YEMEN ARAB REPUBLIC

STAFF APPRAISAL REPORT ON THE

WATER SUPPLY AND SEWERAGE PROJECT FOR IBB AND DHAMAR

August 14, 1979

Water Supply and Sewerage Division
Europe, Middle East and North Africa Regional Office

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CURRENCY EQUIVALENTS

<table>
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<th>Currency Unit</th>
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<th>Yemeni Rial (YRls.)</th>
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<tr>
<td>YRls. 1.00</td>
<td></td>
<td>US$ 0.22</td>
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<tr>
<td>US$ 1.00</td>
<td></td>
<td>YRls. 4.50</td>
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MEASURES AND EQUIVALENTS

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<tr>
<th>Measure</th>
<th>Equivalent</th>
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<tr>
<td>Kilometer (km)</td>
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</tr>
<tr>
<td>Square Kilometer (km²)</td>
<td>0.386 square miles</td>
</tr>
<tr>
<td>Hectare (ha)</td>
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</tr>
<tr>
<td>Millimeter (mm)</td>
<td>0.03937 inches</td>
</tr>
<tr>
<td>Centimeter (cm)</td>
<td>0.3937 inches</td>
</tr>
<tr>
<td>Meter (m)</td>
<td>39.37 inches</td>
</tr>
<tr>
<td>Cubic Meter (m³)</td>
<td>264.0 US gallons</td>
</tr>
<tr>
<td>Cubic Meters per second (m³/sec)</td>
<td>22.8 million US gallons per day</td>
</tr>
<tr>
<td>Liter (l)</td>
<td>0.264 US gallons</td>
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<tr>
<td>Liters per second (l/sec)</td>
<td>22,800 US gallons per day</td>
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<tr>
<td>Liters per capita per day (lpcd)</td>
<td>0.264 US gallons per capita per day</td>
</tr>
<tr>
<td>Milligram per liter (mg/l)</td>
<td>1.0 parts per million</td>
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<tr>
<td>Million cubic meters per year</td>
<td>Mm³/year</td>
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GLOSSARY OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>LDA</td>
<td>Local Development Association</td>
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<tr>
<td>MM</td>
<td>Ministry of Municipalities</td>
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<tr>
<td>MPW</td>
<td>Ministry of Public Works</td>
</tr>
<tr>
<td>MPWM</td>
<td>Ministry of Public Works and Municipalities</td>
</tr>
<tr>
<td>NWSA</td>
<td>National Water and Sewerage Authority</td>
</tr>
<tr>
<td>RWSD</td>
<td>Rural Water Supply Division</td>
</tr>
<tr>
<td>UNCDF</td>
<td>United Nations Capital Development Fund</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Childrens Fund</td>
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<tr>
<td>UNIDO</td>
<td>United Nations Industrial Development Organization</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Program</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>YAR</td>
<td>Yemen Arab Republic</td>
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NWSA's Fiscal Year

July 1 - June 30
YEMEN ARAB REPUBLIC

STAFF APPRAISAL REPORT ON THE

WATER SUPPLY AND SEWERAGE PROJECT FOR IBB AND DHAMAR

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This report was prepared by Messrs. S. G. Serdahely (Sanitary Engineer), B.K. Thomas (Financial Analyst), A. Banerjee (Procurement Officer), and A. J. Hutchins (Consultant).

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CHAPTER I

THE WATER SUPPLY AND
SEWERAGE SECTOR

General

1.01 The Yemen Arab Republic (YAR) located in the southwest corner of the Arabian peninsula, consists of about 195,000 km² of mostly mountainous country. It is bordered on the north and northeast by Saudi Arabia, and on the south and southeast by the Peoples Democratic Republic of Yemen, and on the west by the Red Sea. The country has three distinct geographical regions: the rainless coastal plain, extending about 70 km inland along the Red Sea; the central highlands, covering most of the interior where roughly two-thirds of the population lives; and the eastern plateau, a desert, which extends into the sands of Saudi Arabia (see Map No. 14050).

1.02 As of mid-1977, the Government estimated the population at 6.5 million with less than 10% resident in urban areas, at least 10% emigrant to neighbouring oil countries and the remainder living in scattered rural communities. Although economic development is constrained by limited natural resources and by scarcity of technical and administrative skills, the 1976/1977 per capita GNP reached a level of approximately US$ 400, largely as a result of cash inflows from the migrant workers' US$ 1.0 billion in remittances. Although the resultant unprecedented increase in personal incomes has alleviated the traditional problems of poverty, hunger and underemployment, it has created new ones such as pollution, congestion and competition for goods and services, which require urgent attention.

1.03 The Government is now making a major effort on a massive scale to improve the water supply and sanitation services in the five urban centers through a program which will provide an estimated half million persons with improved water supplies and sewerage services. As part of the financing arrangements for this program, the Government has requested IDA's assistance for a project that will provide piped water supplies and sewerage to approximately 130,000 users.

Water Resources and Sewerage

1.04 Because there are no permanently reliable sources of surface water, reliance is principally placed on groundwater for urban water supplies. During the summer rains some wadis experience heavy flows, but none contain running water throughout the year. Springs in and around Sana'a, Taiz and Ibb provide fractional contributions to the water supplies of these cities. Moderate mineralization characterizes the groundwater in most areas. Alkalinity and hardness are relatively high (250 to 450 mg/l) in the highlands, while in the coastal areas salinity is relatively high (2,000 to 3,000 mg/l).

1.05 Shallow wells provide most of the people in YAR with drinking water. In the urban centers of Sana'a, Hodeida and Taiz, piped water is supplied
through systems now under large scale expansion by the National Water and Sewerage Authority (NWSA). Limited piped water supply is provided by local cooperatives and private enterprises in Ibb and Dhamar. Village areas depend primarily on hand dug wells although a number of drilled wells are being installed. The existing water supplies can generally be defined as inadequate.

1.06 Hydrogeological studies have been undertaken for the cities of Sana'a, Hodeida and Taiz, and potentially adequate groundwater sources sufficient to meet their long-term needs have been identified. Data covering the remainder of the country is limited. Test drilling over a substantial part of the country, however, indicated that many rural communities can be adequately served through wells drilled into the cretaceous sandstones 200-300 m below ground surface. In Sana'a well drilling is prohibited unless performed under the aegis of NWSA. The Army has assigned a non-commissioned officer to NWSA for monitoring and enforcement purposes.

1.07 Although construction of sewage collection and treatment systems is to commence under ongoing projects in Sana'a, Hodeida and Taiz, no large scale municipal systems are presently in operation in the country. A limited area of Taiz is presently served with piped sewerage (2,000 persons), but the system requires augmentation and extensive improvement. Rudimentary collection systems exist in parts of the other urban centers but these are ineffective and conducive to disease transmission.

Sector Development Program

1.08 The total investment program for water supply and sewerage facilities for the main urban centers: Sana'a, Hodeida, Taiz, Ibb and Dhamar is estimated to reach US$370.0 million by 1983. The following table shows the estimates of investments for each of the five cities through 1983.

<table>
<thead>
<tr>
<th>City</th>
<th>YRls. (Millions)</th>
<th>US$ (Millions)</th>
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<tbody>
<tr>
<td>Sana'a Water Supply</td>
<td>308.9</td>
<td>68.6</td>
</tr>
<tr>
<td>Sana'a Sewerage</td>
<td>217.1</td>
<td>48.2</td>
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<tr>
<td>Hodeida Water Supply</td>
<td>89.4</td>
<td>19.9</td>
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<tr>
<td>Hodeida Sewerage</td>
<td>243.2</td>
<td>54.0</td>
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<td>Taiz Water Supply</td>
<td>186.3</td>
<td>41.4</td>
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<tr>
<td>Taiz Sewerage</td>
<td>218.7</td>
<td>48.6</td>
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<tr>
<td>Dhamar Water Supply</td>
<td>108.3</td>
<td>24.1</td>
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<tr>
<td>Dhamar Sewerage</td>
<td>112.7</td>
<td>25.1</td>
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<tr>
<td>Ibb Water Supply</td>
<td>82.9</td>
<td>18.4</td>
</tr>
<tr>
<td>Ibb Sewerage</td>
<td>109.9</td>
<td>24.4</td>
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1.09 A rural water supply development program undertaken by the Rural Water Supply Division (RWSD) of the Ministry of Public Works and Municipalities (MPWM) 1/ is ongoing with assistance from WHO (as the executing agency

1/ Separate Ministries of Public Works (MPW) and Municipalities (MM) were recently established in YAR.
for UNDP, UNICEF and donors including: United States (USAID), Abu Dhabi, Saudi Arabia, Japan, Federal Republic of Germany, and the Netherlands. IDA’s agricultural development credits have also included rural water supply elements. The 1975 census indicated a total of some 32,000 communities in YAR. Government estimates of the number of rural communities to be served vary from 10,000 to 30,000. The total cost of providing these communities with adequate or improved access to an unpolluted water source, could be over US$ 500 million. Presently, it is estimated that, on an annual basis approximately 50 villages with populations of up to 3,000 persons are being equipped with minimum level systems (wells, service reservoirs and public standpipes).

Government’s Priorities in the Sector

1.10 The principal problem facing the Government in the sector has been the shortage of trained engineers and technicians. In view of the limited human resources available, Government allocated first priority to the urban centers: Sana’a, Hodeida, Taiz, Ibb and Dhamar because their concentration of population was conducive to outbreaks of water-associated diseases; and, by its nature, the concentration allowed maximum use of the limited human resources available.

1.11 In line with this approach, major projects are being implemented by Government in Sana’a, Hodeida and Taiz in which water supplies and piped sewerage systems are being provided. In each of these cities the volume of wastewater generated through the establishment of large community water supply systems is such as to require piped sewerage systems. The common problems of narrow streets in old town areas, and unfavourable soil conditions tend to preclude the application of other forms of wastewater disposal. Sewage treatment in Sana’a and Hodeida will be effected through the use of aerated lagoons. In Taiz, treatment will include trickling filters in addition to aerated lagoons.

