1035

17a

Draft for discussion only

Not for citation

DEFINING A ROLE FOR WATER SUPPLY AND SANITATION ACTIVITIES IN THE HEALTH SECTOR IN THE ASIA REGION:

AN ISSUES PAPER FOR THE ASIA BUREAU, USAID

January, 1985

John Briscoe

Department of Environmental
Sciences and Engineering
School of Public Health
University of North Carolina

SUMMARY

This is an issues paper, the objective of which is to identify and discuss concepts which are central in defining the appropriate role for water supply and sanitation services in the context of the health sector. The core of the paper is the development of a method for identifying the portions of the overall costs of water supply and sanitation services that are (i) serving non-health needs which are recognized by the consumers (and are correctly borne by the consumers themselves), and, (ii) serving unrecognized and often external health needs (and are correctly supported from public funds). Application of the method requires information on the capital and recurrent costs of services, and on the willingness of consumers to pay for the services. To assess the appropriate level of water supply and sanitation services, additional information on the relationship between level of service and health impact is required.

The bulk of the paper is devoted to defining the information needed for practical application of the conceptual model, to summarizing what information is presently available and indicating how presently unavailable information might be collected. Out of this discussion emerge some general conclusions of direct relevance in defining the role of water supply and sanitation projects in the health sector in the Asia Bureau. These conclusions are summarized by sector.

Urban water supply

Costs

The per capita capital costs of water supply systems increase sharply as the level of service is increased. Much better information is needed on recurrent costs. Applied investigations of engineering and management techniques for reducing the costs of water supply systems are needed.

Willingness to pay

In many cities the poor, who use far less water of poorer quality than the rich, pay more per month for this water. Willingness to pay for basic services is high, even among the poor. Willingness to pay for high level services (multiple taps in the house) is high among the middle and upper classes. Little reliable information on demand is available, but it is likely, once a basic level of service is obtained, that the price elasticity of demand for the urban poor is relatively high.

Health impact

The evidence on the relationship of level of service to health impact is mixed. Site-specific information is needed.

Overall role

Because consumers are usually willing to pay the full costs of service, any health impact comes at no finan-

cial cost to the health sector. For health and equity reasons, high priority should be given to improvement in the service provided to poor urban dwellers who are not served by the public systems. Documentation of the institutional, economic and engineering features of non-piped distribution systems is needed so that constraints to improvement in the quality of service and reduction in the cost of water can be identified. Of high priority, too, is the identification of means for reducing the high levels of unaccounted-for water.

Urban sanitation and sewerage

Costs

Costs increase sharply as level of service increases. Information on recurrent costs is inadequate.

Willingness to pay

Information is poor. However it appears that willingness to pay for basic services in urban areas is relatively high, even for low-income groups.

Health impact

Information on the effect of level of service on health is inconsistent, and site-specific data are needed. It appears, however, that the major health impact is gained when basic sanitation facilities are used, and that the marginal impact of higher levels of service is small.

Overall role

Since even low-income urban dwellers are probably willing to pay for most of the costs of basic sanitation services, and since the health impact of introducing such services is substantial, investments in basic sanitation for urban dwellers are probably cost-effective health investments. Support is needed for the development of institutions for periodically removing and disposing of sludge from on-site sanitation facilities in urban areas. There appears to be little justification in expending public resources on higher levels of sanitation. Where these sanitation services are provided, consumers should be made to bear the (high) full costs of the services.

Rural water supply

Costs

Because water supply systems are characterized by large economies of scale, and because rural systems are small and the population densities low, the per capita costs of rural systems are often higher than the per capita costs of urban systems which provide comparable levels of service. Applied investigations are needed to identify least-cost solutions in a variety of rural settings, and to identify design procedures which can

reduce the cost of these supplies.

Willingness to pay

Progress in rural water supplies depends critically on incorporating the concept of willingness to pay into the design and operation of such systems. However, little information is available on willingness to pay for water in rural areas. It is likely that willingness to pay is higher than has previously been assumed, especially among middle- and higher-income groups, and where the service provided represents a marked improvement (in terms of convenience, reliability and perceived quality) over the existing service. In arid areas an "improved service" could be simply a more convenient and reliable supply; in wet areas an "improved service" would often imply piping of water to the house. Systematic investigations of willingness to pay for water in rural areas should be given high priority.

Health impact

As with urban water supplies, the effect of different levels of service on health is largely a matter of conjecture. Site-specific studies are needed.

Overall role

Where willingness to pay is high (i.e. where income is relatively high, the opportunity cost of women's time is relatively high, and the level of service represents a marked improvement over the existing service), rural water supplies often represent cost-effective health interventions.

Rural sanitation

Costs

The costs of rural sanitation facilities are typically substantially lower than the costs of similar services in urban areas.

Willingness to pay

Information on willingness to pay for rural sanitation facilities is virtually non-existent. It appears that willingness to pay may be heavily dependent on culture and level of development. In many instances (e.g. Bangladesh), except for the wealthiest villagers, willingness to pay is very low, and often, even if the services are provided free of charge, the facilities will not be used. In other countries (e.g. Thailand), willingness to pay may be substantially higher. Empirical data are needed.

Health impact

In general, the health impact of using basic rather than no sanitation facilities is probably lower in rural than urban areas. As in urban areas, there is unlikely to be additional health impact from the use of higher levels of service.

Overall role

Where willingness to pay is high, rural programs for the provision of basic services will often be cost-effective investments of health sector resources. Where willingness to pay is low, these programs become less cost-effective, particularly since adequate maintenance of the facilities is unlikely. The provision of higher levels of service is unlikely to be a cost-effective intervention in either urban or rural areas, and therefore such programs should not be subsidized from public funds.

BACKGROUND

In 1978 at Alma Ata, the governments of the world committed themselves to reaching the goal of "Health of All by the Year 2000" by implementing a comprehensive set of Primary Health Care programs. In a related development in 1979 in New York, the decade of the 1980's was declared the "United Nations' International Drinking Water Supply and Sanitation Decade," and ambitious targets were set for the provision of adequate water supply and sanitation facilities for all by the year 1990.

Implicit in the resolutions of Alma Ata and New York were two assumptions. First, it was assumed that improvements in water supply and sanitation conditions were an indispensable element in an overall strategy of health improvement. And, second, it was assumed that, primarily through large increases in development assistance, increased resources would become available to the health sector in general and to the water and sanitation sector in particular.

When governments and international agencies came to draw up specific plans for implementation of these resolutions, however, a series of problems arose. It was immediately apparent that there were serious **resource availability** problems arising both from the political commitment of developing country governments to maintaining expensive, subsidized services for the middle class in urban areas, and from the generalized economic crisis which limited the

mobilization of resources from domestic and external sources. In light of these resource limitations, it was apparent that neither could all components of Primary Health Care be implemented simultaneously, nor could adequate water supply and sanitation facilities be constructed in all urban and rural areas. In other words, it was obvious that difficult **resource allocation** decisions would have to be made. And, finally, it was evident that the closely related issue of **financing** of services was a key to developing sustainable health and water supply and sanitation programs.

These concerns are fundamental to the development of USAID policies in general, and Asia Bureau policies in particular. At the Asia Bureau Health, Population and Nutrition Conference in 1982 it was concluded that AID resources available through the health account should be used primarily to support health interventions which were deemed cost-effective in terms of reducing young child mortality. General AID health sector policy dictates that water supply and sanitation facilities should be part of PHC programs "only when financial resources and support systems are available(USAID, 1982b);" the Asia Bureau has tentatively concluded that such conditions may exist only in the better-off countries of the Region, such as Thailand and the Philippines (Asia Bureau, 1983).

Not entirely satisfied that this analysis captures the complexity of water supply and sanitation issues in the context of the health sector in the Region, the Asia Bureau

has commissioned this "issues paper" in the hope that this will assist Bureau of Mission staff in identifying the appropriate role of water supply and sanitation activities in light of limited development assistance funds for health.

In preface, it should be reiterated that this is an **issues** paper, not a **policy** paper. The purpose is to develop a framework which helps identify the salient underlying issues in water and sanitation programs as part of the health sector, to sum up what is known and not known at present about each of these issues and to suggest what might be worth trying to find out through future studies.

CONCEPTUAL FRAMEWORK

The objective of USAID activities in the health sector is to assist countries develop sustainable programs for reducing severe morbidity and mortality, especially among young children. AID is able to influence the attainment of this objective in two ways: particular health sector programs can be funded by USAID, and recipient government policy in the health and related sectors can be influenced. The objective of our analysis is to suggest under what conditions water supply and sanitation programs might be included in the AID health sector portfolio, and which recipient country policies in the water supply and sanitation sector might be the object of a "policy dialogue" between USAID and the recipient country.

As a first step in clarifying the key concepts neces-

sary for a description of the problem, it proves useful to focus our attention on two related policy decisions, namely how to allocate health sector resources among various health-related activities (including water supply and sanitation services), and how to finance such activities.

In applying these general principles of public finance (Musgrave, 1959) to the specific problem of the role of water supply and sanitation programs in the health sector, two principles are of fundamental importance. These are:

(i) **Resource allocation:** Additional resources should be allocated to any given activity as long as the extra net benefit to society exceeds the benefit foregone from the best alternative use of the same resources;
(ii) **Financing:** Under ideal conditions user charges, based on long-run marginal cost, promote both efficiency and financial viability.

