FIELD REPORT

STRATEGY FOR PLANNING PERIURBAN WATER SYSTEMS:

A CASE STUDY FROM GUATEMALA

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WATER AND SANITATION for HEALTH PROJECT

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Strategy for Planning Periurban Water Systems:

A Case Study from Guatemala

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by

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Related WASH Documents

Guidelines for Conducting Willingness-to-Pay Studies for Improved Water Service in Developing Countries. WASH Field Report No. 306. October 1988

Estimating Operations and Maintenance Costs for Water Supply Systems in Developing Countries. WASH Technical Report No. 48. January 1989.

Guidelines for Maintenance Management in Water and Sanitation Utilities in Developing Countries. WASH Technical Report No. 63. June 1989

Water Vending and Development: Lessons from Two Countries. WASH Technical Report No. 45. May 1988.

Willingness-to-Pay for Water in Rural Areas: Methodological Approaches and an Application in Haiti. WASH Field Report No. 213. September 1987.

Evaluation of the Environmental Component of the Community-Based Integrated Health and Nutrition Project in Guatemala. WASH Field Report No 251. February 1989.

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EXECUTIVE SUMMARY

Some of the most pressing community water supply problems in developing countries are in the periurban areas adjacent to large cities. Planning for these places is especially difficult for several reasons· the residents frequently do not have land tenure; the areas are often inaccessible, on steep slopes above or below the cities or even subject to flooding; conventional levels of service are usually inappropriate, requiring a unique plan for each community; and residents are poor, presenting a special challenge for financial self-sufficiency.

Governments and international funding agencies are generally in agreement that the periurban areas cannot be ignored with respect to water supply. However, a clear planning strategy of how these places can best be served has not emerged. The principal task is to select a water system that the community wants and is willing to pay for. Some of the simplistic approaches of the past, such as automatically providing public standposts or basing the level of service on the assumption that households will pay 3 percent to 5 percent of income, have proven erroneous

The contingent valuation approach to estimating willingness to pay, which is still in the research phase and has been supported by the WASH project and the World Bank in a number of instances, holds significant promise as a method for obtaining required planning data Another approach, however, is to study existing water markets in periurban communities, which is the approach taken here.

The underlying assumption of this study was that, if the characteristics of the proposed improved water system are similar to those of the existing market, the information on the present market might provide a reasonable basis for planning the improvements. This is the case in numerous periurban areas served by vendors who provide relatively high levels of service comparable with that which a piped system can offer. Indeed, it is argued that in many cases private water vendors define the standard against which piped systems must compete if present revenues are to be captured. In order to test this hypothesis, a field study was made in a periurban community of squatters adjacent to Guatemala City called Tierra Nueva.

The study of Tierra Nueva showed that 99 percent of the households purchased from vendors in the dry season, and more than 90 percent used them in the rainy season. Average consumption was about 40 lcd, at an average cost equivalent to about $20 per person per year. This expenditure would be more than sufficient to pay debt service on a construction loan plus O&M costs for an improved system. The planning task is how to capture this revenue.

Most households obtained water at the door or nearby, which argues for the use of yard taps in the improved system. They purchased water at prices set by the vendors, which argues for the use of meters rather than a flat rate tariff; in addition, neighboring Guatemala City has the institutional capacity and experience to operate a metered system in Tierra Nueva. Households do not have to pay an initial or up-front charge to the vendors, which suggests that a connection fee for the improved system should not be charged. However, they purchase from vendors and pay on a more or less continual basis, which suggests that, if monthly billings are employed for the piped system, it would be difficult to capture the entire present revenue because of household cash flow problems. The vendors were perceived by households to provide water of reasonably good quality on a reliable basis. If the improved system cannot be certain of doing as well, it might be better for the water authority to not even try, since it might discredit itself and households would continue to purchase from vendors.

One of the key planning decisions is selection of the price to be charged for water from the new system. In principle, the number of households that will connect can be predicted from the distribution of the average costs that they presently pay for water. However, the average costs are much lower in the rainy season than in the dry, from which it follows that price selection must pay particular attention to rainy season expenditures. Also, most households are unaware of their present average costs, which implies the need for a community education campaign to promote the new system.

Price selection also depends on enabling households to match or increase present consumption without increasing (nor substantially decreasing) present expenditures. For this, the effect of alternative prices on present expenditures was investigated under assumed quantities of consumption. While such a sensitivity analysis cannot produce a precise water demand function, it is preferable to selecting values based on the experience of other communities.

A bottom line for the kind of study conducted in Tierra Nueva is that, if the water authority is unwilling to use its findings for planning improvements, it cannot predict future revenues based on the present market. In Guatemala, this means, for example, that if the present *paja* system of charges cannot be changed in favor of a tariff that more closely resembles the vendor market, or if reliability of the new system is highly uncertain, it will be difficult or impossible to predict future household behaviors

Chapter 1

WATER SUPPLY IN PERIURBAN AREAS

Periurban areas in developing countries are growing at tremendous rates and have some of the most pressing water supply problems. The WASH project, which is developing an information network on water and sanitation for periurban areas, reports that "the United Nations estimates that from 1950 to the year 2000, the urban population in developing countries will increase from 300 million to almost 2 billion. According to projections, the urban population will continue to increase past the year 2000. In developing countries, it is estimated that on average, 50 percent of urban populations live in periurban areas. Water supply is considered a top priority . . ."

Periurban residents acquire their land in various ways. Frequently, they are squatters with no legal tenure. However, it is not uncommon for the government to provide the land, either free or at low cost, or for the residents to purchase their land. In some cases unsuspecting migrants to cities purchase from "developers," only to find that the developers did not actually own the land.

In many cases, the land occupied by periurban residents is in undesirable areas. The *favelas* of Rio and other Brazilian cities are located on steep slopes high above the cities. About one-third of the population of Tegucigalpa, the capital of Honduras, lives in periurban areas similarly situated. In Guatemala City, which is on a high plateau, the periurban areas tend to be in deep ravines below the city, and in Manila, Bangkok, and other coastal cities, many periurban communities are on low-lying land which is flooded all or part of the time.

The traditional attitude of governments toward providing periurban areas with improved water supplies has been largely to ignore them. Fear of attracting even more migrants accounts for part of the reluctance to build piped water systems. The problem of land tenure has been a major obstacle, since construction might give tacit approval to squatters. Also, governments have little recourse with squatters who refuse to pay their water bills.

Other reasons for the neglect of periurban areas are the assumption that the residents are poor and cannot pay as much for water as other residents of the city, and the knowledge that periurban areas usually need a different type of water supply, such as public taps or yard faucets, from the rest of the city. Conventional house connections are inappropriate when sewers are lacking, as they are in the urban fringe. Selection of the level of service poses a problem which many city governments cannot or do not want to deal with.

On top of this, periurban areas are often hard to serve with piped water supplies. It is estimated that in Tegucigalpa, for example, at least 14 different pressure zones would be required in the water network to serve the entire city. The combination of high construction costs, different service level options, and the poverty of the residents makes selection of a tariff system difficult, which is another obstacle to planning.

During the 1970s, prior to the Drinking Water Supply and Sanitation Decade, international lending agencies and donors began to realize that the water supply problems of periurban areas could no longer be neglected, whether the residents had land tenure or not. For the reasons cited above, they also recognized that improved water systems for these areas would have to be different from those in the main parts of cities, especially with respect to service level, tariff structure, and the approach to planning. "Appropriate technology" was the slogan.

In the 1980s, "system replicability" became a major concern for periurban areas. As the Decade got underway with its ambitious goals and with clear indications that governments cannot heavily subsidize some water systems without simultaneously limiting service to others, financial self-sufficiency became a major objective of planning. No longer were lenders and governments content if communities, especially in periurban areas, merely covered operating and maintenance costs; the beneficiaries of the majority of systems were also expected to cover debt service.

During the Decade, it also came to be recognized that the assumptions made by engineers and planners about the level of water supply service that periurban residents wanted and were willing to pay for were often erroneous. A common rule of thumb was that if the cost of an improved water system did not exceed 3 to 5 percent of a household's income, the household would use it. Consequently, it was assumed that if periurban households purchasing water from private vendors at prices 20 to 30 times those charged in the cities were offered service at public standposts, they would abandon the vendors. However, many communities were willing to pay far more than 5 percent of their income for the convenience of water delivered to the door by vendors, with the result that "improved" standpost systems frequently went unused and unpaid for. The lesson learned was that the residents themselves needed to be consulted in the water supply planning process.

While the water supply profession has come to realize that periurban areas cannot be neglected even if residents do not have land tenure, that improved systems generally need to be financially self-sufficient, and that simplistic assumptions about what the communities want and are willing to pay for are prone to error, it is still not entirely clear about how to proceed. The profession continues to search for planning strategies to address such issues as service level, tariff structure, method of billing, connection costs, and system capacity.

Some of the most recent efforts to find a suitable strategy employ willingness-to-pay (WTP) studies using the contingent valuation (CV) approach. These efforts are aimed at obtaining information from periurban residents via carefully structured household questionnaires to predict demands in contingent (hypothetical) markets, specifically the monthly amounts that residents are willing to pay for alternative levels of water service such as public taps, yard taps, and full house connections. Although for years the likelihood of getting accurate information from households via questionnaires was viewed with skepticism, this strategy is being reexamined.

Results so far are promising. WTP bids by households for different types of water service have in most cases been satisfactorily explained by economic demand theory, leading to the conclusion that they are not randomly given and consequently can be used as a basis for planning. Reports by WASH and the World Bank show how WTP data can be used in selecting the service level, predicting the number of households that will connect to an improved water system, predicting the revenues that will achieve financial self-sufficiency, and selecting the tariff structure and amount to be charged. One of the main advantages of WTP studies is that they involve the potential beneficiaries. Members of the community are interviewed, and planners get first-hand information from field studies, thus reducing the need for simplistic assumptions.

While WTP studies are continuing, the final judgment on this technique is not in and alternative planning strategies need to be investigated, in part because the CV approach is still in the research phase.

This report is concerned with one such alternative strategy. It describes a study in a periurban area of Guatemala City called Tierra Nueva that employed a questionnaire for a sample of households, but, instead of focusing on willingness to pay for hypothetical levels of service, concentrated on present water use and present payments to vendors.

The underlying assumption of this study was that, if the characteristics of the proposed improved system were similar to those of the existing market (vendors in the case of Tierra Nueva), information on the present market might provide a reasonable basis for planning the improvements and information on demands for hypothetical service levels would be unnecessary. Indeed, a major role for the CV method seems to be in areas where the proposed level of improved service is substantially different from the present one, which is often the case in rural zones where water is frequently hauled from natural sources and not paid for. However, where the proposed and existing levels of water service are nearly the same, which is often the case in periurban communities purchasing from vendors, a careful examination of the existing market may be a sufficient basis for planning.

Chapter 2

TIERRA NUEVA: THE EXISTING MARKET

2.1 Introduction

This study began with a two-week reconnaissance trip to Guatemala in January 1988, after the research had been explained to key individuals and a determination made that suitable study conditions prevailed. Several potential study sites were visited, and the assistance of faculty and students from the Regional School of Sanitary Engineering (ERIS) at San Carlos University in Guatemala City was enlisted for the study It was concluded that Guatemala was suitable for this project.

