- PD-AAW-197

JESS INTERIM REPORT ON HEALTH CONSEQUENCES OF DESIGN CRITERIA FOR WATER SUPPLY AND SANITATION IN NEW AND RESETTLED COMMUNITIES

JESS Report No. 6

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Under AID contract number AFR-0134-C-00-5047-00.

Date: 12 November 1986

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PREFACE

The Jubba Environmental and Socioeconomic Studies (JESS) (number 649-0134) are jointly funded by the government of the Somali Democratic Republic (GSDR) and the U.S. Agency for International Development (USAID). JESS is part of a larger project funded by USAID and the GSDR, the Jubba Development Analytical Studies (JuDAS) project. Technical assistance and JESS management are being provided to the Ministry of Jubba Valley Development (MJVD) by Associates in Rural Development, Inc. (ARD) of Burlington, Vermont, under AID contract number AFR-0134-C-00-5047-00. This interim report is one of many to be produced during Phase II of JESS, a two-year period of intensive project field studies. This interim report concerns analyses made in the early part of Phase II, during a consultancy for ARD by Dr. William R. Jobin of Blue Nile Associates. The report was developed after a June 1986 consulting visit concerning water quality and public health engineering aspects of the proposed Baardheere Dam on the Jubba River in southwestern Somalia.

I. EXECUTIVE SUMMARY

Creation of new communities and resettlement of existing ones because of development of the proposed Baardheere Dam project on the Jubba River in Somalia will inevitably cause severe health problems if proper water supply, sanitation and health facilities are not provided in these communities. Experience in central Sudan and other countries has shown that the death rates in children due to diarrheal diseases are inversely proportional to the rate of safe drinking water provided by community supplies in rural areas similar to the Jubba Valley. The same studies showed that the prevalence of bilharzia in agricultural communities also increased with decreased supplies of safe water. Conversely, the cost of construction, operation and maintenance of safe community supplies increased with the need for greater capacity because of new communities and resettlement. Providing the increased capacity will require considerable expenditures if community health is to be protected.

By combining information from studies in the Sudan during 1982 with the Decade Plan for Water Supply and Sanitation in Somalia, published in 1983, it was estimated that about $12* per person (including construction, operations and maintenance costs, and loan interest) would be expended annually over 50 years for community water supplies in the new and resettled communities along the Jubba River. This amount would provide 65 liters per person daily, sufficient to lower bilharzia prevalence to the minimum possible, and to reduce the annual death rate in infants to half its present value, which is about 170 deaths per 1,000 live births. Lower expenditures for community water supply will result in higher prevalence of disease and in higher death rates.

Since these new settlements will result directly from construction of the dam and subsequent developments, it is recommended that the initial construction costs for community water supplies and sanitation, as well as other health and community needs, be included in the funding for the dam. At least $58 per person for water supply and $5.80 per person for sanitation should be provided as funds for initial construction in new or resettled communities.

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*Costs are given in 1986 U.S. dollars unless otherwise indicated.

II. INTRODUCTION

A. Basic Concepts Related to Water Supply and Health

Construction of the proposed Baardheere Dam on the Jubba River in Somalia, as well as the subsequent flood plain and irrigation development that will occur downstream, will lead to resettlement of existing communities and creation of many new ones, with significant environmental health problems. Experience with other dam projects in Africa has shown that considerable effort should be made to provide basic water and sanitation requirements and thus minimize disease and death among the resettled and new populations. Experience with the Gezira-Managil Scheme of central Sudan, in addition to other experience documented in the literature, was used as an information base for this report.

The amount of safe drinking water available per person in a community has a direct influence on the prevalence of water-associated diseases in that community, including the dramatic epidemics of cholera, hepatitis and typhoid fever, as well as the more persistent endemic diseases such as bilharzia (also known as schistosomiasis), intestinal parasites and a variety of bacterial and viral infections.

The amount of safe drinking water available depends on the capacity of the water supply system, and the operation and maintenance practices of the community using it. Thus, design standards for water supply systems can be expected to have direct impacts on disease prevalence and death rates in the community.

B. Purpose and Organization of This Report

The main objective of this and other interim JESS reports is, to the extent possible, to meet the need for timely information for dam planning as MJVD, World Bank and other organizations begin to consider budgets for construction and operation of the dam, as well as associated Jubba Valley development activities. It is the purpose of this report to outline the magnitude of the required effort, especially related to community water supplies and sanitation--the major elements for protecting community health in the Jubba Valley.

