FIELD REPORT

WATER SUPPLY ISSUES IN THE PERI-URBAN (INFORMAL) SECTOR

WASH Field Report No. 355
May 1992

WATER AND SANITATION for HEALTH PROJECT

Sponsored by the U.S. Agency for International Development
Operated by CDM and Associates

WASH Field Report No. 355

WATER SUPPLY ISSUES IN THE PERI-URBAN (INFORMAL) SECTOR

Prepared for the Office of Health,
Bureau for Research and Development,
U.S. Agency for International Development,
under WASH Task No. 039

by

R. McGowan
J. Hodgkin
P. Kaplan

May 1992

Water and Sanitation for Health Project
Contract No. 5973-Z-00-8081-00, Project No. 936-5973
is sponsored by the Office of Health, Bureau for Research and Development
U.S. Agency for International Development
Washington, DC 20523

CONTENTS

FIGURE

ABOUT THE AUTHORS

Richard McGowan has degrees in mechanical and civil engineering and philosophy, and twelve years of development experience in Asia, Africa, and the Middle East. He is the Senior Engineer at Associates in Rural Development, Inc. (ARD), in Burlington, Vermont, and works on rural/peri-urban water supplies and renewable/conventional energy systems analysis. His special interest is the comparative assessment of water and energy technologies for developing country applications.

Jonathan Hodgkin has degrees in mathematics and civil engineering and 10 years experience working in Africa and the Middle East. He has worked with ARD for eight years. His experiences and interests span the water resources and energy sectors from water pumping and water quality to renewable energy systems. The focus of his recent work has been operations and maintenance, cost analysis, and resource management.

Paul Kaplan is a Cornell University trained consulting Rural Development Sociologist whose experience has been mainly in South and South East Asia. During ten years of work in Nepal, he worked mainly on water-related research especially regarding water user organizations. As an Associate Sociologist with ARD, he has worked on several WASH pro-active tasks over the last three years.

ACRONYMS

HMG	His Majesty's Government (Nepal)
MSF	Médecins sans Frontières
NRWC	National Rural Water Corporation (Sudan)
NUWC	National Urban Water Corporation (Sudan)
NWC	National Water Corporation (Sudan)
O&M	Operations and maintenance
PCI	Project Concern International
PVO	Private voluntary organization
SCC	Sudan Council of Churches
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
WASH	Water and Sanitation for Health Project

PREFACE

This report presents an overview of the major issues involved in peri-urban water supply systems in developing countries. It provides descriptions of the major components of typical systems, and discusses how certain important elements determine whether a system operates successfully or not. Two detailed case studies of peri-urban systems (one in Kathmandu, Nepal and the other in Khartoum, Sudan) are given to illustrate the diversity of peri-urban water supply configurations and many of the unique problems they face. Many of these unique problems are due to the fact that peri-urban systems are often neither fish nor fowl, in that they are unlike most rural systems (i.e., completely physically and often financially independent of any other system) and unlike most urban systems (i.e., inter-tied to a large, often well-supported system which has multiple water sources, physical facilities which provide redundancy in the event of occasional failures, and have vocal and often politically well-connected constituencies which help to insure their successful operation and maintenance).

Peri-urban water systems are often those which have little or no legal standing, are supported largely by the informal sector, and receive the lowest priority from the perspective of their primary (often their only) water supplier, often a spur line of the main city water system. Peri-urban areas typically do not have the social and organizational coherence of a rural village, and so may not have any effective formal and informal leadership to take responsibility for insuring the successful operation of their water supply. Beyond simply being ignored by municipal water authorities, peri-urban areas may be actively disassociated from their main source of water, in an effort to discourage further rural-urban migration to that area.

Given the increasing emphasis in development circles on providing improved levels of service to rapidly increasing peri-urban populations, there is a need to address the many problems unique to peri-urban water supplies as new WS&S development projects in peri-urban areas are designed. This report is a first step to identify and address some of those problems.

The authors would like to thank several people who were of particular help in undertaking the case studies in this report. Much of the information in the Sudan case study was gathered with the assistance of the Rev. John Ashworth and Ms. Hannah Parks, who worked with the people living in the peri-urban areas we visited near Omdurman. Mr. Nourella Yassin of the Energy Research Council helped with our visits to several pumped water systems in the same area. We would also like to thank several local staff from CARE/Sudan and the Sudan Council of Churches representative Mr. Bernardo who accompanied us on our visits to Hilat Shook. We would also like to thank the persons who were interviewed during our visits to the various peri-urban sites situated around Kathmandu Valley.

EXECUTIVE SUMMARY

Peri-Urban Context

This paper explores the connection between water production and the systems that have sprung up to distribute the water to peri-urban consumers. It is meant to provide insights that will help water system planners better understand the role that the nonformal sector can play in water provision. Both advantages and disadvantages of peri-urban water development are outlined, which planners must carefully weigh in considering adequate service to peri-urban dwellers.

For the purpose of this report, the term *peri-urban* refers to informal settlement areas, peripheral to urban centers, that are outside of the formal government service network. The term *peri-urban* is not a geographic distinction, since peri-urban settlements may exist within urban zones, but rather a reference to the degree of government involvement. Such settlements often spring up virtually overnight because of the extraordinary urbanization occurring in developing countries, as rural dwellers flock to the cities to look for work or to escape natural or man-made disasters and civil unrest.

Peri-urban residents face a variety of difficulties related to their water supplies: there may simply be too little water; access to it may be limited and difficult; its quality may be poor; and distribution may be inequitable. Such difficulties often reflect the temporary and/or emergency nature of the communities themselves, whose residents generally have neither political nor economic power—at least one of which are usually necessary to obtain adequate services.

Water Supply Systems

Currently, water supply arrangements in peri-urban areas fall within a broad range of system configurations that vary according to whether they involve the public or private sector (or both) and vary also according to how they combine three elements: the water source, the production facility, and the mode of distribution. Because each of the three water-supply elements may be separately owned, a given system may present a complex pattern of ownership that includes public institutions, voluntary organizations, and private enterprises.

Some peri-urban water supply arrangements involve a city water utility or department as the main supplier. Wholesalers then lease taps from the utility and, in turn, market water to retail distributors who ply their routes using barrels on donkey carts to move water from the wholesaler to the point of consumption. Others are entirely private operations, involving households or enterprises that have their own wells and satisfy at least part of their water needs from this source. Other private enterprises buy water from private truckers, who in turn purchase it from public water utilities. Still other water supply arrangements involve consumers

who, through poverty, inadequate supplies, or supply interruptions, cannot afford to purchase water and so turn as a last resort to open-access sources: rivers, lakes, and in one case, polluted outfall waters from a tannery.

Case Studies in Sudan and Nepal

The case studies of peri-urban water supply systems in Sudan and Nepal reveal complex systems that take on the characteristics of "public service industries" for water supply. There are often multiple water producers and distribution modes. These systems incorporate elements of competition among water wholesalers and among water retailers, which redound to the benefit of peri-urban water consumers. Most consumers appear to enjoy at least some margin of choice, and can credibly threaten to change suppliers if water prices or related considerations are unacceptable. Even limited options help keep water producers from engaging in price gouging.

Recommendations

Recommendations for donor and NGO organizations are provided which fall into four categories—political considerations, engineering design elements, program design elements, and environmental and health issues.

Political Considerations

- Determine the perceived needs of peri-urban dwellers to confirm the priority that they attach to improved water supply.

- Investigate the possibility of peri-urban areas being absorbed into urban or "planned" areas.

- Help peri-urban areas gain formal government recognition so that they can use normal government powers to mobilize resources for water supply activities and also have the option of establishing formal relationships that may attract government resources for developing and sustaining local water supplies.

Engineering Design Elements

- Design the physical infrastructure (and associated levels of service) based on a clear understanding of (a) the role vendor competition plays in protecting consumers and (b) the financial constraints that will affect long-term system sustainability.

- Decide beforehand whether the goal is to create a temporary relief system or to address emergency relief needs while also laying the groundwork for more-permanent installations.

- Try to incorporate consumer water storage into system designs.

Program Design Elements

- Design peri-urban water supply programs to include formal, enforceable rules that guarantee consumers reliable access to the water supply.

- Identify and take advantage of existing informal and formal water supply and distribution arrangements. Selectively discourage and encourage participation in development activities by using incentives (for instance, through assignment of tariffs, inclusion in training programs, etc.)

- Carefully allocate responsibility for critical tasks, and then ensure that proactive training and support programs are available to strengthen local capabilities.

Environmental and Health Issues

- Before designing a system, first evaluate the environmental impacts of program implementation and then promote specific training and education programs that relate to findings.

- Include health and hygiene programs in project designs.

Chapter 1

INTRODUCTION

1.1 Defining the Peri-Urban Context

Most developing countries have experienced an unprecedented growth in their cities in recent decades. Current projections indicate that 40 percent of the population in developing countries will be living in cities by the year 2000. Average growth rates in cities are approaching 40 percent annually but some cities are exceeding 8 percent, more than three times their rural growth rates. The provision of services and amenities essential for a healthy, adequate life have lagged behind the rapidly expanding populations, especially in peri-urban areas. The rapid growth of cities has usually been associated with a rapid increase in the number of people living in overcrowded, substandard housing, much of it built illegally, with inadequate provision of water, sanitation, collection and disposal of household waste, and health care. In some African cities from 40 to 80 percent of urban poor are living with inadequate facilities and services. In virtually all developing countries, local and city governments lack the resources to meet their responsibilities in providing such services and facilities. An adequate and safe water supply, so essential for health, is one amenity that is particularly lacking and is therefore the focus of this report.

For the purpose of this report, the term *peri-urban* refers to informal settlement areas, peripheral to urban centers, that are outside of the formal government service network. Such settlements often spring up virtually overnight because of the extraordinary urbanization occurring in developing countries, as rural dwellers flock to the cities to look for work or to escape natural or man-made disasters and civil unrest.

Peri-urban areas frequently develop in a series of stages, beginning as squatter settlements with little sense of private space or permanence. Water supply in such areas is often uncertain: quantity is inadequate, quality and reliability are poor, access may be limited and difficult, and distribution patterns may be inequitable. These circumstances reflect the temporary and emergency nature of many peri-urban communities, whose residents are fleeing worse conditions or are trying to establish an economic toehold in an urban area. Whatever their background and purpose for being there, peri-urban residents usually have at least one thing in common: they lack political and economic power and, thereby, the leverage to obtain adequate services.

National and municipal governments sometimes wish to deny the existence of these settlements and are thus reluctant to provide them with public services. Such provision would, after all, imply some legal recognition of the inhabitants' right to be there. Or, if such settlements are considered a necessary (but temporary) evil, governments may resist providing services as a way of discouraging permanency. In other cases, willing governments simply lack

the financial resources to provide adequate services to rapidly expanding settlements. Thus denied access to municipal electricity and water and sewer hook-ups, peri-urban residents must often look to the informal sector for these services, which are likely to be less adequate and more expensive than those available to urban municipal consumers.

1.2 Purpose and Structure of the Report

This paper explores the connection between water production and the systems that have sprung up to distribute the water to peri-urban consumers. It is meant to provide insights that will help water system planners better understand the role that the nonformal sector can play in water provision. Both advantages and disadvantages of peri-urban water development are outlined, which planners must carefully weigh in considering adequate service to peri-urban dwellers.

Chapter 2 presents an overview of peri-urban water supply, analyzing the nature of peri-urban water resources, production facilities, and distribution facilities and the ways these elements combine to form a water service system. Chapter 3 discusses the elements and conditions that make up a functional system, and Chapters 4 and 5 relate the circumstances of specific case studies in Khartoum, Sudan and Kathmandu, Nepal to these elements. And finally, Chapter 6 offers recommendations for designing and modifying peri-urban systems and also provides suggestions for follow-up activities.