The classic method for application of these principles is that of benefit-cost analysis. Computing the dollar benefits of water supply and sanitation projects, however, is virtually impossible because of the multiple impacts of such projects, the difficulty in accurately predicting the results of these many impacts, and the arbitrariness of the procedures for reducing the multiple impacts to a common denominator. In practice, therefore, it is necessary to allow the users themselves to (implicitly) transform the vector of perceived outputs into a dollar value and to use the resulting "willingness to pay" for the service as a partial guide to resource allocation. Although exclusive reliance on this criterion is inappropriate primarily

because individual consumers do not perceive all impacts accurately and because they take no account of "external" benefits, recognition of the concept of consumers' willingness to pay is "absolutely essential to the achievement of noticeable improvement in water supply and sanitation in rural areas (Saunders and Warford, 1976)." Since 80 % of the $10 billion invested in water supply and sanitation facilities annually in the developing countries comes from the developing countries themselves (UNDP, 1984), the extent to which the costs of water supplies can be recovered from both urban and rural beneficiaries will be the primary determinant of the pace at which coverage can be increased (Shipman, 1984).

The implications of the general principles of public finance for both the health and the water supply and sanitation sectors have been carefully enunciated, particularly by the World Bank. As we proceed with our analysis it will become evident that much of the discussion hinges on a clear understanding of the conditions under which a substantial public role (including subsidies) is or is not appropriate. Accordingly, drawing heavily on the work of de Ferranti (1983), we outline the factors which need to be taken into account in determining the correct role of the public sector, and the closely related issues of the roles of subsidies and user charges, in different health-related activities.

Appropriate roles for the public and private sectors

Arguments in favour of a public role

It is often argued that market mechanisms are inherently incapable of ensuring the socially optimal allocation of resources available to the health sector because:

... for certain categories of service (such as immunizations) the benefits of participation are not limited to those who participate (i.e. externalities are often large);
... difficulties in evaluating and perceiving the effects of health-related services mean that consumers of health services often cannot make rational, well-informed choices;
... the possibilities for competition among suppliers of certain types of services (such as urban water supplies) are limited;
... decision-making power is not equally distributed either among different economic classes or among different family members.

Arguments against a strong public role

It is also often argued that, for at least certain health-related activities, market mechanisms are preferable to mechanisms which rely on a strong public role because:

... the alleged market failures outlined above apply only to certain health-related services, not all;
... goods and services are produced more efficiently by the private sector;
... private markets may be more effective in mobilizing resources for health-related activities than mechanisms which rely chiefly on tax revenue.

The appropriate roles of the public and private sectors in different health-related activities

Still following de Ferranti's analysis closely, in the following table health-related activities are separated into three main groups, depending on the appropriate role of the public sector.

TABLE 1: Public & Private Sector Roles in Health Programs

GROUP	CHARACTERISTICS	APPROPRIATE PUBLIC SECTOR ROLE?	APPROPRIATE PRIVATE SECTOR ROLE?	EXAMPLES OF ACTIVITIES
A	**Public sector role?** Large externalities Uninformed consumers Often public goods	MAJOR	MINOR	Spraying against malarial mosquitos
	Private sector role? Unlikely to mobilize resources			
B	**Public sector role?** Social benefits often exceed private benefits Consumers' information imperfect	SOME	SOME	Preventive MCH services
	Private sector role? Disadvantaged groups' needs might not be met Resource efficiency might be improved through competition			Rural water supplies Basic excreta disposal services
C	**Public sector role?** Externalities small Consumers well-informed Production sometimes a natural monopoly	MINOR	MAJOR	Curative medical services
	Private sector role? Potential for resource mobilization high Production efficiency through competition often possible			Urban water supply High level excreta disposal services

Appropriate roles for user charges and subsidies

Water supply and sanitation services can be financed either through user charges or through subsidies from public funds. The arguments which determine the balance between subsidies and user charges are closely related to the above arguments which determine the balance between public and private sector roles, but supplemented by additional points from pricing theory (de Ferranti, 1983). Accordingly, the activities in Group A (such as spraying of malarial mosquitos) are those for which subsidies from public funds are appropriate and user charges inappropriate, the activities in Group B (such as rural water supplies and basic sanitation services) are those for which a mixture of public subsidies and user charges are appropriate, while those in Group C (such as urban water supplies and higher levels of sanitation service) are those for which full cost recovery through user charges is desirable.

A simple resource allocation model

A fundamental difficulty in comparing investments in, say, water supply facilities with investments in, say, a tetanus vaccination program is that water supply facilities have multiple impacts (economic, social, and health) while a vaccination program affects only health outcomes. If such programs are compared by comparing total costs with health impacts, by, for instance, comparing the "cost per infant death averted" (Walsh and Warren, 1979), then it is not

surprising that the programs which have a unique impact appear superior to those which have multiple impacts" (Briscoe, 1984).

One approach to resolving this incomparability problem is to attempt to partition out the costs of the water supply program, and then to use that part of the total cost which is assigned to the health impacts as the numerator in the cost-effectiveness calculations. In general, this problem of joint cost allocation is a difficult one; in the particular case of water supply and sanitation programs, with a reasonable set of assumptions such partitioning can be done, thus making comparisons of water supply and sanitation projects with other health projects possible.

Specifically, it may be assumed that:

(i) amenity benefits (including time savings in the case of water supply and privacy, convenience and status in the case of excreta disposal) are perceived accurately;
(ii) health benefits do not affect household decisions both because these benefits are not perceived by the household and because the benefits are partially external to the household (i.e. they accrue to others who may not use the service);
(iii) the value placed on the vector of perceived benefits can be measured by willingness to pay.

Where it is possible to estimate the costs of, the willingness to pay for, and the health impact of different levels of water supply and sanitation service, Table 2 below can be constructed.

TABLE 2: Assessing the cost per unit of health impact of water supply and sanitation investments

SERVICE LEVEL (I)	COST (CAPITAL + O&M)	WILLINGNESS TO PAY	COST TO GOVT	HEALTH IMPACT	MARGINAL IMPACT ---------- MARGINAL COST
1(high)	C_1	W_1	$G_1=C_1-W_1$	I_1	$(I_1-I_2)/(G_1-G_2)$
2(intermediate	C_2	W_2	$G_2=C_2-W_2$	I_2	$(I_2-I_3)/(G_2-G_3)$
3(low)	C_3	W_3	$G_3=C_3-W_3$	I_3	I_3/G_3
4(no improvement)	0	0	0	I_4	--

From Table 2 it may be seen that where consumers are willing to bear a substantial portion of the costs of services, only a small part of the total cost becomes attributable to health, and the activity becomes relatively more cost-effective than would otherwise be the case. While the same logic applies to other health projects, in general consumers are only willing to pay for curative services (which have a limited impact on health). Thus, while full costs can be recovered from the consumers of urban water supplies, user charges are typically able to recover only about 15% of the costs of publicly provided health services in developing countries (de Ferranti, 1983).

From Table 2 it is apparent that, in determining the appropriate level of service in a particular community, there are two different "solutions." First, there is the "market solution": without any public intervention, the level of service provided will be that for which the population is willing to pay (i.e. the highest level of service

for which $W_R \geq C_R$). This "solution" may be level 4, i.e. no improvement, in many cases. Second, there is the "socially optimal" solution: if the marginal impact: marginal cost ratio for any level of service (say level "n") is higher than the marginal impact: marginal cost ratio for all alternative programs in the health sector, then G_R units of public resources should be invested (along with W_R units of private resources) to ensure that the socially-optimal level of service ("n") is provided.

In the remainder of this paper we will

(a) assess the implications of the model for the overall policy issues of resource mobilization, resource allocation and financing;
(b) assess the implications of the model for specific policy issues which have been identified as key by USAID (such as the correct roles for the public and private sectors, the development of strong institutions, support for existing local organizations, and mechanisms for dealing with recurrent costs);
(c) summarize the state of existing knowledge of each of the information needs of the model and suggest priorities in strengthening this information base;
(d) draw some tentative conclusions on the implications of the model for the role of water and sanitation programs in the overall health sector strategy in the Asia Region.

Information needs

In attempting to use the simple allocation model to investigate the appropriate role for water supply and sanitation activities in the Asia Bureau health sector portfolio, the following specific questions need to be answered:

Question 1: What resources are available for allocation to water supply, sanitation and other health-related activities?

Question 2: What are the costs of different levels of water supply and sanitation services?

Question 3: How can these costs be reduced?

Question 4: What is the willingness to pay for different levels of service in different natural and economic settings?

Question 5: What financing mechanisms can be used to recover the costs of water supply and sanitation services?

Question 6: How can institutions, particularly existing local organizations, in the water supply and sanitation sector be strengthened:

Question 7: What is the health impact of different levels of water supply and sanitation service in different settings?

The remainder of this paper is devoted to an analysis of these questions.

Question 1: What resources are available for allocation to water supply, sanitation and other health-related activities?

To governments of developing countries, the most important constraint in improving the level of water supply, sanitation (and other basic health services) is often perceived to be the paucity of public resources available for construction and maintenance of facilities. In specifying the level of resource availability, however, it is generally assumed that the "available resource" are those which are available after allocations have been made to "existing commitments." What are these "existing commitments?"

