Good Sewers Cheap?

Agency-Customer Interactions in Low-Cost Sanitation in Brazil
GOOD SEWERS CHEAP?
AGENCY-CUSTOMER INTERACTIONS IN LOW-COST URBAN SANITATION IN BRAZIL

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WATER AND SANITATION DIVISION
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Nearly 80 percent of Brazil’s 154 million people now reside in cities, reflecting the increasing urbanization of Latin American countries and placing inordinate strain on weak infrastructure services that have traditionally left the poor largely unserved, particularly in terms of sanitation. In the early 1980s, an innovative sanitary engineer, Jose Carlos de Melo, sought an alternative to expensive conventional sewerage systems which had consistently failed to address the technical and financial needs of low-income peri-urban communities. He developed a waterborne sewerage system in which sustainable operation relies not only on effective, inexpensive technology, but on consultation and ongoing interactions — partnerships — with users and agencies.

Over the past decade, thousands of people have acquired connections to condominial sewerage systems. But do they remain in use? And what are the implications for significant improvement in Brazil’s sanitation sector?

Gabrielle Watson’s examination of these questions indicates that progress lies not only in resourceful engineering, but in a reorientation of customers and service providers toward increased accountability for successful operation and maintenance of sanitation services. This document surveys how the condominial system enables poor communities to investigate sewerage options and later provoke timely responses from neighbors and agencies when repairs or modifications become necessary.

Readers seeking further information regarding the essential concerns of financing and other such issues as initial and recurrent costs, accounting procedures, subsidies, and tariffs should look toward the forthcoming data from the PROSENEAR project. The merit of this paper is that it probes for the triggers and catalysts that stimulate users and agencies toward responsible fiscal action and performance.

John Briscoe
Division Chief
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The World Bank
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ABSTRACT

Condominial sewerage is a low-cost, waterborne system developed in the early 1980’s in Brazil. Residents who wish to access service consult with implementation staff to choose from three layout design options. This study reviews experiences in seven Brazilian cities where municipal and state agencies built condominial sewerage over the past twelve years. Most of the systems were placed in poor neighborhoods, though condominial sewerage has also been built in middle-and upper-income neighborhoods.

Condominial sewerage is different from conventional sewerage, which costs three to four times more, in two significant ways. First, condominial sewers involve design modifications such as reduced minimum diameter and minimum depth, shallower slopes, and pipes located under sidewalks or within residents’ yards instead of in streets. These modifications reduce the need for deep trenching, costly manholes, and waste pumps. Second, condominial sewerage, unlike similar low-cost sewerage systems such as simplified sewerage, involves intensive negotiations between agency staff and customers during project planning and implementation.

This study asks how public agencies learn to adopt not only significant design modifications, but also a fundamentally different service approach for a customer base that they are largely unaccustomed to working with, the urban poor. It also examines how communities organize themselves formally and informally to work with public agencies toward service provision.

The survey used for this study revealed mixed results. In roughly half the cases, condominial projects performed as well as conventional sewerage, but cost between a third to a quarter of those systems. Thanks to unconventional layout options, condominial systems may reach customers living in high density irregular settlements who have historically been excluded from conventional service. Some systems, however, suffered from low connection rates, poorly constructed networks, and inadequate operations and maintenance.

Unsatisfactory performance in condominial systems was attributable to the same problems that plague conventional systems: lax construction practices and inadequate or inappropriate agency efforts to involve customers in project planning and implementation. In cases where customers did not fully understand or know how to use their systems, connection rates were less than 40 percent of the intended beneficiary population. Where community consultation was sufficient, connection rates of 95 to 98 percent were observed. Most of the problems associated with condominial sewerage, then, are institutional in nature rather than caused by an inherent design problem or an uneducated customer population, as some infrastructure planners in Brazil have argued.

The condominial system has worked well when political support from mayors and agency administrations provides innovative engineers with opportunities to introduce designs and be available for consultation and modifications of the system, and when both customers and public agencies have been able to learn how to interact productively. Successful projects have all involved:

- City block-by-block customer consultations
- Demonstration projects in each neighborhood
- Gradual acceleration of project pace driven by customers’ demands
- Local contractors

While this report provides some financial and performance data on condominial sewerage in Brazil, it is not a systematic study of either of these questions. The focus presented is on institutional issues, with the aim of highlighting the achievements of the condominial system and pointing to areas that require more attention. Much more documentation is warranted. Specifically, research is needed on cost recovery, initial and recurrent cost, tariff policies, operations and maintenance arrangements, and health benefits, including comparisons with conventional sewerage systems.
PART I
INTRODUCTION

THE CHALLENGE OF URBAN SANITATION

Inadequate sanitation is one of the principal environmental health problems facing poor urban residents in developing countries today. Despite massive investments in sanitation during the 1980s, approximately 40 percent of the urban population in low-income countries remains unserved. This service deficit falls disproportionately on poor people living in squatter settlements, illegal subdivisions, and working class neighborhoods. Residents resort to individual solutions such as shunting wastes into gullies along footpaths and roadways or digging pit latrines that rapidly fill and contaminate the groundwater. These measures put public health, the environment, and local drinking water supplies at risk.

The cost to households for many safe on-site solutions, such as septic tanks, is actually higher than waterborne systems because at high population densities, off-site systems achieve economies of scale (Sinnatamby 1990). Yet conventional waterborne sewers are inappropriate to the conditions in most poor neighborhoods. The narrow streets and irregular layouts typical of these communities, which are often located on the worst urban lands – rocky, hilly, slide-prone, flood-prone, and distant from main sewer trunk lines – make conventional solutions prohibitively expensive, or technically impossible.

When conventional systems have been built in poor neighborhoods, they have suffered a series of problems: low connection rates, shoddy construction work, sporadic or non-existent operation and maintenance, and poor financial sustainability. These problems are not unique to sewers built in poor neighborhoods; they are common throughout the water and sanitation sector and in public infrastructure in developing and industrial countries.

Most sanitary engineers focus on construction rather than operation and maintenance, and uniform, high technical standards over innovation. Both of these tendencies make sector agencies resistant to serving poor neighborhoods, where users cannot afford the higher design standards with lower breakdown rates and reduced operation and maintenance requirements. Building more expensive systems ensures that agencies will not face high recurrent maintenance costs. Further, construction is more attractive to engineers and politicians because it is a visible improvement, whereas maintenance only becomes visible when it is not performed, and service begins to break down. Thus, construction activities bring prestige, while operation and maintenance are low-profile and low-status tasks that are chronically under-funded and institutionally marginalized within service agencies.

The reluctance to adapt sewerage design standards to address poor urban residents' needs is also linked to a lack of institutional accountability to the unserved urban poor. In Brazil, state water companies were created through federal enabling legislation in the early 1970s to provide water and sanitation services. Municipalities were encouraged under the national sanitation plan, PLANASA, to give a concession to the state water companies, which were expected to act on behalf of municipalities to provide high level services more efficiently than they were able to on their own. All national sector financing as well as significant direct transfers were made available exclusively to state water companies. Any municipality that resisted buying into PLANASA was excluded from financing.

In practice, the state water companies became more powerful than the municipalities they were supposed to serve, and did not always act in the best interest of people. Instead,
the state water companies focused on providing the services that were the easiest to deliver (primarily water and technologies that did not require any deviation from conventional construction practices), and brought the most prestige (i.e., involved large capital investments for sophisticated treatment and pumping systems).

Those who got conventional sewerage from the state water companies were (a) always the better off, and (b) heavily subsidized. Residents in wealthier neighborhoods typically enjoy 100 percent sewerage coverage, for which they pay no initial connection fee, while the majority of poor residents have no sewerage service. In 1990, 83 percent of urban residents had access to piped water, while only 37 percent were served by sewerage. In the northeast of Brazil, just 11 percent of the urban population has access to sewerage (ABES 1992).