Chapter 2

OVERVIEW OF PERI-URBAN WATER SUPPLY

Current practices in peri-urban water supply span a broad range of public (formal), private (nonformal, including community organizations), and even combined system configurations. Some of the most common are ad hoc responses to water needs in unplanned—often actively discouraged—developments in urban fringe areas. Others provide a more rational response in areas that clearly could be absorbed eventually into the adjacent urban jurisdictions and serviced by those water supply infrastructures.

System configurations vary according to the way they combine three components of peri-urban water supply: the water source, the production facility(ies), and the distribution facility(ies). Water may be drawn from a variety of surface and groundwater sources and can vary in quality from potable to polluted. The source itself, however, is distinct from two other facilities involved in meeting peri-urban water needs: the production facility, which captures the water, and the distribution facility, which moves the water from the point of production to consumers.

A single water supply system may encompass multiple production and distribution facilities. Water production, for example, employs various technologies: spring catchments; drilled and dug wells; river or lake pumping stations; roof catchment and cistern installation; and wastewater reclamation. A production resource may be subject to any of several ownership systems or property rights regimes. Distribution resources also employ a variety of forms—piped systems, bottled water vending, and tanks and barrels transported by truck or donkey cart. They, too, are subject to different ownership regimes.

2.1 Water Sources

Whether urban, rural, or peri-urban, water sources include springs, surface water, groundwater, and/or collected rainwater. Springs that can provide enough water are often the most desirable source to develop because the water quality is usually considerably higher than surface sources. In addition, mechanical pumping systems, which are expensive to install, operate, and maintain, are usually not required.

Surface water sources include lakes, rivers, and catchments for water run-off (including reservoirs, runoff collection ponds, etc). These sources often provide free and open access for those within reasonable proximity, although lakes and reservoirs may be privately or publicly owned and therefore subject to exclusion. Complex pumping and piping is not utilized with surface water unless the water must be distributed or lifted to users located well above the source. In some cases, the water may be located some distance away from consumers and require transport—by hand, donkey cart, truck, or pipeline. Although frequently offering

unrestricted access, surface water sources may be polluted chemically or bacterially and thus contribute to local disease and poor health. In most cases, treatment is recommended for surface water but rarely performed outside of the formal sector. Also, once treated and transferred by pipeline, water is rarely available to consumers without charge.

Groundwater is found in underground saturated zones. These sources (particularly those at greater depths) are less conveniently accessible to users because of the need for well development, pumping equipment, and operation and maintenance. Shallow aquifers can be exploited with hand-dug wells constructed either by private individuals or through community initiatives. Access to open-well sources will depend to some degree on custom, ownership issues, and/or the location of the well. Groundwater sources are likely to be of significantly better quality than surface water. However, chemical or bacteriological contamination is possible either from naturally occurring chemicals (e.g., salt, fluorides, etc.) or from human intervention (e.g., sewage and point or nonpoint chemical pollutants). The use of water from underground sources may be restricted, depending on the nature of the water source and the production process.

In areas where the climatic conditions are favorable, rainwater catchment provides a means of tapping an open-access water resource. Where water is expensive, rainwater catchment may be practiced in an ad hoc manner, with people collecting water during a rainstorm from roofs or, in extreme circumstances, from puddles. A more-formal method of rainwater harvesting, which requires high rainfall, employs permanent cisterns for collection and provides a long-range water supply solution in some areas. Rainwater users can control water quality with minor precautions or treatment. By its very nature, rainwater is difficult to restrict, although control of the collection areas may imply exclusion for some.

2.2 Water Production Systems

Water production includes private- or public-sector initiatives by which water is made available in bulk at a single point. Water production usually implies that water becomes a restrictable resource available only to the owners of the means of production and to those granted access (usually for payment). In peri-urban zones with no formal water-supply institution, water production commonly combines several production and distribution systems in a complex mix that varies from place to place.

In peri-urban areas (and other rural and semi-rural settings), water production systems commonly fall into several general categories, which may include private-sector configurations and public or parastatal municipal water agencies. Four common configurations follow.

2.2.1 Commercial

In some cases, an enterprising person or group may create a private-sector water production system in order to sell water. Hand-dug or drilled wells often serve as water sources for these arrangements, although other sources (such as a large roof catchment at a business or factory site) are clearly possible. When wells are used, water is usually mechanically pumped. Although there may be a water-storage tank at the well site, there is unlikely to be any form of piped distribution except in wealthy urban fringe areas. These features allow the commercial enterprise to exclude users and thereby charge fees for water.

Water is generally sold to individuals who live close to the water source or to vendors. It is usually sold by unit-volume measures, such as a jerrican (about four U.S. gallons), donkey cart, common-size pail, drum, etc. Prices (unlikely to be regulated) will reflect water-source development and operations costs and a profit for the entrepreneur/operator. Formal establishment of private water producers may be regulated by law (enforced or unenforced), which will affect their legal standing and the degree to which they can operate openly. Where these producers are tolerated by government or other powers, they often provide a reliable water supply for those with access to it, since the owners' profits depend on continuing water sales.

2.2.2 Private Cooperatives

Cooperative water-producing enterprises in peri-urban areas may arise through the initiative of neighborhood groups—religious, political, or ethnic organizations—or even collective vendors. These cooperatives may then seek and receive development assistance from religious groups, local or central government agencies, or locally active PVOs.

Cooperative institutions will be governed in some manner by users or user proxies. The cooperative will develop rules concerning such things as—

- Facility operation (including times of water availability, water fee structure, etc.)
- Financial, in-kind, or labor commitments required of members
- Water access
- Governing bodies (such as village committees) to deal with water issues

The physical system is likely to resemble that of the private water producer, although a cooperative may also arrange for water delivery to cooperative members. Payment may take the form of individual/family membership dues or unit fees for water consumed. The reliability of water supplies will likely depend on the cooperative's management and accounting

capabilities. Cooperatives are likely to be characterized by limited access to water, with services provided only to members. If water supplies exceed member needs, the water may be sold to nonmembers.

2.2.3 Private Individuals

Individual producers typically arise in areas where water tables are shallow and inexpensive pumping equipment can be used. These water sources are often polluted because of shallow water tables and because wells may be inadequately designed or constructed; also, local sanitation facilities and practices are often inadequate for high-population densities. Usually, private arrangements provide water for only a single family or set of families and do not generate income. However, these producers may pass excess water to neighboring users for cash or barter, or even without charge if the users are family or friends.

Ad hoc or improved water-catchment techniques relying upon impermeable surfaces are also used by individuals to meet family needs.

2.2.4 Public Authority

In urban settings water is typically supplied by government agencies or parastatals within clearly defined water districts. Water-supply systems are normally large and complex, with single or multiple sources and many distribution points. Water may come from surface sources such as rivers or water impounded in reservoirs; these sources may be some distance from the urban area. Groundwater sources may also be used, alone or in combination with other sources. Urban water, particularly from surface water sources, is usually treated and piped to distribution points.

Water may be purchased according to the volume delivered at metered connections, by a flat fee for use of a tap or through municipal taxes. Water users have formal access through private connections or public standpipes. Although this system provides the urban population with access to water, peri-urban populations outside the limits of the recognized area may have little, if any, access to water.

Depending on resource limitations and/or technical or logistical constraints, the public authority may make water available to peri-urban dwellers by allowing its sale at public water points within the urban jurisdiction. This practice may be formally agreed upon by government officials or allowed only by policy omission, and the security of these sources for peri-urban dwellers will partly depend on the formality of these arrangements. Sales revenues may accrue directly to the government water authority or may be collected indirectly through franchising arrangements with private-sector operators.

Municipal water systems managed as parastatal enterprises may be more aggressive about fee collection and more open to service expansion to peri-urban populations, either through

expansion of distribution facilities or selling water in bulk. Parastatals are often not subject to government personnel policies. Fees collected are unlikely to flow directly to the overall government treasury (although subsidies may well flow in the opposite direction). The semi-private status of parastatals allows for easier loan qualification from multilateral lending agencies, a situation that may allow (and encourage) expansion of services to peri-urban areas.

2.3 Water Distribution Systems

Water-distribution mechanisms take various forms: manual collection, bulk delivery, pipes, or some combination thereof. The most convenient form of access is the in-house tap; next is the yard tap, followed by a nearby public tap, etc. When consumers get their water from a public standpipe some distance away from their homes, they can either carry the water themselves or pay a water vendor or laborer to carry it for them. For this added convenience, however, the peri-urban user pays a premium.

Access is to some extent a function of water cost to the user (whether measured in money, energy, or time). The nature of the water source and the characteristics of local water production systems can have a major impact on system costs, which in turn affect the consumer. For example, water from underground sources that require pumping or lifting will usually carry higher production costs than will water from typical surface-water sources. Similarly, using the same type of production system, a private entrepreneur will usually charge more for water than a cooperative does because profit would presumably be excluded from the cooperative's cost calculations.

2.3.1 Collected Water

Water can often be collected by users themselves, either directly from the source or indirectly through a producer. Open-access sources such as surface water (rivers or lakes, for example) are usually available to users free of charge. However, users must live close enough to these sources to take advantage of them. Although surface water sources are often polluted, many low-income users appear to value water quality less highly than ease of access and lower cost.

There are exceptions, however. In Sri Lanka, for example, most homes in one peri-urban area near Kalutara just south of Colombo, have their own dug wells, complete with bucket and rope, in their backyards. But because they live near the coast, their water has a high mineral content, especially salt, and is used mainly for washing dishes or clothes. Where possible, water for drinking and cooking is taken from another source. Some middle-class families have their drinking water carried in by someone who gets the water from a developed spring at a nearby temple grounds. These people are clearly willing to pay a premium for better-quality water.

Sometimes, standpipes within peri-urban areas (or just outside the formally recognized or "planned" urban public service areas) provide free water, but usually water at these sites is provided upon payment of a fixed fee. Water at these sites is usually of good quality and much better than at open-access sources. Use of the standpipes depends on the time and energy needed to get the water, the degree of access allowed by those controlling the standpipe, and water fees at the site.

Occasionally (as in some of the Sudan case studies in Chapter 4), inferior water such as engine-cooling water or wastewater overflow from filling donkey-cart tanks may be collected free. Sometimes, users may be allowed to collect water from a neighbor's tap, a family member's well, or water points owned and/or operated by private cooperatives, churches, or private voluntary organizations. In other situations, water is simply stolen from public mains through illegal taps on public systems. In Pakistan, for example, illegal taps of both water and electrical power are a significant problem.

Some consumers use water-catchment techniques to meet all or part of their water needs. For example, in the Pacitan District of East Java in Indonesia, CARE has assisted communities to build several thousand rainwater catchment systems in individual homes. Families use these systems to meet their water needs for three to six months of the year, depending on the rainfall for the year. Occasionally, in areas with shallow water tables, water is available from open wells or from boreholes equipped with handpumps owned by the community or individuals within their own compounds. Such situations are rare, however, in less-affluent peri-urban areas.

2.3.2 Delivered Water

Many peri-urban dwellers prefer to have their water delivered or find themselves in a situation where there is no feasible alternative. These consumers, who usually pay for their water on a unit-volume basis, receive it in one or more of the following ways:

- Delivered by household connection (either a yard tap or in-house connection)
- Delivered by vendors (donkey carts, burro bags, trucks, hand-carried, etc.)
- Purchased in bottles

Piped water supplies interconnected to municipal mains are rarely found in peri-urban areas. Exceptions might include closely knit cooperatives in small areas whose members have developed their own independent water sources and piped systems, or wealthier peri-urban areas whose residents may have done the same. (Riyadh, on the west bank of the Blue Nile near Khartoum, is one such example.)

In areas without other adequate means, by far the most common method of obtaining water is to purchase it from vendors who deliver door to door in many peri-urban areas.

