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THE VALUE OF WATER SUPPLY AND SANITATION IN DEVELOPMENT: AN ASSESSMENT OF HEALTH-RELATED INTERVENTIONS

WASH TECHNICAL REPORT NO. 43

SEPTEMBER 1987

Prepared for
the Office of Health,
Bureau for Science and Technology,
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by

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GLOSSARY OF ACRONYMS

IDWSS	International Drinking Water Supply and Sanitation (Decade)
lpcd	liters per capita per day
O&M	Operations and Maintenance
ORT	Oral Rehydration Therapy
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WS&S	Water Supply and Sanitation

EXECUTIVE SUMMARY

Water supply and sanitation have, for more than a century, been perceived as the principal instrument for protecting communities against diarrheal disease. Today, however, oral rehydration therapy (ORT), a new and simple ministration that averts many deaths from diarrhea among children, is diverting attention from the importance of water supply and sanitation (WS&S) in developing nations.

The strong attraction of ORT is its apparent low cost per diarrheal death averted in children when compared with WS&S. In addition, ORT saves the lives of young children at a time when they are most vulnerable and preserves lives until more lasting measures can be taken. Saving young children in crisis is a social responsibility of those who have the resources to help.

WS&S provides many more benefits, however, benefits that are essential to sustaining the lives saved by ORT and vital to maintaining and enhancing the lives of adults and children. WS&S prevents the causes of diarrhea; controls many other water- and sanitation-related diseases; improves the delivery of primary health care; improves nutritional status; services health centers and schools; releases women from the heavy and time-consuming burden of carrying water from distant sources; provides water for household gardens and animals; promotes commercial activity; supports other sectors, such as housing and industry; improves community organizations that can serve other purposes; and, most significantly, improves the quality of life in the community.

Comparisons between WS&S and ORT are misleading because they have different objectives and provide different benefits. WS&S, among other things, is a long-term investment in preventive health, while ORT is a response to an immediate life-threatening situation. WS&S interventions are intended to eliminate unsanitary conditions leading to illness and death; ORT programs, on the other hand, have no effect upon the basic causes of diarrheal morbidity. ORT programs are important, but they do not and should not replace WS&S. If infant mortality rates in the poorer developing countries, more than tenfold higher than in industrialized countries, are to be reduced, programs of WS&S introduced with active community participation and accompanied by hygiene education are absolutely essential. The costs are not high; $5 to $10 per capita annually will provide basic WS&S services. The poor in many villages and periurban areas in Africa, Asia, and Latin America are already paying far more for a poor quality water service. A wide range of interventions for improving child health can be justified, but without WS&S and hygiene education they are not likely to achieve long-term improvement in health or quality of life.

Chapter 1

INTRODUCTION

In aqua sanitas. This belief, "in water is health," led the ancient Romans to invest heavily in public water supply facilities, some of which are still in service. That they perceived water to bestow other benefits is evidenced by the renowned fountains of Rome. The introduction of public water supplies in Western Europe and America resulted in the virtual disappearance of cholera and typhoid before immunizations and other medical measures were introduced. More important, the availability of water supply and sanitation (WS&S) facilities became the hallmark of civilized living. Accordingly, the provision of WS&S facilities in the developing world would seem to need little justification. Yet, WS&S appears to be less emphasized today in comparison with the more dramatic "life-saving" ministrations of oral rehydration therapy (ORT) and mass immunizations.

ORT is the oral administration of a mixture of salt, sugar, and water to sufferers of acute diarrhea. Its appeal stems in large measure from its ease of administration as compared with intravenous rehydration therapy. Because of its low cost, apparent simplicity, and the dramatic response it often elicits, ORT has come to be viewed not only as an efficient way of averting child deaths but as the basis for health programs of many international development agencies.

"UNICEF Says 4 Million Saved by Two Child Health Programs" was the headline over a news dispatch in the Raleigh News & Observer (December 15, 1986), delivered to newspapers throughout the United States by the New York Times News Service. The text, attributed to the United Nations Children's Fund (UNICEF) annual report, goes on to say that "it is 'morally intolerable' that so many children die when treatments costing only pennies per use have proved effective." The two health programs referred to are immunizations and ORT. Entreaties for donations supported by such statements and poignant TV programs have been eminently successful in raising funds for UNICEF and the many voluntary agencies that provide assistance to the poor in developing countries.

The philosophical support for selecting immunizations and ORT as the major thrust for health interventions originated with Drs. Julia Walsh and Kenneth S. Warren of the Rockefeller Foundation (1979) who criticized the concept of primary health care incorporated in the Alma Ata Declaration of 1978 (WHO 1978) as being too comprehensive in scope to be implemented in the face of limited financial resources. The Alma Ata Declaration included "an adequate supply of safe water and basic sanitation" as well as immunizations, appropriate treatment, and provision of essential drugs. In its place Walsh and Warren proposed "Selective Primary Health Care," which involves examination of the costs of each separate element of primary health care, whether it be immunizations, treatment, or WS&S, and the effectiveness of each in reducing infant mortality. They concluded, after examining all interventions, that the most cost-effective approach combines immunizations of children, tetanus toxoid for all women of child-bearing age, encouragement of long-term breastfeeding, chloroquine for malarious children, ORT, and

occasionally specific chemotherapy. Because they estimate the cost of this "package" at $200 to $250 per child death averted as compared with $3,600 to $4,300 per child death averted for WS&S, the latter is omitted as a recommended program element.

Immunizations and ORT have become attractive to agencies, such as UNICEF, the World Health Organization (WHO), and the U.S. Agency for International Development (AID), because of their apparent low cost, plus, in the case of ORT, the provision of instant gratification through averting child deaths. The troublesome feature of this approach, however, is that it has diverted attention and funds from assessing the causes of diarrheal disease and other activities that are essential for sound child health efforts, most particularly WS&S. In a report to the U.S. Congress on its Child Survival Program, AID (1986) omits WS&S.

Generalized cost comparisons between health interventions, such as those by Walsh and Warren, are misleading. While the costs of implementing WS&S in a community may be substantially greater than immunizations and ORT, and often they are not, the impacts of these interventions are markedly different. For example, ORT is directed only at averting child deaths from diarrhea; WS&S is directed at maintaining and enhancing life. Further, the ancillary and long-term benefits of WS&S are substantially greater than the benefits of immunizations and ORT. The failure of cost comparisons lies in allocating the costs of WS&S to the sole objective of reducing child mortality.

Briscoe (1984a) has made a persuasive case against "Selective Primary Health Care," presenting data that show that if poor women in developing countries were to choose the mix of activities to be included in primary health care programs, water supply would frequently constitute a part of that mix.

The purpose of this paper is

(1) to put the value of WS&S interventions in more realistic perspective;

(2) to demonstrate that WS&S interventions are necessary, if not always sufficient, for controlling diarrheal diseases; and

(3) to demonstrate that, in relation to benefits, many WS&S interventions are low in cost.

Chapter 2

HEALTH STATUS IN DEVELOPING COUNTRIES

The traditional measure of public health status is infant mortality, the number of children who die during the first year of life per 1,000 live births. It is also a definitive measure of child health, which has become the focus for health interventions.

As indicated in Table 1 on the following page, infant mortality rates in developing countries are on the order of tenfold greater than in industrialized countries. The 90 percent reduction in infant mortality rates required to reach levels characteristic of industrialized countries would require far more change than can be accomplished by immunizations, ORT, and WS&S interventions combined. The WHO (1978) estimated that, in the first two years of life, 20 of 1000 children may die from diarrhea. Thus, even if all diarrheal deaths of infants were averted, the infant mortality rates in developing countries would not be significantly reduced. Much more is required.