1.12 Although a great deal of emphasis has been placed on urban water supply and sewerage projects, the Government has not neglected the rural sector. Close coordination is maintained between the urban and rural sectors through the Deputy Minister of MPW who is a principal member of NWSA’s board of directors and also heads RWSD (para. 1.16). Progress in rural water supply development, however, must continue to rely on the limited expatriate technical assistance available to carry out the rural water supply program.

1.13 Some of the projects prepared by the UNDP project team for the RWSD have been built utilizing funds and materials provided by a variety of donor agencies. From 1972 onwards UNICEF had been annually providing about US$ 0.5 million worth of equipment and materials. The Federal Republic of Germany has made funds in trust in the amount of US$ 810,000 available to UNICEF from 1973 to 1976. United Nations Capital Development Fund (UNCDF) has similarly provided US$ 1.5 million for UNICEF funds in trust from 1976 to 1978 and is expected to repeat the assistance in 1979. In 1973-74 an Abu Dhabi grant of US$ 3.0 million was utilized for purchasing drilling rigs and another grant of US$ 4.0 million to cover pumping installation costs. Qatar supplied 60 pumping units as well. Iraq drilled and constructed 33 rural water supply wells in 1971-72. USAID has been active in well drilling and construction
from 1972 onwards, and has included training for well drillers and technicians. UNDP and WHO have provided technical assistance on a continuing basis since 1974. Saudi Arabia has, between 1973 and 1978, built 36 rural water supply systems at a cost of about US$ 16.0 million. Japan embarked on a US$ 15.0 million program in 1977, which, when completed in 1982 will provide systems for about 50 rural communities. Then, in 1977, Netherlands made a grant of about US$ 2.6 million available for the construction of 12 systems. IDA provided US$ 1.8 million for rural water supplies under the Southern Uplands Rural Development project.

Sector Organization

1.14 Several Government entities are involved in the sector. The principal agency, NWSA, was established in November 1973 in order to achieve Government's objectives in the sector. Specifically NWSA was delegated the responsibility for the planning, execution and operation of water supply and sewerage systems in urban centers. Among subsequent decrees was that in which NWSA was also required to take over any system for which external borrowing is required.

1.15 NWSA took over the operation of the Sana'a waterworks from the Sana'a Cooperative in November 1974, amalgamating the Cooperative staff into the NWSA organization. An agreement signed by the Port Authority and NWSA in March 1976 provided for the take over of the Hodeida water supply system from the Port Authority, and physical take over was effected in 1976. The John F. Kennedy Memorial Water Supply System in Taiz, the first community network constructed in YAR and financed by USAID is currently operated by the Taiz Cooperative Organization. Preparation for the take over of this system by NWSA has been initiated, with only final documentation still awaiting completion. The existing water supply for Ibb is operated by a cooperative, while in Dhamar the responsibility rests with a semi-public organization. Procedures have been initiated by NWSA to take over these supplies.

1.16 The Rural Water Supply Division (RWSD) of MPWM was established in 1972 and made responsible for planning and construction of rural water supply systems, including the coordination of external assistance for projects. Headed by a Deputy Minister, the division has a small staff of local technicians. A UNDP project which was completed at year-end 1978, provided the services of a full-time WHO sanitary engineer and up to three UNDP volunteers to the RWSD. Rural water supply systems are initially operated by the RWSD on completion of construction and are subsequently turned over to the local authorities, generally the Local Development Association (LDA). In some cases an area-wide organization (e.g. Tihama Development Association) constructs and operates the systems until the LDA can assume the responsibility. Operation and maintenance of the rural systems is not generally of a high standard. The UNDP project which became effective in January 1979 will address this problem as one of the project's objectives.

Performance in Previous IDA Lending

1.17 The initial IDA Credit (464-YAR) of US$ 6.25 million for urban water supply for Sana'a became effective on July 15, 1974. Delays by the consultants
preparing project documentation originally set back project construction by one year. Subsequently, after all contracts were awarded and construction was underway, the Yemeni civil works contractor experienced financial difficulties and ceased production in the pipelaying contract. Therefore, NWSA entered into a contract with an international construction firm in order to complete the pipe laying, and this operation is proceeding satisfactorily. However, instead of being completed by year-end 1977, the civil works were finished in mid-1979. The cost overrun is being met by the YAR Government as an equity contribution to NWSA.

1.18 In June 1975, an IDA Credit (559-­YAR) of US$ 8.1 million was approved for the financing of the water supply component of the Hodeida water supply and sewerage project. The Arab Fund for Economic and Social Development provided parallel financing for the sewerage component in the amount of US$20.2 million. The Credit became effective on December 29, 1975. Although the design work proceeded on schedule, award of the major civil works construction contracts was delayed because of lack of response from bidders and because of the high construction costs reflected in the (two) bids received. Following further delays due to re-bidding after pre-qualification of contractors, contracts were awarded in February, 1979. Again, the YAR Government has agreed to meet the cost overruns.

1.19 In order to enlarge the water supply scheme being built for Sana’a under Credit 464-­YAR and in order to construct the first phase of the sewerage master plan, Credit 670-­YAR was approved on January 14, 1977 and became effective on August 22, 1977. The US$ 10.0 million Credit principally covered sewerage construction materials and equipment as well as engineering. Co-financing was provided by the Arab Fund, approximately US$ 17.0 million, for water supply, and by the Saudi Government, approximately US$ 15.0 million, principally for sewer civil works. As a result of lessons learned from earlier project experience NWSA has prequalified contractors, and contract awards are underway.

1.20 Having analyzed the reasons for delays encountered in earlier IDA project activity NWSA has instituted contract control procedures designed to minimize the possibility of future delays in contract administration.

1.21 Credit 545-­YAR for the Southern Uplands Rural Development project was approved on May 13, 1975 and became effective on January 27, 1976. The US$ 10.0 million Credit includes a US$ 1.8 million element for well drilling and rural water supply development. Problems of rapid cost escalation have caused the scope of this activity to be adjusted, with Government’s participation having to be increased.

Other Works

1.22 In addition to the IDA project, NWSA has undertaken additional works to improve water supply and sewerage services in YAR. Contracts have been awarded for the extension and modernization of the Kennedy Memorial water system in Taiz, which is being effected with the guidance of consulting engineers (Hazen and Sawyer). This project will replace the present intermittent and low pressure service with a dependable 24-hour per day utility
providing 31,600 m³/day of treated water to a 1990 population of 178,000. The
new sewerage system features a major trunk line and a system of collectors to
serve the same population. Treatment will be effected through trickling
filters followed by aerated lagoons. Cost estimates as of November 1978
showed a total investment of YRs 423.0 million (US$94.0 million) for the
project.

IDA's Objectives in the Sector

1.23 Through its lending to the sector, IDA assists the Government in
achieving its logical priority objective of creating maximum impact with
limited available human resources and of lessening the risks of outbreaks
of epidemic diseases in urban centers. In addition, IDA continues to assist
in developing NWSA's institutional and operational capabilities to enable
it to become a competent and financially viable institution for the adminis-
tration of water supply and sewerage in YAR. NWSA engineers and technicians
have been gaining experience in construction supervision under the ongoing
credits for the Sana'a and Hodeida water supply and sewerage projects.
Completion of civil works for the water supply in Sana'a has been followed by
the initiation of the house connection program by NWSA. Groundwater exploita-
tion in Sana'a and Hodeida are under NWSA's control and surveillance. The
progressive development of NWSA as a technically capable organization is
evident in the diminishing of periods of delay in project execution in IDA-
assisted water supply and sewerage projects and in the increasing confidence
NWSA has developed in assuming greater responsibility for project implementa-
tion.

1.24 Funds for rural water projects are being provided through approved
IDA rural development project credits, and these, in turn, attract other
donors who share IDA's objective.
CHAPTER II

PROJECT AREA

Location and Water Resources

2.01 Ibb is the center of a rich agricultural region and serves as a marketing and administrative center, however, industrial development is minimal. Located in the southern maritime climate region of YAR, and due to its topographical and morphological location, Ibb enjoys the highest average rainfall in the country, over 1,400 mm per year, principally occurring during the spring and summer rains. Two alluvial plains flank the town of Ibb. The quaternary sediments of the southern plain, the basin of the Wadi Salabat As-Sayyedah, are presently exploited as a groundwater resource for approximately 30 lps. The wells range from 30 m to 64 m in depth with static water level a few meters below ground level. The aquifer is readily recharged during floods.

2.02 Dhamar is also the center of a productive agricultural region and functions as a marketing and administrative center with only limited prospects for industrial development. Dhamar is located in the central "transition" climatic zone in YAR about 130 km south of Sana'a and, therefore, is subject to similar climatic conditions as Sana'a. Generally, the rainy seasons are April-May and July-September, and the average annual rainfall is 400-500 mm. Groundwater occurs in the fractured volcanic rock on the highland plateau and also in the alluvial basin sediments in the Dhamar area. On the basis of inventories of 123 wells, present extraction is about 45 lps (including irrigation) with no significant water level lowering observed. The water table in the Dhamar area is evident at a depth of 2 to 10 m below ground level.