A CUSTOMER-CENTRED URBAN SANITATION ALTERNATIVE

In the early 1980’s Brazilian sanitary engineers, led by the innovative Jose Carlos de Melo, developed a low-cost waterborne system that addresses many fundamental technical and financial barriers to urban sanitation, and offsets the lack of accountability that plagues conventionally-built systems. The condominial system – so named because it mimics a horizontal apartment building, with its lines passing through or close by each neighbor’s lot – costs between 50 and 80 percent less than conventional sewers, depending local conditions. It is readily adaptable to the physical conditions found in rapidly changing poor urban neighborhoods. It combines small pipes laid at shallow depths, making it inexpensive. Residents select among an array of service options, allowing them to match the service level with their preferences and pocketbooks. By involving residents in project design and implementation, the condominial system can achieve close to 100 percent connection rates.

Between 1980 and 1990 more than 75,000 condominial connections were built throughout Brazil, serving approximately 370,000 beneficiaries. This development has occurred in an unstructured, almost spontaneous fashion, with municipal and state administrators and engineers from different states sharing their experiences through professional associations and personal contacts.

Condominial systems have attracted wide interest throughout Brazil, and are now the service norm in Brasilia, the nation’s capital, and in Recife and Petrolina in Pernambuco state. Condominial service represents the majority of all sewer connections in Petrolina, Cuiabá, and in numerous smaller townships in Rio Grande do Norte. Condominial sewers account for 100 percent of all new sewer connections over the past decade in Natal, Petrolina, Cuiabá, Recife, Joinville, and Itapissuma.

Currently, condominial systems are being constructed in a number of cities through a World Bank-funded program, PROSANEAR, which aimed to serve 850,000 people by the end of 1994. Together with the existing condominial connections, this represents nearly 6 percent of all new sewer connections made between 1980 and the present, and the majority of sewer connections made in poor urban neighborhoods in Brazil.²

The condominial system is not a uniquely Brazilian experience. There have been similar efforts with shallow and small-bore sewers in other parts of the world. The most notable is the Orangi Pilot Project (OPP), which eventually became an NGO in Karachi, Pakistan. It mobilized extensive community involvement to achieve per household costs of $66 (Arif Hassan 1990, as cited in Sinnatamby 1990). While the OPP helped only 15 percent of residents build condominial sewers, another 25 percent built sewers on their own, copying what they had learned from their neighbors. Municipal agencies were not involved in any of the sewer construction.

Another example is the shallow sewers in Christy Nagar, also in Karachi, that cost $45 per household, including household sanitary fixtures, house connections, public street lines, and primary treatment. These sewers, built in 1984 after the Natal experience, were working well five years after construction. In Colombo, Sri Lanka, shallow sewers have been built in two urban settlement upgrading projects. Per household costs, including household fixtures, came to $60 (Sinnatamby 1990).

Surprisingly, a variation on condominial sewers has been placed in a rural New Hampshire subdivision on one acre lots previously served with expensive and failing septic systems. City engineers achieved nearly 100 percent connection rates at one half the cost of conventional street sewers by placing collector lines in residents’ backyards. In this case, formal right-of-way easements were secured from residents to allow city workers and their machinery to access and maintain the lines (Matthew Steel, telephone interview, New Hampshire 1994).
Figure 1. Study Cities

Table 1. Study City Comparisons

<table>
<thead>
<tr>
<th>City</th>
<th>Urban population</th>
<th>Number of condominial connections</th>
<th>Condominial as percent of all sewer connections</th>
<th>Population with sewer access (percent)</th>
<th>Areas served with condominial sewerage</th>
<th>Cost per household</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrolina</td>
<td>125,400</td>
<td>11,400</td>
<td>69</td>
<td>64</td>
<td>12</td>
<td>$304</td>
</tr>
<tr>
<td>Natal</td>
<td>606,500</td>
<td>11,800</td>
<td>43</td>
<td>31</td>
<td>8</td>
<td>$370</td>
</tr>
<tr>
<td>Brasilia</td>
<td>1,513,500</td>
<td>12,000</td>
<td>29</td>
<td>16</td>
<td>8</td>
<td>$548</td>
</tr>
<tr>
<td>Itapissuma</td>
<td>14,000</td>
<td>400</td>
<td>100</td>
<td>10</td>
<td>2</td>
<td>$485</td>
</tr>
<tr>
<td>Recife</td>
<td>1,297,000</td>
<td>8,000</td>
<td>8</td>
<td>38</td>
<td>20</td>
<td>$450</td>
</tr>
<tr>
<td>Joinville</td>
<td>333,900</td>
<td>450</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>(n.d.)</td>
</tr>
<tr>
<td>Cuiabá</td>
<td>401,000</td>
<td>8,500</td>
<td>53</td>
<td>18</td>
<td>9</td>
<td>$305</td>
</tr>
</tbody>
</table>

1. Population figures include urban population of municipal areas only. (IBGE 1993)  
   n.d.: No Data.
Scope of Report and Methodology

This report explores the factors that contribute to the successful implementation, operation, expansion, and dissemination of the condominial system, focusing on the dynamics of community participation and improved public agency performance. Research was conducted over four months in seven cities: four capital cities (Natal, Recife, Brasilia, and Cuiabá), two secondary cities (Petrolina and Joinville), and one small rural township of 14,000 residents (Itapissuma in Pernambuco state). This sample represents roughly two thirds of all condominial connections existing in Brazil: 52,550 of the over 75,000 connections country-wide.

These cities (see figure 1 and table 1) were chosen because, with the exception of Brasilia, the systems have been in place for at least seven years, permitting evaluation of operational performance and institutional dynamics over time. In three of the cities (Brasilia, Petrolina, and Recife), new condominial systems were being constructed during field work, permitting first-hand observation of community mobilization and construction process. The research sample was divided among large, medium, and small urban centers in order to control for institutional factors peculiar to any one scale. Some cities were selected because they were reported to work well (Petrolina, Natal, Brasilia, and Itapissuma), and others because they did not (Cuiabá, and Joinville), though instances of good and less good performance were observed in all cases. Five of the seven systems were built by municipal governments, and the other two were constructed by the state water companies, permitting analysis of different institutional arrangements.

The findings are based on extensive interviews in each city with municipal and state administrators, sanitary engineers, technical staff, and laborers; local and state politicians; consulting engineers and construction firms; community leaders and residents; community activists and religious leaders. Documentation sources include project documents and secondary literature on condominial systems, including previous studies of some of the cities examined here. One of the shortcomings of this report is the lack of reliable and comparable performance and cost data. A single, in-depth case study was subsequently carried out in Petrolina, providing detailed construction and operational cost data, technical performance information, and customer satisfaction indicators. Some data from that report is incorporated here (see Watson forthcoming).

Each of the seven cities examined has systems with aspects that work well and aspects that work less well. In some cases parts of the system are well maintained, while other parts are in disarray. Condominial systems were abandoned after a first try in some urban centers. In others they have continued to be built and refined over the years. The cases presented are in descending rank order of "good" G, "average" A, and "less satisfactory" L, based on a composite analysis of physical performance (portion of the network in good working condition), the quality of maintenance arrangements (formal and non-formal), the level of institutionalization of the system within municipal and/or state agencies, the numbers of condominial connections, and the portion of condominial connections relative to conventional connections. Many of these indicators are non-quantifiable, and there is no quantitative survey data to compare physical performance across the cases. The ordering from "good" to "less satisfactory" was based on a combination of available data, field interviews, and first-hand observations.

Rather than breaking the presentation into seven discrete case studies, this report focuses on the substantive issues that cut across the cases, making frequent reference to the cases. The ranking system (G, A, and L) will be used throughout the text. Profiles for each of the seven cities and systems are presented in annex 1. The case profiles provide a brief history of project development and the key performance and institutional findings in each case.