Table 2, compiled by Rohde (1983) from WHO data, lists disease causes of infant and child deaths and shows a 60 percent potential reduction in deaths by vaccinations, antibiotics and other treatment, maternal food supplements, contraception, and ORT. Immunizations and ORT account for approximately 70 percent of the reduction.

As Mosley (1986) indicates, Table 2 is a simplistic device that overestimates the effectiveness of single interventions, especially when directed at a single disease. As importantly, it ignores the settings that affect health status, especially child health. Moreover, some developing countries, such as Sri Lanka, Costa Rica, and Brazil, have achieved a 60 percent reduction in infant mortality without large-scale immunizations and ORT interventions (Rockefeller Foundation 1985).

The infectious diseases important in the developing countries, with their prevalence, mortality, and morbidity, are listed in Table 3. The diarrheal diseases, schistosomiasis, amebiasis, ascariasis, and typhoid, all of which can be reduced by improved WS&S, dominate the mortality and morbidity statistics. Immunizations do not address these water-related diseases, and ORT comes into play only for the dehydrating diarrheas and only after the diarrhea has exercised its debilitating and life-threatening impact.

Table 1

Infant Mortality Rates[a]

Country	Infant Mortality[b] 1965	1983
Low-income economies		
Bangladesh	153	132
Mali	184	148
Malawi	201	164
India	151	93
Sierra Leone	230	198
Pakistan	150	119
Haiti	160	107
Industrial economies		
Spain	38	10
Australia	19	10
Sweden	13	8
Japan	18	7
United States	25	11

[a] From World Bank 1985.

[b] Deaths per 1,000 live births during the first year.

Table 2

Potential Reduction in Infant and Child Deaths

Disease	Estimated Deaths (millions per year)	Interventions	Intervention Effective-ness	Potential Reduction in Death Rate (millions per year)
Immunizable diseases	3.3-5	Vaccines	80-95%	3-4.5
Pneumonia/ lower respira-tory infection	4	Pencillin	50%	2
Low birth weight, malnutrition	3	Maternal supplements Treat infec-tions Contraception	30%	1
Diarrhea	5	ORT	50-75%	2.5-3.5
TOTAL ANNUAL DEATHS	15.3-17		REDUCTION IN NUMBER OF DEATHS	8.5-11

Source: Rohde 1983 (from WHO data).

Table 3

Prevalence, Mortality, and Morbidity of the Major Infectious Diseases of Africa, Asia, and Latin America, 1977-1978

Infection	Infections (thousands per yr.)	Deaths (thousands per yr.)	Disease (thousands of cases per yr.)
Diarrheas	3-5,000,000	5-10,000	3-5,000,000
Respiratory infections		4-5,000	
Malaria	800,000	1,200	150,000
Measles	85,000	900	80,000
Schistosomiasis	200,000	500-1000	20,000
Whooping cough	70,000	250-450	20,000
Tuberculosis	1,000,000	400	7000
Neonatal tetanus	120-180	120-180	100-180
Diphtheria	40,000	50-60	700-900
Hookworm	7-900,000	50-60	1500
South American trypanosomiasis	12,000	60	1200
River blindness	30,000	20-50	200-500
Meningitis	150	30	150
Amebiasis	400,000	30	1500
Ascariasis	800,000-1,000,000	20	1000
Poliomyelitis	80,000	10-20	2000
Typhoid	1000	25	500
Leishmaniasis	12,000	5	12,000
African trypanosomiasis	1000	5	10
Leprosy	Very low		12,000
Trichuriasis	500,000	Low	100
Filariasis	250,000	Low	2-3000
Giardiasis	200,000	Very low	500
Dengue	3-4000	0.1	1-2000
Malnutrition	5-800,000	2000	

Source: Walsh and Warren 1979. Based on estimates from the World Health Organization and its Special Programme for Research and Training in Tropical Diseases, confirmed or modified by extrapolation from published epidemiologic studies performed in well defined populations. Figures do not always match those officially reported, because under-reporting is great.

Chapter 3

BENEFITS OF IMPROVED WATER SUPPLY AND SANITATION

The benefits of WS&S interventions are contingent in part upon active community participation and hygiene education. For the full benefits of WS&S to be realized, more is required than installation of the structures, pumps, and pipes. Years of effort by international agencies in assisting developing countries with the provision of WS&S facilities have demonstrated that community participation in the planning, construction, operation, maintenance, and financing of a project is essential to successful continued performance of the facilities and their use by the people to be served. Africa, Asia, and Latin America are littered with inoperative pumping stations, wells, pipes, and treatment plants that may have been well conceived at the office of a donor agency and/or a country ministry but fell into disrepair because of the absence of local commitment at all stages of the project. Community participation, including local financing, has been the hallmark of successful sustained projects (Hewitt and Becker 1986).

Further, hygiene education has been found to be essential to achieving the full value of WS&S interventions. Without effective hygiene education, WS&S facilities are often misused. Latrines that are used to store grain or new safe water supplies that are bypassed in favor of traditional, contaminated sources of water may be credits to the program on the books but have little impact on health. Reductions in diarrheal incidence attributable to hygiene education programs alone were between 14 percent and 48 percent in Bangladesh, the United States, and Guatemala (Feachem 1984).

The provision of an adequate supply of safe water has achieved great success in reducing disease incidence in the industrialized world without medical intervention. Its role in developing countries has been described by McJunkin (1983), who summarized some 50 studies in water and human health. The proceedings of the Cox's Bazaar Workshop contains some 25 abstracts of workshop papers assessing the relationship between WS&S and health (Briscoe, Feachem, and Rahaman 1986).

The benefits from WS&S programs range far beyond the prevention of diarrheal deaths among children. Improved WS&S addresses the causes of the diarrheas responsible for these deaths and, at the same time, prevents the transmission of other diseases, raises the efficacy of other health interventions, and provides many other benefits not directly related to health. More than 150 benefits were attributed to improved WS&S in rural America (Warner and Dajani 1975), while 30 benefits were attributed to improved village WS&S in Tanzania, only 6 of which were health-related (Warner 1973). Table 4, on the following page, contrasts some of the more significant benefits of improved WS&S with those of immunizations and ORT. The benefits of WS&S are discussed below.

Table 4

Benefits Associated with Major Interventions

Benefits	Interventions		
	WS&S[a]	Immunizations[b]	ORT
Health			
Control of diarrheal diseases			
Curative			X
Preventive	X	X	
Control of other WS&S-related diseases	X		
Improved primary health care	X	X	
Improved nutritional status	X		
Service to health centers	X		
Economic			
Time released for women	X		
Household irrigation & animal watering	X		
Promotion of commercial activity	X		
Support for other sectors	X		
Social			
Improved community organization	X	X	
Improved quality of life	X	X	

[a] WS&S: Water Supply and Sanitation introduced with community participation and hygiene education.
[b] Immunizations: Measles, DPT, cholera, typhoid, and polio.