In some countries (e.g., the Republic of Yemen), bottled water is commonly sold by commercial firms in neighborhood shops or by street vendors, although these sources are rarely used by poorer sections of the peri-urban population. Prices are usually far too high to use bottled water for anything other than drinking, although the bottling process does offer (at least in theory) the assurance of safe water. When buying water from other types of vendors (licensed or unlicensed), users are often unable to determine water quality.

2.3.3 Combined Distribution Methods

In practice, peri-urban water supply often combines several of the categories just described. For example, drinking water may be first produced at a privately owned borehole (or from a public mains tap), transferred to a truck for "wholesale" delivery to a number of distribution points, transferred again at each distribution point to rubber bags carried on a donkey or to barrels on a donkey cart, and then carried by the "retail" vendors to individual homes for consumption.

Chapter 3

ELEMENTS OF A SUCCESSFUL SYSTEM

To serve its consumers properly, a peri-urban water system must meet several interrelated conditions:

- It must have enough accessible and reliable water for resident use.
- Its water must be of reasonable quality.
- The cost of the water must be low enough for most people to afford.
- The production and distribution systems must be adequately maintained.

Failure to meet any of these conditions for even a short time will decrease user satisfaction; prolonged failure will disrupt users' lives.

Before planning innovations, it is important to determine which of the above conditions are already being met. It is important, as well, to respect the balance that must be struck between the needs of the consumers for service and those of the suppliers for a livelihood. Without such an understanding, attempts to assist peri-urban water users will be less effective than they might otherwise be and may even work against the consumers' best interests.

3.1 Quantity, Reliability, and Accessibility

The amount of water available and its reliability will usually depend upon the hydrological conditions of the source. Streams, springs, and shallow aquifers typically vary in output seasonally and are also subject to significantly lower yields during droughts. When a community draws its water from a single source, water shortages and even stoppages may occur. Production and distribution elements, also, may be vulnerable to breakdowns and operator unreliability. Alternate options give consumers some protection from supply cutoffs.

3.1.1 Multiple Water Points

Parallel water sources generally increase the reliability of a supply system, as a breakdown in one source will not impede the flow from the other(s). Deliberate decisions to interrupt supply, to discourage new settlers from migrating to a particular zone for example, are also more difficult to implement in parallel systems with separate sources. The costs of creating such systems may be higher, however, because each may have an independent system for

delivering water to users or at least to the point where the peri-urban network begins. Serially linked systems may be cheaper to construct if all share a common delivery system to the point where they diverge for distribution in the peri-urban community. However, a mechanical failure in a serial system will cut off water supply thus leaving consumers in a more vulnerable position. Generally, separate production and distribution facilities should provide better system reliability.

The capacity to increase the number of autonomous water supply points is constrained by at least four factors: legal barriers to drilling new boreholes; financing; local peri-urban capacity to manage autonomous supply systems; and pollution problems. Legal barriers currently pose no problems, for example, in Nepal where boreholes may be drilled on private land without authorization, even in the urban jurisdictions of the Kathmandu Valley. By contrast, recent national legislation in Sudan requires that permission be obtained from the rural council before drilling in rural jurisdictions (presumably drilling is controlled in the urban jurisdictions, as well). While this rule may not be currently enforced in Sudan, it is a potential constraint and one that may occur in peri-urban areas in many countries. In areas not owned by the Sudanese government, traditions of tribal land ownership allow land-holding tribes to prohibit borehole-drilling by nonowner groups. Such a custom can create difficulties, particularly along tribal borders where property lines are not well defined.

The second constraint, financing, is likely to be a serious hindrance in the case of borehole-drilling unless peri-urban groups can obtain support from either government or assistance agencies. (Some peri-urban communities may be able to gather enough funds without outside assistance if construction costs for shallow boreholes or dug wells are modest.)

The third constraint, management capability, influences both day-to-day operations and sustainability, financial as well as institutional. As exemplified by the case studies in Chapters 4 and 5, some peri-urban communities are able to manage a water system perfectly well, financing current operations through user fees. Many communities would be able to maintain a fund for equipment replacement, although others such as Sudanese refugee groups may have a harder time because of both poverty and the utter disruption of social relationships upon which management capability would rest.

Because of the flow patterns of much surface and underground water, pollution—the fourth constraint—often exceeds the regulatory capacity of a single local community. Where pollution is not a problem or where pollution levels can be moderated by local sanitary installations, the issue may well be manageable. Where pollution is serious, management may require overarching institutions and large-scale investments.

Public policies that apply to ownership of water rights and sources and constraints on private individual development of water resources have a marked impact on the development of viable long-term alternatives for meeting peri-urban water needs. Innovative solutions to water supply needs are now being put into practice in some areas. Formal recognition that these

approaches are legitimate would provide welcome assurances for water users and incentives for suppliers to continue development of more-workable approaches to peri-urban water supply.

3.1.2 Patterns of Production

It is important to recognize the distinction between provision and production of a traditionally public service. Typically, *provision* involves definition of the supply area, customers, terms of access, level(s) of service, system design(s), financing, and monitoring and evaluation of outcomes. *Production* involves combining inputs to produce desired outputs. Provision and production may be undertaken by a variety of players. Primarily, the players in a peri-urban setting consist of (1) formal urban public water utilities that are accessible by peri-urban dwellers; (2) informal peri-urban community organizations; (3) private-sector entrepreneurs; and (4) individual households. Each of these players may act as provider or producer in a specific setting, and often all four are involved in a variety of possible arrangements. Typical arrangements include the following:

- Provision by urban public utility with allowances for production by peri-urban hoseholds who individually procure water and arrange transport
- Provision by urban public water utility with production by private-sector entrepreneurs who transport water from public and/or private sources and sell it to households
- Provision by informal peri-urban community organizations (or rural development councils) who also handle production by developing sources and arranging distribution through a variety of channels (pipes, standpipes, wells, and vendors)
- Provision by community organizations with distribution by contracting with private entrepreneurs (vendors) or allowing individual households to buy and transport water
- Provision by private entrepreneurs who also handle production by selling to wholesale vendors who retail to households based on market conditions
- Provision by a federation of community organizations that coordinates the production activities of individual jurisdictions

3.1.3 Distribution

While water source and production modes are critical to the issue of reliability, equally important are the methods of distribution. Most urban households receive their water through municipal mains terminating in house taps or in taps that serve housing compounds, neighborhoods, or even entire communities. Consumer access is subject to periodic stoppages that may result from cutoffs at the source or from system breakdowns.

Households that purchase their water from travelling vendors (hand- or donkey-carts or trucks) may experience similar stoppages if the vendor, too, is affected by water cutoffs at the source. Some vendors, however, draw from alternate sources at such times and continue to provide their clients with at least some water, although often at higher rates. Another reliability issue would be the nature and dependability of the vendors themselves. If a vendor operates an inconsistent route or schedule, consumers may miss the opportunity to purchase water and thereby suffer a shortage either until the vendor passes by again or until the customers can locate another.

One way consumers can gain more-reliable access to water is through increased storage capability. Such storage might take the form of additional household pots, larger containers shared by compounds, or even neighborhood storage tanks.

3.2 Water Quality

In peri-urban areas, water quality may vary a good deal, depending on the source itself, the mode of distribution, and the method of household storage. Pristine vendor tanks or impeccable household storage will count for little if the primary source is contaminated, which is usually the case if surface water is used. Or, water that is potable at the source may be degraded by factors beyond the water point. For example, water passing through Kathmandu's aging municipal pipes quickly becomes contaminated through leaky pipes and breaks in the system that allow sewage to seep into the system. Dirty donkey-cart tanks could have the same effect, as could unwashed storage vessels in the home.

Health and hygiene education should be considered fundamental elements of water supply projects. Such training is best directed toward both users and vendors, particularly in situations where they can substantially reduce health problems by making relatively minor efforts to avoid drawing polluted water or adding pollution to water they are transporting, storing, or consuming. Particularly in peri-urban areas, it may not be easy to avoid using polluted drinking water, but even such measures as maintaining vendor hygiene and keeping containers clean can help residents improve family and community health.

3.3 Water Cost

To obtain reliable water supplies at acceptable prices, consumers must be able to bargain with suppliers, a leverage they can gain in two ways: through access to a competitive water market or through political institutions to control water prices. When water buyers can choose from among a range of itinerant vendors, as is frequently the case in peri-urban areas, it becomes much more difficult for retail vendors to gouge consumers. This same competition, brought about by the low cost of entering the water-vending trade in many settlements, makes it difficult for the vendors to organize a cartel price. For example, a cart and donkey may be purchased in Khartoum for U.S. $300-350. Even allowing for donkey fodder and government fees and taxes, donkey-cart vendors can start their operations for a reasonable outlay.

Were a group of vendors to adopt a cartel pricing strategy, others might find it attractive to undercut them, and in the end cartel members would presumably have to lower their prices. In areas where high entry costs exclude potential competitors, finding a way to increase the number of entrepreneurs (donkey-carters, truckers, etc.) offers a simple but effective mechanism to increase competition and thus use market pressures to moderate prices. It also avoids the risks involved in relying on an administered pricing system to control water costs to consumers.

When residents cannot pay for their water, the government water utility may choose not to charge and thus allow residents to meet their water needs for only the cost of carrying it home. Many do not enjoy such access, however, and must seek out less-expensive (and possible polluted) alternatives to the customary sources. To overcome cost constraints, such groups may need help in organizing themselves into leverage groups, or it may be necessary to find ways to subsidize their water use.

3.4 System Maintenance

Reliability is to a great extent a function of appropriate strategies to deal with breakdowns in physical supply systems. In a water service industry with multiple producers and distributors, production and distribution facility operators (who derive their livelihood from these activities) have strong incentives to run efficient operations. Since their prices must respond to market demand, only by improving the efficiency of their facilities can they derive somewhat more income or profit.

In a system with multiple production and distribution facilities, the breakdown of any single facility is far less critical than in fully integrated and centralized water supply systems. When a pump, a donkey cart, or a truck breaks down, despite the immediate inconvenience for water users, the impact is limited by several factors. For one thing, other production and distribution facilities exist and continue to operate, so that users are not left totally without water. Most areas are served by multiple vendors, and a breakdown of one or two carts will

be a matter of inconvenience only, as other carts will continue to function. A truck breakdown would have more serious consequences, however.

Producers and distributors who depend directly on water users for their livelihood, rather than on salary payments from a large bureaucracy, immediately feel the impact of a fall-off in personal income; thus, they have a strong incentive to fix the facility. Ready availability of money, parts, and trained labor will speed the process, whatever the circumstances. However, when water producers do not need to operate through water company channels and can obtain parts wherever available, they may pay higher prices but the costs in time and energy are far less than in many bureaucracies. Further, it is characteristic of private entrepreneurs to be inventive and forceful in solving repair problems and often to employ a wide range of strategies in the process. Some measures, however, are ad-hoc and may endure for shorter periods of time as compared with an institutionalized approach. Some water systems are literally held together with wire, misfitted parts, and similar accessories.

3.5 Consumer Participation

Some peri-urban water supply systems are vertically integrated, that is, a single organization controls the water source, provides the investment for and operates the production process, and also runs the distribution network to neighborhood or household taps. But in many peri-urban areas, water, production facilities, and distribution facilities are all separate, with different inherent attributes and different ownership. Generally, the latter is the preferable circumstance since peri-urban water consumers should have access to alternative sources if their main water source fails or becomes unattractive for reasons of price, pollution, or other reasons. Peri-urban water supply systems should be structured so that consumers do not confront a monopoly supply in which a breakdown will cut off their access to water. Such practical leverage may be particularly useful for consumers who lack standing as a community and may be unable to rely on political pressure to restore interrupted water supplies.

If all components of the system are privately owned, internal organization is of little consequence to peri-urban consumers, so long as water is reliably available at reasonable cost and in reasonable quantity and quality.