Chapter two, The Condominial System, describes the technical and institutional characteristics of the condominial system and its initial development in Natal. Chapter three, System Implementation, examines the factors that contributed to the condominial system's ability to address the challenge of serving low-income urban communities. Chapter four, Operation and Maintenance, discusses some reasons why self-maintenance is particularly difficult for communities to manage collectively, and what communities and agencies have done to address the problem. Chapter five, Adoption and Expansion, explores factors critical for system dissemination and adoption throughout Brazil. The document ends with a concluding chapter highlighting the achievements and remaining challenges to the condominial system. A short profile of each of the seven cases is presented in annex 1 at the end of this report.
Condominial sewerage was developed as part of a larger response to what was seen by water and sanitation practitioners in Brazil as a failure of the sector to address the needs of the poor, particularly the urban poor. Condominial sewerage was conceived as one physical component of a larger institutional reform effort.

Before presenting the technical and operational characteristics of condominial sewerage, this section introduces the structure of the water and sanitation sector in Brazil and the critique and counter proposal to the sector that formed the basis of the condominial service approach. This is then followed by the technical and operational description of condominial sewerage, and a brief history on how the condominial system was first developed and then disseminated throughout the country.

**The Water and Sanitation Sector in Brazil**

State water companies were created in the mid-1970s in Brazil to provide water and sewerage services to towns and cities, and municipalities were encouraged to give concessions to them. All federal sector funding was channeled through the National Housing Bank (BNH) to the state water companies, providing a strong incentive for municipalities to participate in the program. Municipalities that did not take part were ineligible for low-interest financing from the BNH.

Between 1974 and 1983 major advances were made in water provision, particularly in high-income neighborhoods. Sewer service, however, lagged far behind. Data on urban water and sewerage coverage from 1980 and 1990 (see table 2) show marked increases in both, but reveal a wide gap between water and sanitation coverage.

Although many low-income neighborhoods were served with water for the first time, in most cities the poorest 10 to 30 percent of the population remained without water service. Low-income neighborhoods were also largely left out of what little sewerage service advances were made. By 1983, national economic crisis and the resulting de-capitalization of the sector at the national level severely limited new investments. The abolition of the BNH in 1986 further weakened the sector, when no unified national program or institution was created to fill the void.

Since the collapse of the national water and sanitation policy and funding structure, municipalities have stepped in to fill the void. Municipal initiative in the face of state water company inaction was already common in smaller municipalities during the period of state water company dominance, largely because they received little assistance from the states. Municipalities acting alone, however, are unable to cross-subsidize between better- and worse-off municipalities, one of the aims of the state-wide systems, whether or not it was ever fully achieved.

**Critique of the Sector**

Condominial sewerage was first developed as part of a larger strategy conceived to increase service coverage to the urban poor by changing

| Table 2: Percent of Brazilian urban population with water and sewerage service |
|-------------------------------------------------|-----------------|
| **Percent in** \(1980\) | **Percent in** \(1990\) |
| Piped Water | 55 | 83 |
| Sewerage | 22 | 37 |

of the service policies public agencies. This strategy grew out of a critique of the standard service approach used in Brazil and in much of the developing world. The critique, and the condominial system, were developed in the early 1980s by a group of progressive engineers working in Northeast Brazil led by a Recife-based engineer, Jose Carlos de Melo.

According to Melo's critique of the conventional sewerage approach in Brazil, the low rates of service coverage (28 percent of urban residents and 2 percent of rural residents in the Northeast Brazil in 1984 (Najar 1987) could be explained in part by the lack of financial resources. Institutional factors inherent to the sector's organization were also at fault. Sectoral centralization excluded municipalities from access to resources and control over investment decisions, and excessive sectoralization separated sanitation planning from the planning of related urban services such as drainage, street paving, and water services. Excessively high technical standards were inappropriate for developing countries and particularly expensive for the poor, and a technocratic service approach stymied engineers' abilities to think creatively and innovatively about service provision. This fostered a stagnant environment where uniform solutions were applied without questioning their adequacy (Melo 1985, Netto, Coelho, and Fernando 1985).

Out of this critique of traditional engineering approaches within the sector, Melo and his colleagues developed a seven point reform strategy aimed at broadening service coverage to the urban poor and increasing the responsiveness of sector agencies - both state and municipal - to the needs of the poor. The reform strategy consisted of:

1. **Adaptation to Local Conditions.** Lack of financial resources, prevalent poverty, and abundance of unemployed residents are conducive to simple, labor intensive methods that use locally available materials and resources as much as possible.

2. **Community Participation.** Increasing residents' knowledge about project information and their rights, and promoting organized community action enhances users' abilities to (i) negotiate effectively with agency staff, (ii) make informed decisions, and (iii) honor agreements.

3. **Gradualism.** Systems should reach as many people as possible and be upgraded as more resources become available, rather than reaching only a few users with unrealistically high-standard services and leaving the majority with no services.

4. **Dissemination.** Investments should be distributed broadly across municipalities rather than concentrated in a few large cities.

5. **Differentiated Services.** The basic service standard should be that which is appropriate to the majority. Those wishing higher levels of service should be responsible for the increased cost.

6. **Service Integration.** Related urban services should be integrated to improve efficiency and to rally different service agencies in support of service improvements.

7. **Municipalization.** Cities and towns are the natural institutional jurisdiction for mediating between the interests of their residents and the service provider. Municipalities are best at mobilizing community efforts to improve service access.

There are few if any cases where all of the points of this reform proposal have been implemented. None of the state water companies have ceded their concessions back to municipalities, investments continue to be concentrated in large urban areas, and the centralized, bureaucratic nature of these companies has not changed substantially since the early 1980s. In some respects, however, this proposal has proved to be ahead of its time, foreshadowing changes that are only now, in the mid 1990s beginning to take shape. For example, there is a large national movement among progressive and activist municipalities to regain control over water and sanitation services in their cities. Many cities have issued ordinances that require coordinated infrastructure planning, particularly in relation to street paving, storm drainage, and sewerage. And finally, community participation has become an accepted aspect of nearly all projects that serve low-income neighborhoods, regardless of the political leanings of the administration.

**Technical and Operational Characteristics of Condominial Sewerage**

The condominial system is best understood in comparison to its alternative, conventional sewerage. Conventionally-built sewer systems have high installation costs because each street
must have a collection line to gather the wastes from each house on either side; collection lines are laid deep under the street to protect them from vehicle weights, requiring costly asphalt removal, trenching, and resurfacing. Conventional sewerage uses expensive cast iron manhole covers rather than reinforced concrete covers that resist traffic wear equally well and are not subject to theft. Pipe diameters and pipe slopes are designed generously to decrease operation and maintenance costs, although smaller pipes and more gentle slopes would also perform well, and reduce overall system costs. The steeper slope in conventional systems causes trunk lines to reach significant depths, which make trenching difficult and costly. Pump stations lift effluents to minimum depths, but are themselves costly, and require frequent maintenance. Gentler slopes require fewer pump stations. Design standards used in conventional sewerage often exceed operating requirements, placing manholes every 30 feet, rather than every 50 or 100 feet, which line clearing machinery can easily reach. Using manholes instead of less expensive inspection boxes also increases costs.

The condominial system addresses each of these critiques, significantly reducing costs, thus making the system accessible to residents typically excluded from conventional sewerage schemes. The condominial collection or feeder network costs approximately one quarter of conventional network, per household served. Household wastes are collected via a 100mm (four-inch) feeder line rather than a 150mm (six-inch) or 200mm (eight-inch) public street line. Feeder lines are laid at a gentle slope (between one in 167 to 200, as opposed to one in 100 for conventional lines). Up to 100 households are connected to one 100mm lines laid at this gradient.

The feeder line can pass through residents’ backyards, front yards, or under sidewalks, collecting all household wastes, one city block at a time. This reduces the overall length of larger public trunk lines needed (see figure 2). Houses connect to the feeder line through small concrete collection or inspection boxes that can be opened for blockage removal. Collection boxes range in size from 20cm to 80cm in diameter.

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*Figure 2: Schematic diagram of the three condominial options.*

![Diagram](image-url)
depending on the depth of the line (see figure 3 for a diagram of two collection box designs). The deeper the line, the larger the collection box, in order to provide easy access to the line for clearing.

