nomads".

Table 2.3.2 presents an economic classification of households for Bay Region residents according to the primary productive activity (Univ. of Wyoming, 1984). The figures should be viewed with caution, however, since it "masks the fact that households of two or three types are often grouped together in larger extended management units (Boston University, 1983, V.5).

Table 2.3.2. Economic Classification of Households*

Primary Economic Activity	Percentage
Non-agricultural (wage earners and urban residents)	20%
Settled farmers and part-time pastoralists	45%
Pure nomads (most of whom are residents of the region	35%

*The figures include the urban population of the Bay Region.

The major crops grown in the region include several varieties of sorghum, cowpeas, maize and mung beans. Rainfed agriculture is practiced throughout the region although irrigated fields are found in a few villages. Irrigated fields are used primarily to produce grains but are are also used to cultivate sesame, watermelons, tomatoes, lemons, bananas, pumpkins, papaya and sugar cane (Wyoming 1984: Vol.2:27-34).

The herding of animals provides most residents with a major source of food and is a form of savings and investment. According to the Wyoming study, 27 percent of the rural housholds own camels, 33 percent own goats, 80 percent own at least one head of cattle and only 10 percent own any sheep. Putnam's (1985) sample of 21 households in a village north of Baidoa, indicated that about 60 percent owned camels, approximately 50 percent owned goats, and all families owned cattle (1984:478). The total number of livestock owned per family varies significantly within villages and between ecological zones. In general, the size of herds is much larger in the non-agricultural zones where pastoralism is the principal economic activity. Unfortunately, the Wyoming baseline study does not provide this information for each ecological zone. Estimates of average family livestock holdings are 10-15 units, with a range from 5 to 50. The breakdown of ranges is roughly 2-40 for cattle, with a mean of about 5-15; 0-50 sheep and goats, with an average for those families who own them of about 20-30; and 2-20 camels, with a mean of 3-6.

3.1.5. Social Organization

The village is the central focus of social organization and where residents claim a common male ancestor. Although residents often consider themselves of the same "tribe", most villages are composed of members of several lineages and thus regard one another as "non-relatives". Lewis (1969) writes:

> "The most important divisions [in the Bay Region] are the villages...These local residential units with their members fields scattered around them, comprising people of different sections of a clan, have a strong sense of local autonomy and cohesion".

Village size varies throughout the region, with larger villages resulting from a combination of factors such as availability of arable land, quality of rangeland, access to roads, and availability and dependability of water. The residence pattern can be described as scattered, and households within a single villages are often spread over several square kilometers. The largest villages are found in areas with good arable land, are located near major roads to market towns, and have a permanent supply of water, usually a WDA well or large reservoir. The evaluation of CDGP project villages in which water facilities were installed indicate that people from within and outside the area tend to move close to the well. The size of villages appears to significantly affect the number of commercial and public services available.

There is an elected/appointed government representative in each village (gudoomiye). There are also traditional leaders (nabadoon, "peace-seeker), selected by the residents. The nabadoon has authority within a single village although through extended kinship ties may exercise authority over households in several adjacent villages. The relationships between these officials varies among villages and it is difficult to describe a general pattern for the region.

There are Local Peoples Assemblies organized in each district. They are made up of government approved or appointed representatives (gudoomiye) from each beel in the district. Committees (gudi) are also found in each village and beel to manage local resources. The committees provide the link between the residents, the government, and the party (XHKS). They have from five to ten members each and rarely include women.

The responsibilities of the village and beel level committees include the communication of official directives to the population and the management of land, water and livestock. While these committees are now integrated into the district and regional political-administrative structure, their organization and responsibilities are rooted in the traditional system of social control.

The government role in the management of the day to day affairs of the village is minimal. The council of respected elders, the agiyaarta, are the principal decision-makers and coordinators of local events, which include the implementation of, or resistance to, official directives. Agiyaarta are, with few exceptions, adult males considered to be wise and intelligent. Any adult may achieve this status regardless of family affiliation or amount of land and livestock he may possess. In most villages, the council of elders selects the village representative (the gudoomiye) to the government sponsored committees.

3.1.6. Management of Water Sources

As part of a Bay Region baseline survey, Dr. Paula Roark (LBII Exploratory Report, 1983) and Diane Putman (1983, 1984) studied traditional systems of water use and management in several villages. They investigated patterns of ownership and control and identified local committees and leaders who played an important role in the management of water resources. This knowledge was used to plan the initial approach to the communities and the community participation strategy for the Bay Region. The Socioeconomic Baseline Study of the Bay Region also has a section on water management.

The maintenance and regulation of hand dug wells and village reservoirs (war) is a community activity, directed and organized by either a separate committee, sometimes referred to as a yogor, or a sub-committee of the village committee (the gudi). The responsibility for the management of the war is divided between a sagaale who schedules peoples access to the water, and a gobta (the "gate of the war"), who enforces the rules, and can impose fines. Both the sagaale and the gobta maintain the fencing around the war and arrange for strangers to use the war. They also negotiate for the use of neighboring wars when theirs is dry. The gobta settles disputes related to the use of the war and may be assisted in this by the sagaale.

The person who owns the land on which the war is dug (the aaw) is recognized to have authority over it, and may also participate in management decisions and the adjudication of disputes. Rights to collect water from the war are, however, shared by all members of the village who help maintain it. They are referred to as fatiir. The failure to perform the work needed to maintain the war is punishable by a combination of fines and the withdrawl of water rights. Putman (1985:237) reports that the fine is often a three year old oxen.

Wars are sometimes used by persons from outside the villag including residents of nearby hamlets and strangers. Mutual arrangements are often made among residents of neighboring villages. According to Moslem law, no one in need and passing through the area can be refused water. The length of time this free access is granted, however, will vary with the season and the amount of water available.

The proposed strategy for the management of CDGP wells incorporates the key features of the traditional war system. The major differences are the multi-village, "community" well committees, and locally recruited pump operators who are WDA employees. While local participation during the drilling and construction stages was high in villages where the CGDP organized community committees, WDA has not allowed full village participation in the management of diesel pump wells. The committees do, however, continue to take some part in the maintenance of the enclosures and tanks, and help control people and animals during periods of high demand.

3.1.7. Selection of Drilling Sites

Another output of the preliminary Bay Region baseline surveys was the identification of socioeconomic criteria for the selection of drilling sites. They have been tested, modified, and integrated into a general set of criteria, which also consider hydrogeological and political factors. Although the Somali and W.H.O. standard, of 15-20 liters per day per person, remains as a criteria, the analysis of water use data suggests that this figure might be lowered for Somalia.

The primary set of criteria based on local needs are:

(a) Adequacy of available local water resources. Villages without a permanent water source or sources not able to supply 15-20 liters per person, and between 20-30 liters per day per head of livestock normally kept in the area. Villages in which the quantity or quality of water do not meet the standards are considered eligible for a project well.

(b) Distance to the nearest water point. Villages more than 5 kilometers from a reliable water source. Good quality grazing areas with no permanent water point within an area enclosed by a 30 kilometer radius.

(c) Population density/social infrastructure. Villages with a population of more than 1000 residents or, those with a state school or health post.

(d) Transhumant communities forced to migrate from their normal "home" areas for several months of the year because of the shortage of water. The application of this criteria should take into account the quality of the rangeland and agricultural potential of the soils.

(e) Agronomic potential. Good quality agricultural and grazing areas that are under-utilized because they lack adequate water sources.

These criteria should be subject to three additional ones before a decision is made to begin drilling. These criteria are:

(a) The hydrological suitability of the site, as determined by the hydrogeologist.

(b) The interest of the residents of villages in the target zone, and their willingness to organize a management committee and contribute to the construction and maintenance of the well. This should be determined through the community participation program outlined in Section 2.5.7.

(c) Approval of the site by regional, district, and local level government officials, and by WDA and/or other development agencies, such as the Bay Region Agricultural Development Project (BRADP) and the National Range Agency (NRA).

These criteria need to be more thoroughly investigated and adapted to conditions in the Central Rangelands and other regions of Somalia. The Range and Livestock Associations (RLA's) presently being formed by the Extension Department of the NRA may be able to participate in the organization of water management committees. The RLA's however, are new and inexperienced associations, and water development is a more ecologically complex, and politically sensitive issue, in this region.

In general, the need for reliable water supplies is found throughout rural Somalia, and the careful application of socioeconomic and technical criteria will facilitate the equitable and most productive allocation of scarce resources available for water development.

3.2. Socioeconomic Conditions, Central Rangelands

The Central Rangelands is a sparsely settled dry region with little agriculture. It is an area almost exclusively of livestock production, with a principally nomadic population. Its three regions comprise an area of roughly 117,000 square kilometers.

The population of the region is estimated from the 1975 census figures to be about 900,000, growing at about 3% each year. At least 75% of the population is nomadic, and another 15% consists of sedentary pastoralists, the remainder is urban-oriented. Population varies seasonally as changing climatic conditions compel nomads to move herds in search of water and pasture.

3.2.1. Social Organization and Livestock Production

The basic social unit of the area is the deegan, the area inhabited by a given nomadic group, and the area of year-round residence for at least some members of the group. A deegan may be 1,000 to 1,500 square kilometers in size, and each will have at least one year-round water source, shared between 400 and 2000 households. There is an identifiable leadership structure which typically manages grazing areas, decides on migrations of people between and within deegans, and adjudicates disputes. It is not, however, a tightly organized collective that engages in day to day administrative affairs: rather, it is a more fluid set of relationships defined in terms of social networks and geography. The social cohesion found within a deegan may or may not extend beyond its limits. Some neighboring deegans cooperate over such issues as water and grazing rights, while others do not. Siting of wells on the boundary between two or more deegans may result in conflicts over control and access.

A deegan may have less than 100 to over 1,000 livestock owners, who are considered as heads of households. Deegan populations vary from a few hundred to 5,000.

The number of animals per family range from 20 to over 350, with roughly ten times the number of goats and sheep to cattle and camels. An average family owns nearly 300 goats and sheep, 25 camels and 14 cattle. Populations of <u>deegans</u> fluctuate seasonally and tend to concentrate around the few water points that contain water at the height of the dry season. Consequently, conflicts often arise over the use of water and grazing areas during this time.

3.2.2. Impact of CGDP Well Drilling

At present there are four wells constructed by the CGDP operating with diesel pumps, none of which have completed civil works. Water must be pumped into depressions in the ground near to the wells to allow animals to drink. The pumps must operate for long periods to provide enough water for animals. Three hand pumps have been installed at other well sites, and another three wells are awaiting pumps.

A trend toward agro-pastoralism has emerged, following recent well construction, whereby families stake claims within a 6 kilometer radius around a well site. Fences are erected to protect these areas, in which cowpeas are cultivated in the wet season, and animals are pastured in the dry season. Families with enclosed areas can provide themselves with incomes from cowpeas, and forage for their animals in the dry season. Those who have not made any claims are forced to walk their animals great distances through the fenced areas to the well site, and then back out to pasture beyond the fenced land. This system is a source of conflicts, because it provides unequal access to water and grazing. It is the private appropriation of access to a public resource. These changes in land use have caused severe degradation around the well sites and require that water management schemes be integrated with land use schemes. Long-term effects may result in the creation of sand dunes, which may be a worse outcome than having no wells at all. Problems of managing these new conditions were recognized at the beginning of the CGDP, but are only just beginning to be investigated in any detail.

3.3. MES and Water Development Planning

Many different approaches to water development have been used in Somalia, yet little information is available about the operation, cost, and impact of water supply facilities which could effectively guide those responsible for planning and management. The major thrust of the MES is to provide WDA with a strategy and methods to improve the effectiveness of current operations and to provide feedback to the planning process at all levels, local, regional and national. The framework for monitoring and evaluation is presented in Figure 2.3.3.

The proposed monitoring and evaluation system follows events from the Community Orientation and Assessment Stage through the Operations and Maintenance Stage. A distinguishing feature is the integration of technological, socioeconomic and management variables. The underlying premise is that technological factors (hours of pumping, the design of distribution systems), sociological factors (utilization patterns, community attitudes) and institutional factors (fuel supply, water fee policies) are related and should be analyzed in relationship to one another. For example, the rate of water utilization could be a function of fees charged, the availability of water at other sources, the supply of fuel, management decisions to limit the water supply and/or social conflict. Similarly the condition of the pump and civil works might be related to the quality of the construction, the technical knowledge and skill of the pump operator and/or the ability of the water community to organize control and maintenance procedures.

3.3.1. Purpose and Goals

Monitoring and evaluation are related activities which provide WDA with information needed to guide operational decisions and plan future programs. The proposed program is not, however, a comprehensive project or management information system for all WDA hydrological, construction or administrative activities. While the system could be used in connection with the monitoring and evaluation of specific projects such as the CGDP, it is primarly designed to monitor the recurrent activities and evaluate interim and long term effects of WDA programs in all regions of Somalia.

The main goals of the monitoring component are:

(1) To provide information on the progress of construction, community participation and operations and maintenance activities.

(2) To describe and assess the effects of the new water systems on the population and environment.

The main goals of the evaluations are:

(1) To provide feedback to WDA administrators on the effects and impact of the water system on the population. This involves: a comparison between initial conditions and objectives, and current conditions; information on how the

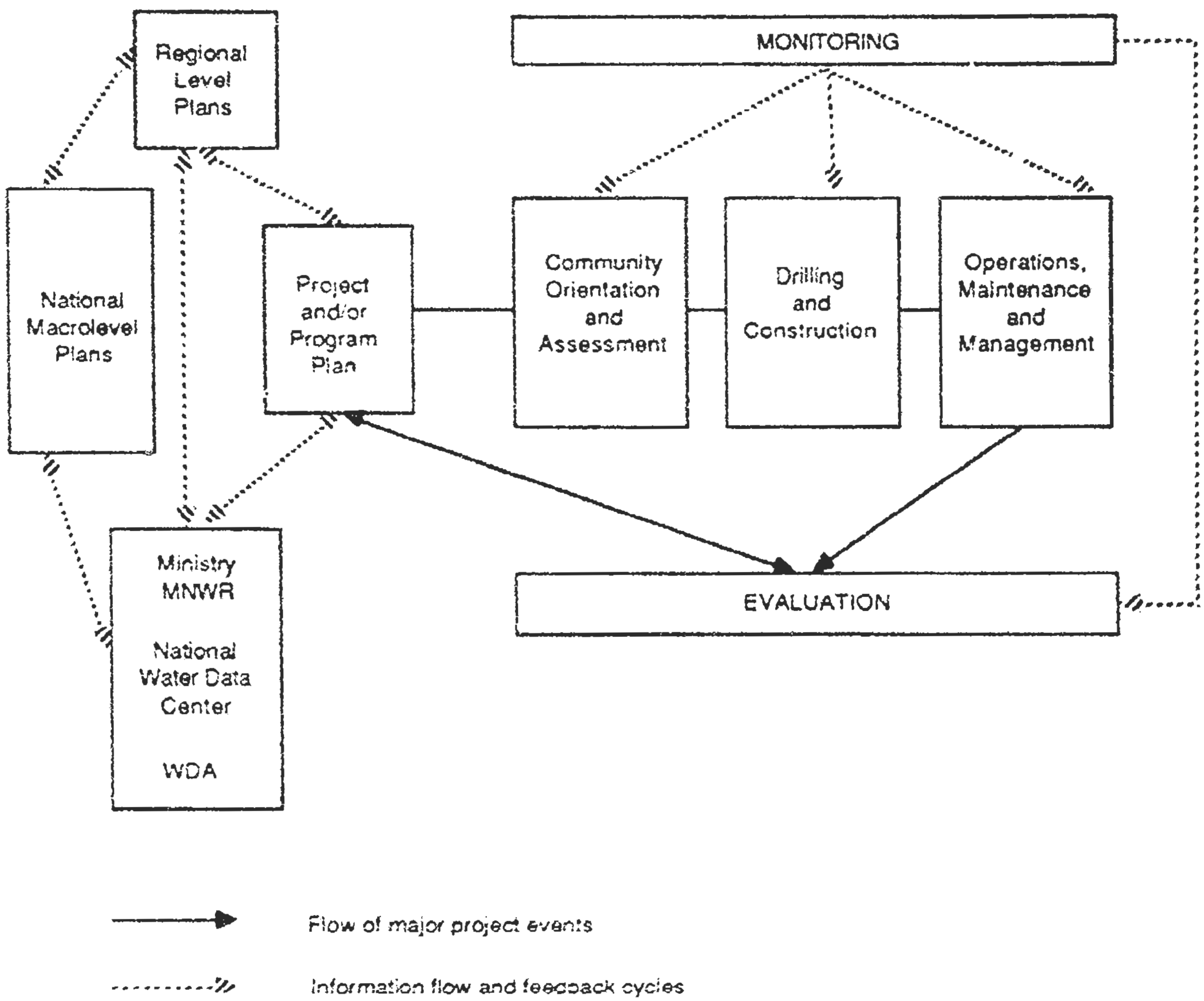


Figure 2.3.3 FRAMEWORK FOR MONITORING AND EVALUATION ACTIVITIES

changes are viewed by different groups in the community; and an explanation of the direct and indirect role of the water system in bringing about the changes.

(2) To provide feedback to regional, sector and national planners. This involves comparative analysis and explanation of water development strategies and changes which have occurred among the population and in the environment.

The major distinctions between the monitoring and evaluation activities is that monitoring is more closely tied to the ongoing management of WDA programs and operational decisions such as the provision of fuel and repair of water systems. Evaluation results draw on data collected in monitoring surveys but focus on longer range issues such as policy formulation, technical design changes, program planning, and management strategies.

3.3.2. Major Topics, Issues and Questions

The MES system focuses on the following factors:

Operations and maintenance
Water use
Socioeconomic conditions
Community participation.

The principle which underlies the monitoring and evaluation system is that information should be related to decisions which have to be made for the effective planning and management of operations. While the MES program tries to adhere to this principle, the system has not been adequately tested and is, therefore, longer and more complex than it should be. It should be viewed as a pilot program which requires additional field testing and modification. The major issues and questions the system addresses are listed below.

(1) The condition of the water distribution system and the effectiveness of WDA operations and management activities.

(2) What technical improvements are needed at the well site and in the organization of operation and maintenance services?

(3) What are the effects of the well on patterns of water consumption by people and animals?

(4) What savings in time and labor have been achieved and how are these utilized in other activities?

(5) What changes in socioeconomic conditions have occurred in

villages near the well? This includes categories such as population, physical infrastructure, agricultural production, herding, commerce and public services.

(6) What are the positive and negative effects of the changes on social and environmental conditions?

(7) What changes in strategy and complementary services are needed to mitigate the negative impacts and increase the number and distribution of social and economic benefits?

(8) What role should local institutions play in the construction and management of community water systems and how can WDA facilitate this participation?

3.4 MES Methodological Framework

The suggested approach to monitoring and evaluation includes the use of baseline studies and control communities (groups of villages without a drilled well). While some baseline data may have to be collected retrospectively, there is a substantial amount of information from recent studies in the Bay Region and the Central Rangelands which can be used to develop fairly accurate baseline profiles. The recommended strategy is relatively intensive but justifiable in view of the high cost of drilled wells and the fact that little is known about their effects on the people and the environment of Somalia. The suggested approach involves 3-4 visits a year, lasting 2-4 days each to a stratified sample of villages in well site target zones. Villages in control communities will also be surveyed 3-4 times a year, but only for one or two days each. Communities with diesel pumps and civil works require more field work than those with hand pumps.

The term "community", or "target zone", refers to all villages within a five to six kilometer radius of the well and/or with a representative on the Community Water Committee. "Community" and "target zone" are used to distinguish this area from other political-administrative boundaries which may extend far beyond six kilometers. Four to six communities will be intensively surveyed in each region. Data collection will occur in the well site village and at least two other villages within the six kilometer limit. Other communities with WDA wells will be less intensively surveyed, but should be visited at least twice a year for one to two days each.

The recommended MES activities would require between 90 and 150 days of field work in a region with 20 wells. They could, however, be integrated into the community participation program and thus visits to support well committees could also be used to administer monitoring forms.

Figure 2.3.4. presents a model for the proposed MES approach. This approach is the one recommended for the WDA Planning Unit. In communities for which baseline data is not available, a cross sectional survey in which baseline data is collected retrospectively in project and control villages is suggested.

The MES system includes a package of forms and questionnaires for baseline studies, monitoring surveys, and evaluations. Some forms are administered in both project and control communities, others are only used in communities with new water facilities. Surveys conducted in both types of communities cover socioeconomic conditions and the utilization of major water sources. They are: the Community Socioeconomic Surveys, the Community Water Point Surveys, and the Household Surveys. Each form is slightly different according to its use in baseline research, monitoring, or evaluation. Forms and questionnaires administered in target zones only deal with the activities of the community well committee, the construction and operation of the water supply system, and the pump operator. Surveys of control villages during different stages of project implementation are outlined in Table 2.3.3.

3.5. Data Collection Instruments and Survey Forms

This section outlines the contents of survey forms and describes the uses of the information they provide. Methodological issues and some of the problems involved in the collection of information are also discussed. An outline of the data collection instruments, and a full set of forms, is included in the Appendix, Volume IV.

3.5.1. Baseline Surveys

Baseline surveys are used to obtain socioeconomic and water use information for villages in the target area (in general, those within a 5 to 6 kilometer radius of the well site) before interventions occur. They provide benchmarks against which changes are measured. While some baseline information should be collected before drilling begins, much of the data can be completed any time before the system starts to operate. If necessary, baseline conditions can be established retrospectively but this information will be less reliable.

Information in regional studies, project documents, and agency reports, can also be used to generate baseline data for project areas. This approach is particularly applicable to the Bay Region and the Central Rangelands, for which a great deal of data was, and is being, collected. The problem is that village level data is not yet available for the Bay Region, and the

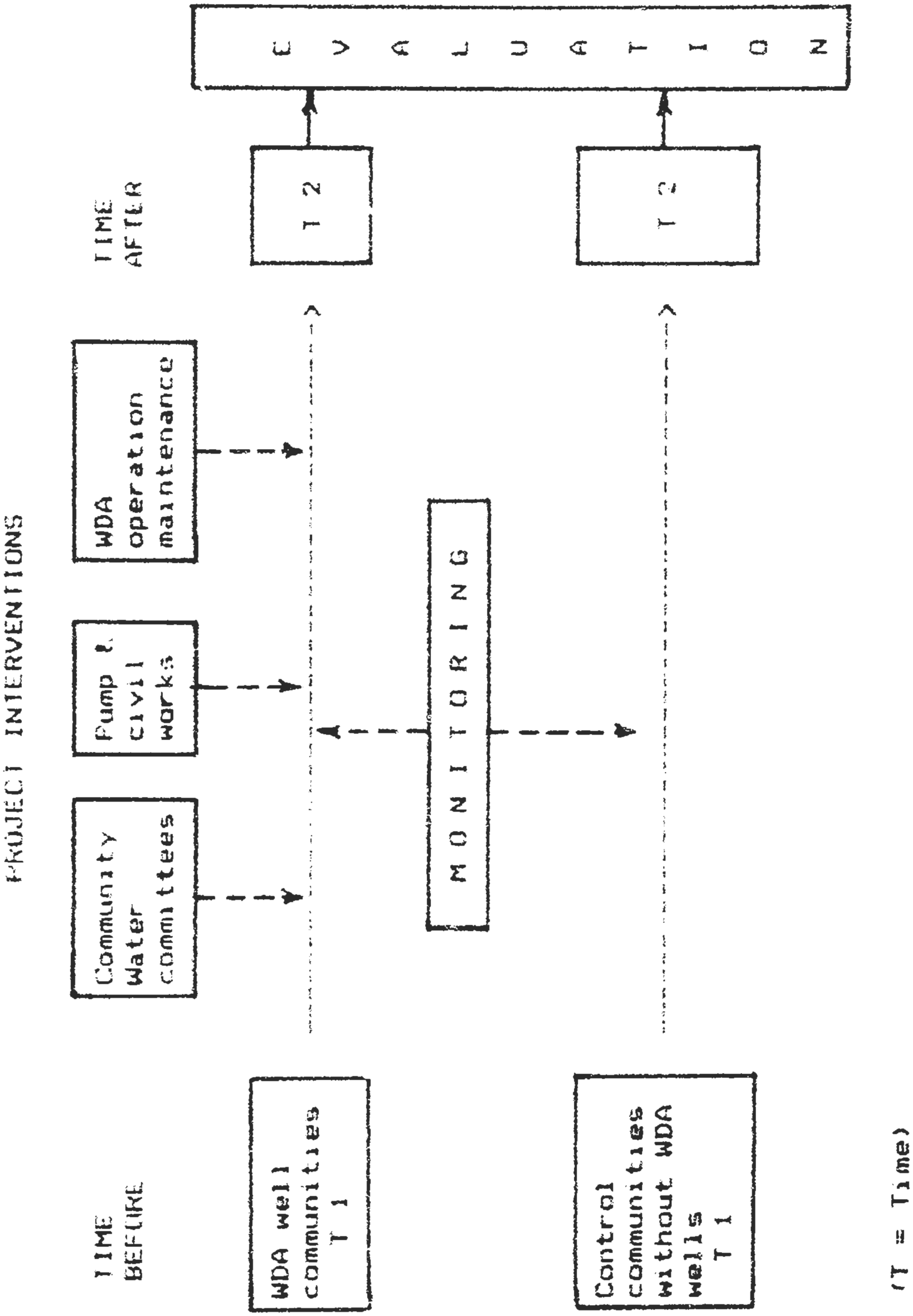


Figure 2.3.4 MODEL FOR PROPOSED MES APPROACH

Central Rangelands socioeconomic data needs professional assistance to put it into a format from which it can be easily retrieved. While the entry of secondary data into the MES data bank will take some time, this approach is highly recommended. Baseline studies are time consuming and the WDA monitoring staff will not have sufficient numbers of trained field staff for many years.