3.1 Prevention of Diarrheal Diseases

The precise impact of WS&S on diarrheal disease cannot easily be established; estimates have ranged from a reduction of 80 percent during the enthusiasm of the start of the International Drinking Water Supply and Sanitation (IDWSS) Decade to a reduction of only 5 percent in the original Selective Primary Health Care calculations (WASH 1985). A recent authoritative WHO study has shown that WS&S programs do have substantial impacts on diarrheal disease morbidity, as indicated in Table 5 (Esrey, Feachem, and Hughes 1985) below:

Table 5

Impact of Water Supply and Sanitation on Diarrhea Morbidity in Children

Improvement	Number of Studies	Median of Percent Reduction
Water Quality	9	18
Water Quantity	17	25
Quality and Quantity	18	37
Excreta Disposal	10	22

In a later paper, Esrey and Habicht (1986) reported that six of eight studies showed beneficial impacts from both water supply and sanitation interventions; most of 33 studies showed beneficial impacts from improved water quality and quantity; and 20 of 26 studies reported beneficial impacts from improved sanitation.

In the twelfth edition of Maxcy-Rosenau Public Health and Preventive Medicine, officials of the WHO Diarrhoeal Diseases Control Programme concentrate on ORT and mention WS&S only in passing (Merson and Hogan 1986). WHO now recommends that WS&S be included in national diarrheal disease control programs (WHO 1986). James P. Grant, executive director of UNICEF, although a strong advocate of ORT, does state "Diarrhea and allied diseases will recur unless safe water and hygiene practices support the life of the poor" (UNICEF 1986).

Improved WS&S is a necessary, if not always a sufficient, condition to achieve the full measure of reduction in disease incidence possible. If, however, the better water is not used for bathing, washing of food, and general hygiene, other routes of disease transmission will continue to operate. Hence, hygiene education is also a necessary if not itself a sufficient intervention to achieve significant benefits.

3.2 Control of Other Water- and Sanitation-Related Diseases

WS&S is known to be effective in controlling cholera, typhoid, amebiasis, giardiasis, and a variety of helminthic diseases. One or another of these is likely to be a significant health problem in the developing countries suffering from high diarrheal disease rates. For example, studies of the impact of improved WS&S in St. Lucia revealed significant reductions in ascariasis and trichuriasis, along with diarrhea (Henry 1983).

Schistosomiasis is a special case in that WS&S is only one of the major structural interventions used to control the disease; control of the snail intermediate host is more frequently the chosen approach, although this has been found to have indifferent success. The provision of protected water is particularly effective in controlling schistosomiasis where people are exposed to infested waters during bathing and clothes washing. The provision of WS&S in St. Lucia, the one island of the Caribbean host to the disease, demonstrated the role of WS&S in controlling schistosomiasis along with the other enteric diseases (McJunkin 1983). Providing laundries, showers, and simple swimming pools in a village reduced the number of daily contacts with infested waters from 375 to 66 (82 percent) and total contact time in one day from approximately 190 to 7 hours (96 percent), thereby resulting in a reduction of new infections in children up to 10 years old from 31 percent to 12 percent after five years. Meanwhile the change in schistosomiasis prevalence rate for all ages dropped from 77 percent to 36 percent.

Dracunculiasis (guinea worm disease) is a debilitating but nonfatal disease that puts 10 million to 50 million people in West and Central Africa and Western India at risk. While not a disease that impacts upon young children, dracunculiasis has a high attack rate where it does occur. Transmission depends upon direct contact of infected individuals with water used for drinking, generally in shallow ponds or wells where suitable cyclops species are present, and then ingestion of the water containing cyclops infested with the mature larvae. Chemical treatment of the water kills the cyclops. "Thus far, however, the most effective means of preventing dracunculiasis has been to provide safe water supplies" (National Research Council 1983). Provision of safe water from wells in rural areas in the Ivory Coast and Nigeria reduced the prevalence from 30 percent to approximately 1 percent. The construction of a piped water supply for a town of 30,000 in Nigeria in the 1960s reduced the incidence of dracunculiasis from 60 percent to zero in two years. A National Research Council Workshop in 1982 recommended that because dracunculiasis has been drastically reduced or eliminated as a side benefit of water supplies introduced for other purposes, "...there is no need to justify providing safe drinking water solely as a means of eliminating dracunculiasis, only to encourage endemic countries to consider this disease when assigning relative priorities to areas where elimination of the disease would occur in addition to other benefits." Nevertheless, it was estimated that a program to eradicate dracunculiasis would justify an investment of approximately $6 billion, or $150 per person at risk, on economic benefits (avoiding the loss of marketable goods) alone (National Research Council 1983).

Infection with trachoma is the leading cause of preventable loss of vision and blindness. An estimated 400 million to 500 million people are afflicted with the disease, with blindness occurring in up to 3 percent of the population at risk. Spread and severity of the disease are related, inter alia, to lack of water and poor hygiene. According to McJunkin (1983), "Most authorities are in general agreement that personal and public hygiene emphasizing the use of water is the most effective method for prevention or reduction of trachoma."

Trachoma morbidity dropped 90 percent and conjunctivitis 80 percent in Baribanki Block, Uttar Pradesh, India, following introduction of a piped water supply in 1965. In the Ryukyu Islands, trachoma was 6- to 100-fold more prevalent in villages without water than in those with piped water to households. Personal hygiene using adequate amounts of water also reduces the prevalence of scabies, other skin diseases, and louse-borne and fly-borne diseases.

3.3 Improved Primary Health Care

The Alma Ata Declaration (WHO 1978) incorporated WS&S as an element of primary health care, together with health education, control of local endemic disease, maternal and child health, immunizations against infectious diseases, food and nutrition services, and treatment of common ailments. ORT falls under the last item, providing treatment for diarrheal disease. Adequate quantities of safe water and a sanitary method for excreta disposal are necessary for controlling many local endemic diseases, such as dracunculiasis, for maternal and child health care, for preparing safe food and preventing malabsorption, and for treating many common ailments, particularly where fluid intake is essential. The care of many young children, particularly when several have diarrhea, is a difficult and time-consuming task made considerably more difficult and time-consuming if adequate quantities of water are not readily available.

Studies made to evaluate the impact of participatory water supply projects in villages in Indonesia on DPT immunization completion rates revealed that such projects achieved 60 percent rates as compared with only 49 percent for villages with nonparticipatory projects and villages without water supply projects (Eng, Briscoe, and Cunningham 1987). Thus, the community participation necessary for successful water supply projects also serves to facilitate community organization and other interventions.

Hygiene education is an element of primary health care and is essential to the effective utilization of WS&S facilities. Studies have not been made of the effectiveness of hygiene education programs with and without the availability of improved WS&S. Nevertheless, the difficulties of providing hygiene education in the absence of adequate WS&S facilities need little elaboration. In the absence of readily available water, the mother, to whom most hygiene education is addressed, is obliged to spend an inordinate amount of time bringing water to the home and will have little time, energy, or enthusiasm for any type of education. In addition, only small volumes of water can be carried long distances, which further mitigates against recommended hygiene practices. More significantly, hygiene is not possible where bathing and laundering can be done only in highly contaminated streams and ponds. Where drinking water is drawn from such sources, home purification by boiling, chemical treatment, or filtration is infeasible for the poorest in the

community, those most likely to be victimized by diarrheal disease. In summary, the availability of water in the home has a significant impact on a wide range of household activities and behavioral patterns, including the provision of primary health care services, all of which represent improvements in the quality of life.