It is generally assumed that subsidies in this sector are justified in order to maintain basic services to those who cannot afford to pay the full marginal cost of such services. In fact in many developing country settings subsidies are used to underwrite the costs of the very high levels of water supply and sanitation services which are enjoyed by the politically important middle and upper class urban consumers. The urban poor, however, often pay the full marginal costs for their services, or pay very high unit costs because the formal services do not reach them. To quote just two of many such examples, in Lima, Peru, residents of poor areas which are not reached by the piped water supply system pay more than 20 times more than the middle class for a cubic meter of water (Adrianza and Graham, 1974), and in Surabaya, Indonesia, the rate for the unserved poor is between 20 and 60 times the rate for those

served by the piped water system (Suleiman, 1977). For the health budget the situation is similar, with the majority of resources spent for curative services for the middle and upper classes in urban areas.

Reflecting back on the early discussion of activities for which subsidies are or are not justified (summarized on Table 1), it is striking that large portions of the water, sanitation and health budgets in developing countries are spent on precisely those activities (viz. urban water supply, waterborne sewerage, and curative medical services) for which the justification for public subsidies are the weakest. Exacerbating this inappropriate resource allocation procedure is the fact that most of these subsidies do not go to poor people but to the upper and middle classes.

The upshot is that, when the size of the "pie" which is to be divided up amongst competing water supply, sanitation and health programs is being determined, consideration should not be limited to newly-available resources, but the resources which have historically been allocated to particular programs (usually high-level urban services for the middle and upper classes), too, should be included (see Mosley, 1983, and Goldman, 1984).

A useful exercise for the Asia Bureau, then, would be to document, for each of the countries in the Region, the existing allocations of public and private resources to health and water supply and sanitation activities, to identify the income groups who benefit from the expenditures of

public resources and to discuss the findings with the governments of the countries.

Question 2: What are the costs of different levels of water supply and sanitation services?

In Table 2 we outlined the information needed to make decisions on whether public resources should be allocated to water supply and sanitation activities. Under any particular setting it is necessary to know the costs of different levels of water supply and sanitation service (the focus of attention in this section), the willingness of different groups in the population to pay for such services, and the health impact of different levels of service (the focus of attention in subsequent sections).

Capital costs

Substantial information on the capital costs of water supply and sanitation facilities are available. The World Bank (Burki, et al., 1977) has estimated "typical" per capita capital costs as follows:

Table 3: Typical Capital Costs of Water and Sanitation Projects

	URBAN	RURAL
Water supply through public standposts	$30	$25
Basic excreta disposal facilities	$20	$ 5

In any particular setting, however, the actual capital costs might be quite different from these "typical" costs. In some settings (particularly arid areas) the costs of water supplies might be much higher, in others (such as in Bangladesh, where the groundwater table is high, where a

low-cost drilling method has been perfected, and where hand-pumps are locally manufactured), the per capita costs are much lower. As indicated in Table 4; costs also increase sharply as the level of service is increased.

TABLE 4: The Effect of Level of Service on Capital Costs of a Water Supply and Sanitation System for a Small Town (after Lauria, 1983)

LEVEL OF SERVICE	TYPE OF WATER SUPPLY	TYPE OF EXCRETA DISPOSAL	PER CAPITA WATER USE (lcd)	RELATIVE COST
I	Standpost within 100 meters	Household improved pit latrine	25	100%
II	One yard hydrant per household	Pour-flush toilet with soakaway	50	200%
III	One kitchen tap and shower per household	Pour-flush toilet with septic tank	100	340%
IV	One kitchen tap and shower per household	Pour-flush toilet with small-bore sewer	100	440%
V	Full plumbing	Conventional water-borne sewerage with	200	580%

Recurrent Costs

Because the focus of development agencies has largely been on the construction of new facilities, relatively good information is available on the capital costs of water and sanitation facilities. Typically, however, recurrent costs have been considered to be the responsibility of the recipient government or institution and have been of little more than passing interest in the project preparation procedure. As in many other development sectors, "the sheer absence of data on the recurrent expenditure implications of projects...is extraordinary" (Heller, 1979). In the absence of such data, "rules of thumb" based on little (if any) empirical data are used to "estimate" the recurrent costs of projects. (A common rule, which, for lack of better information is still used by certain major development agencies, assumes annual operation and maintenance costs of water projects to be 3% of the total capital cost of a project.)

This neglect of recurrent cost issues in the water and sanitation sector (as in other sectors) has had serious consequences. For many developing country governments it is easier to mobilize capital through grants or loans from donors than it is to generate the internal revenues needed for the operation and maintenance of facilities. The result is usually heavy overcapitalization, with the choice often being to build a new facility rather than to repair an existing malfunctioning facility. This "recurrent cost problem" has now been widely recognized by development

agencies. The World Bank considers the problem to be so serious that it has been suggested (Baldwin, 1983), that, in choosing technologies, the standard procedure of discounting future (recurrent) costs should be abandoned and that a dollar incurred in operations and maintenance in the future be considered equal to a dollar spent on construction at the beginning of a project.

The recurrent cost problem has been identified as a critical development problem by USAID. It is now AID policy that "all Project Papers should analyze the recurrent cost implications of the project" (USAID, 1982c). The difficulty with implementation of this policy, however, is that virtually no empirical data are available on the actual recurrent costs of water supply and sanitation services in developing countries. Accordingly, a high priority item in the water supply and sanitation sector is the collection and analysis of information on the recurrent costs of water supply and sanitation services and analysis of the effect of design, institutional and economic factors on these costs.

Question 3: How can these costs be reduced?

Water supply and sanitation facilities are expensive to construct and to maintain. If the populations served are to be increased, and if facilities are to be maintained through user charges, then it is essential that the capital and recurrent costs of these systems be reduced.

Sewerage and sanitation

Under the leadership of the World Bank, substantial advances have been made in the last decade in developing low-cost sanitation technologies which are appropriate for both urban and rural areas. As shown on Table 5 below, the average annual investment and recurrent costs per household for the low-cost systems (notably pour-flush latrines and ventilated improved pit latrines) are an order of magnitude less than similar costs for septic tank or sewerage systems (Kalbermatten et al, 1980).

Table 5: Average Annual Investment and Recurrent Cost per Household for Sanitation Technologies (after Kalbermatten et al, 1980)

	Mean Total Annual Cost per Household (1978 $)
Low-cost	
Pour-flush toilets	20
Ventilated improved pit latrines	30
Low-cost septic tank	50
Medium-cost	
Aquaprivy	170
Japanese vacuum-truck cartage	190
High-cost	
Septic tank	370
Sewerage	400

For areas in which the low-cost services are acceptable, the high-priority technical problems are now the development of technologies for desludging on-site latrines in urban areas and the further reduction of the unit cost of the latrines. In many intermediate-income urban areas, however, households can afford a higher level of service without yet being able to afford full water-borne sewerage.

A key element of the World Bank approach is that of "upgrading" (see Figure 1) from one service level to a higher level, as the availability of water increases and as willingness to pay increases. For the medium-cost technologies (such as low-volume flush systems) substantial applied research on the latrines, the sewers and the disposal systems is still required.

Water supply

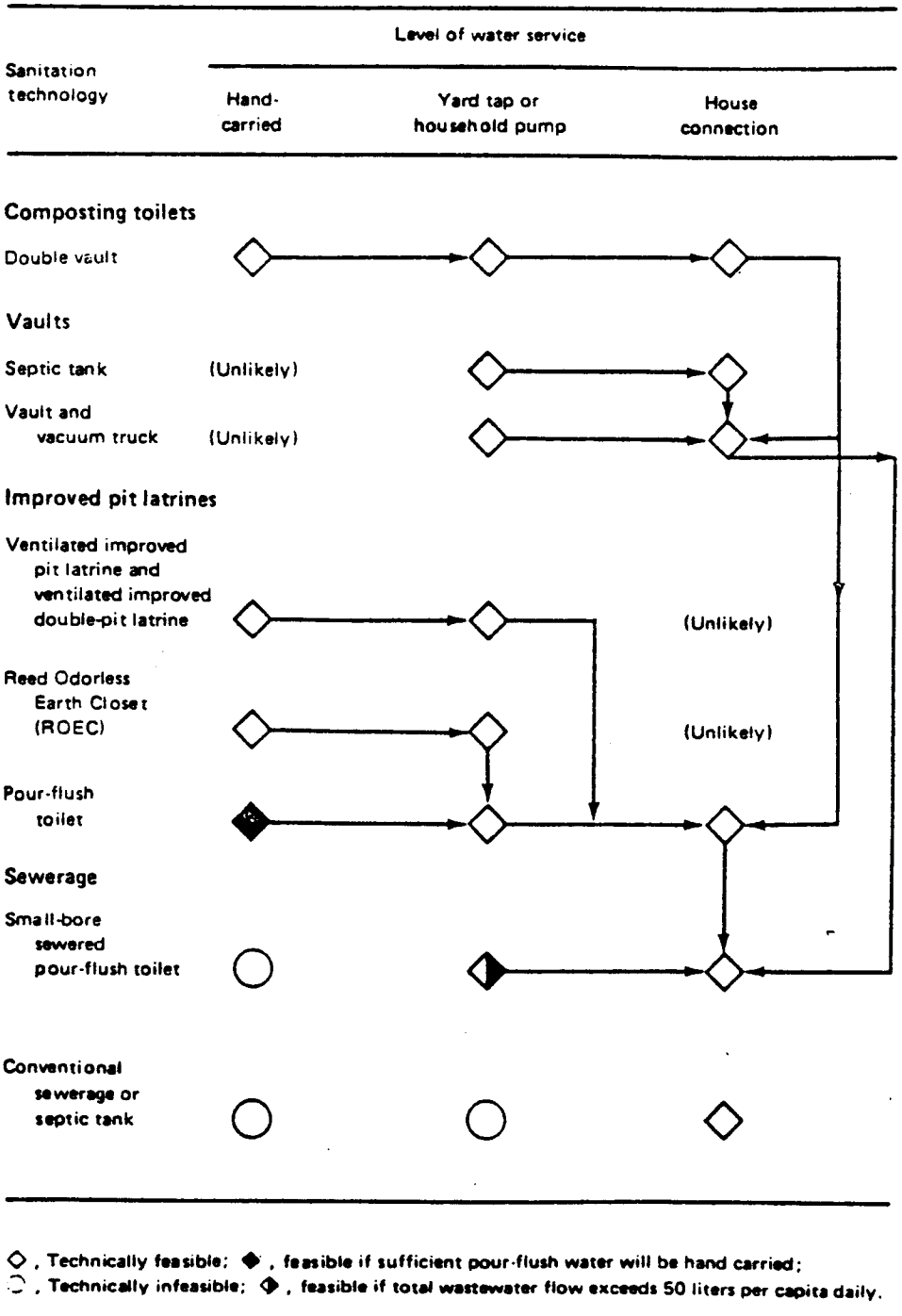
In water supply systems, as in sanitation systems, costs vary sharply with the level of service. Typically (as shown in Table 4), the investment required to pipe water into multiple taps in a household is an order of magnitude greater than that required to provide water through a communal standpipe or handpump.

