

1

-FNAAAR 245

IAN: 36800

**A SURVEY OF WATER ACTIVITIES
UNDER FOREIGN ASSISTANCE IN THE
YEMEN ARAB REPUBLIC**

**REPORT PREPARED UNDER THE USAID / YEMEN
CONTRACT N° 279-80-589.**

Zohra Merabet

October 1980

1. <u>Preface:</u>	Page	6
2. <u>Methodology:</u>	Page	8
2.1 Organisation of the report	Page	8
2.2 Survey	Page	10
2.3 Principles for the description of projects	Page	11
3. <u>Physical Conditions:</u>	Page	15
3.1 Geographical division	Page	15
3.2 Yemen watersheds	Page	16
3.3 Climatic conditions	Page	16
4. <u>National Institutions:</u>	Page	21
4.1 National Water and Sewerage Authority	Page	23
4.2 Rural Water Supply Department	Page	24
4.3 Ministry of Agriculture/TDA/SURDU	Page	25
4.3.1 Ministry of Agriculture	Page	26
4.3.2 Tehama Development Authority	Page	27
4.3.3 Southern Upland Rural Development Unit	Page	28
4.4 Yemen Oil and Mineral Corporation	Page	29
4.5 Civil Aviation and Meteorological Authority	Page	30
4.6 Confederation of Yemen Development Association	Page	31
4.6.1 LDAs	Page	31
4.6.2 Agricultural Cooperative	Page	33
4.7 Central Planning Organization	Page	34
5. <u>Water Projects:</u>	Page	36
5.1 Irrigation use	Page	36
5.1.1 Agricultural development projects	Page	37
5.1.1.1 Lowlands	Page	37
a. wadi Mawr	Page	38
b. wadi Surdud	Page	41
c. wadi Siham	Page	43
d. wadi Zabid	Page	45
e. wadi Rima	Page	49

f.	wadi Rasyan	Page	52
g.	wadi Mawza	Page	54
5.1.1.2	Midlands	Page	55
a.	wadi Beihan, wadi Tiban	Page	55
b.	wadi Bana	Page	55
c.	wadi Dhanah	Page	56
d.	wadi Jawf	Page	57
5.1.1.3	Highlands	Page	60
a.	Sana'a plain irrigation project	Page	60
b.	Hajjah RID	Page	61
c.	Mahweet RID	Page	62
d.	Khawlan, Beni Hushaish RID	Page	62
e.	SURDP	Page	62
f.	Project of hundred small dams	Page	63
5.1.2	Institutional support to the Department of Irrigation	Page	64
5.1.3	Research/experimental farms	Page	65
5.1.3.1	Lowlands	Page	65
a.	wadi Surdud/Al-Kadaf, Garabeh	Page	65
b.	wadi Siham/Gumeisha	Page	66
c.	wadi Rima/Al-Jarubah, Husayniah	Page	67
d.	wadi Zabid/Zabid farm	Page	67
5.1.3.2	Midlands	Page	68
a.	Batana	Page	68
b.	Central for Agriculture Research, Ta'izz	Page	68
c.	British Mechanisation Program	Page	70
5.1.3.3	Highlands	Page	70
a.	Al-Boun	Page	70
b.	Research farms in Sana'a	Page	71
5.2	Domestic use:	Page	71
5.2.1	Urban use:	Page	72
5.2.1.1	Development projects:	Page	72
a.	Sana'a water supply and sewerage system	Page	75
b.	Hudaydah water supply and sewerage system	Page	77

c.	Ta'izz water supply and sewerage system	Page 79
d.	Ibb water supply and sewerage system	Page 81
e.	Dhamar water supply and sewerage system	Page 83
5.2.1.2	Institution support:	Page 86
a.	USAID	Page 86
b.	AFESD/IDA	Page 87
5.2.2	Rural domestic use	Page 88
5.2.2.1	Rural Water Supply Department	Page 90
5.2.2.1.1	Institution Building:	Page 90
a.	WHO/UNDP	Page 90
b.	UNICEF	Page 91
c.	DED	Page 92
d.	Dutch Volunteer Organization	Page 92
e.	West German Assistance	Page 92
5.2.2.1.2	<u>Turn-Key Projects:</u>	Page 93
a.	USAID	Page 93
b.	Peace Corps Volunteers	Page 95
c.	Japanese Technical Assistance	Page 95
d.	Iraqi Technical Assistance	Page 96
e.	Dutch Technical Assistance	Page 96
f.	Saudi Technical Assistance	Page 98
g.	West German Technical Assistance	Page 98
h.	Small Town Project	Page 99
i.	Mahweet Town Water Project	Page 100
5.2.2.1.3	Ministry of Agriculture/TDA/SURDU	Page 101
5.2.2.2.1	Tehama Development Authority	Page 102
a.	wadi Rima	Page 103
b.	wadi Mawr	Page 103
c.	wadi Surdud	Page 103
5.2.2.2.2	SURDU	Page 103
5.2.2.2.3	Ministry of Agriculture	Page 105
a.	Rada'a RID	Page 105
b.	Al-Boun	Page 105
c.	Hajjah RID	Page 106
d.	Mahweet RID	Page 106
e.	Khawlan, Beni Hushaish RID	Page 107

5.2.2.3	CYDA/LDAs	Page 107
5.2.2.3.1	CYDA	Page 109
a.	UNDP	Page 109
5.2.2.3.2	LDA/CCs	Page 110
a.	SURDP	Page 110
b.	USAID	Page 110
c.	Peace Corps	Page 111
5.2.2.3.3	LDAs	Page 112
a.	USAID	Page 112
b.	Catholic Relief Services	Page 112
5.2.3	International Drinking Water Supply and Sanitation Decade	Page 113
5.3	Water Resources	Page 115
5.3.1	Institution Building	Page 116
a.	Strengthening of Meteorological Department	Page 116
b.	Water resources planning and management	Page 117
c.	Strengthening of the Department of Hydrology	Page 120
5.3.2	Support for the Development of the Water Resources Activities	Page 121
a.	agricultural development support project	Page 121
b.	water resources study in the Tehama coastal plain	Page 123
c.	Unified geological and water resources mapping	Page 124
6.	Index:	Page 126
6.1	Donors/Institution/Geographical Areas	Page 127
6.2.	Geographical Areas/Projects/Data	Page 138
7.	Bibliography	Page 142
8.	List of Abbreviations	Page 150

1. Preface

Due to the complexities in the Y.A.R.'s field of water, both the institutional responsibilities of national agencies and the number and diversity of foreign funded water projects, a systematic study of all the national institutions and of technical assistance was needed in order to improve the country's planning and coordination of water projects.

The first step was taken by the German Volunteer Service, (DED). Confused by many requests of several national agencies for technical assistance in the field of water, they decided to finance a systematic study. DED asked this writer to undertake the study, but it appeared at a very early stage that such a broad task could not be properly carried out within the time allowed. Therefore, I decided to concentrate on national agencies and to also seek potential funds to cover the second aspect of the study, i.e., foreign technical assistance.

Among the foreign agencies contacted, USAID expressed a serious interest in the subject. A large part of USAID assistance in the Y.A.R. involves water projects. A proposal was submitted to USAID at the close of May, 1980 and the fund approved by June, 1980, a remarkably short period.

Because the study was split in two and had two different donors, it was essential to show how complementary the two parts were together, the two works give a better understanding of water activities and provide the basic data for an approach of the development and management of water resources problems in Yemen.

However, it must be said that this two part study does not cover the entire field. An important private sector also exists. Because it is developing the country's water resources at a rate which may endanger the future of its limited

water resources, the private sector's water activities cannot be neglected. Among the follow-up activities required is an inventory of the drilling and engineering supply companies operating in the country in order to collect information on their activities.

Another follow-up activity concerns this very report. While it is a basic reference document for current funded water projects in the Y.A.R., the development in this sector is faster than our ability to document it. Hence, this study must be regarded as the first step in a continuous study which should be undertaken by a national institution to improve the planning and coordination of water projects in the national hydrological activities of the Y.A.R.G.

Also, I would like to apologize for the mistakes and omissions which are necessarily present in a study which is reviewing such a large number of projects. It is my hope that the next supplement to this study, undertaken by some national agency, can correct whatever mistakes are here present.

I am grateful to all members of national and foreign agencies who have helped and encouraged me during this survey, my especial gratitude is due to CPO, YOMINCO, NWSA, the German Advisory Team to CPO, the Dutch Representative and USAID.

Also, I am grateful for the help given me by the library team of the Department of Hydrology, UNDP's Junior Program Officer who granted me UNDP library privileges and Mr. H. Johnson, Program Officer at USAID office, and Mrs. Diane Ponasik, the Rural Social Sciences Advisor and Project Manager, who assisted me in getting the funds for the translating and printing of this report in Sana'a.

Sana'a, October 1980

Zohra Merabet
Engineer

2. Methodology

2.1 Organisation of the Report

Initially, the report was to be organized by donor, type of project, geographical area and relevant national institutions. However, during the field work, we recognized that primary emphasis should be put on the major factors such as physical conditions and national institutional arrangements which influence the nature and location of water projects.

Information on donors and funding are therefore now reduced to lists of the funded projects.

Our study has been organized within the following frame:

- description of physical conditions;
- introduction to how responsibilities are divided among institutions;
- description of the water projects;
- index of reference by donors and by geographical areas.

The reasons which have been dictating such a decision are explained in the following paragraphs.

The combination of the hydrological, geographical, climatic and geological conditions of each region gives specific water resources to each region and defines its potential for agricultural development through its irrigation system such as rainfed, spate irrigated, pump irrigated and its source of supply for drinking water either by surface water catchment or abstraction of groundwater.

In most cases, the nature of the water project is directly dictated by the physical condition of the area and

similarly the area's physical condition is often the most convenient way to classify a project. Therefore, we felt that a brief introduction to the country's geography, supported by maps was necessary in order to fully understand the overall distribution of water projects.

However, the dependency of the existence of water to the geological factor is not only related to the main geological zone on the surface of the country, but also to the sub-surface layers which are the result of a complex development through the geological ages and which have still to be investigated area-by-area. Therefore, in our description of the country's physical conditions, we will not give an introduction to the geology of Yemen, because the only clear and accurate description we could give would be of the main surface geological zones. However, it has to be pointed out that in some water projects, the geological factor is the "gambling" factor, because it can transform completely the cost estimate of the project.

Furthermore, in order to understand the institutional arrangements behind Y.A.R.G.'s water projects, we must be clear about the responsibilities and functions of each of the national institutions involved in water related activities. Though this subject has been studied and described in the report "Survey on the water resources development and management", we assume that a lot of people who will read this report will not have the opportunity to read "Survey...", thence a brief summary of its findings will be given in the National Institutions chapter.

Again, the objective of this study was to provide a catalogue of the water projects in the Y.A.R. and to provide basic data for future compilations. Therefore, it should have an easily understood classification system and yet, there are different possible systems of classification such as by water use, by water activities, by geographical areas of activity and by the concerned national institutions. Also, the classification

chosen must be closely related to the expected final use of this report whether that be planning a data collection network, designing new water projects, planning overall agricultural development, choosing a recipient or an area for technical assistance, pinpointing the nature of the technical assistance, etc...

By introducing a classification by water use, i.e., irrigation, domestic water, we achieve a unity throughout the report and this will be a convenient base for a future comparative analysis in the agricultural, hydrological or engineering fields. A geographical or institutional criteria has been used for the sub-classification.

We follow by water use with a section on water activities in water resources development and management. Water resources development and management are means to improve the water use; there is a feed-back between irrigation and domestic water projects on the one hand and water resources development and management projects on the other, for the optimisation of their respective efficiencies.

Industrial water use are largely handled by the private sector and are beyond the scope of this study. Furthermore, we have often ignored the socio-economic aspects of many projects in order to avoid a confusion created by an accumulation of different types of data. Nonetheless, we hope that our study's limits do not prove too restrictive for the study's future use.

2.2 Survey

Because this survey is a follow-up to the report "water resources development and management in Y.A.R.", the first step in this survey was to compile the data accumulated in the initial survey which had not been reviewed. The second step was to study all technical reports from individual projects and to conduct visits and interviews with project managers,

whenever feasible. As a guideline for interviews, the questionnaire prepared during the first survey (see appendix 2.1) was used.

2.3 Principles for the Description of Projects

Uniformity in the data provided such as number of hectares irrigated, number of beneficiaries, water requirements, source of water supply is desirable. But every project has its own little history relating to source of funding, socio-economic conditions of the area involved, implementing agency and of course, actual physical conditions. Therefore, we felt that in every description we should emphasize the salient features in the project's development rather than try and keep to a standardized form.

- Funding System:
- Agencies Funding:
 - (1) loan, grant
 - Local participation (if there is, please precise)
 - Management of the fund by Organization/
Beneficiary Authority

- Control System:
- Site supervision
 - Financial reporting system: monthly, yearly, other
 - Evaluation system.

Training: (1) On-the-job training, in Yemeni Institution, abroad, please precise nature and the number of beneficiaries:

Data Collection: Please answer accurately to this section, it will be used for the completion of the water data bank.

- areas it covers;
- nature;
- (1) way of collection own project/others;
- data storage system;
- processing;
- publication: how?
- are you promoting a systematic data collection in your project area? what system?

Inter-relations

- level of relation with the Yemeni Authority concerned direct/through counterpart
- level of coordination regular meetings/regular reports/ occasional communication
- relation with other Yemeni Authority: national level/ regional
- (1) cooperation, coordination if yes, please precise the related activities;
- relation with other organizations: national/regional
- name of the organizations;

- cooperation, coordination if yes, please precise
the related activities:

Future Plans:

- (1) extension of: project, activities, area
- way of keeping project going after the foreigners' leave?

Remarks: If there are some more important features to indicate, please write them down. Also, if there is any document about your project, could you please either provide a copy or indicate how and where to get it.

- 1) underline your answer
- 2) list them

3. Physical Conditions

The country is back boned by two mountainous chains, the one which runs North-South from the Southern Saudi border to the PDRY and the other which runs East-West from the PDRY to Oman, of the great desert of Rub Al-Khali constitutes the eastern part of the Y.A.R.G. It is estimated that about 72% of its territory is above 1,000 m altitude.

Located at the Southern tip of the Arabian Peninsula, the Y.A.R. stretches from a altitude of 12' 40' to 18' and it is classified as a sub-tropical to tropical area.

The Western areas are under the maritime influence of the Red Sea, the Southern areas are under the maritime influence of the Gulf of Aden. The Northern and Eastern areas are partly under a continental influence.

3.1 Geographical Division (see the map 3.1)

There are three natural zones. Determined by their altitude, they constitute strips parallel to the Red Sea:

1. the lowlands which are the areas below 1,000 m altitude;
2. the midlands which are the areas located between 1,000 and 1,500 m altitude;
3. the highlands which are the areas above 1,500 m altitude;

and two natural zones, parallel to the Gulf of Aden, the Southern highlands and the Southern midlands.

A sub-division is dictated by the watershed pattern.

3.2 Yemen Watersheds (see map 3.2)

The watershed divides are created by the two main mountainous chains which frame the country, one North-South and the other East-West. However, the East-West chain only affects a small area in the Southern regions.

These two main watersheds divide the country into the following hydrological units:

- the Western escarpement draining towards the Red Sea;
- the Eastern escarpement draining towards the Rub Al-Khali;
- the Southern escarpement draining towards the Gulf of Aden.

3.3 Climatic Conditions (see map 3.3)

The climate is mainly influenced by the South and Southwestern winds that come from the Indian Ocean in spring and in summer, they create two rainy seasons within the period from April to September, the first peak happens around May, the second around August.

The occurrence of the rain is related to the altitude of the areas, and the distance from the ocean. Areas above 1,500 m that are exposed to Western and Southwestern winds get the most precipitation. The highest rainfall occurs in areas such as Ibb, where Western and Southwestern influences meet. The precipitation decreases in the Eastern escarpement from West to East with isohyets roughly parallel to the boundary of the escarpement.

During the rest of the year, from October to March, the climate is marked by the continental dry air masses coming

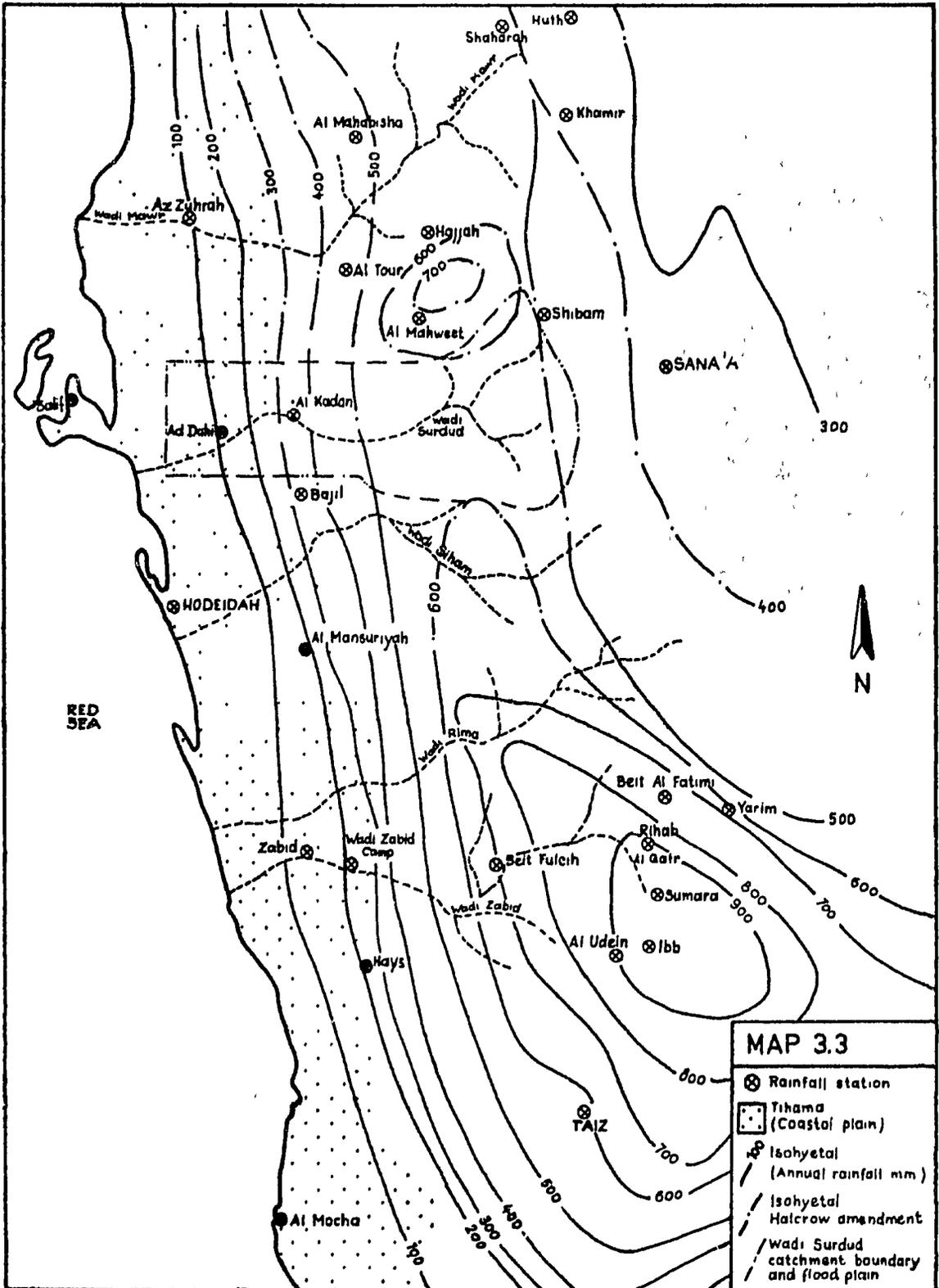
from the Arabian peninsula. During this period, there is no rainfall but some exceptional precipitations.

Map 3.3 shows one of the latest isohyetal map which has been amended according to the rainfall data recorded up to 1978. However, it can be seen that the Eastern escarpment is not totally shown, there is a complete lack of data on the distribution of the isohyetal in this area.

Although the rainfall in areas above 1,500 meters ranges from average to high the perennial streams are scarce and limited to a few small streams, in fact, they are only perennial in a limited section of their watercourse. However, due to a complex system of aquifer in both the lowlands and midlands areas, most of the country's large wadis are perennial throughout a large section of their watercourse despite the lower precipitation in these zones.