Because no vehicle traffic passes over the feeder line it can be laid at a shallow depth, reducing the amount of trenching and the number of manholes required. Trenching and manholes account for a large portion of conventional sewerage construction costs. Therefore, the greater portion of the network made up of feeder lines, the greater the cost savings. Feeder lines are laid at a minimum depth of 30cm to 40cm, and rarely exceed one meter in depth. Conventional trunk lines generally have a minimum depth of one meter. When feeder lines cross streets they are protected from vehicle loads by cement or cast iron braces, so a series of city blocks can be connected without losing the shallow depth of the line. Because feeder lines do most of the collection work, not all streets need trunk lines, reducing the overall length of trunk pipe laid, and reducing the ratio of trunk to feeder lines. And because feeder lines are laid at a shallow depth, and do not have vehicle traffic, simple collection boxes can be substituted for manholes.

Once effluent has been collected from the block level and reaches a public trunk line, there is little difference between a conventional and a condominial collection system, except that initial public trunk line depths are typically shallower in the condominial system, thus excavation costs are lower, and fewer pumping stations are needed. Effluent can be treated within each drainage subbasin using simple technologies or can be brought to a central treatment area. Centralized treatment usually involves higher costs because wastes must be transported over long distances with frequent pumping stations to lift wastes, and plant

Figure 3: Diagram of two collection box designs

![Diagram of two collection box designs](image-url)
facilities typically involve capital-intensive technologies and high recurrent costs. It is up to residents to decide the layout of feeder lines at the block level — backyard, front yard, or sidewalk. The three options have ascending construction costs, connection fees, and tariffs. If a household wants full conventional service, it is available but the users must pay the entire cost of installing street lines from the trunk line to their residences. Sidewalk lines (the next level of service below conventional service) afford individual household connections to the public sidewalk line maintained by the service provider. Front yard lines pass just within residents' front lots, usually inside low walls residents build in front of their houses. Two front yard lines are needed for each block, one on each side of the block.

Backyard layouts often only require one line — though it may zig zag from house to house — because all households connect to the same line that runs down the middle of the block. While backyard lines require less pipes, front yard lines have the advantage of being more easily accessed by utilities if customers need assistance. Also, front yard lines are more visible to other neighbors, so it is less likely residents will abuse the system by putting solid objects into it. Backyard lines are advantageous when existing household fixtures already empty to a pit latrine in the back, and front yard lines are better when residents are directing their wastes to storm drains and ditches in the street.

As with conventional sewerage systems, customers are responsible for buying and installing all household sanitary fixtures such as toilets, wash basins, and showers. Customers are also responsible for both financing and making the household connection between these fixtures and the feeder line. In some cities, implementation agencies helped residents make their household connection during project implementation, and even included household connections in overall project costs. The cost of effecting household connections is approximately $50 per household (Rondon 1990). No data is available on the cost of private investments made by householders in improving household sanitary fixtures. Figure 4 shows construction and operational costs of conventional and condominial sewerage in Petrolina.

Operation and maintenance arrangements for the condominial system are different from conventional sewerage systems. Residents maintain feeder lines located on their property, and service agencies maintain only sewerage lines on public property, which includes trunk lines and sidewalk feeder lines. Backyard and front yard customers maintain their feeder lines, and pay a reduced tariff (40 to 60 percent of the water bill, as opposed to 100 percent for conventional customers). Front yard customers, like conventional sewerage customers, maintain only their private household connections, but they also pay a reduced tariff (40 to 80 percent less). Condominial sewerage customers receive verbal explanations of blockage removal procedures and often receive a users’ manual during project implementation. None of the cases reviewed involved direct technical training for customers. Residents are encouraged to cooperate among themselves to remove obstructions within the block feeder lines. They can also hire plumbers or masons or designate one community member to assist with blockage problems.

In Natal, one resident on each block was given a long stretch of rigid wire that all block residents could borrow for blockage removal. This arrangement has not worked as well as project planners envisioned. Residents are able to resolve simple blockages, but have difficulty with more serious problems caused by faulty construction, damaged lines, or trunk line blockages that back up into feeder lines. Residents also have difficulty cooperating in many cases. In addition, as with conventional systems, agencies frequently perform inadequate routine trunk line maintenance. This causes a cascading effect throughout the system, reducing flow velocities in upstream sections and allowing suspended solids to settle and build up, eventually leading to complete blockage of the feeder lines. These problems, and the cases where they have been successfully addressed, are discussed in detail in chapter IV.

**Innovation and Dissemination**

Natal was the first large, organized condominial experience in Brazil, and it served as the model upon which nearly all subsequent condominial projects were based. In 1980, a conventional sewer project for three poor neighborhoods funded under the World Bank's Medium-sized City loan was transformed by the system’s originator, Jose Carlos de Melo, into the condominial system's pilot experience. Supported by the president of the state water company CAERN, and backed by a group of entrepreneurial and socially committed young engineers within the company, Melo tested and developed his ideas for the condominial system, building on simplified sewerage innovations from other parts of Brazil.
**Figure 4: Construction and operational cost comparison**

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Condominial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Backyard</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder lines</td>
<td>$87</td>
<td>$148</td>
</tr>
<tr>
<td>Feeder &amp; trunk lines</td>
<td>$750-1,500</td>
<td>$269</td>
</tr>
<tr>
<td>Feeder, trunk &amp; treatment</td>
<td>$473</td>
<td>$534</td>
</tr>
<tr>
<td><strong>Front yard</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder lines</td>
<td>$87</td>
<td>$148</td>
</tr>
<tr>
<td>Feeder &amp; trunk lines</td>
<td>$750-1,500</td>
<td>$269</td>
</tr>
<tr>
<td>Feeder, trunk &amp; treatment</td>
<td>$473</td>
<td>$534</td>
</tr>
<tr>
<td><strong>Sidewalk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeder lines</td>
<td>$87</td>
<td>$148</td>
</tr>
<tr>
<td>Feeder &amp; trunk lines</td>
<td>$750-1,500</td>
<td>$269</td>
</tr>
<tr>
<td>Feeder, trunk &amp; treatment</td>
<td>$473</td>
<td>$534</td>
</tr>
</tbody>
</table>

**Utility operation & maintenance costs/household/month**

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Condominial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost/call for service</td>
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<td>$45.20</td>
</tr>
<tr>
<td>Calls for service/1,000 households</td>
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<td>5</td>
</tr>
<tr>
<td>Expenditure/household</td>
<td>$0.23</td>
<td>$0.21</td>
</tr>
</tbody>
</table>

- Collection box
  - 150mm public trunk line
  - 100mm private trunk line

The Natal experience is surprising because it mirrors the innovation and experimentation more often associated with NGOs and community groups than with public agencies, particularly large, engineering-oriented ones like CAERN. While public enterprises (like the state water companies in Brazil) are not usually the most fertile ground for experimentation in and advocacy for innovative technologies, CAERN’s involvement was crucial to the system’s development and broad dissemination throughout Brazil. Because the condominial system was first developed there, it was afforded a legitimacy the approach would not have, had it begun in a more humble setting, such as through an NGO or municipal public works department. The project’s professional rigor, the high-level support provided internally from the company’s president and externally from the World Bank, and the stature of the state water company itself all helped to make this early effort a solid beginning for the condominial system. Engineers and city officials came from all over Brazil to see Natal’s new sewers, and returned to their own cities to build new sewerage.

Over a two-year period the project team worked intensively with residents, focusing first on a few blocks, working out technical and logistical problems while simultaneously developing skills for interacting and negotiating with residents. Once the general implementation strategy was developed, and sewers were in place in the first few blocks, the rest of the three neighborhoods’ sewers were built relatively rapidly. The implementation team worked out many of the technical details and learned how to negotiate with residents. The residents, for their part, had seen that the team was actually serious about building sewers, and that their neighbors had already benefited from the sewerage. This gave the project team a boost in credibility in the residents’ eyes, and made subsequent negotiations much easier.

The condominial system was developed by a small, informal, essentially non-hierarchical group within CAERN. This team had considerable autonomy of action: they developed their own work plans, ordered materials without going through lengthy procurement procedures, and hired consultants as they saw fit. It was mission-oriented and composed of young, eager engineers, who saw their work as providing previously excluded groups access to critical social benefits.