Water distribution systems, which often comprise a major portion of the overall costs of a water supply system, are usually designed according to standards used in developed countries. In many circumstances this practice is inappropriate and leads to inefficient (i.e. more costly) designs. To cite but a few of many examples, it is evident that:

... because interest rates are much higher in developing than developed countries, less excess capacity should be built into developing country than developed country systems;
... minimum pressures in distribution systems can often be lower in many settings in developing countries;
... by reducing peak load factors and providing for in-house storage, the costs of distribution systems may be reduced.

FIGURE 1: POTENTIAL SANITATION UPGRADING SEQUENCES

(from Kalbermatten et.al., 1980)



In each case what is needed is a sustained theoretical and empirical investigation of methods for reducing system costs. In many cases good ideas will not work out the first time they are tried. Rather, it will be necessary (as with the current work being done by USAID and others on reducing peak load factors in systems in the Philippines and Indonesia), to carefully monitor initial experiments and to make a series of modifications until an acceptable operational procedure is developed.

A particularly grave problem facing most authorities responsible for water supply in most developing countries is that of unaccounted-for water. In any particular system there is an optimal level of leakage, at which the marginal cost of detecting and repairing leaks is balanced by the marginal cost of the water which is lost through these leaks. In the United States water supply utilities typically operate with about 12% of water not accounted for and with virtually all of this due to leakage in the system (Blum, 1978). In developing countries it is common to find utilities operating with between 60% and 70% of water not accounted for (Bachman and Hammerer, 1984). Much of this unaccounted-for water may not be lost through leakage but may be used by consumers who are not billed for the water. While this proportion of the water should not be considered as "lost" (since it is still being used for socially productive purposes), it is evident, first, that the levels of leakage in most systems are much greater than the optimal

levels, and, second, that the high levels of unaccounted-for water undermine the financial viability of the utility, making it impossible to raise sufficient operating revenues let alone raise the resources necessary for expansion of services. The World Bank and other development agencies, recognizing the importance of this problem, have started to make reductions in unaccounted-for water a condition for loans in this sector.

For larger cities the problems of reducing unaccounted-for water are extremely complex and require long-term commitments for their solution. The experience of Sao Paulo in Brazil, which has reduced the level of unaccounted-for water by about 50% over a ten-year period (Yassuda et al, 1981), shows that with the necessary commitment, progress can be made. For the most part, however, it is necessary for such large systems to draw upon specialized technical assistance from consulting firms or other utilities with particular experience in this area. Given the relatively small role of USAID in large urban water supplies in the Asia Region, this is probably not an area to which USAID resources should be devoted.

Although little documentation is available for any but the large cities, it is virtually certain that the situation for medium and small urban and rural water supply systems is equally serious. As with the larger utilities, high proportions of unaccounted-for water mean high unit costs of water and little possibility for the development of financially

viable institutions. In these settings (in which USAID activities are more significant than in the large urban setting), virtually no assistance is available to managers for dealing with the problem of unaccounted-for water. Because of the size and number of such systems, what is needed is a generic approach which indicates to a system manager what information needs to be collected and which, in light of that information and the general characteristics of the system, the most cost-effective measures for reducing unaccounted-for water might be. Development of such "guidelines" would be a contribution of major practical importance.

Question 4: What is the willingness to pay for different levels of service in different natural and economic settings?

Once the costs of different levels of services have been determined, the next piece of information required to assess the appropriate level of an activity (see Table 2) is the willingness of different groups in the population to pay for the service. As discussed earlier, clarification of the role of water supply and sanitation services vis a vis other investments in the health sector, and progress in both the urban and rural water supply and sanitation sectors depend critically on incorporating an understanding of the concept of willingness to pay into the planning and operation procedures.

(a) The determinants of willingness to pay

(i) Water

A simple notion of the concept of willingness to pay has been used to indicate to development agencies the level of service which consumers might be willing to support. Most commonly it has been (and is) assumed that consumers will be willing to spend no more than 5% of total income on water supply and sanitation services (Saunders and Warford, 1976), thus setting a limit on the technologies which are considered to be "affordable" in any particular setting. As the importance of the concept of willingness to pay has become more widely appreciated, and as more data on actual behavior have been gathered, it has become evident that income is but one of several factors determining willingness to pay, and that a more sophisticated understanding of the concept is required.

As an example of the shortcomings of the notion that willingness to pay is dependent on only the income of families, consider the experience of a series of USAID rural water supply projects in Northeast Thailand (Dworkin, 1980). In the first of these projects handpumps were installed. After a few years it was found that many families were not using the (free) supplies, and that over 50% of the handpumps were not working, in part because the population was unwilling to cover the costs of maintenance and operation. In a second project piped water was distributed through public standposts. The fate of the project was little

different, since the population again proved unwilling to pay for the costs of this service, but preferred to continue to use the traditional (often contaminated) surface water supplies. Finally, in a third project, USAID and the Government of Thailand decided to experiment with a higher (and more expensive) level of service. House connections were allowed, with connecting households required to pay the full costs of operation and maintenance of the systems. The fate of this project was very different: although the rates were substantially higher than rates in Bangkok, a high proportion of the families were willing to, and did, make the necessary regular payments for the service. The project, unlike its two predecessors, was a success. The institutions necessary to run the projects developed, and, because the consumers were willing to pay for the recurrent costs of the project, the institutions were financially viable.

In the present context the key message of the Thailand project was that willingness to pay was not uniquely a function of the income of the population, but was also dependent on the perceived quality (including convenience, reliability and perceived -- but not bacteriological -- water quality) of the improved service relative to the traditional service.

It is thus evident that a more satisfactory specification of the willingness-to-pay function for a family would take account not only of the income of the family, but also of the perceived quality of the improved service relative to

the perceived quality of the existing service. Where, as in the case of the handpumps and the standposts, the "new" service was, as in the case of the household connection project, perceived as being substantially superior to the existing service, then willingness to pay would be high. (A similar phenomenon exists for certain types of health care: contrary to what conventional price theory would predict, users in several countries prefer providers with higher fees over lower-cost alternatives, almost certainly because the higher perceived quality of the more expensive services [de Ferranti, 1983]).

In other settings, of course, where the existing source is not (as in Northeast Thailand) a nearby surface source, but a distant and unreliable borehole (as in many arid areas), then a reliable handpump nearer to the home will certainly be considered to be a major improvement over the traditional source.

In a similar vein, there are other factors which might be expected to affect willingness to pay for a water supply. The opportunity cost of time of household members is evidently important (as indicated by the high use of water vendors by single people in urban areas), and thus the willingness to pay might be expected to vary according to family composition and the opportunity cost of women's time.

A simple specification of the willingness-to-pay function, then, might be as follows:

Willingness to pay = f (income; opportunity cost of time; convenience, reliability & perceived quality of new service; convenience, reliability & perceived quality of old service.)

Table 6 is an attempt to indicate qualitatively the anticipated effect of some of these determinants on willingness to pay.

TABLE 6: Anticipated willingness to pay (as proportion of household income) for water services in different social and natural settings

		Income Group	URBAN Wet	URBAN Arid	RURAL Wet	RURAL Arid
LEVEL OF SERVICE	HIGH	Rich	+++++	+++++	+++	+++++
		Poor	+++	++++	++	++++
	MED-IUM	Rich	++++	+++++	++	++++
		Poor	+++	++++	+	+++
	LOW	Rich	+++	++++	+	++++
		Poor	++	+++	0	+++

Note: "+++++" indicates very high and "+" indicates very low willingness to pay.