Table 2.3.3. The Organization of Surveys in WDA/CGDP Communities and Control Communities.

	STAGE OF PROJECT IMPLEMENTATION			
	I Orientation and Assessment	II and III Drilling and Construction	IV Operation and Maintenance	
TYPE OF SURVEY -->	Baseline	Monitoring	Monitoring	Evaluation
With WDA Wells and control communities				
Socioeconomic	x			x
Water Point	x	x	x	x
Household	x	x	x	x
With WDA Wells				
Water Committee	x	x	x	x
Post-Construction			x	
Pump Operator			x	
Well Site		x	x	x

Baseline survey forms include the following:

Baseline Community Socioeconomic Survey
Baseline Household Survey
Baseline Water Point Survey
Village Self-Assessment Survey
Community Water Committee Baseline Survey

The Baseline Community Socioeconomic Survey is used to collect data on population, the number of villages, social organization, economic activities and social services such as health and education. Particular attention is given to the identification of water sources used by the residents and traditional methods of water management. It includes a section on how to draw maps of the target area (a 5 Km radius around the well site) and how to use maps to collect land use and physical infrastructure data.

Baseline data will also be obtained through a review of socioeconomic and agricultural surveys which are now available for several regions of Somalia including the Bay Region and the Central Rangelands. These surveys are sources of detailed information and are the result of lengthy investigations. The appropriate se of this information will reduce the time and increase the comprehensiveness of the baseline profiles.

The survey should begin to get population data, and other data essential for site selection and community participation activities, as soon as the potential well site area is identified. The survey can, however, be completed anytime during the period in which the system is under construction. In communities where pumping operations have started and for which baseline data is not available, or incomplete, the survey can be done retrospectively.

The Baseline Household Survey is administered to selected households, and establishes the patterns of household water use, the location of sources, the time required to obtain water, costs, and the quantities consumed. It also includes questions about land and animal ownership.

Baseline Water Point Surveys are conducted at several of the most frequently used sources within the target zones. Information is collected on the type of source (hand dug wells, wars, etc.), reliability, utilization patterns, fees, and ownership and management systems, of the more intensively surveyed villages. These sites are monitored throughout the year to establish benchmark data to measure changes which occur after the well is completed.

The Village Self-Assessment Survey is included in the list of baseline survey forms, although its major function is to stimulate community discussion and participation. It is basically a simplified version of the Community Baseline Survey to be filled in by the leaders and residents of villages in the target area. Additional testing and research is needed to improve the self-assessment approach and the reliability of the data collected by villagers.

The Water Committee Baseline Survey is used to obtain information of the composition and organization of the committee formed to coordinate community participation and well management activities. It is used to record agreements between the community and WDA in regard to local contributions of labor and resources during and after the installation of the pump. While the primary use of baseline data is to accurately describe conditions which are expected to change when the well is completed, the information is also used to assist in the selection of communities for well projects, the selection of the well site village within a target zone and, to validate data from other sources.

3.5.2. Monitoring Surveys

The purpose of these surveys is to describe and assess:

(1) The physical condition of the pump and water distribution system.

(2) The management of well operations.

(3) The interim effects of well use on socioeconomic conditions and patterns of water utilization.

(4) The participation of villagers in well construction and management.

Periodic monitoring is done to measure the progress of well construction and to obtain opinions from villagers and WDA employees on desired changes in the design of the distribution systems and management procedures. Technical data on the pump and civil works is obtained through interviews with the pump operator and a visual inspection of the system while in operation. Water use and consumption data is collected in the Water Point and Household Surveys.

Ideally, quantitative data on operations, fuel supply and maintenance would be kept by the pump operator. A model Water System Record Book is included in the list of monitoring instruments. There are several obstacles to the immediate implementation of this method, however, including the low level of literacy of the operators and the lack of incentives to keep accurate records. These problems are not easy to resolve and the field staff will have to rely to a large extent on interviews and observations until pump operators or other village officials are trained to keep these records.

Water meters are essential to well site monitoring and should be installed as soon as possible on all pumps. They will provide accurate information on the volume of water pumped which can be used to check fuel consumption and water use data collected through interviews and observations.

The monitoring of socioeconomic change and village participation provides data needed for an in-depth analysis of well impacts and for planning future projects. Although part of the system involves the collection of quantitative data from a sample of villages and residents, most socioeconomic monitoring relies on group interviews to broadly identify the scale and direction of change. A list of data collection instruments and monitoring forms is presented below.

- Drilling and Construction Questionnaires
- Post-Construction Assessment Questionnaire
- Pump Operator Survey
- Water System Record Book
- Well Site Monitoring Form
- Water Point Monitoring Form
- Household Monitoring Form
- Community Water Committee Monitoring Form

The Drilling and Construction Questionnaires are administered during visits to the community while the borehole is being drilled and while the water distribution system is under construction. They contain questions on village contributions of labor and material resources and the role of the water committee in the organization of local participation. The data can be collected during visits organized to promote community participation.

The Post-Construction Assessment Questionnaire is administered after the water system begins operation and the civil works are completed. It is a supplement to the Water Committee Monitoring Form and the questions are addressed to committee members and a group of women It deals with the history of village participation, and with local contributions during the drilling and construction activities.

The Water System Record Book. At present, the only records kept by the pump operators are receipts for water use. These receipts are not regularly issued in all villages and cannot be considered a reliable source of data. When (and if) the obstacles to water system records can be overcome, the book will contain data on well operations, fuel supply, maintenance, repairs and seasonal patterns of water use by people and animals. This data will be tabulated and the results entered into the Well Site Monitoring Form each time the site is visited.

The Pump Operator Survey is used to collect background information on the pump operator and his assistant. It covers vital statistics and questions on job experience, WDA training and their participation in earlier stages of the project. The information will be used in connection with monitoring and evaluation data to determine if there is a relationship between background factors, training and performance on the job.

The Well Site Monitoring Form is organized to facilitate the entry of data from the Water System Record Book and to collect information on technical and organizational problems. It contains an observation checklist to monitor the status of the pump, civil works and environmental health conditions at the well site. It contains questions on the relationship between the pump operator, and the community water committee, the WDA, and other institutions involved in the operation and maintenance of the system. One section queries the pump operator on progress made toward the resolution of past problems and actions needed to resolve current ones.

The Water Point Monitoring Form is used to survey water sources, other than the project well, frequently used by permanent and temporary residents of the area. The purpose is to determine the effect of the drilled well on patterns of water use, numbers of users and reliabilty of supply at these other watering points. A major issue is the extent to which the availability of water at the drilled well reduces the demand at these other sources and increases their reliabilty, particularly during the dry season. Data collected on fees charged at these other points can be compared with those at the well and should provide data which will permit an analysis of the relationship between costs to consumers and patterns of use. The survey form is essentially a repeat of the Baseline Water Point Survey.

The Household Monitoring Form repeats questions from the Baseline Household Survey, including those on time and labor expended to collect water. The data will be analyzed to determine the time saved by households and how it is used. This survey will be administered periodically to the same households over the life of the monitoring period. It should capture the seasonal pattern of water use at different sources and should reveal the changes which result from the availabilty of water at the drilled well.

The Community Water Committee Monitoring Form is used to obtain information on changes in the organization and activities of the water committees. It contains an activities checklist and questions related to well management and village participation. It is designed to get the villagers perspectives on changes, problems and how they may be solved.

This form, administered during periodic visits to the communit", will be an integral part of the Planning Unit program to strengthen the water committees. Discussions held during the question period will cover ways in which the water committee and local residents can more effectively participate in well management and other related development activities.

3.5.3. Evaluations

The Annual Well Site Evaluation addresses the full range of issues and questions presented in Section 3.3. and summarized in Table 2.3.4. The evaluation program includes questionnaires on technical status and operations, water use patterns and on socioeconomic change and community participation. Data from the baseline, monitoring and evaluation surveys will be analyzed to produce a report for each well site. Results from all surveyed villages will then be compared and analyzed in the Annual Regional Evaluation. Several villages will be selected for in-depth study in order to more fully understand variations among villages with regard to the quality of technical operations, socioeconomic change and the distribution of benefits.

The data collection instruments used for the annual evaluation are:

The Annual Community Evaluation Form.
The Annual Well Site Evaluation Form.
The Annual Household Survey Form.
The Water Point Evaluation Form.

The Annual Regional Evaluation involves a comparative analysis of results obtained in the Annual Well Site Evaluations done in communities with pump wells and control villages. The information will be used to produce a regional evaluation report based on community level data and an in-depth analysis of variations between communities and key issues identified in the field studies. Topics to be addressed will include:

Variations among communities in regard to the use of the system and the physical condition of the pump and civil works.

The relationship between water development and socio-economic change.

Differences between villages in regard to the type and scale of change and the distribution of benefits within families, groups and communities.

The effectiveness of alternative approaches to community participation in the management of the water system.

Table 2.3.4 MIS Surveys and Evaluation Issues

TOPICS/CATEGORIES	SOURCES OF DATA	EVALUATION ISSUES
TECHNICAL/OPERATION & MAINTENANCE: Physical Condition of: Pump Water Distribution System Enclosures Pump Operations Fuel Maintenance Repairs	Water Supply System Records Well Site Surveys Pump Operator Questionnaire Water Committee Surveys	Adequacy of design: capacity, technology & layout of distribution system Condition of pump and civil works--repairs & improvements needed Are maintenance & repair services & supplies delivered when needed Ability of WDA to resolve problems identified by pump operators & committees
WATER USE Information by season: Who Collects it Quantity Collected Where Collected Time Spent Collecting Use Patterns at Different Sites	Water Point Surveys (Non-well) sites Household Surveys Well Site Surveys	How much time is being saved on water collection by season How additional time is being used by season Changes in patterns of use at other water sources Changes in costs of water use Villagers perceptions about changes in water quality
SOCIO-ECONOMIC CONDITIONS Population Number & Distribution of Villages Household Size Local Institutions Leadership/Traditional & other Physical Infrastructure Services Water Resources Schools, health posts Roads/Transportation Major Economic Activities Farming & Herding Trade & Commerce Health & Hygiene	Community Socioeconomic Surveys Household Surveys Records of Other Development Agencies (NRA, BRADP,etc.) Water Committee Surveys	Changes in number & distribution of residents Changes in physical infrastructure & services available Impact of water supply on livestock Impact on seasonal herding patterns & rangeland conditions New agricultural & commercial activities Effects of water supply on local environment & health status Variations in benefit distribution within & between communities
COMMUNITY PARTICIPATION The community water committee Drilling & construction Operations & management System design, site location Relationship to WDA	Community Socioeconomic Surveys Water Committee Surveys Well Site Surveys Post Construction Assessment Survey	To what extent community organizations have been involved in construction & management of wells Whether communities have adequate power & authority to manage pumping operations Whether communities with well organized committees & high levels of local participation have more effective water systems

The first Annual Well Site Evaluation is conducted 12-15 months after the water system is fully operational and on a yearly basis thereafter. In addition to the annual evaluations, the Planning Unit should schedule an in-depth impact evaluation three to five years after the wells have been in operation. It will be based on an analysis of the annual evaluation results and focus on key policy and program planning issues.

3.6. The Analysis and Use of Monitoring and Evaluation Surveys

The results of the monitoring and evaluation surveys will be analyzed in relation to a wide range o technical and organizational issues. Several of the key issues, and their relationship to program decisions, are discussed in Section 3.8, which describes and analyzes the data from an evaluation conducted at a sample of well sites.

3.6.1. Technical Operations, Maintenance and Costs

Information on the quality of the civil works and their appropriateness to utilization patterns will be used to make necessary technical changes in the type and size of material components, and in the design of the water distribution system. This has already occurred during the pilot testing of the Well Site Monitoring Form and has led to several significant changes in the design of water distribution points.

The identification of factors which contribute to effective and efficient well operations will be provided through periodic economic analyses and will cover a wide range of socioeconomic and technical factors. They include the scope and effectiveness of water management activities, user demand and pump maintenance. The data will also permit preliminary economic analyses of well operations. Early identification of significant factors will have immediate implications for water development plans.

The monitoring and evaluation reports will increase information flow between villages and regional and national WDA offices. This should result in a more rapid resolution of logistical difficulties, and solution of maintenance and repair problems before they become serious.

3.6.2. Patterns of Water Use and Time Savings

This will include a description of the changes in the patterns of water use that have occurred since the well was constructed. The focus is on the analysis of time saved by individuals and families and how it is being used in other activities. Comparisons will be made of changes within and between communities.

This information, combined with other household and community level data on socioeconomic changes, will eventually enable estimates of economic and "quality of life" benefits. Preliminary analyses can be made with the data from the annual evaluations, but at least three years of data will be required for a meaningful impact evaluation. This information will be useful to planners who need to present comparative cost-benefit analyses of alternative water development strategies.

3.6.3. Socioeconomic Conditions

The Annual Community Evaluation will describe and measure changes in socioeconomic conditions that have occurred since the well was constructed. It covers demographic trends, services available, and changes in agricultural patterns, range conditions and commercial activities. Some health related data will also be analyzed, but the lack of health facilities which regularly collect epidemiological data limits the extent to which these impacts can be measured. Many changes, such as population growth and physical infrastructure, can be quantified, while others, such as number of livestock, will be examined to define trends. The regional analysis will compare the results from different communities and attempt to explain the reasons for these variations.

Several communities, and from four to six families in each well site target area, will be the subject of longitudinal surveys. Additional communities and families will also be chosen for in-depth studies after the regional level data is analyzed to determine variations between villages.

Because there are no systematic studies in Somalia of the impact of water development on socioeconomic and environmental conditions, these evaluation results will be useful to planners within the Ministry of Minerals and Water Resources and other development agencies. Of particular importance will be the analysis of negative effects and unintended consequences, which will help planners to anticipate and, hopefully, avoid some of the more serious mistakes.

3.6.4. Community Participation

Community participation is part of the WDA strategy and is also used by other agencies in the Bay Region and Central Rangelands. At present, several approaches to local involvement are being used, and even within a single region different patterns are emerging with respect to the management of water resources. The evaluations will analyze the relative advantages and disadvantages of each approach and indicate how WDA regulations could be modified and adapted to local organizational contexts. This information should also contribute to discussions with respect to policy issues such as community control and the privatization of operation and repair services.

3.7. Schedules and Reporting

This section describes the sequence of data collection and reporting activities, and the types of information shared with departments within and WDA and other agencies. Copies of all reports are kept at the regional and national headquarters of the WDA Planning Unit. Full reports, and sections of some, are shared with other WDA departments, development projects, such as BRADP and the CRDP, and with the ministries of Agriculture and Planning.

3.7.1. Baseline Surveys

All baseline surveys should be completed within two to three months after community participation activities are begun. If this is not possible, the missing information can be obtained while drilling and construction takes place. Some baseline data will be used in connection with the selection of villages for a well, and in the selection of a well site village within the target area. The survey reports are kept by the regional and national planning unit offices and summary reports sent to other development agencies.

3.7.2. Program Monitoring.

Formal monitoring begins during the drilling stage and visits should be made to the well site while the drilling operations are in progress and while the civil works are under construction. No reports are involved, although information on problems and needs can be communicated to the regional WDA office and other departments responsible for these activities.

The Post-Construction Assessment Questionnaire is administered shortly after the water system begins operation. This information is shared with WDA units involved in drilling and construction and would be made available to other agencies and private companies who may assume responsibility for these activities.

The other monitoring forms are administered twice a year in all well site target areas, and four times a year in those areas selected for more intensive surveillance. If training can be provided to the pump operators in the use of the Water System Record Book, data will be entered there on a daily basis. Data from the Well Site Monitoring Form will be used to produce a technical report to WDA departments which deal with well operations and maintenance. Copies of this report will also be sent to the pump operator and the community water committee.

3.7.3. Evaluations

Evaluations will be conducted in each target area approximately one year after pumping operations begin. This report will be sent to and discussed with the pump operator and the community water committee. The information from each community will be analyzed and summarized annually and used to prepare a regional evaluation report. These reports will be sent to all relevant agencies involved in project implementation and planning.

The following sections present the results of an evaluation of eleven well sites conducted as part of the process to develop a monitoring and evaluation system. The presentation also illustrates many ways in which the data can be tabulated, compared, and analyzed.

3.8. Monitoring and Evaluation Survey Results

This section is a summary of monitoring and evaluation surveys conducted in nine communities with CGDP wells. Some data is reported for the Central Rangelands, but the report concentrates on the situation in ten Bay Region communities. The research was done on an intermittent basis between July 1985 and March 1986, and included seven field visits which lasted from four to ten days. Five visits were directed by LBII consultants and two were carried out independently by a member of the Planning Unit staff. The CGDP conducted most drilling activities in the Bay Region and this emphasis is reflected in the socioeconomic investigations.

Two members of the BRADP Monitoring Unit participated in an evaluation of well site villages in the Bay Region. The original Work Plan anticipated a larger amount of field time, but the lack of WDA staff, and the fact that BRADP personnel were not available until March 1986, reduced the scale and intensity of the evaluations.

Field methods included the administration of several survey forms, observations of physical conditions and patterns of water use, interviews with the pump operators, and group discussions with local leaders and members of water committees. Informal interviews were held with individuals using the wells, and data were obtained from a Water System Record Book that had been completed for two months in one village. Baseline information was generated from socioeconomic studies conducted by LBII consultants (Roark 1982, 1983), Wyoming University (1984), the Hunting report (1982) and in restrospective interviews during the evaluation research.

When possible, local leaders were contacted in advance and requested to notify water committee representatives from other villages within a five to six kilometer radius of the well site. Most visits began with the observation of well operations, and inspection of the system using the Well Site Monitoring (or Evaluation) Form. This was followed by an interview with the pump operator, and the collection of data using the Water Point Monitoring (or Evaluation) Form. The next step was to interview the water committee members and other leaders about well management, community participation, and changes in the villages since pumping operations began. Survey instruments used during these meetings included forms for Post-Construction Assessments, Water Committee Monitoring, and the Annual Community Evaluation. The testing and evaluation of these instruments was an important part of the investigations.

The validity and reliability of the data presented below is highly variable. Although accurate information was obtained on the well site conditions, pump operations and maintenance, data on fuel consumption and prices are less reliable. Diesel fuel is often purchased from sources other than WDA, and those who control these activities frequently manipulate the figures to protect their own interests. Patterns of water consumption vary within and between communities. Daily records were available at one well, and satisfactory data was obtained at four others. More field work is required to generate reliable statistical information on the number of people and animals who use the well.

Data on socioeconomic conditions, and changes in physical infrastructure and services such as schools and shops, accurately indicate the scale and direction of change. Informants estimates of the number of new households are, at best, very rough. The collection of reliable data will require field work in a representative sample of all villages within each target area. There is, however, sufficient data to estimate the percentage of growth in some communities, and the impact of the well on settlement patterns and migration. In spite of their reservations about the accuracy of some data, the LBII socioeconomic staff decided to make quantitative estimates whenever possible, rather than simply report trends. The sections below describe conditions and changes in communities with wells installed by WDA and the CGDP.

3.8.1. Technical Conditions, Operations and Maintenance

The physical condition of the pumps and distribution systems are generally good. The major problem is the lack of supplies such as oil and filters required for proper maintenance. Table 2.3.5 summarizes the findings from ten sites in the Bay Region and one in the Central Rangelands. The paragraphs below briefly address the findings in relation to the evaluation issues presented in Section 3.3.

(i) Adequacy of design.

In most villages, the capacity of the pump, tanks and distribution systems are adequate to meet the demand during the dry season. The major problem noted by the pump operators and committee members is the slow rate at which troughs fill. The small diameter of the pipe between the storage tank and the troughs was identified as the cause of this problem.

Table 2.3.5. Condition of Pumps and Civil Works

Category	Ratings and Number of Villages		
	Good	Fair	Poor
Pump system	10 (1)*		
Maintenance	9 (1)	1	
Pump operation supplies		1	9 (6)
Storage tank	5	2	
Distribution system: domestic	6	1	
Distribution system: animals	5	2	
Control and protection	7		
OVERALL RATING	6	1	

* Figures in parentheses are for the Central Rangelands. Civil works are found at 7 of 10 sites in the Bay Region and are not present in the Central Rangelands.

Two other serious problems are the lack of tank covers and the inability of sheep and goats to use the troughs. Covers are needed to prevent dirt and debris from entering the tanks and to slow the rate of algae growth. The wall of the watering troughs are too thick (about 20 cm) for them to be used by small ruminants. At several sites, residents scoop water from the troughs and fill wooden dugouts or pails from which the animals drink. Villagers suggest that a third trough, adapted to the needs of sheep and goats, be added to the distribution system.

These and several other design issues, were identified during an evaluation visit made by LBII staff that included an anthropologist, Dr. Ronald Schwarz, a civil engineer, Mr. Peter

Templer, and a WDA construction supervisor. Solutions to these and other technical problems were addressed in a revised set of specifications submitted to BRADP and the CRDP.

No water meters have been installed at any site, although they are available at the WDA warehouse in Baidoa. Water meters are essential to well site monitoring and should be installed as soon as possible. They can provide an accurate measure on the volume of water pumped. This information is needed to check fuel consumption and water use data collected by other methods.

The lack of civil works at well sites completed with diesel pumps are a major problem. Several well sites in the Bay Region, and all sites in the CR, are without storage and distribution systems. Presently, the water at these sites is pumped into abandoned mud pits or reservoirs dug in the ground. These conditions are inadequate and unsanitary.

(ii) Maintenance and repairs.

The pumps appear to be well maintained, although in many cases they have not been operating long enough to have had severe problems. Fuel supplies have been adequate, but there have been some interruptions. Most villages have purchased diesel from private suppliers in addition to the fuel obtained from WDA.

Only a few well sites had even a mimimal supply of oil, and none had replacement oil filters. Pump operators protect and clean the pump carefully, but their skills are limited to turning it on and off. Routine maintenance, including filter changes, involves the intervention of WDA technicians.

Some informants stated that WDA was slow to respond to requests for assistance. WDA's capacity to supply inputs and provide maintenance and repair services is already limited and could become a more serious issue as the number of diesel pumps increases. The lack of supplies such as oil and filters is a problem and these items should be available at each site so that proper maintenance procedures can be followed. The involvement of the private sector to provide maintenance and repair services would substantially improve the effectiveness of well operations. A program to train technicians and finance commercial maintenance and repair contractors would increase the options available to villagers and facilitate the continuity of pump operations.

A few a small leaks were found in most storage tanks but loss of water does not seem to be a serious problem. Troughs in several villages have begun to crack and in a few instances these are, or may soon become, major structural defects. Almost all human watering points have several spigots out of order or with leaks. These spigots are intensively used throughout the year and the quality of those installed does not appear to be adequate. They should probably be replaced by a more heavy duty model.

The sanitary condition of the storage tanks was generally satisfactory although small quantities of dirt, debris and algae was found in most of them. Villagers have contributed labor to help maintain these tanks.

(iii) Pump operations.

The use of the hand and diesel pumps vary with the supply of water at other nearby sources. Local reservoirs (_wars_) are close to most villages in the Bay Region, and the inhabitants who help maintain them do not pay for the water. As long as water is available in the _wars_, they are a more convenient and less expensive source. Observations and interviews in villages between July and October, 1985, when the village reservoirs had adequate supplies, revealed that pumping operations were limited to between 10 and 20 hours a month at most sites. The consumers were generally residents of nearby villages, or pastoralists passing through the area. Most water collected was for domestic, rather than animal, use.

In December, January, and February, as the _wars_ begin to dry up, the drilled wells are used with increasing frequency. Demand continues at a high level until the April (_Gu_ season) rains resupply the _wars_ and the animals are sent to graze far from the village. Table 2.3.6 presents data on the frequency and length of pumping operations at diesel wells in the Bay Region.

Table 2.3.6. Dry Season Pumping Operations, Bay Region

Month 1986	# days in month	Ave. # days operated	Ave. # days not operated	Ave. # hrs/day operated	Total hours/ month
February (5 wells)	28	24.2	3.8	4.4	123
March (7 wells)	20.4	15.5	5.0	5.8	181*

* This figure is an estimate based on the data from pumping operations during 20.4 days in March, 1986.

In the Central Rangelands, the number of animals using each well is higher than in the Bay Region. Data collected there, in December, indicated that pumps operated between five and ten hours a day at the beginning of the Jilaal season. Pumps, including those at old WDA sites, were turned on most days, although the lack of fuel occasionally limited the frequency and level of operations. At sites with civil works, four to five hours of pumping generally indicates that the facilities are in use from early morning through dusk.

3.8.2. Well Use and Fees

The reliable supply of clean water has had a significant impact on the behavior of villagers during the three to four month dry season (Jilaal). The major change is the reduction of time spent by women and children to water animals and to collect supplies for domestic use. Table 2.3.7 summarizes time allocation data from several baseline studies and from the Planning Unit surveys.

Table 2.3.7 Average Time Spent for Water Collection
Jilaal Dry Season

Source of Baseline Data	Before well	After well*	Hours Saved/per family per day	per 100 days
Bay Region water point survey (human & animal)	8-10	3.0	5-7	500-700 (63 - 88 days)
Roark (LBII) (domestic use)	4.4	1.5	2.9	290 (36 days)

* After well data is from Planning Unit surveys.
Person days are calculated on an eight hour work day.