The project group got internal support from CAERN’s president and external support from World Bank mission members and the UNDP/World Bank Technical Advisory Group (TAG). During the two-year incubation period, the condominial team worked slowly, developing and perfecting the new system. Once the system had been developed, the CAERN condominial team was ready to share it outside Natal. Within Brazil the most significant dissemination mechanisms by far were personal and professional contacts among sanitary engineers through the Brazilian Association of Sanitary Engineering, ABES. The National Public Health Foundation, FSESP (now National Health Foundation, FNS), and the Brazilian Institute of Municipal Administration, IBAM, and others also played a role in disseminating the system, but ABES was the primary vehicle. Reports at two bi-annual conferences, 1983 and 1985, were the first glimpse the rest of the country had of the Natal experience. CAERN engineers and consultants presented numerous well-written and well-documented papers. After this, municipal and state engineers and politicians from other states visited Natal and hired members of CAERN’s condominial team to advise them in setting up their own programs. Joinville’s engineers drew on ABES published papers; the city of Cuiabá hired Natal engineers to advise them; Brasilia’s first condominial team was composed of some CAERN engineers on temporary leave; Petrolina’s first system relied on technical assistance from Melo’s consulting firm, and one of the firm’s consultants eventually moved there and has continued to support and promote the system there for the past ten years.
Most conventional sewer contractors and implementing agencies think of their work in terms of length of laid pipe, but network extension does not equal service benefits, nor does laying pipes mean that sanitary or health conditions will improve. As with any on-site system, health and sanitation benefits depend on the system's proper installation, proper use, and on basic hygiene practices. In condominial systems, residents must have toilets and wash basins connected to the network, and they must keep rainwater out of the system because the flow would otherwise exceed the system's design capacity, causing sewage back-ups. In most poor neighborhoods, residents are unfamiliar with sewers, and many do not have toilets, etc. Residents typically use self-built pit latrines or direct their wastes into open ditches in the street. Thus access to sewers is a major change requiring new skills and altered habits. In regular settlements the transformation may not be as significant because more residents are familiar with the technology, but in most condominial projects the lack of previous exposure must be taken into account.

Seeing the goal of urban sanitation projects as simply that of laying pipes also ignores the question of long-term financial and institutional sustainability. While there is often a powerful lobby of construction firms, politicians, and lenders behind building new sewers, there is rarely any incentive for public utilities to perform operation and maintenance tasks well. These tasks do not involve large contracts, and thus cannot be driven by the rent seeking behavior or electoral ambitions that often drive new construction projects. Maintenance tasks represent recurrent costs for the utility that must be recovered from tariffs or supported by repeated transfers from municipal, state, or federal budgets. But many utilities charge subsidized tariffs or do not charge at all because politicians intervene citing the low income levels of their constituency. Rather than matching investments with customers' tastes and ability to pay, conventional projects predetermine the technology (and thus the cost) of the intervention, and rarely give customers the option of not accepting the service, if the costs are too high. The end results are utilities that produce standardized services that are technically inappropriate and are financially unsustainable because the majority of poor residents cannot pay the tariffs. The alternative—what has largely happened in Brazilian cities to date—is that only the better-off are served (at heavily subsidized rates), and the urban poor make do with self-built, on-site solutions, or the "no-solution solution": directing wastes into the street or nearest drainage ditch or storm drain, thus contaminating local waterways and drinking water supplies.

**Customized Service Approach**

The condominial system addresses these difficulties by involving residents from the start in project planning, service level selection, and defining cost recovery and maintenance arrangements. In addition to the range of service level choices provided by the backyard, front yard, and sidewalk options, residents also have the implicit choices of leaving things as they are or getting full conventional sewers, as long as they are able to pay.

The condominial system goes beyond providing a menu of service options to residents. There are several features of what could be called a customized service approach, where residents define project design and further tailor project details to reflect their needs. More important than the particular technologies involved, is the process by which service selection is made, complementary services are
determined, and financing and maintenance arrangements are worked out. There are seven key features to the customized service approach:

- Community Mobilization
- Neighborhood-by-Neighborhood Pilot Projects
- Customized Household Layout
- Complementary Services
- Multi-Disciplinary Implementation Teams
- Gradual Acceleration of Project Pace
- Accountability Mechanisms for Construction
- Quality and Project Design

Some problems with cost recovery are addressed at the end of this chapter.

Community Mobilization: Conflict and Negotiation

Before any construction crews enter a neighborhood, a lengthy process of project introduction, conflict, and negotiation must first take place. During community mobilization project teams present the parameters of the project to residents, and residents negotiate with the team about service levels. Teams of project planners, engineers, social workers, and low-level technical personnel working with municipal agencies, state water companies, or consulting and engineering firms hired by these agencies work with residents to explain the proposed project, the costs of each option, and the role of residents and the public utility. Community mobilization begins with neighborhood meetings for initial project presentation, and then continues with block-by-block meetings to go over the technical, financial, and maintenance details. Block-by-block mobilization introduces residents to the condominial system, and allows them to learn about, discuss, question, and define the construction and maintenance arrangements. Attendance is not mandatory, but project teams usually insist on at least 50 percent attendance in order to hold the meeting. Block leaders and neighborhood association members help by announcing meeting times, and summoning residents. Once residents decide on service options, they sign a formal petition asking that condominial sewers be built, and committing to pay the agreed-upon tariff. Only then does construction begin.

Generally, each block must reach consensus about the layout option residents want — backyard, front yard, or sidewalk. If the majority wants backyard, but one resident either doesn't want the service at all, or wants a different option, it is more difficult to build the network, because the line must circle around that person’s property. Usually the predominating view of the block wins out, and the hold-outs go along with their neighbors’ wishes. Letting each block decide their option is easier for the project team than working with each resident individually because they can leave negotiations about service to levels residents. The team returns when each block has arrived at its decision. In some cities, project designers have built a few “hybrid” blocks, with a mixture of two or three of the options. This usually happens when residents have not been able to reach consensus, and an impasse would result in excluding the whole block from service.

Negotiations, and exactly what is negotiated, are the centerpiece of the demand-driven approach. Over time, some issues that were initially negotiated with residents have become standardized such as tariffs and connection fees for each option, while others that were at first non-negotiable have been opened for discussion with residents. Financing and maintenance arrangements are examples.

Natal’s experience in building the first large condominial system illustrates how the rules of negotiation have developed. In 1980, Natal’s project planners did not have a clear idea what the tariff structure should be. After months of negotiations with residents, the project team and the finance division at the state water company decided residents should pay a lower tariff than conventional customers, since condominial users had more maintenance responsibilities. Tariffs were set somewhat arbitrarily at 40 percent of the full sewer rate. Once this precedent was set, subsequent state and municipal projects in other cities copied the Natal example of charging lower tariffs, but differentiated among the different layout options (which were not initially offered in Natal). Tariffs then became standardized; each option was presented with a specific tariff. By standardizing tariffs, planners of each new project did not have to “reinvent the wheel,” and residents were provided with clear price tag attached to each layout option.

Maintenance arrangements, by contrast, were not initially put on the table for negotiation in Natal, or in other cities. If the pipe was within lot lines, it was the residents’ collective responsibility. Once it crossed over to a public right-of-way, it became the utility’s responsibility. Residents had to agree to this arrangement if they wanted services, but there were no
existing formal or informal structures to manage collective tasks within each block. Houses with individual connections, as in conventional and sidewalk condominial systems, are responsible for blockages on their property. But in collective lines, the delimitations of responsibility become blurred since backyard and front yard lines are shared by all residents connected to them.

Who should resolve blockage problems? The household that first detects the blockage? The household that caused it? How does one know? Should residents ask one another for help? What if neighbors do not get along? None of these questions were answered before the system was built. Although the project team in Natal tried to foster collaboration around maintenance tasks, neighbors have rarely worked collaboratively. More recently, as planners and residents realize that collective, voluntary maintenance does not always work well, the maintenance question has been negotiated during community mobilization in some cities, as will be discussed in the next chapter.