This report outlines the available range of water system and sanitation cost parameters for proposed settlements and resettlements in the Jubba River Valley of Somalia in relation to Baardheere Dam, and to estimate the consequent disease prevalence and death rates that can be expected from various design standards based on different cost levels. This information thus gives GSDR decision-makers a clear choice regarding the

expenditures to be budgeted for settlements in the proposed development of the valley. Additional interim reports during Phase II and final reports during Phase III of JESS will provide more detailed information for project planning purposes in relation to health.

Relevant experience from other regions is provided first in this report. Subsequent sections use that experience to address the Jubba Valley situation specifically. Section III presents experience from the Gezira-Managil Scheme in central Sudan and from the island of St. Lucia in the eastern Caribbean. Section IV provides predictions regarding disease prevalence and water supply and sanitation for dam planning purposes.

III. EXPERIENCE IN CENTRAL SUDAN AND CARIBBEAN BASIN

A. Gezira-Managil Scheme

Because of many similarities between central Sudan and the Jubba River Valley, and the availability of extensive, recent data from a water supply project in the Gezira-Managil Irrigation Scheme of central Sudan, experience from that area is presented here to indicate what may be expected in communities planned for the Jubba River Valley (Blue Nile Health Project, 1981-1985).

The purpose of the study in the Sudan was to evaluate the impact of improvements in domestic water supplies as one component of a comprehensive strategy to control diarrheal disease and bilharzia (Tameim et al., 1986). The improvements consisted of increasing the available supply of safe water by using local design and construction techniques and improving operation and maintenance procedures.

Prevalence surveys for diarrheal disease in children aged zero to four years were conducted in July 1981 in three study villages by interviewing mothers to determine disease incidence in the previous two weeks and deaths during the previous year. Bilharzia prevalence was determined from microscopic examination of fecal and urine specimens using the modified Kato method for stools and centrifugation for urine.

In each of the villages, daily recording forms were provided to the water supply operator for information on consumption of water and cost of operation. The forms were collected monthly for one year. Construction and maintenance costs were obtained from the regional water supply agency that had technical responsibility for the systems. Plans for improvements were made in cooperation with the agency's engineering and field personnel and with previously established health committees in each of the villages. Improvements were carried out from the latter half of 1982 through 1985 by construction and maintenance personnel of the water agency under the supervision of Blue Nile Health Project staff, who kept monthly records of all costs, including training, salary supplements, travel, labor and materials.

Analysis of the sample from a January 1981 census in a study zone surrounding the three villages indicated a total population in the study zone of 57,000 people, with a prevalence of *Schistosoma mansoni* infections varying from 13 percent in villages outside the irrigated area, to 49 percent in the three study villages, averaging around 44 percent.

The diarrheal disease survey among children aged zero to four years indicated a prevalence during the preceding two weeks of 53 percent in all three villages, with the highest prevalence

in the smaller, poorly sanitated village of Gad Al Ain-Awlad Yusif (Table 1). There were 31 deaths reported for these children during the 12 months prior to the survey, of which 19 were due to diarrheal disease. Thus, the diarrheal disease mortality rate was 49 per 1,000 (Table 2). This indicated that diarrheal disease caused over half of the infant mortality in the study zone, or approximately 335 deaths per year in the population of 57,000.

Table 1.

Prevalence of Diarrhea among Children Zero to Four Years Old During Two Weeks Previous to Survey in Three Villages, July 1981

Village	Infants	Cases of Diarrhea
Gad Al Ain-Awlad Yusif	98	66
Dolga	93	46
Tayiba Sheikh El Gurashi	199	93
Total	390	205 (53%)

Table 2.

Deaths among Children Zero to Four Years Old in Three Villages for Year Prior to July 1981

Age in Months	Number of Deaths	Deaths due to Diarrhea
0-11	16	8
12-23	9	9
24-35	1	1
36-48	5	1
Total	31	19
Total population of children		390
Annual diarrhea-associated mortality rate		0.049

Water supply systems in the villages consisted primarily of deep borewells with diesel or electrically powered pumps and with 45 cubic meters of elevated storage in the larger villages. In the villages that produced reliable records, the capacity of the systems was about 100 liters per capita per day, the original design capacity of the standard systems. However, these systems were operating only about 72 percent of the time due to electrical power outages, fuel shortages and maintenance

problems. In addition, many of the smaller villages and labor camps had to obtain all of their water from the highly contaminated canals.