3.4 Improvements in Nutritional Status

The prevention of diarrheal diseases improves nutrition because enteric infections decrease food intake and increase metabolic losses, because diarrhea produces malabsorption of nutrients, and because chronic subclinical enteric disease is associated with impaired intestinal function and with morphological abnormalities of intestinal mucosa. A conclusion of the comprehensive nutrition studies conducted by the Institute of Nutrition of Central America and Panama in Guatemala is that improvements in WS&S "...will aid and enhance other measures tending to ameliorate the population's nutritional status" (Torun 1983).

3.5 Services to Health Centers, Clinics, and Schools

Education of mothers about increased breastfeeding, proper weaning, and other child care practices is most effectively accomplished in hospitals, clinics, health centers, and even in schools. Such institutions require WS&S facilities. Often the first WS&S facilities in a community or rural area are provided for health centers and schools, as both water supply and sanitation are perceived as being essential services for such centers. Where adequate WS&S facilities are absent, there can be high potential for the transmission of childhood diseases. When a health center or school is being planned, incorporation of WS&S facilities for the community, as well as for the center and school, is attractive, as economies of scale render the costs less than if the WS&S facilities were planned and built separately.

3.6 Time Released for Women

Much has been written about the burden that the lack of WS&S facilities places upon women who are already overburdened in the poor areas of the developing world. The time spent in carrying water to the home is substantial. Briscoe (1984) has summarized some of the studies which indicate that family members (almost exclusively women) often spend from two to five hours daily carrying water. The time varies from place to place and season to season, with much greater time being devoted to the task in dry seasons and periods of drought. In addition, time is required to go to streams and ponds for bathing and laundering.

The provision of an adequate quantity of safe water, preferably in the home or at least at a reasonable distance from the home, would free women for many more rewarding tasks, such as child-caring in illness and in health, education, tending home gardens and animals, and proper food preparation, while reducing the ill effects on lactation and fetal development. The release of women from bondage marks the beginning of their empowerment.

According to the Alma Ata Declaration, primary health care services are to be provided by a method acceptable to and affordable by the people and with participation of the community in program policy formation and operations. Many of the health care services, such as breastfeeding, supplementary feeding, and household hygiene, as well as the administration of ORT, increase the burden on women. Were women to be given a voice in program policy formation, WS&S would probably enjoy a much higher priority than afforded to it by national and international program policy planners.

3.7 Household Irrigation and Animal Watering

In rural communities, piped water to households is widely used for irrigating garden plots and watering animals. The economic value of this practice varies widely but is often substantial. Moreover, such local food production contributes to improved nutrition.

3.8 Promotion of Commercial Activity

The availability of piped water and proper sanitary facilities is a considerable stimulus to the development of household commercial activities, shops, eating places, tourism, small industries, and the like. Such enterprises offer employment and increased local income for the community and in turn provide a firm financial base for supporting the water utility. Strong evidence of the commercial value of piped water has been demonstrated in rural villages in the People's Republic of China.

3.9 Improved Community Organization

When people are involved with the planning, construction, operation, and financing of their WS&S facilities, they strengthen community organizations which constitute important resources that can be used for other community projects. The lessons learned from such experiences lead to the development of local initiatives for all types of projects through learning how to identify and resolve problems, how to organize for action, and how to raise funds locally.

3.10 Support for Other Sectors

Basic housing is essential to public health, even if housing cannot be shown by itself to reduce child mortality rates. In any event, housing programs are not mounted to serve health objectives; adequate housing is an end in itself. Nevertheless, a housing program without WS&S services is inconceivable. In fact, WS&S is viewed as so essential that "sites and services" projects provide resources for WS&S on the site, thereby leaving it to the householder to provide the house itself. WS&S projects associated with housing provide benefits far beyond those that can be measured in terms of reduced child disease morbidity or mortality.

In arid and semi-arid areas, which account for a substantial portion of Asia, Africa, and Latin America, agriculture requires irrigation. Where surface or groundwaters are deployed for irrigation, they can also provide water supply for domestic purposes, often at a much smaller cost than where the domestic water supply must be developed separately. In such multipurpose projects, the sharing of costs reduces the costs to each sector. In addition the agricultural sector has an interest in WS&S which serves to maintain the health and productivity of farm workers.

Private industry, on a small scale in rural areas and a larger scale in urban and periurban areas, has a stake in WS&S projects. Joint participation of industry and community in developing WS&S projects serves each, and reduces the cost to each where industry pays its fair share. In some instances, the industry will subsidize the WS&S services in its own self-interest, as a healthy work force is necessary in any industrial enterprise. Another attribute of WS&S projects is that, if materiel is to be indigenous, as it should be, manufacturing of pumps, pipes, valves, meters, and related materiel should be developed locally, thereby ending the dependence on costly imports and increasing the level of industrial activity.

3.11 Financial Viability

While not a benefit per se, a distinguishing characteristic of water supply projects is that they have the potential for earning revenue sufficient to operate and maintain the facilities and often to generate a return on capital. In contrast, immunizations and ORT generally require continuous contributions of funds from international donors and/or national exchequers to sustain the programs. Water supply projects can be initiated with borrowed funds, perhaps from a national revolving fund supported by loans or grants from donor agencies, with income from the water service often being sufficient to repay the loan so that the revolving funds can be used to provide facilities for other communities.

The conventional wisdom has been that the poor in developing countries cannot afford or will not pay for water service. That they can and will pay is demonstrated in poor villages and in the poor periurban areas of cities throughout Asia, Africa, and Latin America. In the absence of a suitable water supply, people buy water from distributing vendors at rates per liter often as much as 40-fold greater than rates paid by those served by piped water in the same area. In fact, the evidence is clear that service from water vendors costs substantially more per month than is paid by customers on piped water systems, with that being received from the vendor often of poorer quality. (The manual delivery of water is inherently more costly than piping.) The poor often pay as much as 30 percent of their income for water (Zaroff and Okun 1984), where the well-to-do pay less than 2 percent. In the slums of Lima, the poor paid three times more per month for buying 23 liters per capita per day from vendors as contrasted with the rich who used 152 liters per capita per day from the piped system (Adrianzen and Graham 1974). Similar data are available from villages in Kenya and Haiti and periurban areas in Indonesia and Honduras. Where projects are initiated with community participation on the basis of perceived need and local priorities, users have been found to be prepared to pay for improved water service, particularly where their costs will be sharply reduced.

When donor agencies compare alternative interventions. the total project costs are not as appropriate a parameter as the total funds required in grants or loans. For medical interventions, the funds required at the local level are generally recurring costs and need to be in grants, as user charges are seldom appropriate. For water supply interventions, however, much of the financing can be from loans, with cost recovery locally being actively sought.

3.12 Improved Quality of Life

The availability of "running water" endows a community with enhanced status. (Witness the pride associated with the presence of an elevated tank or a fountain in a community.) Piped water makes possible a wide range of community amenities: public drinking fountains, laundry and bath houses, swimming pools, animal watering troughs, and so forth. Showers and baths in the home add to the quality of life. The ubiquitous photos of children playing in water are testimony to the pleasure provided by running water.

The role of water in society should not need to be stressed. Its place in civilization is evidenced by the celebratory activities that accompany the first introduction of water supply to a community. An extract from the History of the Introduction of Pure Water into the City of Boston described the events following the first flow of water into the city in 1848: "After a moment of silence, shouts rent the air, the bells began to ring, cannons were fired, and rockets streamed across the sky. The scene was one of intense excitement, which it is impossible to describe but which no one can forget."

Water is welcome.