Existing Facilities - Water and Sewerage

2.03 The water distribution systems provide service to approximately 80% of the population of each city. However, because of limited sources and inadequate distribution the consumption is about 30 to 35 lpcd. Intermittent service occurs in both systems because of limited facilities for storage and well pumping. In Dhamar because of the low level of storage tanks, system pressure is very low and multi-story buildings require booster pumping units. The galvanized iron pipe distribution networks in both cities have been installed at various times according to the growth of each city. The maximum depth at which the existing pipe is buried is 30 to 40 cm, with some of the network above ground. Maximum diameter of the existing galvanized iron pipe is 4-inches, but most of the "mains" are 1- and 2-inch pipes; and a substantial amount of the distribution system is in bad repair. Maintenance is difficult and, therefore, is limited. House connections are generally exposed. Leakage is visible in those streets where heavy vehicular traffic has damaged the superficially installed lines. The unsatisfactory condition of the systems
in both cities has reached a degree where replacement is imperative. Bacteriological analysis performed by Government at the consultant's request showed some contamination in both systems, particularly in Dhamar. In Ibb the cooperative started distributing water in 1963, while the water organization in Dhamar commenced distribution in 1965. There are no municipal piped sewage collection systems in either city.

2.04 The water supply for Ibb is derived from two different sources. The first, which comprises a rudimentary intake and masonry channel, utilizes gravity flow from the mountain stream, Wadi Badan, and directs the flow into a centrally located cistern. Major flows are available only during the two to three month rainy season. The second, a well field south of the town center, includes three drilled wells (total yield of 20 lps) which are in operation 12 to 14 hours per day. Private hand dug wells provide only a minimal fraction of the water consumed. Preliminary hydrologic and hydrogeologic investigations performed by the consultants revealed that quantities of water in the range of 4 Mm³/yr would be available from the alluvial reservoir serving Ibb. Agreement has been reached that Government will proceed with the preparation of hydrogeological studies in the Ibb area in order to ensure adequate groundwater supplies to the year 2000.

2.05 Dhamar depends on groundwater exclusively for its source of potable water. A large (5.5 m diameter x 27 m. depth) hand dug well, fitted with two centrifugal pumps (one of which operates 24 hours per day with a yield of about 9 lps, and the other is standby), is located south west of the city; and two drilled wells (total yield of 9 lps), one in the town center and the second, south of the city, each operated four to eight hours per day represent the major existing sources. Two reservoirs provide combined storage capacity equivalent to 440 m³. Dug wells are utilized by the military barracks, seven mosques and the electricity station. The hospital has its own dug well and reservoir which it uses for part of its supply.

2.06 The public water supply of Ibb is operated by a quasi-municipal cooperative which owns the existing source and distribution facilities. The cooperative estimates that there are approximately 3,000 house connections in the system of which about 350 are metered. According to the cooperative officials, approximately 1,000 m³ is distributed to consumers daily, and total daily production is about 1,300 m³. Those houses which are not connected obtain their water from public taps (there are 20 of these in present use) or from connected neighbours. All 32 mosques in Ibb are connected to the public water supply and provide for part of the demand of the unconnected population.

2.07 In Dhamar, the water supply is operated by a "cooperative" in which a portion of the financial interest is privately owned. According to the organization's principals, there are over 3,000 house connections, including about 1,600 metered connections. About 900 m³ per day is distributed, with over 1,200 m³ of water produced daily. Only eight public taps are still operable in the system. As in Ibb, the unconnected population obtains water from their connected neighbours, from public taps and from mosques. Of the 40 mosques in the city, 33 are connected to the existing systems.
Urban Poor

2.08 In Sana'a and Hodeida an inner-city community of squatters principally peopled by transient worker-families exists. These constitute the urban poor element in these cities. In the cities of Ibb and Dhamar where there are no squatter settlements, the number of urban poor is very small, but even these have access to water through the piped water supply system and private wells. Labor shortages are pervasive throughout the country, and Ibb and Dhamar are no exception. Worker remittances sent home to YAR by migrants go mostly to rural small town areas which supply the bulk of the migrant labor force. Strong family ties have ensured the benefits accruing to a large number of people in these cities. Labor scarcity has driven up wage rates in YAR and a large share of the new cash incomes has been spread among those people who previously had been desperately poor. With common labor earning YRls. 80 to YRls. 100 (US$18-22) per day, the number of urban poor is very limited. In neither city is water sold by itinerant vendors, an indication of the relative minimal number of unserved population and also usually an indicator of the presence of urban poor. It is also customary in YAR for poor people to obtain water at the numerous mosques. The Ministry of Awqaf (religious trusts) has the responsibility of paying the standard rate to NWSA for water consumed at the mosques. Average consumption at the mosques for Ibb and Dhamar is about 2 m³/day.

Water Losses

2.09 The NWSA consultants (Italconsult) estimated the present level of water losses on the basis of average daily total consumption compared with the average daily total quantity of water produced. The value obtained in this manner was approximately 25% to 30%. Considering the condition of the distribution systems as well as the occurrence of leaks in the galvanized iron pipes due to their frequent exposure to traffic, this figure may be even higher. On the basis that 25 to 30% of production is lost and a further 10 to 15% of production fails to be accounted for because of under-registration of meters and an additional miscellaneous 10% of production is not tallied, the present total of unaccounted-for water is probably in the vicinity of 50% of production. In the proposed project the level of unaccounted-for water is projected at 25% as of 1983.

Sewerage Connections

2.10 Present collection and disposal of sewage in Ibb and Dhamar is through pit latrines, cesspools and septic tanks. In most houses the connection from the toilet and bath facilities to the pit latrine or cesspool is through a vertical shaft or pipe on the front of the building. Sewerage service connections from the buildings to the laterals will be facilitated since these vertical shafts already exist. Presently, however these discharge shafts contribute to the obnoxious condition of wastewater ponding in roadways. Where the shafts have become clogged, fecal material is thrown into the streets. In Ibb an odious stream of septic sewage courses through the central market plaza. Offensive pools of stagnant sewage exist in both Ibb and Dhamar because of latrine and cesspool overflows, due to the present provision of
even limited water service without adequate wastewater disposal. Since water supply is already available to a degree in Ibb and Dhamar, and toilets and sinks are already drained, it is anticipated that the deposition of faecal solids in the sewer laterals will not constitute a major problem. Occasional flushing with mobile tankers will be useful in those areas which might require such attention. All new residential construction in both cities includes the installation of sanitary fixtures and fittings. The proposed UNIDO/IBRD construction materials study will include a factory in YAR for manufacturing these fixtures. In Sana'a and Hodeida, NWSA has been subjected to increasing demands from property owners for sewer service. The proposed connection fee of YRls. 1,900 has not been a deterrent to these demands. Installation of household sanitary fixtures in both cities has been accelerating in anticipation of sewer construction. A final draft plumbing code has been prepared by the consultants, Howard Humphreys and Sons (HHS), and this is expected to serve as the national urban prototype. Compulsory sewer connections and the extension of credit facilities for poorer users are envisaged for the Ibb and Dhamar sewerage systems (para 4.07).
CHAPTER III

THE BENEFICIARY

Introduction

3.01 The Yemen Arab Republic will be the borrower of the proposed Credit of US$ 12.0 million and will on-lend the Credit proceeds to NWSA on terms and conditions acceptable to the Association. This is the fourth credit to be provided for the development of adequate water supply and sewerage systems in urban areas in the country (paras. 1.17-1.19).

Organization and Management

3.02 NWSA was established in November 1973 as an autonomous agency with complete financial accountability, to provide adequate water and sewerage service in urban centers. The law establishing NWSA provides for the takeover of existing water supply systems in Sana’a, Hodeida, Taiz, Ibb and Dhamar, subject to the issuing of Government decrees authorizing the takeovers. Subsequent legislation provides that NWSA will assume control of those water supply and sewerage systems for which external borrowing is required. Formal transfer of the Sana’a water supply system to NWSA became effective in November 1974; and that of Hodeida and Taiz is in the process of completion except for finalization of administrative details. Agreement has been reached that the Government will take all steps necessary to transfer to NWSA the exclusive jurisdiction over the water supply and sewerage systems in Ibb and Dhamar by the date upon which the project shall have been completed.

3.03 Annex 1 shows NWSA’s organizational framework. NWSA’s structure emphasizes decentralization in which the branch offices deal with the day to day operation, allowing for the scarce managerial skills to be concentrated in the Head Office in Sana’a, from which new works are planned, policy is established, consultants’ activities are supervised, and branch operations are coordinated.

3.04 Control of NWSA is vested in a seven member Board; the Chairman of the Board has ministerial rank and is directly responsible to the Prime Minister. Other members of the Board are: the General Manager of NWSA; the Deputy Minister of MPW; the undersecretary of MM; the undersecretary of the Ministry of Finance, Government Accounting Section; and two qualified representatives of local government and the private sector, respectively. The Board is directly responsible to the Council of Ministers whose regulatory powers typically affect the major resolutions to be implemented by the Board. The General Manager is responsible to the Board, through the Chairman, for NWSA’s performance. Reporting to the General Manager are the departments of Finance, Administration, Engineering and Operation. The branch offices report to the General Manager through the Operations Manager who provisionally fulfills the function of Deputy General Manager.
Personnel

3.05 At the time of appraisal, NWSA had a total of 290 staff members of which 85 were at headquarters, 120 in the Sana'a branch and 85 in the Hodeida branch. The water authority in Taiz presently has 160 employees and the branches in Ibb and Dhamar are expected to have about 50 employees each when the project is completed. NWSA presently can contract with qualified candidates for positions at salary levels comparable to those of private industry.

3.06 NWSA is regarded as a relatively effective, albeit developing, organization; however, NWSA will have reached the limit of its operational capacity when the Ibb and Dhamar systems are added to its present responsibilities. Continuing efforts are being made, therefore, to adequately staff NWSA's head offices and branches, particularly in the senior positions. Recent salary increases have made it possible to retain qualified staff in many technical positions, and the prospects for recruiting engineers for future vacancies is also good. However, most of the new recruits are young and relatively inexperienced, and therefore the need for a few experienced expatriate advisors remains. Experience with recruiting professionals for the financial positions has been less satisfactory. The position of Financial Manager is currently being held by an expatriate on an acting incumbency basis.