The actual amount of time caved in the dry season by residents of some of the more distant well site villages may be as much as 50 percent higher than the above figures indicate. In addition, before the wells were installed many villagers had to make between 10 and 15 overnight journeys per month during the dry season to obtain water. Entire villages were occasionally forced to relocate closer to permanent water sources.

There is substantial variability in the actual patterns of use within and between villages. This is related to factors such as the reliabilty of the water supply at other sources, numbers of animals owned and distance from the well. In addition, the data on demographic change indicates that the number of permanent residents in villages around the well is increasing dramatically and in the very near future should lead to very substantial increases in the rate of water utilization.

In principle fees charged for water at the wells are set by WDA. In practice, WDA has a strong influence on the fees because it controls the supply and price of diesel, but local factors also enter into consumer prices. In the early months of 1985 WDA charged villagers 6000 S/sh for a 200 liter barrel of diesel fuel (30 S/sh per liter). The average price per barrel in February-March 1986 was 8000 S/sh per barrel (40 S/sh per liter), an increase of 25 per cent. In contrast, water fees have more than doubled in some villages although there are significant differences in the prices in each community. Table 2.3.8, based on data from nine communities, illustrates the changes in the fee structure.

Table 2.3.8. Water Fees (S/sh)

Type of container or user	Initial cost	Current cost	Increase in costs
Ashuun	0.2-0.25	0.25-0.50	25-100%
Haan	1.5	3.0-3.5	100-133%
200 litre barrel	4 - 5	5 - 10	25-100%
Goats and sheep	0.2-0.25	0.25-0.5	25-100%
Cattle	0.4-0.5	1.0	100-150%
Camels	0.7-1.0	1.5-2.0	100-114%

There is some evidence that the fees reported were lower than those actually charged by the pump operator. This may reflect a difference in prices charged to permanent residents and those paid by guest nomads and/or temporary visitors. The water committee in three villages have established a system whereby regular users of the well pay a fixed monthly fee for the collection of water for domestic use. The charges range from 35 to 60 shillings per household per month.

The issue of who should have authority to establish fees and control revenues requires additional investigation, and might indicate the need for a policy change. Villagers want more authority, but this in itself is not sufficient to resolve questions such as how prices should be determined and how profits should be distributed and/or invested. In villages with high levels of use, revenues may exceed costs by as much as 100,000 shillings per month during the dry season. Resolution of this issue will require substantial discussion within WDA and with members of the water committee, village leaders and consumers.

3.8.3. Case Study: Analysis of Well Use at Maleel

The analysis of well use is based on data from several communities, but draws heavily on data from one target zone which includes 15 villages around the village of Maleel. While interviews were carried out and observations made in a number of communities, Maleel was the only one in which reliable daily records on well use were kept. The analysis demonstrates the importance and utility of accurate water use data.

While the figures vary for each village, the patterns reflected by data from Maleel are similar to those found in other villages where data were less complete.

(i) Time and measurement.

The analysis considers categories of well use for different seasons, per capita water consumption rates, pump operation and capacity, revenue, and well use for Maleel and four other sites. The data for Maleel cover February 12-28 and March 1-21, with figures extrapolated for both months from averages calculated with the raw data. Conveniently, these two months are during a period of peak demand in the dry season.

The tables are based on data collected from an observer at the well, unless otherwise noted. In tables of human or domestic consumption, <u>ashuuns</u> refer to containers carried mostly by women that range in volume from 8-12 liters, with an estimated average of 10 liters. <u>Haans</u> are the containers carried by camels, usually four of them, ranging on average from 12-20 liters, with an estimated average of 15 liters. All calculations are based on four containers per visit, or 60 liters. Population figures are from The Socioeconomic Baseline Survey of the Bay Region (Univ. of Wyoming, 1984).

(ii) Dry season domestic water consumption.

Table 2.3.9 presents average daily water use at peak demand during the dry season. This high level lasts from three to five months in normal years and for longer periods during years when rainfall is low. The figures are considered typical for normal dry season use.

Table 2.3.9. Average Daily Domestic Dry Season Water Use Maleel, February and March, (1986).

	Ashuuns	Haans	200 Ltr. Barrels
Ave. No. Containers/day	204	676	1.6
Vol./Container (liters)	10	15	200
Ave. liters/Day	2,040	10,140	325

The total volume of water collected per day for domestic use is about 12,500 liters. It is estimated that from 70 to 90 percent of the total volume is consumed by individuals who live in villages other than that adjacent to the well site. The 200 liter barrels are all sold to a group of people who come by truck twice a month to take the water outside the target zone.

Table 2.3.10 relates the daily rates of water use (from Table 2.3.9) to per capita consumption requirements, and shows the number of people potentially served at different levels of consumption. While the per capita consumption figures are low, the calculations are presented to illustrate the consumption rates if the well was the only source available. In fact, from 30-50 percent of the population in the zone use the hand pump well at Mintanno, about six kilometers to the south, as an additional source of domestic water.

Table 2.3.10. Water Availability and Potential Beneficiaries in Maleel Target Zone

Liters available	Daily Per Capita Consumption Estimate		Potential Population Served	% Target Population Served	Target Zone Population
12,505	/5 Liters	=	2,501	72	3,450
12,505	/4 Liters	=	2,126	90	3,450
12,505	/3 Liters	=	4,168	121	3,450

For the lower figure of 3 liters/day/person, the estimated population in the target zone is more than adequately supplied at 121%. At 4 liters/day/person 90% of the target zone population would be served and at 5 liters/day/person 72% of the population. Because a significant portion of the population has access to the hand pump at Mintanno, the actual per capita consumption figures are higher and perhaps double those shown in the table.

It is important to note that the human consumption figures are estimates based on the number of containers filled at the well sites, and not the volume of water pumped nor the volume which could have been collected by the inhabitants. Livestock consumed four times the volume estimated for people and the supply of water was plentiful.

(iii) Animal water use.

Table 2.3.11 is the basis for calculating how frequently animals are brought to drink and how much they consume during one visit at a well site.

Table 2.3.12 shows daily figures on numbers of animals watered on average per day, and the approximate volume consumed by each type. Water consumption by camels represents 80% of the total, cattle account for 19%, and sheep and goats for 1.6%, of the total volume consumed.

Table 2.3.11. Estimated Water Requirements for Stock

Animal	Watering Interval (Days)	Requirement/ Day/Animal (Liters)	Consumption/Animal/ Well Visit (Liters)
Goats/Sheep	3 - 4	0.8	3.2
Cattle	2	20	40
Camels	9*	15	135

Source: International Livestock Center for Africa

* Most people in the Bay Region report that camels are taken for water every 6 days, rather than every 9, as specified in the ILCA document.

Table 2.3.12. Dry Season Water Consumption by Animals, Maleel, February and March Averaged.

	Goats & Sheep	Cattle	Camels
Ave No. Animals/day	227	217	266
Qty Cons/Visit/Animal (ltrs)	3.2	40	135
Ave Daily Quantity (ltrs)	726	8,680	35,910

Table 2.3.13 below compares the volume of water collected by people, with the amount of water consumed by animals.

Table 2.3.13. Total Average Daily Volume of Water Sold in Maleel During Two Dry Season Months.

	Volume (ltrs)	% of Total
Human Consumption	12,505	22
Animal Consumption	45,316	78
Total	57,821	100

Combining the two categories, average daily water consumption for this period is almost 58,000 liters. The high volume of water consumed by animals during these months suggest that the well played a crucial role in meeting the livestock requirements during the critical dry period.

(iv) Pump capacity and operation.

A comparison of the information on consumption rates in Table 2.3.13 to figures for the theoretical capacity of the pump in Table 2.3.14 shows that the pump is operating at 80% of its potential capacity. Because the 12,000 liter calculation is hypothetical, actual rates are expected to be lower due to inefficiencies in the system.

Table 2.3.14. Theoretic Diesel Pump Capacity and Maleel's Performance

	Hourly Pumping Rate	Quantity at 8 Hours Pumping/Day	% of Theoretic Pumping Rate
Theoretic	12,000	96,000	100
Maleel	9,636	77,088	80

Table 2.3.15 shows pump operations reported in an interview with the operator. The quantities of water sold in relation to the 6 hours of daily pump use are consistent with engineering estimates. While the pump could have run for 8 hours as demand was high enough and fuel was available, the capacity of the pipe to the troughs prevented them from filling as quickly as animals could empty them. The quantity of water available from six hours of daily pumping was all that could be moved through the animal distribution system.

Table 2.3.15. Maleel Dry Season Pump Operation

Month	# Days in Period Reported	# Days Operated	Hours/ Day	Total # Hours Operated in Month
February	28	28	6	168
March	21	21	6	126

(v) Wet Season Well

Use Data for wet season use are not as complete as for the two months shown in earlier tables. Data in Table 2.3.16 are from a site visit made in August when the village reservoir, the <u>war</u>, had adequate supplies. The numbers are indicative of the low levels of use during the wet season. In contrast to the dry season when users come from distant villages, only those living in the village near the well and nomads passing through the area used the well.

Table 2.3.16. Maleel Wet Season Well Site Use

Period	Ashuun	200 Liter Barrels*	Goats & Sheep	Cattle	Camels
Day of Visit	20	0	30	0	40
Av Day This Mon. (Oct)	50	9	30	0	60
Total Last Mon. (Sept)	300	150	300	0	-

* The 200 liter barrels are utilized by people who live outside the five to six kilometer radius of the well site.

The hours of pump operation is one of the best indicators of demand. The two months presented below in Table 2.3.17 indicate an average rate of pump operations of approximately 20 minutes per day. In practice, the pump operated on average of 4 days a month, for 2 to 4 hours a day. Though these figures are low, they are considered normal for this period of the year.

Table 2.3.17. Maleel Wet Season Pump Operation

Month #	Days in Period Reported	# Days Operated	Hours/ Day	Total # Hours Hours Operated in Month	Av.Hours/ Day for Month
August	31	3	3	12	0.3
September	30	5	2	10	0.3

(vi) Revenue.

No records were available on the revenue collected at Maleel, but estimates have been made from the numbers of containers filled and numbers of animals served. The actual daily revenue collected by the pump operator during this period may be different, but is probably close to the figures reported in Table 2.3.18.

The estimated daily revenue from water sales at Maleel was So.Sh.1,516. Of this, So.Sh.786 represents domestic use, and So.Sh.730 represents consumption by animals. The 1,516 shillings represents an average daily revenue for the peak demand season which normally lasts between three and four months. Based on an estimated dry season use of 100 days, the revenue for the entire period would be 151,600 Shillings.

Table 2.3.18. Estimated Daily Dry Season Revenue from Water Sales

	Ashuuns	Haans	200 Ltr. Barrels	Goats & Sheep	Cattle	Camels
Ave #/Day	204	676	1.62	227	217	266
Cost/Unit (Sh)	.50	1	5	.50	1	1.5
Ave Daily Rev.	102	676	8	114	217	399

Fuel is the major expenditure, and in Maleel the pump operator reported purchases of 300 liters between January and March, which cost 22,000 Shillings. Thus, 129,600 Shillings would be the estimated revenue collected by the pump operator. While there are other operational and miscellaneous expenses, this is probably close to the upper limit of possible revenue for a well site during a 100 day period. The figures suggest why the pump operator at Maleel and those interviewed at other sites were reluctant to record, let alone openly discuss, the revenues generated from water sales.

(vii) Other well sites and beneficiaries.

Table 2.3.19 presents estimates of daily use at a number of well sites during the dry season. The number and types of users are estimates made by the pump operator and members of the water committee in four villages.

Table 2.3.19. Average Daily Water Sales and Potential Beneficiaries.

Village	Total Vol.	Pop.	% Pop. Served at Per capita Water Cons. Levels (Ltrs/Day/Person) 5	4	3
Taflow	10,540	2,808	75	93	125
Sarman Dheere	11,900	3,430	70	87	115
Maleel	12,505	3,450	72	91	121
Gduudo Dhuunte	6,600	1,970	67	83	116
Buulo Haawo*	8,400	4,560	37	46	61
Total	49,945	19,462	-	-	-
Average	9,989	3,244	62	77	102

* Buulo Haawo has no civil works, so levels of use are lower

relative to other wells with similar target zone populations.

These calculations are based on estimates of well use recorded at the villages. The total volumes are estimated levels of water sold in ashuuns and haans.

The figures indicate that if the wells were the only source of water available in the area, the inhabitants collected between three and four liters per capita per day in all but one village. Whether these estimates reflect the actual level of consumption depends on the validity of the population estimates, and on the volume of water use at other sites in the area. The interview data indicates residents of several villages in some of these communities used other sources, including WDA and CGDP wells in neighboring villages.

(viii) Conclusions.

The patterns of well use demonstrated by the above analysis is one where demand in the dry season increases as other water sources dry up and as people and animals rely more heavily on the well. The volume of water available at the Maleel well site is sufficient to supply all or most of the domestic and animal requirements of the target zone population for all of the peak demand period. The hours of pump operation, and the quantities of water pumped, are reasonably efficient, given the capacity of the pump and the distribution system. The revenue generated from water sales provides a very high level of profit for the pump operator and/or the water committee and/or WDA. The low level of well use in the wet season is related to the fact that other, more convenient and less costly, sources are available.

The patterns described for Maleel can be generalized, with a reasonable level of confidence, to other villages. Sufficient observations were made at site visits during the months of February and March to support this conclusion, and to confirm the general trends illustrated by the data from Maleel.

3.8.4. Water Quality and Health

Environmental conditions around the water distribution points were found to be good. The concrete aprons keep the areas adjacent to the watering points dry. Observations made in February and March confirmed the lack of stagnant, muddy water which might affect disease transmission. Conditions during the rainy seasons were obviously wetter, but the level of use is low and thus the health hazards are minimal. Only one informant stated that the well water had caused an illness in the village. All others said the water was clean and some suggested health conditions had improved in their villages.

The original CGDP Project Paper, and the sociological scope of work, noted the importance of health issues, and stated:

> "...The AID health program will be implemented in the Bay, Togdher and Mudug regions and...will effectively compliment the water development program by providing information regarding water borne diseases and sanitation ..."

In 1983, the LBII anthopologist met with the expatriate health project coordinator in Baidoa and the discussions indicated that they would cooperate in the collection of health data from CGDP villages. In July 1985, the LBII anthropologist met with Dr. Rose, USAID health officer, and Dr. K.T. Thomas, Director of the Primary Health Care Project, in an attempt to obtain epidemiological data. Both stated they had no knowledge of where such information could be found, or even if studies had been carried out.

Because water development can result in substantial health benefits as well as facilitate the transmission of water borne diseases, it is strongly recommended that USAID finance a short term consultant with field epidemiology skills and African experience to develop a strategy to monitor and evaluate health impacts. The work should take about two months.

3.8.5. Socioeconomic Conditions

Communities in which pumps are operating have undergone many changes that appear to be directly related to the large, and reliable, supply of water from the CGDP wells. They include increases in the number of permanent households, shops, schools and transportation. Perhaps the most important impact, and one not adequately reflected in the quantitative results, is the new level of security the residents have about their lives and communities. In past years, it was not uncommon for entire villages to move in search of water when prolonged dry seasons reduced local wars to dust bowls. Even in normal dry seasons, members of every family spent most of their time collecting water for domestic consumption and herding animals to water. The new wells have significantly altered the environmental situation and have stimulated the construction of more durable, structures and the permanent settlement of hundreds of families.

(i) Population and settlement patterns.

The collection of accurate statistical data on the size and distribution of the population in Somalia is difficult and time consuming because of the dispersed settlement pattern and seasonal herding activities far from the village. Village level data was collected by the Wyoming socioeconomic research team, but it is not included in their final report, nor is it available at AID or in the BRADP office in Baidoa. The population figures presented are estimates based on beel level data from the Socioeconomic Study of the Bay Region (Univ. of Wyoming 1984) and from CGDP sociological studies and evaluations. There are between 90 and 110 villages in the ten communities visited by the Planning Unit and there was not enough time or manpower to collect accurate data on the number of households or animals.

Data have been, and are being, collected by the extension team in the Central Rangelands project and results from a few deegans are available. Preliminary data from the Central Rangelands indicates that water development does result in a population increase and overgrazing in the area around the water facility. The seriousness of the problem, however, has not yet been determined. One of the principle activities recommended for the WDA Planning Unit is the acquisition of the socioeconomic data bases generated by the BRADP and CRDP projects.

The accuracy of the data on changes in the number of households in a well site community (a target zone) was limited by the fact that interviews were only conducted in the villages near the well. Representation from other villages was low in most cases. Another problem was that statements about population growth often reflected a shift in residence of families within the target area to sites closer to the well. The lack of time and limited research skills of the local field personnel made it difficult to conduct the systematic interviews needed to get accurate information. In short, the figures for new households should be viewed as indicative of trends rather than actual rates of increase.

There are approximately 200 villages in the 20 target zones, or communities, in which diesel and hand pumps have been installed. Most well site communities have between seven and twelve villages and the average village has from 30 to 60 households. The population of the communities estimated to directly benefit from the wells is approximately 60,000. These calculations are based on data from the Bay Region socioeconomic study (University of Wyoming 1984) and the Planning Unit field studies. Table 2.3.20 summarizes the population data for the 20 well site communities.

Table 2.3.20. Population of the CGDP Communities		
Category	Totals	Estimated Range
Well site communities (target areas)	20	
Villages	200	180-220
Households	9,200	8,000-10,000
People	60,000	50,000-65,000
	Averages	Approximate range
Villages per community (target area)	10	7 to 15
Households per village	46	20 to 90
People per household	6.47	5.2 to 6.8
People per village	306	104 to 612

Table 2.3.21 presents baseline and population figures from three Bay Region communities for which data on growth could be generated for an entire target area.

Table 2.3.21. Population Change in Three Communities

Community	# of villages	Number of Households 1984	Number of Households March 1986	Percentage increase
Buulo Fuur	9	410	498	21%
Awshinle	8	368	428	8.5%
Buulo Yuusuf	7	416	436	5%
TOTALS	24	1,194	1,362	11.5%

The figures indicate that the population of these communities increased by 168 families, or about 1000 persons during the 12-24 month period since pump operations began, a change of approximately 11.5 percent. Villagers estimated that at least half of this growth is due to the permanent settlement of households that previously migrated to other regions during the Jilaal season. Most of the new permanent residents in these and other target areas have settled in the two or three villages closest to the well and have increased the number of households there by more than 15-20 per cent.

Another significant change has been the rapid establishment of new villages adjacent to wells located in sparsely or uninhabited areas between several existing villages. Several new villages were reported to have more than 100 households. Again, most of this change probably reflects a shift of residence within the target area rather than a major increase in the total population.

Most villagers consulted during the evaluations viewed the settlement of new families as a positive development, and attributed this and the increase of schools and shops to the well. The response in the CR does not seem to be consistently favorable. Residents, as well as some NRA officials, are against the development of farms and the settlement of families from outside their residential-grazing area, the deegan. The sociopolitical issues in this region are more complex than in the Bay Region and require careful investigation, particularly in regard to the location of boreholes and water management plans. Many locations were discussed in a recent conference sponsored by the NRA and the CRDP and are on their agenda for future study.

(ii) Infrastructure, services and commercial activities.

There has been a significant increase in the number of Koranic schools, small stores (<u>dukaans</u>) selling foodstuffs and household goods, and tea shops. Table 2.3.22 is based on data from the development indicator checklist found in the baseline and evaluation surveys.

Table 2.3.22. Development Indicators (9 villages)

Indicator	Total Number 1984	Total Number 1986	Average per Village 1984	Average per Village 1986
Koranic schools	28	84	3.1	9.2
Health posts	0	1	0	0.1
Dukaan (small stores)	8	62	0.8	6.8
Tea shops	11	69	1.2	7.6
Markets	0	1	0	0.1

In the sample villages, the number of Koranic schools approximately tripled (from 28 to 84). The largest increases are in the number of new dukaans (from less than one per village to almost seven) and tea shops (from about one per village to almost eight). One community now has a health post and a market has been established in another.

Access to the communities has increased, and there are now more trucks and buses passing through some villages. The value of farmland is reported to have increased in all communities. A few informants stated that land values have increased between 100 and 200 per cent in the five kilometer area around the well. The cost and availability of agricultural labor has also risen. The higher cost of land will make it more difficult for poorer and younger men to purchase farms, but will increase benefits to those who want to sell and those who work as agricultural laborers. These changes have occurred in a relatively short period and are likely to continue.

No information was collected on changes in the number of livestock owned by residents, but several informants reported substantial increases in the number of animals in and passing through the area during the Jilaal season. Animals which, in past years were forced to make frequent trips to distant water sources, are now able to remain closer to the village. While the scale of this change is limited by the availability of pasture and forage, the expansion of farms and the cultivation of forage crops may be able to reduce part of the deficit.

Quantitative data on livestock ownership as well as information on animal morbidity and mortality is needed but will require household interviews. Questions on this and other family level impacts are included on the revised questionnaires.

The overall impact of the wells on socioeconomic conditions in these villages has been substantial and residents feel their situation has improved since the well was installed.

3.8.6. Community Participation

The community participation program (CAPP), the evaluation of its effectiveness, and recommendations, are discussed in detail in Section 2.5.7. of this report. The paragraphs below are limited to a presentation of the major findings.

(i) The organization of water committees.

Committees were organized in 12 Bay Region communities. They are similar in structure and function to the traditional water committees which manage the village reserviors, the <u>wars</u>.

There was a high level of community participation during the three early phases of the project -- orientation and assessment, drilling and construction. In spite of reports which indicated the success of the community paticipation strategy, WDA support for these activities did not continue. The result is that the water committees organized at the start of the project, are not now significantly involved in the management of the facilities. Many committee members believe that WDA failed to follow through on agreements to consult with them on management decisions, such as water fees, fuel supplies, and the use of revenues generated by well operations. Several leaders mentioned that they thought the well was to be a community well, but now view it as another WDA well and outside their control.

(ii) Community participation and contributions.

Villagers made substantial contributions during all stages of the project. They include:

Information on socioeconomic conditions, well operations and project effects.

Labor and materials for drilling, construction and some maintenance operations.

Food and cash contributions during drilling and construction.

Payment of user fees on a regular basis after pump operations begin.

Coordination and supervision of villager contributions.

Control of animals around the civil works and cleaning of the storage tank.

Contributions to drilling crews are presented in the Table 2.3.23. These contributions include labor inputs, and gifts of cash, animals, and staples, to work crews during drilling, pump testing and construction of civil works.

Table 2.3.23, below, shows that communities where there was some effort by social scientists and/or technical staff trained to promote participation, the level of contributions were more than three times higher than in those where the CAPP approach was not used. Data available for four villages in which civil works were constructed reveals a similar pattern and level of contributions. Table 2.3.24 shows community labor inputs during drilling, pump testing, and construction of civil works.

Table 2.3.23. Community Contribution to Drilling Crews

	# villages in sample	Average cash payment	Cash value animals	Average cash value
CAPP*	14	8,000 S/sh	19,000 S/sh	27,000 S/sh
NON-CAPP	7	3,300 S/sh	5,000 S/sh	8,300 S/sh

* Communities in which some meetings were held to promote local participation and organize well committees.

Table 2.3.24. Community Labor Inputs, (CAPP villages)

	Labor Inputs (person days)			
	Drilling and pump testing	Civil works construction	TOTAL DAYS	Cash value*
Average per Village	565	1238	1,803	324,540 S/sh
TOTAL four Villages	2,260	4,952	7,212	1,298,160 S/sh

* The cash value of labor is calculated at 85 S/sh per day for salary and 95 S/sh per day per diem costs. Total 180 S/sh per laborer. This is the minimum paid by WDA/CGDP to Somali workers in the field.

Table 2.3.24, above, indicates that in communities in which the CAPP strategy was used, villagers contributed 1,803 person days of labor which has a value of approximately 325,000 Somali Shillings or $4000 dollars.

In general, village leaders in the Bay Region have demonstrated a high level of interest and ability to promote and manage water development. The concept of shared responsibility among residents of different villages is well established in the region and the contribution of goods and services has been relatively high. The social science activities supported by the CGDP have demonstrated the viability of community participation and produced an integrated program (the CAPP) to guide this component. With adequate logistical and manpower support from WDA, the CAPP strategy could facilitate the expansion of water resource development and reduce capital and administrative expenditures.

(iii) Community Participation Issues in the Central Rangelands.

The socioeconomic and development contexts in the Central Rangelands are significantly different from those found in the Bay Region. Population density is smaller, the number of animals per household is much larger (about ten times greater) and the principle mode of production is pastoral. The NRA and the CRDP have a strong informal education-extension program which focuses on the creation of Range and Livestock Associations (RLA's) at the deegan level. The major issues in this region are:

(1) The participation of the RLA's in the drilling, construction, and management, of the water development program, and,

(2) The institutional support available to promote and sustain their participation once the system is constructed.

The RLA's are still new organizations and while they are based on social and geographical conditions, they are composed of many groups spread out over a large area. Because the management of a diesel powered pump and civil works is somewhat complex, and has a high potential for generating conflict, a serious question remains as to the the appropriateness of local control of these systems by the embryonic RLA's. Additional long term research is needed to adapt the CAPP to extension activities in the CRL, particularly in regard to the role of RLA's in water management.

4.0 COST ANALYSES

Comprehensive cost estimates for groundwater development in Somalia have been produced during the project. This section of the report describes the methodology used, explains the rationale behind it, and presents the major findings. Only the cost of well construction and maintenance has been determined. Using this as a model, the cost of other operations of WDA, such as the building of reservoirs and the construction of urban water supplies, should be determined by the Planning Unit over the coming years.