In May 1988, shortly after the beginning of the rainy season, a team of three persons from the University of North Carolina (UNC) returned to Guatemala to conduct three weeks of field work. The group was assisted by a team of 11 postgraduate students in sanitary engineering plus one professor from ERIS (see Appendix A). At this time Tierra Nueva was selected as the study site, and the methods and questionnaire to be used in examining the water market there were developed and tested. The ERIS team was trained in obtaining field data and instructed in the role that the data could play in planning.

Tierra Nueva is a community of about 600 households near Chinautla on the outskirts of Guatemala City. Only a few years old, it consists entirely of squatters who do not have title to their land. Access to Tierra Nueva is over a single road, part of which is unpaved and rough, and commercial bus service comes near but not into the community. The houses, on a flat peninsula with deep ravines and sharp drop-offs on the sides, are laid out in a rectangular grid that allows access to most of them by cars and trucks except during the worst periods of the rainy season. Most houses have a fenced yard. The population density is fairly low, probably between 200 and 300 persons per hectare. The community has neither electricity nor piped water; the households use 55-gallon drums for storing water Sanitation consists of individual pit latrines.

Guatemala City by comparison has a population of about 2 million, with a well-developed infrastructure. Nearly all residents within the city boundaries have both piped water with meters and piped sewerage. Water charges are levied according a modified flat rate tariff. The majority of residential customers own a water right purchased for a lump sum of about $210.[1] This right, called one-half *paja*, entitles the holder to 30 cubic meters (m^3) per

[1] All costs in this report are expressed in U S. dollars. The rate of exchange at the time of the study was 2.5 quetzals = $1.0

month, which would cost about $2[2]. The rate for the first 30 m^3 is thus a little less than $0.10/$m^3$. Consumption in excess of the base quantity is billed at $0.10/$m^3$. For a household of, say, five persons, the base quantity provides for average consumption of 200 liters per capita per day (lcd).

Guatemala City is in need of an increased water supply; several bilateral donor agreements plus a loan from the World Bank are addressing this problem. Limited groundwater reserves in the vicinity of the city are expected to be developed within the next few years, but it is likely that after these the next major source will be far from the city and will have to be developed at high cost. The municipal water authority, EMPAGUA, is under pressure to raise its low tariffs.

Appendix B includes an English version of the household questionnaire that was used to obtain information on the existing water market in Tierra Nueva. It begins with questions on the number of persons in the household and follows with questions about the water sources being used. Based on the pretest, the sources were found to include tanker truck vendors, a few public tanks filled by the government and put into service just a couple of weeks before the study started, one or two private wells, bottled water sold in five-gallon[3] containers from trucks driving through the community, rainwater, and water from neighbors, usually in the form of loans which have to be repaid. The interviewer asked whether each source was used by the household, the average quantity used per week, the price paid, the distance the water had to be carried to the home, its quality, the reliability of the source, and the uses to which water was put. All these questions were asked for both the rainy and dry seasons. The final part of the questionnaire requested information on the workers in the household, their incomes, the respondent's opinion of whether the government should pay at least half the cost of an improved water system, and whether the household would be willing to pay a fee for a connection to an improved system.

Of the 600 households in Tierra Nueva, 225, or nearly 20 percent, were interviewed once the pretest of about 50 households had been completed. Rather than drawing a random sample, the interviewers worked in all parts of the community, visiting every second or third house as they walked through the neighborhood. To the extent possible, they tried to conduct their interviews in private so as to minimize comments and input from neighbors. In this they were generally successful, because it was usually raining and respondents invited them into their houses.

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[2] m^3 = 1000 liters.

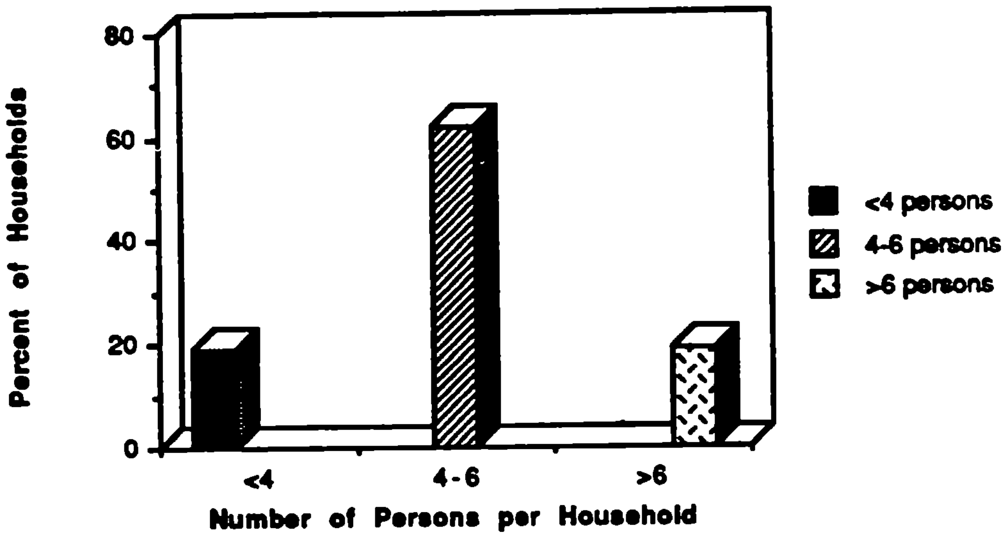
[3] gallon = 4.5 liters.

2.2 Household Size

The average number of persons per household was five, and nearly two-thirds of the households had between four and six persons (Figure 1).

Figure 1

Household Size



2.3 Sources Used

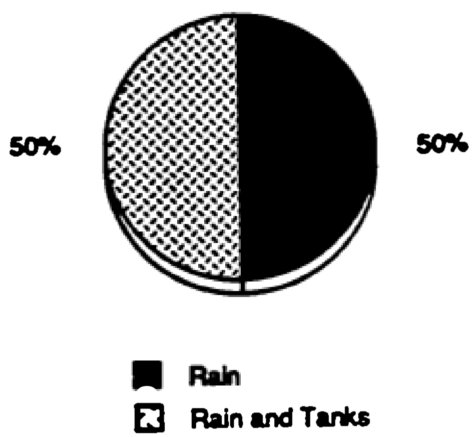
In the dry season, 99 percent of the households purchased water from vendors (two households used private wells). Moreover, vendors were the only source for nearly all these households. A few purchased small quantities of bottled water for drinking, and several borrowed water from their neighbors when their own 55-gallon storage drums ran low. But vendors essentially were the sole source of supply for the entire community in the dry season.

The situation in the rainy season was different. A little more than 90 percent of the households purchased from vendors, and among them, 95 percent used additional sources as well, as shown in Figure 2. The next most common source was rainwater, and the third source was public tanks which had recently been installed. These ground-level tanks were periodically filled by the government, but their operating history was too short to determine whether they would provide water in the dry season.

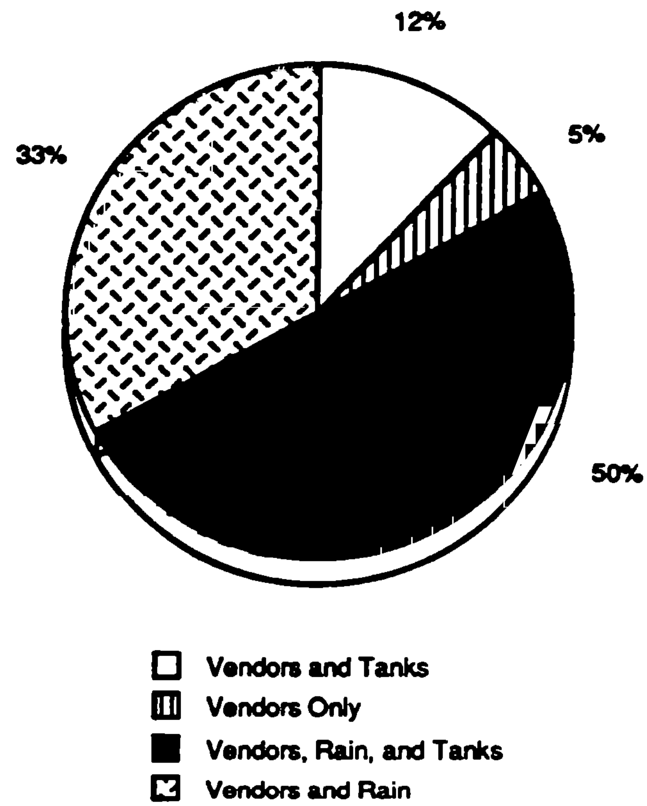
Among the 10 percent of households that did not use vendors in the rainy season, half obtained all their water from rooftop rain catchments, and half used a combination of rainwater and the public tanks.

Figure 2

Water Sources in Rainy Season



Households Not Using Vendors



Households Using Vendors

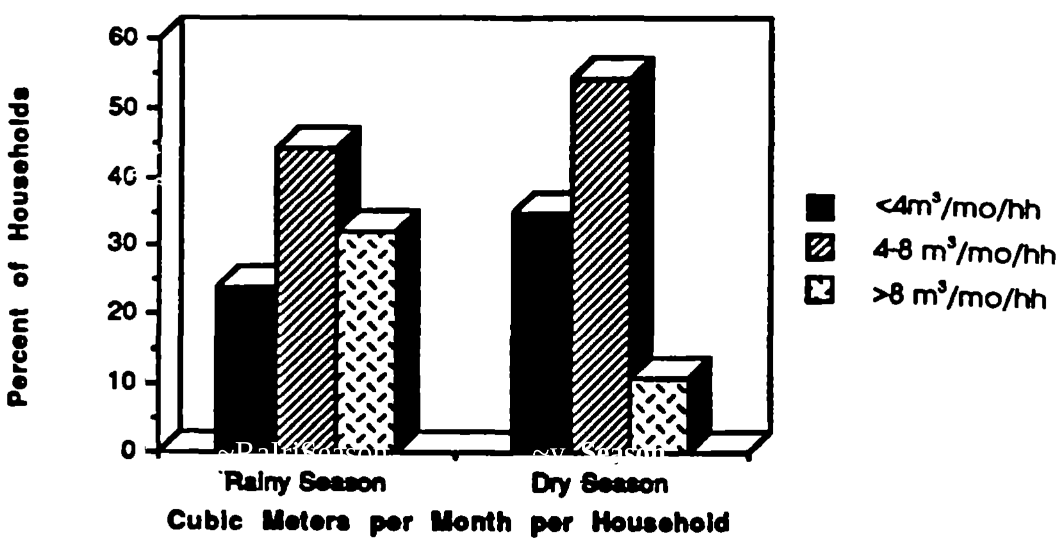
In summary, 99 percent of the households purchased all of their water from vendors in the dry season, and more than 90 percent purchased from vendors in the rainy season. However, 95 percent of those who purchased from vendors in the rainy season used additional sources, the most common being rainwater.

2.4 Quantities

In the dry season, the average quantity of water consumed was 4.7 m^3/mo per household, which was the sum of the amounts the households said they used each month divided by 225, the number of households in the sample. Average per capita consumption in the dry season was 33 lcd.[4] Figure 3 shows the distribution of household consumption. Figure 4 shows the distribution of per capita consumption, and that in the dry season about 25 percent of the population consumed less than 20 lcd, and only 15 percent consumed more than 50 lcd.