The evolution of what is negotiated and what is not reflects both project planners' refinements of the process of providing residents with choices, and the ability of residents and neighborhood associations to push for their concerns with service providers. The lesson is that there is no "right" way to approach projects, but that each project's design, implementation strategy, and management arrangements evolve during the course of give-and-take negotiations between the project team and residents.

**Multi-Disciplinary Implementation Team**

Project teams need to be both technically competent and able to provide genuine channels for questioning and learning. During the 1980s nearly all the teams were composed of sanitary engineers who had been involved with social issues through student movements, literacy campaigns, health campaigns, and the like. These engineers were attracted to the condominial system because it combined their technical expertise with their social commitments. They are, however, a distinct minority within the engineering community. While they make quite effective condominial practitioners, their particular background is difficult to find and next to impossible to cultivate.

More recently, as the condominial system moved from the exclusive domain of the first "pioneers," municipal and state agencies have tried to recreate the mix of engineering and social perspectives by including social workers, sociologists, or other community development specialists on the teams. Yet social workers, though trained to work with communities, do not always understand the technical issues, and can sometimes be paternalistic and patronizing with residents. Sanitary engineers with no "social" background are equally ill-equipped to deal with resident concerns. Although social workers and sanitary engineers often have mutual distrust of the others' qualifications, and despite potential internal disputes and turf wars, the multi-disciplinary approach can work well. The mix provides checks and balances, with each group limiting the excesses of the other. The engineers maintain the project's goal orientation, while the social workers ensure productive negotiations with residents and moderating tendency of many engineers to value rigid construction norms above residents' concerns.

Over the past ten years a number of consulting firms have developed considerable skill and expertise in building condominial systems, and are now training municipal and state implementation teams. These consultants, many of them made up of the original project team members from the first condominial experiences in Natal and Pernambuco state, work best when they are integrated into the service agency's own multi-disciplinary implementation team, rather than hired as a separate "community mobilization" team isolated from construction. Integrating the team with agency staff allows the agency to learn how to coordinate the community mobilization process, design the system, and be flexible enough make adjustments to the process as necessary. In Brasilia, for example, an experienced condominial consulting team worked with agency staff for the first two years of the project. The agency project staff learned from the consultant, and are now running new projects successfully on their own, training newly hired engineering firms in condominial design and process.

Most implementing teams have a mix of a few experienced engineers and social workers with larger numbers of paraprofessionals and lower-level technical staff to minimize costs of the labor-intensive mobilization process. Using paraprofessionals has the additional advantage of placing workers in the field who are more likely to be receptive to residents' concerns and more flexible in their responses. Some of the most committed and effective condominial staff, especially at the municipal level, are the lower-level sanitation vocational school graduates.
who were brought into public service with the condominial system. Because their first experience was with condominial sewers, they do not question it the way older, conventionally-trained staff do.

There is a direct relationship between the amount of time spent tailoring a network design to residents’ needs and the appropriateness of the network itself. This also applies to financing and maintenance arrangements. Efforts to reduce transaction costs up front by imposing the options that are simplest to design and construct often results in dissatisfied customers who later reject the system. Network designers cannot know where to effectively place the line and collection box to go without asking residents. In the most successful projects, field staff—engineers, social workers, and technical interns—worked block-by-block with residents to define the optimal network layout. Neighborhood associations and block representatives often aid in reducing transaction costs by discussing individual neighbors’ needs and communicating the block’s final decision to the implementation team.

Careful attention to residents’ future plans during project implementation results in much more appropriate network layout. This is most important where the network is placed within lot lines, and especially in backyards. Most residents are continuously improving their homes: adding a new room, expanding an existing one, or rebuilding altogether as resources permit. But renovations often conflict with network layout. Because lots are so small, additions to the house may have to go on top of the sewer line. Because the network is not designed to carry heavy loads, this can dislocate, crush, or completely block the line. These problems are particularly serious when the network passes through the middle of the backyard rather than at the rear or side lot line where residents are less likely to build. (See figures 5 and 6 for diagrams of actual block layout designs in regular settlements and in irregular settlements.)

Most traditional sanitary engineers and project administrators find sidewalk options preferable to the front yard or backyard options because there is no need to contact residents individually, or even get resident consent, both of which result in high initial transaction costs.
before construction. Neighbors do not need to agree among themselves, or even agree to having sewer lines built, and there is no question as to the best location for the line or collection box – lines go under sidewalks, and boxes are built in front of each house, just as in conventional sewerage. Agencies lacking experienced condominial implementation staff are best at executing this kind of service because it is very similar to conventional systems. But the pitfalls of this agency-driven service option are illustrated in the Petrolina experience (see box 1).

**Complementary Services:**

**Household Connections & Sanitary Fixtures**

As with conventional sewerage projects, condominial customers are expected to make their own household connections and buy any new sanitary fixtures they may need. In some cases, household connections are considered part of the network, but in most cases construction ends at the collection box installed on, or adjacent to, each residential lot. Fixtures (toilets, wash basins, showers, bathroom floor drains, kitchen sinks, grease traps, etc.) and the pipe to connect them to the collection box are seen as private investments to be made by the household.

Many projects reviewed here began with the premise that providing complementary services – technical orientation, practical training, financing or direct provision of sanitary fixtures and household connections – would improve project benefits. Evidence from survey research in Natal and Cuiabá indicated that there is a high correlation between connection to condominial sewerage and private improvements to household sanitary fixtures. As people connect to the system, they tend to add new sanitary fixtures. Not all projects, however, had high connection rates. It appears the challenge i
Table 3: Evolution of sanitary fixtures in condominial project by type of fixture, Natal

<table>
<thead>
<tr>
<th>Type of Fixture</th>
<th>Before Project</th>
<th>During Project</th>
<th>After Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Wash Basin</td>
<td>122</td>
<td>57</td>
<td>138</td>
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<tr>
<td>Kitchen Sink</td>
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<td>47</td>
<td>112</td>
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<tr>
<td>Toilet</td>
<td>197</td>
<td>91</td>
<td>209</td>
</tr>
<tr>
<td>Floor Drain</td>
<td>60</td>
<td>28</td>
<td>206</td>
</tr>
<tr>
<td>Bide</td>
<td>24</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td>Bathroom Sink</td>
<td>17</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Shower</td>
<td>87</td>
<td>40</td>
<td>88</td>
</tr>
</tbody>
</table>

Source: CAERN 1986. n=216 (households)

to get users to make their connections. Projects that involved extensive community mobilization with detailed discussion about what household improvements residents should make and how to make them all had high customer connection rates. Projects that provided free or reduced-cost sanitary fixtures had mixed results because of the complexity of the task, and did not always affect connection rates. This section reviews some of the experiences in the study cities.

Data from Natal's first condominial project, where 96 percent of households connected to the system, shows that the intervention stimulated a significant increase in private investment. Most of the improvements are concentrated in four types of fixtures (see table 3 and figure 7). Eighteen months after project completion, residents' improvements included 149 floor drains (65 percent), 45 wash basins (19 percent), 19 kitchens sinks (8 percent), and 17 toilets (7 percent). No cost estimates are available for these improvements.

Data on the number of fixtures per household before, during, and after project completion provides graphic illustration of the pace and nature of private investments. Most of the residents' improvements occurred during project implementation. Seventy percent of the residences surveyed carried out improvements during project execution, and an additional 3 percent made improvements only after project completion. Sixteen percent made improvements both during and after the project (CAERN 1986).

Natal is an exemplary case, however. In other cities connection rates were much lower, in part due to lower income levels in the project neighborhoods, but primarily because of inadequate community mobilization during project implementation. In Cuiabá, where there was minimal community mobilization, only 39 percent of residents in one area surveyed had connected to the system by the end of the project cycle. In those households that connected, the presence of grease traps went from 41 percent before project initiation to 89 percent after project completion (Rondon 1990), indicating positive effects similar to those observed in Natal at least for the households that connected. (The survey did not include questions about other kinds of sanitary fixtures or residents' reasons for not connecting.) The negative effects of low connection rates greatly overwhelm these positive effects, however.