3.07 In view of the continuing scarcity of accounting and financial experts in YAR it is necessary that NWSA be assisted by expatriate financial advisors in the next few years. USAID has as part of its "Water Management Project" an advisory technical assistance program whereby services of three financial experts will be made available to NWSA in advisory capacities (para 3.10). The proposed Credit provides funds for an expatriate financial/administrative expert as part of NWSA's on-line operational staff.

3.08 Because of the rapid growth foreseen for NWSA in the next five years, it is possible that its staff might be overstretched in some high level functional areas whereas greater efficiencies might be obtained in certain lower echelons. Agreement has been reached that NWSA will, on an annual basis, submit to the Association a detailed program of work to be undertaken in each year, together with concomitant staffing needs and availability of staff.

Training

3.09 A basic training program for NWSA's personnel is underway with the assistance and financing of a UNDP project in which WHO is the executing agency. Training of professional staff was included in the on-going IDA assisted project (Credit 559-YAR) and this program is complementary to the UNDP program. As a result of NWSA's 1975-1977 recruitment drive at home and abroad it was established that only a limited number of qualified professionals are available in YAR, and that NWSA will have to continue the administration of training programs to provide qualified personnel for all of its operational aspects. In consultation with the appraisal mission, NWSA reviewed its 1980 staffing requirements and projected its needs to 1985. These requirements were then compared with present NWSA personnel to determine the recruitment and training necessities. The principal emphasis in training
will be to upgrade the capability of incumbent staff in order to meet the additional requirements imposed by the expanded facilities evolving from the proposed investment program.

3.10 The estimated costs of the training needs and technical assistance to NWSA through 1984 is more than US$ 6.0 million, excluding the salaries of trainees payable in local currency and costs of training in local establishments. NWSA has commitments for all of this financing. Under the Hodeida Water Supply and Sewerage Project (Credit 559-YAR) IDA provided US$ 200,000 and the Arab Fund for Economic and Social Development allocated US$ 925,000 for training. Additionally, the proposed Credit provides for US$ 200,000 for the cost of training. USAID in its US$ 3.9 million Water Management Project is providing advisory staff over a three year period in the following areas: technical planning, finance, administration and maintenance. Expatriates assigned to the project will be exclusively advisory. However, these expatriates will also assist in the on-the-job training of Yemeni counterparts. Provision has been included in the proposed Credit for US$ 911,000 to cover the foreign exchange costs of expatriate operational "on-line" staff, in branch management, engineering, and operational capacities. The expatriate staff will be seconded from the following authorities which have agreed to assist NWSA: Societe Nationale d'Exploitation et de Distribution des Eaux (SONEDE), Tunisia; and the Amman Water and Sewerage Authority (AWSA), Jordan. SONEDE was established in 1968 as an autonomous water agency as a result of Bank-assisted institutional development in water supply projects in Tunisia. Similarly, AWSA came into being in 1973 as a corollary to IDA-financed water supply projects in Amman. Agreement has been reached that NWSA will have started recruitment of the expatriate staff so that initial field assignments can be made before year-end 1979.

3.11 In order to develop and strengthen the institutional capacity of the Rural Water Supply Department in the MPW, UNDP is implementing a new three-year project as of January 1979, with WHO as the executing agency and with a budget of US$1.7 million and YRls. 18.3 million. In addition to providing 19 fellowships (420 man-months total) the UNDP/WHO project also provides expatriate technical assistance and training of technical and non-technical (villagers) staff.

Billing and Collection

3.12 NWSA's customers are billed monthly for a fixed charge. Because of frequent interruption in services, consumption has not thus far been metered. However, as new sources of water are introduced into the system, making 24-hour continuous service possible, all connections will be metered. A meter installation program is in its early stages of implementation in Sana'a as part of the house connection program. At present different charges for domestic and commercial usage are levied on the connections based on the different levels of service, and this practice will continue once meters are installed. The customers pay their bills to the branch office cashiers; and if a bill is not paid within three months of its submission, the service is disconnected. Accounts receivable presently stands at 1.7 months sales, which is acceptable.
NWSA is in the process of obtaining mini-computers for the purposes of billing and augmenting its collection and control capabilities. Existing and new customers will be required to pay a deposit to NWSA that would cover an estimated three months of water sales. Low income users, however, will be allowed to arrange installment payment of the deposit.

**Accounting Practices and Procedures**

Since NWSA's establishment, while the accounting system which started on a simple cash basis has become increasingly more sophisticated, to the degree that audited accounts through fiscal year 1977 have been produced, much still remains to be done.

In compliance with the provisions of the Project Agreement for Sana'a Water Supply Project (Credit 464-YAR) a new accounting system was designed for NWSA by a Lebanese consulting firm, Shair and Company. The system consisted of mechanized customer billing, collection and control, financial and cost accounting and budgeting; and these were approved by NWSA. With the decision to acquire mini-computers, programs were designed by the vendors for review by the consultants and these were approved. As from fiscal 1979 all accounting in Yemen, including that of NWSA, has been required to adopt a standard format similar to the French "Plan Comptable" system. This will entail substantial revisions to the computer programs, which are being done at present, and the system will be implemented soon after their completion.

NWSA's accounting arrangements are adequate for its present level of operations, but it is clear that considerable work remains to be done to achieve the higher accounting skills necessary to control such a large and rapid increase in consumers and assets. To this end, advisors are being employed through the USAID project to advise and assist in training NWSA accounting staff (para. 3.10), and the Credit includes the engagement of expatriate on line accounting staff to enable NWSA to bridge the interim period while also training counterpart staff.

**Audit and Insurance**

As required under previous Credits, NWSA's accounts are audited by certified accountants who are acceptable to the Association.

Some minor assets belonging to NWSA, such as motor vehicles are insured through the Mareb Yemen Insurance Company. As a Government entity the bulk of all major assets in operation are not insured. Projects under construction are insured by the respective contractors under the terms of their contracts.
CHAPTER IV

DEMAND AND MARKET ASPECTS

Present Production and Consumption

4.01 There are no systematic records available relating to water production and consumption for the cities of Ibb and Dhamar. Estimates and projections were prepared by the consultants (Italconsult) based on information provided by the water company officials and on observations by the consultants.

4.02 Water consumption in Ibb and Dhamar is principally made up of domestic usage, while commercial, industrial and governmental consumption is limited. Present domestic consumption in both cities is estimated by the cooperative and the consultants at 30 to 35 lpcd, with the unconnected population consuming as little as 15 lpcd. This low consumption is attributed to the limits imposed by the present difficulties in water production and distribution. On a comparative basis, in Hodeida overall average per capita consumption in 1978 is 66 lpcd while in Sana'a the figure is over 50 lpcd.

Population Forecast

4.03 Estimated mid-year population in the years 1978 through 1990 is shown in Annex 2. They are based on population levels established by local authorities through block counts performed in the cities. These counts differ somewhat from the 1975 census in which the maps and block designations are considered to be inaccurate by local authorities. In Ibb the 1978 city population of 34,600 is estimated at approximately 4% of the governorate population, which is consistent with the character of the region, together with the proximity of Taiz, which is expected to have a slightly curbing effect on the growth of Ibb. For Dhamar, which is less affected by the nearness of a larger city the 1978 population of 36,480 represents 8% of the governorate population. The growth rate of Ibb is expected to average approximately 5% per year with a natural increase of about 2.3% and a migratory balance of 2.7% per year. Thus the 1990 population is expected to reach about 63,000. For Dhamar, a slightly higher average growth rate is forecast. The 5.3% average total is estimated on the basis of 2.3% natural increase and 3.0% migratory increase. In 1990 the Dhamar population is forecast at about 70,000.1/

Forecast of Consumption and Number of Connections

4.04 The mission's forecast of water consumption and production in the period 1978 through 1990 as agreed upon by NWSA are shown in Annex 2. For

1/ The urban planning consultant, Kampsax-Berger, forecast the 1990 population for Ibb at 57,700, and for Dhamar at 106,000.
Ibb, average daily per capita consumption is estimated to increase from the 1978 level of 35 liters to 130 liters by 1990, while for Dhamar the range will be from 30 liters to 130 liters for the same period.

4.05 In 1978 there were 3,000 water connections in Ibb, and it is projected that there will be about 6,500 connections by 1985 and about 7,800 by 1990. For Dhamar, the 1978 total of water connections was 3,000, and the projections for 1985 and 1990 were about 6,800 and about 8,600 respectively. In Ibb the number of metered connections existant in 1978 was only about 350 while in Dhamar the figure was about 1,600. By 1985 NWSA plans to have all house connections metered in both cities. The level of unaccounted for water forecast to be achieved by 1983 is 25% of all production. The maximum day demand is projected to be 20% more than the yearly average demand per day and the maximum hour demand is projected to be 50% more than the maximum day demand.

4.06 The proposed project would have the capacity to meet the cities' water supply and sewerage needs up to the year 1990. It is not anticipated that the projected tariff levels will significantly affect usage levels.

4.07 The piped sewerage systems for both cities would become operative in 1984. In Ibb the system would provide collection through about 4,600 service connections by 1985, and by 1990 the installed total is expected to reach about 6,100 connections. Similarly for Dhamar, by 1985, 4,800 connections would be installed, and in 1990 about 6,300 premises would be connected to the sewer system. Agreement has been reached that by the date upon which the project shall have been completed the Government will have taken the measures necessary to ensure that those water customers with sewerage facilities available to them be required to connect to the sewer system, and that NWSA will give credit facilities to low income customers to help them meet the cost of connecting to the sewer system. These measures are also defined in the previous Credit (670-YAR).
CHAPTER V
THE PROJECT

Genesis

5.01 Funds for feasibility studies for development of adequate water supply and sewerage facilities, for Ibb and Dhamar were included in Credit 670-YAR, Sana'a Second Water Supply and Sewerage Project. NWSA issued terms of reference in November 1976 and the selected consultant initiated field work in July 1977. Final draft reports were submitted to NWSA and IDA in October 1978.