Figure 3

Household Water Consumption



In the rainy season, the average quantity consumed was 6.3 m^3/mo per household (45 lcd), or one-third more than in the dry season. Also, the variation in consumption among households was higher in the rainy than in the dry season (the standard deviations for the two seasons were 3.7 and 2.5 m^3/mo per household, respectively). The distribution of per capita consumption in Figure 4 shows that in the rainy season 35 percent of the population consumed more than 50 lcd, compared with only 15 percent in the dry season.

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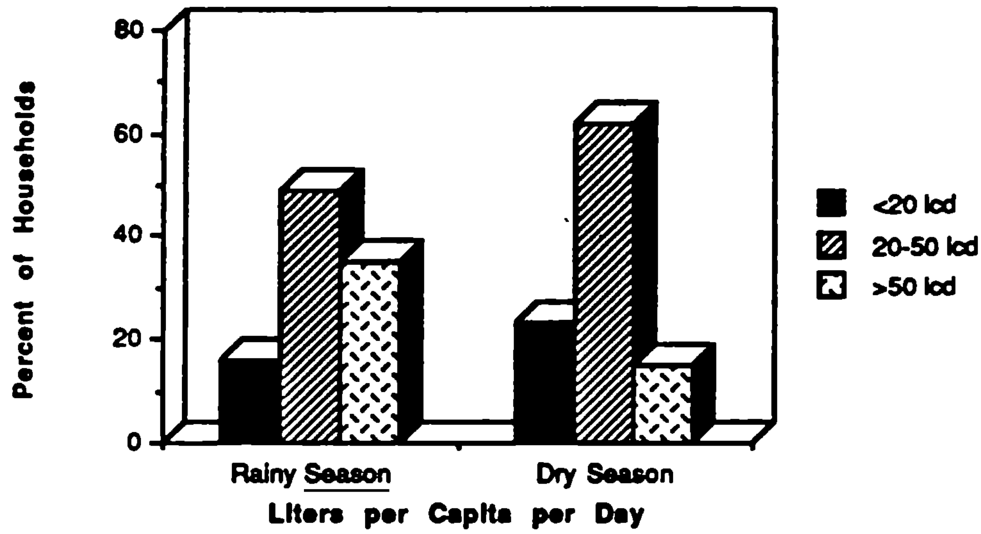
[4] 33 liters is equivalent to about 9 U.S. gallons.

Figure 4

Per Capita Consumption



Although average consumption was higher in the rainy season than in the dry (6.3 vs. 4.7 m^3/mo per household), the amount purchased from vendors was less (3.2 vs. 4.7 m^3/mo per household). Hence, vendors sold 50 percent more water in the dry than in the rainy season. Figure 5 shows the average amounts of water obtained from the principal sources in the dry and rainy seasons. These data are summarized in Table 1.

2.5 Prices, Expenditures, and Average Costs

The only source for which households had to pay was vendors; rainwater and the public tanks were free. Although several tanker truck vendors operated in Tierra Nueva and there were more of them in the dry than in the rainy season, all charged the same price, namely one quetzal (Q) per drum, which did not change from one season to another. With a capacity of 0.2 m^3/drum (200 liter), the price was equivalent to $2 per m^3, or about 25 times higher the price charged by the water authority in Guatemala City.

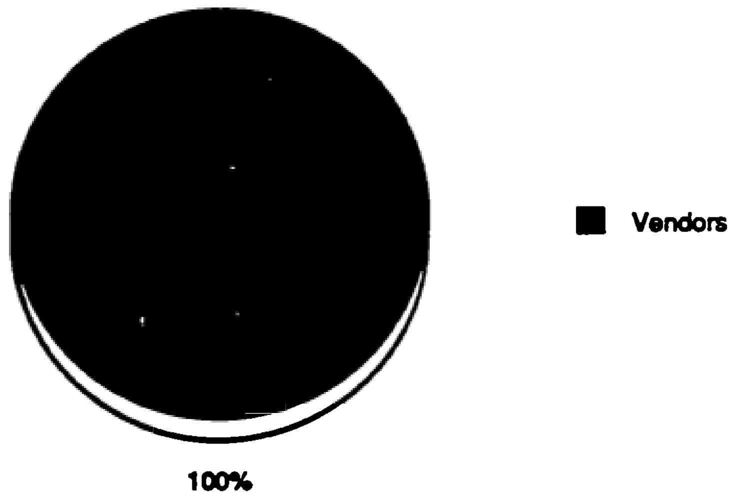
TABLE 1

WATER CONSUMPTION DATA

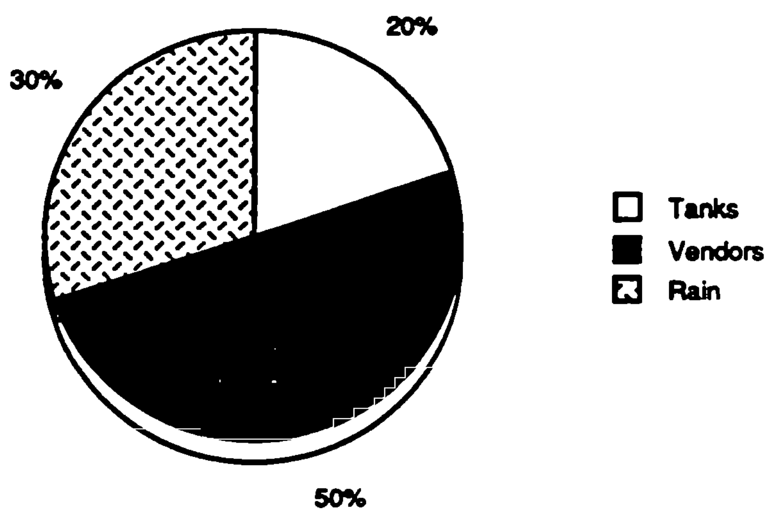
	RAINY	DRY
VENDORS		
AVERAGE M^3/MO/HH	3.2	4.7
STD. DEVIATION, M^3/MO/HH	2.1	2.5
% OF TOTAL CONSUMPTION	50	100
AVERAGE LCD	21	33
PUBLIC TANKS		
AVERAGE M^3/MO/HH	1.3	0
STD. DEVIATION, M^3/MO/HH	1.4	0
% OF TOTAL CONSUMPTION	20	0
AVERAGE LCD	9	0
RAINWATER		
AVERAGE M^3/MO/HH	1.8	0
STD. DEVIATION, M^3/MO/HH	2.4	0
% OF TOTAL CONSUMPTION	30	0
AVERAGE LCD	12	0
TOTAL		
AVERAGE M^3/MO/HH	6.3	4.7
STD. DEVIATION, M^3/MO/HH	3.7	2.5
AVERAGE LCD	45	33

Figure 5

Average Household Quantities from Principal Sources



Dry Season

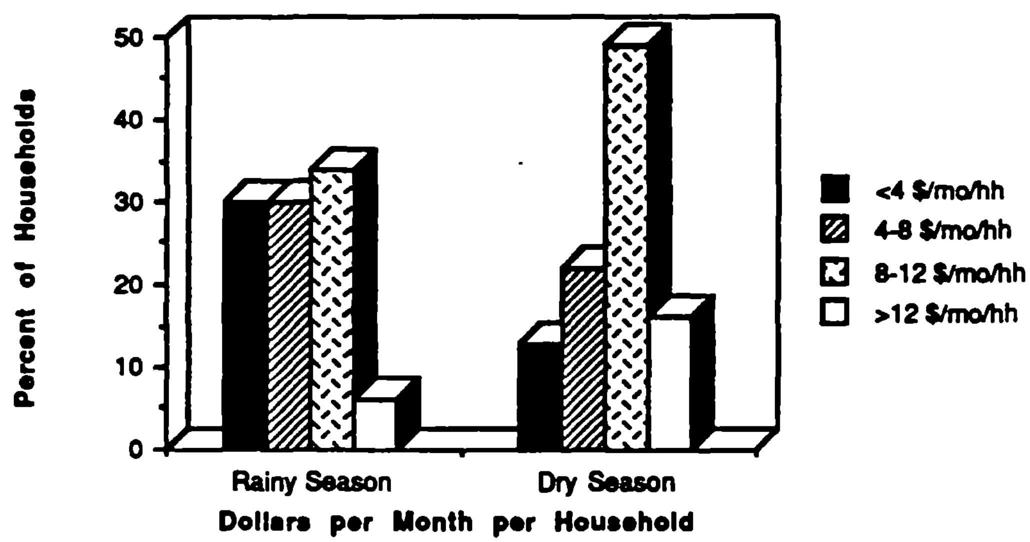


Rainy Season

Recall that the average purchase from vendors was 4.7 and 3.2 m^3/mo per household in the dry and rainy seasons, respectively. Accordingly, the average expenditures were $9.40 and $6.40 per month per household in the two seasons. Figure 6 shows the distribution of monthly household expenditures, and Figure 7 shows the distribution of annual household expenditures. On a percentage basis, half the households spent at least 8 percent of their income (average household income was $100 per month) and about one-quarter of the households spent more than 18 percent of their income on purchasing water from vendors, as shown in Figure 7.

Figure 6

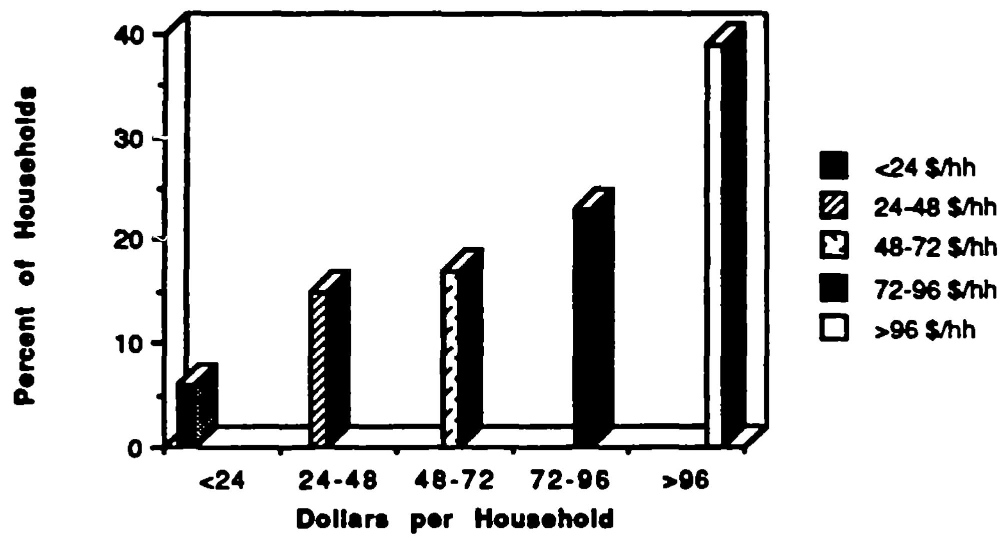
Monthly Household Expenditures



The average monthly cost of water for a household was its total monthly expenditure divided by its total monthly consumption, expressed as quetzals per drum or dollars per cubic meter. In the dry season, the average cost was identical to the price charged by vendors, $2/$m^3$, because vendors were the only source of supply. The standard deviation of average cost was only $0.10/$m^3$, indicating little variation from one household to another. The distribution of average costs is shown in Figure 8.