The low connection rates in Cuiabá increased the effective per capita costs of providing services. The total project cost not including household connections or sanitary fixtures was $86,925. Divided among the 285 project area households, this reveals a per capita cost of $61 per capita, at five residents per household on average. However, since only 39 percent of area households connected, the effective per capita project cost (the amount of money spent on each person who benefited from the project) was $146. Rondon estimates that household connections, costing $10 per capita, would have increased total project costs, but would have actually reduced the effective per capita cost from $146 to $71. This still compared favorably to the $300 per capita costs for building conventional sewerage systems in Brazil.

Many households do not connect because they do not have the resources to purchase household sanitary fixtures or to make the connection from existing fixtures to the network at the time of construction. In Natal, 25 percent of households that did not connect cited economic reasons (CAERN 1986). (The bulk of the remaining non-connecting households could not connect for technical reasons.) In Recife, residents at community meetings repeatedly cited high construction costs as the principle
obstacle to agreeing to the system.

Another problem to consider during project execution is that residents are often unable to make the connections correctly because of lack of technical knowledge or access to proper materials. In order to make connections residents must make a hole in the concrete collection box, fit a ceramic or plastic pipe to it, and reseal the area around the pipe, a task most residents cannot perform without the help of a plumber or mason. Faulty connections leave collection boxes opened or damaged, allowing rainwater and debris to enter the system, impairing its performance. In Natal, 18 percent of collection boxes were left open or damaged when residents attempted their hook ups (CAERN 1992, Formiga & Pinheiro 1993). In Petrolina, 21 percent of collection boxes were open or damaged (Franca 1991). In Brasilia, project planners have avoided these problems by leaving a connection pipe stub attached to the collection box regardless of household intent to connect; this practice facilitates future connections.

Four of the seven projects studied offered poor users help in obtaining sanitary fixtures (toilets, washbasins, etc). In the two smaller projects, Itapissuma and Joinville, this was undertaken by the same agency that executed network extension. Project staff had personal contact with nearly all of the residents. In the two larger projects, Cuiabá and Petrolina, the scale of the efforts made individual household selection and service delivery difficult. The number of residents was so large that project staff were overtaxed coordinating the project among the various neighborhoods. Instead, social service and public health agencies that already have a large field staffs working directly with the population helped customers obtain sanitary fixtures. These agencies are accustomed to working with low-income populations and running campaigns on specific issues such as communicable diseases, health education, and emergency shelter. They work directly with community groups and have established contacts with local leaders and are well suited to providing this kind of complementary service.

In the two cases where separate agencies provided toilets or other sanitary fixtures, some mechanism for collaboration between customers and agency staff was established. In Cuiabá, the municipal social service agency asked selected poor residents to build foundations for outhouses according to the agency's specifications, and the agency then provided modular kits including flush toilets relatively simple to erect over the bases. Residents provided cement and labor, but received the outhouses for free. In Petrolina, the municipal social service agency asked residents to contribute sacks of cement and in return they received concrete washbasins and scrub boards. The Petrolina approach worked somewhat better than the one
Box 1: Private initial transaction costs vs. system sustainability

After nearly ten years of building high quality condominial sewerage, in 1992, the Petrolina municipal leadership prioritized rapid construction with no customer construction because the city wanted to have as many block sewers in place as possible before the municipal elections. Municipal engineers successfully completed construction on a large portion of the system quite proficiently. But all connections were sidewalk, with double the tariff of front yard or backyard layouts, and the blocks served had a high number of unconnected households. As residents began to receive their new sewer bills, many were dismayed, saying they had not agreed to this service and wished they had been given other, less expensive options. While the 1992 Petrolina sewers were shallow and less expensive to build than conventional sewers, they were not condominial, in the sense that they did not involve any consultation with residents except a perfunctory notice that sewers were to be built. Residents were not aware that there were other less expensive options. As a result, this “streamlined” implementation method did not produce high coverage rates, nor did it provide the close fit between level of service and beneficiary preference often yielded by true condominial sewers. After a new mayor was elected, this period of exclusive sidewalk construction ended, and Petrolina returned to its previous practice of block-by-block mobilization and full customer choice.

in Cuiabá, where building the concrete base to the outhouse proved too complicated for most residents (see box 2).

By the end of the Cuiabá project, the social service agency was providing cement and building entire structures. The outhouse walls were made of asbestos-reinforced concrete slabs, a much higher quality material that most local houses. During project implementation many residents sold their outhouse walls, though most kept the toilet. Rondon (1990) reports the one year after project completion, 56 percent of the 56 outhouses that were provided in one of the eight Cuiabá neighborhoods were either never completed or never connected to water supplies or to condominial collection lines. Providing washbasins or simple low-volume flush toilets in exchange for cement or tubes may have been a better intermediary input. This approach worked well in Petrolina, where washbasins from the 1983 municipal social service department efforts are still in active use throughout the project neighborhood.

Although many social service and public works agency staff believe residents cannot afford new fixtures and should be given them for free, the Petrolina case shows that when residents are asked to make a simple contribution to the fixtures, they will respond. The sack of cement was within residents’ reach, and provided them with an opportunity to make a tangible contribution.

Neighborhood-by-Neighborhood Pilot Projects

Despite often exhaustive community mobilization, most residents do not fully understand the condominial system until they have seen it working. Each neighborhood has to learn about the system from scratch, through a gradual process of seeing its construction. The first blocks that mobilize and reach the construction phase serve as a pilot experience for the rest of the neighborhood. Other residents can go to the sites and see exactly what the project team has been talking about.

Negotiating details and reaching consensus can take quite some time initially. The first block in Petrolina took four months to mobilize, and the first one in Natal took nearly a year. During this time, the project team met repeatedly with residents and identified block and neighborhood representatives. Residents learn what relationship the project team has with the city or the state, and the two groups begin to hash out the project details, negotiating each issue that comes up. Project staff in all cities report that once the first blocks have sewerage, adjacent blocks want it too, initiating a chain-reaction of increasing demand throughout the neighborhood. In Brasilia and Petrolina, a pilot approach allowed agencies to successfully expand the system throughout the project neighborhoods without sacrificing quality at the sub-project level.

In addition to taking time to develop, neighborhood mobilization depends on developing demonstration projects in order for residents to assimilate new technical information and begin to organize themselves for the project. Though most meetings used some form of visual aid — slides, scale models, and videos, informed participation on the neighborhood scale only emerges after some construction has begun, and the neighborhood association has learned how to negotiate effectively with the project staff. A
Box 2: Assimilating new information and developing negotiation skills: Cuiabá

One of the first areas to receive condominial sewerage in Cuiabá, the neighborhood of Canjica, is a fifteen-year-old squatter settlement. Residents received title to the land in the mid 1980s. Yet the neighborhood still looks much like it did when it was a favela: most streets are unpaved, houses perch precariously over waste-filled gullies, one fifth of residents are illiterate, and one quarter earn less than $50 a month. Yet relative to its inception, when the site was a hilly, muddy area of brush and trees far from the city’s center, Canjica today is considered a real neighborhood. All residents have water and electricity, and many houses boast garages with cars, neat fences, and tidy yards.

Each of these improvements emerged from the hard-fought struggles of residents and community leaders. Water service came after four years of active mobilization, a clinic took three years, and getting adequate storm drain infrastructure is a continuing battle, now in its seventh year. As a result, Canjica has a well-organized neighborhood association and an active health NGO. Both already existed in 1986, when the city first proposed putting in condominial sewers.

The municipal sanitary engineers had never built conventional sewers, much less condominial sewers, and had never worked in poor neighborhoods. Implementation staff quickly realized they were ill-equipped to carry out the neighborhood mobilization, but they plodded on with some help from the city social services agency. A few community-wide meetings were held (roughly a quarter of the residents showed), and staff met with the neighborhood association leaders. After this cursory introduction, implementation crews descended on the neighborhood to design and begin construction of the system. If residents refused to cooperate with construction crews, block meetings were held to explain the system, and try to convince residents to “come on board.” There was no discussion of connection fees or tariffs (and none have since been charged), and there was only minimal discussion of feeder line maintenance.