Where it is judged appropriate to encourage greater water-user involvement in a peri-urban water supply system, special institutions may be necessary. Two of these are consumer cooperatives (described in Section 2.2.2) and local jurisdictions.

3.5.1 Local Jurisdictions

If peri-urban areas have community organizations with governing responsibilities, and preferably with some formal status, those bodies can serve as water-supply units that assume responsibility for—

- Determining the quantity and quality of water desired
- Setting reliability and distribution network standards
- Licensing providers
- Mobilizing resources to finance production or distribution resources

A variety of entities could then supply water through pipe and tap hook-ups to central urban networks, private or cooperatively organized wells, donkey carts and trucks distributing water, and so on. Water might be paid for through a contract with the jurisdiction or through user fees.

Such a system offers users a degree of indirect control over the water supply system, depending on the extent to which officials of the local jurisdiction look to users for continuation in office and on the desire of producers to serve the peri-urban area in question. If local officials are appointed by superiors in an overlapping regime, they may be relatively insulated from user pressure. But if these officials are elected or appointed by locally elected officials and depend for their salaries on taxes raised from residents, they will have strong incentives to represent water-users' interests.

Although offering a promising structure for some areas, the jurisdictional approach to peri-urban water supply has its drawbacks. For one thing, many peri-urban areas lack standing in the eyes of government officials, who may discourage settlers from remaining where they are and may withhold services as a strategy to force peri-urban residents to decamp. Under such circumstances, to advocate formal recognition of peri-urban informal jurisdictions may be self-defeating. Government officials may also oppose autonomous jurisdictions in peri-urban areas because the officials worry that such local government units might be used to launch protests against central government authority or policies. Thus, government opposition could arise even if the proposed peri-urban jurisdiction were a special-purpose district authorized solely to organize water supply services. However, a settlement that the government opposes on policy grounds may still acquire a water supply system, if the government will tolerate short-term assistance. Such communities would probably be allowed to organize private water-supply enterprises. They may be allowed to organize consumer cooperatives to provide water supply, and they may be able to get help from the urban water-distribution resources, if its managers are willing and able to make water available to other private entrepreneurs or cooperatives. The community may also be able to ask PVOs for assistance.

Where it is possible to obtain formal recognition as an autonomous jurisdiction, the upgrade in status may be worthwhile. Establishing and running a general-purpose government for the jurisdiction or even just a special-purpose district for water supply will require residents to mobilize considerable time, energy, and money. However, the capacity of such a jurisdiction to provide services and the advantages to be derived from this capacity may outweigh the

costs of organization and operation. If so, residents of the peri-urban community may derive a net benefit from organizing themselves.

3.5.2 Incorporation

When urban governments are willing to incorporate new peri-urban areas into the existing city jurisdiction, settlement residents may or may not have a choice about this option. If allowed to choose among being incorporated into the city, creating an autonomous jurisdiction for water provision, or remaining unorganized, residents will have to weigh the options.

Although incorporation provides residents with a formal claim to a complex package of municipal services, water supply included, it may also cost them money if incorporated peri-urban residents become subject to urban municipal taxes. The practicality of this option will depend on the likelihood of the community receiving services, when those services will be provided, how reliable they will be, and so on. If the city is facing budgetary constraints, politically powerful neighborhoods will likely capture more public services than will less-powerful ones. The political situation of the peri-urban neighborhoods should influence whether residents decide to seek incorporation.

Chapter 4

PERI-URBAN WATER SUPPLY IN CENTRAL SUDAN

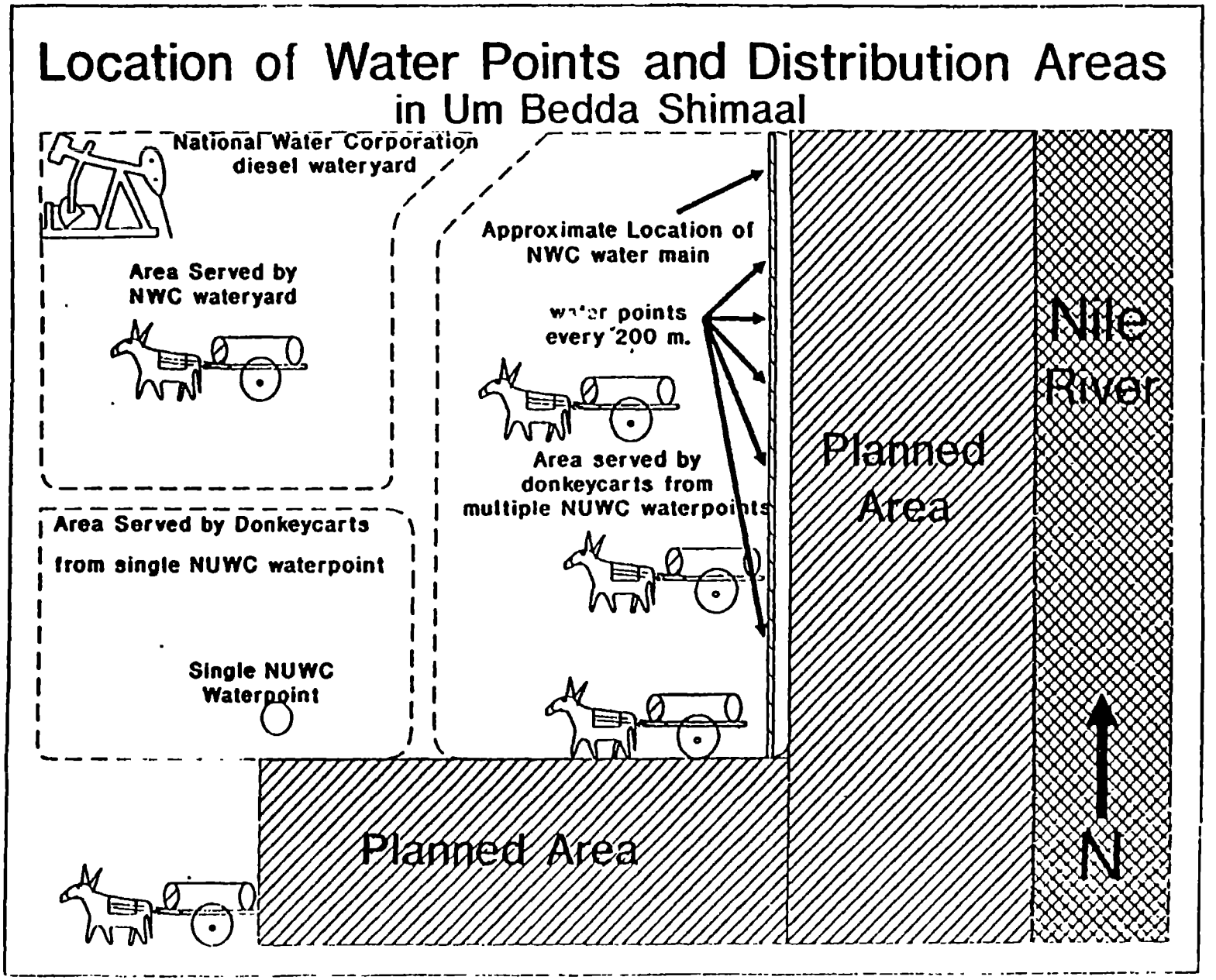
The site descriptions included in this and the following chapter present peri-urban water supply issues from a consumer perspective. Chapters 4 and 5 focus on situations in which governments permitted water supply efforts to occur, even if those efforts received little or no government assistance. The case studies from Khartoum (Chapter 4) and Kathmandu (Chapter 5) reveal complex systems for meeting the needs of water users in these environments. Sources ranging from mud puddles to fully piped systems that supply water to household taps may be publicly or privately owned. Facilities used to capture water reflect the diversity of these sources. At the low end, people use roofs and buckets to harvest rainfall or rely on surface water—springs, lakes, and rivers. Other consumers use open wells and boreholes to tap into aquifers. As with the water sources themselves, ownership of production facilities varies, even within the same area.

Distribution facilities are also highly variable, encompassing jugs, water trucks, and piped systems. Combinations of distribution facilities are common, as in the Khartoum peri-urban areas where donkey carts transport water to residences from a number of different production facilities and points on piped distribution networks. Viewed overall, the pattern of peri-urban water supply in Kathmandu and Khartoum is surprisingly complex.

This chapter presents the observations from several brief visits to Sudanese settlements near Omdurman to study water production, distribution, and cost. Residents were asked to discuss the water source; pumping or other equipment used; cost of water to vendors and consumers; cost-recovery mechanisms; responsibility for construction, operation, and maintenance of the systems; frequency and causes of outages; and alternate water sources used when the primary source became unavailable.

Many semi-permanent mud brick structures stand in the general area visited, but the number of temporary shelters has risen dramatically; these are mainly *tuquls*—round huts, about 3 meters across and 2 meters high, constructed of tree limbs and sticks covered over with cardboard, rags, burlap bags, and tattered pieces of plastic, then tied together with rope, string, or wire. Usually found in public "unplanned" spaces (as opposed to planned areas laid out by government or city planners), these settlements sometimes spring up in industrial areas between walled factories or warehouses. Their residents live under fairly crowded conditions, with minimal water supplies and little or no sanitation. Figure 1 provides a schematic drawing of the Um Bedda Shimaal area and shows the major points visited.

Figure 1


Location of Water Points and Distribution Areas
in Um Bedda Shimaal
National Water Corporation
diesel wateryard
Area Served by
NWC wateryard
Approximate Location of
NWC water main
water points
every 200 m.
Area served by
donkeycarts from
multiple NUWC waterpoints
Area Served by Donkeycarts
from single NUWC waterpoint
Single NUWC
Waterpoint
Planned
Area
Nile
River
Planned Area
N

Five different water supply arrangements were observed at the sites:

- Water obtained from vendors using donkey carts filled at a National Urban Water Corporation (NUWC) tap on the fringe of the refugee settlement area

- Water obtained either directly by consumers (the exception) or more commonly from vendors with donkey carts at a diesel-pumped borehole originally established by the National Rural Water Corporation (NRWC)

- Water obtained through yard taps served by NUWC lines, a service available only in planned areas

- Water obtained at a diesel-pumped borehole apparently drilled by UNICEF and equipped by a local group through contributed funds

- Trucked-in water stored in large rubberized storage bags/tanks (portable when empty) at sites supported by Médecins sans Frontières (MSF-Belgium)

The most common arrangement observed was water delivery to individual homes by the ubiquitous donkey cart. These carts are generally single-axle, single-donkey carts with two standard steel barrels welded together, each having a filler hole on top and a drain at the bottom rear. When full, these carts hold about 88 (Imperial) gallons of water, or about 22 jerricans. The jerrican (or tin) is the common measure of individual water purchase; costs are almost always quoted as pounds per jerrican because of the amounts commonly sold in a single transaction. The typical price was one Sudanese pound (S£) or about US $0.05, per four-gallon (18 liters) jerrican on the free market.*

4.1 Site 1—Pumps and Donkey Carts

A site near Khartoum offers a good example of local entrepreneurship in a peri-urban situation where water supply poses a daily problem. The solution was organized in part by the NRWC through creation of the pumping site, but operations and maintenance (O&M) have been taken over by a local self-help committee. Through a subcommittee set up to deal with water supply issues, management of water production is handled by the subcommittee and financed by water sales to consumers. Distribution is handled by private entrepreneurs.

---

* In June 1989 the official exchange rate was pegged at S£4.45 per US $1, and the black market rate at S£20 per US $1. There are 100 piasters in one Sudanese pound (S£1). Calculations in this report use the black market rate.

The site, lying some 8 kilometers northwest of the confluence of the White and Blue Niles, is an unplanned peri-urban settlement area that is, in effect, a suburb of Khartoum. It is separated from the Nile by a planned area that has been incorporated into Khartoum and receives, among other services, city water piped to taps in each compound.