Chapter 4

ORAL REHYDRATION THERAPY

Oral rehydration therapy is available at low cost, is relatively easily administered, and provides rapid recovery from many previously fatal diarrheas. Moreover, ORT is saving the lives of young children who are on the verge of death. Such a dramatically successful remedy must be offered wherever and whenever necessary, much as famine relief enjoys a high priority where children are dying of starvation. A caring society cannot fail to offer this opportunity for life. ORT has understandably become attractive for child survival programs.

Rehydration of fluids lost during periods of acute and prolonged diarrhea has been practiced for many years, but it was only in the early 1970s that serious investigations were begun into the physiological nature of diarrhea and the role of replacement fluids. It was found that replacing water and essential electrolytes lost from the body during diarrheal episodes was best accomplished by oral administration of a mixture of sugars and salts having the following formula (Merson and Hogan 1986):

3.5 gms sodium chloride,
2.9 gms trisodium citrate,
1.5 gms potassium chloride,
20 gms glucose (anhydrous), all dissolved in
1 liter of drinking water.

In recent years, considerable effort has gone into identifying alternative formulae using readily available materials in the community and developing procedures and user education programs for the application of oral rehydration salts.

The potential benefits of ORT are considerable. Acute diarrhea kills approximately five million infants and children annually. It has become widely accepted that many of these deaths can be prevented by ORT. A significant number of development organizations, including UNICEF, WHO, and AID, as well as numerous private voluntary organizations and non-governmental organizations, have made ORT a major focus of their health programs.

What is not so readily demonstrated is why ORT has been perceived as being the program of choice, replacing other options and particularly WS&S. ORT alone, without WS&S and other interventions, does not constitute an effective child health diarrheal disease control program. The following points characterize the role of ORT in developing countries.

1) ORT is not a preventive measure. Only when diarrheal disease has struck, and then only when it has struck with some ferocity, is an ORT program likely to be initiated. By that time, much of the health and economic consequences will have been visited on the community. ORT serves only for "damage control."

2) As Feachem (1986) points out, ORT has been proven to be highly effective in preventing deaths from dehydration caused by acute watery episodes of diarrhea. Its role in preventing deaths from dysenteric or chronic diarrheas is not well documented but is believed to be limited. With vast differences in regional environments, in countries where the acute diarrheas are not predominant, ORT may have only limited impact. Further, ORT cannot be expected to have any significant impact on diarrheal morbidity, the control of which may well be a more significant goal than averting child deaths from diarrhea.

3) The life that might be saved by ORT is only saved until the next attack of diarrhea. Inasmuch as no immunity is conferred by ORT, and ORT itself does not address the condition responsible for the diarrheas, the "saved" child may need to be "saved" again and again unless the environment for the child is improved. Diarrheal disease, in addition to exacting a toll, is a symptom of poor community health and/or household behavioral patterns that result from inadequate and unsafe water, lack of sanitation facilities, poor hygienic practices, and so forth. ORT relieves the symptoms and, as with many diseases, that is a welcome outcome. If the cause of the disease is not removed, however, little long-term improvement in disease incidence or mortality can be expected.

4) ORT is not an investment in future public health. To be effective, ORT must be administered ad infinitum unless other interventions are introduced. Should the financial or administrative support for ORT falter at any time, the community will be in little better shape than if ORT had not been initiated. "In the long run only sanitation, clean water and food, better nutrition and improved living conditions can reduce the incidence of diarrhea among infants and children" (Parker et al. 1984).

5) The administration of ORT requires a solution made up of salts and water. The logistics of providing a few grams of salts may be simpler than providing the liter of water required. A source of water must be available, whether from a well and handpump, a public tap, or a piped system. In many countries, only a small percentage of those who need ORT use the therapy, even where oral rehydration salts are available.

6) ORT programs must generally be initiated, organized, and funded by central governments, only reaching the target community after passing through a fragile and often inefficient bureaucracy. WS&S, on the other hand, may be introduced by a community that recognizes its need, with the central government playing only a supportive role.

7) While ORT may often prevent death from dehydration, if applied without major changes in nutrition it will have little effect on the increasing frailty in the population at risk (Mosley 1986).

Because children may have 20 or more diarrheal episodes during the first five years, if other interventions are not pursued, an increase in frailty in these impoverished children is bound to occur, which puts them at a greater risk of death than the population of children at large. Resuscitation of children who otherwise would have died thus increases the risk to survivors (Mosley 1986). The net effect of ORT is, therefore, significantly less than is estimated on the basis of deaths averted by the procedure.

8) Lastly, because ORT is directed only at averting child mortality from diarrheal diseases, the cost or so-called cost effectiveness of ORT should not be compared with the cost effectiveness of other interventions where child survival from diarrheal disease is only one of a wide range of benefits, many of which contribute to child survival directly or indirectly as well as to improved health and quality of life for the community as a whole.

In summary, ORT is an important curative measure, but it should not be the keystone in child health programs.

Chapter 5

OTHER HEALTH INTERVENTIONS

Interventions to improve health can be preventive or curative and they can be directed at a community's health status or they can be directed at selected individuals in the community. Preventive interventions include, for example, immunizations and WS&S. Curative interventions include hospital care and ORT. Community interventions include the construction of hospitals and WS&S projects, while individual interventions include immunizations and ORT. Table 6, on the following page, characterizes interventions to improve health in developing countries. Some interventions do not fit neatly into these categories. The construction of a health clinic is a community enterprise, but it may facilitate individual preventive and curative measures, such as immunizations and ORT.

Most interventions which address enteric diseases improve the effectiveness of other interventions. For that matter, nonhealth interventions, such as improved housing, improved education, literacy campaigns, and improved employment opportunities resulting in improved economic status may have a greater impact on health than direct health interventions. Thus, almost all interventions can have a positive impact on enteric disease; some will be direct, some indirect, and some quite incidental.

Vector Control. The most important water-related disease transmitted by a vector is schistosomiasis. Because infection can take place by penetration of the skin by cercaria that are discharged in water by snails, as well as by ingesting the water, one method of control is the provision of a safe water supply, thereby making exposure to infested waters unnecessary. Another intervention is the provision of sanitation facilities which keeps the surface waters free of the schistosome eggs. Contact with the infested water often cannot be avoided, particularly where rice farming and fishing are important to the local economy. In such instances, molluscicides have been used, often with indifferent or short-term success.

Supplementary nutrition. That nutrition can play a role in preventing diarrheas and promoting health is well established, although the cost of achieving adequate nutrition in poor countries is high (Feachem 1983). A corollary is that diarrheal diseases have been shown to interfere with absorption of food, creating in effect a cycle where poor nutrition contributes to diarrheas and diarrheas contribute to malabsorption.

Health center construction. The administration of almost all preventive and curative interventions, whether community-based or involving individual ministrations, such as immunizations and ORT, will be enhanced by the presence of a health center, which may include a clinic and supporting services for other activities, most particularly hygiene and health education.

Family planning. The value of education and facilities for family planning and appropriate child spacing hardly needs elaboration. Family planning has been viewed as being a prerequisite for any meaningful attack on poverty and for the promotion of health.