In project appraisal terminology, three kinds of analysis are possible, financial, economic, and socioeconomic. Financial, or "commercial", appraisal uses estimates of the actual local costs which would be relevant in assessing the commercial viability of an operation. Economic appraisal assesses the viability of an operation from the position of the country as a whole; as such, taxes and tariffs are excluded, and prices used are c.i.f. or f.o.b. "world prices" or "shadow prices". Socio-economic appraisal is based upon economic appraisal, but makes additional allowance for the "social" goals of the government; in this type of analysis savings might be valued differently from consumption, and some weighting might be given for beneficial distribution of income or profits. The analysis which follows is closest to an economic analysis in that prices used are world prices exclusive of taxes. The costs used relate to a donor-funded groundwater program in Somalia. This explanation is somewhat simplistic, and the issue is discussed more fully in Section 4.3, where possible adjustments, and the difficult question of evaluating benefits, are considered.

In this section of the report, the cost of well construction is dealt with first, beginning with a brief description of the overall methodology, and then dealing with each phase of the work involved. Operation and maintenance costs, and the amortisation of total costs is discussed next. Finally, some issues on shadow prices for possible use in a true economic or socioeconomic appraisal are discussed, including a discussion of the significance of user charges.

Two economic analyses of the Comprehensive Groundwater Development Project have previously been completed by LBII consultants during the project. The first of these was undertaken by Mark B. Pape, (Pape, 1982) and the second by Carter Brandon, (Brandon, 1984). For the sake of brevity, these reports will be referred to as the Pape and Brandon reports respectively. These reports contributed substantially to the understanding of the costs and economics both of the project, and of the development of groundwater resources in Somalia. A further analysis has now been completed and is presented in this report. Because the figures developed in this report are, in some cases, considerably different from those arrived at in the previous reports, and the methodology used differs, some comments are appropriate here.

The Pape analysis was written at the time when there existed virtually no CGDP project experience from which to draw. It sets out an excellent methodology for the estimation of the costs of well construction. The model is very detailed, with sufficient variables to allow it be used for any proposed drilling operation in Somalia. The methodology resulted in an analysis that closely predicted the actual cost of well construction (Pape, 1982, p.46).

The Brandon analysis estimated an average direct cost for basic well construction of $53,500 (Brandon, 1984, p.29). This appears deceptively close to the latest available figure of $54,030 for Bay region drilling. However, the three analyses included significant variation in estimates of the cost of surface casing, well casing, screen and diesel pump. Differing costs for screen and casing reflect differing standards required. Experience determines the appropriate standards for a particular region. The variations in the estimates made are as follows:

	Latest Figures		Brandon	Pape	
	Steel[1]	P.V.C.	Steel	Steel	P.V.C.
8" Casing	49	40	76	75	18
8" Screen	85	57	104	84	37
Surf. casing	85	--	144	144	--
Diesel pump	$15,225		$20,020	$13,500	

[1](Steel supplied from Nairobi, transported by road (+16% freight) P.V.C. supplied from U.S.A., transported by container (+25% freight), figures in U.S.$ per meter including freight charges.)

The most recent estimates are shown in summary form in Tables 2.4.1 through 2.4.4. The Brandon analysis cost of $53,500 does not include any allowance for capital equipment purchase, depreciation, or repairs and maintenance. The most recent estimate of $54,030 quoted above for operations in the Bay region includes a realistic capital replacement charge, and an annual repairs and maintenance charge for all equipment, based on 10% of the capital costs.

The construction cost, "including sunk capital costs", arrived at in the Brandon analysis is of the order of $188,000, (Brandon, 1984, p.40). The analysis presented in this report

Table 2.4.1. Summary Construction Cost - Production Well (Diesel Pump)

Production Drilling Program - Bay Region	Cost (So.Sh.)	Cost (US$)	Total US$ equiv.
Hydrogeology	5,612	556	638
Drilling	72,857	25,514	26,414
Logging	1,494	311	330
Well testing	7,345	880	974
Civil Works	69,056	6,594	7,447
Pump Installation	4,716	18,171	18,229
Grand Totals	162,282	52,027	54,02[illegible]

	Labour	Materials	Transport
Hydrogeology	82		556
Drilling	595	8,[illegible]	17,5[illegible]9
Logging	18		311
Well testing	9[illegible]		88[illegible]
Civil Works	329	5,[illegible]	2,[illegible]4
Pump Installation	59	17,225	94[illegible]
Grand Totals	$1,45[illegible]	$30,2[illegible]	$[illegible]
			$54,0[illegible]

Exploratory Drilling Program - Central Range	Cost (So.Sh.)	Cost (US$)	Total US$ equiv.	Increased cost of C/R Program as % of Bay Region Costs
Hydrogeology	10,649	1,101	1,232	93%
Drilling	118,65[illegible]	50,[illegible]	52,218	98%
Logging	2,230		617	88%
Well testing	9,433	1,216	1,332	37%
Civil Works	74,387	7,577	8,495	14%
Pump Installation	6,603	18,699	18,781	3%
Grand Totals	[illegible]	[illegible]	82,677	53%

	Labour	Materials	Transport			
Hydrogeology	131		1,101	61%		98%
Drilling	1,465	9,730	41,023	63%	22%	131%
Logging	28		592	49%		90%
Well testing	116		1,216	25%		38%
Civil Works	395	5,023	3,077	20%	0%	47%
Pump Installation	82	17,225	1,474	40%	0%	56%
Grand Totals	$2,217	$31,978	$48,482	50%	6%	117%
			$82,677			53%

Table 2.4.2. Summary Construction Cost - Exploratory Well

Production Drilling Program - Bay Region	Cost (So.Sh.)	Cost (US$)	Total US$ equiv.
Hydrogeology	5,612	556	638
Drilling	47,878	12,197	12,788
Logging	1,494	311	330
Grand Totals	55,[illegible]	13,064	13,755

	Labour	Materials	Transport
Hydrogeology	82	0	556
Drilling	591	2,200	9,997
Logging	18	0	311
Grand Totals	$691	$2,200	$10,864
			$13,755

Exploratory Drilling Program - Central Range	Cost (So.Sh.)	Cost (US$)	Total US$ equiv.	Increased cost of C/R Program as % of Bay Region Costs
Hydrogeology	10,649	1,101	1,232	93%
Drilling	79,102	30,321	31,297	145%
Logging	2,230	592	619	88%
Grand Totals	91,982	32,013	33,148	141%

	Labour	Materials	Transport			
Hydrogeology	131	0	1,101	61%		98%
Drilling	977	6,225	24,096	65%	183%	141%
Logging	28	0	592	49%		90%
Grand Totals	$1,136	$6,225	$25,788	64%	183%	137%
			$33,148			141%

Table 2.4.3. Summary Construction Cost - Production Well (Hand Pump)

Production Drilling Program - Bay Region

	Cost (So.Sh.)	Cost (US$)	Total US$ equiv.
Hydrogeology	6,612	556	638
Drilling	72,857	25,514	26,414
Logging	1,494	311	330
Well testing	7,546	880	974
Pump Installation	5,093	4,636	4,698
Grand Totals	93,602	31,898	33,052

	Labour	Materials	Transport
Hydrogeology	82		556
Drilling	899	8,005	17,509
Logging	18		311
Well testing	93		88[illegible]
Pump Installation	47	3,870	781
Grand Totals	$1,139	$11,875	$20,038
			$33,052

Exploratory Drilling Program - Central Range

	Cost (So.Sh.)	Cost (US$)	Total US$ equiv.	Increased cost of C/R Program as % of Bay Region Costs
Hydrogeology	10,549	1,101	1,232	93%
Drilling	118,653	50,753	52,218	98%
Logging	2,230	592	619	88%
Well testing	9,433	1,216	1,332	37%
Pump Installation	6,980	5,141	5,226	11%
Grand Totals	147,945	58,002	60,627	83%

	Labour	Materials	Transport			
Hydrogeology	131		1,101	61%		98%
Drilling	1,465	9,750	41,023	63%	22%	134%
Logging	28		592	49%		90%
Well testing	116		[illegible],216	25%		30%
Pump Installation	70	3,870	1,286	50%	0%	65%
Grand Totals	$1,810	$13,600	$45,217	59%	15%	126%
			$60,627			83%

Table 2.4.4. Summary Cost of Drilling Program

Production Drilling Program - Bay Region

16 Production (diesel)	$54,030.35	=	$864,486
2 Production (hand)	$33,052.23	=	$66,104
12 Exploratory Wells	$13,755.41	=	$165,065
		Total:	$1,095,655
Net cost per well		18 wells =	$60,870
		+ overhead (say)	$20,000
			$80,870

Production Well Costs (diesel)

Direct costs	$38,579	
Cap. recov/spares	$15,452	
Overhead	$20,000	(estimated)
	$74,030	

Exploratory Drilling Program - Central Range

				Increased cost of C/R Program as % of Bay Region Costs
4 Production (diesel)	$82,677.05	=	$330,708	
1 Production (hand)	$60,627.00	=	$60,627	
5 Exploratory Wells	$33,148.46	=	$165,742	
		Total:	$557,077	
Net cost per well		5 wells =	$111,415	83%
		+ overhead (say)	$20,000	
			$131,415	63%

Production Well Costs (diesel)

Direct costs	$46,563		21%
Cap. recov/spares	$36,114		134%
Overhead	$20,000	(estimated)	
	$102,677		39%

arrives at an equivalent figure ranging from $80,870 for the Bay region to $131,415 for the Central Range (Table 2.4.4). This major difference relates to the treatment of capital costs, and deserves some explanation.

The Brandon analysis attempted to forecast the cost of continuing the Comprehensive Groundwater Development Project through to the end of the expected life of the most expensive equipment, the drilling rigs. Wherever possible, the cost of expatriates was excluded. However, the analysis was unable to separate out the overhead capital costs associated with the element of training and supervision built into the project by the inclusion of expatriates. As an example, it is now felt that maintaining an inventory of 40 light vehicles, or even 32, to support the operation of four drilling rigs would be somewhat excessive (Brandon,1984, p.17). Less vehicles are able to service a larger number of active drilling teams.

In the light of experience, the projected life of many of the vehicles appears to have been a rather conservative estimate, certainly for operations in the Bay Region. Estimating the life of vehicles in Somalia can be a difficult exercise. On the one hand, the terrain, especially for those vehicles operating in the Central Range, is very rough, and the standard of driving and the level of maintenance is not of an optimum level. On the other hand, faced with the difficulty of acquiring spare parts, Somali ingenuity keeps a large number of vehicles operating far longer than might be expected.

With the establishment of the Planning Unit, and the introduction of micro-computers, it was decided to create a new costing model. At the same time, it became increasingly obvious that USAID did not propose to continue funding the Groundwater project in its existing form beyond the current extension period. In order to retain the benefits of continuity by keeping "the project" operating as a unit, WDA proposed that the facilities be used for an exploratory drilling program to cover the whole of Somalia. With this in mind, the costing model was designed to serve the broader costing needs of WDA as well as being able to focus on the operations of the Groundwater project.

4.1. Well Construction

The well construction model consists of 26 tables, and is reproduced in full in this report in two versions. Appendix 4.4.1 represents the cost of a production drilling program in the Bay region. Appendix 4.4.2 represents the cost of an exploratory drilling program in the Central Rangelands. The difference is in the primary objective of the program: the Bay Region production drilling program incorporates some aspect of exploratory drilling, and the objectives of the Central Rangelands exploratory drilling program includes the construction of production wells. The different variables which are assumed for the two programs are explained in detail below.

The whole operation of constructing a well is assumed, for costing purposes, to consist of six separate phases . These six phases are hydrogeology, drilling, well logging, well testing, civil works construction, and pump installation. The model's treatment of each phase is described in some detail below. The significance of each phase in terms of its contribution to the total costs is shown in Figures 2.4.1 and 2.4.2 for the construction of wells equipped with diesel pumps, and in Figures 2.4.3 and 2.4.4 for those equipped with hand pumps.

The proportion of total costs for labour, materials, and transport and equipment. for wells equipped with diesel pumps, is shown in Figures 2.4.5 and 2.4.6 for the two regions. Figure 2.4.7 shows these total costs split between direct costs, repairs and maintenance charges, and capital recovery charges.

The model contains well over two hundred variables, all of which are interrelated. The benefits of a computer model are that it is dynamic, rather than static, and the figures presented here should be viewed as the most accurate available at this time. Each of the Tables 1 through 9 of Appendices 4.4.1 and 4.4.2 is supported by a set of notes. Many of the variables are embedded in these notes. The model is set up using the Lotus™ SYMPHONY™ software package.

4.1.1. Overall Variables Used in the Model

The model is largely self-explanatory, and will not be described in extensive detail here. A number of variables are, however, worthy of some discussion.

4.1.1.1. Currency Exchange Rate

An exchange rate of So.Sh.81 equal to US$1 has been used throughout. Three exchange rates are currently in use in Somalia. The "official rate" of 61:1 is used for all government-to-government transactions. A "commercial rate" of 83:1 is currently operating, though the supply of funds at this rate is scarce. The "market rate" is floating at approximately 120:1. The local currency component is less than 4% of the total program cost, so this is not a critical variable in the model (Appendix 4.4.1, Table 21).

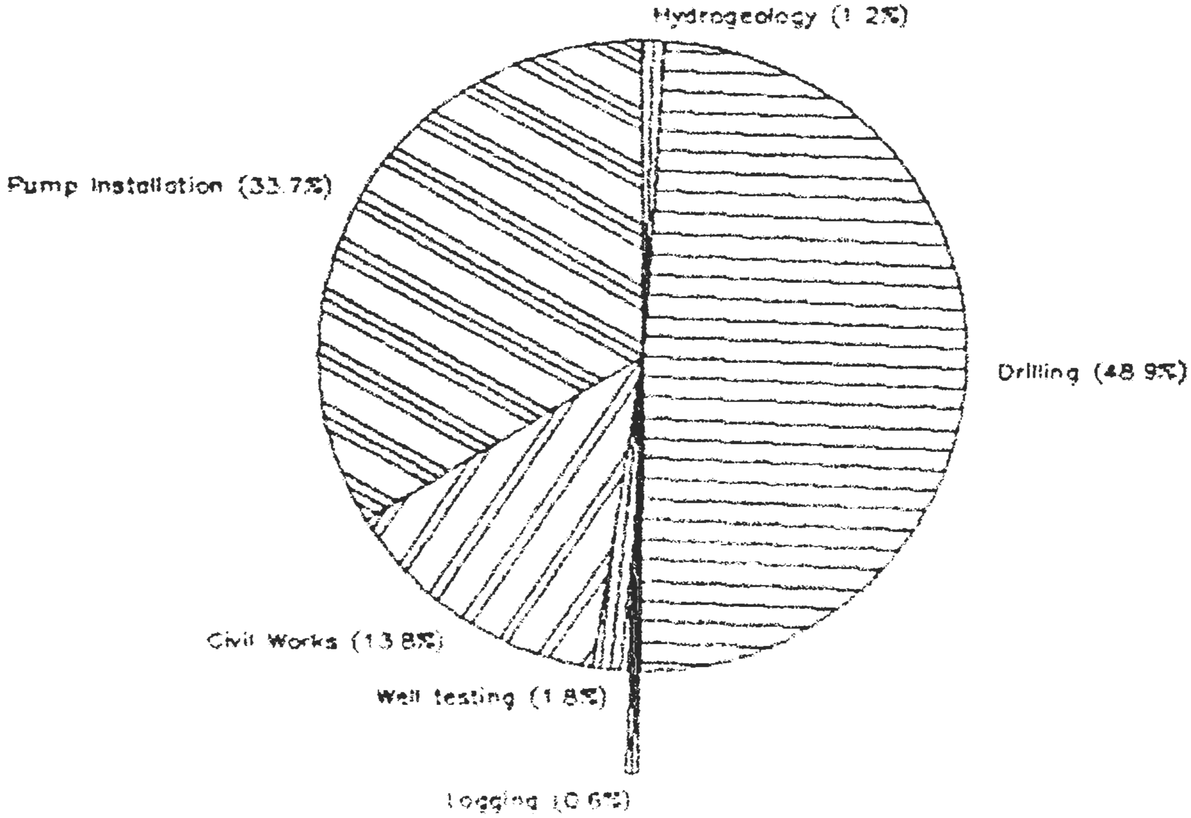


Figure 2.4.1 WELL CONSTRUCTION COSTS Diesel Pump – Bay Region

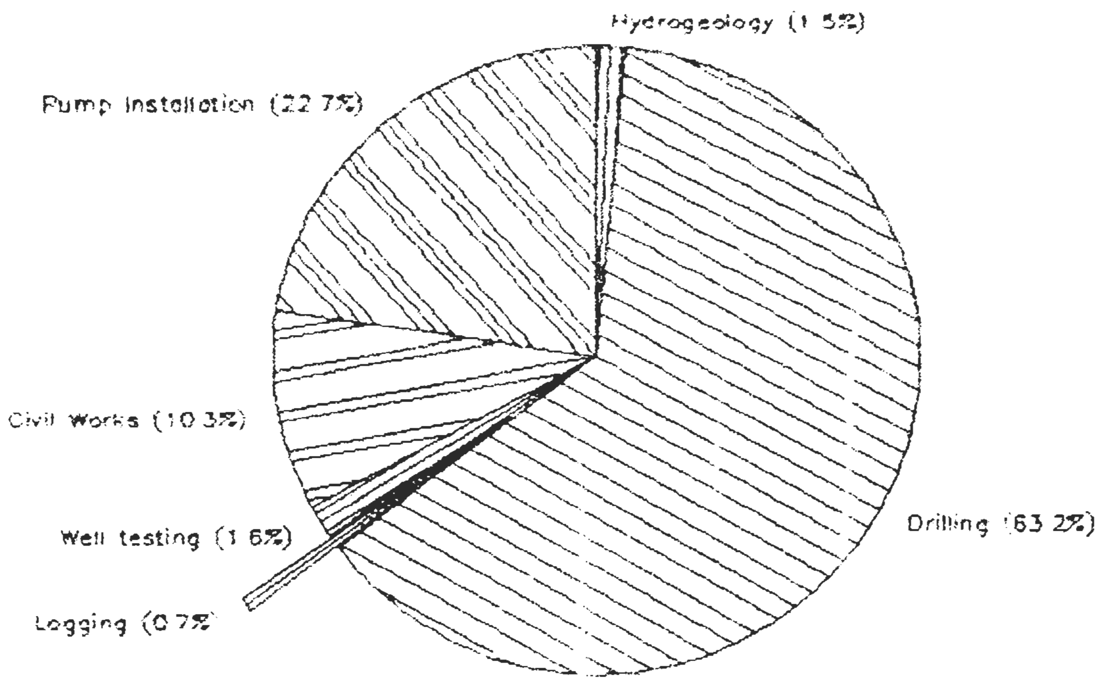


Figure 2.4.2 WELL CONSTRUCTION COSTS Diesel Pump – Central Range

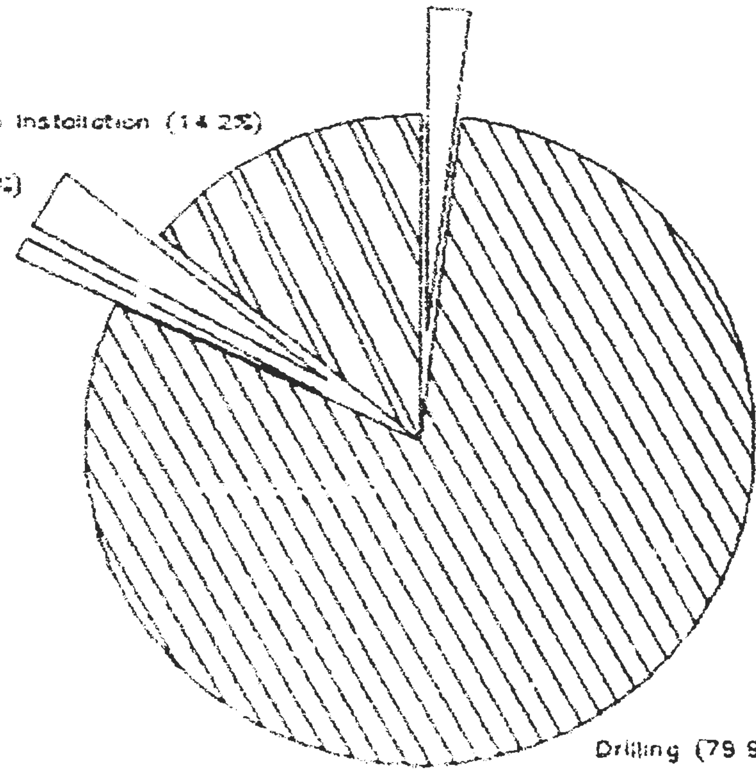


Figure 2.4.3 WELL CONSTRUCTION COSTS Hand Pump – Bay Region

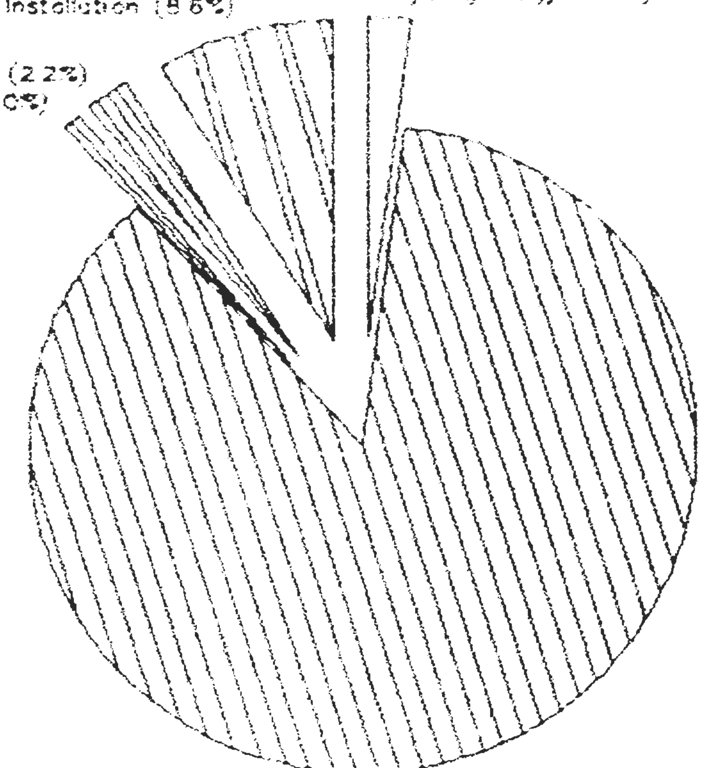


Figure 2.4.4 WELL CONSTRUCTION Hand Pump – Central Range

4.1.1.2. Freight and Insurance

All costs of imported equipment and materials include freight charges to Somalia. For the project, the bulk of this has been purchased under PIOC by USAID, a total of some $9,000,000 throughout the life of the project. Because the United States government carries its own insurance, no insurance charge has been included. The figures quoted, therefore, are not "c.i.f.", but "CIF", cost including freight.

4.1.1.3. Travel Time

In estimating the time taken for each stage of well construction, some time has been allowed for travel to and from the site. As a general rule, one day has been allowed each way for work in the Bay Region, and two days each way for work in the Central Rangelands. In all cases, a day is assumed to be a working day; a month consists of 25 working days; a week, six working days; and for the sake of convenience, a year is assumed to consist of 300 working days.

4.1.1.4. Vehicle and Equipment Costs

The model has been designed to assist WDA in estimating the cost of well drilling programs, rather than for determining the cost of an individual well. Table 21 of the model is specifically designed to deal with the three-year project budgeting procedure required of WDA, (Appendix 4.4.1). Though the model can be used for costing individual wells, the figures derived will not be as accurate because of the way in which the model deals with costing the use of vehicles and equipment.

All vehicle and equipment costs, including fuel, are calculated on the basis of a daily use charge averaged over the expected life and total usage of the vehicle. In calculating the cost of a program specifically for the Central Rangelands, for example, the variables concerned with average life expectancy and kilometers per year are different from those used in the Bay Region (Appendices 4.4.1 and 4.4.2, Table 9). Because of the rough terrain of the Central Range, vehicles used there are expected to have a shorter life, and to complete less kilometers during that life. Overall, this method is felt to be more accurate, and, more importantly, it allows WDA to recover the realistic total operating cost of any program.