(ii) Sanitation

Just as people value different levels of water supply service differently under different social and natural conditions, so, too, are different levels of excreta disposal facilities valued differently in different settings. Like water supplies, excreta disposal facilities confer benefits other than health benefits upon the user. Excreta disposal facilities are valued by users because of the privacy, convenience and status which ownership and use of such facilities confer on the household.

As was done in the water supply case, we can assume that:

(i) the amenity benefits (mainly privacy, convenience and status) are perceived accurately;
(ii) health benefits do not affect household decisions (because of lack of knowledge and externalities);
(iii) the value placed on the perceived benefits can be measured by willingness to pay.

As in the case of water supply, then, it is possible to "partition" the costs of an excreta disposal program so that only a portion of the total costs (specifically that portion that the consumers are not willing to pay for) are assigned as "health-related costs."

In the case of excreta disposal, the specification of the willingness-to-pay function is similar to that specified for water supply.

Willingness to pay = f (income; cultural factors; privacy, convenience and status of new sanitation system; privacy, convenience and status of existing system)

As before, it is possible (see Table 7) to speculate on the anticipated willingness to pay for different levels of excreta disposal facilities under different conditions.

Table 7: Anticipated willingness to pay (as proportion of household income) for sanitation services in different social and natural settings

		Income Group	URBAN	RURAL
LEVEL OF SERVICE	HIGH	Rich	++++	+++
		Poor	+	+
	MED-IUM	Rich	+++	++
		Poor	+	+
	LOW	Rich	++	+
		Poor	+	0

(b) Determination of willingness to pay in a particular setting

(i) Urban areas

A large number of studies of the impact of price on demand for water have been carried out in developed countries, using data collected through billing systems (e.g. Howe and Linaweaver, 1967). In general these studies have shown that the demand for water is relatively inelastic with respect to price (with a 10% increase in price typically accompanied by a 2% to 4% reduction in the quantity of water used). However, there are reasons to believe that such studies systematically underestimate the price elasticity of demand, because apparent price increases are often simply adjustments for inflation and because many price increases are instituted to finance capital works and thus price increases coincide with a spurt in previously suppressed demand (Golladay and Katsu, 1981).

As is the case for other health-related services (de

Ferranti, 1983), few adequate studies of the demand for water have been carried out in developing countries. However, because increases in water prices have a more drastic effect on the income of poor than wealthy people, it is anticipated that price elasticities in developing countries are high, particularly among the poor. In the low-income areas of many developing countries, households of similar socio-economic status are often served by quite different water supply systems. For instance, in some areas poor people may have access to the city water supply through standposts or house connections, while in other areas similar families rely on much more expensive non-piped distribution systems. Under such conditions it is possible to use cross-sectional data to estimate the demand for water and thus to determine the willingness to pay for water in low-income urban areas. Despite the advantages of such cross-sectional approaches, almost no efforts of this kind have been undertaken (Golladay and Katsu, 1981).

(ii) Rural areas

In a World Bank book on rural water supplies, Saunders and Warford (1976) review available studies on the willingness to pay for water in rural areas of developing countries. Most of these surveys have been carried out in Latin America, and most have been either superficial or have attempted to have villagers answer a series of hypothetical questions. In both cases little about willingness to pay has been learned. It appears that useful results will only

be obtained when actual practice is observed and inferences drawn from these observations. Saunders and Warford have suggested that an appropriate procedure may be to "test the market" by gradually introducing new tariffs and then observing the response of the users to new prices.

We would argue, however that there is a large amount of "revealed preference" type of information which has been collected, albeit not systematically, over decades of experience with rural water supply projects. Recalling that a good deal could be learned about willingness to pay for different levels of service in rural Thailand form the successful and unsuccessful AID projects, a useful first step might be to collect the information specified in Table 8 for a number of successful and unsuccessful rural water supply projects in countries in the Asia Region, and to use these data to qualitatively assess the effect of the income, opportunity cost of time, quality of prior service and quality of new service on choice of water supply. Obviously, such information would be most informative where it is national policy that beneficiaries pay for the services provided. Accordingly, it might be appropriate to start collecting information in those Asian countries -- of which there are several (Saunders and Warford, 1976) -- in which the beneficiaries are expected to pay part of the construction and all of the operation and maintenance costs.

Table 8: Information to be collected from successful and unsuccessful rural water supply projects.

PROJ. NAME	IN-COME GROUP	COMMUNITY CHARACTERISTICS			PRE-PROJECT SUPPLY				POST-PROJECT SUPPLY				CHOICES MADE	
		Income	Education	Opp.cost of time	Cost	Time	Level Serv.	Reliability	Perceived water qual.	Cost	Time	Level Serv.	Reliability	Perceived water qual.	Old or new?	Quantity
I	Poor Middle Rich															
II	Poor Middle Rich															

etc.

Question 5: What financing mechanisms can be used to recover (at least partially) the costs of investments in water supply and sanitation facilities?

For the operation of a water supply or sanitation service, revenues (from a combination of public and private sources) must be generated to cover the costs of the service provided. As suggested by Table 1, basic excreta disposal services and rural water services should be paid for through a combination of public subsidies and user charges, while urban water supplies can usually aim for full cost recovery from user charges.

User charges

For many reasons AID and many other development agencies are strongly supportive of a policy of charging users for water supply, sanitation and other services. The arguments for user charges include the promotion of efficiency and cost recovery, the development of financially viable institutions, and the initiation of self-sustaining programs in which resources for expansion are generated internally.

Water rates are often set on the basis of considerations of historical prices and the average cost of supply. Many development agencies (and the World Bank in particular) have argued that this procedure is incorrect and that the basic objective of a tariff system should be to provide an effective mechanism through which consumers can indicate whether or not the value to them of incremental output exceeds its cost. As the cheapest water sources are the

first to be tapped, the marginal cost price will normally be higher than the average cost, implying that utilities should be able to generate resources which can be used for expansion of services.

While incorporation of the concepts of willingness to pay and marginal cost pricing are fundamental to progress in the water supply and sanitation sector in developing countries, strict enforcement of these criteria would effectively mean that large numbers of people would be denied even basic services. Accordingly, in practice, it is generally advisable to modify the marginal cost approach by using a tariff schedule which consists of two steps: a low, subsidized "lifeline" rate for basic services, and a charge equal to the long-run marginal cost for all additional consumption (Saunders, et al, 1977).

Despite the clarity of the theory of marginal cost pricing, substantial practical problems still remain. For instance, in many developing countries mechanisms for encouraging connections to water and sewerage services are poorly developed, with substantial applied research being necessary in most cases (Little and Lauria, 1984).

Public subsidies

The institution of sound financing practices, including marginal cost pricing, is fundamental to progress in the water supply and sanitation sector in developing countries. Nevertheless, as discussed with reference to Table 2, where the health benefits (which are generally non-perceived and

external to the consumer) are substantial, public subsidies for water supply and sanitation services may be appropriate. These subsidies, which may take the form of grants, loans or low-interest loans, should correctly vary depending on the willingness to pay for the services, and on the anticipated health impact. Thus, for instance, it is the policy of the Indonesian Government to make grant financing available for urban water supply projects which provide a minimum level of domestic water consumption, to provide concessionary loans for higher levels of service and to force utilities to seek funds for further expansion from commercial sources or internally-generated funds (Porter, 1983).

The appropriate mix of public and private financing

The appropriate mix of public and private financing, as is implicit in Table 2, will depend, first, on the difference between the cost of a service and the willingness to pay for the service (with larger subsidies being required when this difference is larger) and, second, on the likely marginal health impact.

In the urban water supply sector, as indicated on Table 6, willingness to pay for services is high for all income groups at all levels of service. Accordingly, it is generally possible (and desirable) that urban water supply services aim for full recovery of all costs and even generation of funds for subsequent expansions of service. Despite this, as shown on Table 9, in a substantial number of

developing countries it is still not policy to recover full costs for urban water supplies.

Table 9: Cost-recovery policies in the water supply sector of 124 developing countries (after Saunders and Warford, 1976)

	O & M + capital	O & M + partial	O & M only	Partial O & M	No payment
URBAN	30%	24%	17%	26%	2%
RURAL	6%	16%	20%	31%	28%

In the rural water supply sector the situation is more complex. Where willingness to pay is high (for high-level services in wet areas and for any level of service in arid areas [see Table 6]), costs, too, are high. The combination of low per capita incomes and high per capita costs means that without some form of subsidy such services are seldom viable. Since the health benefits of improved rural water supply services are often substantial (a recent WHO review [Hughes, 1983] suggests that diarrheal disease morbidity is typically reduced by over 30% through such improvements), public subsidies are often used to cover some of the costs of such supplies. Accordingly, as shown in Table 9, cost recovery through user charges is much less common in rural than urban areas, with public subsidies being correspondingly greater in rural areas.

For basic sanitation services, while costs are often not as high as those of water supplies, willingness to pay (see Table 7) is typically much lower, particularly in rural areas. Since the health benefits of basic sanitation

services are probably higher in urban than in rural areas, and since willingness to pay is higher in urban areas, the proportion of population with basic sanitation services is correctly much higher (75% vs. 15%, Feachem, et al, 1983) in urban than rural areas. Even in urban areas, however, it is generally necessary to provide subsidies from public sources for the provision of basic sanitation facilities.