The settlement is not formally organized as an autonomous jurisdiction, falling instead within a rural administrative subdivision. The local self-help committee governs the settlement, taking responsibility for provision of education and water supply services, among others. Various tribes are represented on this committee, although refugees have not yet been included, possibly because they are seen as temporary residents only.

Two organizations are involved in water supply for the settlement: the self-help committee and the local rural council. The rural council sets standards for vendor health by requiring an annual health examination (costing S£30) and licenses water carts (S£120 annually). Vendor compliance with these regulations is monitored by rural council officials, who occasionally inspect water operations in the settlement.

Settlement residents can obtain water from three different sources, each independent of the other two. The main source is a diesel-pumping system in a settlement wateryard created by the National Rural Water Corporation, a subsidiary of the National Water Corporation. The wateryard is managed on an ad hoc basis by the settlement's self-help committee. Another wateryard—similarly created, equipped, and managed—is located about one kilometer south of the settlement and serves as a back-up water source when the settlement facility breaks down or is temporarily stopped for maintenance. The third source is the Nile itself, providing water which, although twice as costly to deliver to the settlement as locally pumped water, is extremely reliable.

The settlement's main water supply system involves three separate operations: capture (production), wholesaling (distribution), and retailing (distribution). Daily, the pumping system captures about 80 cubic meters of water from the shallow aquifer that underlies the Nile Valley. This water is stored in a 30-cubic-meter elevated holding tank until used. Some of this amount is taken free by permanent residents of the settlement who live nearby and carry the water home in jugs. Refugees, some walking as far as three kilometers, also receive water free if they transport it themselves. Most of the water, however, is sold at wholesale prices to itinerant vendors who drive their donkey carts from door to door. Perhaps as many as 100 donkey carts make up the distribution facility for one location.

The pumping facility is managed by an operator and guard housed at the wateryard and salaried at S£500 and S£300 per month, respectively, by the settlement self-help committee. Water is pumped six hours a day to fill the tank, once from 6:00 a.m. to 9:00 a.m. and again from 3:00 p.m. to 6:00 p.m. Tank water is available to users around the clock except during breakdowns and maintenance operations. During periods of high demand—morning and evening—donkey carts queue up in orderly fashion to be serviced at loading points some 20

meters from the wellhead (to reduce source pollution) by two flexible hose outlets. Because the storage tank is elevated, water pressure is high, service is rapid, and waiting times are kept to a minimum.

Repairs and routine maintenance are completed rapidly and efficiently on a regular basis to ensure that equipment remains in good operating condition. Oil and filter changes are carried out by the operator, but he does no repairs. When breakdowns occur, the operator informs the water subcommittee, which dispatches someone to try to get spare parts from the NRWC parts store. As the latter rarely has enough supplies, the settlement representative usually gets the parts at the local market. The committee then hires a moonlighting NRWC mechanic to complete the repairs and conduct nonroutine maintenance.

All operating costs (salaries, diesel fuel, spare parts, and labor) are covered by the user fees collected at the wateryard. As far as O&M costs are concerned, this wateryard is a sustained operation. Excess funds are kept in a bank account controlled by the water subcommittee.

Reportedly, the water subcommittee pays nothing to the NRWC which, according to local informants, transferred total control of the yard to the subcommittee. The NRWC did, however, replace a diesel engine that had ceased to function when its injectors became clogged.

A donkey cart of water costs S£3 (about US $0.15 on the free market) at wholesale, three times the cost of piped water available from NUWC taps in areas nearer Khartoum. At this site, water costs S£1-S£1.5 ($0.05-0.08) per jerrican, depending on how far the sale point is from the water source; those farther from the yard normally pay more. Retail water costs more during breakdowns, as vendors must travel to the second or third sources to obtain water.

Vendors have regular routes and regular customers, serving refugees as well as long-term residents. Some even provide credit to families with temporary cash-flow problems. When water is scarce, carters seem to guarantee priority service to those who are regular, long-term customers, and low-priority users sometimes have to make their own arrangements. For long-term settlement residents, daily per capita water consumption averages 31-36 liters. For a family of seven, this amounts to 12 jerricans at S£12-S£18 (US $0.60-$0.90) per day. Refugees usually cannot afford this level of water consumption.

Donkey-cart vendors can easily enter the retail water trade, as the pay-back time for a cart and donkey, purchased locally for a combined price of S£6-7,000 ($300-350), would appear to be under a year. This estimate is based on an average of four runs a day at a gross income per run of S£25 ($1.25) and includes overhead costs for the driver's wages and donkey fodder, as well as for licenses.

4.2 Site 2—Donor-Supplied Borehole and Locally Owned Pump

Another pumping arrangement observed is situated approximately one kilometer northwest of the southern and eastern borders of the unplanned area. This site developed in an area that was neither clearly "planned" or "unplanned." The nearby buildings, although permanent and fairly well-built structures (mud/brick walls, block houses), were somewhat randomly placed, which suggests that the area was not a planned one. Although not operating when visited, several observers reported the site to be similar to an NRWC wateryard in many respects. It includes a six-inch (15 cm) borehole of undetermined depth, drilled apparently by UNICEF. A medium-size (about 15-20 kw) Italian diesel drives a vertical turbine pump. Water flows from the wellhead to a ground-mounted storage tank sitting somewhat awkwardly due to its lack of foundation. When observed, the tank was about half full, indicating that it had been operated recently.

Informants reported that the NWC had nothing to do with constructing this site; instead, a local committee reportedly had taken up a collection, solicited UNICEF cooperation in drilling the borehole, and then purchased the equipment itself. The water is now sold to users and, presumably, to local donkey-cart vendors. The resulting revenues support the operation and maintenance of the site. Unfortunately, informants were unable to provide more information.

Like the NRWC wateryard, this case represents a quite distinct approach to resolution of peri-urban water supply problems. The water source is an aquifer; water production relies for lifting power on a diesel pump purchased with locally generated funds. Informants reported that a local committee, which apparently is unrecognized by the Government of Sudan, owns the production facility. The committee is organized in what appears to be an established community whose residents have some economic means at their disposal.

The water source seems to be an open-access aquifer: the committee reportedly obtained permission from no one before having the well bored. The production equipment is operated by the committee on a fee-for-service basis for the good of the surrounding community. Distribution is either directly to users living close enough to the site to carry water to their dwellings or to donkey-cart vendors. It is unclear whether only committee members can purchase the water produced or whether they have priority during water shortages over other users, such as donkey-cart vendors. The distribution equipment is treated as private, whether jerricans or pots headloaded home from the borehole or donkey carts owned by entrepreneur water vendors.

This site provides a useful example of local self-help and public entrepreneurship coupled with an evidently sound economic operation. The production and distribution arrangements seem to reflect an appropriate approach to providing reasonable service, but further investigations would be necessary to confirm this.

4.3 Site 3—Commercial Standpipe and Vendors

The third site is an industrial area called Zagalona, where brick-walled courtyards surround small factories and warehouses. In the open areas outside the walls, more-recent refugees have congregated and built closely packed huts, roughly 175 to 250 of them within a 100 by 300 meter area.

The general condition of this area reflects the fact that many residents have recently arrived from the south and generally are not as well-off as those of more-permanent areas. Such "villages" are frequently tolerated by the authorities, but often only on a temporary basis; for example, some have been bulldozed after permanent residents became sufficiently unhappy with their new neighbors. (While this did happen in 1988 in Zagalona, bulldozing is currently thought to be more of a threat than a realistic expectation.) No community government or committee has arisen to help reduce the chaotic nature of living conditions there because, although many Zagalona refugees originated from the same areas in the south, the peri-urban refugee group is neither homogenous nor organized.

Zagalona residents get their water from a nearby standpipe, with flexible hose, that is serviced by an NUWC line. (Residents may have chosen to locate in that particular spot because of the availability of water, but it is equally likely that they chose it simply because it was an open area where they thought it unlikely they would soon be evicted.) Here, individuals carrying jerricans and all manner of other containers share the tap with several donkey-cart vendors. Given the close proximity of the tap to the "village," it was relatively convenient for consumers to get (and pay for) their own water rather than buy it from a vendor. In Zagalona, a jerrican of water at the tap costs S£1.5. Information was not collected about those who operate the tap and collect water revenues, but based on information obtained at other sites, it may be a vendor who pays a fixed rental fee to the NUWC to operate the site.

At a small church school functioning in Zagalona, water is purchased in bulk from donkey-cart vendors, with purchases funded by external donations. It costs S£70-200 per day to meet the needs of about 200 children. Residents said that the nearest waterpoint after the communal tap was a diesel pump site a half-kilometer away, but it seldom worked since there was no fuel available. The settlement has no electric power to operate such a pump.

Water was also distributed in this area under the auspices of the community center, which provides a donkey cart for a local laborer to haul water. In return for use of the cart, the laborer hauls one load per day free to the community center. Beyond that commitment, he can make as many additional runs as he wants to sell water to other customers. He retains the revenue (minus his operating costs) from these additional runs. Under another arrangement, the local youth committee hires a laborer to drive a donkey cart (which the committee provides) in order to make money for the community center. Given the laborer's lack of incentives under this arrangement, however, its long-term sustainability is doubtful.

Zagalona has an interesting range of operators retailing water to consumers after buying at the NUWC mains tap. The community center and youth committee compete with private vendors in servicing the needs of local residents, no doubt providing a certain check on vendor pricing. The donkey-cart system allows considerable flexibility in responding quickly to changing water demands in the settlement; if refugee numbers increase, more private entrepreneurs can be expected to enter the water-retailing trade, as entry costs are quite low. If the numbers shrink, entrepreneurs and their carts can shift away to other tasks requiring small-scale transportation facilities.

Several observers report a general lack of community cohesiveness among displaced persons in camps such as this one. While this was rarely true of camp residents when they lived in their own communities in the south, communal bonds tend to disintegrate when people become displaced. Thus, it becomes difficult for residents to organize themselves into cooperative entities that would strengthen their position, for example, when dealing with local water authorities or vendors.

4.4 Site 4—Mains Taps and Vendors

This site lies at the eastern edge of the unplanned settlement. The housing in this area (mud-and-brick construction, occasional windows, walled-in yards), while not up to the standards of planned areas, generally reflects higher income levels than those in more-remote areas.

In Site 4, water needs are handled through an informal partnership between the public water authority and private vendors. An NUWC main runs along the eastern border of the "unplanned area" (see Figure 1), about one-half kilometer east of and parallel to Sikka Senghetti Road and 1.5 km north of the Blue Arch, which is itself north of the main Omdurman souk. Located at about every 200 meters along a one-kilometer section are water points consisting of a single two-inch (5 cm) pipe, with a flexible hose for filling the donkey carts. (Women with jerricans sometimes dip water out of the drainage sump, obviously very contaminated, but only to use in making building-blocks.)

By far the greatest number of users at these sites are itinerant water vendors with donkey carts. Observers usually noted from five to ten carts congregated around each pipe. The average price to fill the donkey cart is S£1, and vendors say they can usually sell the water for about S£20-24 (about S£1 per jerrican), depending mainly on how far the retail point is from the wholesale water point. (During periodic outages, the retail price reaches S£1.5 and above per jerrican.) The local rural council sets the wholesale rate, which is negotiated periodically between the council and the merchants who rent the water points from the NUWC. It apparently varies little over time.

People who live near water taps and wish to buy water directly pay 25 piasters per jerrican. Although this is one-quarter of the price (S£1) charged by donkey-cart vendors, it is still five

times the official government rate of five piasters per jerrican charged at most NRWC village wateryards.

When queried about general water availability, vendors indicated that the piped water is available about half the time. Outages of more than a few hours do occur occasionally, requiring a round trip of up to three hours east to the Nile to load up. Under such circumstances, the retail price of a cartload can rise to as high as S£50 (or about S£2.30 per jerrican).