Table 6

Classification of Health Interventions

Preventive Interventions:

- Community
  - Water supply and sanitation, including community participation and hygiene education
  - Vector control
  - Supplementary nutrition
  - Health center construction
  - Family planning
  - Improved breastfeeding and weaning practices
- Individuals
  - Immunizations
  - Chemical prophylaxis

Curative Interventions:

- Community
  - Hospital construction
  - Epidemic control
- Individuals
  - Oral rehydration therapy
  - Medical and nursing treatment

Improved breastfeeding and weaning practices. Studies have shown that breastfeeding of children under one year of age is protective against diarrheal morbidity and mortality (Feachem and Kublinsky 1984). Education and support of mothers and changes in hospital routine can improve the numbers of children who are breastfed up to 40 percent in infants up to two months of age. Weaning education is an appropriate adjunct to promotion of breastfeeding. Evidence suggests that weaning education can improve the nutritional status of infants and children and can reduce diarrheal mortality rates 2 to 12 percent in children under five (Ashworth and Feachem 1985).

Immunizations. The suitability of cholera vaccinations for diarrhea control is far greater in Asia than in Latin America although in Bangladesh, it is estimated that immunization would avert only 0.1 percent of diarrheal episodes and 1.7 percent of deaths in the first five years of life (de Zoysa and Feachem 1985b). Problems with cholera vaccines are their efficacy, which has been low, and the necessity to administer the vaccines much later than the other child vaccines, so that the cost is likely to be relatively high and the coverage relatively low. Aside from its major role in the reduction in measles rates, a measles immunization program, with 60 percent coverage of children at 9 to 11 months, might reduce diarrhea morbidity by 1.8 percent and mortality by 13 percent among children under 5 (Feachem and Kublinsky 1983). While diphtheria is a low priority intervention because of its low morbidity and mortality, the availability of a diphtheria, pertussis, and tetanus (DPT) vaccine makes this immunization attractive. Given the high incidence of measles, the high mortality of neonatal tetanus, the effectiveness of immunizations and their relatively low cost, immunizations can easily be justified in countries where measles and/or neonatal tetanus are prevalent. Except for the better health afforded to children who might otherwise be ill and, therefore, less resistant to diarrheal infections, the DPT immunization program cannot be expected to have an impact on diarrheal disease morbidity and mortality.

Chemical prophylaxis. The principal role of drugs in controlling diarrheal diseases is in treatment to reduce the severity of the disease and prevent death. Mass chemotherapy may be used prophylactically to reduce the pool of people who excrete pathogens, and drugs may also be used to protect uninfected people who may be exposed to diarrheal diseases, such as travelers. De Zoysa and Feachem (1985a) have estimated that prophylactic chemotherapy at best can reduce diarrheal morbidity and mortality in children under five by less than 1 percent. They conclude that even if chemical prophylaxis were feasible, and they assert it is not in many instances, it would not be a cost-effective measure.

Chapter 6

ROUTES OF TRANSMISSION, INTERACTIONS, AND MULTIPLE INTERVENTIONS

Many diseases of concern in the poorer countries of the developing world, especially the diarrheas, can be transmitted by any of several routes. In such instances, any single selected intervention may appear to be ineffective. This difficulty has beset many of the studies of the effectiveness of WS&S.

The importance of considering the several routes of transmission is elegantly demonstrated by Briscoe (1984b). He cites the studies in Matlab Thana, Bangladesh, in the 1970s where cholera transmission took place via drinking water, ingestion of water in bathing, through contaminated food, and by person-to-person contact. The microbiological data indicated that most transmission would take place through drinking water.

Because of transmission through other routes, however, elimination of drinking water as a route did not effect large reductions in cholera, thereby leading to a conclusion that cholera is not water-borne! Similarly, any other single intervention may appear to be ineffective in reducing disease incidence. Where prior, apparently ineffective interventions are introduced, subsequent minor interventions may make a major impact (Briscoe, Feachem, and Rahaman 1986). Nevertheless, because most studies of WS&S interventions have been shown to have beneficial results, improved WS&S is acknowledged as a necessary. even if not always a sufficient, requirement for preventing diarrheal and other enteric diseases.

Mosley (1986) has addressed the simplistic approach of assessing the cost-effectiveness of single interventions against single diseases. He examined a series of scenarios based on a model population of children exposed to several diseases where several different interventions may be attempted. His conclusions are of interest:

1) Competing risks from disease substantially reduce the benefits of a single intervention, such as ORT, because the deaths averted are among the most vulnerable segment of the population so that survivors are then subject to higher than average risks.

2) An intervention, such as an immunization for measles, will not only prevent deaths due to the targeted disease but, by improving the health of the immunized children, will avert deaths that might have resulted from other diseases. Thus, certain interventions have greater benefits than can be assigned on a single disease, single intervention model.

3) Nonselective interventions have the potential for increasing the resistance of children and/or decreasing their risks. A wide range of interventions, including WS&S, health and hygiene education, nutrition programs, and so forth, fit into this

category. While the impact may be small for any specific cause, the overall effect is likely to be substantial because of the many diseases that are affected. Table 7, which follows, illustrates the apparent and real impacts of several types of interventions.

The significance of selecting the appropriate strategy is best summarized by quoting from Mosley (1986):

> "(There is) a common failing among many health professionals who are proposing choices among health care strategies. The typical approach is to begin with a specific disease such as diarrhea and then examine the cost-effectiveness of alternative intervention strategies. As is clear from this model, if strategies are selected only on the basis of their benefits in preventing disease-specific deaths, narrowly focused technologies will almost always appear to be far more cost-effective than the broad based program interventions. However, if one is looking beyond disease-specific death prevention to the promotion of survival, the broad based interventions will generally prove more favorable, even when implementation costs are taken into account."

Mosley concluded:

> "Preventive measures that reduce the risk of death, either by increasing individual resistance such as with immunization or nutrition programs or by reducing the child's exposure to disease risks, will have a far greater survival impact. The greatest improvements in child survival can be expected from nonselective interventions that prevent diseases that not only kill but which singly or with recurrent episodes produce a high level of frailty, increasing the risk of death among survivors." (emphasis added)

While ORT does not fit Mosley's model for an appropriate intervention, WS&S does.

Table 7

Apparent and Real Impacts of Health Interventions
(Adapted from Mosley 1986)

Example of Intervention	Characteristics of Situation	No. of Deaths Averted[a] Apparent	Real
ORT	Diseases cured but increase frailty	+++	+
WS&S; Hygiene education	Wide range of diseases affected	+	++++
Neonatal tetanus immunization	Survivors more vulnerable to other diseases	+++	++
Measles vaccination	Resistance of all children to other diseases increases	+++	++++

[a] + few; ++++ many.

Chapter 7

COSTS OF WATER SUPPLY AND SANITATION PROJECTS

While it is possible to make reasonable generalized estimates of the costs of some interventions, such as immunizations and ORT (Creese 1979; Shepard, Lerman and Cash 1985), the capital and operating costs of WS&S projects inherently vary widely even within one country. They depend upon the local rainfall, availabilities of sources, topography, geography, density of population, pumping requirements, levels of service, costs and availability of materiel locally, requirements for treatment, costs of labor and power, and the costs of borrowing money.

Recognizing the considerable variability in the costs of providing improved WS&S services, and appreciating that in any given funding period, it is not feasible to provide all communities that require improved WS&S with facilities, one useful criterion for selecting communities to be served is the estimated cost. The successful village water supply program in Malawi was based on serving first those villages that could be served by gravity, so that pumping and treatment were not required. Accordingly, when examining the wide spread of WS&S costs, the lower costs are of most interest, as they would represent the simplest technology and the most available sources and are the most likely to be implemented. Also, costs vary with levels of service and the consequent volumes of water provided per capita. The following figures are roughly indicative of various levels of service.