Question 6: How can institutions, particularly existing local organizations, in the water supply and sanitation sector be strengthened?

In the water supply and sanitation sector (as in other sectors of development activity), probably the most important reason for the slowness of progress is the inadequate development of local institutions to operate and maintain the services, and to generate the revenues necessary for reinvestment. Accordingly, USAID has afforded high priority in its overall development strategy to institutional development in general (USAID, 1983), and to the development of local organizations in particular (USAID, 1984b).

In urban areas there are generally two separate institutional problems which need to be addressed. First, and most obvious, there is the problem of development of the institution responsible for the operation and management of the piped water supply system. As indicated in Table 1, the arguments for a public role in urban water supplies is generally weak, with the most persuasive argument being the "natural monopoly" characteristic of such utilities. Since the monopoly issue can be addressed through the exercise of

oversight responsibility by a public board, the model of a regulated, privately-run water supply utility probably has considerable scope in many developing countries.

The second set of "institutions" in developing countries are far less identifiable and far less well understood. These "institutions" are the private vendors who distribute water to low-income urban dwellers who are not served by the piped water supply systems. As indicated earlier, the rates paid by the poor urban dwellers who are served by these informal systems are typically an order of magnitude higher than rates paid by those served by the formal system.

From one perspective, these vending systems appear to be simply an anachronism which will disappear when the efficient means of transporting water (by pipeline) replaces the inefficient means (transport by truck, by animals, and by humans) on which they depend. On the other hand, despite major efforts in urban water supply for many years, the numbers served by such systems are very large, (typically accounting for 20% - 30% of total urban population) and are increasing.

Part of USAID's general development policy mandates that rather than creating new organizations, support should be directed to pre-existing local organizations, particularly in the service sectors. As indicated in the USAID policy document (USAID, 1984b), it should be general policy to strengthen existing organizations prior to considering the

development of new ones because:

> "(a) existing organizations persist because they often meet real needs and serve their clientele well, whereas new organizations may take years to become effective and gain local credibility; and
> (b) even where existing local organizations seem deficient to planners, it is unlikely that new organizations will escape whatever administrative, technical or political pathologies weaken the existing organizations."

Accordingly, as with other private enterprise development projects (USAID, 1982a), attention should be given to identifying and evaluating the constraints under which the organizations operate and to eliminating or reducing these constraints. Given the almost total ignorance of how vending systems operate (Okun, 1982), the first step needs to be field research aimed at documenting the engineering, financial, economic and social aspects of the operation of these institutions. Given the enormous financial drain placed on poor families by the cost of water delivered through these systems (in Lima, Peru, for instance, for those served by vendors, payments account for as much as 25% of family income) and given the high priority accorded the urban poor in the Asia Bureau Health Population and Nutrition Strategy (Asia Bureau, 1984), such field research is of high priority.

In the urban sanitation sector the situation is similar in some respects. In the Indian sub-continent, for instance, many poor urban dwellers rely on "scavengers" for the removal of night soil, yet little is known -- with the exception of one excellent study in Karachi (Streefland,

1976) -- of the operation of these informal institutions. As low-cost urban sanitation programs expand (as is occurring rapidly in the Asia Region), so too will the need for institutions which service these facilities expand. Given USAID's commitment to private sector institutional development, and given the relatively poor performance of the main actors in this sector in terms of institutional development, this could be an opportunity for USAID to make a substantial contribution.

In rural areas the institutional problems are even more difficult and even more poorly understood than in urban areas and will only be touched on in this presentation. As was implicit in the Thailand example described earlier in this paper, it may be that in many cases the problems most commonly identified (technology which is too complex, lack of spare parts and motivated and trained manpower) are not primary problems but rather reflections of the fact that the service which has been provided is not valued by the population. Consequently, it may be that a major part of the solution to the problems of weak water supply institutions in rural areas is a more thorough assessment of recurrent costs and willingness to pay in the planning phase of rural water projects. In addition, although this occurs at a much lower level than in urban areas, there are rural vending systems in many parts of the developing world. Careful analysis of the operation of these systems might well provide useful insights both into the factors which affect

willingness to pay for water and the possibilities for private sector involvement in the operation and maintenance of rural water supply systems.

Question 7: What is the health impact of different levels of water supply and sanitation service in different settings

The final requirement of Table 2 is information on the health impact of different levels of water supply and sanitation service under different social and natural conditions.

Large numbers of studies of the health impact of water supply and sanitation programs have been conducted throughout the developed and developing world for many years. Two excellent recent books summarize the available data on the health impact of water (McJunkin, 1983) and sanitation (Feachem, et al, 1983) interventions. As indicated in Table 10, evaluations of the health impact of water supply and sanitation projects typically show reductions in morbidity due to diarrheal diseases of over 30%.

Despite the large number of studies which have been carried out, little of the available information is useful in estimating the likely health impact of different levels of water supply and sanitation services. This is so in part because most studies have concentrated on whether a particular program had an effect on health outcomes and have not addressed the more important policy question of the differential impact of different levels of services.

With respect to water supply, the pioneering work of

TABLE 10: THE EFFECT OF WATER SUPPLY AND SANITATION PROGRAMS IN 24 NON-INTERVENTION STUDIES (after Hughes, 1983)

Parameter Affected	Number of Studies	Per Cent Reduction in Diarrheal Diseases (median)
Water quality	6	30
Water availability through standpipes	11	34
Quality and availability	4	40
Excreta disposal	8	40

TABLE 11: THE TRANSMISSION OF WATER-RELATED INFECTIONS (after White, Bradley and White, 1972)

Transmission mechanism	Preventive strategy
Water-borne	Improve quality of drinking water Prevent casual use of other unimproved sources
Water-washed	Increase water quantity used Improve accessibility and reliability of domestic water supply Improve hygiene
Water-based	Decrease need for contact with infected water[a] Control snail populations[a] Reduce contamination of surface waters by excreta[b]
Water-related insect vector	Improve surface water management Destroy breeding sites of insects Decrease need to visit breeding sites Use mosquito netting

David Bradley (White, Bradley and White, 1972) clarifies the mechanisms by which improved water supplies affect health. Specifically, as shown in Table 11, improvements in the quality of water affect the transmission of water-borne diseases, and improvements in the quantity of water used for hygienic purposes affect the transmission of water-washed diseases.

On a priori grounds, Bradley's system suggests that basic services (such as a community standpost) may be sufficient to reduce the transmission of water-borne diseases (providing the quality of water at the source is adequate and contamination does not occur in transportation and storage), but that reductions in water-washed diseases depend on attaining that level of service necessary to induce the use of increased quantities of water for personal hygiene. What of the empirical evidence?

Shigellosis is the classic example of a disease which is primarily water-washed. In Table 12, the results of four shigella studies carried out in different settings in the 1950s are summarized. From these data it is not possible to assess the impact of the provision of the most basic level of service (since no data are available on families without an improved water supply), but it appears that there is (in the specific case of shigellosis) little benefit to having water delivered to the yard rather than off the premises, and that there is a substantial improvement when water is actually available inside the house. In Table 13, the

TABLE 12: SHIGELLA PREVALENCE RATES AND LEVELS OF WATER SUPPLY AND SANITATION (from McJunkin, 1983)

Sanitary Facilities for Each Dwelling	*Kentucky 1954-56 %*	*Guatemala 1955-56 %*	*California 1952-53 %*	*Georgia 1949-53 %*
Water Inside/Flush Toilet Inside	1.1	-	1.6	0.4
Water Inside/Privy Outside	2.4	6.3	3.0	2.2
Water Outside/Privy Outside	5.9	9.4	5.8	5.0
Water on Premises	5.8	-	-	4.1
Water off Premises	6.0	-	-	5.8

TABLE 13: DIARRHEA INCIDENCE AND WATER SUPPLY IN INDIA (from McJunkin, 1983)

Source	*Diarrheal Incidence %*	*Reduction From Open Well %*
Open Well	18.4	—
Standpost	7.8	57.7
House tap	6.2	66.3

results of a study of diarrheal incidence among children in India are reported. These data suggest, in contrast to the data in Table 12, that the major gain occurs when the quality of the outside water source is improved, and that little further is gained by piping the water into the house.

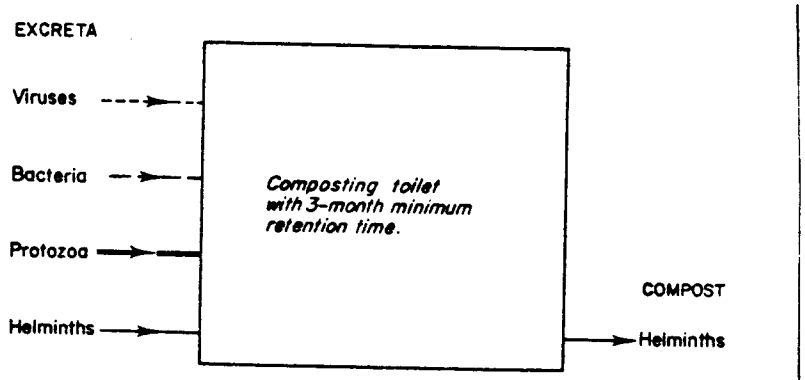
The results of these studies on the impact of different levels of service on diarrheal disease are, then, contradictory. The first set of data suggest that a high level of service is necessary before transmission is interrupted, while the second suggest that only moderate improvements in service will suffice. While there are many possible explanations which could reconcile these findings (perhaps because the studies dealt with different outcomes, perhaps because of characteristics of the populations studied) the fact remains that existing empirical data give no basis for a universal conclusion of the impact of different levels of water supply service on health outcomes.