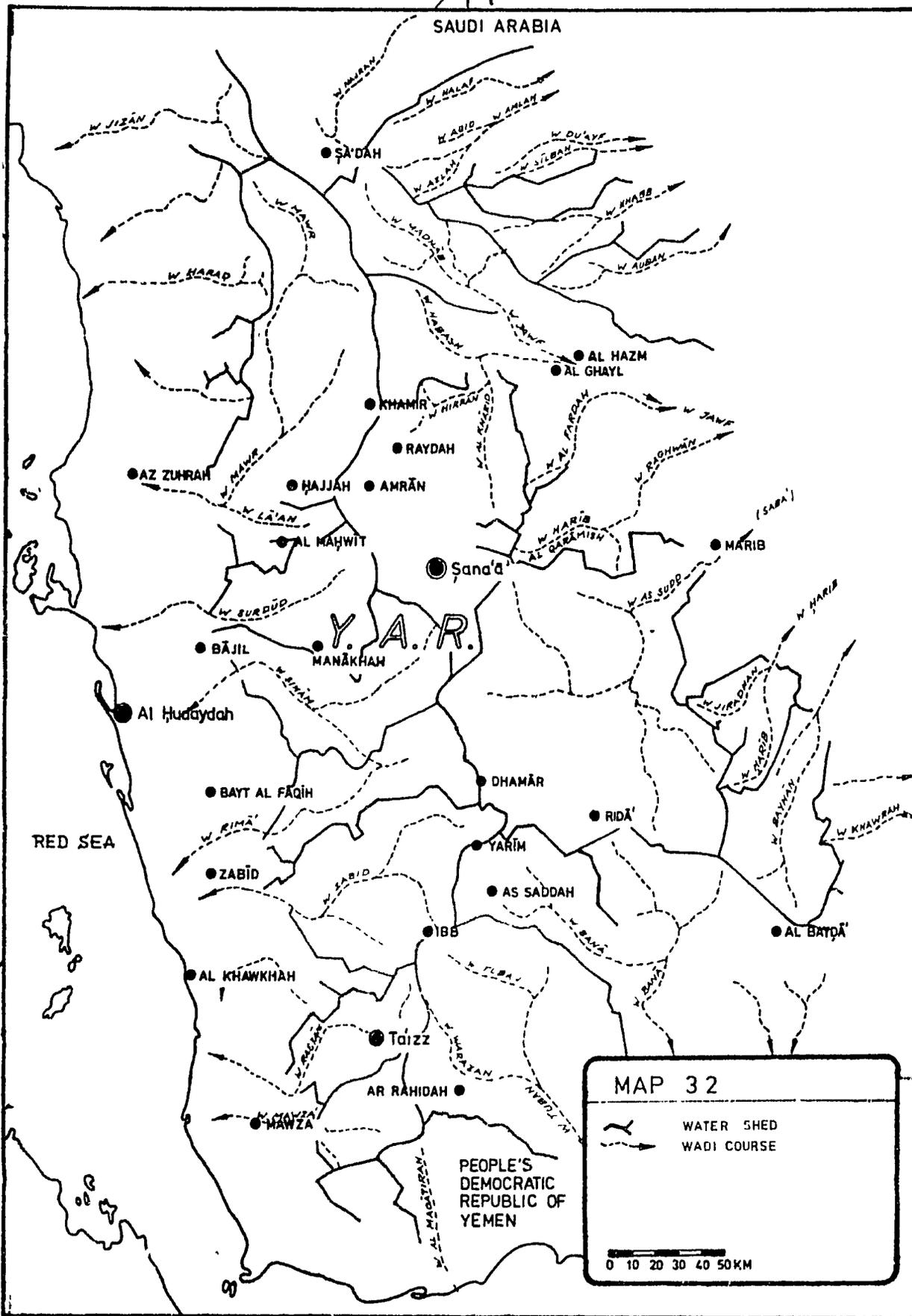
It has to be noted also that there are numerous seasonal springs in the midlands and highlands.

-18-
ISOHYETAL MAP



MAP 3.3

- ⊗ Rainfall station
- ▣ Tihama (Coastal plain)
- Isohyetal (Annual rainfall mm)
- - - Isohyetal Halcrow amendment
- · - · - wadi Surdud catchment boundary and flood plain

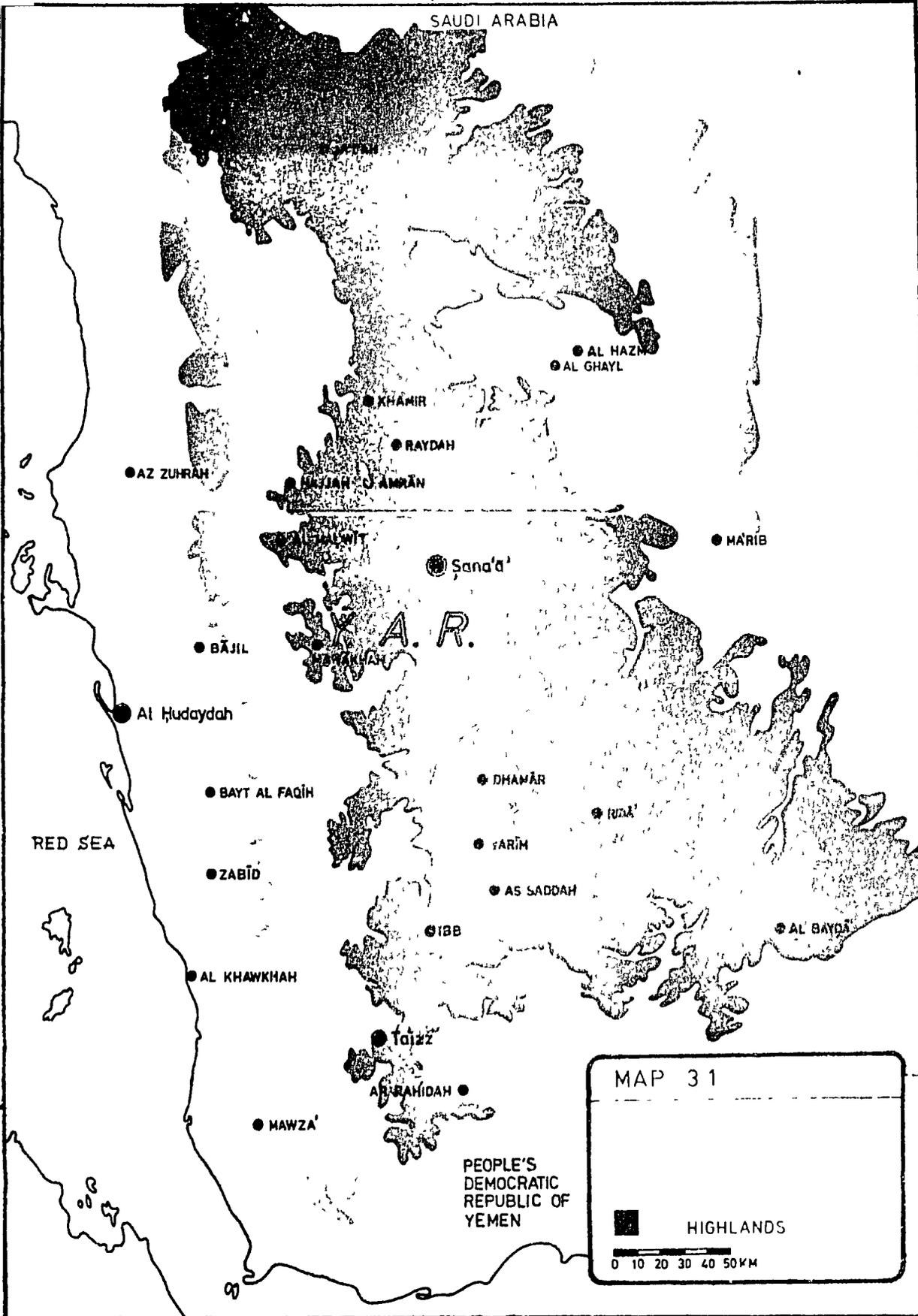


MAP 32

 WATER SHED
 WADI COURSE

0 10 20 30 40 50 KM

20
SAUDI ARABIA



MAP 31

PEOPLE'S
DEMOCRATIC
REPUBLIC OF
YEMEN

HIGHLANDS

0 10 20 30 40 50 KM

4. National Institutions

This chapter summarizes some findings from the report, "Survey on the water resources development and management in the Y.A.R." * by Zohra Merabet. (For more detail, readers should consult the report itself).

Table 4.1 of this report shows how the responsibilities of national authorities are divided according to the water sector involved (study, development, exploitation, management, control) and the intended water use (domestic, agricultural, commercial, industrial). If the national authorities' responsibilities are distributed nationwide, then the institution is placed in the upper part of the square but if its responsibilities are limited to one geographical area or a group of scattered geographical areas, then the institution is placed in the lower part of the square.

The black dots indicate cases in which more than one agency is involved while the blank dots indicate cases in which there is no responsible agency.

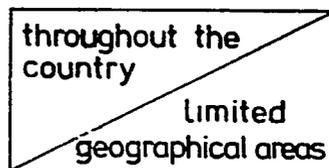
There are actually more governmental agencies involved in water activities than the ones described in this chapter. For example, the Ministry of Health conducts water sampling campaigns for bilharziasis; the Ministry of Municipalities occasionally carries out water quality tests and the Ministry of Economy controls industrial projects along with the importation of drilling equipment, etc. However, since these national institutions are not major recipients of existing water projects, they are not introduced here.

* "Survey on the water resources development and management in the Y.A.R." by Zohra Merabet, May 1980, prepared under a contract with DED, German Volunteer Organization.

TABLE 4.1

Water activities versus water use of the national authorities

activities \ use	study, research	development	exploitation	coordination / control
domestic	RWSD, DOH ● NWSA	RWSD ● LDAs, NWSA	○ LDAs, NWSA	DOH, CPO CYDA ● LDA/CCs, NWSA
agricultural	DOH, CAMA MOA ● TDA, SURDU	MOA ● TDA AgC, SURDU	○ AgC, TDA	DOH, CAMA, CPO CYDA, MOA ● TDA
commercial / aviation	DOH, CAMA ● NWSA	○ NWSA	○ NWSA	DOH, CAMA CPO ● NWSA
industrial	DOH NWSA	○ NWSA	○ NWSA	DOH, CPO ● NWSA



● overlapping

○ no authorities

22

4.1 National Water and Sewerage Authority (NWSA)

In November 1973, Law No. 13 created NWSA. It was responsible for locating, exploiting, and distributing water for domestic, commercial and industrial uses in urban areas. Attached to the Ministry of Public Works until 1979, it is now attached to the Ministry of Municipalities.

NWSA's first project was under an IDA loan. IBRD appraised the water supply and sewerage for Sana'a and Hudaydah. By the end of 1978, it had three branch offices fully operating at Sana'a, Hudaydah and Ta'izz. By 1982, two extra offices at Ibb and Dhamar will open when the construction of their water supply and sewerage systems are expected to start.

The functions of NWSA are defined as follows:

- to search for water, exploit it and distribute it in the urban areas;
- to provide sewerage services in the urban areas;
- to fix and impose the price of water supplied by NWSA and to collect the fees;
- to take all necessary steps to protect NWSA's underground and surface water against pollution.

Originally, NWSA was assigned full responsibility water supply and sewerage systems for the towns of Sana'a, Hudaydah and Ta'izz only. Later, when it appeared that the Rural Water Supply Department could not handle the new projects in Ibb and Dhamar, the two towns were turned over to the NWSA. In the Law, the term "urban areas" is restricted to major towns, however, Law No. 13/73 provides for the extension of NWSA operations to small towns in so far as this does not hinder its main operation and in so far as substantial financing from

foreign aid is involved.

NWSA is currently supervising the design and construction of water and sewerage systems for the five major towns under the auspices of seven international companies.

4.2 Ministry of Public Works/Rural Water Supply Department (RWSD)

In 1972, decree No. 16 of the Council of Ministers created RWSD within the Ministry of Public Works. Among RWSD's responsibilities are these:

- to supervise the implementation and exploitation of all water subprojects in the Y.A.R., whether financed by the YARG, by foreign assistance or by local organizations, except for the towns of Sana'a, Ta'izz and Hudaydah. In 1978, responsibility for Ibb and Dhamar was switched from RWSD to NWSA;
- to program the extension of the plan for safe drinking water in all rural areas;
- to prepare program requests for assistance and to forward them to the YARG, and foreign organizations;
- to train villagers before the projects were put under local control;
- to issue permits for the importing of equipment and materials necessary for implementation of the project;
- to open branch offices in all the governorates as it is deemed necessary.

Very early on, RWSD was seen as the major organization for improving the water supply situation in rural areas. Enormous pressure to implement more and more projects was put on the Department by the villagers and the central government.

At the same time, more multilateral and bilateral donors have been providing assistance to the Department.

The Department now has its own drilling rigs and with the assistance of various donors, the following activities should be carried out yearly:

- the establishment of twenty-five integrated projects every year (an integrated project consists of a well, a pump, a pump room, a main tank, a main network, pipes and taps);
- the improvement of thirty water sources: expanding ditches, building dams and cleaning water passages;
- the drilling or deepening of fifteen wells.

In term of institutional development, RWSD was assigned the task of opening four branch offices during the period of the first Five-Year-Plan.

4.3 Ministry of Agriculture/Tehama Development Authority/ Southern Upland Rural Development Unit

The Ministry of Agriculture (MOA) was one of the first ministries to be created along with the MPW, but since each ministry had a department of irrigation, the situation was confused. As part of the Three-Year-Plan, the MOA was reorganized and irrigation was clearly assigned to the MOA only, by Republican decree No. 26/73. Three branch offices (Hudaydah, Ta'izz, and Sana'a) were renewed during this period, a central research station in Ta'izz along with a substation at Ibb were set up. During the same year, along with the first Tehama Project (IBRD), the Tehama Development Authority (TDA) was created to carry out development projects in the Tehama region. In 1976, the Southern Upland Rural Development Unit (SURDU) was created in order to

support the IHRD/FAO rural integrated development project and to cover the areas of Ibb and Ta'izz.

The creation of semi-autonomous agencies such as TDA and SURDU in order to regionally implement development projects has resulted in an informal division of responsibilities between MOA, TDA, and SURDU. They work throughout the country in three main geographical areas. As we are concerned with water projects only, we will consider MOA through its General Directorate of Irrigation (GDI). It should, however, be said that some of its water projects are under the directorate of agricultural services as part of integrated rural development projects). The geographical areas are:

- TDA for the Tehama Plain;
- SURDU for Ibb and Ta'izz governorates;
- GDI for the Central, Northern highlands and the Eastern valleys.

Although, all three bodies are under the authority of the Ministry of Agriculture, they will be described separately.

4.3.1 The General Directorate of Irrigation

Its main activities are to improve existing irrigation systems and to expand the irrigation network to the cultivable areas. Also, within the integrated rural projects, it is supposed to provide clean drinking water to the villagers, but this point is not really clear because rural clean drinking water should be the responsibility of RWSD. Some rural projects report to the RWSD for drinking water and some do not.

The GDI (through MOA) was the first governmental institution to be given full responsibility for developing

and managing the country's water resources. Republican decree No. 1/1974 clearly assigns GDI the following duties:

- carrying out a comprehensive survey of ground and surface water resources in the whole country in order to organize their exploitation and preservation;
- enacting the necessary legislation for the use of groundwater and surface water and defining water rights.

However, because of staff shortage, the GDI, with the assistance of various foreign agencies, has been restricted to the following:

- supervising the consultants appointed to the Wadi-Jawf development project and Mareb dam project;
- coordinating existing rural integrated projects, in various geographical areas;
- surveying and designing the improvement of a few small dams;
- collecting meteorological data;
- supervising the studies of the Tehama wadis which have not been turned over to TDA.

4.3.2 Tehama Development Authority

Created in 1973 by Law No. 2, amended by Law No. 8/73, it is responsible for studying, implementing, operating and maintaining all the development projects in the Tehama Plain.

As previously mentioned, the responsibilities given to MOA in developing and managing water resources have now been transferred to TDA within its geographical areas of operation.

TDA has the following legal powers:

- to own the wadi beds within the limits it defines, to demolish any existing works or to construct any new works within these limits;
- to regulate and control the distribution and use of all surface water;
- to regulate the development of groundwater;
- to operate wells and to sell water to others at rates it sets itself.

TDA's creation parallels the implementation of the first Tehama Project financed by IDA in Wadi Zabid where it now has its headquarters. Although, TDA is responsible for the Tehama area, it cannot undertake new projects there without the prior agreement of IDA in order not to hinder the building of that institution.

TDA now has five major wadi projects to supervise from its headquarters. A branch office has recently been opened in Wadi Mawr to undertake the implementation of Phase II of the Wadi Mawr project.

Every project works with a consulting firm. The American firm of Tipton and Kalmbach is currently assisting TDA. TDA's main functions, over any above administrative tasks, are to continue hydrometeorological observations and to monitor weather and streamflow measurement stations, they also supervise and follow up the on-going projects.

4.3.3 Southern Uplands Rural Development Unit

Established in 1976 by the MOA along with the IERD/FAO project, this unit has successfully grown to a level where it

could be turned into an authority similar to TDA. Up to now, however, its statute has not been formalised. However, the unit is relatively autonomous in planning and carrying out its tasks.

It has MOA's responsibilities in water resources activities, but must act through MOA in the provinces of Ibb and Ta'izz.

It is mainly involved in surveying, designing, and supervising the construction of water supplies to the villages. It also handles irrigation systems planned within the IBRD project and provides technical assistance to the projects of the Local Development Associations (LDAs) with the assistance of the FAO/IBRD team.

In its area, it is collecting hydrological and hydrogeological data within a limited monitoring program.

4.4 Yemen Oil and Mineral Corporation/Department of Hydrology

By decision of the Council of Ministers, decree No. 5/78 the Department of Hydrology (DOH) has been created within the Geological Survey Board of the Yemen Oil and Mineral Corporation (YOMINCO). It has been assigned the following responsibilities:

- to collect and organize water-related studies, and to carry out studies throughout the country;
- to collect data in the hydrological field, both surface and ground water, and to receive any data in this field from all other sources.

As the Department was created as a follow-up to USAID's project Water Survey of North Yemen which included

geological mapping and the groundwater study of Amran basin, one of the DOH's main activities has been to take over the monitoring programs in the Amran and Sana'a basins.

Since then, it has extended its sphere to include the collection of data from the various projects in Y.A.R. in order to set up a central data bank of water resources. It will also concern itself with the analysis of said data and the identification of future water studies to be undertaken by the DOH.

4.5 Civil Aviation and Meteorology Authority

The Meteorological Department (MD) was informally created in 1973 with the construction of meteorological stations at the Sana'a, Hudaydah and Ta'izzairports. It is assisted by the World Meteorological Organization (WMO).

Meteorological activity was limited to the aviation matters, at the same time, agrometeorological and rainfall stations were constructed throughout the country under the initiative of various authorities, ministries, and foreign agencies of the many water projects.

In 1976, ministerial decree No. 54 created the MD within the Civil Aviation Authority which became the Civil Aviation and Meteorology Authority (CAMA). It is responsible for developing and maintaining a meteorological network for air and maritime navigation, involving water and agricultural matters throughout the country. It is also responsible for initiating a meteorological council.

Early in 1978, CAMA was given the responsibility for collecting, analysing, and distributing meteorological data from the entire country. By October 1978, a meteorological council held its first meeting in order to coordinate and supervise any activity related to the meteorological field.

The activities of the MD include constructing and operating of meteorological stations, calibrating, repairing, and maintaining equipment, training of observers at the stations, assisting governmental as well as private bodies by providing instruments when necessary and by supervising in their installation. The MD collects data from existing stations and then both processes and redistributes the data. It is also involved in daily weather forecasting and in an international exchange of data for aviation purposes.

Since 1978, it has started reviewing and taking over most of the existing meteorological stations in the country (usually it does not include the simple rainfall stations).

4.6 Confederation of the Yemeni Development Associations

4.6.1 The Local Development Associations (LDAs)

The YAR's cooperatives, based on the Islamic principle of charity, were officially recognized by the government in 1963 in Law No. 11/63, later-on, Law No. 26/63 specified the type of organization.

In June 1973, there were twenty-eight local associations, they organised a conference and decided to create the Confederation of Yemeni Development Associations (CYDA).

In 1975, Law No. 35 set up the legal and administrative framework of the LDAs, CYDA. The fundamental documents of the institution include:

- basic regulations for cooperatives societies;
- statute of coordinating councils at the provincial level;
- statute covering the reorganized statutes and role of CYDA.

Law 35/75 was financially organized so that LDAs were entitled to receive half of the local tax (zakat), 25% of the municipality tax, a percentage of customs, a few local revenues, and foreign aid through CYDA. In 1978, they were entitled to receive 75% of the zakat.

Today, there are 191 LDAs registered at the Ministry of Social Affairs, Labor and Youth.

The generating factor behind LDAs was the need to improve living conditions in rural and urban areas where the government was not in a position to do so.

By the time they became legally recognized and were given an annual budget from the central government, their aims and the scope of their activities in the water field were formalized in the Basic Unified Statute:

- provision for various kinds of water supplies such as the construction of canals, drilling of wells and the building of dams in the agricultural field;
- the provision of uncontaminated drinking water by various means and exploration of potable sources for areas deprived in the health field.

The LDAs usually have a Three-Year-Plan coinciding with the election period of three years. The new Three-Year-Plan begun in February 1979 and projected a goal of 3381 water supply schemes to be achieved within the three-year period.

Both the selection and cost of a particular project is usually undertaken by the villagers themselves, the LDAs and CYDA. In certain cases, the cost is shared with a governmental or foreign donor.

4.6.2 Agriculture Cooperative (AgC)

The LDAs started studying the possibility of creating special cooperative societies in relation with the ministries and authorities concerned with agriculture during the Third Conference in 1975.

In February 1978, twelve agricultural cooperatives attended the first conference of the AgCs; today thirty-two cooperatives report to CYDA.

The first conference defined the statute and organization of the AgCs. Among its statutes were:

- a cooperative should not have less than twenty members, each member of the cooperative pays an annual fee and can buy shares in a number limited by the cooperative;
- the area's LDA is a member and its share should not be less than 10% of the total shares of the AgC;
- the annual gain should be distributed as follows:
 - 45% from the net benefit to the capital reserves of the AgC;
 - 10% of the liquid capital to finance projects for the general benefit of the area;
 - 20% of the liquid capital to the capital of the local AgC;
 - 5% of the liquid capital to promote the membership of the cooperative and pay employees;
 - 25% of the liquid capital for distribution to members, according to their shares. It should not exceed 6% of their shares.

In the water field, the AgCs usually undertake irrigation projects such as small dams, pumping units and irrigation

networks.

Out of the thirty-two AgCs, nine of them own their own drilling equipment. The wells are for irrigation purposes and the members of the AgC get a discount, while the other farmers pay the full rate, which varies from place to place.

4.7 Central Planning Organisation (CPO)

Though the CPO is not directly involved in water activities, it has an important role to play in defining and implementing a water resources policy, through its planning and coordinating function at the national level.