A composite summary for the entire study zone, including the unserved camps and small villages and the effect of supply interruptions in the larger villages, indicated that the overall consumption of safe water was only 40 liters per capita per day, considering the entire year and population.

When the data from the diarrheal disease surveys and the mean safe water consumption were evaluated for the three villages studied, there was a direct inverse relation between consumption and disease prevalence (Table 1 and Figure 1). Although only three points were available to establish the line, their high correlation coefficient (0.9) indicated a likely, and quite logical, relationship. Also, the death rate due to diarrheal disease was very high, about 49 per 1,000 children (Table 2).

The indication of an impact of safe water consumption on disease prevalence was further strengthened by analysis of the data for six villages with water supplies, and for three unserved labor camps for which there were data on prevalence of bilharzia. The analysis indicated that increased consumption correlated inversely with bilharzia prevalence up to a consumption of about 70 liters per capita per day (Figure 2). Additional consumption above that amount did not appear to correlate with decreased disease for these villages.

By analyzing data from the small villages in the study zone without community supplies, an additional insight was gained on bilharzia transmission. Prevalence of bilharzia decreased directly with the distance of these small villages from the nearest canals, measured on a scale map of the study area. Those villages one kilometer from the canal had half the prevalence of the villages along the canals, and those villages at a distance of two kilometers had virtually no bilharzia.

B. Caribbean Basin

The close relation between water consumption rate and bilharzia prevalence was confirmed in a comparable study on the impact on bilharzia from improved water supply in a community in St. Lucia, an island in the eastern Caribbean Sea where *S. mansoni* infections were endemic (Jordan et al., 1978). Prior to provision of safe water to the village of Riche Fond, the prevalence of bilharzia was 56 percent. A system providing 65 liters per capita per day was constructed, resulting in a drop in prevalence to 38 percent after five years. This coincides quite closely with the data from the Sudan and gives some evidence of its general applicability (Figure 2).