With regard to sanitation, as demonstrated in Figure 2, on a priori grounds there is little reason to believe that a well-maintained improved pit latrine or pour-flush latrine would have less impact on health than a much more expensive water-borne sewerage system.

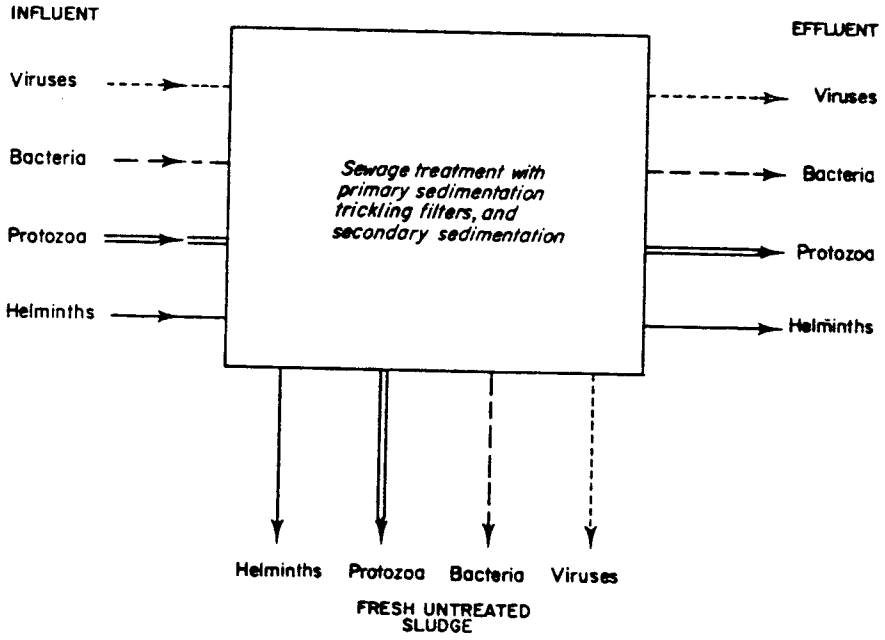
As was the case with water supply, however, few empirical data are available on the effect of different levels of sanitation service on health. From the Georgia and Kentucky data on Table 12 it would appear that there is little impact when a family changes from using no privy to using an

FIGURE 2: PATHOGEN FLOW THROUGH LOW-COST AND HIGH-COST SANITATION SYSTEMS

(after Feachem, et.al., 1983)



Pathogen flow through a batch composting toilet (double-vault)

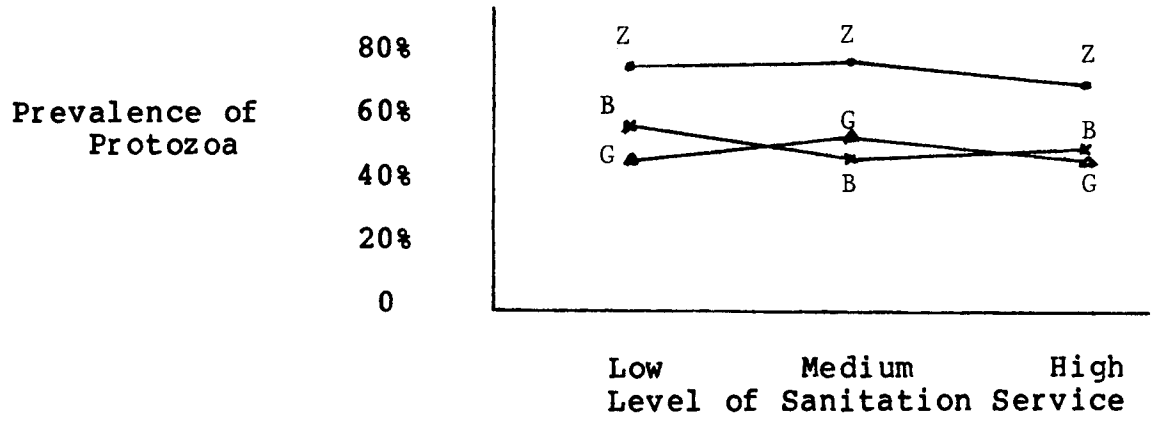


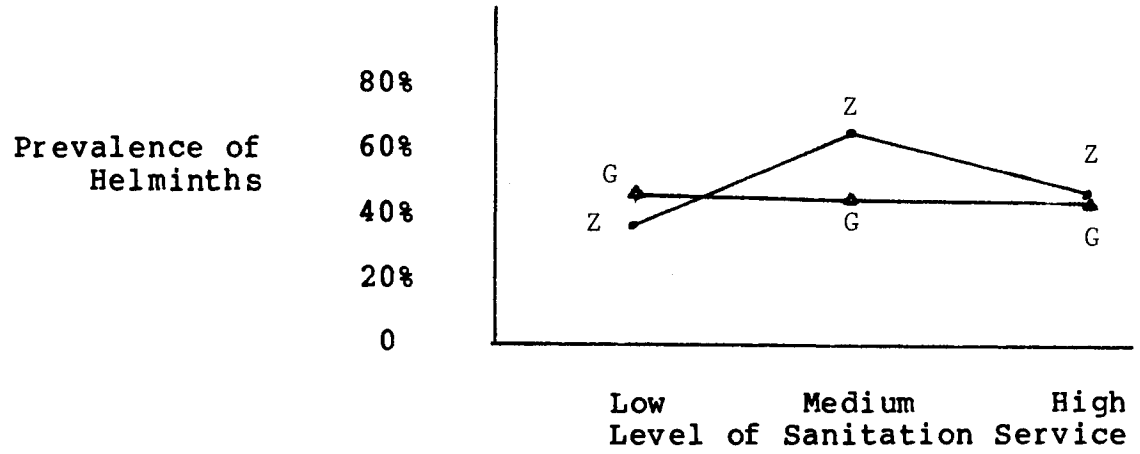
Pathogen flow through a conventional sewage treatment plant featuring trickling filters

outside privy (comparing lines 3 and 5) but a substantial improvement when an inside rather than an outside privy is used (comparing lines 1 and 2). In Figure 3, the results of a recent study of the effect of the level of sanitation service on intestinal parasitism in urban areas of Africa are presented. These results do not indicate whether families using any latrine have a lower incidence of parasitism than those who do not use such facilities, but do suggest that after a basic level of service is met there is little additional health benefit from the (very expensive) further improvements in service. As in the water case (and perhaps for similar reasons), these results are contradictory, with one set of data suggesting that a high level of service is necessary if health impact is to be substantial, and one set of data suggesting that the marginal health benefits from increasing the level of service above a basic level are small.

There are several reasons why the state of knowledge on the impact of different levels of water supply and sanitation services is so poor. First, it is extremely expensive (sometimes costing over $1 million per study) and takes a long time (at least 5 years) to conduct such studies using the standard quasi-experimental design. Few of the published studies have had the necessary resources available. Second, even where the studies have had these resources available and have been well designed and executed, there are systemic problems with the methodology

FIGURE 3: INTESTINAL PARASITISM AND THE LEVEL OF SANITATION IN THREE AFRICAN CITIES (after Feachem et.al., 1983b)





Legend: Countries are represented by the following symbols: B -- Botswana, G -- Ghana, and Z -- Zambia.

leading, in most cases, to meaningless results (Drake, et al., 1983). Most published studies of the impact of water supply and sanitation programs suffer from such serious methodological problems (Blum and Feachem, 1983) that little credence can be placed in the results. Indeed, the situation is so serious that an Expert Panel, convened by the World Bank in 1975, concluded that:

> "because of the high cost, limited possibility of success and restricted application of results (of studies of the quantitative relationship between water supply and health)...the Bank should not undertake such studies [World Bank, 1976]."

Since 1975, however, there have been two major advances which suggest that it may now be possible to develop a more valid and yet rapid and inexpensive method for assessing the health impact of different levels of water and sanitation service. First, while in 1975 diarrhea was an "inscrutable syndrome" (since pathogens could be isolated in less than 20% of cases), today, largely because of the identification of rotavirus, enterotoxigenic E. coli and campylobacter as major diarrhea pathogens, it is now possible to identify pathogens in about 40% of cases detected through field surveillance, and around 80% of cases which are serious enough to report to a clinic (Black, 984). Second, over the last fifteen years (primarily in connection with chronic diseases in developed countries) there has been rapid progress in understanding of the problems of case-control studies and in the development of methods for improving the reliability of the method. It is now appreciated that the

method offers substantial possibilities for the conduct of rapid, inexpensive yet valid epidemiological studies of a variety of infectious disease problems (Smith et al, 1983). Over the past year, under the auspices of the WHO, the usefulness of the case-control method in evaluating the health impact of water supply and sanitation programs has been assessed (WHO, 1985). The method seems to hold promise for providing, at modest cost and in a short time, site-specific information on key policy questions (such as the impact of different levels of service on the incidence of severe diarrhea). If, after the initial field trials are completed, the method is deemed to provide valid results, then planners will have a tool which can be used to provide information on the health impact of different levels of service. Because it should take no more than six months to complete such studies, it should be possible to provide answers to specific policy-relevant questions during the early stages of the project preparation cycle.