To sustain life: 2 liters per capita per day (lpcd)
To provide hygiene: 20 to 30 lpcd
To enhance quality of life: 80 to 120 lpcd
To provide for commerce and related activities: >150 lpcd.

Most interventions generally involve starting with little resources available. With WS&S projects some facilities may be in place, as people obtain water somehow. Where people purchase water from vendors the provision of a piped water supply system reduces costs substantially; the release of funds spent on vended water, when capitalized, will almost always provide more than sufficient funds for construction of piped systems (Whittington et al. 1987). Accordingly, generalized estimates of costs for WS&S projects are often overstated. Nevertheless, when cost data are available for WS&S interventions, they are useful.

Estimates of the costs of finished WS&S projects have been abstracted from several sources. WHO has reported such costs in connection with the International Drinking Water Supply and Sanitation Decade. Project reports of the World Bank, the Inter-American Development Bank, and WASH field teams also contain cost data, although comparable information is not readily available in these reports.

Tables 8 and 9, on the following pages, are based upon 1983 data collected by WHO (1986). Countries reported their estimates of costs for implementing both urban and rural WS&S projects. Per capita construction costs of water systems

Table 8

Costs of Water as of December 1983[a]

Region	Construction, US$/capita			Operation
	Rural	Urban Standposts	Urban House Convections	US$/m^3
Africa				
median	39	56	98	0.48
range[b]	8-200	2-200	12-300	0.20-1.18
Americas				
median	94	50	122	0.11
range	25-410	5-500	25-350	0.04-1.15
Southeast Asia				
median	14	58	61	0.16
range	2-70	6-111	60-150	0.10-1.00
Western Pacific[c]				
median	38	--	130	0.35
range	5-210	--	19-400	0.18-0.80
Summary				
median	38	56	80	0.25
range	2-410	2-500	12-400	0.04-1.18

[a] Adapted from WHO 1986. Europe and Eastern Mediterranean excluded.

[b] Range by countries.

[c] Excluding U.S. territories.

Table 9

Costs of Rural Sanitation as of December 1983[a]

Region[b]	Construction, US$/cap
Africa	
median	30
range[b]	8-300
Americas	
median	45
range	6-536
Southeast Asia	
median	9
range	3-20
Western Pacific[c]	
median	12
range	2-34
Summary	
median	21
range	2-536

[a] Adapted from WHO 1986. Europe and Eastern Mediterranean excluded.

[b] Range by countries.

[c] Excluding U.S. territories.

ranged from $2 to $500, with additional operations and maintenance costs from $0.04/m^3 to $1.18/m^3. Rural sanitation per capita costs ranged between $2 and $536. Using median values from these tables, annualized costs, inclusive of O&M, for WS&S facilities consisting of standposts and pit privies would then be $9.40 per capita for water and $2.50 per capita for sanitation (Table 10).

Allowing approximately 10 percent additional annualized costs for community participation, hygiene education and local training, the median annual cost per capita for WS&S would be approximately $13 per capita. The lower cost installations that would take priority might range from $5 to $10 annually per capita.

Table 10

Annual Per Capita Costs for Water Supply and Sanitation[a]
(US $ 1980)

	Capital Costs	Annualized Capital Costs[b]	O&M[c]	Total Annual
Standposts	$56	$6.70	$2.70	$9.40
Pit privies	21	2.50	-	2.50
TOTAL				$11.90

[a] Based on WHO 1986, taken from Tables 9 and 10.

[b] At 10 percent discount rate over 20 years.

[c] Based on 30 lpcd, 11 m^3/cap/yr.

Data from the World Bank (1980) on sanitation facilities are shown in Table 11. The annual per capita cost of pit privies averages approximately $3.10 but is based on higher amortization factors than used for the WHO data.

Data collected from project reports, each of which covers many villages, are shown in the Appendix. While these projects and their reporting vary substantially, the magnitude of the annual per capita costs for water supply are somewhat lower than WHO data, being approximately $4.50 per capita annually.

Lauria (1982) made an estimate of costs for various levels of water supply service, the results of which are summarized in Table 12. He found an annual per capita cost, including O&M, of less than $3 for public standposts, which is consistent with the other data reported herein.

Table 11

Annual Per Capita Costs of Sanitation Facilities[a]
(US $ 1978)

Place	Pit Privy	Bucket Latrines			Water Seal Latrines			Communal Latrines		
	Capital	Capital	O&M	Total	Capital	O&M	Total	Capital	O&M	Total
Kayu Awet, Indonesia	$0.80[a]				$2.60[a]	$0.90	$3.50			
Manggarai, Indonesia								$1.80[a]	$0.70	$2.50
Tambaksari, Indonesia					2.60[a]	0.90	3.50	6.90[a]	1.30	8.20
Darmo, Indonesia					7.20[a]	1.80	9.00			
Malacca, Malaysia		$3.10[b]	$4.50	$7.60						
Alor Star, Malaysia		3.20[b]	4.10	7.30						
Haj Youssef, Sudan	6.00[c]									
Ibadan, Nigeria	4.10[b]	1.70[b]	2.20	3.90						
Ndola, Zambia	3.20[b]									
Villarrica, Colombia	1.40[b]	1.00	0.90	1.90						
AVERAGE	$3.10	$2.20	$2.90	$5.10	$4.10	$1.20	$5.30	$4.30	$1.00	$5.30

[a] Annual cost based on opportunity cost of capital of 20%.
[b] Annual cost based on opportunity cost of capital of 12%.
[c] Annual cost based on opportunity cost of capital of 16%.

Source: Adapted from World Bank (1980).

Table 12
Annual Per Capita Costs for Water Supply and Sanitation[a]
(US $ 1982)

	Capital Costs	Annualized Capital Costs[b]	O&M[c]	Total Annual
Standposts	$15	$1.80	$0.50	$2.30
Yard Taps	30	3.60	0.90	4.50

[a] Adapted from Lauria 1982.
[b] At 10 percent over 20 years.
[c] At 25 percent of annualized capital costs.

Taking estimates from the various sources, costs for water supply and sanitation programs with public standposts on piped systems and pit privies would range from approximately $5 to $10 per capita annually. Yard taps, which provide a substantially higher level of service might increase the cost by half. These are the same order of magnitude as the WS&S cost figures from WHO used by Walsh and Warren (1979).

For modest sums per household, WS&S will not only help avert death, but will enhance the quality of life and provide a potential for breaking the cycle of poverty that is at the root of the problem of infant mortality. Accordingly, a policy for promoting child health in developing countries should include ORT where diarrheal disease is prevalent but must also include WS&S programs if a lasting impact is to be made.

Chapter 8

CONCLUSIONS

International, national, and voluntary public and private agencies throughout the world are committed to programs of primary health care generally and child health and survival particularly. The picture of emaciated children at death's threshold has impressed itself on the conscience of society.