Project Objectives

5.02 The overall project objective is to continue the development of NWSA's institutional and operational capabilities by:

(a) assisting NWSA in its program of improving water supply and sewer service in Ibb and Dhamar;

(b) providing on-line operational, technical and financial assistance for several branches of NWSA;

(c) upgrading the technical and professional skills of NWSA staff by assisting in the implementation of a training program; and

(d) assisting NWSA during project supervision with particular emphasis on NWSA's own staff assuming additional responsibility for project supervision.

Scope of Project

5.03 The proposed project (Map Nos. 14051 and 14052), which represents a further developmental stage in the field of water supplies and sewerage in the Yemen Arab Republic, was prepared by Italconsult and would improve and expand water supplies and provide piped sewerage for the towns of Ibb and Dhamar through the year 1990. Both cities have existing but unsatisfactory water supply systems, with consumption levels at about 30 lpcd; and the systems are not adequate for the provision of additional quantities of water to the cities. The project will increase the quantity of water available in Ibb from 0.4 million m3/year in 1978 to more than 3.0 million m3/year in 1990 through drilling of eight additional wells. The distribution system will be divided into two level service areas. For Dhamar the increases in water production and average consumption will be of the same order with the drilling of nine additional wells projected. All connections will be metered.
5.04 At present the city of Ibb has no municipal piped sewerage system. The few drains that exist are local and private in nature, serving as combined sewage and sullage drains. Except for the central part of the city where there are steep slopes, ponding of sewage occurs in flat areas. Similarly in Dhamar, rudimentary sewerage, consisting of covered masonry channels, transports both domestic wastes and stormwater where flow conditions permit; and stoppages and accumulation are common. These channels conducts the sewage to four ponding areas located within the urban zone. The ponds constitute a serious health hazard to the public as well as contributing to acquifer pollution. The proposed project will provide both cities with piped sewerage systems and appropriate wastewater treatment.

**Project Description**

5.05 The project works include:

A. **Ibb - Water Supply:**

(a) drilling and equipment of eight wells (90 lps total capacity);

(b) a collection tank (60 m³) and pumping facilities (3 pumps - 127.5 lps total capacity);

(c) 2 electric power stations (one with 2x300 KW and the other 2x25 KW generators);

(d) a 400 mm transmission line (2.1 km length);

(e) headworks (2 reservoir - 1,500 m³ each, pumps and pressure tanks);

(f) distribution network (12.7 km of 400 mm, and 12.0 km varying in diameter from 80-250 mm);

(g) 3,000 house connections; and

(h) consulting engineering services for final design and supervision (approximately 74 man-months).

B. **Ibb - Sewerage:**

(a) Collection system (60.5 km varying from 200-600 mm diameter and 1,200 manholes);

(b) a treatment plant (aerated lagoons and stabilization ponds with design flow rate of about 90 lps);

(c) land for the treatment plant;

(d) a power plant;
(e) 4,000 house connections; and
(f) consulting engineering services for final design and supervision (approximately 100 man-months).

C. Dhamar - Water Supply:

(a) drilling and equipment of nine wells (102.4 lps total capacity);
(b) a collection tank (150 m^3) and pumping facilities (5 pumps - 237.5 lps total capacity);
(c) two electric power stations, one with 2x300 KW and the other 2x20 KW generators;
(d) a 400 mm transmission line (16.5 km length);
(e) headworks (2 reservoirs - 3,400 m^3 each and pumping station - 216 lps);
(f) distribution network (11.5 km of 400 mm and 11.2 km varying in diameter from 80-200 mm);
(g) 3,000 house connections; and
(h) consulting engineering services for final design and supervision (approximately 96 man-months).

D. Dhamar - Sewerage:

(a) Collection system (64.3 km varying from 200-600 mm diameter and 1,300 manholes);
(b) a treatment plant (aerated lagoons and stabilization ponds with design flow rate of about 90 lps);
(c) land for the treatment plant;
(d) a power plant;
(e) 4,000 house connections; and
(f) consulting engineering services for final design and supervision (approximately 100 man-months).

E. Assistance in the Institutional Development of NWSA:

(a) construction of two office buildings (Ibb and Dhamar);
(b) 430 man-months of on-line assistance providing operational, technical and financial staff for several branches of NWSA; and

(c) training of staff from NWSA.

Cost Estimates

5.06 The total estimated cost of the project is YRls. 413.72 million (US$91.94 million) with a foreign exchange cost of YRls. 250.43 million (US$55.65 million) equal to 60% of the total cost. A summary of the cost estimates is as follows:

<table>
<thead>
<tr>
<th>Local (US$ Million)</th>
<th>Foreign (US$ Million)</th>
<th>Total (US$ Million)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibb-Water</td>
<td>2.26</td>
<td>7.10</td>
<td>9.36</td>
</tr>
<tr>
<td>Dhamar-Water</td>
<td>2.62</td>
<td>9.89</td>
<td>12.51</td>
</tr>
<tr>
<td>Ibb-Sewerage</td>
<td>3.61</td>
<td>8.72</td>
<td>12.33</td>
</tr>
<tr>
<td>Dhamar-Sewerage</td>
<td>3.80</td>
<td>9.14</td>
<td>12.94</td>
</tr>
<tr>
<td>Land and Administration, Buildings</td>
<td>0.34</td>
<td>1.07</td>
<td>1.41</td>
</tr>
<tr>
<td>Technical Assistance and Training</td>
<td>2.56</td>
<td>0.09</td>
<td>2.65</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>15.19</td>
<td>36.01</td>
<td>51.20</td>
</tr>
<tr>
<td>Engineering</td>
<td>0.75</td>
<td>2.10</td>
<td>2.85</td>
</tr>
<tr>
<td>Construction Supervision</td>
<td>0.71</td>
<td>2.01</td>
<td>2.72</td>
</tr>
<tr>
<td>Physical Contingencies</td>
<td>1.86</td>
<td>5.24</td>
<td>7.10</td>
</tr>
<tr>
<td>Price Escalation</td>
<td>17.77</td>
<td>10.30</td>
<td>28.07</td>
</tr>
<tr>
<td>Total</td>
<td>36.28</td>
<td>55.66</td>
<td>91.94</td>
</tr>
</tbody>
</table>

The cost estimates are based on actual construction prices prevailing in existing large scale water supply and sewerage projects in Yemen, as of October 1978. Average monthly cost of expatriate consulting engineering services is estimated at about US$9,600. An exchange rate of US$ 1.00 = YRls. 4.50 has been used in the estimates and is expected to continue throughout the construction period in spite of the high local inflation rate. Detailed cost estimates are shown in Annex 7. Physical contingencies of 15% were added to the base costs. Price contingencies of 50% of the base cost plus physical contingencies were also provided for in the project cost estimates. Construction supervision is estimated at 5% of base construction costs. To provide for price escalation during the project execution, foreign expenditures were escalated at an annual rate of 6-1/2% for 1979, and 6% thereafter for equipment; 7-1/2% for 1979, and 7% thereafter for civil works; and local expenditures were escalated at 30% for 1979, 25% for 1980 and 1981, and 20% thereafter.1/

1/ "EMENA Historical and Projected Rates of Inflation" dated January 1, 1979 shows lower overall rates but states: "Figures for construction and housing likely to be significantly higher."
5.07 NWSA proposes to finance the YRls. 414.0 million (US$92.0 million) required for the project as follows:

<table>
<thead>
<tr>
<th></th>
<th>YRls (Millions)</th>
<th>US$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDA Credit</td>
<td>54</td>
<td>12</td>
<td>13</td>
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<tr>
<td>Co-financing</td>
<td>198</td>
<td>44</td>
<td>48</td>
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<tr>
<td>Total Borrowing</td>
<td>252</td>
<td>56</td>
<td>61</td>
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<tr>
<td>Government Equity</td>
<td>162</td>
<td>36</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>414</td>
<td>92</td>
<td>100</td>
</tr>
</tbody>
</table>

5.08 The Government funds represent the local currency costs of the project. Agreement has been reached that Government will provide such funds to NWSA as needed, and also any funds required to meet local and foreign cost overruns.

5.09 In order to secure co-financing of the foreign exchange costs of the project, the Government has approached several international and bilateral lending agencies and has already obtained reasonably firm financing commitments. KfW has agreed to provide about US$10.0 million equivalent in grants for the Ibb water supply. The Arab Fund and Saudi Fund have indicated that they would be prepared to consider providing about US$10.0 million and US$15.0 million respectively. The Government is continuing to exert efforts to secure financing to cover the remaining gap. Signature of loan agreements with these lenders on terms acceptable to the Association would be a condition of effectiveness of the Credit.

Project Implementation

5.10 The network diagram for project implementation, covering as well the IDA functions as they relate to the construction schedule, is attached as Annex 3. On-line technical and operational assistance would be assigned to field duties in the second semester of 1979. NWSA is in the process of selecting consultants to carry out the final designs and prepare the tender documents, which should be completed in the first half of 1980. The consultant retained will be instructed to prepare combined tender documents for both Ibb and Dhamar to the extent possible, and particularly for procurement of goods, in the interest of economy and efficiency of project administration. Cost savings of between five and ten percent are estimated to be derived from tendering in this manner. Tendering can then take place in the second half of 1980, and construction will be completed by mid-1983. The Credit would be fully disbursed by mid-1984.

5.11 For construction supervision NWSA will be assisted by foreign consulting engineers who will provide in-service training to NWSA’s staff. Under the ongoing Credits for the Sana’a and Hodeida water supply and sewerage projects, as well as the USAID project for Taiz, NWSA engineers and technicians have been gaining experience in construction supervision.
addition, a well qualified expatriate sanitary engineer is currently advising NWSA’s technical staff in his capacity as counterpart to the Deputy General Manager. Most of his activity has been directed towards project development and execution with emphasis on the relationships existing between NWSA, consultants and contractors. The technical assistance to NWSA and training of its staff is covered in paragraphs 3.07 to 3.11. Agreement has been reached with NWSA that consultants acceptable to IDA will be retained, under terms and conditions acceptable to IDA, to assist in project supervision and to continue the process of developing this expertise in the Authority.