Just a half-kilometer north of the main set of water points is a single water tap on the same main, reportedly controlled by a merchant who pays the NUWC a certain amount of money to control the source. Only two donkey carts fill up there, and the drivers pay the standard S£1 per cart. The merchant, essentially a wholesale vendor, then collects the water fees directly from the donkey-cart operators, who work as itinerant vendors. The merchant apparently controls several such water points; whether all of the other 10 to 12 nearby sites are operated in this same wholesale/retail manner is unclear, but some definitely are. The donkey-cart vendors operating from this tap charge the standard retail rate of S£24 per cart, with the price rising to S£50 if they must bring water from the Nile during a local outage.

The donkey-cart taps are right across the street from a planned area, where the houses have in-yard taps. However, when the power is out, water does not flow in the mains (since the NUWC booster pumps are out of order and the mains' pressure too low at this distance from the elevated storage tanks). However, back-up diesel pumping systems exist on boreholes at varying intervals along the mains line. It is not known if they are old NRWC sites that the expanding city simply engulfed or whether they were originally installed by the NUWC as back-up systems. During power outages, they actually pump water back into the mains, and people in the planned areas (whose taps are then empty) buy water from the donkey-cart vendors during these periods.

4.5 Site 5—Trucked-in Storage

At a fifth site, in Markheiyat, a community health unit is supported by Médecins sans Frontières-Belgium. A large inflatable rubber and plastic storage tank (portable when empty) sits near a small community health center in the northwestern part of the settlement, about the farthest point from any water source. A tanker truck periodically refills the bag, which holds 7 donkey carts (14 barrels or about 5.6 m^3) of water and is filled as often as needed. This water is used exclusively by the MSF clinic and never sold to local individuals.

The water source, production, and piped distribution network are NUWC owned and operated. A private entrepreneur who owns a vehicle buys water at a NUWC mains water point and trucks it to the clinic for sale. (In this area, consumers pay S£1 [$0.05] per jerrican and S£24 [$1.20] for a full cartload.) All parties to this set of transactions treat water as a

private commodity, although NUWC may be selling water at a subsidized, submarket price under national regulations. Nonetheless, the arrangement is largely market-oriented. The water consumer can deal with a number of truckers and can obtain water from several water points on the NUWC mains as well as from back-up water points nearer the Nile, in case of disruption in the mains flow. The in-house storage facility provides a further buffer against disruptions of supply for the clinic. The greater economic power available to this externally funded institution allows it obtain a reliable supply of reasonably good water, which is critical in light of the clinic's medical functions.

4.6 Site 6—Water Taps and Vendors

About three kilometers east of the White Nile and seven or eight kilometers south of the confluence of the Blue and White Niles lies a displaced persons* (internal refugees) camp called Hilat Shook. Several groups of people live there:

- Muslims mainly from Darfur and Kordofan
- Easterners from the Kassala area
- Dinka, Nuer, and Shilluk tribe members from the south

The Sudan Council of Churches (SCC) supports one clinic at Hilat Shook with a small supplemental feeding program for children. Help the Aged, a PVO, supports an eye clinic. Two small primary schools are in operation, the Comboni (Catholic) school and another supported by the Islamic Africa Relief Agency.

Most of the people in Hilat Shook are in dire economic straits, living in small, round huts of sticks, string, burlap bags, and cardboard. A large number of the residents work in Khartoum, although many also work in the factories around Hilat Shook, such as the leather tannery. Typical wages for men who have managed to get full-time jobs are about S£400-450 per month (about US $20-22.50); women earn about S£300 per month. Their relative security and uncertain job prospects elsewhere combine to make camp residents reluctant to move away unless there are clear prospects for peace and subsequent repatriation to their original homes around the country.

Sanitation and water supply facilities in the camp are rudimentary, and water-borne diseases are rampant in the camp; like many such areas, diarrheal diseases are the main cause of

---

* In Sudan, the government refers to people who have fled other countries and are now living in Sudan as *refugees*; however, people who have fled southern Sudan or other areas of the country where there is civil war or intertribal strife are officially called *displaced persons*. In this report, "refugee" refers to both categories.

death, especially among children. Bilharzia is also prevalent. There appear to be no pit latrines anywhere in camp, although normally people use unoccupied areas around the camp for urination and defecation.

Most of the camp water supply comes from two sources:

- An NUWC water main running along the eastern edge of the camp. Typically filtered and chlorinated before distribution, NUWC water usually retails for S£1-1.5 per jerrican (or about US$2.80 per m^3).

- A pipeline leading from the tannery, from which water can be purchased at 75 piasters per jerrican. The potability of this water is suspect, and people buy and drink it only if they cannot afford other water.

Although 25 taps on the NUWC mains were originally operated as wholesale outlets for potable water, only 15 to 18 now operate. These are controlled by entrepreneurs who purchase franchises or one- to two-year leases from the NUWC and then sell water to donkey-cart drivers or to consumers who buy direct. Water is treated as a private commodity by all parties.

Some people living near the taps fill their water containers directly from the taps (usually about 25-50 piasters per jerrican), but the great majority buy their water from donkey-cart vendors. All of the carts observed during the visit (driven by young boys—usually relatives of the cart owners) were the usual welded two-barrel type with car wheels and a single axle and donkey. The drivers pay the tap keepers around S£12 per double-barrel load and retail the water to individual consumers for anywhere from S£16 to S£32.

The price of water in Hilat Shook can vary considerably; this year, for example, tannery water cost 75 piasters per jerrican, with NUWC water selling for twice that. Nearly everyone consulted in another Khartoum refugee camp (Um Bedda Shimaal) pays S£1 (or 100 piasters). For most of last year, one jerrican cost 25 piasters in Hilat Shook. But during the floods, the price went up to S£1 per jerrican because of the difficulty of driving carts on the camp's muddy paths. Although the water vendors themselves set the retail price of water, competition among vendors (most of whom are independent owner/operators) makes it very difficult for anyone to raise the price independently and arbitrarily. Apparently, when someone tries to do so, nobody will buy his water.

Some sources estimate that one double barrel lasts a household of 20 for two days, working out to 10 liters per person per day at a cost of 42 piasters per person per day. If the family income amounts to S£15 per day, 14 percent of that sum goes for water. While admittedly only a very rough calculation, this parallels estimates of 15 percent of income spent for water in another camp, and compares favorably with the estimated 54 percent spent in yet another.

Under the latter circumstances, a refugee family can finance water purchases only by reducing expenditures for food, with the predictable devastating effects, particularly upon children.

When questioned about people's strategies when water flow ceases in the pipes, an informant replied that since he has been living there this has never happened. After further questioning, he said that whenever the government (NUWC, presumably) had to fix the main line, they warned the people over the radio a day or two in advance so that they could store enough water to last until the pipes were fixed. It was unclear what the capacity of this storage might be, but it appeared unlikely that many families would have more than one or two jerricans (or similar containers). Apparently, maintenance outages rarely last for more than two or three days; what happens during unexpected outages could not be determined in the course of this visit. Some people complained of occasional water-supply interruptions at the NUWC taps that force them to drink the poorer-quality tannery water as the source of last resort.

Indeed, water quality is something about which people are actively concerned. The chiefs have instructed all cart operators to wash their carts out twice a day "so that the people will not be poisoned" by poor-quality water. One informant said that the water from the NUWC taps is good most of the time, as it is filtered and chlorinated before being distributed. However, he said that sometimes during floods the downtown filtration system plugs up and overflows; then people get muddy water in their taps. Many people, however, simply cannot afford NUWC's relatively good water and are forced through economic necessity to use water from the tannery pipe, which everyone agrees is of poor quality. It is unclear whether the "tannery water" is outfall (basically industrial waste) or just a water pipe that comes out of the tannery. Whichever it is, people clearly do not care for it and avoid drinking it unless they have no other alternative.

4.7 Site Analysis

All of the sites visited were alike in having some access to water; they differed somewhat, however, in the amount of water available to them, the manner of its delivery, the quality of the water, and its cost. The following sections relate site observations to the water supply issues raised in Chapter 3.

4.7.1 Quantity, Reliability, and Accessibility

Among the sites, water accessibility varied a good deal, ranging from virtually on-demand at two sites, to about half-time at another, to once or twice a day at the rest, depending on whether residents collected the water themselves or relied on donkey-cart delivery. Periodic and seasonal NUWC shortages were experienced at most sites, although many residents could then turn to more-expensive (but also more-reliable) water from the Nile or to lower-quality water, as in the Hilat Shook refugee camp. Except during these times of shortage, the *amount* of water available to the consumer depended more upon economics than upon the commodity

itself. Presumably, most consumers could have as much water as they could pay for or, in one instance, carry.

By far the most common method of water distribution appeared to be home delivery by donkey cart. This is a flexible mode, as the carts can traverse most settlement paths during much of the year. Vendors often have regular routes and customers and appear to provide reliable service to those who can afford it, at one site giving priority to long-term customers during water shortages.

4.7.2 Water Quality

NUWC taps serve as the water source for some of the sites and, because this water is generally filtered and chlorinated, water quality is not much of an issue for many residents. The quality of pumped water, which is the source for two sites, would depend upon the condition of the aquifer and also upon the storage facility. Water contamination beyond the source is always a possibility if tanks and jerricans are improperly cleaned; however, in at least one site, ethnic chiefs have instructed all cart drivers to wash their carts twice a day.

During times of water shortage, water quality becomes more of an issue for everyone, as suppliers must look to surface waters (including the Nile). Then, some contamination of their water source becomes a possibility for many. Those who cannot afford the higher cost of long-distance water—such as from the Nile—are forced to rely upon certain local water sources that all recognize to be of questionable quality.

4.7.3 Water Cost

With one exception, people in the six sites were charged for their water, paying either at the water source itself or at the delivery point. Residents purchased water in jerricans, which generally cost from S£1 to S£1.5 (about US $0.05-$0.08), a price difficult for most refugees to meet when buying for an entire family.

Competition from community-sponsored vendors and the competition among vendors themselves helps to keep prices from rising above a certain level. The donkey-cart trade attracts many local entrepreneurs, as it is relatively easy to get into. A quick estimate of the donkey cart drivers cash-flow provides some rough insight into the economics of the water trade at one site (Hilat Shook). Drivers pay S£12 to fill their 400-liter double barrels at the mains taps. Assuming around 10 percent loss in tank leaks and spillage, they are probably able to sell about 20 jerricans (18 liters each) of water per load to gross S£25-30 per trip. Given the four-trip average, drivers gross S£100-120 daily, which provides a comparatively good income. If they do not operate the cart themselves (which few appear to do), cart owners must pay each driver S£15-20 per day and also buy donkey feed (probably about S£5 per day). From the remaining S£75-100 they pay any maintenance expenses and amortize the cost of the donkey and cart. The remaining amount is profit.

When people first began to settle in this area, the SCC distributed donkey carts to the chiefs or leaders of the five major tribes, who then assigned people to operate them. Once it became clear that profits could be made from water vending, a number of entrepreneurs purchased their own rigs, which reportedly cost S£3,000 complete with donkey—considerably less than the reported price of S£6-7,000 in Um Bedda Shimaal. The informant estimated that between 40 and 80 donkey carts operate in the camp, although it was impossible to estimate how many people they actually served.

4.7.4 Production System Maintenance

At least one settlement (Site 1) has set up its own formal maintenance system for the production source, one that uses paid employees and calls upon a professional mechanic when repairs are needed. NUWC also maintains systems that serve the sites observed, often informing the public in advance by radio to lessen consumer inconvenience and perhaps discourage price gouging by vendors.