Figure 1

RELATION OF PREVALENCE OF DIARRHEAL DISEASES AND SAFE WATER CONSUMPTION FOR INTENSIVE STUDY VILLAGES, 1981

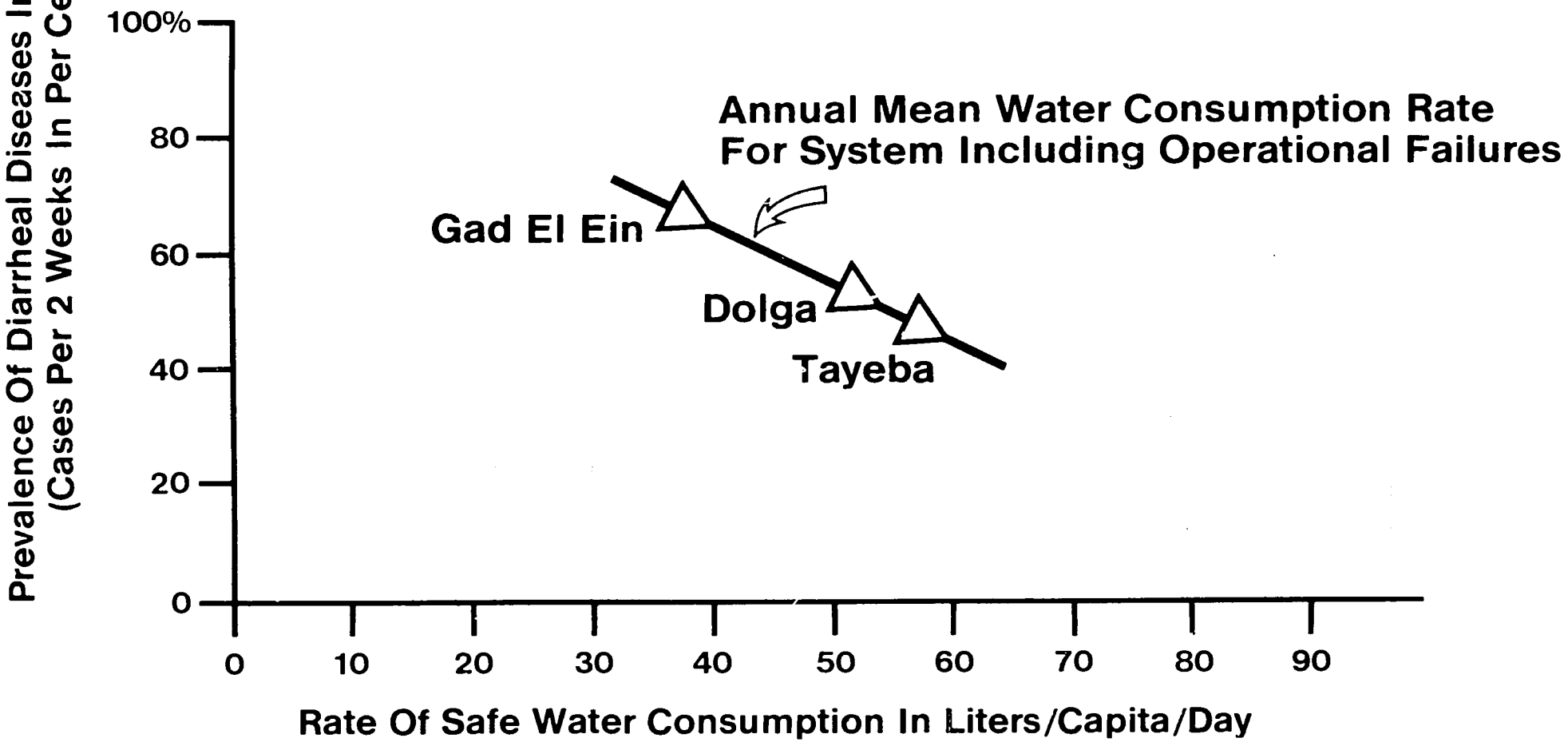
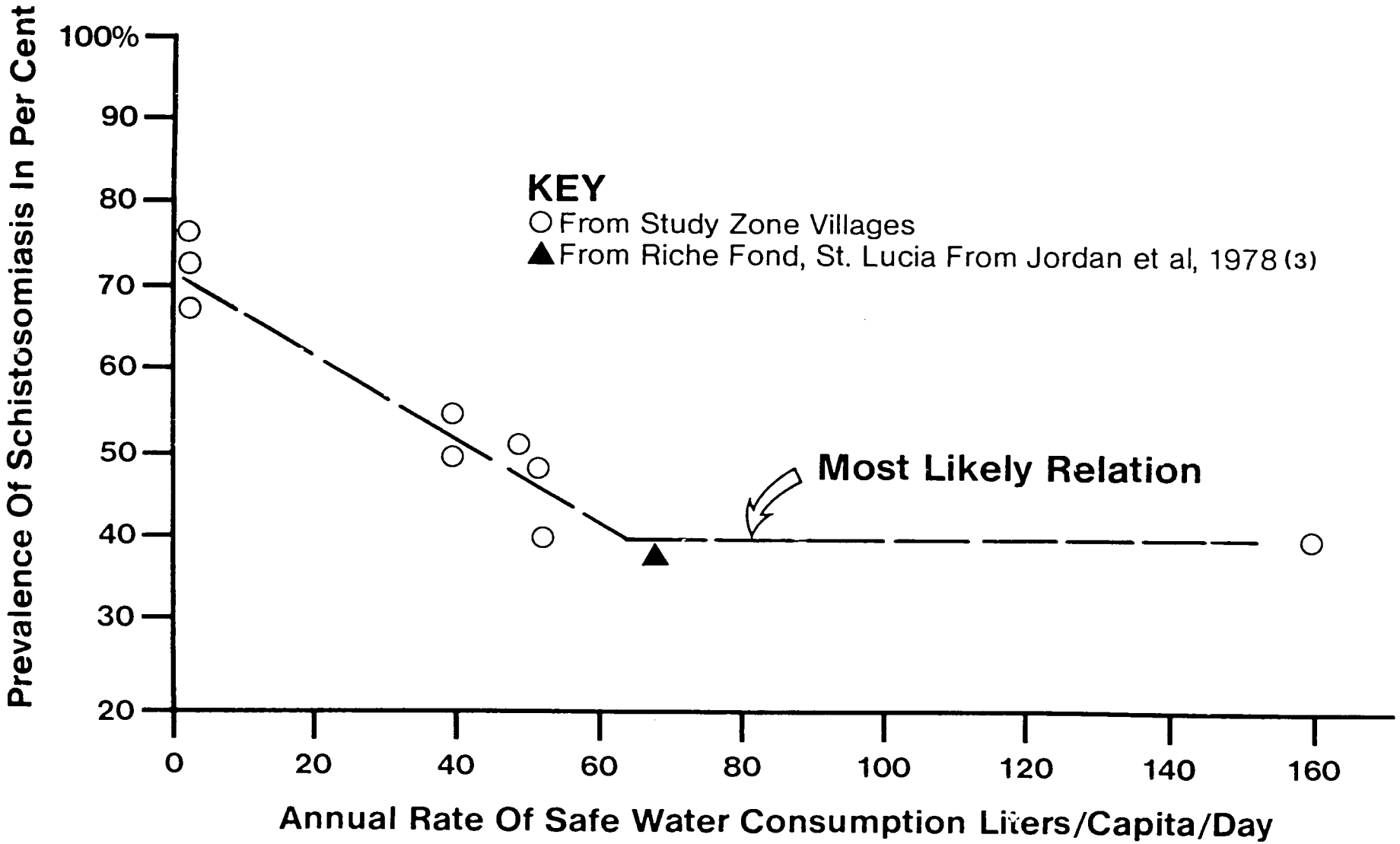