Procurement

5.12 All contracts financed by IDA would be procured through international competitive bidding in accordance with Bank Group Guidelines for Procurement. For bid evaluation purposes, a 15% margin of preference or customs duties, whichever is lower, would be allowed for equipment manufactured in the Yemen Arab Republic. Contracts for goods of less than YRs 225,000 (US$50,000), aggregating to not more than YRs 1,350,000 (US$300,000) would be awarded on the basis of competitive bidding advertised locally and in accordance with local procedures acceptable to IDA. Items financed by other external lenders including civil works would be procured in accordance with their own guidelines.

5.13 Except for water pipes and sewers of less than 10 inches diameter, foreign suppliers are expected to win all the contracts for supply of equipment and materials. Foreign contractors are also expected to win the civil works contracts for construction of the water supply and sewer systems.

Disbursements

5.14 The proposed IDA Credit of US$ 12.0 million would be disbursed against the cost of the project elements as follows.

(a) Equipment and Materials
(US$ 7.10 million) - 100% of foreign exchange expenditures, 100% of local expenditures (ex-factory), 85% of local expenditures for locally procured goods, related to the cost of pipes for water supplies and electrical/mechanical equipment for sewage treatment plants.

(b) Consultants Services
(US$ 2.01 million) - 100% of the cost of consultants for supervision of construction.

(c) Technical Services
(US$ 0.91 million) - 100% of the foreign exchange for expatriate operational assistance to NWSA.
(d) Training
(US$ 0.16 million)  -  100% of the foreign exchange of training cost of NWSA personnel.

(e) Unallocated
(US$ 1.82 million)

Estimated disbursements of the IDA Credit are shown in Annex 5.

Monitoring Criteria

5.15 Annex 6 shows the key indicators which would be monitored during project execution to measure the achievement of the technical, financial and administrative goals set for overall NWSA operations as well as the proposed project. Agreement has been reached that NWSA will report the evolution of these indicators to IDA on a quarterly basis during project implementation (except for those items which are meaningful only on an annual basis) and on an annual basis for five years following project completion, and that it will carry out any remedial actions suggested by the Association.
CHAPTER VI

FINANCIAL ANALYSIS

Past Results and Present Financial Position

6.01 Through FY 1977, NWSA's operations were confined to Sana'a and earned a modest surplus. During FY 1978, the Taiz and Hodeida systems were acquired by means of equity funds subscribed by Government, and the Authority's net worth increased from YRls 45.7 million to YRls 111.2 million. Provisional consolidated results for FY 1978 show a continuing small surplus. At June 1978, current liabilities slightly exceeded current assets but this situation is temporary and is not considered to give cause for alarm.

Tariffs and Revenues

6.02 At present, NWSA's revenues derive entirely from water supply operations and are based on a fixed monthly charge per connection (para 3.12). This varies from city to city; currently the average is equivalent to YRls 1.86/m3 of consumption (US$1.56/1,000 galls). Tariff studies already underway in Taiz, Sana'a and Hodeida have indicated that differences between the cost of service in different centers are not significant, and it is intended to introduce a uniform system of charging in all centers. This system will be based on consumption as recorded by meters which are now being installed in Sana'a and which will be introduced gradually in other centers. An objective of the tariff studies will be to develop a progressive block rate structure which will ensure a basic supply at low cost to poor consumers while discouraging excessive use through high charges.

6.03 Agreement has been reached that the tariff studies will be completed and consolidated by December 31, 1981, with the intention that the results should be discussed, agreed and implemented by December 31, 1982. This timetable is considered to be realistic in the context of YAR. By 1983, the metering program should be reaching completion in all centers and sewerage facilities should be in service in Sana'a, Taiz and Hodeida. It follows from this timetable that NWSA's charges will be based:

(a) through 1981, on local fixed fees for water supply;
(b) during 1982, on local fixed fees for water supply plus a fixed supplement for sewered consumers;
(c) from 1983, on a national scale of commodity rates for water according to metered consumption, with a supplementary rate for sewer use where appropriate, but fixed charges may continue to apply where metering has not been completed.

6.04 The economic analysis (para 7.02) suggests that national average long-run incremental costs (LRIC) are YRls 3.03/m3 for water supply and YRls
3.48/m³ for sewerage in 1978 prices. By comparison with the present level of charge (equivalent to YRls 1.86/m³ for water only) there is clearly a need for substantial increases in real terms before economically efficient levels can be reached. Further, with cost inflation forecast at 15% a year through 1982, it will be necessary for NWSA to keep its charges under frequent review to safeguard its financial viability. The financial projections (Annex 4) assume an increase in the effective charge for water on the order of 25% annually until it reaches the level of LRIC in 1985, but that sewer charges will be introduced at the level of LRIC in 1982 when new facilities come into operation. In practice, the timing of the discrete adjustments necessary to achieve these purposes may vary. The affordability of such charges can be established in average terms with reasonable confidence (para 7.06), but at this stage it is difficult to assess the impact on individual consumers, whose bills will be affected also by the changeover to metered charging and by the introduction of a uniform rate schedule. These aspects are being addressed in the tariff study and will be taken into account in the construction of the rate schedule.

Financing Plan

6.05 Government subscribed the initial capital to establish NWSA and to enable it to commence operations in Sana'a; further capital subscription financed the acquisition of the Taiz and Hodeida systems. Equity will increase still further as a result of Government's undertakings under previous Credits to subscribe in the form of equity:

(a) 100% of local project costs;
(b) 44% of foreign exchange costs;
(c) cost overruns, now expected to amount to about YRls 186 million.

These arrangements have provided NWSA with a substantial equity base and a debt:equity ratio which will continue low throughout the period of project construction. The Authority is now in a position to accept harder terms for its future finance, and accordingly the Government intends that 100% of the Credit and the other foreign loans for the proposed project should be on-lent to NWSA. Current interest rates in YAR range from 6-8%. The proposed Credit will be on-lent at 8% for a term of 20 years including 5 years of grace; the execution by Government of a subsidiary loan agreement to this effect would be a condition of effectiveness of the proposed Credit.

6.06 On this basis, NWSA's total financing plan for the period of project construction would appear as follows:
**APPLICATION OF FUNDS**

<table>
<thead>
<tr>
<th>Location</th>
<th>Project</th>
<th>YRls. Million</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sana'a</td>
<td>Water Supply I</td>
<td>35.91</td>
<td>2</td>
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<tr>
<td></td>
<td>Water Supply II</td>
<td>210.53</td>
<td>13</td>
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<tr>
<td></td>
<td>Sewerage</td>
<td>200.08</td>
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<tr>
<td>Hodeida</td>
<td>Water Supply</td>
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<td></td>
<td>Sewerage</td>
<td>222.19</td>
<td>13</td>
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<td>Taiz</td>
<td>Water Supply</td>
<td>179.11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Sewerage</td>
<td>205.91</td>
<td>12</td>
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<tr>
<td>Ibb</td>
<td>Water Supply</td>
<td>73.29</td>
<td>4</td>
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<tr>
<td></td>
<td>Sewerage</td>
<td>103.29</td>
<td>6</td>
</tr>
<tr>
<td>Dhamar</td>
<td>Water Supply</td>
<td>94.71</td>
<td>6</td>
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<tr>
<td></td>
<td>Sewerage</td>
<td>107.37</td>
<td>6</td>
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<tr>
<td>Head Office - Deferred Expenditure</td>
<td>6.36</td>
<td>-</td>
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</tr>
<tr>
<td>Interest During Construction</td>
<td>58.50</td>
<td>4</td>
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</tr>
<tr>
<td>Increase in Working Capital</td>
<td>97.58</td>
<td>6</td>
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<tr>
<td><strong>TOTAL APPLICATION OF FUNDS</strong></td>
<td><strong>1,685.03</strong></td>
<td><strong>100</strong></td>
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</table>

**SOURCES OF FUNDS**

<table>
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<tr>
<th>Source</th>
<th>YRls. Million</th>
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<tr>
<td>Internal Cash General</td>
<td>181.64</td>
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<tr>
<td><strong>Less:</strong></td>
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<tr>
<td>Debt Service</td>
<td>138.51</td>
</tr>
<tr>
<td>Capitalised Interest</td>
<td>58.50</td>
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<tr>
<td><strong>Net Cash Generation</strong></td>
<td>101.63</td>
</tr>
<tr>
<td><strong>Borrowing from Government</strong></td>
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<tr>
<td>Existing IDA Credits</td>
<td>40.62</td>
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<tr>
<td>Existing Foreign Loans</td>
<td>173.74</td>
</tr>
<tr>
<td>Proposed IDA Credit</td>
<td>54.00</td>
</tr>
<tr>
<td>Other Foreign Loans</td>
<td>198.00</td>
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<td><strong>Government Equity</strong></td>
<td>1,057.40</td>
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<tr>
<td><strong>Consumers Contribution</strong></td>
<td>59.64</td>
</tr>
<tr>
<td><strong>TOTAL SOURCES OF FUNDS</strong></td>
<td><strong>1,685.03</strong></td>
</tr>
</tbody>
</table>

1/ Excludes YRls. 11.0 million which will be spent in 1984 and 1985.
2/ The cost of expatriate personnel.
Future Financial Performance

6.07 Tariff arrangements such as are described in paras 6.02-6.04 will be adequate to cover NWSA's operating costs and financing charges through 1985. Previous Credit Agreements call for NWSA to achieve a positive rate of return on average net fixed assets in operation properly valued by FY 1978, of 5% by 1984, and 7.5% by 1987 and this will be repeated in the proposed Credit. The financial projections (Annex 4) show that these targets can be met using assets at historical cost as the rate base, as is customary in Yemeni financial statements. The value of assets presently in service represents less than 1% of the values to be added during the period of project construction, and the rate base is therefore not significantly affected by inconsistencies of valuation throughout this period. If asset values in the years of project completion and subsequent years (1983-85) were increased by reference to the forecast indices of construction costs, the rate of return would still exceed 5% in 1984.