Historically, planning was assigned to the Ministry of Economy in 1963. In 1966, the Supreme Development and Construction Board was created. In 1968, a Supreme Board for Planning was created in Law No. 14/68. Republican Decree No. 1 of 1972 established CPO attached to the Prime Minister's Office. Industrial planning responsibilities remained within the Ministry of Economy.

The general objectives of the CPO are:

" to draft the general objectives of economic and social development which the government endeavours to achieve in the long, medium and short-term periods and to determine the main objectives and choose the appropriate priorities and strategies for the success of the development plan... "

In the water field, the CPO can request assistance from foreign agencies to help in a special area or activity. It also coordinates approves and supervises water projects nationwide. Its Projects Department and Planning Department however, do not have any proper technical expertise.

By preparing the country's development plan, CPO defines the role water should play in the country's growth.

5. Water Projects

5.1 Irrigation Projects

The National Development Plan gives highest priority to agriculture and more specifically, to irrigation. Therefore, a large part of foreign assistance has been directed to irrigation development projects. The availability of surface water resources has dictated their location.

The development of groundwater for irrigation, as it is easily accessible (hand dug and drilled wells) and as it requires low cost investment, has been largely developed by the private sector. By contrast the development of the use of surface water requires large investment and changes in the pattern of water rights, neither of which can be achieved without the support of the public sector. Therefore, most irrigation projects are surface water based schemes, though some groundwater projects have been developed in areas where surface water is not available (i.e. the highlands).

In the western watershed, the steep slopes, the high rate of sediment load of the floods, the irregularity of rainfall and the evaporation rate have led to the conclusion, at a very early stage of these projects, that a storage system was not economically feasible. Therefore, planning has been directed towards the construction of permanent diversion structures, the protection of the banks and the reduction of losses in the distribution networks, which aim towards better management of water resources rather than their development. The major constraint for the most of these projects is not the quality of the soil, but the quantity of water. Furthermore, as a result of the experience gained from the operation of irrigation projects such as those of Wadi Surdud and Wadi Zabid, it has been recommended that future projects should not develop major irrigation works based on large weirs and concrete canals.

They are not justified by economic return, instead efforts should be made to improve and rebuild the existing distribution network. Such a solution also avoids disturbing the touchy water rights prevailing in these areas (c.f. Wadi Zabid). The focus of these projects should be to improve irrigation practices by operating research farms and developing an extension services staff in each area involved.

In the Eastern watershed, the gradient of the slope is gentler and the rate of sediment load smaller. Therefore, the possibility of developing a storage system can be considered. Historically, the example of the Mareb dam shows that it was feasible (although there is still much controversy as to whether it was a diversion structure or a storage dam, and whether it collapsed because of siltation problems or as a result of a flood of unexpected magnitude). Despite the fact that this part of the country was very famous in ancient times for its sophisticated irrigation structures, at present, not much remains of its agricultural prosperity. One of the most striking features of these areas, such as Wadi Jawf, is the huge amount of abandoned agricultural land, and the not negligible amount of surface water which is not used to its utmost efficiency (the largest wadi catchments are Wadi al-Jawf and Wadi Dhanah). The use of groundwater for irrigation is still very limited. Added to these features, the shortage of hydrological data makes any planning agricultural development in these areas very difficult.

5.1.1 Agricultural Development Projects

We will classify this type of project by geographical zone.

5.1.1.1 Lowlands

This area, with an average width of 40 Kms, has three distinct agricultural areas:

- a coastal belt about 10 Kms wide which has low rainfall and where agriculture is concentrated in the wadi delta where the aquifer is rather shallow, allowing irrigation by hand dug wells. Large date plantations exist in this area and there is no public investment development project in that area. UNDP/FAO attempted one a few years ago, but since then it has been abandoned. At the request of the date palm growers, FAO has recently started a date palm improvement activity in its Agricultural Extension and Seed Introduction project in the Tehama region.
- A rainfed area between the coastal belt and the foothills where the rainfall is sufficient to grow sorghum and millet, but the poor quality of the groundwater does not offer any development potential for irrigation. Some parts of this area are taken into consideration by certain projects and they should benefit from the increase in spate flow resulting from a better management of the flow in the project areas.
- The wadi basins, which run from the foothills where the major wadis are perennial to the limit of the coastal belt reached by the spate flow. They have a development potential through the improvement of surface water irrigation. All the foreign funded irrigation projects are located in these areas.

a) Wadi Mawr

It is the largest wadi in the Tehama with a catchment area of 9000 Kms² and 60,000 ha of cultivated land which is mostly owned by a few landlords. The total spate irrigated area varies between 8,000 ha and 22,000 ha from year to year and is served by a traditional irrigation system. Until 1974, the use of groundwater was mostly limited to domestic use.

In December 1971, an FAO/IBRD preparation mission recommended a soil reconnaissance study of wadi Mawr, using some of the funds allocated to wadi Zabid. The Hungarian firm Tesco-Viziterv-Vituki (TVV) carried out the investigation, consisting mainly of an inventory of the wells and the drilling of three wells to provide information to the IBRD mission coming in June 1972.

This appraisal was followed by the feasibility study carried out by an American firm Tipton and Kalmbach (TK), funded by IDA/FAO and the Kuwait Fund. Some of the terms of reference for the feasibility study were:

- Soil and topographical survey and land classification for the study area (60,000 ha);
- Collection and analysis of the weather, streamflow and sedimentation data;
- Planning and design of a surface irrigation system including reconnaissance for a storage reservoir in the catchment area;
- Planning for a future groundwater development project utilizing the potential indicated by the feasibility exploration.

The feasibility study started in April 1973, and the final report was submitted in January 1979. It is to be noted that the drilling of the 60 wells was contracted by TDA which acquired its own rig and completed work in 1978. Most of the wells were turned over to the Local Development Associations of the farmers with an ACP loan. Most of the pumps mounted on these wells were provided under a separate Lybian loan.

The conclusion of the study was that there is limited scope for increasing the area under cultivation (except for a modest increase in area irrigated by groundwater) but that

agricultural production in the area could be increased by improving water management of the irrigation system by the following means:

- construction of permanent diversion structures and supply canals and remodelling of the existing canals to serve an area of 17,000 ha;
- construction of 42 new tubewells to serve an area of 4,000 ha;
- a few complementary activities were proposed such as provision of 103 domestic water supplies to serve the villages of the project area.

In February 1979, the Third Tehama Project was appraised for the detailed design and construction of the surface water irrigation system and the drilling of the wells and the complementary activities in wadi Mawr.

The construction of the 103 domestic water supply sources designed with a 60 l/d/c rate consumption will be carried out in cooperation with the RWSD and the local LDAs which should take over the operation and the maintenance of the systems.

The traditional water masters who are in charge of the supervision of the operation and maintenance of the canals (one for each canal) will be incorporated into the staff of the new irrigation system with basically the same duties.

The irrigation system will be composed of two diversion structures commanding respectively 8,400 ha and 9,469 ha and a canal networks designed to provide 2 l/s per ha. The system is designed to capture the base flow for it has been found that only 28% of the annual flow is carried during the flood stages and only 12% in flood waves.

A sea intrusion well monitoring network has been designed and started at the end of 1978.

TK has been nominated as advisor for TDA to assist in the supervision of the detail engineering design, procurement and the layout.

Six consulting firms have been invited to submit their proposals for the detailed design and the preparation of the tender documents for construction in early 1980. Due to the disparity in the choice of the different agencies involved in the selection and the small differences between the six proposals, the nomination of the firm has been delayed but a definitive choice is expected by the fall of 1980. The funding agencies for the forthcoming phases are: IDA, EEC, IFAD, UK, West Germany. The project should be implemented within 5 years and TDA will be the implementing agency assisted by TK.

b) Wadi Surdud

With a catchment area of about 2,500 Kms² and a spate irrigated area within the limits of 15,000 ha, most of which is owned by the YARG, Wadi Surdud has been the first wadi to be studied for an irrigation project. In 1964, with USSR assistance, an area of 925 ha was developed in the government farm of Al-Kadan.

In 1976, a preliminary reconnaissance study was carried out by a British Consulting firm Halcrows and Partners, to assess the potential of agricultural development of the Surdud area. In 1977, under an IDA loan, the same firm was entrusted with a complementary feasibility study of feeder roads and drinking water supplies.

The project area covers the spate irrigated area of Wadi Surduud which has the right to use the wadi flow for irrigation. The potential use of groundwater for irrigation and the improvement of the surface water system were to be investigated.

The final report was submitted in August 1978, and contains the following recommendations:

- the provision of 4 permanent diversion structures and canals, and eventually a storage dam;
- the control of water quantity rather the development of groundwater usage;
- a review of water rights in the area;
- improvement of the water supply of 60 villages from hand pumps to motor pumps and reticulations.

It is to be noted that this project is still under the responsibility of the MOA and the YARG has not yet obtained enough assistance to pursue it to the next stage, i.e. that of detailed designed and construction of the irrigation schemes. (One of the reasons for this is that the study has not been approved by the funding agencies.)

Out of the 31,000 ha of cultivable land, 8,000 ha are spate irrigated in average years (15,000 ha in exceptional years) of which 3,000 ha is state owned either in the form of state farms or cultivated by tenants. The wadi is divided into 14 spate irrigated areas commanded by 12 diversions. The proposed scheme to improve the irrigation system would be commanded by 4 diversion structures and a canal network. There is no mention of how the new distribution system would incorporated the traditional one, but there is a recommendation to review the water rights of the area. The introduction of the

new efficient system would consistently decrease the recharge of the groundwater supply (7 million m³), and due to the present development of private wells, there is no possibility for development of a groundwater irrigation scheme. Strict control of the water use in that area is strongly recommended in order not to endanger the region's agricultural future.

Sixty villages have been selected for the improvement of water supply systems which should be done in cooperation with the local LDAs.

c) Wadi Siham

Since the mid-1960s, Wadi Siham has been supplying water to the town of Hudaydah and up to now it is the only Tehama wadi in which the abstraction of water for urban areas limits agricultural potential.

In 1976, MOA invited international consulting firms to submit proposals for the feasibility study of wadi Siham. The Kuwait fund agreed to finance the study under a loan.

A French firm SOGREAH was selected and the study started in early 1978. The final report was submitted at the end of 1979.

The study area covers 15,000 Kms² for hydrological and climatological phenomena, but the irrigation practices and the water rights study area was limited to 1,000 ha, a detailed study of well irrigated areas was carried out over 100 ha.

During the period of the study, 6 exploratory wells were drilled, 3 flow measurement stations and 12 rain gauge stations throughout the catchment area were installed.

The conclusion of the survey was similar to that of other projects insofar as the aim of recommended development works is to improve the use of available water and limit any further withdrawal from the groundwater supply. However, it was found during the study that the unreliability of spate irrigation led a significant number of farmers to use groundwater in areas which were traditionally spate irrigated; thus there was no point in the firm proposing the design of an irrigation scheme which would have overlapped with the new groundwater-irrigated areas.

The suggested schemes would command 2,000 ha of land regularly and 3,000 ha on an irregular basis. There are three alternatives:

1. A flood water storage system with a live storage of 20 million m³;
2. A flood diversion system to flatten out the peak flood, constructed for 150 m³/s, but this needs a high cost maintenance system;
3. A flood water infiltration system consisting of a few weirs to divert the floods in spreading areas to recharge the groundwater.

It must be noted that with the new trend in irrigation, land becomes concentrated under the control of a few landowners in the traditionally spate-irrigated areas.

The recommended solution should be a combination of alternatives 1 and 3.

The TDA took over the operation of a 12 wells monitoring program and the supervision of the rainfall and streamflow measurement stations.

After a review of the study, the MOA requested that SOGREAH reconsider some of the schemes proposed because their very high cost was not justified by their future economic return. It is expected that by the end of 1980, new alternatives will be proposed by the firm, which would enable the MOA to seek financial assistance to move the project to the next stage, that of detailed designs and preparation of tender documents.

e) Wadi Zabid

It is the project which is at the most advanced stage; therefore we will give more details about its historical development, because it can explain the development of other projects.

The first investigation to evaluate the potential agricultural development of wadi Zabid started in 1966 with an FAO evaluation team. In 1968, the project was authorized and funded from the UNDP Special Fund and the Hungarian firm TVV was appointed to carry out the study of the land and water resources of wadi Zabid de a with emphasis on surface water, and to identify the existing spate irrigation pattern with a proposal for the improvement and extension of the irrigated areas. By the end of Phase I in October 1971, the conclusions were that:

- Most of the available surface water is used by the farmers;
- The construction of a major flood control structure to control surface water would be highly expensive and the expected return in agricultural production would not justify the investment;
- Further study on the groundwater potential should be carried out.

One year's extension was provided to the program to investigate the groundwater potential of the area with the drilling of 5 wells 250 to 400 meters deep; however, due to technical difficulties the wells dug did not exceed 250 m in depth.

The results of the drilling were less optimistic than the preliminary seismic geophysical survey. The thickness of the aquifer does not exceed 100 m at its utmost instead of the depth of over 400 m which had been expected. This demonstrates that the storage of the basin was much smaller than anticipated and therefore the plan to increase the irrigated area by increasing groundwater abstraction was abandoned.

One of the recommendations made at the end of the extension period was to conduct deeper drilling in order to locate some confined aquifer but up to now, it has not been possible to carry out such a program.

A well monitoring program of 32 wells was started during this period and it is still operating, but 12 wells were added in order to monitor the sea intrusion.

Another year's extension was granted in order to provide more hydrological and meteorological information to TVV in order to complete their proposed scheme. During the whole project period, an FAO resident engineer was attached to the project.

The feasibility report of TVV (1972-73) made the following recommendations:

- To develop 14,000 ha of land using surface water resources by retaining the existing basin structure with appropriate intake structures and reconstruction

of the main canals, i.e. 10 diversion weirs and the extension of the secondary and tertiary canal network. This would offer a 10% gain in the irrigated area by improved water management;

- To develop 4,000 ha of irrigated land by tubewells.

An appraisal by IBRD of the First Tehama Project suggested a soft loan of \$10 M to pursue the project. The Kuwait Fund provided a complementary loan to the YARG in order to carry out the recommendations contained in the feasibility report. The creation of TDA has been supported by the same project to provide a national institution to undertake the study and to create the Agriculture Credit Fund (ACF).

After an international tender, the American firm Tipton and Kalmbach (TK) was selected in 1974 and its terms of reference included:

- A review of the TVV proposals;
- Assistance to the TDA in the preparation of the final design, specifications and tender documents, and in supervision and construction;
- Training Yemeni engineers and technicians in all phases of the work including operation and maintenance of the weirs and structures;
- Preparation of a plan for the installation of up to 35 tubewells to replace existing wells and/or supplement sparse water supplies after reviewing all the existing investigations.

After the review of the TVV study, TK proposed the following:

- To build five diversion weirs instead of ten, for economic reasons, that would command 17,000 ha of land;

- To limit the development of groundwater abstraction, since the annual withdrawal for irrigation already exceeds the average annual recharge of the aquifer.

IDA, through ACF, would provide loans to farmers to meet up to 80% of the cost of the 35 tubewells.

In 1976, a Pakistani contractor, Khan, was selected for the construction of the diversion structure which was completed by mid-1979.

The drilling was completed in 1978 and the program with the farmers has started.

Since the irrigation scheme's inception, a certain number of problems have arisen which have resulted in low efficiency of the system and a decrease in the total area which used to be controlled by the traditional system. In order to understand the situation, a brief introduction to water rights as they are practiced in wadi Zabid is necessary.

The water rights system in wadi Zabid is unique among those practiced in Yemen because instead of using the "upstream right" principle, it has a system based on a time schedule.

There are 16 canals and 10 non-permanent diversion structures which distribute either perennial water or the spate flow to 3 groups. The three groups are numbered I, II, III from the upper one to the downstream one.

Group I: Most of the perennial flow is diverted to this group. It has 5 canals which command an area of 4,805 ha; water rights are for 288 days, about 160 of which are perennial flow. During the period of the perennial flow, the water allocation is fixed by a defined time schedule, during the high flow the upstream right prevails.

Group II: It has seven canals commanding an area of 10,175 ha. It has water rights for 42 days of the year, mostly related to the high flow period of the wadi. Distribution within the group is based on upstream right.

Group III: It has four canals commanding an area of 1,450 ha. The period in which it has water rights is 35 days which are at the end of the high flow period of the wadi. The water in this group is mostly divided according to the irrigated area.

Each canal has at least one water master who supervises the distribution of water and the maintenance of the canal. These water masters are nominated by the farmers, or they inherit their position and they receive fees from the farmers.

At first glance, it appears that the water distribution system is not equal, giving the greatest advantages to group I, to the prejudice of group II. The new project has been trying to modify this system by increasing the time allocated to group II. The farmers rejected this solution and therefore they are not helping in the maintenance of the network which is progressively getting silted up. The plan called for the incorporation of the water masters into the TDA staff, but they are not yet receiving any salary from the government, and they are still receiving their fees from the farmers. Therefore, they do not support the new system or initiate maintenance operations because they could lose their benefits from the farmers.

Recently, a special commission has been created with the MOA to study the problem in order to find a solution which would satisfy the farmers.

d. Wadi Rima

This wadi has a peculiarity due to its history:

following the war between the Imam and the Zaranig tribe in the early 20th Century, the Imam took over 2,000 ha of spate irrigated land out of the 7,000 ha of spate irrigated land and constructed a canal on the North bank to irrigate this land, thus creating a special water right system which does not follow Koranic laws (the farmers of the South bank and downstream pay fees to get their water during the period of perennial flow).

The existing surface irrigation system consists of one deflector, at the mountain foot diverting the perennial and spate flow in Al-Hudayd canal, the single primary canal of the North Bank, and ten major primary canals fed by ten earth barrages to irrigate the South Bank. It must be noted that since the historic events which changed the water distribution system, an important irrigable and cultivable area has been abandoned in the lower part of the delta.

In 1972, following a request from the YARG, the British government incorporated in its technical assistance program to the YAR the Montane Plains and Wadi Rima' project.. This project was to evaluate the existing land and water resources and issue a proposal for a development program for these two regions.

The first two years of the project were spent in making topographical maps of the area at the scale of 1:20,000 and the resources study started in 1974. The Land Resources Department (LRD) of the Overseas Development Ministry (ODM) carried out the study and the final report was submitted in 1977. It contains a program of development for the area broken down into four specific proposals.

- a) Improvement of agricultural and public services.

b) Groundwater evaluation and development, including the improvement of 68 water supply systems for the villages of the area.

c) Restructuring of the wadi irrigation scheme.

d) A pilot program for sand stabilization.

Groundwater was not thoroughly investigated during this period (4 test boreholes); however, due to the fast developing groundwater abstraction by the farmers for irrigation, it was strongly recommended that a control system be set up.

The hydrometeorological network installed during the study, e.g. rainfall and streamflow measurement stations, was taken over by the TDA staff.

Proposal a received a grant from the UNDP in order to develop the research farm and extension services in the area.

Proposal b was appraised by the second Tehama Development Project by IBRD and loans from IDA, and the Kuwait Fund were approved to cover the cost of this project. The drilling of 40 wells for the groundwater investigation and the village water supply systems could be undertaken by the TDA staff using the drilling equipment they purchased for the wadi Mawr project. The TDA proposal has just been submitted and implementation should not start before January 1981.

Proposal d has not yet received financing source.

At the request of the YARG, the Dutch government agreed to fund the proposal c in 1977. Following the agreement and the tender, the Dutch firm DHV was appointed to review the proposal of the LRD and to carry out the detailed engineering studies.

The initial proposal for the irrigation projects was to construct seven permanent diversion and storage structures and to improve the distribution system. After review, DHV submitted a final report in January 1979 containing four alternative solutions including the LRD solution, with an economical comparison.

The alternative chosen by the YARG consists of one permanent concrete diversion weir with flushing sluice and intake and two supply main canals feeding the North and South banks of the wadi. Recommendations are provided for changing the water right distribution system.

Fieldwork for detailed engineering started in February 1979. It included additional investigations pertaining to the alternative chosen by the YARG, location of the weir and evaluation of the cost estimate. In June 1979, an addendum to the feasibility study report was submitted with the following conclusions:

- Construction of one diversion structure which would divert 80% of the annual flow volume;
- Improvement of the canal intake to serve an area of 7,500 ha;
- A secondary distribution system should be implemented at a later stage.

The review from DHV was accepted by the YARG and the funding agency and the preparation of the tender document is on its way in order to select the contractor for the construction.

f) Wadi Rasyan

It is the smallest wadi under study in the Tehama

with a catchment area of 2,100 Kms² and 1,100 ha of spate irrigated land. Though the project area does not include the upper catchment area, it is important to note that the well fields for the water supply of Ta'izz are located in the upper catchment area. This might create a constraint for the further development of irrigation under perennial flow in the lower part of the catchment area and also mean a pollution hazard due to industrial waste.

In 1976, a British-French joint venture GIBB/BCEOM carried out a preliminary study of the development potential of wadi Rasyan and instead of proposing a single big project, they submitted a list of small projects - 13 engineering projects and 12 hydrogeological ones, these would improve existing structures, irrigation systems and bank protections without disturbing existing land tenure, the mode of life or current water rights. Due to the unusually poor quality of water, they recommended the establishment of a monitoring system to determine the causes of high salinity.

After the decision of the EEC to finance the next stage of the study, international firms were invited to submit proposals under the terms of reference defined by GIBB/BCEOM. The Dutch firm DHV was selected. DHV suggested that the experience gained in wadi Rima be applied so that an alternative irrigation system, based on a single permanent structure that aims at the diversion of the base flow rather than several diversion weirs, be studied. A single permanent structure would increase irrigated areas which, in turn provide a better quality of water than does groundwater.

The terms of reference include the establishment of a regional development plan combined with detailed engineering and economic analyses. No socio-economic evaluation of the proposed plan's impact on existing land tenure and irrigation practices is specified.