While water supply and sanitation programs have addressed these problems for years, the promise of newly developed oral rehydration therapy for averting child deaths from diarrheal diseases quickly and easily has led to the obscuring and downgrading of WS&S programs by donor agencies and in the eyes of the general public. WS&S programs, particularly when initiated with active community participation and accompanied by hygiene education, continue to demonstrate their efficacy in preventing diarrheal diseases. In addition, with the same investment, WS&S programs confer a host of other benefits, particularly for women and children. Among these are:

Health Benefits

- Prevention of diarrheal diseases
- Control of other WS&S-related diseases
- Improved primary health care
- Improved nutritional status
- Service to health centers

Economic Benefits

- Time released for women
- Household irrigation and animal watering
- Promotion of commercial activity
- Support for other sectors

Social Benefits

- Improved community organization
- Improved quality of life

ORT has been shown to cure diarrheal diseases simply and at low cost, demonstrably saving lives. ORT, however, makes no attempt to prevent disease. Children are known to require ORT many times during their first five years. Each bout of diarrhea renders them more frail and more vulnerable to death, which means the data on the "life-saving" attributes of ORT are overstated. If, while ORT is being administered, measures are taken to improve WS&S, the prospects for improving child health and averting death are substantially enhanced.

One of the apparent attractions of ORT is its low cost per death averted as compared with WS&S programs. The two programs should not, however, be compared in monetary terms per death averted because their benefits are so disparate. Additionally, ORT costs are estimated on an annual basis. The program needs to be repeated at regular intervals, because the first administration of ORT does nothing to reduce the need for a second. On the other hand, WS&S costs are based on the project costs, with the project serving for 20 years and more. The annual costs of WS&S projects, including both capital and operations and maintenance, are approximately 12 percent of the initial capital cost. Thus, the costs of WS&S projects, while varying widely, amount on average to $5 to $10 per capita annually, or literally pennies per day for each person benefited.

The real financial constraint to implementing WS&S programs is lack of initial funding. Ample evidence exists to show that in villages and periurban slums of Africa, Asia, and Latin America people are prepared to pay for water service. The ubiquity of water vending, which results in households paying substantially more per month for water than households with piped connections, is testimony to the readiness and capacity to pay. What is needed is the initial capital investment and means for ensuring effective O&M. Donors can make loans or grants which, with establishment of revolving funds, can help ensure long-term viability of the WS&S programs. Repayment of early projects can provide the funds to initiate later rounds of project investment.

A wide range of interventions can be justified for the purpose of promoting community and child health. Without a community investment in WS&S and hygiene education, however, these interventions are unlikely to achieve any long-term improvement in either health or quality of life.

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Appendix

COST DATA FROM PROJECT REPORTS

Appendix

Cost Data from Project Reports

Country	Type Project	Year	Population Served	Capital Costs, $/cap	Annualized Capital Costs,[a] $/cap/yr	O&M Costs, $/cap/yr	Total Annual Costs,[b] $/cap/yr	Total Adjusted Annual Costs,[c] $/cap/yr
Burundi	Rural Water	1981	100,000[d]	6[e]	0.70	NA	0.90	1.00
UNICEF WS&S project. 650 springs serving 100-250 people each. Spring capping, distribution at source (1).								
Cameroon	Rural Water	1982	17,400	20	2.40	NA	3.00	3.20
CARE water activities in East Province. 40 springs serving villages of 200-5000 people. Spring capping, distribution at source (2).								
Cameroon	Rural Water	1982	46,000[d]	10	1.20	NA	1.50	1.60
CARE water and sanitation activities in North Province. 23 wells serving approximately 2000 people each. Dug wells with distribution by pumps at source. Health education latrine construction, use and maintenance (2).								
Dominican Republic	Rural Water	1983	47,700	43	5.10	2.00	7.10	7.10
USAID Health Sector project. 795 wells serving approximately 60 people each. Handpumps for deep and shallow wells (3, 4).								
Indonesia	Rural WS&S	1983	71,000[d]	5[d,f,g]	0.60	NA	0.80	0.80
Foster Parents Plan's WS&S projects in Yogykarta. 2000 hand dug wells with bucket and pulley, latrines with septic tank and bathhouses with soakways (5).								
Tunisia	Rural Water	1978	100,000	20	2.40	0.60[d]	3.20	4.70
CARE water projects. 325 projects serving approximately 300 people per site. Renovation of existing shallow and deep wells and springs; distribution at source; some handpumps and diesel pumps (6).								

Appendix (Continued)

Country	Type Project	Year	Population Served	Capital Costs, $/cap	Annualized Capital Costs,[a] $/cap/yr	O&M Costs, $/cap/yr	Total Annual Costs,[b] $/cap/yr	Total Adjusted Annual Costs,[c] $/cap/yr
Haiti	Rural Water	1980	30,000	8[e]	1.00	NA	1.30	1.60
CARE/AID Rural Potable Water programs. 50 water systems. Gravity transmission from springs to public standposts; and pumps at dug wells (7).								
Nepal	Rural Water	1985	4,900	20	2.40	NA	3.00	2.90
Save the Children Federation rural water projects. 30 water supply systems. Gravity transmission from springs and streams, public standposts (8).								
Malawi	Rural Water	1986	335,000	26[h]	3.10	0.40	3.90	3.70
Self-Help rural water supply program. 18 projects serving between 1900-45,000 each. Gravity transmission from surface waters, public standposts. Hygiene and sanitation (latrines) education (9).								
Indonesia	Rural Water	1984	8,500	24	2.80	NA	3.50	3.40
CARE/AID projects in Java, Bali and Nasa Tanggara Barat. 8 systems serving between 600-1800 people. Spring capping, gravity transmission to public standposts (10).								
Kenya	Rural Water	1976	46,400	16[f]	1.90	NA	2.40	4.10
CARE small scale, low-cost self-help water systems. 11 projects serving 600-7700 people. Gravity transmission from springs and streams, pumps for wells; mix of public standposts, yard taps and house taps (11).								
Indonesia	Rural Water	1983	32,400	26	3.10	NA	3.90	3.90
IKK water supply systems. 9 systems each serving approximately 3600 people. Deep wells with pumping to conventional treatment plants (some package), public standposts and house connections (12).								

Country	Type Project	Year	Population Served	Capital Costs, $/cap	Annualized Capital Costs,[a] $/cap/yr	O&M Costs, $/cap/yr	Total Annual Costs,[b] $/cap/yr	Total Adjusted Annual Costs,[c] $/cap/yr
Thailand	Rural Water	1972	>500,000	9[f]	1.10	2.00	3.10	7.20
USAID potable water project. 250 systems serving between 500-10,000 people. Deep wells and surface waters pumped to conventional treatment plants, metered house connections and few public standposts (13).								
Philippines	Rural Water	1981	27,200	32[f]	3.80	NA	4.80	5.50
Barangay water program. 14 systems. Deep wells and shallow wells with electric pumps, springs with gravity transmission; single house taps with low-flow restrictions (14).								
Peru	Rural Water	1984	300,000[d]	30	3.50	NA	4.40	4.30
USAID Peru rural water systems and environmental sanitation project. 100 systems serving approximately 300 people each. Gravity transmission from springs and streams to house connections and some public standposts (15).								
Haiti	Rural Water	1985	63,000	130[f]	15.30	0.90	16.20	15.70
IDB proposed project for 30 communities with public standposts; gravity distribution from rivers and wells (16).								
Panama	Rural Water	1981	24,400	59	6.90	2.90	9.80	11.20
IDB proposed rural water systems. 9 systems for 14 towns. Wells with pumping to house connections and public standposts; disinfection (17).								
Lesotho	Rural San.	1984	2,200	14	1.70	-	1.70	1.70
Rural sanitation pilot project. 400 pit latrines (18).								

a. 20 years at 10%. b. When O&M costs not available assumed to be 1/4 annualized capital costs. c. Adjusted to 1983.
d. Calculated from report data. e. Materials only. f. Exclusive of administrative costs. g. Includes sanitation.
h. Includes evaluation.

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