4.7.5 Community Leverage

Already described is the balancing effect of two vendors at Site 3, one sponsored by the community center and the other by the youth committee, upon their entrepreneurial colleagues. At two other sites, however, community groups control the entire water production system. At Site 1, a water subcommittee oversees operations of a former NRWC pumping site that has been taken over by a settlement self-help committee. Operation costs are met with user fees. At Site 2, a local committee reportedly organized itself to develop a system from scratch, drilling a borehole with donor assistance and then purchasing the necessary equipment. The committee now sells the water at a fair price to residents and (it is assumed) to donkey-cart vendors.

In Hilat Shook camp, a water committee was chosen and, although it was impossible to determine the formal responsibilities of the water committee, a practical example of its role occurred when the government (presumably the NUWC) informed camp leaders that service at 15 of the original 25 water taps would be disconnected. A group of water committee members from various tribes then formally approached the water authorities to discuss the ramifications of this planned action. After bargaining on the issue, the water authorities decided to keep 18 taps operating. The informant believed, however, that the authorities may have been more concerned about the possible reaction of residents to losing 60 percent of their water sources than about meeting the urgent needs of camp dwellers. With 18 taps, there is a limit to which prices may rise because, even if vendors colluded, wholesalers would remain numerous enough to make price fixing difficult.

Some who have worked extensively in the camps around Khartoum believe that water committees and "self-help" committees in general possess largely fictitious power to influence their own lives or those of the people they ostensibly represent. Members are apparently

chosen by the development officers, who are themselves often appointed by persons from outside the camp (either government representatives or PVOs providing relief assistance). The development officer, often also the (appointed) sheikh, may or may not be particularly respected by the camp inhabitants. Prospective members of the self-help committees are approached by the development officer to solicit their involvement. There is apparently no particular term of office nor any formal method of removing unwanted members.

While the potential to develop the committees into truly representative and effective groups may exist, it is difficult to organize the people themselves. Many of them have lost virtually everything they own or hold dear, including family members, possessions, land, and the social connections that allow them to sustain the fabric of their lives. In some refugee camps, conditions have apparently deteriorated to such an extent that people no longer have the ability or even the desire to help any beyond the members of their immediate families. If a young mother dies, the baby may be left to die as well. Commodities are so scarce that fights occur when they are distributed by relief agencies. People can focus only on their own survival, and for many, social bonds belong to the unreachable past. Under such conditions, it is not surprising that camp residents have come to feel powerless, with little incentive or hope that their efforts will bring about any improvement in their lives.

Chapter 5

PERI-URBAN WATER SUPPLY IN THE KATHMANDU VALLEY

Taking a somewhat different approach from that of Chapter 4, the material in this chapter contains both general and site-specific observations. While there are differences among communities, the Kathmandu Valley presents a more-homogeneous picture of peri-urban water supply than do the sites in Sudan. For one thing, water pipes serve a much broader portion of the population here: often a water tap is shared by only one compound, and many homes have a tap actually inside the house.

An interesting difference between residents of the two countries lies in their attitudes toward water cost: whereas the Sudanese expect to pay for this commodity, the Nepalis by religious tradition believe that water taken at the source (as opposed to delivered in some manner) should be free of charge. These and other characteristics will be discussed in the following sections.

Centrally located in Nepal, Metropolitan Kathmandu comprises the old city kingdoms of Kathmandu itself, Lalitpur (Patan), Bhatgoan (Bhaktapur), and Kirtipur. Soon the open space along the roads connecting these cities will be filled by dwellings and businesses, as the area has grown rapidly over the last ten years. This growth is due partly to natural increase alone but more substantially to immigration from other parts of the country and abroad (particularly India and Tibet). Unlike major cities in other developing countries, Kathmandu has developed no *permanent* squatter settlements; both sites described in this chapter would be classified as temporary.

5.1 Drinking Water Supply

In times past, people in Kathmandu Valley relied primarily on tapped springs for drinking water. Because water is an essential element in the Hindu belief system, these fountains had religious significance and were built with philanthropic contributions and maintained by religious bodies. Women, who are responsible for obtaining the family water, collected from the fountains morning and evening. Some of these fountains are still used and maintained, and some are even being restored to their former beauty with local interest and foreign aid.

Unlike the Sudanese, most Nepalis consider water an essential commodity that has always come free of cost (aside from the labor of collecting it). Thus, in Nepal it is politically and socially unacceptable to charge for water that users collect at public fountains and taps.

Water piped directly to houses or house-compounds, however, requires users to pay an installation charge of Nepali Rupees (NRs) 400.00* for the first 100 feet (30 meters) of connecting pipe from the main and NRs 4.00 for each additional foot. A charge of NRs 1,000.00 deposit for connection, refundable at disconnection, is also required. (It is often the case that users wait to install meters until after building construction has been completed; in such cases, a minimum fixed charge of NRs 13.00 per month is levied after the local water and sewerage office has contacted the user.) The minimum water charge per month is NRs 7.00 for the first 10,000 liters ($0.03/m^3) and 1.20 for each additional 1,000 liters ($0.05/m^3) after meter installation. Metered users appear to recognize a distinction between paying for more-convenient access to water and paying for the water itself.

Most peri-urban users who get their water from public water points do not pay for this water, and because of the communal nature of traditional supply points, in times of shortage neighbors do not hesitate to come and draw water from standpipes in the yards of private dwellings. With shortages becoming more frequent, this practice is beginning to create conflict. Many Nepalis, for example, believe that if neighbors leave empty water jugs at their taps, wells, or pumps, it will bring bad luck to them by driving away Laxmi, the goddess of wealth. The same tradition, however, does not hold true for the public taps.

5.2 Alternate Sources and Supplies

In certain areas where groundwater aquifers are known to exist, householders drill shallow tube wells to which they attach pitcher-pumps. In most areas, such water carries sediment and looks murky, making householders reluctant to have it enter the piping system of the house. Although the water (carried by bucket into the house or yard) is used to wash dishes and clothing—especially in the dry season—it is rarely used for drinking or cooking. But in newly established areas on the municipal fringe that are not yet connected to city lines, shallow wells are needed even for house construction. Open-tube wells also exist in certain very old house compounds and, if still functioning, may be relied upon for watering cattle and gardens or for cooking and drinking in times of shortages. Middle-class households sometimes arrange to have someone bring water from public taps, springs, or wells. (A household can use four to six 10-liter cans per day for cooking and dishwashing.) Most people making such arrangements pay NRs 100.00 ($3.48)/month as a regular minimum charge and NRs 1.00 per can for special requests.

The government also delivers water by truck for a fee of NRs 280.00 per 5,000 to 7,000 liters (about NRs 0.05 per liter) and NRs 400.00 per 8,000 liters to households requesting it. During long shortages, household or community success at getting water in this manner may relate directly to political power and connections. There are also private companies whose trucks deliver water for a fee of NRs 250.00 per 7,000-liter load ($1.26/m^3). The water for such

* NRs 28.6 = US $1.00 in June, 1989.

public and private deliveries, obtained at public access points on rivers and reservoirs controlled by the government, costs NRs 25.00/1,000 liters to private trucks.

Rivers and streams are also available as water sources for people living reasonably close. As industrialization occurs and populations increase, however, pollution of these sources will greatly increase and reliance on them in times of water shortage will become less desirable.

5.3 System Problems

Most water now consumed in Metropolitan Kathmandu comes from a system of standpipes built by His Majesty's Government (HMG), with only the houses of the upper-middle and upper classes having taps in the house or compound. Since growth of the system's capacity has been relatively stagnant, newly resident households simply increase consumer demand on an already overextended system.

In the dry months of April, May, and June, there are many days when householders cannot get water from the taps, and women must search for a tap that will yield enough water for cooking and drinking. Other household water needs must wait. During such times, the peri-urban category becomes swollen with people who, although connected to urban water services, must now compete for water with other peri-urban users. Thus, residents may be classified as peri-urban during part of the year when urban supplies are inadequate. Often, people will turn to the old traditional springs (where they still exist) or will draw water from any surface source, regardless of its quality. Then the disease rate rises sharply. With the metropolitan population increasing and spreading rapidly, it is only a question of time until the intermittent and seasonal crises emerge. Already water authorities have begun to institute periodic "brown outs" around the city, sending water only in the morning or evening instead of at both times.

Most new housing has underground cisterns that collect water from municipal waterlines in the mornings and evenings; electric pumps then lift the water to storage tanks on the building roofs. Some households that require more water than can be supplied from one connection make and pay for additional connections. Others by-pass the meter altogether and pump directly into the waterline. (This tactic is not without risk, as the pump may be seized if discovered, and a fine imposed by city inspectors.)

The dwellings of poorer people and newer residents, however, often have no such mechanism for collection and storage. Although they may use taps directly attached to city lines, water is available mornings and evenings only, and without any storage capacity, these residents are the most-immediately affected by supply shortages. During the dry months, water and sewerage offices do their best to truck water once or twice daily to tanks spread around the city. But conflicts often erupt among the waiting residents, who fear there will be too little water to go around.

HMG Water and Sewerage has no policy to service connections for temporary housing, choosing instead to wait until the residents leave of their own accord or become permanent enough to request hook-up to the urban water supply. (See the case of construction workers in Section 5.4.1.)

Old and porous water pipes absorb the pollutants from leaking sewer lines, contaminating the water supply. Gastrointestinal diseases are endemic, and epidemics of typhoid and paratyphoid have also become common in recent years.

In essence, Kathmandu's peri-urban water circumstances can be described in both negative and positive terms:

Negative

- Water supplies are unreliable.
- Water supplies do not meet minimum levels of quantity and quality.
- Consumers have few, if any, alternatives to existing suppliers.
- Production systems are not properly maintained.

Positive

- Most users can afford the water.

5.4 Site Descriptions

Moving from the general to the specific, the next two sections describe the water-supply arrangements of two settlements near Kathmandu. The two settlements are alike in being served by a communal tap that delivers water once or twice daily; however, they differ considerably in their access to alternate supplies during times of shortage.

5.4.1 Site 1—Communal Tap and Truck

Located beside the Narayani Hotel is a temporary settlement of 25 dwellings, each containing a family of about five. Householders come from hill villages near Giri, Dolaka, Okaldunga, and Bojpur to the east of Kathmandu.

At the time of the study, all of the men were working for a Japanese construction company, which had rented the settlement land from a local landowner. Although standing for only three

months, the settlement was already served by an unmetered tap installed by the Patan Water and Sewerage Office; costs were covered by the construction company.

Householders questioned said that they used about 40 liters per day for cooking, washing, and bathing. Working out to eight liters per person per day, this figure suggests that the women and children are reusing water for bathing and that perhaps men are bathing at the construction site. Water is said to arrive more reliably in the morning than in the evening. When they received insufficient water from their own standpipe, settlement residents tried to draw from nearby municipal taps but were not permitted to do so by residents living near these taps. Since the settlement had been in existence such a short time, it had not yet experienced dry-season water shortages. Intermittent shortages were sometimes eased when the construction company trucked water to steel drums at the site.

5.4.2 Site 2—Communal Taps and Surface Water

At the Ring Road and Kalimati Chowk site, containers are always lined up morning and evenings at the two taps: one, a regular standpipe and the other, a tank with a tap. The waiting women said that they walk for 30 to 60 minutes each way. Usually they make two trips a day, carrying two containers of water with each trip. They use tap water for only some of their needs, washing clothes and bathing at a nearby river. When the taps yield no water during the dry season, the women go to the same river to get water for household use, although they know that the water is contaminated. The husbands and fathers of these women are laborers at the nearby brick kilns and in the Ring Road area, and it can be assumed that their families use water much the same as do other laboring families in the valley.

5.5 Site Analysis

Although similarities do exist, residents of Kathmandu also experience significant differences in the characteristics of their water supply. The following sections relate general and site conditions to some of the water supply issues raised in Chapter 3.