A final, difficult complication has to be dealt with in assessing the health impact of water supply and sanitation facilities. On both theoretical (Briscoe,1984) and empirical (Shuval, et al., 1981) grounds, it is evident that the impact of a water supply and sanitation program depends on the efficiency with which pathogens can be transmitted through alternative routes (particularly food and person-to-person transmission). Where these other routes are still operative, the reduction in disease incidence due to a

program which improves water quality may be small, while where transmission through these routes has been reduced, the effect of a similar water program will be much greater. This does not mean that in the latter setting the water program has no health impact, but rather that the full effect of the program will only be realized once improvements in other transmission routes have been made.

This phenomenon is particularly important because, if it is ignored, then there will be a tendency to invest in water and sanitation projects only where levels of living are already fairly high (Shuval et al, 1981). While it is not yet clear how to incorporate this phenomenon into the planning process, a first step might be to weigh health improvements among poor populations higher than improvements among better-off populations.

REFERENCES

1. Adrianza, B. T. and G. G. Graham (1974), "The high cost of being poor: water." Archives of Environmental Health, 1974; 28, 312-315.

2. Asia Bureau (1983), "Asia Regional Strategic Plan, Revision I," Washington, D. C., 72 pages.

3. Asia Bureau (1984), "Recommendations for improved HPN program implementation within the Bureau for Asia," Washington, D. C.

4. Bachmann, G. and M. Hammerer (1984), "80% of losses come from 20% of leaks," World Water, October, 1984, pp. 48-50.

5. Baldwin, G. B. (1983), "Why present value calculations should not be used in choosing rural water supply technologies," World Development, 11; 12, 1075-81.

6. Black, R. E. (1984). "Diarrheal diseases and child morbidity and mortality," Population and Development Review, Supplement to Vol. 10, 1984, pp. 141-161.

7. Blum, D. and R. G. Feachem (1983). "Measuring the impact of water supply and sanitation investments on diarrhoeal diseases: problems of methodology," Int. J. Epidemiology, 12(3).

8. Blum, R. G. (1977). "Water conservation strategy for OWASA," MS thesis, UNC-CH, 170 pages.

9. Briscoe, J. (1984a). "Water supply and health in developing countries: Selective primary health care revisited," Am. J. Public Health, 74;9, 1009-1013.

10. Briscoe, J. (1984b). "Intervention studies and the definition of dominant transmission routes," Am. J. Epidemiology, Vol. 120, no. 3, 449-455.

11. Burki, S., et al. (1977), Global Estimates for Meeting Basic Needs: Background Paper, World Bank, Washington, D. C.

12. De Ferranti (1983), Health Sector Financing: An Overview of the Issues, Population, Health and Nutrition Department, World Bank, Washington, 61 pages.

13. Drake, W. D., R. I. Miller and D. A. Schon (1983), "The study of community-level nutrition interventions: an argument for reflection in action," Human Systems Management, 4, 82-87.

14. Dworkin, D. M. (1982), Community Water Supply in Developing Countries: Lessons from Experience, AID Program Evaluation Report No. 7, Washington, D. C., 81 pages.

15. Feachem, R. G., D. J. Bradley, H. Garelick and D. D. Mara (1983a), Sanitation and Disease: Health Aspects of Excreta and Wastewater Management, Wiley, N. Y.

16. Feachem, R. G., et al. (1983b), "Excreta disposal facilities and intestinal parasitism in urban Africa: preliminary studies in Botswana, Ghana and Zambia," Trans. Roy Soc. Trop. Med. Hyg., 77(4), 515-521.

17. Goldman, W. R. (1984), "Financial viability for the health sector," Asia Bureau, USAID, Washington, D. C., 6 pages.

18. Golladay, F. L. and S. Katsu (1981), "The role of prices in management of water resources," in Water for Human Consumption, papers presented at IVth World Congress of the International Water Resources Association.

19. Heller, P. (1979), "The underfinancing of recurrent development costs," Finance and Development, March, 1979, pp. 38-41.

20. Howe and Linaweaver (1967), "The impact of price on residential water demand and its relation to system design and price structure," Water Resources Research, 3(1), 13-32, 1967.

21. Hughes, J. M. (1983), "Potential impacts of improved water supply and excreta disposal on diarrheal disease morbidity: an assessment based on a review of published studies," Center for Disease Control, Atlanta, 30 pages.

22. Kalbermatten, J. M., D. S. Julius and C. G. Gunnerson (1980), Appropriate Technology for Water Supply and Sanitation: Technical and Economic Options, World Bank, Washington, D. C.

23. Lauria, D. T. (1983), "Water supply in developing countries: capacity costs and pricing;" paper presented at NCIH Conference, Washington, D. C.

24. Little, K. W. and D. T. Lauria (1984), "Connection financing for water supply and sewerage in developing countries," WASH Working Paper No. 35, Washington, D. C.

25. McJunkin, F. E. (1983), "Water and Human Health," USAID, Washington, D. C.

26. Mosley, W. H. (1983), "Will primary health care reduce

infant and child mortality? A critique of some current strategies with special reference to Africa and Asia," Seminar on Social Policy, Health Policy and Mortality Prospects, Paris, Institut National d'Etudes Demographiques.

27. Musgrave, R. A. (1959), The Theory of Public Finance, McGraw Hill, N. Y.

28. Okun, D. A. (1982), "Financing water supply systems," in Water Supply and Sanitation in Developing Countries, ed. E. J. Schiller and R. L. Droste, Ann Arbor Science, pp. 251-267.

29. Porter, R. B. (1983), "Financial Aspects," in Water Supply and Sanitation in Developing Countries, ed. B. J. Dangerfield, Institution of Water Engineers and Scientists, London, pp. 349-363.

30. Saunders, R. J. and J. J. Warford (1976), Village Water Supply: Economics and Policy in the Developing World, Johns Hopkins Univ. Press, Baltimore, 279 pages.

31. Saunders, R. J., J. J. Warford and P. C. Mann (1977), Alternative Concepts of Marginal Cost for Public Utility Pricing: Problems of Application in the Water Supply Sector, World Bank Staff Working Paper No. 259, Washington, D. C.

32. Shipman, H. (1984), "Strategies for financing water and sanitation projects," World Health, 1984.

33. Shuval, H. I., R. L. Tilden, B. H. Perry, et al. (1981), "Effect of investments in water supply and sanitation and health status: a threshold saturation theory," Bull. WHO, 59; 243-8.

34. Smith, P. G., L. C. Rodrigues and P. E. M. Fine (1983), "Assessment of the protective efficacy of vaccines against common diseases using case-control and cohort studies," Int. J. Epidemiology, 13, 1, 87-93.

35. Streefland, P. H. (1976), "The social organization of night-soil collection," pp. 133-138, in Sanitation in Developing Countries, ed. A. Pacey, Wiley, N. Y., 1978.

36. Suleiman, M. S. (1977), "A study of the vendor water distribution system in Surabaya, Indonesia," WHO, Geneva, 18 pages plus annexes.

37. United Nations' Development Program (1984), "Major changes in methods and upward trend in financing for drinking water/sanitation decade after 3 years," New York, 2 pages.

38. USAID (1982a) AID Policy Paper: Private Enterprise Development, Washington, D. C.

39. USAID (1982b) AID Policy Paper: Domestic Water Supply and Sanitation, Washington, D. C., 16 pages.

40. USAID (1982c) AID Policy Paper: Recurrent Costs, Washington, D. C., 24 pages.

41. USAID (1983) AID Policy Paper: Institutional Development, Washington, D. C., 7 pages.

42. USAID (1984a) AID Sector Strategy: Health, Washington, D. C., 8 pages.

43. USAID (1984b) AID Policy Paper: Local Organizations in Development, Washington, D. C., 11 pages.

44. Walsh, J. A. and K. S. Warren (1979), "Selective primary health care: an interim strategy for disease control in developing countries," N. Engl. J. Med., 301: 967-974.

45. Water Research Centre (1977), Cost Information for Water Supply and Sewage Disposal, Technical Report TR 61, London, 627 pages.

46. White, G. F., D. J. Bradley and A. U. White (1972), Drawers of Water: Domestic Water Use in East Africa, Univ. Chicago Press, 306 pp.

47. World Bank (1976), "Measurement of the health benefits of investments in water supply," Report of an Expert Panel, Public Utilities Department Report No. PUN 20, 13 pages, Washington, D. C.

48. World Health Organization (1985), "Measuring the impact of water supply and sanitation projects on diarrhoeal morbidity: prospects for case-control methods," ETS/CDD, Geneva.

49. Yassuda, E. R., J. V. Kochen and E. F. Borba (1981), "Reduction of losses and costs in water distribution systems through appropriate technology," SABESP, Sao Paulo, Brazil, 12 pages.