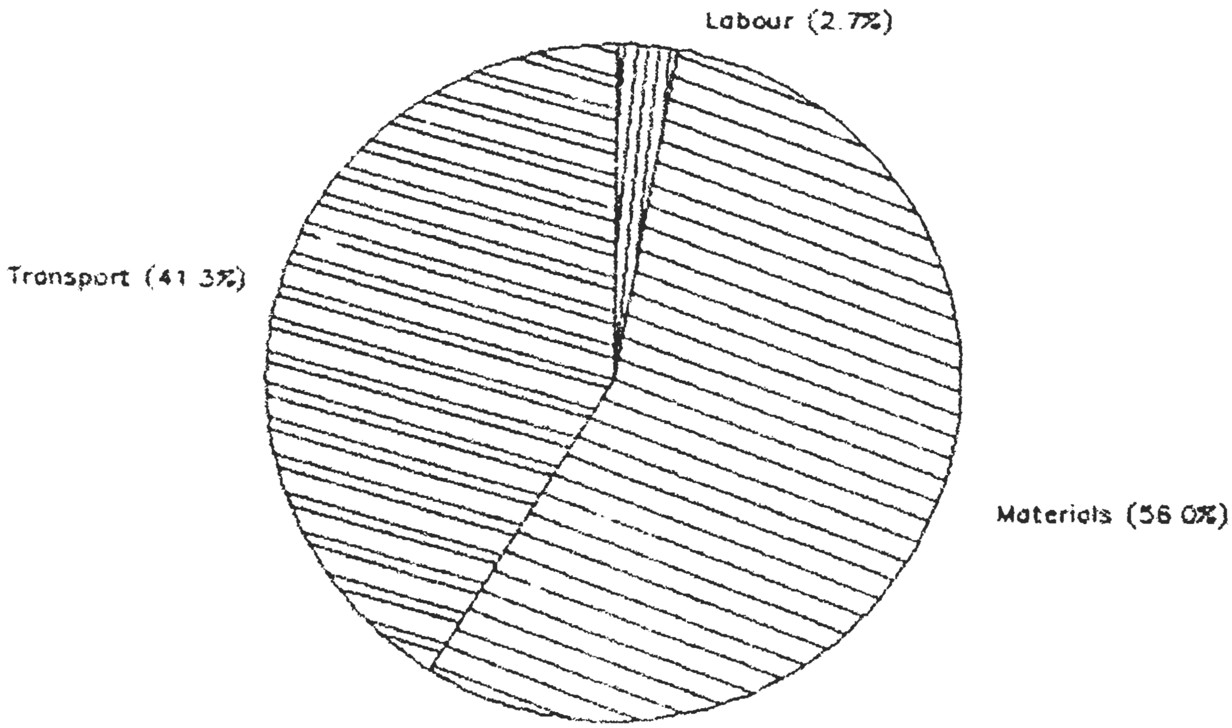


Figure 2.4.5 WELL CONSTRUCTION COSTS Diesel Pump – Bay Region

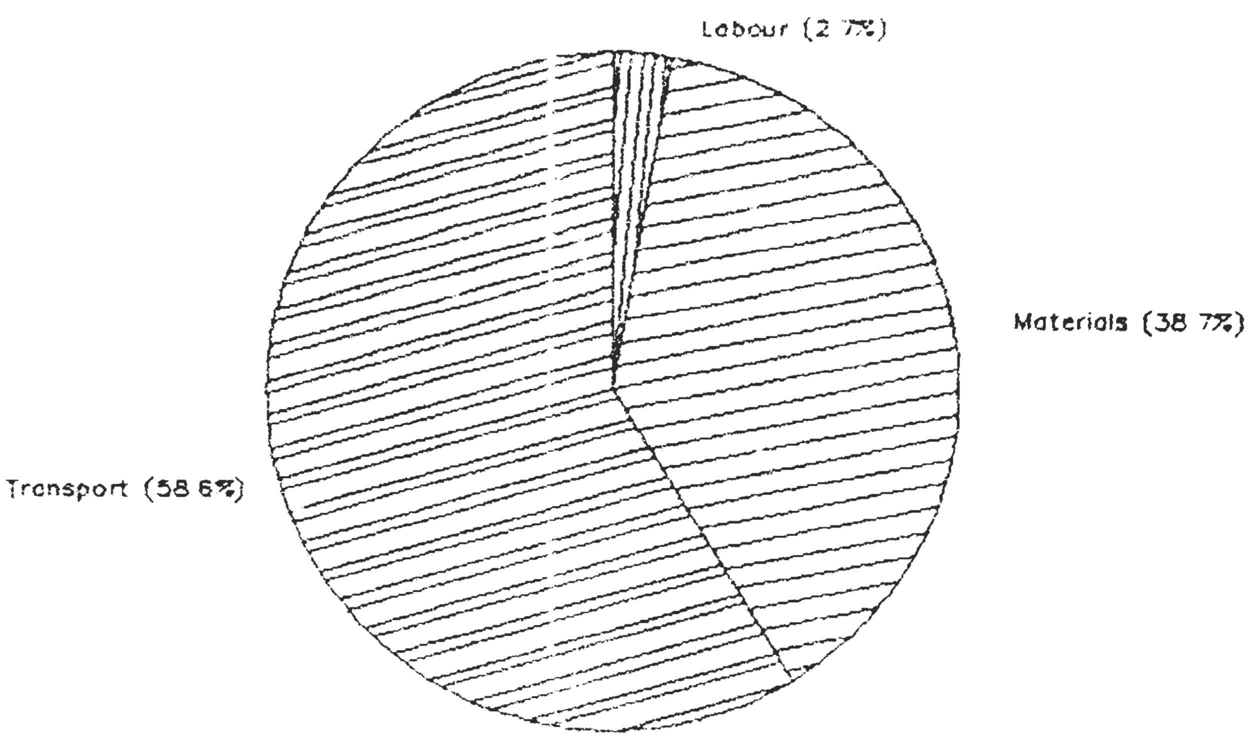


Figure 2.4.6 WELL CONSTRUCTION COSTS Diesel Pump – Central Range

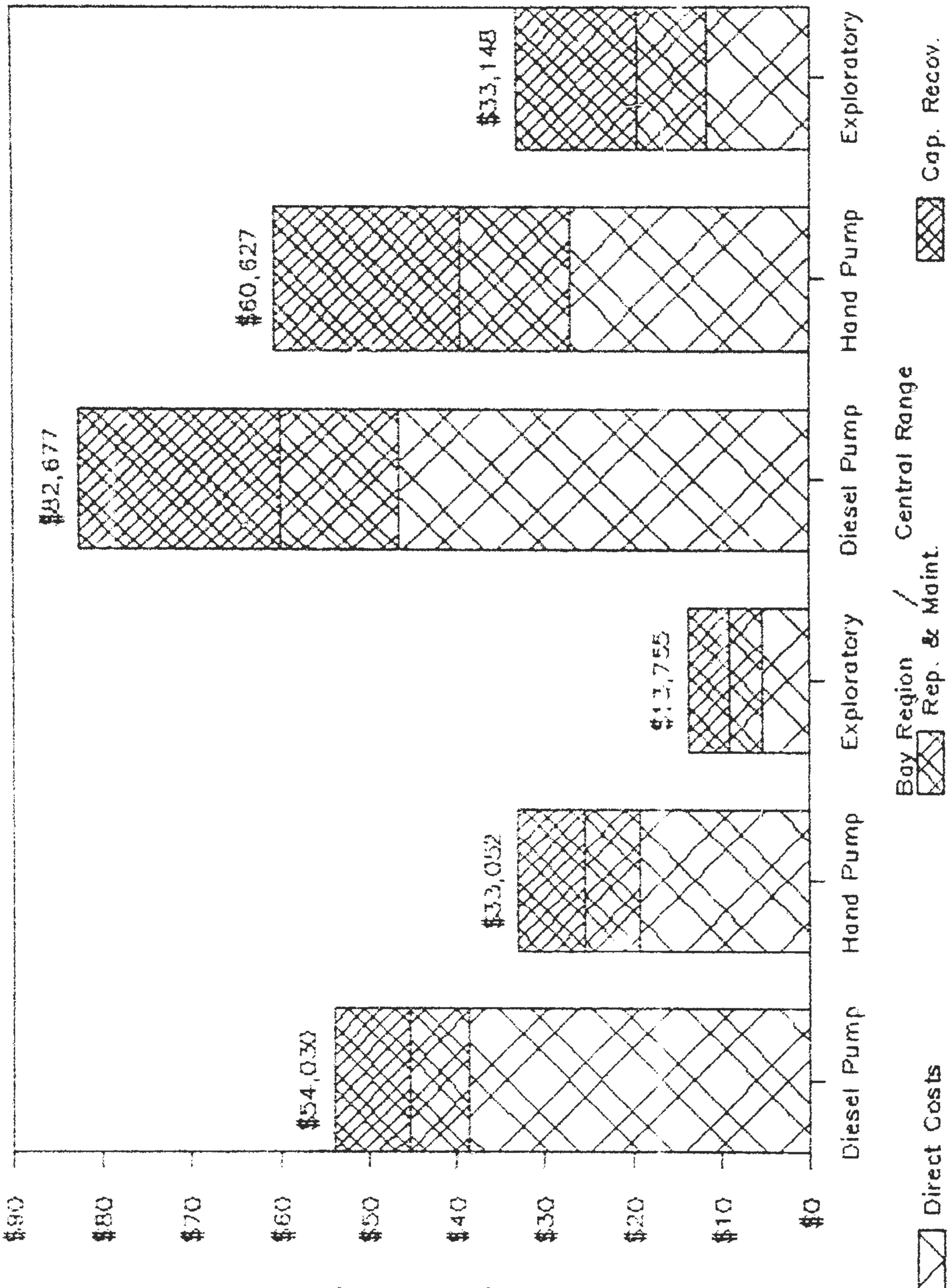


Figure 2.4.7 WELL CONSTRUCTION DIRECT AND INDIRECT COSTS

4.1.1.5. Direct, Indirect, and Sunk Capital Costs

The Brandon analysis laid considerable stress upon the difference between direct costs, indirect costs, and sunk capital costs. Direct costs are those costs which are directly attributable to the immediate requirements of constructing a given well. Indirect costs are primarily the office overhead and management, stores and workshops costs including maintenance, and capital recovery costs. Sunk costs are capital costs already incurred. This distinction was significant when costing the future operation of the Groundwater project, but it is felt to be less so when costing the on-going operations of WDA.

From an accounting standpoint, part of WDA's overall administrative costs should be charged to the cost of constructing wells. WDA administration consists of the Mogadishu headquarters and the regional offices. However, this can only be done if all the operations of WDA, not only drilling, but reservoir building, urban water systems, and the operation and maintenance of existing facilities, are also costed in detail and divided between direct costs and overhead. At present, this is not possible. Furthermore, much of the overhead is financed from the Recurrent Budget, whereas the direct operating costs are financed as projects from the Development Budget. This means that WDA's overhead costs are "guaranteed", and project budgeting need only account for any additional overhead costs. Until a more comprehensive budgetary procedures system is in place, the present costing model, which excludes overhead costs, is most useful to WDA.

Within the context of WDA implementing a number of donor funded projects, each bringing in new equipment, the overall concept of sunk costs has questionable value. After completion of the Groundwater Project, five year old Ingersoll-Rand TH60 rigs will be operating beside cable-tool rigs which are, in some cases, twenty-five years old. No system of depreciation can be completely realistic because the choice of rig to be used at a particular location will depend as much on logistics and availability as on drilling technology and lithology. The cost of a rig can be "sunk" because it is old, or because it has been paid for by a donor.

A uniform costing system has been chosen which attempts to recover the eventual replacement cost necessary to maintain WDA's inventory of drilling equipment. The same philosophy has been applied to all vehicles and equipment. Thus, in any year, various sums will be allowed in WDA's many individual budgets for, say, replacement of light vehicles. By aggregating these, WDA should be able to purchase a number of light vehicles each year to maintain its inventory. A full description of the methodology is given in a manual of recommended budgetary procedures for WDA.

Given the complexity imposed upon WDA of implementing a number of projects funded from different sources, and the concomitant accounting and costing systems imposed by each of them, WDA must strive nonetheless to operate as a comprehensive whole. Insisting upon a standard costing system will be one way to achieve this objective.

4.1.1.6. Labour Costs

The values used as labour cost variables in the versions of the model in Appendices 4.4.1 and 4.4.2 are not those currently in use within WDA. The salary and per diem levels shown are in line with those paid to employees working within the Groundwater Project, which are considerably higher. For example, the salary and per diem rates for a Chief Driller within WDA are Sh.920 per month and Sh.12 per day respectively. The equivalent figures used in the model are Sh.2851 per month and Sh.100 per day respectively. The figures used in the model are thought to be a more realistic estimate of the rates which need to be paid to attract the quality of staff required. In terms of the total cost of well construction, these costs are not of major significance. As shown in Figures 2.4.5 and 2.4.6, labour costs constitute less than 3% of the total construction cost.

4.1.2. Hydrogeology

The first stage of well construction in the costing model, "Hydrogeology", should not be confused with "Site Selection". Unlike previous analyses, the sociological aspects of site selection have been omitted. In reality, it has been found that WDA does not carry out this function, and does not appear to be likely to have the facilities to do so in the foreseeable future. Often, the process is somewhat political, but the distinction between local politics and sociology is ill defined. In this respect, the process requires an important contribution from the WDA regional office, but as such it is considered to be part of that overhead. Any actual sociological work carried out as part of site selection is generally undertaken by the agency for whom WDA is constructing the well. In the case of the Groundwater Project, this has been the Central Rangelands Development Project and the Bay Region Agricultural Development Project. Site selection for WDA, therefore, is purely a technical process, concerned with selecting the best site from available hydrogeological data.

Any socio-economic work undertaken by WDA through the Planning Unit should be viewed for the moment as research, and not as a routine function of well construction. Again, this forms part of the broad overhead cost of WDA administration.

The model assumes three visits to the site by the hydrogeologist and assistant (Appendices 4.4.1 and 4.4.2, Table 1). The purpose of the first visit is site selection, the second visit occurs during drilling, and the third visit is for aquifer testing. Some time is allowed at the office for analysis and reporting. The difference in cost between the two versions represents the difference in time allowed for travel to the site. The total times estimated for the hydrogeological work in the Bay Region and the Central Range are 16 and 24 days respectively.

4.1.3. Drilling

As can be seen from Figures 2.4.1 and 2.4.2, the actual drilling phase of well construction is the most significant. These figures exclude WDA overhead costs but include direct costs, capital recovery, and maintenance charges. Drilling accounts for almost 50% of the total cost of a well equipped with a diesel pump in the Bay Region, and for over 63% in the Central Range. From Figures 2.4.3 and 2.4.4 the percentages rise to 80% and 86% respectively for wells equipped with a handpump.

The average depth of a borehole in the Bay Region program is taken as 120m (Appendix 4.4.1, Table 2). For the Central Range program, 150m is assumed (Appendix 4.4.2, Table 2). In both cases a 5m surface casing is assumed, an average of 18m of steel screen is used, and the remainder of the hole is lined with solid steel casing. The model does not automatically relate the depth to the time taken to drill the well. Drilling time is dependent upon a number of other variables.

Based on project experience, a drilling crew in the Bay Region has been employed on each production borehole for an average of 35 days, and on each exploratory borehole for 23 days (Table 2.4.5). In the Central Range, the corresponding figures are 57 days and 38 days (Table 2.4.6). On average, an exploratory well takes two thirds the time of a production well. The model bases the cost for labour, and, more signficantly, for running costs, capital replacement, and spares and maintenance for all equipment and vehicles, on this number of days. This rule is only varied for calculating the fuel costs of the drill rig.

Table 2.4.5. Drilling Rates with Rotary Rig: Bay Region Production

Number of Rigs	2		Total Boreholes	28
Number of production wells:		16.80	(assumes	60% of total
Number of exploratory wells:		11.20	(assumes	40% of total
Equiv. total production wells:		24.27	(assumes total	prod. wells
Per Rig		12.13		
Time period (months)	17	=	425 days	
Days per production borehole		35		
Days per exploratory borehole		23		

Table 2.4.6. Drilling Rates with Rotary Rig: Central Range Explora

Number of Rigs	1		Total Boreholes	10
Number of production wells:		5.00	(assumes	50% of total
Number of exploratory wells:		5.00	(assumes	50% of total
Equiv. total production wells:		8.33	(assumes total	prod. wells
Per Rig		8.33		
Time period (months)	19	=	475 days	
Days per production borehole		57		
Days per exploratory borehole		38		

In both project areas, a total of 15 days of full time rig use is assumed for production wells, and 10 days for exploratory wells. This operation includes setting the surface casing, drilling an 8" hole, reaming the hole, setting the screen and casing, and developing the hole. The times assumed are the same in each region despite the depth in the Central Range being, on average, 30m greater. The consistent hardness of the limestone encountered in the Bay Region compensates for the wider variety of lithologies encountered in the Central Range. As is consistent throughout the model, total travel time allowed is 2 days in the Bay Region and 4 days in the Central Range.

The total time taken to drill the borehole, less the travel time and the actual drilling time represents the "downtime". This is computed in the figures shown below.

	Production Wells		Exploratory Wells	
	Bay Reg.	Central Range	Bay Reg.	Central Range
Total days allowed:	35	57	23	38
less travel time:	2	4	2	4
Days at site:	33	53	21	34
Days drilling	15	15	10	10
Downtime:	18	38	11	24
	55%	72%	52%	71%

The reasons for this high figure of downtime are discussed elsewhere in the report, but are mainly due to mechanical breakdowns, fuel shortages, and logistical problems. The greater downtime experienced in the Central Range operations is a reflection of the increased distance to the site necessary to provide either fuel or repairs.

A further difference in the cost of operating in the two regions is in the amount of casing lost in exploratory boreholes. In the Bay Region, this averages 30m for each borehole (Appendix 4.4.1, Table 3). In the Central Range the average is 100m (Appendix 4.4.2, Table 3). In the hard limestone of the Bay Region, the success of a borehole can be broadly determined before casing is installed. In the Central Range, however, it is more often necessary to seal off the upper part of the hole from saline water in order to determine whether potable water is found at greater depths.

The greater distances involved in operating in the Central Range increases the number of vehicles required as well as the cost of running them. Without additional facilities, a drill rig has a storage capacity of 756 liters of fuel. At an assumed rate of consumption of 300 liters per day while drilling (50 liters per hour for 6 hours), this lasts only two and a half days. In the Bay Region, where distances are not so great and where road conditions are generally better, one fuel truck can service three rigs. In the Central Range, one fuel truck is required for each rig.

The same rationale applies to the fact that while one water truck is required for each rig in the Bay Region, two are needed for each rig in the Central Range. One of these two is based at the site and used as a stationary storage facility, necessary because the distance to the nearest water supply may be as far as seventy-five kilometers.

The equivalent of one heavy truck is required for each rig operating in the Bay Region. This represents one knuckle-crane truck and one flat-bed truck, each shared between two rigs. In the Central Range the knuckle-crane truck is required to be on site for the whole time. In most circumstances in the Central Range a flat-bed truck, which is only used to deliver supplies, could still be shared between two rigs.

As demonstrated in the Brandon analysis, one obvious conclusion from the above data is that the rate of drilling is of paramount importance. The Groundwater Project has achieved an overall average of 36 working days at each rotary rig borehole (approximately 100 boreholes in 4 years by 3 rigs). Not infrequently, however, the drilling crews have completed their task at the site and moved on within 10 days. The variance about this mean is obviously high. It is not at all unusual for WDA drilling crews not working on the project to spend six months or even a full year at one site. In some cases, this may be the result of the slow rate of drilling of the older cable tool rigs; it can more often be attributed to mechanical breakdown or lack of supplies, particularly fuel.

In very simple terms, a rig costing $400,000, with an expected life of 10 years, drilling 8 boreholes each year, should charge $5,000 for each borehole for capital recovery costs. The same rig drilling one borehole every six months will need to charge $20,000 for each borehole. The answer to this difficult costing question lies not in designing a costing system to deal with it, but in maintaining a high drilling rate. Economies on equipment maintenance and supplies of fuel are, in fact, false economies.

In a separate calculation, reproduced in Table 2.4.7, the cost of an idle drilling team operating a production drilling program in the Bay Region has been calculated at $365 per day.

Table 2.4.7. Estimated Cost of Daily Idle Time for Drilling Crew

[Assumptions as used in calculating well-drilling costs in the Bay Region]

					So.Sh.	US$
Labour						
Monthly Salary (So Sh)	2851				114	1
Assumes per diem rate of					100	1
Monthly Salary (So Sh)	2294		(x 10)		918	11
Assumes per diem rate of Sh		95	(x 10)		950	12
Transport						
Drill rigs						
Capital replacement @	30,000 per year					100
Spares and Maint @ 10% of original value of				300,000		100
Fuel Truck						
Capital replacement @	11,429 per year				(x 1/3)	13
Spares and Maint @ 10% of original value of				80,000	(x 1/3)	9
Water Truck						
Capital replacement @	7,143 per year					24
Spares and Maint @ 10% of original value of				50,000		17
Heavy Truck						
Capital replacement @	9,286 per year					31
Spares and Maint @ 10% of original value of				65,000		22
Light Vehicle						
Capital replacement @	5,000 per year					17
Spares and Maint @ 10% of original value of				25,000		8
Assumed exchange rate 1US$ = So.Sh.		81				365

This kind of calculation is often considered to be too theoretical because the major portion of this cost is made up of capital replacement, spares, and maintenance charges, for which no cash is required at the time. However, referring back to the discussion in Section 4.1.1.5 above, not recognising this cost would cause WDA to fall short on its annual program of vehicle and equipment replacement and maintenance.

As shown in Table 2.4.4, from the recent experience of the project, the following drilling success rates are assumed:-

	Bay Region		Central Range	
Total Number of Boreholes	30		10	
Exploratory wells	12	40%	5	50%
Wells with hand pump	2	7%	1	10%
Wells with diesel pump	16	53%	4	40%

4.1.4. Well Testing

Well testing is considered in the model to be a separate operation from pump installation (Appendices 4.4.1. and 4.4.2., Table 4). In the experience of the Groundwater Project, however, these operations were often carried out during one visit by the pump crew. This practice arose because the project was supplied with one size of diesel pump, and the decision to install a diesel or hand operated pump was made during development. Eight days and ten days are assumed for testing each borehole in the Bay Region and Central Range respectively, of which two days and four days respectively are allowed for travel.

4.1.5. Well Logging

Though not a significant part of the total cost of well construction, the cost of well logging proves difficult to estimate. The problem is one of logistics. Though the actual time required to carry out the work is quite short, generally less than one day, the operation must be carried out immediately upon completion of drilling, and before installation of the screen and casing. Because this stage of the operation is not precisely predictable, and bearing in mind the cost of idle time for a drilling team, the logging vehicle inevitably spends some time waiting on the drilling operation. Five and seven days respectively for each borehole in the Bay Region and Central Range is allowed in the model (Appendices 4.4.1. and 4.4.2, Table 5). Utilizing these figures for a program of drilling such as that shown for 1986 at Appendices 4.4.1 and 4.4.2, Table 21, the following usage is implied for the logging vehicle (Appendices 4.4.1 and 4.4.2, Table 23).

	Bay Region	Central Range	Total
Number of rigs	3	1.5	4.5
Wells with diesel pump	16	4	20
Wells with hand pump	2	1	3
Exploratory wells	12	5	17
% of year logging vehicle required	50%	23%	73%

In a larger program, this may be realistic. A logging vehicle operating in the Bay Region is assumed to last for five years and one operating in the Central Range is assumed to last for only three years (Appendices 4.4.1 and 4.4.2, Table 9). These may prove to be conservative estimates.

4.1.6. Civil Works

The type of civil works constructed by the project is discussed in Sections 2.6 and 3.6. After July 1984, the construction of civil works at Groundwater Project sites became the responsibility of the Bay Region Agricultural Development Project and the Central Rangelands Development Project. Depending upon the design and facilities provided, the cost of civil works can exceed $40,000 per site, as quoted to BRADP in response to a recent tender advertisement, and may be as high as $100,000, as installed by GTZ in the Central Rangelands.

The figures included in the model represent the cost of the less ambitious facility built by WDA and constructed from locally available materials (Appendices 4.4.1 and 4.4.2, Table 6). It consists of a water storage tank, two or three troughs, and a bank of taps.

4.1.7. Pump Installation

A pump crew of five is assumed to require a total of 5 days to install a diesel pump and 4 days to install a hand pump in the Bay Region (Appendix 4.4.1, Tables 7 and 8). In the Central Range these times are extended by two days to allow for extra travel.

The pumps installed by the project were Monolift with Lister diesel engines, and Mono hand pumps. The complete diesel assembly costs approximately $14,500, and the handpump cost $3,600. Ordered in sufficient numbers to fill containers sent from the United States, the additional cost of overland and sea freight is approximately 5%.

4.1.8. Well Completion Time

From the assumptions used in the versions of the model in

Appendices 4.4.1 and 4.4.2 it is possible to construct an estimate of the time taken to complete one production well. The assumptions are that normal breakdown problems remain the same, but that the logistics of having one operation follow immediately when the previous is completed are satisfied. Travel time between each operation is therefore excluded. This is shown in Table 2.4.8. below. No time is included for logging since this takes place during the drilling phase. For the same reasons, the total time taken by the hydrogeologists is reduced.

An additional set of estimates is included in the table showing the "optimum" time to complete a well equipped with a diesel pump in the Bay Region. For this, it is assumed that no downtime occurs, that civil works can be completed in less time, and that pump installation can be carried out at the same time as the civil works are being built. These figures are offered as a realistic estimate of the time required for an intensive program or an emergency situation.

Table 2.4.8 Net Time Taken to Complete Production Wells

	Bay Region		Central Range		Optimum
	Diesel	Hand	Diesel	Hand	Diesel
Site selection	3	3	5	5	3
Drilling	33	33	55	55	17
Logging					
Well Testing	6	6	6	6	4
Civil Works	18		20		10
Pump Installation	3	2	3	2	
	---	---	---	---	---
Total	63	44	89	68	34

Actual drilling is the most costly phase of well construction, and the most significant cost savings can be achieved by the reduction or elimination of downtime. Holding all other variables constant, the increase in the total cost of constructing a well equipped with a diesel pump, against an increase in the number of days the rig is on-site, from a possible minimum of 15 to an excessive 90, is shown in Figure 2.4.8 for the Bay Region, and Figure 2.4.9 for the Central Range. Between these differences, the total cost is approximately doubled.