Figure 2

PREVALENCE OF SCHISTOSOMA MANSONI IN CORE VILLAGES OF THE STUDY ZONE VERSUS THEIR ANNUAL MEAN EXPERIENCE OF SAFE WATER CONSUMPTION IN 1981–1982



IV. EXPECTED DISEASE RATES AND IMPLICATIONS FOR PROJECT PLANNING

The Decade Plan for Water Supply and Sanitation, adopted by Somalia in 1983 (MOH and WHO, 1983), indicated that the present consumption of safe water in rural Somalia was 10 liters per capita per day (Table 3). This corresponded to a crude annual death rate from all causes, for infants less than one year old, equal to 170 deaths per 1,000 live births. In more graphic terms, this low rate of consumption meant that, in a village of 10,000 people, 66 children under five years old would die each year from diarrheal disease (Table 3).

Table 3.

Estimated Amounts of Water-Associated Diseases to Be Expected for Various Expenditures on Community Water Supply in Typical New Settlement of 10,000 People in Jubba River Valley

Water Supply System Design Capacity[2]	Annual Deaths of Children <5 Yrs Old Due to Diarrhea	People with Bilharzia	Required Per Capita Expenditures for Community Water Supply Systems[1]		
			Annual Total Sudan	Construction in Somalia	Annual Operations Somalia
10[3]	66	6,500			
25[4]	56	5,750		$2.00	$0.06
40[5]	47	5,200	$4.10		
50	41	4,800			
65[6]	32	4,000	$6.10	$58.00	$4.60
130[7]	10	4,000	$8.00	$116.00	$9.30

[1]Originally in 1982 or 1983 U.S. dollars, then adjusted with 5% annual inflation rate to 1986.
[2]Liters per capita per day as annual operational average.
[3]Present rate of rural consumption in Somalia.
[4]Goal of Decade Plan for rural Somalia by 1990.
[5]Present rate of urban consumption in Somalia.
[6]Suggested goal for Jubba Valley.
[7]Goal of Decade Plan for urban Somalia by 1990.

Sources: Decade Plan for Water Supply and Sanitation in Somalia (MOH and WHO); Blue Nile Health Project in Sudan.

It is also projected that about 6,500 people would be infected with bilharzia if the village were near permanent bodies of fresh water. It is thus important to include funding for adequate community water supply systems and, to a lesser extent, sanitation, in order to avoid this severe health burden on the new communities.

Based on these existing conditions in the Jubba River Valley and the extensive experience in central Sudan, it is expected that a high prevalence of diseases and many deaths will occur in new settlements in the Jubba Valley, depending on the expenditures for community water supply and sanitation provided for development of the valley.