The team started field work in June 1980. Its first findings are:

- some soil areas have a very high salinity content and the land is currently used to its maximum capacity;
- the delta's level of groundwater aquifer is much lower than the aquifer level of previously studied wadis in the Tehama;
- due to the cost of pump irrigation, there is a trend towards concentration of land by a few landowners in the delta.

An inventory of the wells of the area is underway and a drilling program is being set up to study the aquifer system. Three sites have also been located for streamflow measurement and by the end of 1980, they will be equipped with automatic recorders, plus one cableway at one of these stations.

Due to the project's peculiar situation located within Ta'izz Governorate, but extending into the Tehama region, the project's administrative side is managed by SURDU while technical matters are the responsibility of the TDA.

g. Wadi Mawza

This wadi has a potential of 3,500 ha of cultivable area but only between 600 and 2,000 ha get spate irrigation.

In 1974, a community development project in wadi Mawza started. It was carried out by CIDR (a French organization) which acted as executing agency for OXFAM to improve agricultural and irrigation techniques.

In 1977, SURDU was made responsible for the area and in 1979, the CIDR project was closed. However, preliminary data is available about the area's wells and the development of pump irrigation and the FAO/IBRD project (SURDP) might include this area in the near future.

5.1.1.2 The Midlands

a) Wadi Beihan, Wadi Tiban

In 1976, the AFESD appointed an American firm, the ADAR Corporation, to carry out a survey to determine the requirements for a resource survey program in both the YAR and PDRY that would emphasize project areas of benefit to the two Yemens.

These two wadis were identified for potential agricultural development projects with storage dams in the upper catchment areas (YAR). Recently the AFESD has been evaluating the feasibility of such a project and it is seeking finance from various sources.

Those two projects would be part of the integrated mineral and water resources evaluation programs in both countries.

b) Wadi Bana

In 1976, a preliminary investigation was carried out by GIBB/BCEOM to recommend a development program for this area. As with wadi Rasyan, they identified a list of small projects to improve irrigation practices and protect the wadi banks.

In 1979, responsibility for this wadi was shifted from MOA to SURDU.

Up to now the YARG has not obtained financial assistance to carry out this next stage. However, due to the geographical position of the wadi, shared by YAR and PDRY, the previously mentioned AFESD project is a likely candidate for doing the follow-up work.

c) Wadi Dhanah

Located in the Eastern watershed, it has a catchment area of 10,000 Km². It is rather barren and the spate irrigated area is mostly located in the Eastern Midlands. Though the average rainfall is lower than in the western watershed, due to its large catchment area, the annual flow is roughly the equivalent of that of wadi Mawr, the largest wadi in the Tehama.

This wadi is historically famous for its Mareb dam whose prosperous agricultural civilization was a challenge to the Empty Quarter desert which it bordered.

In order to restore the ancient agricultural prosperity of this area and to honour the memory of the ancestors of the current Abu Dhabi rulers who came from Mareb, the Abu Dhabi Fund provided a grant to the YARG in order to finance the study and construction of a new dam in the Mareb area.

A Swiss consulting firm, ELECTROWATT, conducted the study. By 1978, exploratory testing wells were established to appraise the groundwater resources of the area and to identify features of the dam site. A hydrological network was set up to provide supplementary information for the final design, unfortunately the equipment was destroyed.

ELECTROWATT proposed that a retention/storage reservoir be built upstream from the ancient site, 40m high and with a storage capacity of 400 Ml m³. They also concluded that the

historic Mareb dam was a pure diversion structure because Mareb ancient civilization did not have the proper technology to store a considerable amount of water. Yet it must be said that the proposed design has no reliable data about the sediment load, the evaporation rate and the magnitude of the floods, and it is all extrapolated from the areas of Wadi Zabid and Wadi Najran.

Their irrigation plans depend upon a combination of ground and surface water supplies from the reservoir, controlled by an irrigation outlet in the dam structures at reservoir bottom elevation.

Further planning for this project was delayed by the construction of the Sana'a - Mareb road. A second ELECTROWATT team, however, is expected by February 1981 in order to carry out a detailed engineering design.

Again, the proposed irrigation system will use a combination of ground and surface water, and there would be both a storage dam and two main canals serving the two banks.

d) Wadi Jawf

With its main tributaries, wadi Madhab and wadi Kharid, Wadi Jawf has a catchment area of approximately 10,000 Km². Out of the 16,500 ha which used to be cultivated, only 3,500 ha are used at present either because of problems due to the supply of irrigation water or because of lack of labor.

Though its main tributaries have a perennial flow, Wadi Jawf is not used to maximum capacity because of difficult topographical conditions: most of the perennial flow reaches are located in steep gorges so that only the small tributaries

of wadi Kharid have an easy access to their perennial flow for irrigation purposes.

Also, groundwater irrigation is not yet developed or even explored in these areas. Their traditional difficulty of access has stopped the introduction of modern technology.

In 1976, the firm GIBB/BCEOM, under a YARG fund carried out a preliminary study to evaluate the development potential of wadi Jawf. The project's terms of reference were:

- To observe and measure any major existing irrigation structure;
- To measure the baseflow of perennial stream and estimate the peak flows;
- To locate areas where flood damage and soil erosion are major problems;
- To observe existing irrigation networks, methods of irrigation and water rights;
- To locate possible sites for storage dams;
- To identify projects for implementation in Stage II.

In the recommendations they issued, projects were suggested for 5 hydrological agricultural areas. These included the improvement of diversion structures and the distribution system, the protection of the banks and the reclamation of land. In the overall project area it was suggested that the groundwater investigation be completed, a monitoring program be set up and research on irrigation techniques conducted.

In October 1978, a German firm, Agrar-UND-Hydrotechnik (AHT), was selected to prepare the feasibility study.

The first priority was a program to drill 52 boreholes. Although the initial program contained only 27 wells for exploration and tests, the YARG financed the supplementary program in order to also provide production wells for irrigation in the area.

A Yemeni/Sudanese firm was selected by mid-1979. Due to some local problems the drilling started in early 1980 with the cooperation of the DOH geophysical team, and it is expected that it will be completed by the end of the year. The financial terms on which the production wells will be turned over to the farmers have not yet been defined. Will they be granted or provided under an ACB loan?

The surface water study program started with the installation of streamflow and rainfall stations together with the selection of priority sub-projects such as:

- construction of a weir and off-take at Al-Hazm, lower Jawf;
- construction of a weir and off-take at Al-Gurdud, wadi Kharid.

After surveying the area and considering the problems created by its tribal divisions, AHT submitted the following projects:

- weir and off-take at al-Hazm I;
- weir and off-take at al-Hazm II;
- weir and off-take at al-Khalek, lower Jawf;
- weir and off-take at Gurdud/faruq;
- deflector groyne and off-take at wadi Mayzan.

With the construction of the main canals, the study for possible storage dams was delayed, this was due to a lack of hydrological data (the streamflow stations were broken during the early stage of the study) and the difficulties of water distribution among the different tribes.

An economic review of some of the sub-projects was requested by the MOA and it was submitted in early 1980.

Part of the drilling and field work was completed in September 1980. Now the preparation of the design and tender documents is underway.

5.1.1.3 Highlands

The largest part of this zone is covered by rain-fed agriculture on terraced mountains, but a few basins such as those in Dhamar, Sana'a, Amran, and Sa'ada are filled up by alluvium containing a good aquifer, previously rather shallow, these basins allow for pump irrigation plans. The few irrigation projects in this zone are concentrated in these basins and are usually a complementary activity to a rural development project or an experimental farm.

Because of high rainfall in some of these areas, surface catchment systems for irrigation are used, but so far have not attracted any donor. The MOA does have a project for 100 small dams to be reconstructed or built, but cannot carry out the work by itself (in fact, in 4 years only 2 out of the 100 planned dams have been designed).

a) Sana'a Plain Irrigation Project

This project is still at the planning stage. It will use the treated effluent from the Sana'a sewage plant which is

expected to be completed by 1985. It was proposed in 1976 by FAO/UNDP, but no donor has been found since then.

The project area should be North of Sana'a, its treated effluent should be combined with 30% fresh water provided by 4 tubewells to irrigate 600 ha in 1985 and 2,600 ha by the year 2000. The projected crop is alfalfa.

The national institution which would control this project has not yet been selected. It should be either the MOA or the NWSA.

b) Hajjah Province Integrated Rural Development

Preliminary investigations started here in 1976, financed by a loan from the Japan International Cooperation Agency (JICA). A Japanese firm, Pacific Consultant International, was appointed to study Hajjah Province and in March, 1980, a Master Plan Report was submitted.

The Master Plan proposes to promote water saving irrigation techniques by:

- setting up a hydrological observation program of wadi-flow;
- creating a research station to study crop water requirements and irrigation practice;
- constructing some irrigation facilities.

Following the final report, the Japanese Government agreed to provide a loan to the YARG to implement the Master Plan. It is expected to start by the end of 1980.

c) Mahweet Province Integrated Rural Development

A preliminary investigation was carried out by the Arab Fund for Agriculture Development in 1976. It suggested that further studies should evaluate the water balance for the development of irrigation projects and to study the possible improvement in the techniques.

In May 1980, the West German Government agreed to finance the study of a master plan for Mahweet Province. A team arrived in September 1980 to draft a work plan. It is not yet known if this study will follow-up on the recommendations made by AFAD.

d) Rural Integrated Development of Khawlan and Beni Hushaish areas

Preliminary investigations were undertaken at the same time as those conducted for Al-Mahweet Province and with the same subsequent recommendations. The funding agency (ies) has not yet been identified.

e) Southern Upland Rural Development Project (SURDP)

The project area covers both Ibb and Ta'izz provinces, including Midlands as well as Highlands areas. However, since the project's Highlands areas are much larger than those in the Midlands, we decided to classify the project in the Highlands section.

The project was appraised in 1975 by IBRD/FAO and Phase I was financed by a loan from IDA and the Abu Dhabi fund. In 1979, an evaluation recommended that the project be extended and it has been consequently extended for a 3 year period.

The project covers the Ibb and Ta'izz governorates and it operates within a unit attached to the MOA (SURDU).

During Phase I, most of the 263 medium term loans ACF granted from the project fund were for irrigation projects such as well cleaning and deepening, engines and pumps or for land reclamation projects for farmers. The latter did not involve the SURDU staff.

Farmers were given technical assistance in siting wells, selecting pump sizes and designing distribution networks. Preliminary engineering studies were made for the construction of irrigation works at the sites of old dams, but none of these have been implemented during Phase I.

Phase II plans to extend the irrigation program by providing credit for the rehabilitation of old dams and related irrigation works identified during Phase I. The Dutch firm, DHV has been asked to study the rehabilitation of two dams.

f) Rada'a Integrated Rural Development

Within Rada'a RID project, funded by the Dutch Government, a Dutch implementing firm known as ILACO was asked to carry out a preliminary survey to the feasibility of rehabilitating or constructing small dams in the Rada'a area in order to increase the amount of water available for irrigation.

The survey was carried out in January, February, 1980 and the final report was submitted in June, 1980. Having visited twenty dams, they recommended that further studies be conducted at on two important sites, Al-Khadrah and Shahlah dams. The terms of the reference were also prepared for a detailed study, including both a detailed engineering

design and cost estimates. At present, no decision has been made about undertaking their recommended next stage.

g) Construction and Improvement of One Hundred Small Dams

Planned in 1976, MOA did not find any financing agency for this project. However, in January 1980, the Chinese technical assistance agency approved a loan to cover the cost of a preliminary survey. A team of Chinese experts arrived in September, 1980 to carry it out.

5.1.2 Institutional Support for the Department of Irrigation of the Ministry of Agriculture

Since 1973, IBRD has been providing an irrigation engineer for the project known as "institutional support of the Ministry of Agriculture", under cooperative IBRD/UNDP project.

In March 1980, an AFESD funded project began assisting the Irrigation Department in order to carry out the planning and implementation of the country's surface and groundwater resources studies and to help frame legislation for the use of these water resources.

The two-year project funds the services of three experts: an irrigation engineer, a hydrogeologist and a hydrologist.

Currently, two out of the three proposed experts has been assigned to the department and the candidacy of the third one is now under negotiation. The experts work directly under the Director General of the Department.

5.1.3 Research/Experimental Farms

5.1.3.1 Lowlands

a) Wadi Surdud/Al-Kadan, Garabeh

In 1964, with USSR assistance, an area of 925 ha was developed at the government farm of Al-Kadan. The water distribution system has concrete lined canals and the source is a combination of the flow from the wadi and the ground-water extracted from 20 wells. Originally, the plan was to grow cotton but it appeared that this was not economically feasible; instead maize, millet, sorghum and sesame are grown. There is still a Russian team at the farm which assists in operating the systems and in maintenance.

However, in July 1978, responsibility for the farm was transferred to TDA (it was previously under the MOA); under the IDA Third Tehama Project it will be equipped as a research station (50 ha) and will operate partly as a combined seed and production farm (850 ha) on a commercial basis.

The Al-Garabeh demonstration fruit farm was established and run by FAO experts; it occupies 40 ha and is irrigated by pumping from a well.

The Al-Garabeh livestock farm started in 1978 as a livestock fattening farm funded by the Dutch government and the Kuwait fund. Though it is in the spate irrigated area, 7 tubewells were drilled in order to irrigate the 350 ha of land to produce the necessary fodders. However, because of inadequate design for the wells' filters, five of them are now out of order. They are inoperative because of the corrosion of the pumps by sand and the partial siltation at the bottom

of the wells. Eventually, there is a plan to redrill these wells, but a delay of at least 6 months can be expected before the proper functioning of this irrigation scheme; this may greatly affect the supply of fodder. It is planned that Al-Garabeh Livestock Farm will be a livestock finishing farm, and although it is located in the spate irrigated area, it will have 350 ha irrigated by tubewells to produce fodder, under Dutch funding.

b) Wadi Siham/Gumeisha Farm

The Gumeisha experimental farm in wadi Siham was first established by the East German company VEB INEX who designed and built the farm and its irrigation scheme in 1966. The irrigation scheme has 15 wells and a network of asbestos pipes which was to be used to study the water requirements of various crops. In 1973 it was taken over by FAO in order to study irrigation practices, set up a hydrological monitoring program (meteo station and well observation network) and improve the irrigation network. Since then the farm has been assisted by FAO/UNDP.

In its first stage, the project planned to do basic farm and during the second stage, it intended to extend the results within the region. Along with these activities, a monitoring network of 14 wells was set up by the end of 1974.

In 1976, the farm was turned over to MOA and it is now called North Gumeisha.

Another area was then purchased by the government in order to run an afforestation research program; it is financed by the Arab Fund and is known as the South Gumeisha farm.

c) Wadi Rima/Al-Jarubah and Al-Husayniyah Farms

With an area of 20 ha, the Jarubah farm is located in the spate irrigated government land on the North bank of wadi Rima. In 1972, a UNDP/FAO funded project started research activities on crop varieties and water requirements under spate irrigation conditions.

In 1977, USAID financed the rehabilitation of one test borehole drilled by the LRD during the wadi Rima land resources survey and added two more wells.

The current program is studying desirable irrigation practices and water requirements for sorghum, millet, tree crops under spate irrigation and pump irrigation. UNDP/FAO as well as USAID operate in this area.

The Husayniyah experimental farm, located beyond the spate irrigated area, has 60 ha of land, 30 ha are irrigated by borehole and the remainder are rainfed. It focuses mainly upon sorghum, millet, maize, tobacco, and soy bean production trials, and on improving irrigation practices.

d) Wadi Zabid/Zabid Farm

Wadi Zabid Farm: The farm began in 1970, just when the firm, TVV, was carrying out its feasibility study. It had an area of 20 ha, irrigated by boreholes and it planned to conduct research in crop requirements and irrigation techniques. It also was to establish a model demonstration unit.

In 1974, the farm was taken over by TDA. The program became more specific, i.e. a comparative study of the water requirements of introduced local crop varieties was made and

research on spate irrigation was introduced. Of the additional 10 ha. brought into the farm, two-thirds were for spate irrigation and one-third for pump irrigation.

In 1977, an area of 50 ha was added to the initial area to extend its activities.

5.1.3.2 Midlands

a) Batana

Batana is located in wadi Salat which is a tributary of wadi Mawr in the Western midlands, North of Khamir.

The Chinese technical assistance team surveyed the potential for an experimental farm in this area and made the following proposal: out of the 22 ha of government land, 2 ha should be earmarked as trial fields with pump irrigation from two wells and 20 ha should be rented to the local farmers.

Construction started in 1974 and the operation itself in 1976. It is under the control of MOA, supported by a team of seven Chinese experts and a loan provided by the Chinese government.

The spate irrigation system consists of permanent diversion structures, earth canals, and permanent openings in the bunds in the fields. The leftover from the spate flow irrigates the privately owned fields. There is apparently no special regulation for water rights over the right upperstream.

b) Central for Agriculture Research Services

In 1970, as part of the Midlands farm development project, FAO identified the Ausseifra government farm, in the

vicinity of Ta'izz, as a potential experimental farm for agricultural research and the study of soil fertility in relation to water quality.

In 1974, a water and soil laboratory was constructed at Ausseifra to support an extensive soil and water quality survey throughout the country. During this period, an agrometeorological station was also installed.

Since then, the stations work in the field of water has been reduced to laboratory activity involving soil and water quality mapping of the country's various regions for irrigation purpose, and the publication of regional soil and water quality reports. One FAO expert assisted by a UN Volunteer has been supervising the operation of the laboratory and training Yemeni counterparts. Usually, the published maps contain information on such matters as depth and water quality of the irrigation wells.

In early 1980, the project was extended for a period of three years. It will operate with a soil scientist and an irrigation expert funded by the World Bank through FAO, and UN Volunteers funded by UNDP. In addition to this increased coverage of nationwide water resources for irrigation purposes, the project will also study the water requirements of various crops. Also, the agrometeorological station of Ausseifra farm has been rehabilitated and along with the operation and maintenance of the station, the project intend to collect and organize meteorological data from different regions of the country, at the level of the station and process and disseminate them under requests from national, international, or private bodies.

c) British Mechanization Program

In operation since 1973, this project provides advice and assistance to farmers in agricultural mechanization. It also runs a training center to teach the operation, maintenance and repair of agriculture equipment.

In the irrigation field, besides training in the operation and maintenance of pumps, the project has been surveying the types of pumps used by the farmers, their typical discharge and the irrigation cost per hectare and per millimeter. The project operates mainly in Ta'izz governorate; however, some British experts have recently been assigned to Hudaydah in order to support the agriculture mechanization program there.

Recently, the team has completed its progress report which contains an analysis of the YARG's available agricultural equipment, especially motos and pumps, and which identifies suitable pumps and engines for various water projects in the Y.A.R.G.

5.1.3.3 Highlands

a) Al-Boun Project

Funded by a grant from West-Germany (GTZ), this agriculture project started in 1977 with an agricultural research station at Al-Boun. When the project was reviewed, MOA asked that it changed from an agricultural to a rural development project and that its operation be extended to include the Sa'adah governorate. The first request has been fulfilled, but the project area will be initially restricted to Amran basin. The follow-up project started in early 1980.

In the irrigation field, the stations will carry out research on water requirements and irrigation practices.

No extensive irrigation project is planned because the water resources of Amran basin are already overused by farmers, and a future cement factory is also expected to use much water. The project will focus on improving irrigation techniques and reducing losses.

b) Research Farms in Sana'a

There are two farms North of Sana'a at Bir al-Gohm and Bir al-Shaif in the South of the town. Each is equipped with one well and a PVC distribution system. Both conduct studies of water requirements, irrigation practices and techniques applicable to various crops.

The farm at Bir al-Gohm is used for sorghum and alfalfa trials and the one at Bir al-Shaif for vegetable and fruit trials. Both projects are attached to the University of Arizona sorghum and millet breeding project funded by USAID. Field trials are conducted in much the same way as they are at the University of Arizona, where the same climatic conditions prevail.

5.2. Domestic Use

Responsibility for domestic water use is legally shared between two national institutions, RWSD and NWSA (refer to 2.1, 2.2). Urban use, including sewerage system, is restricted to 5 towns under NWSA and rural water use is handled by RWSD. In other words, RWSD has been assigned all drinking water supply systems not covered by NWSA, but with no mention made of the sewage systems in so called rural areas.

Consequently, the classification used in this paragraph rural/urban versus RWSD/NWSA is slightly arbitrary. RWSD deals

not only with rural areas but also with some urban areas as well. It used to handle domestic water for Ibb and Dhamar and it is now responsible for Mahwit and Mahabisha towns.

5.2.1 Urban Use

5.2.1.1 Development Projects

These projects are under the control of NWSA and all of them are water and sewerage systems projects. As a result of a careful program for building the institutions which tries to give the opportunity to the staff to be trained, most of the Yemeni employees in NWSA act as counterparts to their foreign assistants in the projects' implementation. Both the consulting work and construction are handled by international firms but these are reviewed and supervised by NWSA employees themselves, assisted by representatives of WHO/UNDP and the World Bank.

The five projects concerned (Sana'a, Hudaydah, Ta'izz, Ibb, Dhamar) are water and sewerage systems. The main problems faced by these projects during their design and construction are:

- difficulties in obtaining relevant demographic data and in defining future areas of urban population growth;
- restrictions on agriculture, i.e., in the Ta'izz well field, once the water supply system is in operation, the irrigation wells used in the area will dry out and the perennial flow in the neighboring streams will disappear.

Development stages, donors and funding levels are all summarized in table 5.1.

Table 5.1

PROJECTS UNDER NWSA.