6.08 The substantial injections of equity capital provided to NWSA under past Credits will leave the Authority with a debt:equity of 25:75 after project completion. Agreement has been reached with NWSA that the tariffs will be reviewed and adjusted annually as necessary to generate revenues which will, as a minimum, cover operating expenses including depreciation and interest charges. This will also ensure that NWSA maintains adequate debt service coverage during the project construction period. Sizeable cash surpluses are forecast to emerge as of 1984 and 1985. However, it is prudent to provide NWSA with a substantial self-financing capability to meet the requirements of its post-1983 program which has not yet been defined or costed. The debt limitation covenants of previous Credits (debt not to exceed that which can be serviced out of internal cash flow with a cover of 1.5x) have been repeated in the proposed Credit.
CHAPTER VII

ECONOMIC AND SOCIAL ANALYSIS

Least Cost Solution

7.01 The proposed project represents an essential step towards further development in the field of water supply and sewerage in YAR. It will provide the cities of Ibb and Dhamar with a safe and reliable supply of water as well as piped sewerage through the year 1990. The system has been designed in accordance with sound engineering principles, utilizing acceptable criteria and reasonable assumptions. For water supply in both Ibb and Dhamar several configurations of mains and laterals as well as locations of reservoirs and pumping stations were reviewed by the mission. The alternative selected represents the most cost-effective as well as technologically appropriate solution to the water supply needs for the cities. With regard to sewerage, the mission examined several alternative treatment processes. At IDA's behest the consultant investigated alternative approaches to wastewater disposal including the possibilities of using latrines (conservancy) and cluster septic tanks. Neither system could be justified since manpower shortages in the first case and extremely high construction costs in the second, precluded implementation of these systems. In the case of cluster septic tanks additional areas of concern included: space limitations, land purchase aspects, maintenance requirements and aquifer contamination. The proposed systems for both water supply and sewerage proved to be the least cost solutions at discount rates of 8%, 10% and 12%.

Average Long-Term Incremental Cost

7.02 The average long-term incremental cost of water supply and sewerage in 1978 prices and at a discount rate of 10%, which is appropriate for YAR, is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Sewerage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWSA (5 cities)</td>
<td>3.03</td>
<td>3.48</td>
<td>6.51</td>
</tr>
<tr>
<td>Ibb</td>
<td>3.11</td>
<td>3.69</td>
<td>6.80</td>
</tr>
<tr>
<td>Dhamar</td>
<td>3.53</td>
<td>3.51</td>
<td>7.04</td>
</tr>
</tbody>
</table>

The tariff proposed for combined water and sewerage services in the first year when the systems in Ibb and Dhamar are operational (1983) will be about 95% of the average incremental cost of providing these services in Ibb and about 93% in Dhamar and by 1985 the tariffs will equal the average incremental costs. Given the insignificant differences in the calculated long-term incremental costs as well as the inherent imprecisions associated in their calculation, the analysis indicates that the actual difference in cost amongst the cities is minimal and therefore, the argument for a uniform tariff schedule with all its associated simplicity of design and implementation becomes stronger. The
analyses further suggests that while the proposed tariff has been based principally on considerations of the financial needs of NWSA, it is also adequate in terms of the recovery of costs.

7.03 The tariff studies currently being undertaken for the cities of Sana'a, Taiz and Hodeida aim at encouraging appropriate resource allocation by ensuring that large consumers (industry, hotels, etc.) will, through higher rates, pay the full costs of the incremental supplies they demand; and low income consumers will be provided with their basic requirements at a price they can afford.

Economic Analysis

7.04 The proposed progressive tariff will take into account the needs and ability to pay of different classes of consumers, consistent with the financial requirements of NWSA. Although the proposed tariffs will be high, the projected per capita consumption is such that the demands are unlikely to be affected by high tariffs. At the same time income levels in the urban areas of YAR are such that even at the lowest income levels the monthly water and sewerage costs are unlikely to exceed 4% of their monthly income. Variations in actual water demand will not be difficult to accommodate with the flexibility inherent in the production system.

7.05 Government's provision of adequate water and sewerage services contributes to the improvement of the health, social and economic well being of the population being served. It also facilitates economic investment and development, thereby helping create and expand employment opportunities for the general public. Safe water and suitable sewerage systems for a city, furnish some of the amenities of life for which individuals are willing to pay. The value placed on this service is measured by the estimated amount customers will pay in a situation where a progressive rate schedule relative to the quantity of water is applied with the intention of controlling or restricting water consumption. The absence of either a reliable water supply or a suitable water tariff schedule in Ibb and Dhamar and also the unreliability and sparsity of metering precludes the calculation of a rate of return on the basis of present tariffs. However as a surrogate if the future tariffs are used as a measure of willingness to pay, then the incremental financial rates of return for Ibb and Dhamar are 10.3% and 10% respectively.

Risks

7.06 Since its establishment in November 1973 NWSA's management and staff have demonstrated an increasing capability in coping with their rapidly growing responsibilities. In this they have been assisted by experienced expatriate advisors in engineering, finance and construction supervision. The measures recommended to be taken in the course of the execution of this project, such as the technical assistance to NWSA by experienced on-line staff, training for NWSA staff, construction supervision, the proposed review by IDA of NWSA's financial operations and investment program, and monitoring key indicators of progress will further ensure that the risks are no greater
than can normally be expected with usual water supply and sewerage projects. Based upon present knowledge of groundwater resources in the Ibb area, the reliability of the source is apparently such that the demand through 1990 will be met. The risks of not achieving the institutional, technical and financial objectives of the project are moderate.

Environmental Impact

7.07 The Government is pursuing the program of providing the country's major cities with basic infrastructure such as water supply and sewerage. Through implementation of this project the Authority will be supplying safe and adequate quantities of water to practically the entire population of two cities thereby eliminating their dependence on unsafe and insufficient supplies. Similarly, the provision of piped sewage collection systems to the two cities will eliminate the unsanitary conditions which already exist in the cities and which would be further aggravated if additional quantities of water were introduced into the cities without making provision for their adequate disposal. Further, the installation of piped sewage collection systems in Ibb and Dhamar will reduce the use of cesspools and thereby lessen the danger of aquifer contamination.
CHAPTER VIII

AGREEMENTS REACHED AND
RECOMMENDATIONS

8.01 Conditions of effectiveness of the Credit are that financing agreements between the Government and foreign lenders have been signed, and a subsidiary loan agreement between the Government and NWSA has been executed (paras 5.09 and 6.05).

8.02 Agreement having been reached on the issues set forth in Chapters I through VII of this report, the project is suitable for an IDA Credit to the Yemen Arab Republic of US$ 12.0 million.
Estimated Water Sales, Connections and Population Growth in Dhamar
### YEMEN ARAB REPUBLIC
### WATER SUPPLY AND SEWERAGE – IBB AND DHAMAR
#### Project Implementation Schedule

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<td>3</td>
<td>4</td>
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<td>TENDER NO. 3 – CIVIL WORKS – TRANSMISSION &amp; NETWORK</td>
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<tr>
<td>– HOUSE CONNECTIONS</td>
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<tr>
<td><strong>SEWERAGE COMPONENT</strong></td>
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</tr>
<tr>
<td>E = Evaluation &amp; Award</td>
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</tr>
</tbody>
</table>

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This schedule includes phases of project implementation, from association and project activities to specific components such as water supply and sewerage, with timelines spread across the years 1978 to 1984. The diagram illustrates the flow of activities with symbols indicating execution, disbursement, and other project phases.
GENERAL

1. Rates of Inflation

<table>
<thead>
<tr>
<th>Year</th>
<th>Foreign Equipment</th>
<th>Local Contractors Civil Works</th>
<th>Other Local Costs</th>
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<td>1979</td>
<td>6.5</td>
<td>7.5</td>
<td>30.0</td>
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<tr>
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<td>20.0</td>
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<td>6.0</td>
<td>7.0</td>
<td>20.0</td>
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<td>6.0</td>
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<tr>
<td>1985</td>
<td>6.0</td>
<td>7.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

INCOME STATEMENTS

2. The forecasts assume an increase in the average tariff for water of 35% in 1980 and 25% annually thereafter. Sewerage charges are assumed to be introduced at the level of long run incremental cost and maintained at that level by bi-annual adjustments.

3. Other operating revenue consists of a one-time connection charge for both water and sewerage and are related to the number of connections projected to be installed in each year. The charges are assumed to grow by the local inflation rate.

4. Operating costs comprise:

   (a) Personnel costs based on the current staffing levels of the different branches of NWSA and the Head Office as well as discussions between NWSA and the mission as to how the staffing patterns will develop in future years. Staff have been divided into four categories with average costs at 1978 levels. Having determined the number of people required in each category in subsequent years, the costs were escalated annually at the local inflation rate.

   (b) Other operating expenses broken down into fixed and variable costs and escalated in proportion to system expansion. Fixed costs were escalated at a higher rate than variable costs to reflect a higher local element. Fixed cost volume was increased 5% annually for established branches and 10% for those branches which were becoming operational.
5. **Depreciation expense** has been based upon a detailed analysis of all annual depreciation rates and then reclassifying them into two broad headings—water and sewerage—for forecast purposes. Water supply assets were depreciated at 3.25% per annum and those of sewerage at 2.75%.

**Balance Sheet**

6. Fixed assets are shown at cost and without revaluation. Interest costs have been capitalized up to the date of commissioning of each asset.