Figure 7

Annual Household Expenditures



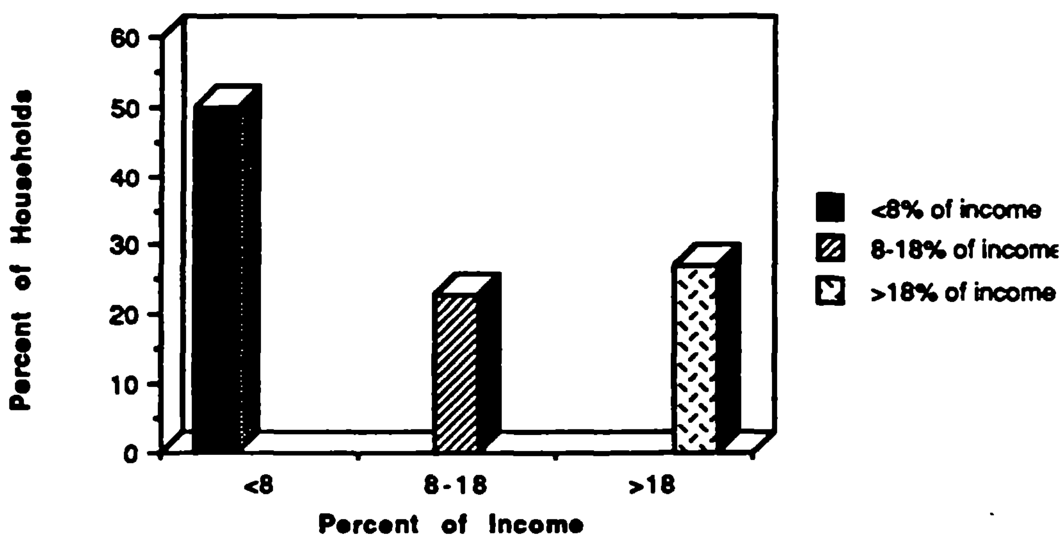
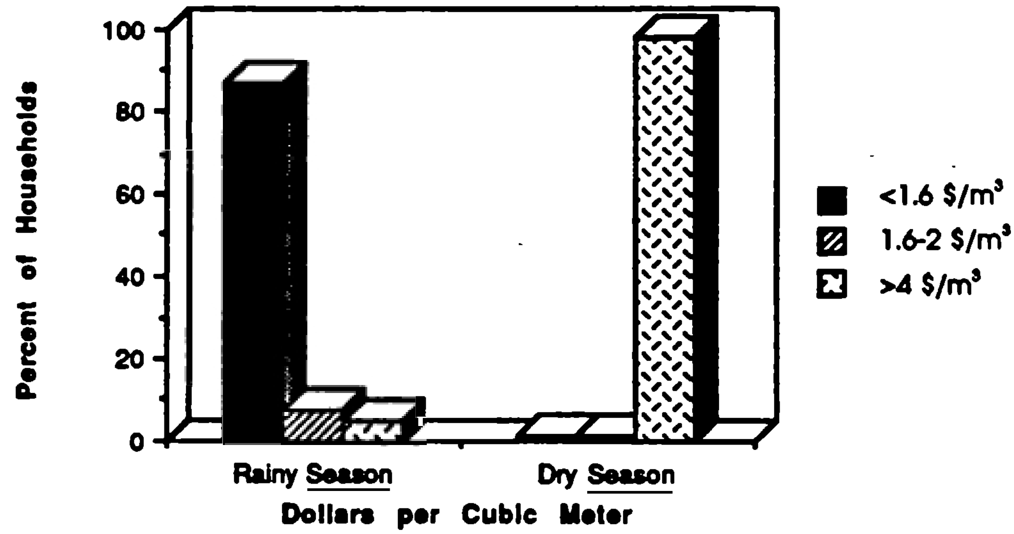


Figure 8

Average Costs Paid by Households



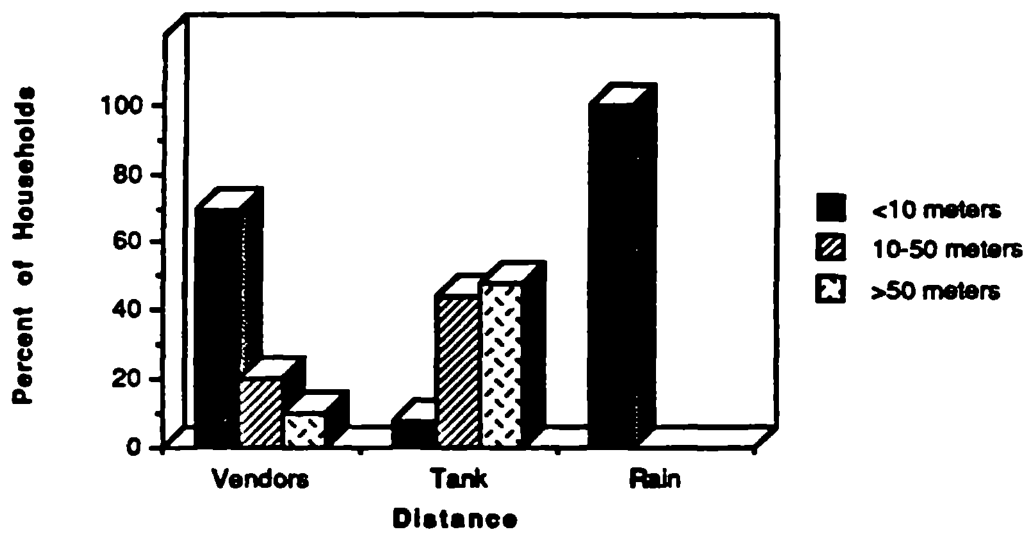
Average costs in the rainy season were lower than in the dry. With an average household expenditure of $6.40 per month and average consumption of 6.3 m³, the average cost was $1.00/m³. Its standard deviation was higher in the rainy season ($0.50/m³) than in the dry because the amount of water obtained from the three principal sources varied more from one household to another. The distribution of average costs in the rainy season is shown in Figure 8.

2.6 Convenience, Quality, and Availability

Households were asked how far they had to carry water from each of the sources to their homes. As shown in Figure 9, vendors delivered water within 10 m of 70 percent of the homes, and within 50 m of 20 percent of the homes. Only 10 percent of the households had to carry water more than 50 m, because their homes were not accessible to the tanker trucks, and they had to walk to the main street for collection. By contrast, more than 90 percent of those who used the public tanks had to carry water at least 10 m, and half of these had to carry it more than 50 m. (Recall, however, that only 20 percent of consumption in the rainy season was from public tanks.) In all cases, rainwater was available at the door. For the vast majority of houses, therefore, water was readily accessible.

Figure 9

Water Accessibility



Households were also asked to rate water quality as poor, fair, or good. Their opinions are shown in Figure 10. About two-thirds said the water quality from vendors was fair, and 12 percent said it was good. About half of the public tank users said the water was good, and most of the rest said it was fair. About half the households said rainwater was fair and one-third said it was good. In summary, water from the public tanks was judged to have the highest quality (only 3 percent said it was poor), and rainwater was judged to be about the same or slightly better than the water from vendors.

Figure 11 shows opinions about the availability of water from the principal sources. Relatively few households said water was never available when they needed it. The majority said it was sometimes ("usually") available when needed, but in the case of vendors, a large proportion said it was always available when needed.

Overall, Tierra Nueva's water demands are well met. The water is at the door or within a short carrying distance for most households, its quality from all sources is judged to be fair or better by at least 80 percent of the households, and it is usually or always available.

2.7 Connection Fee and Government Responsibility

Households were asked whether they would be willing to pay an initial fee, in addition to the monthly cost of water, for a connection to an improved water system consisting of individual yard taps. About half said they would not pay more than $50, one-quarter said they would pay between $50 and $100, and one-quarter said they would pay between $100 and $200.

Figure 10

Household Perception of Water Quality

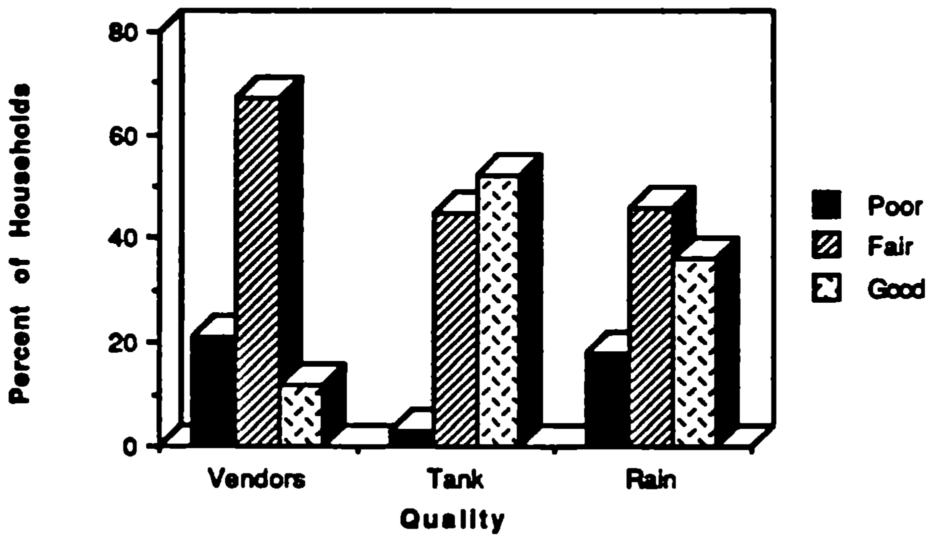
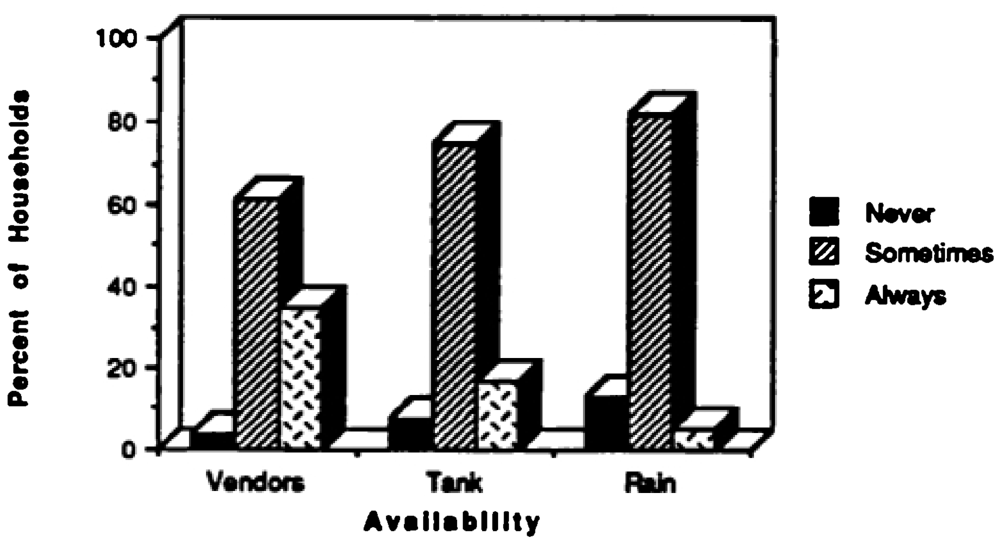


Figure 11

Water Availability



The households were also asked their opinion of whether government should pay part of the construction cost of an improved system. About 60 percent said government should pay more than half, 15 percent said exactly half, and 25 percent said less than half the cost.