	Feasibility Study	Final Design	Construction	
			Phase I	Phase II
Sana'a	IDA ● IDA ●	AFESD ● IDA ●	AFESD (84) ● IDA (83) SAUDI FUND ●	AFESD (86) ● IDA SAUDI FUND ●
Ta'izz	USAID ● USAID ●	USAID ● USAID ●	ABU DHABI (82) ● USAID SAUDI SAUDI FUND ● ABU DHABI ●	
Hudaydah	IDA ● AFESD ● IDA ●	IDA ● AFESD ● IDA ●	IDA (83) ● IDA (83) ● AFESD ●	
Ibb	IDA ● IDA ●	Y.A.R. (82) ● WEST GERMANY ● IDA (82) ● WEST GERMANY ●	WEST GERMANY (86) ● WEST GERMANY (86) ● WEST GERMANY ●	
Dhamar	IDA ● IDA ●	HOLLAND (82) ● Y A R ● AFESD, IDA ● IDA (82) ● Y A R ● AFESD, IDA ● HOLLAND ●	AFESD, IDA (82) ● HOLLAND (86) ● AFESD, IDA ● HOLLAND ●	

131

WATER SUPPLY

● ACCOMPLISHED

(82) EXPECTED DATE OF COMPLETION

a) Sana'a Water and Sewerage System

Before 1971, some assistance was given to improve the water supply of Sana'a; USAID supported the drilling of six (6) new wells and the Chinese Government the drilling of five (5) wells, located in the area South of the town.

In 1971, WHO/UNDP initiated the Sana'a Water Supply project. Financed by an IDA loan, this project was to provide an immediate program to fulfill the town's water requirements up to the year 1980. It was also to carry out a detailed study of the groundwater potential of Sana'a basin, and to draft a master plan for Sana'a's water supply.

The firm ItalConsult was commissioned to execute the project and its first report was submitted in June, 1973. A review of the immediate program requested by WHO was submitted by 1974. This immediate program was accepted, and its construction started in 1975, supervised by a Lebanese firm.

The final design for Sana'a's water supply Phase I and a preliminary engineering design were submitted in 1976.

In the meantime, under an IDA loan, the sewerage system project started in 1974. Undertaken by the ItalConsult firm, this study was also completed in 1976.

Following the submission of ItalConsult's final report, the British firm of Howard Humphrey and Sons (HHS) was appointed to review ItalConsult's design for Phase I (up to 1985) and to study a storm collector and solid waste disposal system.

HHS' review of the water supply design contained the following comments, mainly concerned with demographic and groundwater studies:

- ItalConsult's forecast that the old city's highly populated district will show a gradual depopulation by the year 1985 is not accurate, and therefore, the layout for the old city distribution network will need to be corrected; also the water consumption per capita should be 15% less;
- the groundwater in the sandstone layer located in the Northern part of the town might not cover the future needs of the population up to the year 2000 and the limestone layer should be investigated;
- Sana'a's uncontrolled development of new settlements created a network of streets which hinders a proper general layout for the main lines.

However, the drilling for the implementation of the Phase I, started in 1976, in the area of Dahana, North of Sana'a, carried out by a Danish firm, Glent & Co., and the laying of the main distribution lines began in 1977 with the firm Lilley International. The AFESD provided a loan to complement the IDA loan for construction.

HHS submitted its final design by the end of 1979 and a French firm, Socia Balancey, has been commissioned to construct stage II of Sana'a's water supply. Expected completion date is 1983.

A review of the sewerage system took into account Sana'a's increased consumption of water due to the increase of population, among the alternatives proposed by ItalConsult, HHS recommended the one which uses the treated effluent for irrigation purpose (refer to 3-1.3.d). A detailed design was completed in 1979 and the Dutch firm, Hanab & Steven, was selected for its construction, scheduled to start in 1981.

The standard for the design are:

<u>Date</u>	<u>Main Daily Specific Consumption</u>	<u>% of Connection</u>
1977	89 l/d/c	45%
1985	137 l/d/c	89%
2000	154 l/d/c	93%

and the main elements are:

- the construction of 10 wells with a total yield of 200 l/s;
- construction of a reservoir of 10,000 M3;
- 18,000 meter of pipes for the connection and 50 public taps.

For the sewerage system, 80% of the water distributed is expected to be discharged after use. The treatment plant (40 ha) selected is with a stabilization pond using a mechanical aeration, located in the North-east of the town, close to Wadi Saila, and the two (2) main collectors along the wadi. The flow calculations for the main sewers are based on predicted flow for the year 2000.

The progression of the sewerage network should be:

<u>Date</u>	<u>Area Covered</u>
1984	1,082 ha.
1986	1,489 ha.
2000	3,074 ha., i.e. 98% of the total population should be served.

b) Hudaydah Water and Sewerage System

From 1960 to 1972, the town was connected to the water supply of the port, taking the water from the Hali field, 3 Kms East of Hudaydah. Due to the high salinity of the water and an important increase in the population, another well field, Al-Baydah, was developed 11 Kms East of the town and in 1972, connected to the town's supply system.

In conjunction with the water supply project of Sana'a and under the same IDA loan, a master plan for Hudaydah's water supply was begun started in 1971; carried out by ItalConsult, the study's development has the same history as Sana'a's until April, 1976, when its final report for the sewerage system was submitted.

Afterward, a German firm, F.G. Kocks, was appointed to review the design and carry out the final engineering design and prepare the bid documents, financed by an IDA/AFESD loan.

Due to the YARG's economic boom, important commercial and industrial activities developed in Hudaydah. Both the city's population and its built-up area also increased considerably. Hence, F.G. Kocks' main recommendations involved redesigning the water and sewerage systems to meet increased water requirements along with the increase of generated sewerage flow. The per capita consumption proposed by ItalConsult was reduced and the sewerage system's design was modified in order to take advantage of irrigation rather than disposal into the sea. This was possible because of a new location for the system, North of Hudaydah. This location is suitable for waste stabilization pond construction.

In February, 1976, the British firm, George Stow, started drilling 10 wells in Al-Baydah, 4 Kms East of the previous well field.

In 1978, the final design was completed and F.G. Kocks which became GITEC for some internal reasons, was assigned a supervisory role in the construction of the water and sewerage systems.

In the following year, 1979, a Korean firm, Sam WHAN, was selected to do the actual construction, including the main line and house connections. The work started in May, 1980 and should be completed by 1982.

The standard for the design are:

<u>Date</u>	<u>Mean Daily Specific Consumption</u>	<u>% of Connection</u>
1980	137 l/d/c	48%
1985	143 l/d/c	75%
2000	175 l/d/c	93%

In addition to the existing wells, the nine (9) new wells will provide a total yield of 198 l/s.

The existing elevated tower will be incorporated into the distribution system.

The chosen treatment plant (21 ha.) has a stabilization pond located 2 Kms North of the city and two (2) major pumping stations together with a separate main trunk sewer for the industrial area. The treated effluent should irrigate 130 ha. of land. This irrigated land could be used for cotton experimental crops as well, MOA has been asked for its suggestions, but has not yet given any.

c) Ta'izz Water and Sewerage System

Traditionally, Ta'izz water came from the springs of the Djebel Saber. In 1960, under an USAID grant, the U.S. Corpse of engineers conducted a study to improve the town's water supply system.

Four (4) wells were drilled in Wadi Hawban, 25 Kms North of the town, and two storage tanks were constructed at NWSA's office site. The John Kennedy Memorial system was designed to supply 25,000 people with a specific consumption of 100 l/ /c.

In 1968, due to the town's considerable population growth, six (6) extra wells were drilled, 4 Kms downstream from the first well field in Hougala basin. The new wells were connected to the existing system and help meet the town's new water requirements for a population that by 1975, had reached 80,000. The work was partly funded by USAID,

To help improve the town's water system, an American firm, J.M. Montgomery, was also commissioned under another USAID grant to do a master plan and feasibility study of the town's water and sewerage systems. Their final report was submitted in 1975.

In 1976, an American firm, Hazen and Sawyer, was appointed to both review the Montgomery study and to prepare the final design and the tender document. At the same time, another American firm, Leggette, Brashears & Graham, Inc (L.B.G.) was subcontracted to review and investigate the groundwater potential of the recommended well fields. The drilling began in early November, 1976 with new drilling equipment from NWSA. Supervised by LBG, the work was completed in August, 1977.

The groundwater study suggested that Montgomery had underestimated the capacity of the Haima field, located approximately 25 Kms North-west of the town, this field apparently has the largest groundwater supply potential of all areas previously studied. During this period, NWSA decided to enlarge the study's scope in order to meet anticipated needs for the year 1990. Consequently, the areas of Mikbaba and As Salah were included in the program and altogether, 21 wells were drilled for the supply of the town.

When the final design was prepared, Hazen and Sawyer had to modify the Montgomery's original design to fit the new findings of the groundwater study. The final design and the tender documents were submitted in 1978.

Because of the well fields' distance from town, and the topography involved, construction costs for the project were very high, hence, it took some time to identify funding agencies who would complement the existent USAID grant. After negotiations, the Abu Dhabi and Saudi Funds financed the project through loans, and in mid 1979, a Dutch firm, Hanab & Steven, was selected to construct the water and sewerage systems, including the house connections.

The new water system is designed with 21 production wells to deliver 150 l/d/c for domestic use and 2875 M³/d for industrial use, six (6) storage tanks and five (5) booster pump stations.

Montgomery suggested that the sewerage's treated effluent be used to recharge the aquifer, however, new system will discharge the treated effluent into the wadi, located 10 Kms South-west of the town for irrigation use. The treatment process will be by oxydation. In 1995, 90% of the population should be served by the sewerage system.

It should be noted that the development of the new well fields is expected to turn most of the basin's presently irrigated land by perennial flow or by shallow well into dry farming land.

d) Ibb Water and Sewerage Project.

Though the city has the highest rainfall in the Y.A.R., its water supply, a combination of surface water and groundwater, has so far been insufficient to cover the needs of the population.

Five (5) wells were drilled from 1963 to 1972 in Wadi Salabat As Sayyadah, South of Ibb, but due to a lack of maintenance and/or equipment, the town's water supply has been very poor, and it has been estimated that the average consumption is 24 l/d/c.

The LDA of Ibb is responsible for the existing town's water supply. It has been assisted by the RWSD of MPW which channelled various aid programs to Ibb.

In 1977, the IDA provided a loan for a feasibility study of Ibb's water and sewerage systems. NWSA, in turn is responsible for the system's extension and at its completion, the complete system will be turned over to NWSA.

The terms of reference for the feasibility study contained provision for the improvement and extension of the existing system under Phase II (2005). The firm ItalConsult, was commissioned to carry out the study by August, 1977. Lacking proper topographical maps, their study was delayed until the maps were executed. Their final report was submitted in October, 1978 and it contains a preliminary evaluation of the water supply system and three alternatives for the sewerage system.

In mid-1979, the Y.A.R.G. financed a West German firm, Dorsh Consult, to review the ItalConsult report, investigate the area's groundwater potential and prepare the preliminary engineering design and the tender documents. In May, 1980, the draft of the hydrogeological investigation was submitted and in September, 1980, the draft of tender documents for a detailed engineering design was completed. The tender documents for drilling have been published in November, 1980.

The West German government will finance the next stage, the drilling, the design, as well as the construction itself. During the hydrogeological investigation, three potential well fields were considered, Wadi Salabat, As Sayyidah and Wadi Jiblah, located at the headwaters of Wadi Tuban, South of the town and Wadi Sahool, and the headwaters of Wadi Zabid. If water abstraction for irrigation is controlled, then the well field located at the junction of wadi Salabat and Jiblah with 6 wells and 3 standby wells should cover the needs of the town until 1990. However, at a later stage, wadi Sahool, North-west of the town, should also be used. These recommendations, moreover, should be checked at the time of drilling.

The water supply system that will meet water needs until 1990 will therefore be an extension of the well field at wadi Salabat. Also, a new tank will be constructed at Al-Gabannah with both new pumping facilities and a transmission main.

The town's topography, causes it to be divided into two zones, an upper and lower zone. The upper zone will be supplied by Al-Gabannah tank, save for three small areas which are located at a higher elevation than the tank will be equipped with booster stations. The lower zone will also be supplied

by the Al-Gabannah tank, but due to the important elevation between the two areas, two break pressure tanks will be installed.

The quality of the groundwater is generally good; chlorination alone will be added to the collecting tank before the water is sent to the Al-Gabannah tank.

The specific consumption is 152 l/d/c in 1995, Phase I and 165 l/d/c for Phase II (2005).

The sewerage system is designed for Phase I, but there will be a trunk sewer to meet water flow in Phase II, involving a flow rate of sewerage equal to the rate of water delivery.

After reviewing ItalConsult' three alternative proposals for sewerage treatment, i.e. lagoons, ~~trickling~~ system, and activated oxydation, the firm Dorsh Consult, recommended the third alternative for reasons of economy. However, during the last visit of the German financing agency, the Governor of Ibb promised to acquire the land necessary to undertake the first alternative of lagoons. Now lagoons are the definite choice for Ibb's sewerage system.

Initially, the treated effluent will be used for non-productive agriculture such as forestry. But an option for the future would involve productive agriculture either by pumping the treated effluent to irrigate the terrace or by developing nearby lands for fodder or fruit plantations.

e) Dhamar Water and Sewerage Project

Dhamar's first water supply, one well and a reservoir with a capacity of 140 M3 was constructed in 1964 by USAID,

West of the Sana'a - Ta'izz highway. As the population increased, a second well and masonry tank were added in 1972. This extension was initiated by the town's cooperative which still manages Dhamar's water supply, i.e. the two wells mentioned above, a hand-dug well in the hospital compound which dates from the period of the Imam and two reservoirs.

Unfortunately, both the quality and quantity of town water has gone down since 1972, largely because of the distribution system's poor design and maintenance.

In 1977, IDA financed along with the Ibb project a feasibility study of Dhamar's water and sewerage systems. The study is NWSA's responsibility and when the new systems is completed, NWSA will take over its entire operation and maintenance as well as managing the present water supply system.

ItalConsult undertook the study Dhamar and Ibb's water supply systems under one contract in August, 1977. The Dhamar project was delayed for the same reasons that delayed Ibb (see Ibb project), and so the final report was not submitted until October, 1978. The report gives three alternatives for the water supply system, each using the same well field North of the town, but each using different distribution system, and three alternatives for the sewerage system similar to Ibb's systems.

In mid-1979, Y.A.R.G. financed Dorsh Consult to review the ItalConsult report and to prepare Dhamar's preliminary design along with Ibb's. Its progress, in hydrogeological investigations and in the preliminary designs closely parallels Ibb's. The next drilling stage, along with detailed design and construction, will be financed by AFESD, IDA and the Dutch Government.

The area's hydrogeology was thoroughly studied by the British Land and Resources Development (LRD) under the Montane Plain project so that the two firms, ItalConsult and Dorsh Consult, based their recommendations on the LRD survey. However, the well field which ItalConsult recommended North of the town in Qa' Jahran, where alluvium deposits are fairly thick, was judged unfeasible by Dorsh Consult. It was pointed out that the aquifer has a low specific yield and that due to the latest agricultural development of the area, the yearly water abstraction for irrigation is already double of the yearly recharge.

After considering different alluvium basins within an economical distance from the town, Dorsh Consult decided to investigate the potential of the fractured "Volcanic" areas. Due to the aquifer system's complexity in the fractured area, an important investigative program was designed for three selected basins, the closest being 4 Kms from the town and the furthest being 20 Kms away, with nine reconnaissance drilling and 13 production wells. The final tender documents for drilling are completed and the tenders have been opened in November, 1980. If the drilling is not successful, storage of the surface water for the town's supply will have to be considered.

Though the groundwater investigation has not been completed, the location of the proposed collecting tank is at the nearest potential well field, 4 Kms East of the town, at Milah. If the other well field is selected, this proposed collecting tank could still be used.

The collecting tank is a chlorine contact tank from whence the water will be pumped to the main reservoir, close to Milah, and then distributed by gravity to the town.

For Phase I (1995), the water will be pumped daily for 16 hours at the rate of 170.5 l/s; the main reservoir can store the amount pumped for 24 hours, thus meeting the town's water requirements until 1995. During Phase II, the pumping rate should be increased to 251 l/s for 16 hours a day.

The specific consumption rate proposed by Dorsh is slightly smaller than ItalConsult's proposed rate.

<u>Date</u>	<u>1983</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>
ItalConsult l/d/c	125	142	154	165	172
Dorsh l/d/c	106	139	152	161	165

The proposed sewerage system is designed for Phase I, but it provides for a trunk sewer which meets the requirements of Phase II, assuming that the waste water flow equals the water supply flow delivered.

Due to the poor gradient of the town, the area has been divided into small drainage areas with several interceptors. The treatment plant should be located Southeast of the town.

Among the three alternative treatments of the effluent proposed by ItalConsult, Dorsh Consult recommended the third alternative, an activated oxydation process. This process is the most economical solution, but requires a skilled staff. The treated effluent should be used for irrigation purposes. However, it is depending upon the financing agencies approval.

5.2.1.2 Institutional Support

a) USAID: In order to ensure the most efficient management of capital assistance, USAID has provided NWSA with

a project called "Water Supply System Management". Designed to assist NWSA in planning and managing its urban water and sewerage systems, the project will also train NWSA's staff in the operation and maintenance of these systems, either on-the-job or abroad.

At the close of 1978, an American firm, Technical Management Services International (TMSI), was selected to provide public utility technical and managerial services. Their contract covers a five-year period and is renegotiable after two years.

Assistance will cover the technical, administrative and financial fields, and the team consist of:

- one technical/planning advisor as the team leader;
- one financial advisor at headquarters;
- one financial advisor at the branch office;
- one administrative/procurement advisor;
- one operation and maintenance advisor for civil works;
- one operation and maintenance advisor for electro-mechanical works.

The team works in an operational as well as an advisory capacity, team members are assigned to work cooperatively as the counterparts to various department and branch heads.

b) AFESD/IDA: Also, in relation to the capital assistance, they are providing to NWSA, several advisors at headquarters as well as at branch offices have been funded. However, technical assistance is currently limited to one mechanical engineer at Sana'a's branch office, who advises on the implementation of Sana'a Water Supply Phase I, and one

technical consultant who monitors the construction of the Hudaydah water and sewerage systems.

Still in the planning stage is a project giving branch offices technical assistance in order to improve their managerial and technical capabilities.

5.2.2 Rural Domestic Use

This sector has the largest number of aid projects, but because of the variety of projects, their different levels of funding and the multiplicity of donors, it is the most complex to analyze. However, it is also the most crucial. It is the key to improving health conditions and increasing agricultural production in rural areas by providing the villagers with safe water and releasing the women from unproductive work requiring up to four hours a day in order to satisfy minimal domestic consumption (20 l/d/c).

The nature of the project depends on its geographical location. In areas where rainfall is abundant (highlands, midlands) projects depend upon surface water supplies and in areas where the abstraction of groundwater is either technically or economically feasible (the lowlands and some part of the highlands), projects depend upon groundwater supply.

Because each rural domestic water project usually benefits a small population (75% of the population live in villages of less than 500 inhabitants) and so many villages are in need of water projects, the government cannot undertake a comprehensive program to supply all the rural areas with safe drinking water. For example, the Japanese International Cooperation Agency has estimated that by the year 1981, 14% of the rural population will be served by rural water supply, considering the design capacity of on-going projects.

A large part of project costs are usually covered by the beneficiaries. This does not include the system's operation and maintenance costs after completion. The potential financiers of a project are:

- The government through RWSD or MOA, with a share of 25% to 100%;
- The LDAs with a share of 25%;
- CYDA with a cost share of 25%;
- The beneficiaries with a cost share of 25% to 100%;
- A foreign donor with a cost share of 25% to 100%.

Share breakdown is connected to the total cost of the project; usually, as the project's cost rises, the beneficiaries' share decreases. The beneficiaries' contribution can be in kind (labor, materials), equipment (pump, motor) or in cash.

Usually, these projects do not include provision for the sewerage system or house connections. These are the villagers' responsibility.

There are two main governmental agencies dealing with rural water projects:

- RWSD, the sole legal authority and the one which has the highest number of foreign funded projects;
- MOA, through its Rural Integrated Development projects, and CYDA which cannot be classified as a governmental agency.

5.2.2.1 RWSD

5.2.2.1.1 Institution Building

a) Institutional Support WHO/UNDP

Before 1972, WHO/UNDP assisted MPW in improving and constructing rural water supply projects, and after the creation of RWSD, a strong need to help the young institution to organize and develop itself was felt so that by 1975, a project called "Strengthening of the RWSD of the MPW" was initiated by WHO/UNDP, cost shared by the Dutch Government. Phase I of the project was completed by the end of 1978. In January, 1979, UNDP approved an extension of the project, for the period of three years. In the meantime, a WHO mission came in October, 1979, for a period of two months in order to study a plan for reorganizing the department.

In September, 1980, a WHO/UNDP evaluation team came to review the project and it seems that a few changes in the initial design of the project will be recommended in order to increase the involvement of the WHO/UNDP staff in the construction, operation and maintenance of sub-projects.

The initial goals of the project are:

- To assist RWSD in surveying and designing water supply systems at the rate of twenty-five water supply projects and thirty improved water supplies per year;
- To reorganize RWSD's administrative and technical structure;
- To create a unit which coordinates RWSD's different foreign funded water projects;

- To train the villagers in the operation and maintenance of pumps and the RWSD employees in surveying and designing sub-projects.

UNDP is providing one project manager, one design engineer, one hydrogeologist, a number of short term consultants, two support personnel and nine volunteers (one surveyor, five civil/sanitary engineers, two diesel mechanics and one design draftsman), and in the future, UNV's number may be increased by two hydrogeologists. As well, they have budgeted for nineteen fellowships.

WHO is providing a construction engineer and a sanitarian engineer on a part time basis.

An important target of this project is to set up standards for the design of rural water supply systems and to organize RWSD's data bank in order to compile and publish regular reports.

b) UNICEF

Independent of UNDP, UNICEF has been providing the department with technical assistance in order to optimize its capital assistance since 1978. UNICEF provides a water engineer and a water management advisor.

The water engineer has been surveying the small water projects and evaluating the completed ones, but his contract ended in April, 1980 and it is hoped that his replacement will arrive by the end of 1980.