4.2. Well Operation and Maintenance

Based on the computerized model for estimating the cost of well construction, a similar model has been set up for determining the annual operating costs of wells in Somalia. Two versions of the data are presented. One version represents the

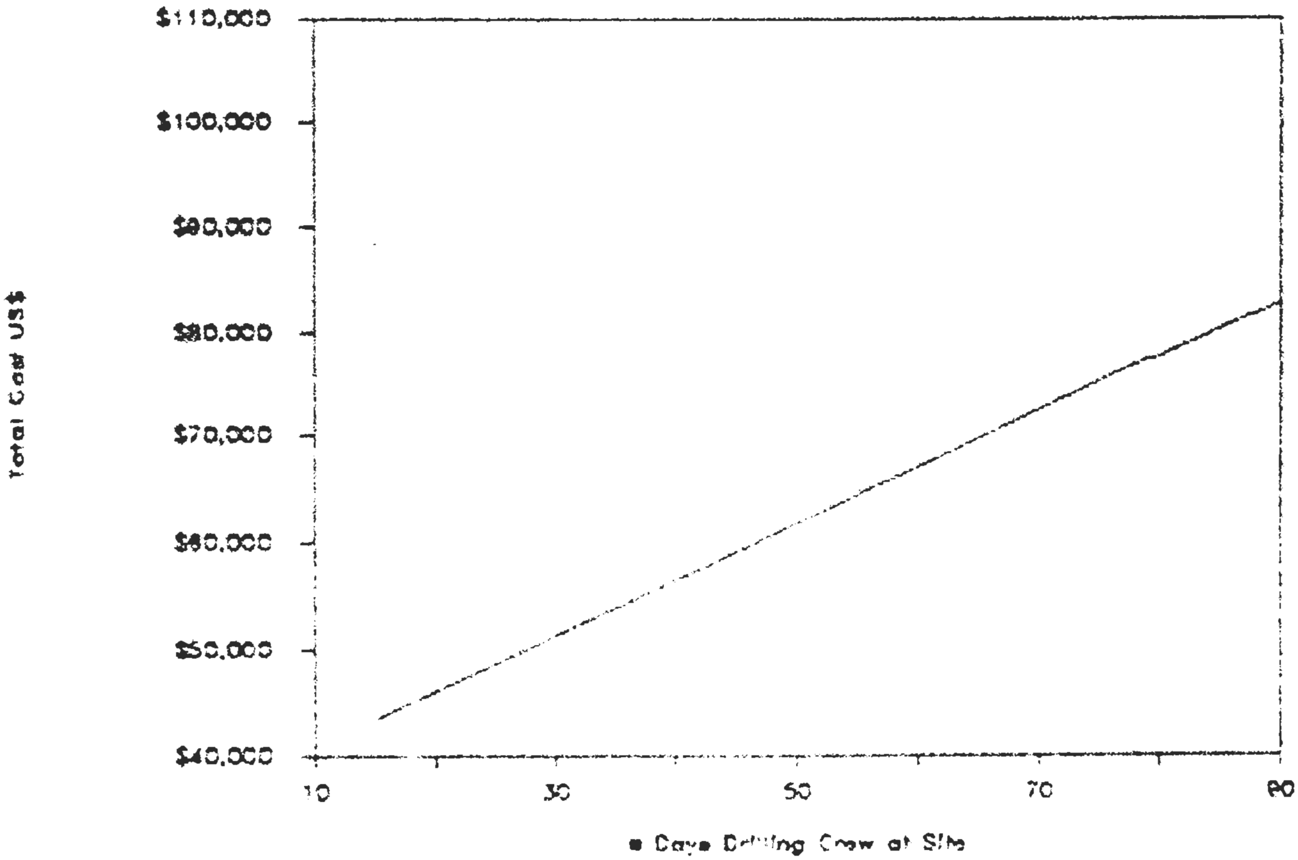


Figure 2.4.8 COST / DRILLING TIME Diesel Well – Bay Region

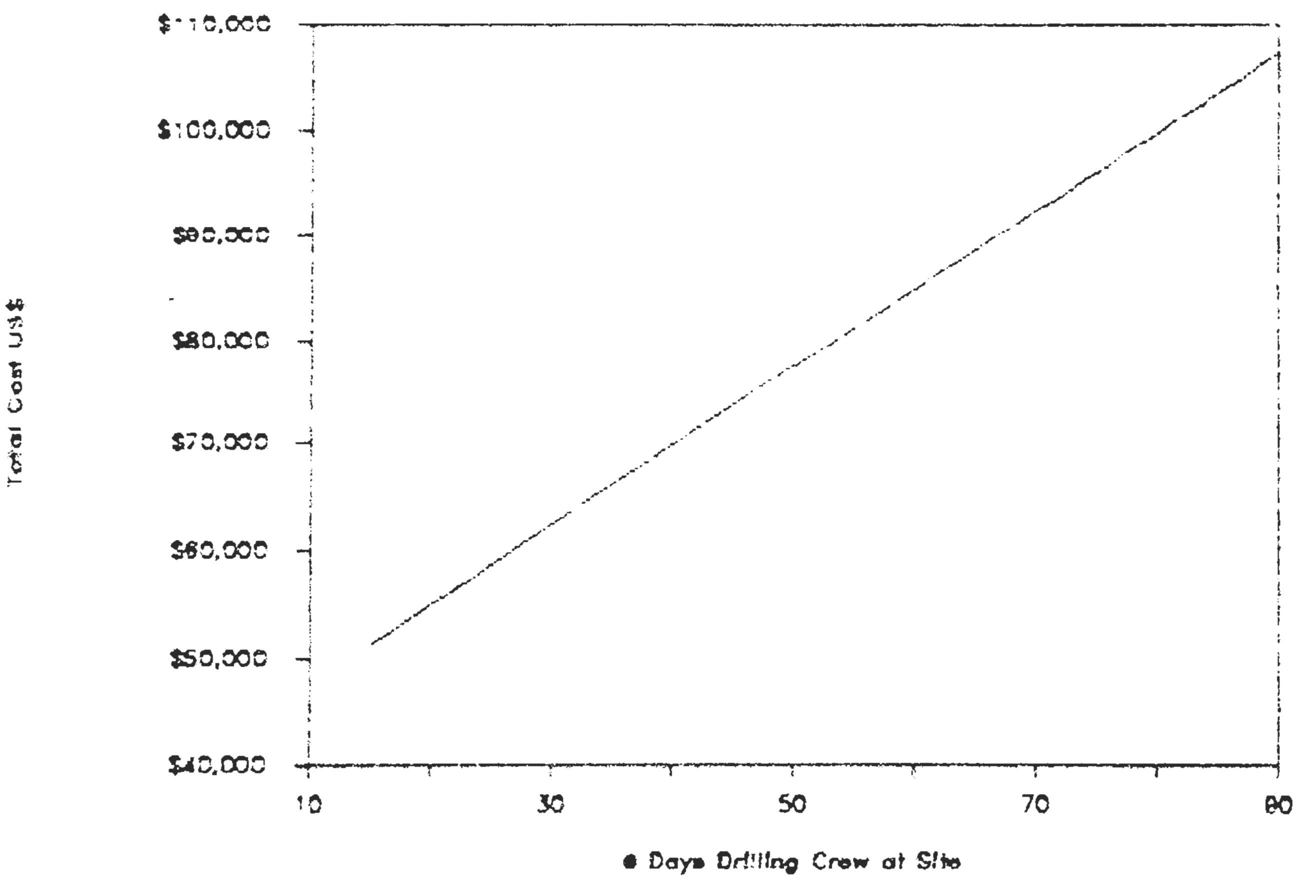


Figure 2.4.9 COST / DRILLING TIME Diesel Well – Central Range

costs applicable to an area such as the Bay Region, where a relatively large number of wells have been constructed relatively close together and accessible over good roads. These costs are shown in summary form in Table 2.4.9, and in detailed form in Appendix 4.4.3. The other version represents the costs applicable to an area such as the Central Range, where a few wells are spread out over a vast area, and are accessible over extremely poor roads. These costs are shown in summary form in Table 2.4.10, and in detailed form in Appendix 4.4.4.

Three elements make up the annual operating costs of wells. In the Bay Region, the direct cost of operating the pump constitutes 57% of the total; routine maintenance constitutes almost 8%; and major overhauls constitute almost 35% (Figure 2.4.10). The proportions are not significantly different for the Central Range, though the actual costs are higher (Figure 2.4.11).

In the following discussion, the overall assumptions are explained first, followed by a detailed explanation of the assumptions made for each of the three elements costed. Combining the construction costs, operation and maintenance costs, and revenues collected, establishes the amortization potential, which is discussed in Section 4.3.

4.2.1. Overall Assumptions.

The variables and assumptions used in this analysis are basically the same as in the well construction costing model, and are discussed in Section 4.1.1. The assumptions concerning vehicle costs and life expectancy are as set out in Table 9 of Appendices 4.4.1 and 4.4.2.

The same wage rates as in the well construction costing model, which are significantly higher than those currently paid to WDA staff who are not employed on the Groundwater Project, have been used for all staff except pump attendants. Using actual WDA salary rates reduces the total cost of annual operation and maintenence for one diesel-equipped well in the Bay Region by So.Sh.2400 (US$30). This represents 1% of the total annual cost, and is not, therefore, significant.

The maintenance schedules assumed are in line with those recommended in the well maintenance manuals produced by the Project.

4.2.2. Operating Costs.

Operating costs for a well equipped with a diesel pump are considered to consist of the wages paid to the pump attendant and assistant, the cost of fuel used by the pump, and the cost

Table 2.4.9. Annual Well Operation and Maintenance Costs - Bay Region Program

Summary Cost of Well Operation and Maintenance - Diesel Pump

	Labour	Parts	Fuel	Capital Recovery	Spares & Maintenance	Total
Operating Costs						
Labour	195					$195
Fuel			1,322			$1,322
Transport			46	83	58	$187
Routine Maint.						
Labour	6					$6
Parts		152				$152
Transport			13	22	11	$46
Major Overhaul *						
Labour	31					$31
Parts		508				$508
Transport			142	207	160	$509
Total	$232	$660	$1,524	$312	$229	$2,956

Summary Cost of Well Operation and Maintenance - Hand Pump

	Labour	Parts	Fuel	Capital Recovery	Spares & Maintenance	Total
Routine Maint.						
Labour	3					$3
Parts		38				$38
Transport			[illegible]	11	6	$2[illegible]
Major Overhaul *						
Labour	16					$16
Parts		126				$126
Transport			[illegible]	[illegible]	80	$[illegible]
Total	$19	$164	$8[illegible]	$11[illegible]	$86	$466

Annual Program Costs

	# Wells	Labour	Parts	Fuel	Capital Recovery	Spares & Maintenance	Total
Diesel	16	3,717	10,556	24,384	4,988	3,662	$47,29[illegible]
Hand pump	2	[illegible]	328	167	229	171	$9[illegible]
Total		$3,744	$10,884	$24,547	$5,2[illegible]	$3,833	$48,2[illegible]

* Major Overhaul assumed every three years

Table 2.4.10. Annual Well Operation and Maintenance Costs - Central Range Program

Summary Cost of Well Operation and Maintenance - Diesel Pump

	Labour	Parts	Fuel	Capital Recovery	Repairs & Maintenance	Total
Operating Costs						
Labour	229					$229
Fuel			1,322			$1,322
Transport			139	347	173	$659
Routine Maint.						
Labour	18					$18
Parts		152				$152
Transport			39	111	33	$183
Major Overhaul *						
Labour	39					$39
Parts		508				$508
Transport			172	337	200	$709
Total	$286	$660	$1,672	$795	$407	$3,819

Summary Cost of Well Operation and Maintenance - Hand Pump

	Labour	Parts	Fuel	Capital Recovery	Repairs & Maintenance	Total
Routine Maint.						
Labour	9					$9
Parts		[illegible]				[illegible]
Transport			[illegible]	[illegible]	[illegible]	[illegible]
Major Overhaul *						
Labour	[illegible]					[illegible]
Parts		[illegible]				[illegible]
Transport			[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	$164	[illegible]	$258	[illegible]	[illegible]

Annual Program Costs

	# wells	Labour	Parts	Fuel	Capital Recovery	Repairs & Maintenance	Total
Diesel	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,507	[illegible]
Hand Pump	[illegible]	64	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]	[illegible]	[illegible]	$6,780	[illegible]

* Major Overhaul assumed every three years.

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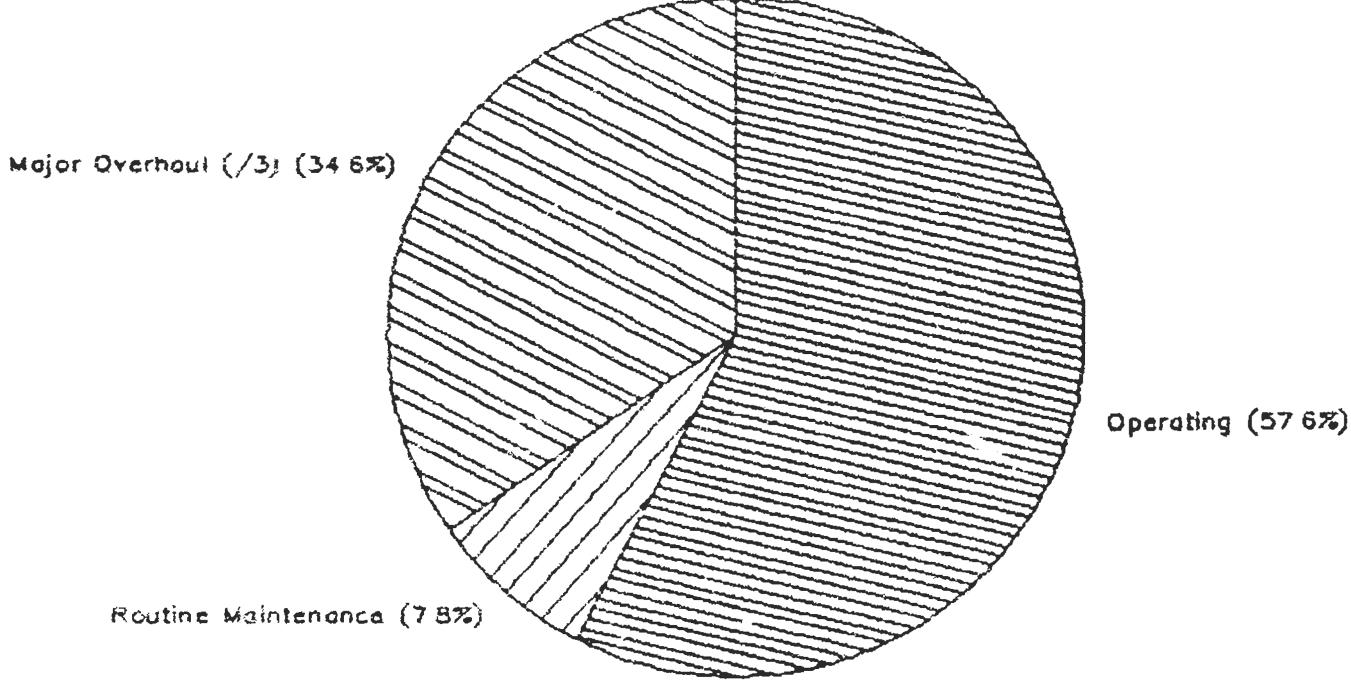

Figure 2.4.10 ANNUAL OPERATING COSTS Diesel Equipped Well — Bay Region

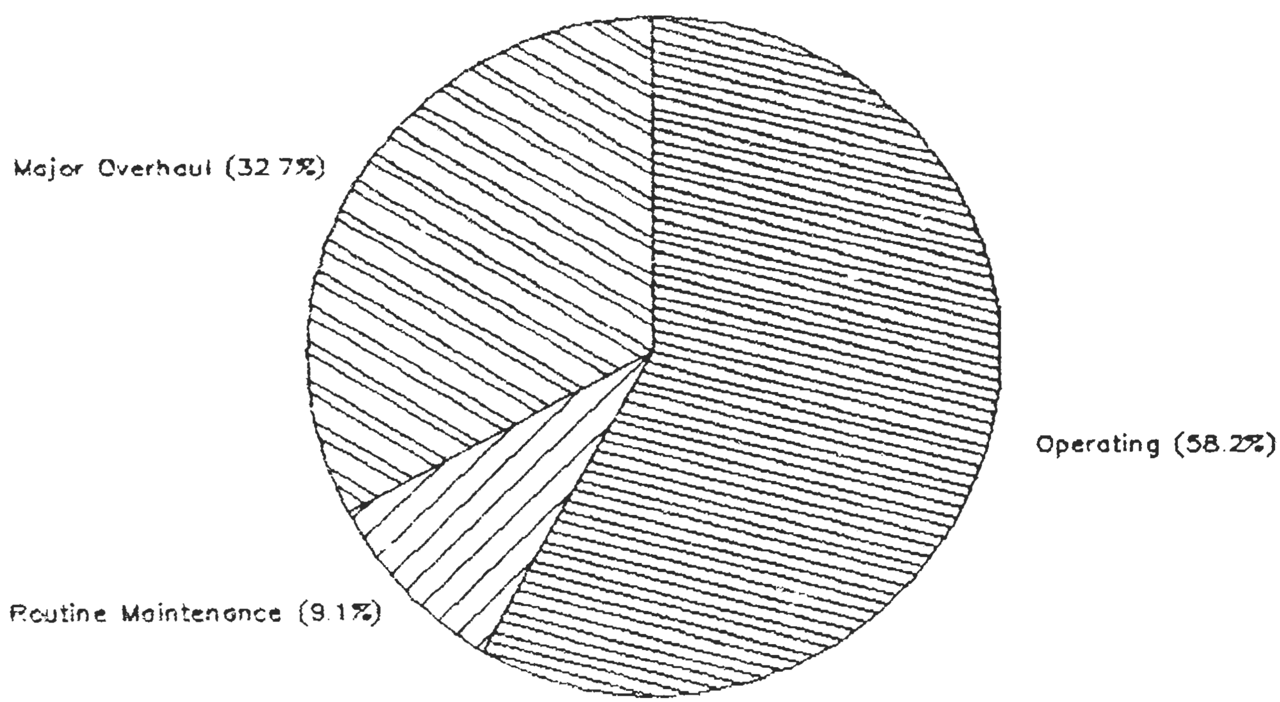

Figure 2.4.11 ANNUAL OPERATION COSTS Diesel Equipped Well — Central Range

of delivering that fuel. No equivalent costs are associated with a well equipped with a hand pump.

The most significant element of this total is the cost of fuel used for pumping, being approximately 75% and 60% of the total in the Bay Region and Central Range respectively. The average annual fuel cost for each well site of $1,322 is based upon consumption of 3,390 liters at a current cost of US$0.39 per liter.

Accurate data on fuel supplied to well sites is scarce. Appendix 4.4.5 shows the reported value of fuel delivered to pre-project well sites in the Bay Region during 1984. The figures available are for the three months of the Jilaal dry season, January to March, and for the whole year, 1984. Though the number of cases in this sample is not sufficient to allow firm conclusions to be drawn, a linear regression suggests that these are reliable figures. It is assumed that for the three months of the Jilaal season the pumps are operated every day for 90 days. Based upon the fuel consumption for a full year , it can be assumed that the pumps are operated, on average, for eight months of each year.

The fuel consumption rate of a diesel pump is obtained from the following formula (Pape, 1982, p.19):-

$$C = 0.001635 \times D \times V \times P,$$

where:

C = Operating costs	- to be determined for 1 hour of operation	
D = Depth of well	- assumed to be	90 m.
V = Volume of water required	- known -	12 cm/hour
P = Price of diesel ($/ltr)		$0.39

Therefore cost = $0.69 per hour,
representing 1.77 litres of fuel per hour.

From Appendix 4.4.5, the average for the three months supply, Sh.9,364, costing at that time approximately Sh.8 per liter, represents 1,171 liters. If the pump is used every day for 90 days, this represents 13 liters per day. At 1.77 liters per hour, this means the pump is used for 8 hours each day. There appears to be considerable variation about this mean. However, the data is considered reliable enough for program costing purposes.

Fuel is assumed to be delivered by WDA in 200 liter drums. In both regions, it is assumed that fuel deliveries will be made to each site every month for eight months of the year. In the Bay Region, it is assured that a truck can make deliveries to three well sites in one day. In the Central Range, however, the truck is assumed to be able to make only one delivery each day on average, and the driver and assistant are paid per diems.

Actual WDA wage rates for the pump operator and assistant are assumed, rather than the higher rates paid to Project staff. This apparent inconsistency reflects the nature of the work involved in pump operation. Though technically employees of WDA, these staff are usually from the local community. Their duties are carried out in consultation with the community, and their positions are as much social as official.

4.2.3. Routine Maintenance

For a diesel-driven pump, the operations and maintenance manual prescribes levels of routine maintenance to be carried out after every 250 and 1,000 hours of operation. Certain of these duties can be undertaken by trained pump operators. In the dry season, 250 hours represents one month of operation, but it is realistically assumed that WDA does not at present have the resources necessary to visit each site each month for eight months of the year. An average year of operation computes to a total of 1,920 hours. Allowing for emergency visits in the case of breakdown, an average of four visits to each site during the course of the year is assumed for a diesel pump. Two visits each year are required for routine maintenance of a hand-operated pump.

A two-man maintenance crew travelling in a light truck are considered capable of carrying out this work. With the payment of per diems, they are assumed to be able to service three sites in the Bay Region each day, and one site each day in the Central Range.

The annual cost of spare parts required for routine maintenance and emergency repairs is estimated to be 1% of the original cost of the complete pump assembly. For a pump equipped with a diesel engine, the figure of $152 approximately represents the relacement of fuel, air, and oil filters, and an oil change, four times each year. Given the sandy conditions at most sites, this frequency is recommended.

4.2.4. Major Overhaul

A major overhaul of the borehole, pump, and where applicable, diesel engine, is considered to be necessary every three years. A fully equipped pump crew is required to conduct this work which involves removal of the pump from the borehole. As discussed elsewhere in this report, considerable potential exists for the rehabilitation of wells by the removal of encrustation on the screen and casing. For this work the drill rig and crew would be required. Because this is not currently done by WDA, the cost is not included in this model.

The major overhaul of a diesel-equipped well is assumed to require a total of eight days in the Bay Region, and ten days in the Central Range. The difference is a reflection of the travel time required. The major overhaul of a well equipped with a hand pump is assumed to require four and six days respectively for the two regions, including travel time.

The estimate of the cost of materials and spare parts required for this work is assumed to be 10% of the original cost of the pump assembly, approximately US$1,500 in the case of a diesel pump. This is based on the replacement cost of the following major parts, which are expected to be considerably worn after almost six thousand hours of operation:

Diesel engine - valves and guides, bearings, injectors, rings - $600
Gear head - drive shafts, sleeves, spiral gears, bearings - $700

4.3. Amortization of Total Well Costs and Revenues.

This section of the report draws upon the costing models discussed in the previous two sections and presents estimates of the "Net Present Value" (NPV) of well construction in Somalia. From this data, discussion of the selling price of water follows, with a view to determining the extent to which the revenue from wells can offset the initial construction costs and the on-going operation and maintenance costs. The section begins with a further explanation of the methodology used, and the significance of using certain cost figures in the model. This is an expansion of the topic briefly mentioned in Section 3.0, the use and interpretation of different methods of project appraisal.

The main purpose of project appraisal is to determine the profitability of a project. The extent to which the returns from the project pay back the original investment determines the internal rate of return, upon which the wisdom of investing in the project, or the evaluation of its eventual outcome, is mainly judged. As previously mentioned, such an appraisal can be made from three separate viewpoints.

A financial, or commercial, appraisal views the project as if it were the undertaking of a private company, concerned only with the cash profit on investment.

An economic appraisal, by some definitions, assumes the view of the country's economy as a whole. Investment in the project in this sense represents the value of the country's resources employed in the project. Internal taxes are therefore excluded. The true cost, or "shadow price", of labour to a country with high unemployment might be close to zero. Secondary costs or benefits, "spin-offs", which would not be the concern of a private company, but which might significantly affect the national economy, must be evaluated and included in an economic appraisal.

A socio-economic appraisal builds upon the rationale of the economic appraisal, but also attempts to determine the extent to which the project achieves certain "social" goals of the government. The "value" of these factors is then built into the appraisal. Examples of such social goals might be the government's determination to value benefits distributed widely to the poor more highly than profits which accrue to the few who are already wealthy; perhaps conversely, a government priority might be on the generation of savings rather than consumption expenditure; or a national self-sufficiency in an industry might be considered more important than the economic profitability of that industry. Assigning values, or "weights", to these factors, is difficult and controversial. The view is often expressed that these factors should be kept out of the calculations and left to the political decision-makers. The consultants have taken that view in presenting this report, and no attempt is made to adjust the figures to arrive at a socio-economic appraisal.

The inherent problem of appraising a groundwater development project lies in assigning monetary values to the benefits. In a project providing water solely for irrigation the benefits would take the form of increased production on the irrigated land, and could be valued. The water provided from wells constructed during the CGDP, however, produce a number of benefits, many of which are not readily quantifiable. These are discussed more fully in Section 5.0, but include the following:-

1. Improved health from cleaner water
2. More time available for leisure or economic activities from less time taken to fetch water
3. Increased economic activities from the ability to keep larger number of livestock
4. Increased accessibility to pasture during dry season
5. Reduced or eliminated need to move household during dry season
6. Actual saving of life - both of people and livestock - during periods of acute drought
7. Increased ability of the government to provide social services, such as schools and clinics, as a result of nomadic communities settling permanently around well sites

Other benefits are no doubt produced by the construction of wells, as are the dangers of "disbenefits", the negative effects. The most obvious of these in Somalia is the possibility of overgrazing the pasture around the well site.

All of these benefits and disbenefits prove difficult, if not impossible, to evaluate in monetary terms. Project appraisal, in the sense of determining the "profitability" of the investment, is not a meaningful exercise. Instead, this report presents an estimate of the economic cost per unit of water produced over the life of the investment. When data is available, this should be compared with the cost of providing water from other sources, such as uars, ballehs and burkeds, as an aid to policy-makers in determining the most economic methods of providing water in Somalia.