5.5.1 Quantity, Reliability, and Accessibility

Kathmandu's major sources of water—aquifers, rivers, and artificial impoundments—are controlled by HMG; those captured and distributed via city mains service the majority of water needs, including those in peri-urban areas such as the two study sites. Other sources, in the form of controlled-access reservoirs, provide the basis for meeting the extra demand of some households and establishments—often the more affluent. In addition, open-access surface waters in the form of rivers, springs, and temporary ponds and puddles are open to all and are used in time of shortage by poorer residents. Finally, several types of private wells draw from nearby aquifers.

Also controlled by HMG is the primary distribution mechanism: the urban mains and extensions into peri-urban areas. Household, compound, and community taps offer varying degrees of convenience, depending on the distance the water carrier must travel. As seen at the sites, water is rarely available throughout the day and must usually be drawn only during certain hours. Supply is also subject to periodic interruption, seriously so during the dry season. Secondary distribution facilities include jugs and trucks, which are used by families and entrepreneurs to meet regular demands and also the extraordinary demands that cannot be satisfied with mains water. In the case of privately owned wells, little distribution occurs, if any. Typically, the water is consumed on the premises of the household or establishment.

Nepali religious beliefs define water as an open-access commodity, thus theoretically justifying neighborhood use of household taps when flow at public taps is interrupted. However, household tap-holders resist such action, and it is clear that water under these circumstances is generally considered a private commodity.

For those dwellers who are "peri-urban" economically but live in an urban location, the dilemma is twofold. First, these residents live interspersed among households that have hook-ups; thus, there is only limited opportunity to organize themselves to pressure for more-reliable water supply at neighborhood public taps. Second, when a sector's city water supplies are interrupted, no really viable alternatives exist within the immediate area. Household members, principally women, must then go well beyond their immediate neighborhoods to forage for water.

Peri-urban residents in the Kathmandu Valley may be better able to develop autonomous water supplies or to gain access to alternative supplies, especially if they live near surface waters. While these are heavily polluted in the dry season when demand is greatest, they can at least serve laundry and personal hygiene needs. This in turn lessens the amount of potable water that must be imported for cooking and drinking.

A continuing problem for peri-urban inhabitants is the generally strong demand for hook-ups and the limited ability of the urban water department to meet all of these demands simultaneously. Since little new water-supply capacity has been added to the system, Kathmandu and peri-urban water consumers are playing a zero-sum game against each other, just as peri-urban neighborhoods compete with each other for priority in access to the urban water mains. As demand for hook-ups increases, available water per person decreases incrementally. If the service domain is to continue expanding, new capacity will be a necessity. Otherwise, quality of service will deteriorate.

Because "open access" religious beliefs make it difficult for HMG to impose fees for water service, except in the case of hook-ups, the government faces a problem in mobilizing local financing to extend or improve the existing systems as a way to bring water to more people. Recourse to general-fund financing or foreign aid may offer the only practical way to address

this pressing problem, a problem that promises to worsen unless measures are soon undertaken to increase supplies.

5.5.2 Water Quality

Provision for sanitation is inadequate in Kathmandu: HMG mains are old and they leak, allowing pollution from human waste to seep into the mains and degrade water quality. Disease follows. The same problems affect private wells and, depending on depth and underground seepage patterns, boreholes as well. Surface waters, also, are generally contaminated. Reconstruction of the Kathmandu urban water system, proposed by the Japanese and the World Bank, represents a large-scale attempt at solving the pollution problem, although the effort would be enhanced if adequate sanitation facilities, sewage lines, and hook-ups were installed at the same time, and if health and hygiene education were part of the package.

5.5.3 Water Cost

From the perspective of Kathmandu consumers, water supply is a function of location and economic status. Those with enough wealth can develop their own storage facilities to buffer supply disruptions through the mains. Such residents can top up these supplies by purchasing water from vendors when mains supplies are inadequate. Those with major water demand can even establish multiple hook-ups with the city system or drill their own wells.

Most peri-urban residents, however—certainly those at the study sites—confront price barriers to creating enough storage and also to purchasing water during the dry season when mains supplies are inadequate or totally interrupted. Because water supplies are for the most part adequate only three-quarters of the year, inadequate storage capacity becomes a particularly pressing problem. Presumably, small groups of families could organize to create storage and then pool funds to obtain supplies from private truckers, but that seems not to have happened as yet. The same religious belief that renders HMG financing for water supply problematic would probably make it difficult for a group of families to control water usage from a joint storage facility once it was filled. This belief, however, might not affect neighborhood efforts to develop local boreholes, given the assumption that the luxury of easier access must be paid for. But mobilizing funds and other resources to fund drilling on an equitable basis could pose difficulties. And, once completed, such a well would presumably be defined as an open-access resource and could be rapidly consumed by those who had contributed nothing toward it.

5.5.4 Maintenance of Production and Distribution Systems

As noted, the water mains serving Kathmandu are old and in serious disrepair. While the existing maintenance structure appears to meet crises, the system is fragile and concern is expressed as to its long-term sustainability. However, where springs exist, temple or local

"water committees" seem still capable of organizing the labor resources necessary to maintain them.

Chapter 6

RECOMMENDATIONS

Thus far, the report has presented an overview of contemporary peri-urban water supply conditions, identified the elements of a successful water supply system, and related site observations from Sudan and Nepal to those elements. This chapter will suggest ways that donors and NGOs can help peri-urban residents improve available water services, offering recommendations within three general categories: political considerations, design elements, and health issues.

6.1 Political Considerations

Determine the perceived needs of peri-urban dwellers to confirm the priority that they attach to improved water supply.

The first step must be to clearly ascertain the rank which water holds among the many potential problems that people confront. Village surveys should be conducted to determine levels of service needed and the effort that peri-urban dwellers are willing to put forth.

Investigate the possibility of peri-urban areas being absorbed into urban or "planned" areas.

A formal process sometimes exists by which peri-urban fringe areas may be absorbed into such areas, and thereby gain formal access to urban services such as water, power, and sanitation facilities. Or, the process of incorporation may be informal and depend upon the political connections of the peri-urban dwellers to negotiate absorption.

Help peri-urban areas gain formal government recognition so that they can use normal government powers to mobilize resources for water supply activities and also have the option of establishing formal relationships that may attract government resources for developing and sustaining local water supplies.

Some peri-urban populations face explicit government hostility (e.g., the Zagalona community described in Section 4.3, which was bulldozed in 1988 by government officials). If a government is committed to discouraging the establishment, persistence, or expansion of peri-urban communities, it may be very difficult for outside development agencies and NGOs to help peri-urban residents with water supply issues or to obtain government funds to do so. Those involved in peri-urban water supply activities must recognize these political constraints

and work within them. Mediation efforts will be required to find a common ground to satisfy both government policies and community needs.

6.2 Engineering Design Elements

Design the physical infrastructure (and associated levels of service) based on a clear understanding of (a) the role vendor competition plays in protecting consumers and (b) the financial constraints that will affect long-term system sustainability.

When designing water systems, planners face a number of choices: centralized versus distributed systems; in-house versus public water taps; boreholes versus connections into central mains; several taps in a main versus only a few; and so on. It is essential to recognize the consequences that will follow each choice; for example, the kinds of services available to users will depend upon design choices, as will consumer capacity to maintain leverage against water wholesalers and retailers. The design will also influence the extent to which the community must depend on outside forces, as opposed to enjoying system autonomy.

Decide beforehand whether the goal is to create a temporary relief system or to address emergency relief needs while also laying the groundwork for more-permanent installations.

Sometimes the immediate water-supply needs of peri-urban communities force development agencies and governments to take a less than optimal approach to design. However, early attention to questions of sustainability may do much to ensure the longer-term sustainability of emergency relief systems. If more-permanent installations are envisaged, thought should be given to whether the area may eventually be incorporated into a nearby urban area or retain its autonomy; each option carries implications for the design of the short-term water supply system.

Try to incorporate consumer water storage into system designs.

Among the most-negative aspects of short-term supply interruptions is consumer reliance on unpotable water, with the attendant threat of water-borne diseases. This danger may be avoided cheaply and efficiently by increasing short-term storage capacity of households and small groups and also ensuring that household water comes from these storage facilities. Back-up systems for supplying water in emergency situations should be included wherever feasible.

6.3 Program Design Elements

Design peri-urban water supply programs to include formal, enforceable rules that guarantee consumers reliable access to the water supply.

Peri-urban consumer access may be unavoidably restricted during periodic shortages or because of changing political factors. However, it is important to firmly establish ownership of water sources, production, and distribution facilities so that consumer access to the system is never in question.

> *Identify and take advantage of existing informal and formal water supply and distribution arrangements. Selectively discourage and encourage participation in development activities by using incentives (for instance, through assignment of tariffs, inclusion in training programs, etc.)*

In many peri-urban areas, the private-sector plays the major role in distributing water to people with no access to urban mains. Designs for upgrading water services in these areas should build as much as possible on private distributors where they exist, whether individuals or firms. By the same token, where public water systems exist, they represent major elements of a system and should be utilized and expanded to the extent possible. However, in both situations project designers should be alert for indications that either public or private actors may have reasons to impede progress. Increasing the opportunities for more participants in the water supply sector should increase competition and create better prices and choices for water consumers.

> *Carefully allocate responsibility for critical tasks, and then ensure that training and support programs are available to strengthen local capabilities.*

System sustainability will stand or fall depending upon several critical areas in system development and maintenance: capital cost of extension of services, operations and maintenance, training, and payment of personnel. Before these responsibilities are assigned, planners should study the existing allocation of responsibility, government policies, and capacity and willingness of peri-urban communities to shoulder some or all of these responsibilities.

6.4 Environmental and Health Issues

> *Before designing a system, first evaluate the environmental impacts of program implementation and then promote specific training and education programs that relate to findings.*

An environmental analysis should look at water quality, sanitation, the impact of water-resource development in areas where pollution is likely, the use of water for watering livestock, and the like.

Training should help residents understand the importance of—

- Keeping distribution equipment clean (e.g., donkey carts and barrels)
- Building soakaways at water points
- Assuring drainage where excess water collects
- Keeping livestock away from the immediate vicinity of water points

Include health and hygiene programs in project designs.

Many peri-urban water supply systems could better help residents improve their living standards if consumers and suppliers could learn about the dynamics of water-borne diseases and about prevention methods suited to local conditions.

6.5 Next Steps

The complexity in peri-urban water supply systems should be recognized and efforts made to support it. It is not necessarily appropriate to pursue centralization and vertical integration of water supply systems as the dominant solution to water supply problems in the rapidly changing circumstances of peri-urban communities. Instead, efforts should focus on complex peri-urban water supply systems to further assess their strengths and weaknesses from the perspective of water users. Where possible, we should seek to highlight ways in which peri-urban water providers can be strengthened by policy reform that allows consumers to influence the providers to better meet consumer needs. The resource-mobilization strategies employed by informal as well as formal units within peri-urban water supply systems should be examined more fully to explore the extent to which they are adequate and can be strengthened.

There are several outstanding issues that should be addressed in the future. These issues, developed as questions that require research, include the following:

- To improve overall system performance, is it always necessary to organize water provision units as formal jurisdictions?
- Do multiple supplies increase consumer leverage vis-a-vis water producers and both wholesale and retail water distributors?
- Do water supply systems function better if owners of water production facilities are allowed to sell water at market rates?
- Is operations and maintenance of water production and water distribution facilities cheaper and/or more efficient if these activities are contracted out to private firms or individuals?

- Are investments that promote the development of short-term buffer stocks the cheapest way to ensure enough potable water during short-term system disruptions?

Camp Dresser & McKee International Inc.
Associates in Rural Development, Inc.
International Science and Technology Institute
Research Triangle Institute
University Research Corporation
Training Resources Group
University of North Carolina at Chapel Hill

WASH Operations Center
1611 N. Kent St., Room 1001
Arlington, VA 22209-2111
Phone: (703) 243-8200
Fax: (703) 243-9004
Telex: WUI 64552
Cable Address: WASHAID

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.