The water management advisor was assigned directly to the department's director in order to assist him in planning and managing rural water projects; however, following a request

from the department, his function has been changed. Currently, he is studying RWSD's project reports and agreements and he is undertaking preliminary technical negotiations.

Furthermore, UNICEF, has been topping up the salaries of 26 RWSD employees in order to attract new recruits and retain the qualified staff; results, however, were poor and this effort ended in December, 1980.

c) German Volunteer Services

A hydrogeologist was provided, but the program closed when her contract ended.

d) Dutch Volunteer Organization

A water engineer currently works for RWSD in cooperation with the WHO/UNDP project, He assists in surveying and designing sub-projects.

It is planned to send a surveyor to Hudaydah who will be attached to RWSD but who will operate at the province level. RWSD, in turn, will nominate a counterpart who will also be stationed in Hudaydah.

e) West German Assistance

After the German Volunteer Services close its program, the German Technical Cooperation Agency (GTZ) will provide a hydrogeologist and a water engineer. However, their working relation with the RWSD is not yet defined. It remains uncertain as to whether they will work in cooperation with on-going projects (i.e. UNDP/WHO, UNICEF) or will operate independently.

5.2.2.1.2 Turn Key Projects

a) USAID: This project does not really fully fit under either the institutional support section or under turn-key projects. However, we cannot create a special section for it.

Called "Rural Water Project (0022)", it started in 1973 with two goals:

- To strengthen RWSD by providing on-the-job training to its employees in order to prepare them to take over the future operation of the project;
- To drill 15 wells and improve 10 small rural water supply systems each year.

Lacking both sufficient manpower, from USAID and sufficient counterparts from RWSD, the implementation of the training program was rather weak. When the project was reviewed in 1975, it was felt that local hire personnel had received on-the-job training and with the approval of RWSD, it was decided to turn it over to the Ministry. The training itself was complemented by short term training in Egypt. USAID kept on funding the salaries until September, 1978 when RWSD took over the payroll of both the employees and the operation of three drilling rigs.

In June, 1978 an agreement was signed between USAID and RWSD to extend project 0022 until its follow-up, "Small Rural Water Project", 0044, was underway.

A Memorandum of Agreement for project 0044 was signed in July, 1980 and a private American company, "TransCentury", was selected to implement 0044.

The project will last five (5) years, and its goal is to construct one hundred and forty small water projects nationwide.

Due to the many RWSD projects and RWSD's limited number of employees, this project will be run in turn key fashion, i.e., for the first two years, it will focus upon the completion of beneficial projects without any technical involvement on RWSD's part. During this period, it is planned to hire local technicians, they would receive a month short-term training, prior to their employment with the project. They will constitute a team of fully trained technicians who could be recycled either in the governmental or private sector at the end of the project.

During the second period of two years, the involvement of RWSD employees would be increased to prepare the RWSD's taking over of the project.

The project will operate with a project manager, a well master, a civil/design engineer and a water resources engineer, supported by 15 Peace Corps Volunteers.

The villagers will contribute half the project's cost in the form of labor and materials, while USAID, through TransCentury, will cover the other half by providing the cement, pipes, and necessary equipment. A training program in the operation and maintenance of the water supply systems will also be organized for the villagers.

At this time, negotiations between RWSD and the firm are not yet finished, but it is hoped that the project will start by the end of the year, 1980.

b) Peace Corps Volunteers

Along with USAID's funded project, Peace Corps, has been providing five (5) Peace Corps volunteers to supervise the construction of sub-projects during project 0022's extension, and they plan to provide up to fifteen (15) volunteers for the operation of project 0044. (Mechanical engineers, diesel mechanics, construction supervisors...).

c) Japanese Technical Assistance

In 1978, following a request from the YARG, the Japanese Government approved a loan of \$15 million to finance the study and construction of 50 integrated projects throughout Yemen.

The survey and feasibility study were carried out by the Japan International Cooperation Agency (JICA) and the final report and tender documents were completed in March, 1980. This project called "Rural Water Supply Project Part I", includes forty-one deep wells, eight shallow wells and the construction of distribution systems. At completion, each subproject is turned over to RWSD.

Although the contractor has not yet been selected, the contract includes provision for three drilling sets which will be turned over to the Ministry after the three year period of the project.

The YARG has also requested an additional survey of 26 selected sites in order to evaluate the economical and technical feasibility of providing them with water supply systems. This addition, entitled "Rural Water Supply Part II", started

in September, 1979 and the draft final report was submitted in March, 1980. Implementation of Part II awaits the identification of funding agencies.

Also, it should be noted that the way project loans will be repaid is unclear, it is not clear whether the beneficiaries will make partial payments or whether the Y.A.R.G. will cover all loans.

d) Iraqi Assistance

The first project started in 1972, consisted of 36 integrated water supply systems. Each system was composed of a deep borehole, a pumping unit, a water tank and a collective distribution network. The project was run under an Iraqi government grant.

In 1978, the Iraqi Government agreed to renew the grant in order to finance 20 more integrated water supply systems. In 1979, a team composed of engineers and technicians directly hired by the Iraqi Government arrived.

The project has three drilling rigs, and drilling began in 1979. Although the names of the sites are unknown, up to now most of the completed wells have been located in the vicinity of Sana'a basin.

Once a subproject is finished, it is turned over to RWSD. Also after the completion of a project, the drilling equipment will be turned over to RWSD.

e) Dutch Technical Assistance

As part of survey of the Montane Plain's potential

for agricultural development, a team commissioned by the British Ministry of Overseas Development selected twelve villages where drinking water supply systems should be provided. This study was completed in 1976 and the Dutch Government agreed to finance their construction. During the same period, six (6) water supply systems were identified in the Rada'a area by the Dutch funded Rural Integrated Development project. The Dutch Government decided to combine the two different projects under one contracted firm.

ILACO, a Dutch consulting firm already at work in the Rada'a area, was commissioned to begin work on the project in 1980. Though the Rada'a project was technically MOA's responsibility, the project along with that in Dhamar, was assigned to RWSD. There had been a three year hiatus between the study itself and its possible implementation; therefore, RWSD requested a review of the project prior to any decision. The tender documents were completed and approved by the department in May, 1980. A Yemeni drilling company, Alanssi, was selected. It is to be supervised by ILACO, and YOMINCO has undertaken the geophysical logging.

At this time, five wells have been completed in the Rada'a area.

Funding levels differ for Rada'a and the Dhamar areas:

- The twelve subprojects in the Dhamar area are 100% funded by the Dutch Government and are turned over to RWSD after completion;
- The six subprojects in the Rada'a area are included in a rural integrated development project and the beneficiaries provide a contribution in kind (labor and materials) which is about 30% of the total cost. Training and maintenance will be taken over by a

regional team which will create small engineering units.

A workshop at Dhamar center is planned. It would undertake the maintenance of equipment and would be part of the regional operation of RWSD.

f) Saudi Arabian Assistance

In 1973, the Saudi Government approved a grant to finance thirty-six small schemes, each scheme including a deep borehole, a pumping unit and a distribution system. A Japanese firm was selected to carry out the project, supervised by a Saudi team from the Ministry of Water Resources. By the end of the project, two more wells were drilled by RWSD request in order to supply the Arhab area which had an acute drinking water shortage. One of the wells was unsuccessful and the Saudi funded a lorry to carry daily water to the area.

From data collected during the project, a hydrogeological study of the Y.A.R. was carried out by a Saudi hydrogeologist and the report has been delivered to RWSD.

Currently, the Saudi Project Office is considering a possible extension of the project with an emphasis on the Northern and Eastern regions of the country, including the Mareb governorate and Arhab area.

g) West German Technical Assistance

Al-Mahabishah Project: The town of Al-Mahabishah and its surrounding villages are located in one of the best agricultural rainfed areas, producing coffee, qat, they have a population of about 8,000. However, due to the elevation

the main source of drinking water is the rainfall and the first reliable source of water is 600 meters below the area. Hence, the cost of a water supply system to the area's inhabitants from this source is prohibitive.

After a German team's visit at the request of RWSD, initial negotiation between the YARG and the German Government began in August, 1977 and a preliminary study, in cooperation with RWSD, was completed by July, 1978.

Due to the high level of technology required for such a project, 5 pumping stations and a 400 Kw diesel generator in the town (the electrical component has been taken over by the National Electricity Corporation), and its cost of around DM11 millions, an international firm was hired to implement the project.

The consulting firm, Howard Humphrey and Sons, was commissioned to carry out groundwater investigations in early 1979 and their final draft report was submitted in September, 1980. Pending the results of this study, the West German government will decide whether or not to finance the construction of this project.

h) Small Town Water Projects

Following preliminary discussions between the CPO, the German Embassy and the Governor of Mareb, in early 1980, the West German government approved the financing of the water supply and sewerage systems of the new Mareb town.

In November, 1980, a consultant visited the site and the terms of reference will be prepared in December, 1980.

Two wells were previously drilled by the MOA at the location of the new town, in 1978 and they will be used as sources for the water supply system.

The German Advisory Team of C.P.O. will supervise the project until the completion of the detailed engineering design. The responsibility for the supervision will be turned-over to RWSD or NWSA during the construction stage.

There is an on-going negotiation between the CPO and the German Advisory Team as a possible assistance from the West German government to finance the construction of the water supply system of Manakhah town.

1) Mahwit Town Project

Al-Mahwit's water situation is similar to that of Al-Mahabishah. RWSD has been surveying and designing the project, due to its prohibitive cost (about YR. 7 million), no action has been taken, but requests sent to various agencies for a possible financial assistance.

As part of its Rural Water Project Part II, the Japanese firm has been reviewing the design. The review will probably be followed up by a request from RWSD to the Japanese government for a loan.

As part of the small towns water projects, the West German government has been asked to consider funding the Al-Mahwit town project, but at this stage, no decision has been reached.

5.2.2.1.3 Direct Support

RWSD used to get pumps and pipes from the UAE and Qatar for some of its integrated projects; however, the actual project ended in 1978 and although the YARG has requested an extension, it has not received a positive reply so far.

UNICEF has been supplying RWSD with pipes and pumps since 1973 through funds from the West German government and UNCDF. Both projects ended in 1979, but UNCDF is considering to renew its assistance for a two year period, it will finance pipes, fittings, valves and pumps for a total amount of \$2 million. UNICEF will implement the project.

5.2.2.2 Ministry of Agriculture

Provision for rural domestic water through MOA and its agencies is recent. It started in 1976 with the first rural integrated development project in the Southern uplands (SURDP) which pointed out that the improvement of the villages' infrastructure (roads, water, etc) is necessarily part of a region's agricultural development program. Afterward, large scale projects, such as wadi Mawr and wadi Rima, included in their budgets provisions for drinking water.

There are two different types of projects: rural integrated development (RID) and agricultural development. Due to differences in their development strategies, institutional arrangements and the funding levels drinking water supply systems differ from one type to the other.

In RID, the project staff, mostly composed of expatriates designs and supervises each project, having made an agreement at the local level with the LDAs. The MOA's commitment to each

project is slight and there is no involvement on the part of RWSD. Prior to construction, financial participation is required from the beneficiaries and both the operation and maintenance is handled by the local authority.

Up to now, the only agricultural development projects including a drinking water component are located in the Tehama and therefore they are under T.D.A. responsibility. These are all at the planning stage, TDA, supported by the firm, Tipton and Kalmbach, will implement them.

Most villages already have hand-dug wells, but in order to improve the distribution system, it is planned to replace the hand-dug wells by tubewells drilled with TDA rigs. The financial participation of the villagers is not clearly known at this stage, but the LDAs will have an important role in collecting the fees to cover the operation and maintenance costs.

5.2.2.2.1 T.D.A.

Due to the special groundwater situation in the project areas (good quality of water and shallow aquifers), seven models for water supply systems were identified by the British Land Resources Department during its survey of wadi-Rima. These have also been used in the wadi Mawr and wadi-Surdud proposals with T.D.A. approval. T.D.A. is the single agency responsible for their implementation. The systems vary from a hand pump installation on a hand-dug well without house connection to a system with a tubewell, diesel pump and house connections, depending upon the size of the population served, and they are designed with a specific consumption of 60 l/d/c.

a) Wadi Rima

Under the second Tehama project, IDA is providing a loan to cover the cost of forty selected water supply systems in the wadi Rima region. TDA is planning to carry out the necessary drilling and at this stage, it does not plan to involve RWSD during the implementation.

b) Wadi Mawr

Under the third Tehama project, IDA and various funding agencies (see 3.1.1.a) will finance the drinking water supply systems of 103 villages in the project area; it is planned to involve RWSD in the implementation of the project. Previously, T.D.A. drilled 60 wells and some of them were turned over to the LDA which contributed 50% of the cost; this arrangement may be indicative of future financing levels on the villagers part.

c) Wadi Surdud

The feasibility study of wadi Surdud, completed at the end of 1978, includes a program to improve the water supply systems of sixty villages; however, as mentioned in 5.1.1.1.b, the study has not yet been approved and therefore, the whole project has not yet found a funding agency.

5.2.2.2.2 MOA/SURDU

The project, SURDP, financed by IDA and Abu Dhabi Fund, started in 1976. Its objective was to provide safe drinking water in 90 villages; the project areas covers the governorates of Ibb and Ta'izz. However, the project's estimated cost was very low so that L.D.A.'s potential participation was

under estimated; therefore, during Phase I of the project, the budget allocated to the road construction was transferred to the water supply systems and a closer coordination with the local authorities was set up. The number of villages willing to improve their water situation was much higher than what the project could finance. Therefore, a decision was made to enlarge the scope of assistance and to also provide technical advice as well as designs to any village which finances its own system within the project areas.

Given the experience gained from Phase I, Phase II has been designed to take into account the high rural financial liquidity and the strength of the LDAs. Cooperation with the LDA/CCs of the two governorates has been strengthened. Requests for assistance come through LDA/CC, which approves and transmits them to SURDP, it also guarantees the financial commitment of the LDAs. In selecting project sites, priority is given to regions which have either a clinic, school, or market.

In addition to the technical services offered to the villages, Phase II's four year period, one hundred schemes will be partially financed by SURDP. As well, there are five experimental schemes which involve a higher SURDU contribution.

Regarding the one hundred schemes, villages selected to receive financial assistance must provide in advance 40-50% of the total estimated cost which is usually about the cost of the pumping and distribution systems. The villages must also accept a fee system to ensure future operation and maintenance costs.

It should also be noted that in the past, distribution and connection systems were entirely the responsibility

of the villagers, while the first part of the scheme was designed and supervised by a SURDU staff. However, schemes were not properly completed due to a lack of technical assistance so that SURDU decided to also provide the villagers with design and cost estimates of the distribution and connection systems.

The five experimental schemes will be constructed to test special technologies such as solar pumps.

Phase II began in early 1980 and the loaning agencies are IDA, Abu Dhabi Fund, AFAD and Switzerland.

5.2.2.2.3 MOA

a) Rada'a

Though the Dutch RID project in Rada'a is under MOA, the rural water supply component has been implemented in cooperation with RWS as mentioned in (5.2.2.1.2.e).

b) Al-Boun

The agricultural project of Al-Boun (Amran basin), financed by West Germany, started in 1977 and was limited to agricultural activities. However, MOA requested that a drinking water supply component be included and this request was granted. In 1979, a follow-up proposal was submitted including twelve water supply systems in the project area.

The proposal mainly concerned the improvement of small systems, such as cisterns and springs.

This new phase of the project began in early 1980,

and during a preliminary survey carried out to evaluate the water supply of the selected villages, it was discovered that most of these villages had received RWSD assistance or had already undertaken their own systems, consisting of deep boreholes and pumping units.

Therefore, a review of the project was judged necessary in order to redirect project activities to include maintenance and repair services rather than construction alone. All activities in this field have stopped until a new proposal is formulated and a technical team is sent out from West Germany.

c) Hajjah Province

Regarding RID's master plan for Hajjah governorate, the Japanese firm submitted the following recommendations in March, 1980:

- first stage: to undertake 25 projects to supply safe drinking water to almost all the settlements of the governorate with a population larger than 1,000 inhabitants;
- second stage: to concentrate on the villages with less than 1,000 inhabitants.

Though it appears that the Japanese Government will provide a loan to finance the implementation of this proposal, at the time of writing, no definitive commitment has been made.

d) Al-Mahweet Province

A preliminary study of the RID of Al-Mahweet province, financed by AFAD, was completed in June, 1977. In September, 1980, a team financed by West Germany carried out a short survey of

the area in order to estimate project costs and to draw up a work plan for the team which will be in charge of the study's master plan. The survey focussed upon improvement of the drinking water situation and the setting up of a hydrological measuring network which would facilitate project design, especially in Mahweet town.

e) Beni Hushaish and Khawlan

Although, technical and economic feasibility studies for Beni Hushaish and Khawlan RID were completed in July 1977, under an AFAD fund, no funding agencies have thus far been identified to finance the next stage of the study. This next stage would evaluate improvement of the area's drinking water supply systems.

5.2.2.3 CYDA/LDAs

The LDAs have been involved in water projects since their inception and given their self help principle and commitment to improving living conditions in rural areas, they have successfully executed a large number of water projects. Though it is difficult to define exactly the number of projects completed each year (74% of the LDAs report their water plans to CYDA, and 47% report their achievements), it still seems that the number of water projects yearly financed and installed by the LDAs is much higher than RWSD's, even though, the LDAs are given much less foreign assistance. The RWSD does, however, implement some of the LDAs's water projects through foreign funding. These are always systematically coordinated with CYDA.

Foreign assistance to CYDA/LDAs is therefore channeled in two different ways, given the "paragovernmental" statute of the confederation (e.g., locally elected associations presided over by the president of the Y.A.R.G.):

1. From the central government through RWSD or MOA;
2. From CYDA and to the LDAs.

In case (1), assistance depends upon an agreement between RWSD or MOA and the funding agency; through its ministries, the central government supervises the distribution of assistance to areas or LDAs. These, in turn, are not always in accordance with CYDA's plans and priorities. The projects related to case (1) have been listed in paragraphs 5.2.2.1 and 5.2.2.2.

In case (2), although all foreign assistance must go through CYDA, there are three possible levels of "landing" at CYDA, LDA/CCs or LDA for the projects.

These levels of "landing" are determined by the structure of the Confederation and the effective technical and financial responsibilities which are taken in the implementation of the subprojects by CYDA, LDA/CCs, LDAs, Village Committees.

CYDA: Provision for planning, surveying and designing assistance to the LDAs.

LDA/CCs: Assistance in planning and design and supervision of the LDA's financial and technical works at province level.

LDAs: Implementation follow-up and maintenance. However, it should be noted that the distribution of foreign assistance here described does not really follow distribution as defined in the Confederation's general statutes. The statute specifies that CYDA's task is to procure foreign and governmental aid for distribution to the associations; there is no mention of any technical services that it should provide to the LDAs; however, in their general statutes, the LDA/CC's are clearly

assigned the supervision of LDAs' technical and financial works.

This point is stressed because the CYDA/LDAs' structure is such that decentralization of the technical assistance process is possible, which would make for a more effective implementation of water subprojects. However, for some reason, most technical assistance has long been concentrated in CYDA and confined to planning and design matters. Activities such as supervision of construction and maintenance have been the total responsibility of the LDAs, yet of late there seems to be more effort on the part of foreign agencies to decentralize their assistance.

5.2.2.3.1 CYDA:

Four agencies used to provide assistance directly to CYDA in the field of water: CRS, Irish Concern, Peace Corps and UNDP, but only UNDP remains at this level.

a) UNDP

A project entitled "Engineering Services for CYDA", has been funded by UNDP since November, 1978. Two volunteers, one water engineer and one hydrogeologist undertook the preliminary investigation, design and cost estimates of water schemes, which the LDA's requested from CYDA. However, the contract of the hydrogeologist was terminated in August, 1979 and the water engineer has been assigned part-time to RWSD.

After reviewing the project, it was decided to strengthen the program with an expert hydrogeologist and to help CYDA identify water development projects.

Also, it should be noted that UNDP will get involved in these activities because CYDA recently bought some geophysical equipment and three drilling rigs to implement by itself its subprojects.

5.2.2.3.2 LDA/CCs

a) Southern Upland Rural Development Project:

In Ta'izz and Ibb governorates, the LDA/CCs receive assistance in the design of the LDAs' water projects from SURDP, as mentioned in 5.2.2.2.2.

b) USAID:

The project is entitled "Local Resources Development" (0045), and it is under an USAID grant, for a projected period of seven years, starting August, 1979.

This project covers two governorates and operates in cooperation with the LDA/CCs of Hajjah and Hudaydah. It plans to improve the ability of the LDAs to plan their own rural development programs by giving them access to technical support for the construction of local infrastructures such as roads, water schemes and schools as well as providing for the training of local personnel. In each of the LDA/CCs, the plan is to assign one rural development specialist, one rural works engineer and a number of Peace Corps volunteers.

The project's preliminary survey and design started in 1977, and by close of 1978, its funding was approved by USAID. The project involves two distinct activities:

1. A research activity in order to study the areas' socioeconomic conditions and to define the potential of

the LDAs of the two provinces. This activity started in March, 1979, with two Cornell University socioeconomic researchers in the two provinces. This activity should provide a baseline for the second activity.

2. The second activity will provide technical assistance for the implementation of the LDAs' subprojects and for training local personnel. An American firm, Chemonics, was commissioned to begin work in April, 1980;

The amount of financial assistance in the project is limited to \$900,000. This money will be used to finance sub-projects under the following conditions:

- to assist in a project which would benefit all of the governorate or at least several LDAs;
- to encourage innovation in technical design or use of untried appropriate technology;
- to help LDAs whose financial resources are such that they cannot implement projects essential for development.