4.3.1. Financial and Economic Appraisal

The analysis of costs presented in this report represents those faced by a donor agency implementing a groundwater project in Somalia. Because the major part of these costs are for imported materials and equipment, the difference in cost faced by a private company will mainly concern import duties imposed by the Somali government. In this respect, the analysis approximates to a true economic analysis. The cost of imported materials and equipment represents the world price, except, as mentioned in Section 4.1.1.2, that the prices include freight costs to Somalia, but not insurance. A number of other items, not significant in terms of the total cost, might be interpreted differently for the purposes of financial, economic or socio-economic analysis. These alternative, or "shadow", prices are discussed in the following sections.

4.3.1.1. Labour Costs

As discussed at Section 4.1.1.6, the wage rates used in this report represent those which would realistically be needed to operate a groundwater program in Somalia. The economic cost, or shadow price of labour, however, is arguably different. If the shadow price of labour is taken to be the "opportunity cost", that is, the cost to an alternative sector of the economy deprived of that labour, then the shadow price of unskilled labour is considerably lower than the market price in a country where unemployment, or underemployment, is high. Underemployment is represented by the fact that, for the Mogadishu area, salaried employment accounts for only one quarter or one fifth of average household expenditure. A large, but unknown, portion of the remainder undoubtedly derives from remittances from Somali nationals working overseas, mainly in Saudi Arabia. In the case of unskilled labour, the shadow price could be said to be close to zero. For skilled labour, however, the opportunity cost might well be the cost to the economy of preventing that labour from working overseas and earning foreign exchange, which would be considerably higher than the market rate used here.

At most well sites, significant contributions were made by the community in the construction of the well. This consisted of food supplied to the drilling and civil works crews, and village labour and materials provided during site preparation and construction. The value of these inputs should be included in a true economic appraisal, but have not been included here. These issues are discussed more fully in Section 2.5 and 3.0.

4.3.1.2. Currency Exchange Rate

Labour costs form the major part of local currency costs in well construction, operation and maintenance. Once a set of shadow prices for labour has been determined, a shadow exchange rate should be used to provide an economic analysis. This is often claimed to be properly represented by the "free-market", or "black market", cost of foreign currency.

The situation in Somalia is confused by the existence of three exchange rates, as discussed in Section 4.1.1.1. At the time of writing, it appears to be the intention of the Government to eventually bring the "official" rate, now at So.Sh.61 to the U.S. dollar, up to the "commercial" rate, now at So.Sh.83 to the U.S. dollar. A "free-market" rate exists which is currently operated at between So.Sh.105 and So.Sh.120 to the U.S. dollar. In deference to the Goverment's wish that all three rates should converge, a rate of So.Sh.81 has been used throughout this report. The difference made to the basic well construction costs applicable to the Bay Region, for example (Table 2.4.1), are, as shown below, not significant.

	Exch. Rate So.Sh./U.S.	Cost of Diesel Well Installation	Differenc from mode
Official rate	61	$54,687	1.22%
Model	81	$54,030	
Commercial	83	$53,982	-0.09%
Free market low	105	$53,572	-0.85%
Free market high	120	$53,379	-1.20%

4.3.1.3. Fuel Costs

Fuel costs in Somalia vary with the source. The costs used in this report approximately represent world prices of fuel plus delivery costs to Somalia. Most of the fuel supplied to the project was at this cost.

Somalia has its own refining capability and receives crude oil at less than world prices from its neighbours in the Middle East. The market price of fuel in Somalia is therefore considerably less than the world price.

In a financial analysis to test the commercial viability of a groundwater operation, the total cost of well construction, operation and maintenance would therefore be less than that arrived at in this report. The market price of fuel also varies throughout the country, reflecting the high cost of transportation. However, this is taken into consideration in the report by estimating the actual cost of the delivery of fuel to the site in each case.

The world price of a liter of diesel delivered to Somalia at the time of writing is approximately U.S.$0.46. The Mogadishu price is So.Sh.18 per liter, and the up-country price between So.Sh.22 and So.Sh.30. The significance of these different costs, again using the cost of well construction in the Bay Region, is shown below.

		Cost of Well With Diesel Pump	Differenc from mode
Market price, Mogadishu, of So.Sh.18 per liter using exch. rate 83:1	$0.22	$51,112	-5.40%
World price delivered assumed in report	$0.39	$54,030	
Actual world price delivered March 1986	$0.46	$55,247	2.25%

4.3.2. Discounted Well Operation and Maintenance Costs

An investment in the construction of a well also implies a commitment to the operation and maintenance costs over the life of that well. This can be shown as a "stream of costs" over the years, as in Tables 2.4.11 and 2.4.12 for diesel equipped and hand-pump equipped wells in the Bay Region. The corresponding costs for the Central Range wells are shown in Tables 2.4.13 and 2.4.14. In these tables, the productive life of the well is

Table 2.4.11. Twelve Year Stream of Well Operation and Maintenance Costs (Diesel Pump) - Bay Region

Table	Year	1	2	3	4	5	6	7	8	9	10	11	12
1	Operating	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703
2	Rtn Maint	205	205	205	205	205	205	205	205	205	205	205	205
4	Maj. O/H			3,143			3,143			3,143			
	Total	$1,908	$1,908	$5,051	$1,908	$1,908	$5,051	$1,908	$1,908	$5,051	$1,908	$1,908	$1,908

Net Present Value (i = 10%) in year 0 $18,470

Add Overhead @	40%	763	763	2,021	763	763	2,021	763	763	2,021	763	763	763
	Total	$2,671	$2,671	$7,072	$2,671	$2,671	$7,072	$2,671	$2,671	$7,072	$2,671	$2,671	$2,671

Net Present Value (i = 10%) in year 0 $25,858

Table 2.4.12. Twelve Year Stream of Well Operation and Maintenance Costs (Hand Pump) - Bay Region

Table	Year	1	2	3	4	5	6	7	8	9	10	11	12
	Operating	0	0	0	0	0	0	0	0	0	0	0	0
3	Rtn Maint	64	64	64	64	64	64	64	64	64	64	64	64
5	Maj. O/H			1,206			1,206			1,206			
	Total	$64	$64	$1,270	$64	$64	$1,270	$64	$64	$1,270	$64	$69	$64

Net Present Value (i = 10%) in year 0 $2,534

Add Overhead @	40%	26	26	508	26	26	508	26	26	508	26	26	26
	Total	$90	$90	$1,778	$90	$90	$1,778	$90	$90	$1,778	$90	$90	$90

Net Present Value (i = 10%) in year 0 $3,547

Table 2.4.13. Twelve Year Stream of Well Operation and Maintenance Costs (Diesel Pump) - Central Range

Table	Year	1	2	3	4	5	6	7	8	9	10	11	12
1	Operating	2,210	2,210	2,210	2,210	2,210	2,210	2,210	2,210	2,210	2,210	2,210	2,210
2	Rtn Maint	354	354	354	354	354	354	354	354	354	354	354	354
4	Maj. O/H			3,766			3,766			3,766			
	Total	$2,563	$2,563	$6,329	$2,563	$2,563	$6,329	$2,563	$2,563	$6,329	$2,563	$2,563	$2,563

Net Present Value (i = 10%) in year 0 $24,318

Add Overhead @		1	2	3	4	5	6	7	8	9	10	11	12
40%		1,025	1,025	2,532	1,025	1,025	2,532	1,025	1,025	2,532	1,025	1,025	1,025
	Total	$3,589	$3,589	$8,861	$3,589	$3,589	$8,861	$3,589	$3,589	$8,861	$3,589	$3,589	$3,589

Net Present Value (i = 10%) in year 0 $33,625

Table 2.4.14. Twelve Year Stream of Well Operation and Maintenance Costs (Hand Pump) - Central Range

Table	Year	1	2	3	4	5	6	7	8	9	10	11	12
	Operating	0	0	0	0	0	0	0	0	[illegible]	0	0	0
3	Rtn Maint	138	138	138	138	138	138	138	138	138	138	138	138
5	Maj. O/H			1,734			1,734			1,734			
	Total	$138	$138	$1,873	$138	$138	$1,873	$138	$138	$1,873	$138	$138	$138

Net Present Value (i = 10%) in year 0 $3,961

Add Overhead @		1	2	3	4	5	6	7	8	9	10	11	12
40%		55	55	749	55	55	749	55	55	749	55	55	55
	Total	$194	$194	$2,622	$194	$194	$2,622	$194	$194	$2,622	$194	$194	$194

Net Present Value (i = 10%) in year 0 $5,545 assumed to be twelve years. With proper maintenance, however, most wells are expected to remain in use for fifteen to twenty years. The costs shown are at constant 1986 prices, and do not allow for inflation. Therefore, projecting a longer life for the wells would simply require extending the stream of costs over more columns.

Because of the implied commitment to operation and maintenance costs when the decision to construct a well is taken, it is necessary to include these in the estimate of total investment costs. For this, the future costs of operation and maintenance are discounted to give the Net Present Value (NPV).

The principle of discounting is based on the concept that financial investment now, in goods and services delivered in the future, is worth less than financial investment now, in goods and services delivered immediately. In the case of well construction, this is readily obvious from society's point of view. An alternative way to consider this, and a more practical way to arrive at the appropriate discounting rate to be used, is to consider the investment in purely financial terms. In this case, the investment required now, to cover costs incurred one year from now, may be thought of as the amount which, if deposited at the bank, would accrue to the amount required in one year. Excluding the social considerations, the discount rate is the interest rate on investments.

Annual interest rates offered by financial institutions in Somalia at the time of writing vary from 12%, for short-term, to 17% for long-term investments. Corresponding interest rates in the United States range from [illegible]% to approximately 13%. Because the local currency cost of operation and maintenance, which consists only of the labour cost, constitutes less than 10% of the total, it can be argued that the correct discount rate to be used should be closer to the bank interest rates of the United States than to those of Somalia. The rate assumed in this report is 10%.

In these calculations, construction costs are assumed to be incurred in year 0. The first year of operation and maintenance costs are incurred in year 1. NPV's are therefore calculated for year 0, and all costs incurred from years 1 through 12 are discounted. Discounting beyond the twelve years shown in the analysis makes such little difference to the NPV as to be negligible.

The actual discount rate used in the calculation makes a significant difference to the NPV. Using the Bay Region costs as shown in Table 2.4.11 as a base, the NPV in year 0 varies considerably, as shown below:

Rate of Discount	NPV Total O & M
5%	$23,999
10%	$18,470
15%	$14,662
20%	$11,951

Deciding upon, and justifying, the rate of discount to be used for a non-commercial investment can be problematical. Investment in well construction, as carried out by the Groundwater Project, cannot be considered as a commercial investment. In evaluating investment in well construction for the purpose of comparing it to investment in alternative methods of providing water in Somalia, the same discounting rate should be used throughout.

4.3.3. Amortization of Total Costs.

The total amortized costs of well construction, operation and maintenance, assuming a 12 year life and a 10% discounting rate, are shown in Table 2.4.15 for the Bay Region and in Table 2.4.16 for the Central Range. The share of the cost of exploratory wells is based on the program success rate in the two regions, 60% in the Bay Region, and 50% in the Central Range. It is apportioned between diesel equipped and hand pump equipped wells in proportion to the ratio of the total program cost of each. The amortized operation and maintenance costs are taken directly from Tables 2.4.11-14.

Table 2.4.17, the Summary Total Cost of Well Equipped with Diesel Pump, is provided to summarize the analysis to this point. It might also serve to answer the question posed so often, "How much does it really cost to construct a well in Somalia?". As shown already, the number of variables involved, and the decision to include, and how to include, capital costs, exploratory drilling costs, life-time operation and maintenance costs, and overhead costs, renders this a complex question. The "average" shown in the table is a simple average, and not weighted to represent any "average" conditions found in Somalia.

Because monetary values cannot be determined for the benefits, and therefore a cost-benefit analysis is not feasible, a useful costing statistic is the "cost per cubic meter of water produced over the life of the well". For this, the quantity of water produced each year over the life of the well must also be amortized to a "net present value". Assuming 12 cubic meters per hour for 8 hours each day for 240 days each year for 12 years, this computes to a present value of 156,987 cubic meters. Using the total well construction, operation and maintenance

Table 2.4.15. Gross Amortized Total Cost of Well with 12 year life - Bay Region

* Assumption: out of every 100 boreholes, 40% will be exploratory - dry, salty, collapsed
* of which 88% of the remainder, 53% of the total, will be equipped with diesel pump
and 12% of the remainder, 7% of the total, will be equipped with hand pump.
Cost of Exploratory Well = $13,755

	Diesel Pump	Hand Pump
Hydrogeology	638	638
Drilling	26,414	26,414
Logging	330	330
Well testing	974	974
Civil Works	7,447	
Pump Installation	18,229	4,698
Sub-totals	54,030	33,052
+ Share of cost of Exploratory Wells	9,605	5,876
Sub-totals	63,636	38,928
+ Operating and Maint.	18,470	2,534
Totals	$82,106	$41,462

Table 2.4.16. Gross Amortized Total Cost of Well with 12 year life - Central Range

* Assumption: out of every 100 boreholes, 50% will be exploratory - dry, salty, collapsed
* of which 80% of the remainder, 40% of the total, will be equipped with diesel pump
and 20% of the remainder, 10% of the total, will be equipped with hand pump.
Cost of Exploratory Well = $33,148

	Diesel Pump	Hand Pump
Hydrogeology	1,222	1,222
Drilling	52,218	52,218
Logging	619	619
Well testing	1,342	1,342
Civil Works	8,495	
Pump Installation	18,781	5,226
Sub-totals	82,677	60,627
+ Share of cost of Exploratory Wells	35,016	25,677
Sub-totals	117,693	86,304
+ Operating and Maint.	24,018	3,961
Totals	$141,711	$90,265

Table 2.4.17. Summary Total Cost of Well Equipped with Diesel Pump

		Bay Region			"Average"	Central Range		
Direct Costs: So. Sh.			162,282	$2,003	$2,372		221,956	$2,740
F/Exch.	Materials			$29,730	$30,593	Materials		$31,455
	Fuel			$6,845	$9,607	Fuel		$12,368
	Total Direct Costs			$38,579	$42,571	Total Direct Costs		$46,563
Capital Replacement Charge				$8,587	$15,707			$22,826
Repairs and Maintenance Provision			10%	$6,865	$10,076		10%	$13,288
	Direct + Indirect			$54,030	$68,354	Direct + Indirect		$82,677
Exploratory Drilling Overhead			40%	$9,605	$22,311		50%	$35,016
	Total Program Cost			$63,636	$90,665	Total Program Cost		$117,693
Amortized Operation and Maintenance				$18,470	$21,244			$24,018
	Full life cost			$82,106	$111,909	Full life cost		$141,711
Agency Overhead Costs			40%	$32,842	$44,763		40%	$56,685
	Grand Total Cost			$114,948	$156,672	Grand Total Cost		$198,396

costs from Table 2.4.17, the amortized cost per cubic meter are as follows:

	Bay Region	"Average"	Central Range
NPV Total Costs	$114,948	$156,672	$198,396
NPV Total Water	156,987	156,987	156,987
Cost / cubic meter	$0.73	$1.00	$1.26
Cost So.Sh.@ 83:1	61	83	105

Tables 2.4.18 and 2.4.19 are included to show order-of-magnitude cost estimates of a five-year well construction program in Somalia. The projections of "Total Needed Wells" for each year up to 1990 are taken from reports produced by LBII for the Private Sector Study, and represent "...a more modest set of goals presented in the MMWR's planning document...implying less of an attempt to develop groundwater resources and relying relatively more heavily on surface water resources and catchments...", (LBII, 1985), (MMWR, 1983). Based on these estimates, the annual national program costs by 1990 will have risen to between twenty-two and thirty-nine million dollars. These figures exclude WDA overhead costs. In practice, many of these wells will be constructed by the private sector, or directly by donor-funded development projects through the budgets of other Ministries. The figures therefore represent an estimate of national requirements, rather than a budget projection for WDA.

4.3.4. Well Revenues

The official price of water sold from WDA wells is currently set at So.Sh.18 per cubic meter. In practice, this price is very difficult to adhere to with any precision.

The difficulties involved in estimating the actual price charged for water are discussed first. Given these difficulties, the assumptions made are explained. The validity of those assumptions is then examined in terms of a community's ability both to consume the amount of water produced, and to afford the appropriate cost involved. Finally, the implications of aiming to recover investment costs are discussed.

Table 2.4.18. Five Year Cost Projection of National Well Construction, Operation and Maintenance Program. (in thousands of US$, using Bay Region Program estimated costs)

	1985	1986	1987	1988	1989	1990	Total
Needed Total Wells *	686	785	898	1028	1176	1345	
Cumulative increase		99	212	342	490	659	
Addition Cost of Operation and Maint		293	627	1,011	1,448	1,948	
Old Wells Cost of O & M (1985 level)		2,028	2,028	2,028	2,028	2,028	
Total O & M		2,320	2,654	3,039	3,476	3,976	$15,465
Needed New Wells *		169	194	223	255	291	
Cost New Wells		10,754	12,345	14,191	16,227	18,518	$72,036
Total Program Cost		$13,075	$15,000	$17,229	$19,703	$22,494	$87,500

* Source: LBII, 1985, Vol.1, p.36, National objectives modified MMWR.

Table 2.4.19. Five Year Cost Projection of National Well Construction, Operation and Maintenance Program. (in thousands of US$, using Central Range Program estimated costs)

	1985	1986	1987	1988	1989	1990	Total
Needed Total Wells **	686	785	898	1028	1176	1345	
Cumulative increase		99	212	342	490	659	
Addition Cost of Operation and Maint		378	810	1,306	1,871	2,516	
Old Wells Cost of O & M (1985 level)		2,620	2,620	2,620	2,620	2,620	
Total O & M		2,998	3,429	3,926	4,491	5,136	$19,979
Needed New Wells **		169	194	223	255	291	
Cost New Wells		19,890	22,832	26,246	30,012	34,249	$133,229
Total Program Cost		$22,888	$26,262	$30,171	$34,503	$39,385	$153,208

* Source: LBII, 1985, Vol.1, p.36, National objectives modified MMWR.

4.3.4.1. Actual and Assumed Water Prices

Water for human consumption is generally sold at the well site in 20 and 40 liter containers. In some areas an immediate cash transaction occurs in which the correct price is maintained. More often, however, it was found that at villages in the Bay Region, monthly consumption for each household is estimated, and a flat fee is collected each month.

The pricing structure for livestock watering is even more subject to error. Camels need to be watered once every one to three weeks, cattle every other day, and sheep and goats every three or four days. Various estimates exist of the average daily water requirements of these animals. If a camel requires 20 liters per day, and visits the well only once every week, it will consume 140 liters during that visit. At So.Sh.18 per cubic meter, this works out to So.Sh.2.50 per visit. Based on the limited surveys conducted by the Planning Unit, the usual charge for camels averages only So.Sh.1.00 per visit. The calculated figure of 140 liters per visit, however, takes no account of the camel's capacity to drink that quantity at one time, nor, more importantly, what access it has had to water, or water bearing plants, during the preceding seven days. At some village well sites with a fixed population of users, a regular monthly payment from each household is agreed upon for livestock watering. The practice of water pricing at the well sites is discussed more fully in Section 3.0.

Calculation of well revenues based on the amount of water produced is also subject to error. Pumps and diesel engines become less efficient over time. Seepage from pits at sites with no civil works is considerable, and some evaporation takes place at all open storage tanks. At sites equipped with completed civil works, leaks often develop at valves or at troughs.

Existing reliable data on any of these important variables is very limited, and shows a wide range of conditions and practices throughout the two regions studied. The discussion from this point assumes a correct charge of So.Sh.18 per cubic meter paid for all water produced, and a wastage allowed of 10%. Calculation of the volume of water produced is based on the same variables as are used in calculating fuel consumption. There is currently no charge for water drawn from wells equipped with hand pumps.

Tables 2.4.20 and 2.4.21 show the NPV's of 12-year costs and revenues of wells in the Bay Region and Central Range respectively. For the Bay Region, this shows a credit, or "profit", of US$5,540, which goes some way to offset the capital

Table 2.4.20. Net Operation & Maintenance Costs - Diesel Pump - Bay Region

Year	1	2	3	4	5	6	7	8	9	10	11	12
Operating	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703	1,703
Rtn Maint	205	205	205	205	205	205	205	205	205	205	205	205
Maj. O/H			3,143			3,143			3,143			
Total	1,908	1,908	5,051	1,908	1,908	5,051	1,908	1,908	5,051	1,908	1,908	1,908
40% overhead	763	763	2,021	763	763	2,021	763	763	2,021	763	763	763
	2,671	2,671	7,072	2,671	2,671	7,072	2,671	2,671	7,072	2,671	2,671	2,671
Revenue	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608
Total	(1,937)	(1,937)	2,464	(1,937)	(1,937)	2,464	(1,937)	(1,937)	2,464	(1,937)	(1,937)	(1,937)

NPV = (15,540)

Assumptions:

Well operates for 240 days/year at	8 hours/day =	1920 hours/year
water pumped at rate of	12 cm/hour =	23,040 cm/year
allowing for wastage	10% =	20,736
sold at a price of So.Sh.	18 per cm =	373,248
at exchange rate $1/Sh =	81 = total	4,608

Table 2.4.21. Net Operation & Maintenance Costs - Diesel Pump - Central Range Program

Year	1	2	3	4	5	6	7	8	9	10	11	12
Operating	2,210	2,210	2,210	2,210	2,210	2,210	2,210	*2,210	2,210	2,210	2,210	2,210
Rtn Maint	354	354	354	354	354	354	354	354	354	354	354	354
Maj. O/H			3,766			3,766			3,766			
Total	2,563	2,563	6,329	2,563	2,563	6,329	2,563	2,563	6,329	2,563	2,563	2,563
40% overhead	1,025	1,025	2,532	1,025	1,025	2,532	1,025	1,025	2,532	1,025	1,025	1,025
	3,589	3,589	8,861	3,589	3,589	8,861	3,589	3,589	8,861	3,589	3,589	3,589
Revenue	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608	4,608
Total	(1,019)	(1,019)	4,253	(1,019)	(1,019)	4,253	(1,019)	(1,019)	4,253	(1,019)	(1,019)	(1,019)

NPV = [illegible]

Assumption:

Well operates for	240 days/year at	8 hours/day =	1920 hours/year	
water pumped at rate of	11 cm/hour =	21,040 cm/year		
* allowing for wastage	10% =	20736		
* sold at a price of So.Sh.	18 per cm =	373,248		
at exchange rate $1/Sh =	81 = total	$4,608		

cost of well construction. For the Central Range, the NPV represents an additional cost of US$2,227 over and above the initial construction cost. For these calculations, the "border price" of U.S.$0.39 per liter is used for diesel.

If the local market price of So.Sh.18 per liter, converted at the 83:1 rate of exchange to U.S.$0.22, is used, the NPV of net costs and revenues gives a credit of $10,750 for the Bay Region, and $3,270 for the Central Range.

4.3.4.2. Community Consumption and Ability to Pay

Many of the assumptions used in the above calculations are questionable. For example, is it reasonable to assume that the total community with reasonable access to a well can use all of the water produced in eight hours pumping? The following calculation suggests that it is. The population data for the Bay Region is taken, unqualified, from the Southern Rangelands Survey (RMR, 1985).

Production

8 hours per day @ 12 m^3 per hour
96,000 less 10% = 86,400 liters per day

Population

Total Pop'n	Bay Region Data Wet 1983	Dry 1984	Average	Animals per head of population (Dry)	(Ave)
Persons:					
Rural	501,713	479,862	490,788		
Nomadic	226,543	9,942	118,243		
Total	728,256	489,804	609,030		
Camels	742,038	360,599	551,319	0.736	0.905
Cattle	751,468	537,021	644,245	1.096	1.058
Sheep	102,915	78,086	90,501	0.159	0.149
Goats	488,164	455,838	472,001	0.931	0.775
Sh & gts	591,079	533,924	562,502	1.090	0.924

On the assumption that the wells are used for the eight months of the dry season, the "animals per head of population" figures used should be those for the dry season only. Extrapolating those figures to arrive at the populations necessary to consume the maximum daily output of water, gives the following:

Consumption

	Estimated Population	ltr/ day	Total ltr/day		ltr/ day	Total ltr/day
Persons	1,360	20	27,200		30	40,800
Camels	1,001	25	25,031	or	15	15,019
Cattle	1,491	20	29,822		20	29,822
Sheep/goats	1,483	3	4,448		1	1,483
			86,501			87,123

From data collected at Bay Region well sites, these population estimates appear reasonable. The other major question relating to these assumptions concerns whether the cost of this water could be reasonably borne by a rural community.

Assuming a total daily consumption of 96 cubic meters for 240 days each year gives an annual consumption of 23,040 cubic meters per year. At a cost of So.Sh.18 per cubic meter, this represents a total annual bill to the community of So.Sh.414,720. Shared among a community of 1,360 people, this equates to So.Sh.305 per head of population, or approximately So.Sh.1,500 per household of five persons. This represents the approximate selling price of two goats.

4.3.4.3. Water Pricing and Cost Recovery

The final analysis, shown in Tables 2.4.22 and 2.4.23, computes the price for water which would need to be charged if it were the policy of the Government of Somalia to ensure that revenues covered the cost of annual operation and maintenance. A WDA overhead of 40% has been included as in previous calculations, and diesel fuel is costed at the "border price" of U.S.$0.39 per liter. The necessary prices per cubic meter are almost So.Sh.15 for the Bay Region and over So.Sh.19 for the Central Range.