Chapter 3

STRATEGY FOR CAPTURING THE POTENTIAL MARKET

3.1 Market Size

Chapter 2 reported that households were spending an average of $6.40 per month on water during the rainy season (May through October) and $9.40 per month during the dry season, for an annual expenditure of about $100 per household. With an average of five persons per household, this would be a per capita expenditure of $20 per year.

Assume that the entire amount paid to vendors could be captured to pay for an improved system in Tierra Nueva. Assume further that one-third of the total revenue would be required to pay operating and maintenance (O&M) costs, leaving $13 per year per capita on the average for debt service.[5] Assume that a 20-year loan at annual interest of 10 percent can be obtained for construction, in which case the capital recovery factor (CRF) would be about 0.12. Beyond the amount needed for O&M costs, the corresponding debt that could be financed by the fees presently paid in Tierra Nueva would be about $100 per capita.[6] This is the amount that could be borrowed to pay construction costs, assuming the improved system is financially self-sufficient and gets no subsidy from the government. Other estimates of the construction debt that could be serviced under alternative assumptions are shown in Table 2. The estimates range from $75 to $125 per capita for a variety of interest rates, loan periods, and O&M costs likely to exist in Guatemala.

An important question is whether the estimates in Table 2 are sufficient to support an improved water system. A recent evaluation of USAID's rural water supply program in Guatemala revealed an average per capita cost of $70.[7] These systems generally consist of individual yard taps without meters for all households, supply by gravity from springs with only disinfection for treatment, ground storage tanks for meeting peak demands, and transmission mains of varying length from the source of supply to the communities. The $70 covers the complete project including design, construction, supervision, legal, and

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5 This assumption is consistent with findings in WASH Technical Report No. 48, "Estimating Operations and Maintenance Costs for Water Supply Systems in Developing Countries," January 1989.

6 Loan = Debt Service/CRF = $13/0.12 ≈ $100 per capita

7 In fact, the costs in Tierra Nueva might be less than those in rural communities because of higher density requiring less pipe in the distribution network and elimination of source works, supply being obtained by connection to the existing city system. See WASH Field Report No. 251, "Evaluation of the Environmental Component of the Community-Based Integrated Health and Nutrition Project in Guatemala," February 1989.

administrative costs. In addition, it provides for excess capacity to meet demands up to 20 years in the future. If this cost is representative of the cost of an improved system in Tierra Nueva, then the present community expenditures for water are more than adequate to meet it.

TABLE 2

POTENTIAL CONSTRUCTION LOANS BASED ON PRESENT EXPENDITURES

PRESENT EXPENDITURE ($/YR/CAPITA)	20	20	20	20
% FOR O&M	25	25	40	40
AMOUNT FOR O&M ($/YR/CAPITA)	5	5	8	8
AMOUNT FOR DEBT SERVICE ($/YR/CAPITA)	15	15	12	12
CAPITAL RECOVERY FACTOR*	0 12	0.16	0 12	0 16
AMOUNT FOR CONSTRUCTION ($/CAPITA)	125	95	100	75

* THE CRF IS ABOUT 0 12 FOR THE FOLLOWING COMBINATIONS OF INTEREST (I) AND LOAN PERIOD (N).

	I(%)	8	10	12
N(YR)	15	20	50	

THE CRF IS ABOUT 0 16
FOR THE FOLLOWING COMBINATIONS OF I AND N·

I(%)	10	12	15
N(YR)	10	12	20

The principal planning task is how to capture these expenditures What level of service should be provided so that households continue to spend as much, or at least enough for financial self-sufficiency? What level of system reliability is required? Should water charges be based on the use of meters or levied at a flat rate? If by meters, what price should be charged, and if at a flat rate, what fee? What method of payment should be used? Should a connection fee be charged, and if so, how much and how should it be paid? Finally, should excess capacity be included in the system?

These questions are addressed in the remaining sections of this chapter based on the findings from the field study in Tierra Nueva. While this study was for a particular site, its findings could apply to periurban areas in other developing countries.

3.2 Level of Service

One of the most important planning decisions concerns the level of service. Many water systems in developing countries have failed because of selection of inappropriate service levels. Engineers, for example, sometimes select public standposts on the assumption that the poor residents of periurban areas can better afford them, only to find that they want water delivered to their houses and thus continue to use vendors. Costs of the standposts are not recovered, service deteriorates, and systems fall into disrepair and disuse.

There are three candidate levels of service for periurban areas: public standposts, yard taps, and full house connections. If the revenues in Tierra Nueva are to be captured by a new system, the level of service should be at least as high as at present. In the dry season, nearly 100 percent of the households purchase from vendors who deliver water almost at the door. While the percentage that purchases from vendors declines slightly during the wet season, the substitution is mostly with rainwater from roof catchments, water that is still available at the door for most households. Hence, it appears that public standposts, which provide water away from the houses, are not a viable option.

If capturing present revenues were of less concern, public standposts might be considered, but it would not be possible to predict how many households might use them since none of the houses are exclusively using a source comparable with standposts.

Of the other two service levels, yard taps seem most appropriate. They are similar to vendors in that they deliver water at the door, which would permit present water-using practices to continue For the relatively few households that cannot get vended water at the door, yard taps would constitute an improvement in service. Thus, some households would be better off with yard taps as far as convenience is concerned, and none would be worse off.

While full house connections provide an even higher level of service, it is uncertain whether households would be prepared to incur the expense of indoor plumbing Furthermore, the absence of sewers would pose a problem if water use were to increase with full house connections, as it often does.

3.3 Reliability

About 95 percent of the households using vendors said that water from this source was usually or always available when needed, indicating a high level of reliability in the present water market. If an improved system is to capture a substantial portion of present expenditures, it will have to meet or exceed the level of reliability provided by vendors.

The issue of reliability is of great importance. If the water authority charges its customers for an improved system that does not deliver reliable supplies, it can expect them to ignore the bills they are sent and to continue purchasing from vendors who have a proven record of reliability. What is even worse, once households have learned to distrust the water authority, they might refuse to connect or to pay their bills even if service were improved, for fear that service might fail again and they would once again be required to purchase from vendors. Such a situation exists in some upgraded periurban areas of a neighboring capital city in Central America where the accounts in arrears approach 100 percent because of the water authority's inability to provide reliable service.

Although the present water supply situation in Guatemala is not critical, there is some scarcity and rationing, and the quality of service may deteriorate before it is possible to bring new supplies on line. Consequently, the water authority would need to assess its ability to provide reliable service to Tierra Nueva with an improved system. If it cannot compete with the vendors, then it is doubtful that present revenues could be captured.

Although some percentage of households might connect to an improved system less reliable than the vendors, there is no way to predict, from a study of present market conditions, this demand or the revenues that might be realized, nor does it seem likely that accurate predictions could be made using alternative study methods such as the contingent valuation approach. Hence, it seems clear that the water authority should not even consider the possibility of constructing an improved system unless it is certain of matching the reliability of the vendors.

3.4 Meters or Flat Rate

If the task is to capture all or most of present expenditures so as to make an improved system financially self-sufficient, the water authority will have to decide whether to bill on the basis of meters or at flat rates. The arguments for meters are convincing. If the price of water is set to equal the marginal cost of production, consumers by their purchases send a signal that they gain from consumption and that the resources are being used efficiently. With a flat rate, on the other hand, the marginal cost to the consumer is zero and water is undervalued, generally leading to overconsumption and inefficiency.

The proponents of flat rates also make compelling arguments The use of meters is difficult; they must usually be purchased from abroad with hard currency; they are hard to install, maintain, and replace; and they require substantial institutional capacity for reading, rendering bills, collecting revenues, terminating service for payments in arrears, and reconnecting service when required. A system of flat rates is easy to administer and has the appearance of equity.

One of the most important issues in this controversy is loss of revenue with flat rates. In principle, the water authority can require that all households in the community connect to an improved system, and it can prohibit the resale of water by those with connections to those without them. But if the service area is large and complicated, enforcement is usually a problem. It is often common in cities that charge flat rates for customers to resell water, with consequent loss of revenue to the water authority. Furthermore, resale leads to increasing demands which the system is often unable to meet. Service reliability deteriorates, revenues fall, and a downward spiral frequently ends in system failure.

Tierra Nueva is not such a large and complicated community that flat rates might not be made to work there. However, the arguments against metering are not convincing. In the first place, residents presently purchase their water from vendors, so the notion of having to pay for metered quantities consumed would not be foreign. They expect to pay for each drum of water they consume and do not expect an unlimited quantity for a fixed fee. The existing pricing system with vendors works, and if present expenditures are to be captured, there seem to be no particularly good reasons to use an alternative pricing system such as a flat rate.

Furthermore, Guatemala City is well acquainted with meters and has the institutional capacity to purchase, install, repair, and read them, to render bills, and to collect revenues. Hence, the arguments against meters on the grounds of limited institutional capacity are not persuasive. In fact, if the improved system in Tierra Nueva were to be managed by the water authority in Guatemala City, the use of meters would probably be a requirement. The situation is not unlike that in the cities of many other developing countries, from which it follows that where present service in periurban areas is mostly by vendors, meters rather than flat rates are probably the appropriate choice, especially if the adjacent city is already metered.

3.5 Water Price

If meters are the choice in Tierra Nueva, the next question is what price to charge. Guatemala like many other developing countries employs a national system of water prices that permits little flexibility If an improved water system were constructed in Tierra Nueva, it is almost without question that the tariff would have to be based on the present *paja* system, which charges a minimum fee of about $2 per month for most customers. Assuming an average of five persons per household, total annual revenue would be about $5 per capita, which would finance a construction loan of about $40 per capita if nothing were spent on O&M. It is doubtful that an improved system could achieve financial self-sufficiency at this price.

Guatemala, like other countries facing the need for financial self-sufficiency in periurban areas, would have to change the *paja* system and permit site-specific pricing. Assuming this is possible, the question for Tierra Nueva is what the price should be. Price selection rests on two major considerations. the number of households that will connect to the improved system, and the amount of revenue that will be generated.

If most or all households are to be attracted to the improved system, the price probably should not exceed what suppliers are presently being paid. If the price was set below what the vendors charge, to continue purchasing from them would mean paying more for the same quantity of water. On the other hand, some households might use the new system even if it charged more than the vendors (e.g., if service were judged to be superior). But this cannot be predicted from the current market. What can be said with certainty is that the costs to a household would not exceed their present payments if the price charged by the water authority did not exceed that charged by present suppliers, assuming consumption remained unchanged.

To say that the authority must charge a price equal to or less than that charged by the vendors in order to attract customers is a bit too simplistic and not entirely correct. In the first place, it assumes that vendors are the only source of supply, which in Tierra Nueva is not true. Secondly, it assumes that households would be able to recognize that the price charged by the authority would make it advantageous for them to switch to the improved system. Finally, it assumes that the goal is to connect all households to the improved system, which may or may not be true. Let us examine each of these assumptions in turn.

Chapter 2 pointed out that all households obtain their water only from vendors in the dry season, but from vendors, public tanks, and rainwater in the rainy season. The quantities from the three sources are different for each household and even for the same household from one month to the next. Hence, in the rainy season, the average cost of water (i.e., total monthly cost divided by total monthly consumption) varies among households. If the improved system is to be of advantage to a particular household, the price of the water it provides must be equal to or lower than the price presently paid by that household for water from all sources. For households that obtain most of their water from a single source, it is sufficient to compare the price of that source with the price charged by the authority. In Tierra Nueva, this is easy in the dry season but not in the rainy season. In some periurban areas that use multiple sources year round, present average cost is the appropriate measure for comparison with the authority's price.