The project period is seven years. During the first stage, for a period of four years, emphasis will be put on providing support and training at the local level, whereas the second stage should focus on strengthening coordination with the central government and extending activities to the other provinces.

c) Peace Corps:

Along with USAID project, it is providing one geologist and a water engineer to the Hajjah LDA/CCs and a surveyor to the Hudaydah LDA/CCs. However, the assistance program need not be limited to these three, and it might be broadened later on.

5.2.2.3.3 LDAs

The assistance directed to the LDAs through the MOA, under the RID projects is listed in 5.2.2.2.

a) USAID:

A project entitled "Mahweet community based rural development project" started in September, 1977, for a period of three years, implemented by the American Save the Children (ASTC). Among the activities of the project, there was provision for the improvement of the villages' drinking water supply systems. The project started in Mahweet district and expanded its activities to two additional districts in the province.

During the period 1977-1980, a civil engineer, assisted by a Peace Corps water engineer, surveyed, designed and constructed selected water schemes in the area, they also trained local personnel in carrying out the survey and supervised the construction of the subprojects.

After the evaluation of the project in August, 1980, a decision was made to move the project to Al-Khabt district in Al-Mahweet province.

The activities in Al-Khabt district will be limited to health and water matters for a period of 6 months, starting January, 1981. A water engineer is expected by mid-November, 1980.

b) CRS:

Along with the implementation of the food and nutrition program, CRS started in 1974 to assist in the construction of small water projects in cooperation with CYDA.

Having cooperated with CYDA for a few years, CRS decided to deal directly with the LDAs at the district level, but in order to do so, the LDAs must get final approval from CYDA.

The system works in this way: local authorities ask for CRS assistance, CRS usually visits the site and if the project presents the right criteria (e.g., low technology, improvement of cisterns, springs) and if the villagers are willing to provide a contribution in kind, then an agreement is signed. CRS' contribution covers the cost of cement, pipes and transportation.

There is no specific geographical area of activities; however, the majority of the implemented projects are located North of Sana'a.

CRS has written a proposal to help improve the drinking water supply conditions in the district of As Seedah (wadi Bana). It was recently submitted to DANIDA, the Danish association for international cooperation, with a request for funding. This project expects to simultaneously handle water and health activities with a special emphasis on schistosomiasis control and eradication.

5.2.3 International Drinking Water Supply & Sanitation Decade

During the United Nations Water Conference of Mar Del Plata in 1977, an International Drinking Water Supply and Sanitation Decade was declared for the period 1981-1990 with a preparatory phase from 1977 to 1980. The target of the Decade is to provide all with safe water supplies and sanitation by 1990.

The following agencies: UN, UNDP, ILO, FAO, IBRD,

and WHO, established a cooperative plan to promote coordination with official development agencies. At the country level, the UN representative is the "focal point" for cooperative action and during the preparatory phase, he should assist the government in framing a national development program for drinking water and sanitation. He should also promote an increased flow of funds into the sector. A Technical Support Team (TST), composed of representatives of the cooperating agencies, should be organized to support the UN representative in carrying out these responsibilities.

The national program for development which every needy country has been invited to prepare consists first in identifying what national actions and specific plans and programs are needed in order to reach the Decade's target by 1990. The actions might include extension of the drinking water supply to cover the entire population, needed institutional building and training to ensure the operation and maintenance of the systems, and the evaluation of water resources in order to improve the use of drinking water sources. Along with a national program, the concerned governments were advised to establish a national action committee if they were without one. The committee should be composed of members from the concerned national agencies in order to suggest policies and provide technical guidance to reach the target of the Decade.

During the preparatory phase, the YARG was invited to prepare a country report. Its first report on community water supplies and sanitation has been completed and was published in October, 1979.

In early December, 1979, the representatives in YARG of FAO, UNDP, UNICEF and WHO established a Technical Support Team. Through CPO, they offered Y.A.R.G. assistance in setting up a national program concerning drinking water and sanitation;

however, at present, there has not been any further progress in defining the national program or creating the national action committee.

Also, UN representative activities should lead to increased coordination with bilateral agencies and donors. But thus far the necessary action to promote information and coordination between donors and funding agencies has not begun.

5.3 Water Resources

After the Y.A.R.G.'s first development plan in which a high priority was given to water resources development and its increased use but without any management program of the resource, it appeared that in some areas the abstraction far exceeded the recharge and that a monitoring of the country's water resources availability should be carried out in order to improve its use and management.

A growing awareness of the country's limited water resources has stimulated requests for more water resources projects. These would lead, not to short term improvements in the country's standard of living, but to long term improvements of its economic development.

These so called water resources projects are fairly recent; they actually began in 1976, e.g., Phase II of the WMO project (see 5.3.1.a) and their historical development has the following stages:

- first stage: support for the creation of a national institution;
- second stage: support to develop networks and studies.

In the first stage, the projects faced some institutional confusion created by the introduction of new bodies whose responsibilities conflicted with the responsibilities held by the existing institution. This was partly due to a lack of knowledge about existing institutional arrangements when the project was designed.

The problems faced in the development of activities projects are similar, e.g., the difficulty in identifying the national agency specifically responsible for a particular geographical area or type of activity.

5.3.1 Institution Building Projects

a) Strengthening of Meteorological Services Project

Assistance to the Civil Aviation Authority began in 1973. The World Meteorological Organization (WMO) provided experts to install meteorological stations for the airports of Sana'a, Ta'izz and Hudaydah. In the meantime, a project to build up the capacity of the Civil Aviation Authority to install, operate, and maintain a meteorological network was prepared. In 1974, the eight-year project started with a grant from UNDP to cover expatriate personnel cost, the equipment was financed by the Saudi Fund and fellowships by the Dutch government.

During Phase I of the project, assistance was limited to strengthening meteorological services for aviation purpose only. But with ministerial decree, No. 54/76, which created the Meteorological Department (MD) in the Civil Aviation Authority, Phase II of the project is more specifically directed toward the strengthening of MD.

The ministerial decree designated MD as the central data bank for meteorological data. MD was made responsible for

the collecting, processing and interpreting of data and was asked to design and supervise a national meteorological network for aviation, water studies and agriculture purposes. Therefore, the project of WMO extended its activities and assistance to the following:

- networks design and operation;
- process, analysis, publication of data;
- standardization of the instruments.

These activities are in addition to the training, maintenance and forecasting work undertaken during Phase I.

UNDP finances four WMO experts and five UN volunteers to assist in planning, designing, and operating the meteorological network and in teaching at the Civil Aviation Authority's training center.

The Saudi Fund provided a grant to cover operation and maintenance costs at the stations. Furthermore, by the end of 1978, the Saudi government considered being directly responsible for the construction, operation and maintenance of the stations, which would be equipped with a telecommunication system through a national Saudi Team. However, due to some staffing constraints, WMO has been requested to take it over.

The project was recently evaluated, and an extension of three to five years, beginning at the end of 1981, has been agreed upon. During the extension, it is planned to increase the coverage of the meteorological network and to introduce more sophisticated equipment.

b) Water Resources Planning and Management

Under its program of assistance in the water field,

in 1974, USAID initiated the project, "Water Survey of North Yemen" (0025), with the following objectives:

1. To provide a geological map of the YAR, scale 1:500,000 from a landsat map;
2. To carry out a geological and hydrogeological survey of Amran and Sana'a basins, with a groundwater investigation program to evaluate the groundwater potential of the two basins;
3. To institutionalize within the YAR an entity which could execute the basic hydrological measurement.

Objective (1) was completed by January, 1979, with the publication and diffusion in the YAR of geological maps, executed by a U.S. Geological Survey Team in the U.S., with some field work assistance provided by geologists of YOMINCO.

Objective (2) was completed by the beginning of 1978, and a draft report analyzing the results of the investigation was submitted in mid-1980.

Objective (3) began by providing on-the-job training to Yemeni technicians directly hired by the project. However, due to the limited staff of MOA, the project's counterpart Ministry, very little success was foreseen from housing an additional Department of Hydrology (DOH) in the MOA. However, during the implementation of related geological activities, the counterpart agency, YOMINCO, was identified as the potential authority to develop a DOH.

Along with a ministerial decree issued in February, 1978, to create a DOH in YOMINCO's geological survey board, USAID approved to finance an institutional support to the DOH.

Project 0025 was extended until June, 1979, in order to provide sufficient time to design the new project and provide DOH with a transition period for structuring and staffing its different sections (for more details, refer to 4.4).

In November 1978, the design of the project "Water Resources Planning and Management" (0043) was completed and approved for funding, and the agreement between the YARG and USAID was signed in June, 1979, with a project period of four years.

The main goal of project 0043 is to build and strengthen the capacity of the DOH to collect, analyze and disseminate hydrological data throughout the country.

In order to achieve this goal, USAID planned to finance a hydrogeologist from USGS (US Geological Survey) and a Junior hydrogeologist, along with an extensive training program both within the YAR and abroad; however, due to staffing constraints from USGS, which delayed the project's implementation, USAID changed its plans and a private American firm, Sheladia, was nominated to implement the project in March, 1980.

Salaries of newly hired DOH employees and the per diem of all DOH employees (whether newly hired or previous YOMINCO employees) are paid by USAID up to December, 1980. Laboratory and field equipment will be provided by USAID whereas YOMINCO has been financing the construction of the offices and the water quality laboratory which is expected to be finished in early 1981.

Currently, DOH, assisted by the project staff, is monitoring some surface and groundwater observation networks, executing geophysical logging and organizing the filing of available data and reports. They plan to extend both the observation programs and the hydrological data collection to

include additional areas; also, they will undertake some preliminary interpretation and analysis of the existent data.

c) Strengthening of the Department of Hydrology

The following description is mostly taken from the report "A survey on development and management of the water resources in the YAR", May, 1980.

In April, 1980, a preliminary agreement was signed by the Dutch government and CPO to provide a grant for financing DOH institutional support. After the review of the USAID funded project, mentioned above, it was decided to strengthen DOH's regional operation and to complement the building up of the institution at the central level, initiated by the USAID project.

Because of the concentration of Dutch funded projects in the Dhamar and Rada'a areas, priority should be given to these areas during the project's regional implementation. In this way, optimal knowledge of these areas will eventually benefit to other Dutch funded projects.

The project should operate as follows: a hydrogeologist would be assigned to the DOH where he would assist from the DOH's central office in the implementation of the detailed regional study carried out by a team from the Dutch Geological Survey Board. He would be the "coordinating" agent for regional activities and the establishment of the central data bank activity. A DOH team should be assigned as counterparts to the Dutch team.

Phase I, a two-year period, will focus on a regional study assisted by the Dutch Geological Survey Board (DGSB). During Phase II, a three-year period, the implementation of the project will mostly be carried out by a Yemeni staff with

a reduced team from the DGSE in order to prepare for the taking over of project activities by DOH.

The cost of the expatriate personnel, equipment and means of transportation will be covered by a Dutch grant, and the Yemeni Government will endorse the running costs.

A preparatory mission will arrive in the fall of 1980 to draft a project work plan.

5.3.2 Support for Development of Water Resources Activities

a) Agricultural Development Support Project

In April, 1978, the YARG, requested long term assistance from USAID in order to support several activities aimed at developing the agricultural sector. Later on, a project entitled "Agricultural Development Support" (0052), was approved and initiated.

In early 1979, USAID invited a group of American universities, Consortium for International Development (CID), to identify priority activities. During the summer of 1979, an Agriculture Development team came to prepare a baseline support. A lack of management for the available land and water was identified as one of the major constraints by the team. Consequently, one of the recommended subprojects involved natural resources management and conservation. This subproject contains the following activities:

- water resources inventory;
- water policy;
- on-farm water management;
- integrated forestry, range and livestock management.

The long term project was planned for a period of 15 years with a first detailed phase of 5 years, starting in mid 1980.

Once their recommendations were made and a program proposed, MOA requested assistance in the development of YAR's water resources. A CID water resources development team came in August, 1980 for a period of one month to carry out the following tasks:

- to review available reports and data on the Y.A.R.'s water resources and recommend additional studies in order to gain a comprehensive picture of YAR's water resources;
- to assist MOA in drafting a comprehensive national water resources policy;
- to assist in the preparation of emergency regulation for groundwater use;
- to recommend watershed and on-farm management practices;
- to suggest ways in which the project (0052) could assist the YARG in implementing a long range program for development and management of YAR water resources.

By mid-September, 1980, a final draft was submitted to MOA with a review of some reports and available hydrological data in the Y.A.R.; it also recommended national water resources policy and an emergency policy to control groundwater use.

The final draft has been sent by MOA to various national agencies involved in water activities in order to initiate preliminary discussions about the water resources policy. However, at this time, no follow-up activities have been started which would provide a support for implementing the team's recommendations.

b) Water Resources Study in the Tehama Coastal Plain

After the first national five-year plan in 1976 established priorities for agricultural development studies of individual Tehama wadis, it was felt that an overall study of the water resources of all the Tehama should be undertaken. An overall study would improve planning of the area's agricultural development.

In January 1977, the YARG requested financial assistance from the Dutch Government to evaluate such a project and by mid-1977, a Dutch firm, DHV, came in order to formulate a work-plan and estimate the cost of the project.

Given the existing institution and the availability of qualified Yemeni counterparts, DHV, proposed that the study be carried out in two stages. The first stage should be entirely executed by an expatriate team. They would assess water resources based on the existing data and would prepare a proposal for stage II. Two options were identified for stage II:

1. an expatriate team will carry out the project with a training component restricted to the few people directly assigned to the project team;

2. an emphasis will be put on the reinforcement and training of the hydrological section of the TDA in order to prepare them for taking over the project.

Among the list of projects financed by the Dutch Government, as established in April, 1980 by the YARG and the Dutch Government, there was provision for a grant to cover the cost of stage I of the water resources study in the Tehama coastal plain and the firm, DHV, was asked to prepare the terms of reference.

Because of the delay between the formulation of the workplan and the effective start of its implementation, DHV had to review the stage I design following a request from DOH and CPO.

The main changes to be studied are:

- an increased involvement of the Yemeni staff in the project activities;
- a modification of the counterpart authority, e.g., to lodge the project in the DOH rather than in TDA, but to maintain close ties with T.D.A.;
- change the nature of the training to prepare the DOH staff to complete and interpret data rather than to provide a training in the basic hydrological measurement.

Though a final design is still under discussion, the project is expected to start by the end of the year, 1980.

c) Unified Geological and Water Resources Mapping of the Two Yemen:

In 1976, within its mandate for the promotion of inter-Arab projects, the AFESD commissioned an American firm, ADAR Corporation, to conduct a survey entitled "Determination of requirements for Resource Survey Program, Y.A.R. and A.D.R.Y.". The survey was mainly concentrated on geographical areas common to the two countries.

In the final report, the firm identified a certain number of development projects in these areas, and cited development of the geological and water resources of the two Yemen as a major priority.

In 1980, the AFESD, in cooperation with the UNDP, invited representatives from the two governments to discuss the implementation of such a project. By July, 1980, a meeting was held in New York with the representatives of the two Geological Survey Boards, UNDP and AFESD. The meeting defined the terms of reference for "Unified Geological and water resources mapping of the two Yemen".

The project's scope includes an inventory, review and analysis of mineral and water resources data available in the two countries. The geologic map scale 1:250,000 of the two countries should be completed and a geologic map scale 1:100,000 of their border areas should also be carried out.

A water map scale 1:250,000 of the two countries should be prepared and groundwater exploration in selected border areas should be carried out.

At the completion of the studies, programs for mineral investigation and water resources development should be recommended.

A Joint Natural Resources Commission (JONARECOM) will be established by the two governments to implement the project with institutional support provided by UNDP, and headquarters at Ta'izz. The participating agency on Y.A.R.G.'s part should be YOMINCO.

The project is estimated at 5 years duration and AFESD will work to mobilize funds from various sources in order to cover the cost of the mapping activities.

One or two consulting firms should be selected to support JONARECOM in implementing the project.

The project is expected to start in 1981, if the mobilization of funds does not create too much delay.

6. INDEX

Abbreviations

C: Capital Assistance

T: Technical Cooperation

6.1 Index: Donors/National Agency/Geographical Areas

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

ABU DHABI FUND

Urban Domestic	NWSA	Loan	Ta'izz	C	5.2.1.1.a
Rural Domestic	MOA	Loan	Ibb, Ta'izz provinces	C	5.2.3.2.2
Irrigation	MOA	Loan	Ibb, Ta'izz provinces	C	5.1.1.3.e
Irrigation	MOA	Grant	Mareb	C	5.1.1.2.c

ARAB FUND FOR AGRICULTURAL DEVELOPMENT (AFAD)

Irrigation	MOA	Grant	_____	T	5.1.2
Irrigation	MOA	Grant	Khawlan, Beni Hushaish	T	5.1.1.3.d
Rural Domestic	MOA	Grant	Khawlan, Beni Hushaish	T	5.2.2.2.3.e

ARAB FUND FOR ECONOMIC AND SOCIAL DEVELOPMENT (AFESD)

Urban Domestic	NWSA	Loan	Hudaydah	C	5.2.1.1.b
Urban Domestic	NWSA	Loan	Sana'a	C	5.2.1.1.a
Urban Domestic	NWSA	Loan	Dhamar	C	5.2.1.1.e
Urban Domestic	NWSA	-	-	T	5.2.1.2.b
Water Resources	DOH	Grant	South Watershed	T	5.3.2.c

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

BRITISH TECHNICAL COOPERATION

Irrigation	MOA	Grant	Ta'izz Province	T	5.1.3.2.c
Irrigation	TDA	Grant	Wadi Mawr	C	5.1.1.1.a
Rural Domestic	TDA	Grant	Wadi Mawr	C	5.2.2.2.1.b
Irrigation	TDA	Grant	Wadi Rima	T	5.1.1.1.d
Rural Domestic	TDA	Grant	Wadi Rima	T	5.2.2.2.1.a
Rural Domestic	MOA	Grant	Montane Plain	T	5.2.2.1.2.e

CATHOLIC RELIEVE SERVICE (CRS)

Rural Domestic	LDAs	Grant	Throughout YAR	T	5.2.2.3.3.b
Rural Domestic	LDA	Grant	Seedah District	T	5.2.2.3.3.b

CHINESE TECHNICAL COOPERATION

Irrigation	MOA	Loan	Batana	T	5.1.3.2.a
Irrigation	MOA	Loan	Throughout YAR	T	5.1.1.3.g

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

COMPANIE INTERNATIONALE DEVELOPEMENT RURULA (CIDR)

Irrigation	LDA	Grant	Wadi Mawza	T	5.1.1.1.g
------------	-----	-------	------------	---	-----------

DUTCH TECHNICAL COOPERATION

Irrigation	TDA	Grant	Wadi Rima	C	5.1.1.1.1.d
Irrigation	TDA	Grant	Wadi Surdud	C	5.1.3.1.a
Irrigation	MOA	Grant	Rada'a Area	T	5.1.1.3.f.
Rural Domestic	RWSD	Grant	Dhamar, Rada'a Areas	T	5.2.2.1.2.e
Rural Domestic	RWSD	Grant	Throughout YAR	C	5.2.2.1.1.a
Rural Domestic	CYDA	Grant	Throughout YAR	C	5.2.2.3.1.a
Water Resources	DOH	Grant	Dhamar Province	T	5.3.1.c
Water Resources	DOH	Grant	Tehama Plain	T	5.3.2.b
Water Resources	MD	Grant		C	5.3.1.a

DUTCH VOLUNTEER ORGANISATION

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.1.d
Rural Domestic	RWSD	Grant	Hudaydah Province	T	5.2.2.1.1.d

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

EUROPEAN ECONOMIC COMMUNITY (EEC)

Irrigation	MOA	Grant	Wadi Rasyan	C	5.1.1.1.f
Irrigation	TDA	Grant	Wadi Mawr	C	5.1.1.1.a

FOOD AND AGRICULTURE ORGANISATION (FAO)

Irrigation	TDA	Grant	Wadi Zabid	T	5.1.1.1.e
Irrigation	TDA	Grant	Wadi Surdud	T	5.1.3.1.a
Irrigation	TDA	Grant	Wadi Siham	T	5.1.3.1.b
Irrigation	TDA	Grant	Wadi Zabid	T	5.1.3.1.d
Irrigation	MOA	Grant	Ta'izz	T	5.1.3.2.b
Irrigation	MOA	Grant	Ta'izz, Ibb Provinces	T	5.1.1.3.e
Urban Domestic/ Rural Domestic	-	Grant	Throughout YAR	T	5.2.3
Irrigation	TDA	Grant	Wadi Mawr	T	5.1.1.1.a

GERMAN TECHNICAL COOPERATION (GTZ)

Irrigation	TDA	Grant	Wadi Mawr	C	5.1.1.1.a
Irrigation	MOA	Grant	Mahweet Province	T	5.1.1.3.c
Rural Domestic	MOA	Grant	Mahweet Province	T	5.2.2.2.3.d
Urban Domestic	NWSA	Grant	Ibb Town	C	5.2.1.1.d

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

GERMAN TECHNICAL COOPERATION (GTZ) Contd.

Urban Domestic	RWSD	Grant	Mahabisha Town	C	5.2.2.1.2.g
Urban Domestic	RWSD	Grant	Mareb Town	C	5.2.2.1.2.g
Urban Domestic	RWSD	Grant	Mahweet Town	C	5.2.2.1.2.h
Urban Domestic	RWSD	Grant	Manakhah	C	5.2.2.1.2.g
Rural Domestic	RWSD	Grant	-	T	5.2.2.1.1.e

GERMAN VOLUNTEER ORGANISATION (DED)

Rural Domestic	RWSD	Grant	-	T	5.2.2.1.1.c
----------------	------	-------	---	---	-------------

INTERNATIONAL DEVELOPMENT ASSOCIATION (IDA/IBRD)

Irrigation	TDA	Loan	Wadi Mawr	C	5.1.1.a
Irrigation	TDA	Loan	Wadi Rima	C	5.1.1.d
Irrigation	TDA	Loan	Wadi Zabid	C	5.1.1.e
Irrigation	MOA	Loan	Ta'izz , Ibb Provinces	C	5.1.3.d
Urban Domestic	NWSA	Loan	Sana'a	C	5.2.1.1.a
Urban Domestic	NWSA	Loan	Hudaydah	C	5.2.1.1.b
Urban Domestic	NWSA	Loan	Dhamar	C	5.2.1.1.e
Urban Domestic	NWSA	Loan	-	T	5.2.1.2.b
Rural Domestic	TDA	Loan	Wadi Rima	C	5.2.2.2.1.a

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

INTERNATIONAL DEVELOPMENT ASSOCIATION (IDA/IBRD) Contd.