The Decade Plan for Water Supply and Sanitation in Somalia, which was adopted in 1983, included a proposed increase in the daily water capacity per person in rural areas from 10 liters to 25 liters, and in urban areas from 40 liters to 130 liters.* Investments that accomplish these goals would result in significant decreases in death rates and prevalence of bilharzia for urban areas. The improvement in rural areas would be slight, however, due to the relatively small increases proposed in the Decade Plan for the capacity of the systems (Table 3).

In the interest of improving health conditions for the existing and proposed residents of the Jubba Valley, and as a means of ensuring attractiveness of the new settlements for the people needed in development of the valley, it is suggested that a higher and more effective goal for water supply be considered for rural communities in the valley. The recommended goal is an operational year-long average of 65 liters per capita per day. It is projected that this capacity for rural systems would decrease the diarrheal deaths of children from 66 to 32 each year in a village of 10,000 people, and the number of people infected with bilharzia would be decreased from 6,500 to 4,000. It would reduce the crude annual death rate of infants from the present high rate of 170 deaths per 1,000 live births to about half of that value. This recommended design capacity of 65 liters per capita per day is the amount which satisfies all the normal domestic requirements in a hot climate. A lower supply rate would require people to seek additional water from nearby surface waters for their daily needs.

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*The rural water systems considered in these calculations included drilled deep wells with public taps, infiltration galleries, centralized rainwater catchment systems, dug wells, and surface water catchments with sand filter systems. The urban systems considered were deep drilled wells and surface water catchments with sand filter systems.

Additional increases in capacity would decrease the diarrheal deaths, but would not decrease the prevalence of bilharzia further (Table 3). In the Sudan, it was found that a residual 40 percent prevalence of bilharzia in the rural communities was due to agricultural activities and other aspects of human contact with surface water which were not affected by an increased supply of water in the home. Further decreases in diarrheal deaths can best be achieved by provision of oral rehydration therapy in local health units, at an annual cost of a few cents per capita. Recent cost information showed that the costs will be high for reducing diarrheal deaths and bilharzia prevalence (Table 3). Thus, it is necessary to make specific provision for funding community water supplies, preferably in the basic loan made for Baardheere Dam.

Experience in the Sudan indicated that the annual per capita cost for construction, operation and maintenance would be above $4 to reach the capacity of 40 liters per capita, and over $6 to reach the recommended capacity of 65 liters per capita (Table 3). Data from the Decade Plan indicated that the costs for rural systems of very small capacity in Somalia might be somewhat lower than the costs derived from the Sudan, but the cost would be higher for achieving the recommended goal of 65 liters. At a design capacity of 65 liters per capita per day, data from the Decade Plan indicated an initial construction cost of $58 per capita and an annual operation and maintenance cost of $4.60 (Table 3). If a system has a 50-year life, the construction cost would be $1.16 per year, plus an opportunity cost of 10 percent, amounting to another $5.80 annually. Combined with the construction cost and the operations cost of $4.63, this would yield a total annual cost per capita of $11.59, almost twice the $6.10 predicted from experience in the Sudan. The higher cost for Somalia may be due to the local difficulty in finding suitable groundwater supplies.

Assuming the water supply costs from Somalia are more relevant, one should thus provide about $12 per capita per annum for the construction, operation and maintenance, depreciation and loan interest payments of new systems with the recommended capacity of 65 liters per capita per day. For example, a community of 10,000 people would require annual expenditures of $120,000. Small villages of 200 to 300 people would need about $3,000 per year. For these small villages, this could also be interpreted as an initial construction cost of $14,500, followed by an annual operating cost of $1,155 (Table 3).

These costs are large for rural communities in Somalia. Careful planning must go into the institutional, social and engineering arrangements required to deliver a reliable supply of safe water to these new communities in the Jubba River Valley. Since these new settlements will result directly from construction of the dam and subsequent developments, it is

recommended that the costs for community water supplies and sanitation be included in the initial funding for the dam. Specifically, it is recommended that the initial construction costs for water and sanitation facilities in areas affected by dam construction be included in construction funds for Baardheere Dam. The recommended figures are $58 per capita for water supply development plus 10 percent ($5.80 per capita) for sanitation facilities. Other future development activities in the Jubba Valley would have to fund the continued operation and maintenance of these facilities. Certainly, financial input from valley residents for operation and maintenance costs should be considered as well.

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