For a household to see the advantage in using the improved system, not only must the authority's price not exceed present average cost, but the customer must also be able to recognize the difference. This may be difficult for a number of reasons. For example, the households might not know the quantities they obtain from different sources and how these may change from one period to the next. Also, prices may vary among suppliers and between the wet and dry seasons. Finally, price units are frequently different from one source to another since some suppliers charge by the bucket, others by the drum or tank, and still others by a flat monthly fee. All of these variables make it extremely difficult for a household to calculate the average cost of water.

Fortunately in the case of Tierra Nueva, the number of sources used and the prices paid do not vary widely. The prices charged by vendors are based on common units and are fairly constant. In the wet season, however, when rainwater is collected by most households and public tanks are used, the determination of average water costs is more difficult.

Figure 8 shows the distribution of average costs paid by households in the two seasons. Ninety-nine percent of the households pay an average price of more than \$1.60 per m^3 in the dry season. Hence, if the water authority were to set its price at this level, the seasonal cost to these households would be no higher than if they purchased from the present suppliers, assuming consumption remained unchanged. Since \$1 per m^3 is the lowest price paid by any household in Tierra Nueva in the dry season, the water authority could set its price at this level without anyone being worse off by connecting to the new system. In other words, \$1 appears to be the highest price that can be charged in the dry season if the goal is to connect all the households. Clearly, a lower price would result in lower monthly costs for the households but would not be necessary for inducing customers to make a decision.

The situation in the wet season is different. Figure 8 shows that if the authority's price were \$1.60 per m^3, only 13 percent of the households would be likely to pay that much. In other words, although it would be advantageous for 99 percent of the households in Tierra Nueva to purchase from the improved system in the dry season at a price of \$1.60 per m^3, this price would be advantageous for only 13 percent of the households in the wet season. Clearly, this difference must be taken into consideration in making final tariff selection, and in entertaining the possibility of lowering the price in the rainy season so as to maintain the advantage of the improved system over present suppliers.

While the frequency distribution of present average costs in Figure 8 provides a basis for determining the maximum price at which it would be advantageous to buy from the improved system rather than from present sources, it is less helpful in selecting the actual price to be charged. Consider a price of, say, \$0.10 per m^3, which would clearly make it advantageous for all households to use the improved system. If present water consumption remained unchanged at an average of about 40 lcd, average annual revenue at this price would amount to only about \$1.50 per capita, which would be insufficient for a financially viable system. A second consideration in price selection, therefore, is the amount of revenue to be generated.

In order to predict revenues, it is necessary to know the water demand function, i.e., the quantity of water that would be demanded per month from the improved system at alternative prices. Unfortunately, such information cannot be obtained from a study of the existing market in Tierra Nueva, where vendor price is essentially constant, nor by questioning the households, which would be unable to give reliable estimates. One approach in the absence of such data is to make a sensitivity analysis, assuming alternative quantities of consumption at different prices and comparing the resulting costs with present expenditures. This is the method used in the next chapter for this case study.

3.6 Method of Payment

While a case can be made, based on the existing market, for the use of meters and a system of prices for recovering costs, the method of payment remains a critical item for decision. In Guatemala City, the water authority bills its customers on a monthly basis. In Tierra

Nueva, however, households make water purchases continually. The use of meters and prices would be similar to conditions with which they are familiar in the existing market, but monthly billings would not, making the capture of present expenditures uncertain if bills for the improved system are sent only once a month.

The issue of concern is cash flow. When purchasing from vendors on a more or less continual basis, households say they do not feel the expense. Indeed, most households in Tierra Nueva were surprised to learn how much they were spending per month. Paying on a monthly basis for an improved system would pose a difficult problem for many households, since it would require setting aside money from meager incomes that in many cases change from day to day.

It can be inferred from what the households told us that more frequent billing, say, on a weekly basis, would be preferable to monthly or quarterly billing. It is likely that frequent billing would capture a higher proportion of the expenditures being made in the existing market. However, the exact effect of billing frequency on revenues cannot be predicted from the study that was made, nor does it seem likely that any other study would reveal this information. Short of actually changing the billing frequency in selected communities to observe the effect, there seems no way of finding an answer.

In the previous section, it was observed that the present *paja* system of charges would not achieve the goal of financial self-sufficiency in Tierra Nueva and would therefore have to be changed in favor of a price system closer to that of the existing market. Similarly, the present system of monthly billings would probably not capture existing revenues and would have to be replaced by one with greater flexibility and frequency.

3.7 Connection Fee

In the existing market, households are not required to pay an initial or connection fee to obtain water Hence, if existing expenditures are to be captured for an improved system, such a fee should probably be dropped. To some extent, the investment that households have made in storage drums is analogous to an initial fee, but this amount is nominal and not at all comparable with the equivalent of $210 that Guatemala City charges for its most common water right.

Although dropping a connection fee leaves water price as the principal determinant of whether a household would connect to an improved system, an attempt was made to determine whether connections would be affected by this fee. As described in Chapter 2, when households were asked if they would be willing to pay one, half said they would not connect to an improved system if the initial fee were more than $50.

3.8 Excess Capacity

It is beyond the scope of this report to critically examine the question of optimal excess capacity in periurban water systems. Some proponents recommend excess capacity to meet demands for a period of 20 or more years, while others say that improved systems should be designed only for the present population and that incremental expansions should be made as demand grows.

The four main issues that underlie this controversy are economies of scale in construction and operation, the opportunity cost of capital, the existing population to be served, and equity. Periurban water systems typically exhibit economies of scale; that is, their average costs decrease as their scale increases. While it costs more to build a large system with the capacity to meet future demands, the average cost per unit of water production is lower. Hence, on efficiency grounds, water systems should almost always have excess capacity.

While economies of scale argue in favor of excess capacity, the opportunity cost of capital argues against it. The discount rate in most developing countries is high, indicating that it is not advisable to tie up large amounts of capital unproductively in facilities whose capacity will not be fully used for many years. A high discount rate indicates that the system should be designed in most cases to meet the demands for less than 20 years

The third factor that bears on the economically efficient design period is the size of the existing population to be served. If the community is already large, a large system will have to be constructed to meet present demands. It follows that the marginal cost of providing additional capacity to meet future demands may be relatively small, leading to the conclusion that the design period should in general be longer in large communities that are to receive water systems for the first time than in small ones.

These considerations that bear on the optimal design period are well described in the technical literature.[8] For a place like Tierra Nueva, excess capacity in the improved system should probably be sized to cover between 5 and 15 years, assuming demands are expected to increase.

Despite these arguments in favor of excess capacity, the issue on a practical basis often boils down to consideration of equity and financial self-sufficiency. If excess capacity is included in the improved system, the present beneficiaries will have to pay for it if debt service payments are kept constant over time, at least in the early years until new users are in place to pay their share. This raises the question of whether it is equitable to require the present population to pay part of the costs of a system that will benefit others, and whether such costs can be met within the constraint of financial self-sufficiency. This issue is examined in the next chapter via a cost sensitivity analysis for Tierra Nueva.

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[8] See, for example, Thomas (1970) and Lauria, et al (1977).

Chapter 4

HYPOTHETICAL SYSTEM FOR TIERRA NUEVA

4.1 Introduction

This chapter presents an illustrative design of a hypothetical piped water system for Tierra Nueva using data from the field study. In this as in other periurban areas, the system should be one that the users want and are willing to pay for, financially self-sufficient with revenues adequate to cover debt service plus recurrent operating and maintenance costs.

The major planning questions were identified in Chapter 3: level of service, level of reliability, use of meters, price or fee to be charged, method of payment, whether to charge a connection fee, design capacity, and optimal excess capacity.

The discussion of these questions in the previous chapter has established that, if present expenditures are to be captured, the improved system will have to compete favorably with the present sources of supply. The new system should have individual yard taps, meters rather than a flat rate should be used, households should be billed at least once a month (but weekly billing would be even better), and a connection fee should not be charged.

The present sources are generally perceived to be fairly reliable and to provide water of acceptable quality. Undoubtedly an improved system would provide water of better quality, but its reliability is uncertain. If unforeseen scarcity, rationing, low pressures, or breakdowns result in frequent supply interruptions, it is unlikely that present revenues could be captured. For the purpose of this chapter, it is assumed that the improved system would be at least as reliable as present suppliers.

The main planning decisions to be addressed here are capacity, price, and financial self-sufficiency, using the findings from the field study. The next section assumes the planning context is steady state; it is followed by development of a dynamic plan for Tierra Nueva.

4.2 Steady State Plan

Tierra Nueva presently has 600 households and a population of 3,000. Nearly all of the available land has been appropriated, which makes it unlikely that the community can accommodate new households unless lots are subdivided and the few vacant spaces filled. Consequently, for the proposed plan of this section, population is assumed to remain constant at 3,000.

In Chapter 3, it was argued that households might reasonably be expected to connect to the improved system if the price they had to pay for water was less than what they presently pay. In the dry season this is $2/m^3 for almost all the households, but in the rainy season it ranges from zero for households that do not use vendors to $2/m^3 for those that rely on them exclusively (Figure 8).

Assume that a price of $0.50/m^3 were set for the improved system, which would make it advantageous for all households to connect in the dry season. However, 16 percent of the households pay less than that in the rainy season and might not find it financially advantageous to switch to the new system. Let us assume, then, that only 84 percent of the households would use the improved system in the rainy season. Taking the average for the entire year, it could be predicted that 92 percent [(100 + 84)/2] of the households would use the new system if it charged $0.50/m^3. In actual numbers this would mean 560 households (0.92 X 600) and 2,800 people (0.92 X 3,000)[9]. Proceeding in a similar manner from the data in Figure 8, the households that could be predicted to use the new system at prices of $0.75/m^3 and $1.00/m^3 are 84 percent and 74 percent respectively. These results are summarized in Table 3.

TABLE 3

PREDICTED HOUSEHOLDS CONNECTING TO NEW SYSTEM

PRICE ($/M^3)	% CONNECTED DRY	RAINY	AVG %	NO OF HOUSEHOLD	NO OF USERS
0 50	100	84	92	560	2800
0 75	100	67	84	500	2500
1.00	100	48	74	440	2200

The next task is to predict the demand for water at alternative prices. If the price charged was less than what is presently paid, it is reasonable to expect that households would consume at least as much water from the improved system as from present sources, since their total costs would be less. The important question is how much more water might be consumed at prices lower than present average prices.

Again, consider a hypothetical price of $0.50/m^3. Assuming average consumption remained unchanged from the present 40 lcd, the annual cost to an average household would be about $37. If, however, average consumption increased to 60 or 80 lcd, average annual costs per household would be $55 and $73, respectively.

[9] Totals are rounded.

Figure 7 shows the distribution of annual household expenditures in the present water market. About 87 percent of the households presently pay more than \$37, 75 percent pay more than \$55, and 62 percent pay more than \$73 per year (present average expenditure is \$100/yr per household). Hence, if the price were set at \$0.50/m^3, the majority of households could consume more than twice the present per capita amount without increasing their total water bill.