Using the local Mogadishu price for diesel of So.Sh.18 (U.S.$0.22) per liter, the necessary selling price is reduced to So.Sh.12 for the Bay Region, and So.Sh.16 for the Central Range. At the present time, it is the policy of the government to maintain a uniform price throughout the country, so that this would fall somewhere between these two sets of figures.

In order to recover, the "direct costs" of well

Table 2.4.22. Price of Water Necessary to cover all Operation and Maintenance Costs - Diesel Pump - Bay Region

Year	1	2	3	4	5	6	7	8	9	10	11	12
Tot Operating Cost	1,908	1,908	5,051	1,908	1,908	5,051	1,908	1,908	5,051	1,908	1,908	1,908
+ 40% overhead	763	763	2,021	763	763	2,021	763	763	2,021	763	763	763
Less Revenue	3,795	3,795	3,795	3,795	3,795	3,795	3,795	3,795	3,795	3,795	3,795	3,795
Total	(1,124)	(1,124)	3,277	(1,124)	(1,124)	3,277	(1,124)	(1,124)	3,277	(1,124)	(1,124)	(1,124)

NPV = ($2)

Assumption:

Well operates for	240 days/year at	8 hours/day =	1920 hours/year	
water pumped at rate of	12 cm/hour =	23,040 cm/year		
allowing for wastage	10% =	20,736		
sold at a price of So.Sh.	14.825 per cm =	307,411		
at exchange rate $1/Sh =	81 = total	$3,795		

Table 2.4.23. Price of Water Necessary to cover all Operation and Maintenance Costs - Diesel Pump - Central Range

Year	1	2	3	4	5	6	7	8	9	10	11	12
Tot Operating Cost	2,563	2,563	6,329	2,563	2,563	6,329	2,563	2,563	6,329	2,563	2,563	2,563
+ 40% overhead	1,025	1,025	2,532	1,025	1,025	2,532	1,025	1,025	2,532	1,025	1,025	1,025
Less Revenue	4,934	4,934	4,934	4,934	4,934	4,934	4,934	4,934	4,934	4,934	4,934	4,934
Total	(1,346)	(1,346)	3,926	(1,346)	(1,346)	3,926	(1,346)	(1,346)	3,926	(1,346)	(1,346)	(1,346)

NPV = $3

Assumption:

Well operates for	240 days/year at	8 hours/day =	1920 hours/year	
water pumped at rate of	12 cm/hour =	23,040 cm/year		
allowing for wastage	10% =	20,736		
sold at a price of So.Sh.	19.275 per cm =	399,686		
at exchange rate $1/Sh =	81 = total	$4,934		

construction over the twelve year life of the well, $38,579 for the Bay Region and $46,563 for the Central Range, the current price would need to be doubled for the Bay Region, and increased to two and a half times for the Central Range.

4.4. Conclusions

That deep wells are expensive to construct in Somalia is hardly a recent discovery. This report provides up-to-date information on exactly how expensive they are or can be. It also provides some useful clues as to where savings can be made and greater efficiencies achieved.

4.4.1. Well Construction.

Direct costs, though not fixed, probably cannot be varied substantially. Alternative materials and suppliers might make some items available at less cost. The use of PVC for screen and casing in the areas where shallow wells make it appropriate may be less expensive than steel. Reducing completed well diameters from 8 inch to 6 inch would also provide considerable saving without sacrifice to well construction. A pump manufacturing or assembly capability in Somalia would reduce economic costs to the nation.

Major savings can be made in more efficient use of equipment and vehicles. The equipment assigned to one project drilling team represents a capital investment in excess of $500,000. This sum, invested at 15%, would yield interest of $250 per working day. Each drilling team should therefore aim at a level of productivity equivalent to this sum. In this context, having a drilling team unable to work for lack of fuel or spare parts can be seen as inordinately expensive, an expense far in excess of the cost of the fuel or spare part causing the delay. The actual downtime experienced by the project, which is discussed in Section 4.1.3, should be considered realistic, but at the same time unacceptably high. Operating at this level of downtime, the wells constructed during the project appear costly.

There is, however, an alternative way to view this. Rather than an institutional support project producing expensive wells, the Comprehensive Groundwater Development Project can be seen as a well drilling project providing very expensive institutional support. The difference might appear academic until alternative ways of providing institutional support are considered. In short, the cost of combining production with on-the-job training in the drilling industry is unreasonably high because of the cost of capital investment involved.

At the time of writing, WDA is estimated to have twenty drilling rigs in operating condition, and perhaps a further twenty which are not operational but are considered repairable. Though many of these are old, and, in accounting terms, fully depreciated, these forty rigs represent an eventual capital replacement cost of at least ten million dollars. Assuming the drilling rates experienced by the project in the Central Range, with a success rate of only 50%, these rigs could potentially construct 120 production wells each year. The direct costs involved would be approximately US$5,000,000 for the production wells, and an additional US$1,250,000 for the exploratory wells. The success rate would hopefully be much higher than 50%.

This level of production would achieve the targets shown in Table 2.4.18 by WDA alone, not counting the additional wells constructed by the private sector. This level of production could be achieved, but given the present level of management expertise within WDA, and the complete lack of incentives provided to staff, it is unlikely to occur. In considering whether Somalia can afford such an extensive program of drilling, consideration should also be given to whether Somalia can afford not to have the water which it would produce.

4.4.2. Operation and Maintenance, and Well Revenues

From the cost figures shown in Section 4.3.4, the current government price for water appears to be adequate to recover all operation and maintenance costs. In order to recover the direct costs of construction, the price would need to be at least doubled. The revenues actually collected by WDA, however, fall a long way short of those predicted in this report. Many instances were found where village communities regularly purchased fuel on the "black market": for all practical purposes, these wells have been abandonned by WDA. In many other areas, the practice seems to have been established that fuel delivered by WDA is "purchased" by the local community, and this purchase price substitutes for the correct revenues due for the previous operating period. Given these widespread practices, the operation and maintenance costing analyses presented in this report will not be especially useful.

If, in fact, WDA is unable to enforce the correct pricing procedure for the sale of water, and cannot therefore recover anything like the total revenues due, then a case exists for an alternative approach to the administration of wells. This might involve some degree of privatization. Ownership could be transferred to the community, with laws governing the obligation to provide access to water and maximum prices charged. The wells could be sold, leased, or rented to the community. Operation and maintenance would then be the responsibility of the community, to contract with the private sector, or with WDA.

These issues are discussed more fully in Sections 3 and 5 of this report. Their relevance to this section is that the economic analysis of operation and maintenance, and of water pricing, in this report do not correspond to actual practices within WDA or at WDA well sites.

5.0 PRIVATE SECTOR

In recognition of the constraints on the economic development of Somalia caused by lack of water resource development, USAID, in granting the extension of the CGDP, required that a special study be conducted to evaluate the existing and potential involvement of the private sector in the water industry. This study, referred to as the "private sector study", was divided into four phases. These four phases, as set forth in the Inception Report, were:

Phase I	Planning and Reconnaisance
Phase II	Information Gathering
Phase III	Analysis
Phase IV	Recommendations and Report

Phase I was essentially completed with the submission of the Inception Report in January 1985. Phase II was initiated in the LBII Washington offices and continued with the arrival of the study team in Mogadishu. In Mogadishu, two sub-contractors, Geomatec and MAM Brothers, were retained to assist in the information gathering exercise.

Conceptual models of potential options were formulated during the data gathering period, and formalized upon completion of Phase II. Policy options were developed and circulated to WDA, USAID, and CGDP team members for comment in April 1985.

An excutive summary of recommendations was prepared in anticipation of a seminar, to be held in Mogadishu, prior to the preparation of final recommendations and a final report. Unfortunately, the seminar was cancelled, but the study team met with key individuals of WDA, and USAID, to review their initial recommendations.

A three volume final report, entitled "Study of Private Sector Participation in Somalia's Water Resource Development Industry", was completed in February, 1986. The report is organized in three sections. Section I provides an introduction and overview of the study; Section II explains the three phases of the recommended program; Section III discusses the need for private sector participation in the water resource development industry.

Section I is self explanatory. Section II of the report, the consultant's recommended program, contains the main thrust of the study. Each of the three phases described in Section II are presented in the logical sequence of steps that would be required to strengthen the water resource development capability of Somalia.

Phase one, Well Rehabilitation and Maintenance, outlines the steps required to upgrade the numerous existing, non-operating wells throughout Somalia by involvement of the private sector. The action components and technical assistance requirements are carefully detailed.

Phase two, Water Security Role for Somali Private Sector, discusses the role the private sector would take in water development during emergency situations. The action components of this phase employ "Option F", as discussed in the Policy Options Paper of April, 1985.

Phase three, Reoriented WDA Role, discusses the major reorientation of WDA's role as a parastatal rural water well drilling and regulating agency. It recommends that WDA concentrate on the following five functions:

(1) Contracting with the Somali private sector for well operation and maintenance, drilling and construction, and provision of related inputs,

(2) Research and planning for rural water resource development in Somalia,

(3) Public utility regulation of water prices and service,

(4) Exploratory and emergency drilling, and

(5) Operation of selected wells and water systems.

Section III of the report provides the documentation that supports the need for greater private sector participation. The current and future water needs of Somalia are examined, and the capabilities of, and constraints upon, the private sector are described.

Perhaps one of the major products of the study of private sector participation in Somalia's water resource development industry was the formulation of a water industry systems model (WISyMS). This model was designed to provide an integrated analysis of the relationship between water consumers, water supply structures, and inputs to the water industry. Although WISyMS was designed as a tool for comprehensive sectoral analysis for a private sector project, the analyses performed by WISyMS are applicable to any water development planning strategy. The structure and applications of this model are described in an appendix, with ten annexes, to the main body of the report on private sector participation.

The material in this final report on private sector participation is too voluminous for inclusion in this report;

the interested reader is strongly encouraged to review the original document. It is the consultant's opinion that implementation of the recommendations will go far to improve Somalia's self-sufficiency in water development activities.

6.0 WDA'S FUTURE ROLE

This section describes a proposed future role for the WDA over the next ten years, and the gradual restructuring of the organisation that will be necessary to fulfill this role. The proposal draws upon the lessons learned during the implementation of the CGDP, upon the conclusions and recommendations of the Study of Private Sector Participation in Somalia's Water Resource Development Industry carried out by LBII (Section 5.0), and upon the many invaluable discussions held by project staff with WDA, MMWR, and other GDRS employees.

Many of the difficulties currently faced by the WDA derive from its confused role within the water resource planning efforts of the GDRS, a role which has been changing slowly since the time WDA was first established in 1971. These changes are discussed in the context of the widespread re-evaluation of the various approaches to development that have taken place in the last decade. They have occurred largely outside the control of WDA, yet they have radically altered WDA's ability to fulfill its original objectives. This also applies, to some extent, to the roles of the National Water Committee (NWC) and the Ministry of Minerals and Water Resources (MMWR).

Following this necessary reassessment of the current situation, the proposal argues for the implementation of a move to greater privatization within the water industry in Somalia over the next ten years, and discusses the changing role of WDA which will accordingly be required.

6.1. Changes in the Approach to Development

Concepts of the structure of government, of development projects, and even of the basic approach to science and technology, have radically changed in recent years. Some of this rethinking can be traced back to the early part of this century, but much more, particularly that concerned with developmental changes in society, has only begun to have an impact over the last ten or twenty years.

The changes in approach can be characterized by a move from reductionist to systems theory, from the cause-and-effect approach to the environmental systems approach. As it affects the structure of government, the design of development projects, and the role of WDA in water resource development in Somalia, the reductionist cause-and-effect approach can be expressed as shown in Figure 2.6.1. Within this structure, water development is an independent sector within the overall government administration, as are, for example, the health, agriculture,

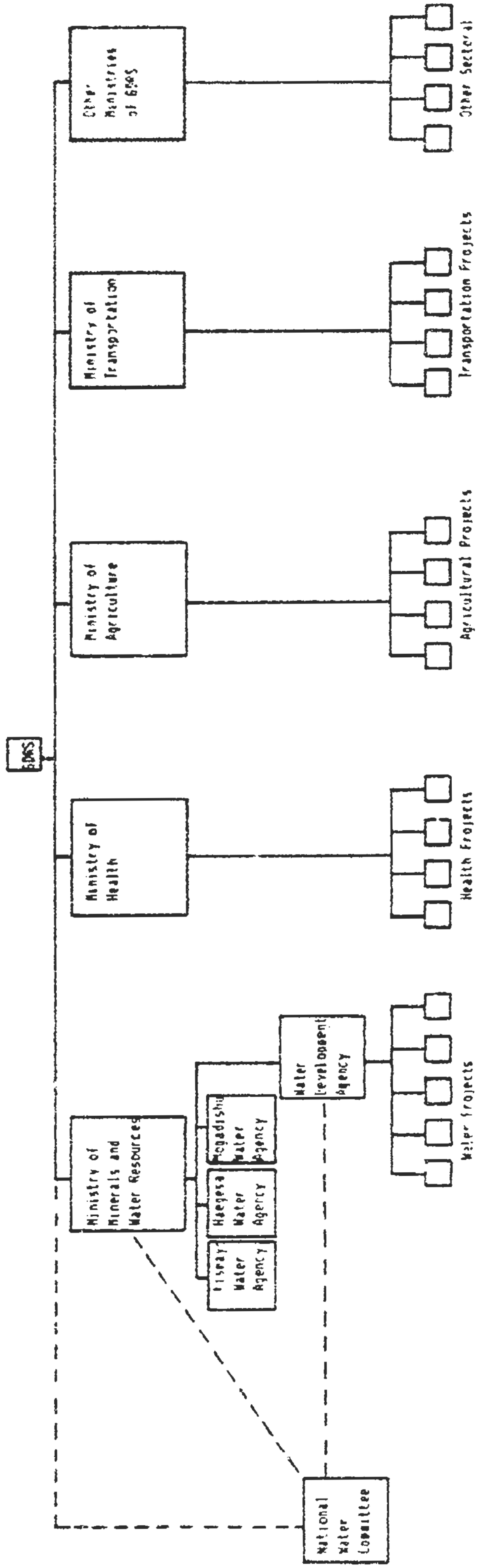

Figure 2.6.1. REDUCTIONIST APPROACH TO WATER RESOURCE DEVELOPMENT

and transportation sectors. Water development is entrusted to a hierarchical structure consisting of the NWC, the MMWR, and the WDA. Other sectors are represented by Ministries such as Health, Agriculture, and Transportation, and have a role in water resource development that is secondary in terms of overall water resource planning. Total development budgets are allocated to sectoral activities, and thus to the Ministries.

The NWC-MMWR-WDA is required to prepare a national water resource development program for which necessary funds are provided. This water resource development program is reportedly related, by the NWC and the Ministry of National Planning, to the pattern of development in other sectors, to the health, agriculture, and road construction programs throughout the country.

It has long been realized that all of these sectors are closely related. They are interdependent to the extent that the creation of a new water source often results in numerous environmental and social changes. These may include increased sedentarization, changes in economic activities, and increased demand for the government to provide social services, such as schools and health centers. Attempts to acknowledge this interdependence among sectors has led to the design of broad-based development projects, with a component for each sector represented. Often called "integrated rural development" projects, these cover specific geographic areas. These projects are frequently given considerable autonomy, and administratively cut across the traditional sectoral lines of government organization. The resulting structure, carried to its extreme, is illustrated in Figure 2.6.2.

Within this structure, a national water resource development program exists only to the extent that it derives from the aggregated water resource development components of the integrated development plans and projects throughout the country. Examples of such integrated projects are the Bay Region Agricultural Development Project and the Central Rangelands Development Project. It is clear that some of these projects are not, in fact, fully "integrated", and do not involve every sector of the government: some areas of the country are not at present within an integrated development project, and must therefore rely upon the former structure whereby the NWC-MMWR-WDA is responsible for their water development planning. The WDA currently finds itself caught between these two structures, and its role within each is considerably different. Before defining its future role, changed as a result of moves towards increased privatization within the industry, its present role must be more clearly defined.

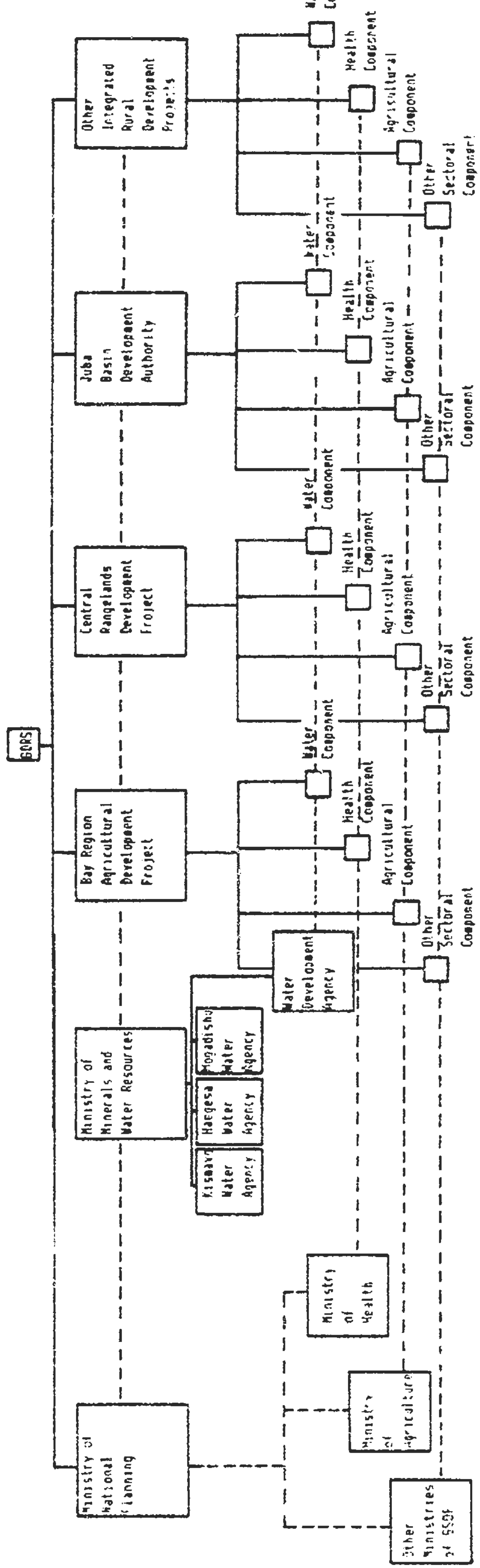

Figure 2.6.2 SYSTEMS THEORY APPROACH TO WATER RESOURCE DEVELOPMENT.

6.2. Redefinition of WDA's Present Role

As indicated above, a system has evolved whereby much of the work required of the WDA is determined by other ministries. In many regions of the country, these ministries are the Ministries of Agriculture, Livestock Development, and Interior. In other areas, the "ministries" are the semi-autonomous "integrated rural development" projects. The extent to which the NWC-MMWR-WDA structure is called upon to develop a national water development plan has been severely curtailed, and the autonomy of the WDA with regard to overall water resource planning is almost non-existent.

The WDA is already better described as a "service agency", providing services to other agencies of the government as required. In terms of creating new water sources, it is required only to advise on hydrogeological issues, and to carry out the actual construction and development of water sources. The function of site selection is largely out of the WDA's hands. It is, however, still left with a formidable set of responsibilities that include, but are not limited to:

1. Construction, of boreholes, surface catchment structures, civil works, and distribution systems.

2. Maintenance, of all water sources not privately owned.

3. Revenue collection, from the sale of water, on behalf of the Ministry of Finance.

4. Emergency water supplies: when called upon in times of severe drought, to devote all available resources to relief drilling.

5. Exploratory drilling, the only remaining area where it is required to develop a national strategy and, through the NWC-MMWR-WDA structure, actual programs.

6. Policy advice, to the government in all its forms, on all aspects of water resource development, including costs, socioeconomic impacts, and water pricing policy.

Even its present position with regard to the design of exploratory drilling programs is becoming less clear. With the National Water Data Center being set up under the MMWR, the logical place for the design of such programs might well become the Ministry, with the WDA being left merely to implement the programs.

The above comments represent the consultant's interpretation of how the role of the WDA has changed, and how, even with no major policy changes in the industry, it will continue to change. The WDA's role, from when it was originally set up in 1971, therefore needs redefining.

6.3. WDA's Future Role

The following proposal is based upon the assumption that many of the present activities of the WDA will be transferred to the private sector over a ten year period. It is based upon "Option H" of the Policy Options Paper presented to the Government of Somalia by the contractor in April 1985 (LBII, 1985). This proposes that "...WDA's role is reoriented by curtailing drilling and civil works functions and by focusing agency activity on exploration, private sector contracting, public utility regulation, and emergency operations".

More specifically, this plan proposes a gradual restructuring of the industry. This will begin with the subcontracting of operation and maintenance functions to the private sector. In a similar manner, civil works construction and drilling operations, for all but exploratory drilling, will also be subcontracted. A methodology for transferring well ownership from the WDA to local communities will be implemented when the operations are able to be conducted by the private sector. The WDA's role will then become that of administrator, to issue permits and register water supply ownership.

In its role as regulator of water resources, the WDA will be responsible for establishing construction standards and for managing water resource development. The WDA will continue to be responsible for exploratory drilling, and for production drilling in emergency situations.

In the initial stages, the WDA will be responsible for the subcontracting of maintenance, and of drilling, to the private sector. Eventually, contracting is expected to be directly between the implementing agency, the community, the ministry, or the project, requiring the well, and the drilling contractor. The WDA's role in contracting at this time will be as regulator of well location and well construction. It will also need to develop the organisational capability to monitor these standards to ensure that the regulations are being enforced.

WDA's other major role will continue to be that of advisor to the government on all aspects of water resource development. Subject to a redefinition of WDA's relationship to the NWDC, its hydrogeology section will be the national resource for this expertise. Its planning, monitoring and evaluation capabilities will require considerable enhancement: detailed plans for the future development of the Planning Unit, upon which much of this responsibility will rest, are given in Section 2.3 of this report.

7.0 RETROSPECT

This section is presented in an effort to aid those persons planning future water development projects. These comments and opinions are applicable to any Ministry or Agency planning to conduct water resource development projects. What has happened during the course of this project is history, and cannot be changed. The experience must, however, serve as a guide to what could be in the future.

A prerequisite for project success is that those responsible for implemention have the authority necessary to exercise control over all aspects of the project. When this function is divided, the chances of success in the project are greatly reduced. In the following sections, those aspects of the project that were affected by this lack of control are discussed.

7.1 Personnel Management

All members of the Consultant's staff expressed the same feeling with regard to personnel - frustration at the lack of control experienced from not being able to hire and fire. On numerous occasions, certain individuals were reported to be not performing adequately, or not at all. Although frequently reported, these individuals were allowed to remain on the job, ostensibly because of the inability to find replacements.

The consultant was aware of the problems faced by WDA in not being able to offer adequate salaries to attract and retain qualified staff. On future projects, it would be advantageous to provide the consultant with the means to hire the staff required to get the job done. Alternatively, the consultant should have equal right of acceptance or dismissal of staff and counterparts provided.

7.2 Supplies and Equipment

One of the difficulties in fulfilling the objectives of the project was the failure of appropriate supplies and equipment to be delivered in a timely manner. If possible, the team selected to implement the project should be responsible for equipment selection. Ideally, an advance team should be brought in to set up whatever infrastructure is required to carry out the work. This team might consist of the project manager, and one or two key personnel of disciplines appropriate to the project being considered. Where delivery times are known to be up to a year, this advance team should be mobilized for a short term of one or two months, and then recalled with the full team when basic supplies and equipment arrive in-country.

Means to reduce procurement time should also be sought. This might involve placing the consultant in direct contact with a procurement agent of the donor's choice. By reducing the number of people involved in procurement, the chances for error, as well as the times involved, are reduced. In addition, accountability for errors is more clearly defined.

7.3 Warehousing

As with procurement, warehouse space and warehouse procedures should be established prior to initiation of project activities, and should also be a task of the advance team. Attempting to establish a system when the project is already under way, leads to confusion and loss.

If accountability for supplies is placed with the consultant, then complete control over those supplies must also be given. It is virtually impossible to account for a warehouse of supplies and equipment where only token control is given.

7.4 Planning/Monitoring Evaluation

The key factors involved in the lack of optimum success by the Planning Unit were the lack of qualified staff and the late initiation. The objectives of planning, monitoring, and evaluation, were to track construction, and operation and maintenance, of wells, and to monitor the impacts of the wells on village communities. Normal feedback of information on a day-to-day basis provided adequate monitoring of construction, and operation and maintenance activities. Monitoring the impacts of the wells on village communities, however, was handicapped by a shortage of qualified staff.

In retrospect, the Planning Unit should have been established at the beginning of the project rather than towards the end. All too often, the Unit was regarded by WDA management as a resource for use by the project, rather than for WDA as a whole. As a result, the institutional support provided did not reach the level originally anticipated.

7.5 Well Site Selection

Site selection, with the exception of the hydrogeologic factors, was carried out by the BRADP and CRDP personnel. Acceptance of the well site by the village community should be a priority issue, and be insured prior to mobilization of equipment and personnel. The establishment of a community participation process (described in Section 2.5), which begins with site selection, should be initiated and monitored by the Planning Unit as soon as possible. This will be especially important if the WDA is to remain as the administrator of water resources in the country.

The selection of well sites must necessarily be a joint effort with the agency for whom the well is being drilled. Final approval of the site, however, must rest with the hydrogeology team selected for that purpose. Considerable time and expense was invested in sites which were known, on the basis of professional judgement, to be poor risk sites for drilling.

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