Rural Domestic	TDA	Loan	Wadi Mawr	C	5.2.2.2.1.b
Rural Domestic	MOA	Loan	Ta'izz, Ibb Provinces	C	5.2.2.2.2.
Urban Domestic/ Rural Domestic	-	-	Throughout YAR	T	5.2.3
Irrigation	TDA	Loan	Wadi Surdud	C	5.1.1.1.b

IRAQI TECHNICAL COOPERATION

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.3
----------------	------	-------	----------------	---	-----------

JAPANESE TECHNICAL COOPERATION

Rural Domestic	RWSD	Loan	Throughout YAR	T	5.2.2.1.2.c
Irrigation	MOA	Loan	Hajjah Province	T	5.1.1.3.b
Rural Domestic	MOA	Loan	Hajjah Province	T	5.2.2.2.3.d
Urban Domestic	RWSD	-	Mahweet Town	C	5.2.2.1.2.h

KUWAIT FUND

Irrigation	TDA	Loan	Wadi Zabid	C	5.1.1.1.e
Irrigation	TDA	Loan	Wadi Mawr	C	5.1.1.1.a
Irrigation	TDA	Loan	Wadi Siham	C	5.1.1.1.c
Irrigation	TDA	Loan	Wadi Rima	C	5.1.1.1.d

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

KUWAIT FUND Contd.

Rural Domestic	TDA	Loan	Wadi Mawr	C	5.2.2.2.1.b
Rural Domestic	TDA	Loan	Wadi Rima	C	5.2.2.2.1.a

PEACE CORPS VOLUNTEER

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.2.b
Rural Domestic	LDA/CCs	Grant	Hajjah, Hudaydah Provinces	T	5.2.2.3.2.c
Rural Domestic	LDA	Grant	Mahweest District	T	5.2.2.3.3.a

QATAR

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.3
----------------	------	-------	----------------	---	-----------

SAUDI FUND

Urban Domestic	NWSA	Loan	Ta'izz	C	5.2.1.1.c
Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.2.f
Water Resources	MD	Grant	-	C	5.3.1.a

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

SWITZERLAND

Irrigation	MOA	Loan	Ta'izz, Ibb Provinces	C	5.1.1.3.e
Rural Domestic	MOA	Loan	Ta'izz Province	C	5.2.2.2.2.

UNITED ARAB EMIRATES (UAE)

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.3
----------------	------	-------	----------------	---	-----------

UNITED NATIONS DEVELOPMENT PROGRAM (UNDP)

Irrigation	-	Grant	Sana'a Plain	T	5.1.1.3
Irrigation	TDA	Grant	Wadi Surdud	T	5.1.3.1.a
Irrigation	TDA	Grant	Wadi Siham	T	5.1.3.1.b
Irrigation	TDA	Grant	Wadi Rima	T	5.1.3.1.c
Irrigation	TDA	Grant	Wadi Zabid	T	5.1.3.1.d
Irrigation	MOA	Grant	Ta'izz	T	5.1.3.2.b
Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.1.a
Rural Domestic	CYDA	Grant	Throughout YAR	T	5.2.2.3.1.a
Urban Domestic/ Rural Domestic	-	Grant	Throughout YAR	T	5.2.3
Water Resources	MD	Grant	-	T	5.3.1.a
Water Resources	DOA	Grant	South Watershed	T	5.3.2.c

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

UNITED NATIONS CHILDREN'S FUND (UNICEF)

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.1.b
Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.3
Urban Domestic/ Rural Domestic	-	Grant	Throughout YAR	T	5.2.3

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

Irrigation	MOA	Grant	Wadi Rima	T	5.1.3.1.c
Irrigation	MCA	Grant	Sana'a	T	5.1.3.3.b
Urban Domestic	NWSA	Grant	Ta'izz	C	5.2.1.1.c
Urban Domestic	NWSA	Grant	-	T	5.2.1.2.a
Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.2.a
Urban Domestic	RWSD	Grant	Mahweet Town	C	5.2.2.1.2.h
Rural Domestic	LDA/CCs	Grant	Hajjah, Hudaydah Provinces	T	5.2.2.3.2.b
Rural Domestic	LDA	Grant	Mahweet District	T	5.2.2.3.3.a
Water Resources	DOH	Grant	-	T	5.3.1.c
Water Resources	MOA	Grant	-	T	5.3.1.a

<u>Water use/ Activity</u>	<u>Institution</u>	<u>Level of Funding</u>	<u>Geographical Area</u>	<u>Type of Assistance</u>	<u>Reference</u>
--------------------------------	--------------------	-----------------------------	------------------------------	-------------------------------	------------------

USSR TECHNICAL COOPERATION

Irrigation	MOA	Grant	Wadi Surdud	T	5.1.3.1.a
------------	-----	-------	-------------	---	-----------

WORLD HEALTH ORGANIZATION (WHO)

Rural Domestic	RWSD	Grant	Throughout YAR	T	5.2.2.1.1.a
Urban Domestic/ Rural Domestic	-	Grant	Throughout YAR	T	5.2.3

WORLD METEOROLOGICAL ORGANIZATION (WMO)

Water Resources	MD	Grant	Throughout YAR	T	5.3.1.a
-----------------	----	-------	----------------	---	---------

6.2 Index: Geographical Areas/Projects

Project Nature Available Data

<u>Geographical Areas</u>	irrigation	Project Nature		Available Data			<u>Reference</u>
		urban domestic	rural domestic	groundwater	surface water	water rights	
Beni Hushaish	x						5.1.1.3.d 5.2.2.2.3.e
Batana Farm	x			x			5.1.3.2.a
Al-Baydah		x		x	x		5.2.1.1.b
Al-Boum	x			x	x		5.1.3.3.a
			x	x	x		5.2.2.2.3.b
Bir Al-Gohm Farm	x			x	x		5.1.3.3.b
Bir Al-Shaif Farm	x			x	x		5.1.3.3.b
Dhamar District			x	x	x		5.2.2.1.2.e
Dhamar Town		x		x	x		5.2.1.1.e
Garabeh Farm	x			x	x	x	5.1.3.1.a
Gumeisha Farm	x			x	x		5.1.3.1.b
Hajjah Province	x				x		5.1.1.3.b
			x		x		5.2.2.2.3.c
			x		x		5.2.2.3.1.b
Al-Haima		x		x	x		5.2.1.1.c
Hougala		x		x	x		5.2.1.1.c
Hudaydah Province			x	x	x		5.2.2.3.1.b
Hudaydah Town		x		x	x		5.2.1.1.b
Husayniah Farm	x			x	x	x	5.1.3.1.c
Ibb Province	x			x	x		5.1.1.3.e
			x	x	x		5.2.2.2.2
Ibb Town		x		x	x		5.2.1.1.d
Al-Jarubah Farm	x			x	x	x	5.1.3.1.c
Al-Kadan Farm	x			x	x	x	5.1.3.1.a
Khawlan	x						5.1.1.3.d
			x				5.2.2.2.3.e

<u>Geographical Areas</u>	<u>Project Nature</u>			<u>Available Data</u>			<u>Reference</u>
	irrigation	urban domestic	rural domestic	groundwater	surface water	water rights	
Mahabisha			x	x	x		5.2.2.1.2.g
Mahweet District			x		x		5.2.2.3.3.a
Mahweet Province			x		x		5.2.2.2.3.d
	x				x		5.1.1.3.c
Mahweet Town		x			x		5.2.2.1.2.h
Mareb Town		x		x	x		5.2.2.1.2.g
Milah		x		x	x		5.2.1.1.e
Montano Plain			x	x	x		5.2.2.1.2.e
Qa'a Jahran		x		x	x		5.2.1.1.e
Rada'a District	x			x	x		5.1.1.3.f
			x	x	x		5.2.2.1.2.e
Sana'a Plain	x			x	x		5.1.1.3.a
Sana'a Town		x		x	x		5.2.1.1.a
Ta'izz Province	x			x	x		5.1.1.3.e
	x			x	x		5.1.3.2.c
			x	x	x		5.2.2.2.2.
Ta'izz Research Station	x			x	x		5.1.3.2.b
Ta'izz Town		x		x	x		5.2.1.1.c
Wadi Bana	x						5.1.1.2.c
Wadi Beihan	x						5.1.1.2.a
Wadi Dhanah	x			x	x		5.1.1.2.c
Wadi Hawban		x		x	x		5.2.1.1.c
Wadi Jawf	x			x	x		5.1.1.2.d
Wadi Jiblah		x		x	x		5.2.1.1.d
Wadi Kharid	x			x	x		5.1.1.2.d
Wadi Madhab	x			x	x		5.1.1.2.d
Wadi Mawr	x			x	x	x	5.1.1.1.a

<u>Geographical Areas</u>	<u>Project Nature</u>			<u>Available Data</u>			<u>Reference</u>
	irrigation	urban domestic	rural domestic	groundwater	surface water	water rights	
Wadi Mawr			x	x	x	x	5.2.2.2.1.b
Wadi Mawza	x			x			5.1.1.1.g
Wadi Rasyan	x			x	x		5.1.1.1.f
Wadi Rima	x			x	x	x	5.1.1.1.d
			x	x	x		5.2.2.2.1.a
Wadi Sahool		x			x		5.2.1.1.d
Wadi Salabat As Sayddah		x		x	x		5.2.1.1.d
Wadi Siham	x			x	x	x	5.1.1.1.c
Wadi Surdud	x			x	x	x	5.1.1.1.b
			x	x	x		5.2.2.2.1.c
Wadi Tiban	x						5.1.1.2.a
Wadi Zabid	x			x	x	x	5.1.1.1.e
Zabid Farm	x			x	x	x	5.1.3.2.a

7. BIBLIOGRAPHY

The references listed are among the most significant documents consulted during the writing of this report.

1. ADAR Corporation. Determination of requirement for resources survey program (YAR and PDRY). Prepared for AFESD, Washington, D.C. 1976.
Part I: findings and recommendations
Part II: integrated resources survey program wadi-Beihan region.
2. AGRAR - UND - HYDROTECHNIK. Development of wadi-Jawf and its tributaries; Hydrology report, wadi-Jawf catchment area. Prepared for Ministry of Agriculture, YAR, ESSEN 1979.
3. Arab Fund for Agricultural Development. Report on the Setting Up of an Integrated Rural Development Project in the Province of al-Mahweet, Y.A.R. Khartoum, June 1972.
4. Arab Fund for Agricultural Development. Technical and Feasibility Study of Integrated Rural Development, Khawlan and Beni Hushaish Areas, Y.A.R. Khartoum, July 1977.
5. American Save the Children Fund. A Community Based Integrated Rural Development Program in Y.A.R. Submitted to USAID/Yemen, August 1979.
6. Barbarossa, N.L.; Fuhrunian, D.K. & Maktari. Report on the Water Resources Sector Study in the Yemen Arab Republic. Prepared for USAID Project No. 298-0035. August 1977.

7. Barbarossa, N.L.; Fuhrunian, D.K. & Maktari. Supplemental Report on Water Resources Sector Study in the Yemen Arab Republic. August 1977.
8. Central Planning Organization. First Five-Year Plan 1976/77 - 1980/81. 7 volumes.
9. Central Planning Organization. Financing Situation of the Individual Plan Project, Agricultural Sector. April 1979.
10. Compagnie Internationale De Development Rural. Presentation of the Mawza District. Autrech, August 1977.
11. Confederation of Yemen Development Associations. Three-Year Plan 1979-1981.
12. Dale. A. Bucks. Irrigation design, joint MOA/USAID research farm. Initial report. US. Water conservation laboratory. Phoenix, Arizona, November 1977.
13. DHV consulting engineers. Access road, feeder roads and rural water supplies in the Tehama coastal plain, Part C. Mission report submitted to International technical assistance Department, Kingdom of Netherland, June 1977.
14. DHV consulting engineers. Detailed engineering studies in wadi Rima, Part B. Mission report submitted to International technical assistance Department, Kingdom of Netherland, June 1977.
15. DHV consulting engineers. Water resources study in the Tehama coastal plain, Y.A.R., Part A. Mission report submitted to International technical assistance Department, Kingdom of Netherland, June 1977.

16. DHV consulting engineers. Wadi Rima Irrigation Development - Feasibility study.
Volume 1: main report - January 1979
Volume 2: annexes - January 1979
Volume 3: addendum - June 1979

17. Dorsh Consult. Dhamar and Ibb water and sewerage projects.
Draft preliminary design report. Prepared for National Water and Sewerage Authority, January 1980.
Volume 1: Dhamar water supply.
Volume 2: Dhamar sewerage.
Volume 3: Ibb water supply.
Volume 4: Ibb sewerage.
Volume 5: Dhamar/Ibb sewage treatment plant.

18. Electrowatt Engineering Services, LTT. Mareb dams Irrigation project, Y.A.R., (8 volumes). Zurich, 1978.

19. FAO. Irrigation projects, identification mission, YAR.
Vol 1, Vol 2, April 1976.

20. FAO/IBRD. Wadi Zabid, Wadi Mawr, Development project,
Draft report, April 1972.

21. FAO/UNDP. Irrigation practices at Gumeisha area, Tehama Region, Agricultural Services Project, Governorate Hudaydah, 1975.

22. FAO/UNDP. Water Resources and quality survey of wadi Siham and Hudaydah area. Water resources report No. 1, 1975.

23. FAO/World Bank Cooperative Program. Second Southern Upland Rural Development Project, Preparation Mission.
Vol I, Vol II, March 1979.

24. Ghaleb, Mohamed Anam. Government Organizations as a Barrier to Economic Development in Yemen. M.A. Thesis, University of Texas, August 1960.
25. GIBB/BCEOM. Development of wadi Jawf, stage I. Preliminary report, Ministry of Agriculture, Reading June 1977.
26. GIBB/BCEOM. Development of wadi Kharid, stage I. Preliminary report, prepared for Ministry of Agriculture, YAR. June 1977.
27. GIBB/BCEOM. Development of wadi Rasyan, stage I. Preliminary report, Ministry of Agriculture, June 1977.
28. Hazen & Sawyer, Engineer and Leggette, Brashears & Graban, Inc. Ta'izz Water Supply and Sewerage project. Hydrologic investigation for well field development in Al-Haima Basin. New York 1977.
29. IBRD/IDA. Appraisal of Hudaydah water supply and sewerage project, Y.A.R. Report No. 773, YAR, June 1975.
30. IBRD/IDA. Appraisal of Tehama Development Project, YAR. March 1973.
31. IBRD. Report and Recommendations on a Proposed Credit to the Yemen Arab Republic for SURDP. April 1975.
32. ILACO. Implementation of Domestic Water Supply Facilities and a Rural Road Network in the Dhamar Project Area. January 1978.
33. ILACO. Water Supply, Rada'a Integrated Rural Development Project. September 1979.

34. ItalConsult. Water supply and sewerage systems for the town of Dhamar and Ibb, feasibility studies.⁴³⁴
Prepared for the National Water and Sewerage Authority,
April 1978.
Volume 1: Town of Ibb, preliminary report.
Volume 2: Town of Dhamar, preliminary report.
35. ItalConsult. Water supply and sewerage systems for Sana'a and Hudaydah (Phase II). Hudaydah sewerage system. Preliminary engineering and feasibility studies.
Prepared for National Water and Sewerage Authority.
June 1975.
36. ItalConsult. Water supply and sewerage systems for Sana'a and Hudaydah (Phase II). Sana'a sewerage system. Preliminary engineering and feasibility studies.
Prepared for National Water and Sewerage Authority.
February 1976.
37. Japan International Cooperation Agency. Rural Water Supply Project Part II. Draft report prepared for Ministry of Public Works, March 1980.
Volume 1: Draft main report.
Volume 2: Hydrogeological report.
Volume 3: Technical report.
38. Kingdom of Saudi Arabia, Ministry of Agriculture and Water. Project 36: Water Well Drilling and Construction in Y.A.R., 1979.
39. Kocks F.H. KG Consulting Engineers. Hudaydah water supply and sewerage projects. Final design. Prepared for National Water and Sewerage Authority, 1976.

40. Melinda Babcock. Bibliography of Water in Yemen.
Yemen Oil and Mineral Corporation. August 1979.
41. Ministry of Agriculture. Annual Report 1978-79.
Submitted to Central Planning Organization (Arabic).
42. Moseley, F. A reconnaissance of the wadi Beihan,
South Yemen, with notes on basement control of gully
alignment in superficial deposits. Proceeding of the
geologists association, Birmingham, February 1971.
43. New TransCentury Foundation. Technical Proposal, Yemen
Rural Water. Draft submitted to USAID/Yemen for Project
279-0044, October 1978.
44. Overseas Development Ministry. Improvement in Village
Water Supplies in the Montane Plain, Y.A.R. 1976
45. Overseas Development Ministry. Montane Plain and
wadi Rima Project. Initial Development projects,
Y.A.R. 1976.
46. Overseas Development Ministry. Montane Plain and
wadi Rima Project. Irrigation and agricultural develop-
ment in wadi Rima, Vol I, Vol II, Y.A.R. 1977.
47. Pacific Consultants International. Rural Water Supply
Project in Y.A.R. Tender and contract documents,
Vol I, Tokyo, August 1979.
48. Pacific Consultants International. Master Plan Study
for Hajjah Province, Integrated Rural Development.
Plan and operation for second stage investigation and
study. 1979.

49. Rethwilm, D. and Brandes W. Proposals for Follow-on Measures for the al-Boun Project, Feasibility Study. German Agency for Technical Cooperation, 1979.
50. Riggs, H.C., 1977. Brief Investigation of the Surface Water Hydrology of the Yemen Arab Republic. U.S. Geological Survey, open file, 1977.
51. Ruiz. Kennedy Memorial water system for Ta'izz. USAID/Yemen, 1966.
52. Rural Water Supply Department. Annual Report 1978-1979. Submitted to Central Planning Organization (Arabic).
53. Sir William Halcrow and Partners. Wadi Surdud Development on the Tehama (8 volumes). Prepared for Ministry of Agriculture, YAR, Swindon. August 1978.
54. SOGREAH Consulting Engineers. Wadi Siham, Feasibility Study. Interim Report, Grenoble, 1979.
55. Swiss Airphoto Interpretation Team. Final Report. April 1978.
56. Tehama Development Authority. Annual Report 1978-79. Submitted to Central Planning Organization (Arabic).
57. Tesco Viziterv Vituki. Supplementary assistance for the survey of the agricultural potential of the wadi Zabid, Reconnaissance investigations of groundwater resources in wadi Mawr. Budapest, 1972.
58. Tesco Viziterv Vituki. Supplementary assistance for the survey of the agricultural potential of the wadi Zabid. Final report, Budapest, 1973.

59. Tipton and Kalmbach. Development of wadi Mawr. Tehama Development Authority, January 1979.
60. Tipton and Kalmbach. The wadi Zabid irrigation project, proposed plan for water allocation. Tehama Development Authority, September 1974.
61. Tipton and Kalmbach. Wadi Zabid groundwater potential. Tehama Development Authority, December 1974.
62. Tombs, J.A.C. and Rollin, K. Geophysical survey to assist hydrogeological investigation in Y.A.R. Institute of Geological Sciences, London, 1977.
63. UNDP. Strengthening of the Rural Water Supply Department of the Ministry of Public Works (Phase II). Project YEM/78/005/A/25/4. January 1979.
64. USAID. Water Resources Planning and Management. Project assistance paper 279-0043, USAID/Yemen, March 1977.
65. USAID. Water Supply Systems Management. Project assistance paper 279-0028, USAID/Yemen, 1977.
66. USAID. Local Resources for Development. Project paper 279-0045, USAID/Yemen, January 1979.
67. Wagner, W. and Nash, H. Preliminary Appraisal of Ground Water Occurrence in the Amran Valley. Prepared for GTZ, February 1978.
68. World Bank. Report and Recommendations for a Third Tehama Development Project. February 1979.

8. LIST OF ABBREVIATIONS

AFAD	Arab Fund for Agricultural Development
AFESD	Arab Fund for Economic and Social Development
AgC	Agricultural Cooperative
ASCF	American Save the Children Fund
CAMA	Civil Aviation and Meteorology Authority
CPO	Central Planning Organization
CRS	Catholic Relief Service
CYDA	Confederation of Yemeni Development Association
DED	German Volunteer Service
DOH	Department of Hydrology
FAO	Food Agriculture Organisation
GSB	Geological Survey Board
GTZ	German Agency for Technical Cooperation
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
LDA	Local Development Association
LDA/CC	Local Development Association/Coordinating Council
MD	Meteorological Department
MOA	Ministry of Agriculture
MPW	Ministry of Public Works
NWSA	National Water and Sewerage Authority
ODM	Overseas Development Ministry
PC	Peace Corpse
PCV	Peace Corpse Volunteer
PDRY	People's Democratic Republic of Yemen
RWSD	Rural Water Supply Department
SF	Saudi Fund
SURDP	Southern Upland Rural Development Project
SURDU	Southern Upland Rural Development Unit
TDA	Tehama Development Authority
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund

USAID	U.S. Agency for International Development
WHO	World Health Organization
WMO	World Meteorological Organization
YAR	Yemen Arab Republic
YOMINCO	Yemen Oil and Mineral Corporation
NWRC	National Water Resources Council