This kind of sensitivity analysis might not produce a precise demand function, but it is better than selecting per capita consumption values out of the air. Let us therefore assume that, at a price of \$0.50/m^3, average consumption would double from 40 to 80 lcd, in which case annual household consumption would increase to 146 m^3.

Proceeding in similar manner, Table 4 shows the percentages of households that presently pay higher costs than those resulting from the indicated per capita consumptions and prices. For example, if the price were set at \$0.75/m^3 and average consumption were 40 lcd, the resulting cost would be lower than what 75 percent of the households in Tierra Nueva presently pay. Based on this analysis, it is assumed that at prices of \$0.50, \$0.75 and \$1.00 per m^3, average per capita consumption would be in the order of 80, 60 and 40 lcd, respectively. This demand function is shown in Figure 12.

TABLE 4

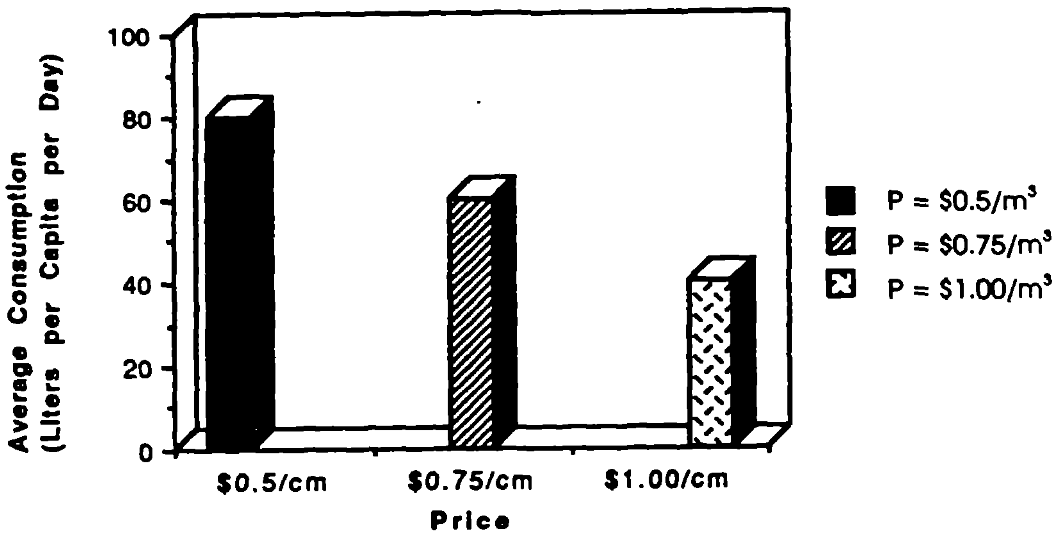
PERCENTAGE OF HOUSEHOLDS THAT PRESENTLY PAY HIGHER COSTS THAN THOSE RESULTING FROM THE INDICATED PRICES AND PER CAPITA CONSUMPTIONS

PRICE CONSUMPTION (LCD)	($/M³) 0.50 %	0.75 %	1.00 %
40	87	75	62
60	75	50	35
80	62	35	10

With estimates of the population that would use the new system at alternative prices (Table 4) and the quantities of water that would be purchased (Figure 12), it is possible to estimate revenues. At a price of \$0.50/m^3, for example, Table 4 shows the estimated number of users to be 2,800, and Figure 12 shows the estimated average demand to be 80 lcd. The corresponding total revenue for the entire system is about \$41,000 per year. Revenues at other prices are shown in Figure 13. It is interesting to note that although 300 fewer persons would use the improved system at a price of \$0.75 than at \$0.50 per m^3, annual revenues are about the same.

Figure 12

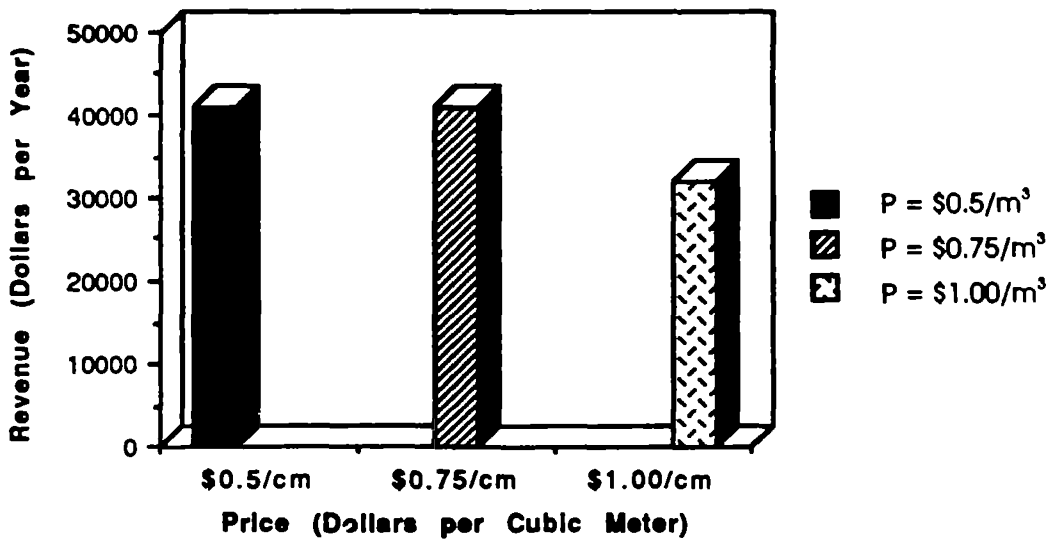
Assumed Demand Function



The final task of this section is to select the price which will achieve financial self-sufficiency. The candidates are in the range of \$0.50 to \$0.75 per m^3. At the higher price of \$1.00/m^3, not only do total revenues decline, but the number of persons served is less. At a price below \$0.50/m^3, the number of customers would be slightly higher, but average per capita consumption is not likely to increase, which would result in lower revenues.

Figure 13

Estimated Annual Revenues



Recall that all households would probably use the improved system in the dry season; hence it would have to serve 3,000 users. At prices between $0.50 and $0.75 per m^3, estimated total revenue is $41,000 per year which, divided by 3,000, amounts to $14 per person served. Assuming one-third of the revenue is required for O&M and the capital recovery factor is 0.12 (see Section 3.1), this revenue could finance a self-sufficient system with an average per capita construction cost of nearly $80. This calculation is shown in Table 5.

In Section 3.1, it was estimated that a yard tap system would probably cost about $70 per capita or even less to construct.[10] Hence, at the proposed prices, the system would be financially self-sufficient. Final price selection should be toward the low end of the range, say between $0.40 and $0.60 per cubic meter, in order to maximize the number of households that would use the improved system in the rainy season.

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[10] Rural systems in Guatemala with a 20-year capacity cost of $70 per capita.

TABLE 5

FINANCIALLY SELF-SUFFICIENT SYSTEM

ANNUAL REVENUE AT PRICES BETWEEN \$0.50 AND \$0.75 PER M^3 = \$41,000

NUMBER OF PERSONS SERVED = 3,000

AVERAGE REVENUE PER PERSON = \$14

O&M COST (ONE-THIRD) = \$4.70

DEBT SERVICE (TWO-THIRDS) = \$9.30

CAPITAL RECOVERY FACTOR (CRF) = 0.12

PER CAPITA CONSTRUCTION COST (DEBT SERVICE/CRF) = \$78

4.3 Dynamic Plan

It is not uncommon for the populations of periurban areas to grow at 3 percent, 5 percent, or even 8 percent per year. Such high rates of growth are unlikely for Tierra Nueva because of restricted land availability. However, for purposes of this illustration, assume the growth rate is 3 percent per year and that the planners have decided to design for the demand at the end of 20 years, when the population will be 5,400.

If it costs \$70 per person to construct an improved system for the present population, the construction cost for the future population will be less since some facilities (e.g., yard taps) can be delayed. Assume it costs \$45 to construct the excess capacity for each of the 2,400 persons that will use the system in the future. As shown in Table 6, the resulting total construction cost is \$318,000.

TABLE 6

SYSTEM COSTS WITH EXCESS CAPACITY

ASSUMPTIONS	
GROWTH RATE (% PER YEAR)	3
CONSTRUCTION COST FOR PRESENT POPULATION ($/CAP)	70
CONSTRUCTION COST FOR FUTURE POPULATION ($/CAP)	45
CAPITAL RECOVERY FACTOR	0.12
RATIO OF DEBT SERVICE TO O&M COST	2/1
20-YEAR DESIGN PERIOD	
DESIGN POPULATION = 3,000 WITH GROWTH AT 3% PER YEAR OVER 20 YEARS	$ 5,400
CONSTRUCTION COST - PRESENT POPULATION = $70 X 3,000	$210,000
CONSTRUCTION COST - FUTURE POPULATION = $45 X 2,400	$108,000
TOTAL CONSTRUCTION COST	$318,000
ANNUAL DEBT SERVICE = $318,000 X 0.12	$ 38,000
ANNUAL O&M COST	$ 19,000
TOTAL ANNUAL COST	$ 57,000
COST PER CAPITA	$ 10.5
5-YEAR DESIGN PERIOD	
DESIGN POPULATION = 3,000 WITH GROWTH AT 3% PER YEAR OVER 5 YEARS	3,500
CONSTRUCTION COST - PRESENT POPULATION = $70 X 3,000	$210,000
CONSTRUCTION COST - FUTURE POPULATION = $45 X 500	$ 23,000
TOTAL CONSTRUCTION COST	$233,000
ANNUAL DEBT SERVICE = $233,000 X 0.12	$ 28,000
ANNUAL O&M COST	$ 14,000
TOTAL ANNUAL COST	$ 42,000
COST PER CAPITA	$ 12.00

Assuming equal annual payments and a capital recovery factor of 0.12, the debt service on a loan of this amount is $38,000 per year If debt service represents two-thirds of total annual system cost (with the remaining one-third for O&M), total annual cost would be $57,000, which is the amount of revenue needed for a financially self-sufficient system.

In the previous section, the revenue in the first year was estimated to be $41,000. Hence, by designing for a period of 20 years and with equal annual debt service payments, there would be a deficit in the first year of more than $15,000. While this deficit would decrease over the years as new customers come on line, it would take more than 10 years for it to be eliminated and for the system to be financially self-sufficient. It must be noted that per capita costs are lower over the 20-year time horizon.

These assumptions and calculations are summarized in Table 6. Although they are merely illustrative, they indicate the problem of trying to include excess capacity while achieving financial self-sufficiency, assuming equal annual payments for O&M and debt service costs. However, the table shows a system with a design period of about five years would incur total annual costs approximately equal to predicted revenues in the first year.

Chapter 5

CONCLUSIONS

In periurban areas supplied mainly by vendors or others (e.g., private wells) that charge for water of reasonable quality delivered on a regular basis, a study of the existing market in most cases will provide a strong database for planning an improved system. Present expenditures indicate the size of the market and potential revenues; the distribution of present average costs indicates the number of households that might connect to the new system at alternative prices; and present household consumption and expenditures provide a basis for estimating demands.