7. The cost of additional on-line technical assistance included in the project (para 6.04) has been capitalized as "deferred expenses" and written down by 20% annually as from 1983 when the project becomes operational.

8. Stocks have been assumed to grow in proportion to system size as reflected in variable costs with additional provision for meter replacements. Receivables are assumed at 90 days sales in the beginning, gradually decreasing to 75 days plus 20% of connection charges.

9. **Accounts payable** have been assumed at two months variable operating costs.
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### Yemen Arab Republic

**Water Supply and Sewerage for Ibb and Dhamar**

**National Water and Sewerage Authority**

#### Sources and Application of Funds

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**Notes:**

/a - Yemeda (3/31/78) and Taiz (10/31/78) taken over by NGWA and consolidated as from 1978. Operating results assumed by NGWA as from these dates. Existing assets, liabilities, depreciation and other reserves assumed purchased by NGWA in 1978 from Government contributed capital.

/b - Includes $8.0 million advance payments. From 1979 these have been shown since 100% of construction projects are funded by Government equity or loan.

/c - Includes net value of Yemeda assets, liabilities and pre-takeover 1978 profit acquired from the Port Authority (YRis. 3.09 million); and the net Taiz assets less liabilities and pre-takeover 1978 loss acquired by NGWA (YRis. 7.99 million).
### ANNEX 5

**YEMEN ARAB REPUBLIC**

**WATER SUPPLY AND SEWERAGE FOR IBB AND DHAMAR**

**NATIONAL WATER AND SEWERAGE AUTHORITY**

**ESTIMATED SCHEDULE OF DISBURSEMENTS**

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YEMEN ARAB REPUBLIC
WATER SUPPLY AND SEWERAGE FOR IBB AND DHAMAR
NATIONAL WATER AND SEWERAGE AUTHORITY

KEY INDICATORS FOR NWSA OPERATIONS

<table>
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<th>Year</th>
<th>Sana'a: Water produced (1,000 m$^3$/year)</th>
<th>Sana'a: Water sold (1,000 m$^3$/year)</th>
<th>Sana'a: Unaccounted-for water (%)</th>
<th>Sana'a: Volume of sewage treated</th>
<th>Sana'a: Number of water connections</th>
<th>Sana'a: Number of sewerage connections</th>
<th>Sana'a: Number of metered connections</th>
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<th>Ibb: Volume of sewage treated</th>
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<th>Dhamar: Volume of sewage treated</th>
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II. Financial Criteria

Rate of Return (NWSA)
Internal Cash Generation (NWSA)
Debt service coverage (NWSA)
Average revenue per m$^3$ sold - Sana'a
Hodeida
Taiz
Ibb
Dhamar
II. Financial Criteria (Continued)

Operating expenses per m$^3$ sold - Sana'a
Hodeida
Taiz
Ibb
Dhamar

Number of permanent employees - Sana'a
Hodeida
Taiz
Ibb
Dhamar

III. Water Quality

(a) Sana'a:
   Total dissolved solids (average)
   Hardness (average)
   Nitrates (average)
   pH (average)

(b) Hodeida:
   (Same as above)

(c) Taiz:
   (Same as above)

(d) Ibb:
   (Same as above)

(e) Dhamar:
   (Same as above)
## ANNEX 7

### YEMEN ARAB REPUBLIC

#### WATER SUPPLY AND SEWERAGE

#### FOR IBB AND DHAMAR

#### COST ESTIMATES

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<td>(US$ '000)</td>
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### Notes
- Local: c.w. - 600, eqmt. - 500
- Foreign: c.w. - 600, eqmt. - 500
YEMEN ARAB REPUBLIC
WATER SUPPLY AND SEWERAGE PROJECT FOR IBB AND DHAMAR
COST ESTIMATES FOR COFINANCING AND CONTRACT IDENTIFICATION

FOREIGN EXCHANGE ASEMBLAGES

<table>
<thead>
<tr>
<th></th>
<th>Equipment (US$ '000)</th>
<th>Civil Works</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>---------------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>I. POWER PLANTS AND ENGINEERING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power Plants</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ibb Water Supply: Well Field</td>
<td>502</td>
<td>57</td>
<td>559</td>
</tr>
<tr>
<td>Head Works</td>
<td>60</td>
<td>14</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>562</td>
<td>71</td>
<td>633</td>
</tr>
<tr>
<td>Dhamar Water Supply: Well Field</td>
<td>553</td>
<td>55</td>
<td>608</td>
</tr>
<tr>
<td>Head Works</td>
<td>34</td>
<td>14</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>587</td>
<td>69</td>
<td>656</td>
</tr>
<tr>
<td>Ibb Sewerage</td>
<td>189</td>
<td>30</td>
<td>219</td>
</tr>
<tr>
<td>Dhamar Sewerage</td>
<td>151</td>
<td>23</td>
<td>174</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,489</td>
<td>193</td>
<td>1,682</td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>2,096</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>3,778</td>
<td></td>
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</tr>
</tbody>
</table>

**II. WELLS**

|                       |                       |             |       |
| Ibb Water Supply: Wells and Connection Lines | 56                  | 1,058       | 1,114 |
| Dhamar Water Supply: Wells and Connection Lines | 274                 | 1,299       | 1,573 |
| **TOTAL**             | 330                  | 2,357       | 2,687 |

**III. CIVIL WORKS - WATER**

|                       |                       |             |       |
| Ibb Water Supply      |                       |             |       |
| Collection and pumping facilities | 301                | 246         | 547   |
| Transmission line     | -                    | 251         | 251   |
| Head Works            | 232                  | 341         | 573   |
| Distribution System   | -                    | 3,148       | 3,148 |
| House Connections     | -                    | 1,031       | 1,031 |
| **Total**             | 533                  | 5,017       | 5,550 |
| Dhamar Water Supply   |                       |             |       |
| Collection and pumping facilities | 426                | 373         | 799   |
| Transmission line     | -                    | 1,871       | 1,871 |
| Head Works            | 10                   | 917         | 927   |
| Distribution System   | -                    | 3,277       | 3,277 |
| House Connections     | -                    | 993         | 993   |
| **Total**             | 436                  | 7,431       | 7,867 |
| **TOTAL**             | 969                  | 12,448      | 13,417 |
### IV. CIVIL WORKS - SEWERAGE

#### Ibb Sewerage

<table>
<thead>
<tr>
<th></th>
<th>Equipment</th>
<th>Civil Works</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection System</td>
<td>2,583</td>
<td>5,244</td>
<td>7,827</td>
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<tr>
<td>Pump Station</td>
<td>90</td>
<td>26</td>
<td>116</td>
</tr>
<tr>
<td>Treatment Plant</td>
<td>-</td>
<td>1,583</td>
<td>1,583</td>
</tr>
<tr>
<td>House Connections</td>
<td>679</td>
<td>1,379</td>
<td>2,058</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>3,352</strong></td>
<td><strong>8,232</strong></td>
<td><strong>11,584</strong></td>
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</table>

#### Dhamar Sewerage

<table>
<thead>
<tr>
<th></th>
<th>Equipment</th>
<th>Civil Works</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection System</td>
<td>2,719</td>
<td>5,521</td>
<td>8,240</td>
</tr>
<tr>
<td>Treatment Plant</td>
<td>-</td>
<td>1,698</td>
<td>1,698</td>
</tr>
<tr>
<td>House Connections</td>
<td>700</td>
<td>1,420</td>
<td>2,120</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>3,419</strong></td>
<td><strong>8,639</strong></td>
<td><strong>12,058</strong></td>
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</tbody>
</table>

**TOTAL**

<table>
<thead>
<tr>
<th></th>
<th>Equipment</th>
<th>Civil Works</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>6,771</strong></td>
<td><strong>16,871</strong></td>
<td><strong>23,642</strong></td>
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### PROPOSED IDA COMMITMENT

<table>
<thead>
<tr>
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<th>US$ ('000)</th>
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<tbody>
<tr>
<td>Water Supply Pipes and Equipment</td>
<td>7,100</td>
</tr>
<tr>
<td>Construction Supervision</td>
<td>2,010</td>
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<tr>
<td>Technical Assistance</td>
<td>910</td>
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<tr>
<td>Training</td>
<td>160</td>
</tr>
<tr>
<td>Unallocated</td>
<td>1,820</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>12,000</strong></td>
</tr>
</tbody>
</table>
YEMEN ARAB REPUBLIC

WATER SUPPLY AND SEWERAGE PROJECT FOR IBB AND DHAMAR

Additional Information in Project File


B1 Population Estimates

B2 Land Use Master Plan

B3 Estimates of Demand

      Town of Ibb : Volumes I through IV
      Town of Dhamar : Volumes I through IV


B6 UNDP Project Document: Rural Water Supply, Phase II.


C1 Existing Water Supply and Wastewater Disposal Services in Ibb and Dhamar.

C2 Basis for Staff Estimates of Population and Water Demand.

C3 Technological Alternatives for Piped Sewerage.

C4 Basis for Cost Estimates.
C5 Tariff Studies for Sana'a, Hodeida and Taiz.

C6 Water Supply Statistics, Ibb and Dhamar.

C7 Calculation of Least Cost Solution.

C8 Incremental cost of water and sewerage and Rate of Return Calculations.

C9 Analysis of Ability to Pay.

C10 Income and Expenditure Statements.
YEMEN ARAB REPUBLIC
WATER SUPPLY AND SEWERAGE

IBB

PROJECT FEATURES:
- Intercepting Sewers
- Trunk Sewers
- Pumping Stations
- Water Mains

OTHER FEATURES:
- Built-up Areas (1978)
- City Limits in 1990
- International Boundaries
- Contours (Elevations in Meters)

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YEMEN ARAB REPUBLIC
WATER SUPPLY AND SEWERAGE
DHAMAR

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