However, this type of study is applicable only where most households pay for their water and have a fairly uniform level of service comparable with that of the proposed improvement. Studies of periurban areas that rely mainly on natural sources such as rivers and springs and that require water to be hauled long distances provide less useful information for planning an improved piped system. To estimate demands and willingness to pay for improvements in these cases, other approaches such as the contingent valuation method hold greater promise

To decide whether the approach used in Tierra Nueva might be applicable in other periurban areas, a preliminary study would be necessary to determine such things as the existing level of service and the proportion of households that pay for water. Several sites were investigated before Tierra Nueva was chosen, but it did not take more than a few hours in each of them to decide that a study of the existing market for water in Tierra Nueva would be the most fruitful.

A study of this type has the advantage of taking much of the guesswork out of planning. Sweeping assumptions are not needed about such things as the level of service, whether to use meters, or the amount of water that will be demanded. Also, willingness to pay is based on the reasonably firm foundation of existing payments. Perhaps most important is that a study of the existing market gets the planners into the field to observe the water-using practices of the community. As in Tierra Nueva, field work can (and should) be done by local people, but interviewers need to be trained, a survey instrument needs to be developed and pretested, and data forms need to be checked for accuracy as they are returned by interviewers to the study coordinators. Although the sample size in Tierra Nueva was adequate and the study was conducted by foreign consultants, its cost was still only about 10 percent of the estimated construction cost of an improved system.

Studies of existing water markets like Tierra Nueva make sense only if the water authority is serious about using the results for planning. Government must be flexible and recognize that the improved system must be able to compete favorably with existing suppliers if present revenues are to be captured. In Guatemala, for example, the water authority would have to change the tariff structure (i e., discard the *paja* system) and charge a price in the periurban community different from that in the adjacent capital (about 5 to 10 times higher) It would have to be aware of household cash flow problems that might make it necessary to render bills more than once a month to avoid a loss of revenue, and would have to recognize that, because some households will continue to use rainwater, revenues would probably decline in the wet season.

The water authority must also recognize that, in principle, it is present average costs in the rainy season that support the competitive price that can be charged for the improved system. However, most households perhaps do not know their present average costs, and the government would have to launch an information campaign to point out the advantages of an improved system over present sources.

Finally, government must be prepared to deal with the reliability issue. Existing sources set the standard; government must meet or exceed it The water authority needs to make a realistic assessment of whether it can compete, and if it finds that it cannot, then maybe it should not try. To attract customers with the promise of reliability and then to fail leaves them disillusioned, angry, and reluctant or unwilling to pay their bills, even if reliability is restored.

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REFERENCES

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APPENDIX A

Team from Regional School of Sanitary Engineering

San Carlos University

Guatemala, C.A.

APPENDIX A

Team from Regional School of Sanitary Engineering,
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APPENDIX B

Household Interview Forms

QUESTIONNAIRE FOR TIERRA NUEVA

INTRODUCTION

We are students from the University of San Carlos, and we are working jointly with the University of North Carolina. We would like to ask you some questions about the system for water supply. Your answers will help us understand what is the major form of portable water supply in this community. These answers will not have any effect on changing the present conditions for water supply in Tierra Nueva.

If you don't want to respond to these questions you can stop me whenever it is convenient.

NAME OF THE INTERVIEWER:

DATE:

SECTOR:

PRELIMINARY INFORMATION

A1. Sex of the person being interviewed M/F

A2. Is the person being interviewed the head of the house? Yes/No

A3. How many adults live in this house? (including all persons) No. of adults ______

A4. How many adult women live in this house? (including all the women) No. of women ______

A5. How many boys and girls live in this house? No. of boys and girls ______

CHARACTERISTICS OF SOURCES

SOURCE 1: VENDORS

S1.1 Does your house sometimes get its water from vendors?

Yes	No
Continue	Go to the next source

S1.2 What quantity of water does your house get each week from vendors? (in drums)

Rainy season ______ Dry Season ______

S1.3 How do you pay per drum for water that you buy from vendors?

Rainy season ______ Dry Season ______

S1.4 How do you consider the taste and purity of the water that you buy from vendors?

Good Ordinary Bad

S1.5 What distance do you have to walk in order to get water from vendors?

Meters _____

S1.6 Can you get water from vendors whenever it is needed?

Always Sometimes Never

S1.7 For what purposes do you use the water that you buy from vendors?

	Rainy Season	Dry Season
Drinking/cooking	______	______
Bathing/cleaning	______	______

SOURCE 2: PUBLIC TANK

S2.1 Does this household sometimes get its water from the public tank?

Yes No
Continue Go to the next source

S2.2 What quantity of water does your household get each week from the public tank? (in drums)

Rainy season ______ Dry Season ______

S2.3 How much do you pay per drum for water from the public tank?

Rainy season ______ Dry Season ______

S2.4 How do you consider the taste and purity of the water that you obtain from the public tank?

Good Ordinary Bad

S2.5 What distance do you have to walk in order to get water from the public tank?

Meters _____

S2.6 Can you get water from the public tank whenever it is needed?

Always   Sometimes   Never

S2.7 For what purposes do you use the water that you get from the public tank?

	Rainy Season	Dry Season
Drinking/cooking	____________	__________
Bathing/cleaning	____________	__________

SOURCE 3: WELLS

S3.1 Does this household sometimes get its water from wells?

Yes   No
Continue   Go to the next source

S3.2 What quantity of water does your household get each week from wells? (in drums)

Rainy season ______   Dry Season ______

S3.3 How much do you pay per drum for the water that is purchased from wells?

Rainy season ______   Dry Season ______

S3.4 How do you consider the taste and purity of the water that you buy from wells?

Good   Ordinary   Bad

S3.5 What distance do you have to walk in order to obtain water from wells?

Meters _____

S3.6 Can you get water from wells whenever it is needed?

Always   Sometimes   Never

S3.7 For what purposes do you use the water purchased from wells?

	Rainy Season	Dry Season
Drinking/cooking	______	______
Bathing/cleaning	______	______

SOURCE 4: BOTTLED WATER

S4.1 Does this household sometimes use bottled water?

Yes — Continue
No. — Go to the next source

S4.2 What quantity of bottled water does your household use each week? (in 5 gallon bottles)

Rainy season ______ Dry Season ______

S4.3 How much do you pay per bottle for bottled water?

Rainy season ______ Dry Season ______

S4.4 How do you consider the taste and purity of bottled water?

Good Ordinary Bad

S4.5 Can you obtain bottled water whenever it is needed?

Always Sometimes Never

SOURCE 5: RAIN WATER

S5.1 Does this household sometimes use rain water?

Yes — Continue
No — Go to the next source

S5.2 What quantity of rain water does your household use per week? (in drums)

Rainy season ______

S5.3 How do you consider the taste and purity of the rain water?

Good Ordinary Bad

S5.4 Can you obtain rain water whenever it is needed?

Always Sometimes Never

S5.5 For what purposes do you use rain water?

	Rainy Season	Dry Season
Drinking/cooking	________	________
Bathing/cleaning	________	________

SOURCE 6: NEIGHBORS

S6.1 Does your household sometimes get its water from your neighbors?

Yes	No
Continue	Go to the next section

S6.2 What quantity of water does your household get each week from it neighbors? (in drums)

Rainy season ______ Dry Season ______

S6.3 How much do you pay per drum for the water that you buy from the neighbors?

Rainy season ______ Dry Season ______

S6.4 How do you consider the taste and purity of the water that you buy from your neighbors?

Good Ordinary Bad

S6.5 What distance do you have to walk in order to get water from the neighbors?

Meters _____

S6.6 Can you get water from your neighbors whenever it is needed?

Always Sometimes Never

S6.7 For what purposes do you use the water that you get from your neighbors?

	Rainy Season	Dry Season
Drinking/cooking	________	________
Bathing/cleaning	________	________

HOUSEHOLD CHARACTERISTICS

Interviewer: Please observe the characteristics of the house and complete the following information.

Type of roof ______________________________

Type of walls ______________________________

Type of floor ______________________________

B1. How many rooms does this house have? (not including the kitchen or bathroom) No. of rooms _____

B2. Does this household have sanitation facilities?

Yes _____ No _____

B3. Does this house have: (Yes or No)

Bicycle	________
Motorcycle	________
Radio	________
TV	________

B4. What is the level of education of the head of the household?

		No. of Years
Primary	__________	__________
Secondary	__________	__________
Other	__________	__________

B5. For the head of the household and all the other persons who are working, please indicate the following:

PERSON	SEX	OCCUPATION	PERMANENT EMPLOYMENT	
Head of the household	___	_________	Yes _____	No _____
_________	___	_________	Yes _____	No _____
_________	___	_________	Yes _____	No _____
_________	___	_________	Yes _____	No _____
_________	___	_________	Yes _____	No _____

B6. We would like to know the level of income of the persons who are working. We do not need to know the exact amount of the salary of each one of them, but we would like to know the range of income. Please indicate in which of the following ranges are the salaries of the persons who are working.

Q/month	Head	# 1	# 2	# 3
< 50	______	______	______	______
51-100	______	______	______	______
101-200	______	______	______	______
201-300	______	______	______	______
301-400	______	______	______	______
401-500	______	______	______	______
>500	______	______	______	______

B7. Please give me your opinion about the fraction of the cost of the potable water system that ought to be paid by the government.

Less than half ______ **More than half** ______

CONNECTION FEE

If you had to pay a charge of "A" per month during the first year in addition to the monthly bill for water that is used by your family, would you be willing to purchase water from the public system? This additional charge is equal to "B" which could be paid in a single payment if you want.

Yes ______
No ______
Don't know ______

The values of "A" in quetzals ranged from Q5 to Q40. The corresponding values of "B" (= 12 * A) ranged from Q60 to Q480.

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THE WASH PROJECT

With the launching of the United Nations International Drinking Water Supply and Sanitation Decade in 1979, the United States Agency for International Development (A.I.D.) decided to augment and streamline its technical assistance capability in water and sanitation and, in 1980, funded the Water and Sanitation for Health Project (WASH). The funding mechanism was a multi-year, multi-million dollar contract, secured through competitive bidding. The first WASH contract was awarded to a consortium of organizations headed by Camp Dresser & McKee International Inc. (CDM), an international consulting firm specializing in environmental engineering services Through two other bid proceedings since then, CDM has continued as the prime contractor.

Working under the close direction of A I.D.'s Bureau for Science and Technology, Office of Health, the WASH Project provides technical assistance to A.I.D. missions or bureaus, other U.S. agencies (such as the Peace Corps), host governments, and non-governmental organizations to provide a wide range of technical assistance that includes the design, implementation, and evaluation of water and sanitation projects, to troubleshoot on-going projects, and to assist in disaster relief operations. WASH technical assistance is multi-disciplinary, drawing on experts in public health, training, financing, epidemiology, anthropology, management, engineering, community organization, environmental protection, and other subspecialties.

The WASH Information Center serves as a clearinghouse in water and sanitation, providing networking on guinea worm disease, rainwater harvesting, and peri-urban issues as well as technical information backstopping for most WASH assignments.

The WASH Project issues about thirty or forty reports a year. WASH *Field Reports* relate to specific assignments in specific countries; they articulate the findings of the consultancy. The more widely applicable *Technical Reports* consist of guidelines or "how-to" manuals on topics such as pump selection, detailed training workshop designs, and state-of-the-art information on finance, community organization, and many other topics of vital interest to the water and sanitation sector. In addition, WASH occasionally publishes special reports to synthesize the lessons it has learned from its wide field experience.

For more information about the WASH Project or to request a WASH report, contact the WASH Operations Center at the above address.