Residents initially welcomed the project because it meant their home values would rise. Also, many were happy to find employment with the construction firms putting in the sewers. Sanitation had long been a rallying point for the health NGO and the neighborhood association. It soon became clear to residents, however, that some of the network was not being constructed correctly. Not feeling they could question the project, however, most residents just let the crews come in and build the system. As a result, 61 percent of residents never made household connections (Rondon 1990). Some stretches had uphill slopes, household inspection boxes were put in above the level of household sanitary equipment, and inspection boxes were so narrow and deep no one could access the line to clear blockages.

After the project was completed, the neighborhood association, backed by the health NGO and the municipal Public Health agency, began to petition the agency to inspect and correct all construction errors. Whereas the main discussion point initially had been whether or not residents wanted sewers (which naturally they did), by this time the residents were demanding a detailed explanation of the system, and were questioning certain aspects of it, such as the pipe diameter and resident responsibility for maintenance. Their underlying doubts, combined with the fact that the network was not working in many places, heightened residents’ distrust of city engineers, and of the system itself.

The city implementation staff, for its part, was frustrated with the neighborhood association, which it felt was inflaming residents and setting them against the system which staff had worked hard to develop. This mutual antagonism erupted during the final meeting called by the neighborhood association. A municipal staff member told residents they should not be living next to the gully in the first place, and that was the cause of their technical problems, rather than shoddy construction (which agency staff had already acknowledged). In the ensuing uproar from residents, who demanded an apology, the municipal representative walked out, breaking off all discussion.
projects the system was presented to all residents, but actual construction proceeded slowly—a few pilot blocks at a time until other residents could see what the system entailed.

The neighborhood association learned that they must be more closely involved with project supervision, and ensure that residents understand the process. The association formed a committee to survey network problems and accompany agency supervisory staff when they came back to inspect the system. This way, they learned quite a bit about the sewerage and were able to point out problems that the supervisors would have missed. They did not view this as collaboration, but the effect was the same.

Agency staff got information otherwise unavailable without the association’s help in gaining access to residents’ backyards. Although this collaboration happened under tense conditions, the association and the health NGO recognized its value, and how it could improve future projects.

Since that time, the association and the health NGO have been much more active in pushing for collaborative efforts with agencies, particularly in the health area. They no longer let agencies come in and “do projects,” because they know that most agencies do not fully understand local problems. The association now acts much more like a partner with agencies—setting agendas, defining interventions, and implementing projects.

The Canjica case points to two key lessons of community participation. First, the assimilation of technical information happens predominantly at the experiential level. Second, without an effective forum for debate, questions, and negotiation, it is impossible for residents to express their needs to the agency implementation staff. Just because the system is low-cost and technically adapted to the physical characteristics of the project site does not mean residents will like it, even if they very much want a solution to their sanitation problems and have been mobilizing for some time.

**Gradual Acceleration of Project Pace**

Nearly all condominial projects studied started slowly and then sped up to accommodate funding cycles or political cycles. Accelerated project pace can negatively impact the amount of time staff dedicate to mobilizing residents, and can lead to shoddy construction, but it can
also provide important incentives to finish the job. Going too fast at the beginning, however, interferes with the gradual start-up period that both residents and project staff need to assimilate new information and tailor the project to each new area.

In most cases where projects were pushed too fast, the pace resulted in low-quality mobilization and technical work. This is true for all of the poorly performing cases: Cuiabá, Recife, Joinville, and the 1992 phase in Petrolina (which on its own, would merit an "F" rating). In Joinville, political motivation to complete the project before the mayoral elections pushed the project team to construct the project, rather than doing the more time-consuming activity of holding block meetings, waiting for resident consensus, or explaining network function in detail. In Cuiabá, also, construction was sped up in the last two of eight neighborhoods served in order to finish before mayoral elections. Portions of the trunk infrastructure were never completed and inspection boxes were incorrectly built and inappropriately placed. As a result, the state water company refused to take over maintenance responsibility from the municipal implementation agency for these two neighborhoods. In the end, neither the municipality nor the state have accepted responsibility for the network, leaving residents unserved.

Ironically, electoral pressures on project pace can be positive at times. Projects often bog down, and even stop, well before they are completed. Politically motivated mayors and governors can off-set this tendency, as in Petrolina, where the early stage, executed under severe financial limitations, was accelerated to conclude before the 1985 municipal elections. The quality of work and residents' opinions of the network there are both high, however, because there had been ample time for residents to be fully involved in project implementation. Project teams had already spent two years developing their expertise, and residents were already mobilized before the push came to speed up.

The key difference that elevates Petrolina and Brasília, where 12,000 effective connections were made between 1990 and 1992, above others is that in both places project staff had sufficient time to learn how to facilitate community participation and fully train their growing staff before the rush to complete the projects (see figure 8). In general, a four-to-six month mobilization process must precede construction in each new neighborhood.

Accountability Mechanisms for Construction Quality and Project Design

One of the common obstacles to successful infrastructure projects everywhere is the difficulty in ensuring quality construction. This is accentuated when large construction firms are hired to build condominial sewerage. Large contractors resist doing condominial projects because the overall budget is low. When large contractors win project bids they typically subcontract to smaller local contractors, who with smaller budgets available for salaries and materials, are forced to hire unqualified labor at low rates, and use low-quality materials. Further, most large contractors lack experience in condominial systems, especially in dealing intensively with residents. Finally, larger construction firms prefer to execute sidewalk networks, which do not require contact with residents. When they do have to deal with residents, the tendency is to discount any complaints as unreasonable, unfounded, or irrelevant.

The most common cause of poor technical performance in condominial systems is low-quality construction. Examples of improperly constructed systems exist in every city. In Natal, a major trunk collector was built with negative slope, affecting 50 percent of all connections in the project area of Rocas (CAERN 1988). In the Recife neighborhood of Sky Lab, poorly joined ceramic pipes began to clog with sand and dirt shortly after construction. Residents now spend a great deal of time manually retrieving the resultant mixture of sewage sludge and sand from their clogged lines. In Cuiabá's Canjica neighborhood, the construction firm put collection boxes at a higher elevation than some residents' homes. Wastes would have to flow uphill to reach collector lines.

Performance data from Petrolina comparing conventional and condominial systems shows that when construction, construction supervision, and operation and maintenance are performed well, condominial systems perform on par with conventional systems, though backyard lines perform less well than front yard and sidewalk lines (see table 4).

Quality construction requires both competent contractors and mechanisms to ensure they perform well. In the better-performing condominial projects, local contractors learned to execute the systems well and were able to develop skills for working with residents. How did this happen, given the forces working against this outcome? The best cases involved
medium-sized local firms under contract with the municipality or the state water company. Unlike large out-of-state contractors, who can leave if they get a bad reputation, local contractors are more susceptible to performance pressures from both agency staff and community members. Local contractors tend to use more skilled and semi-skilled labor from the project area in order to cut down on transportation and food costs. These employee-residents are more sensitive to their neighbors' needs, making it easier for resident complaints to be heard.

In Cuiabá, for example, one of the local contractors began to hold block-level meetings with residents, even though the implementing agency staff had not, when residents complained they had not been informed of the project. They discovered, without any requirement from the municipality, that holding block meetings made their work easier. In Petrolina, local agency engineers have been able to cultivate and train local contractors, who had initially resisted doing condominial systems. They know that if they perform well, they will be hired for subsequent jobs.

The better-performing projects also involved agency implementation staff who were present during all stages of implementation: planning, mobilization, and construction. The continuity in agency staff created a core team that was visible, known, and accountable to residents. Agreements reached during community mobilization were not "lost" when a new team came to supervise construction. Some agencies have tried to streamline the implementation process by assigning different teams to different tasks: sociologists for the mobilization stage, design engineers for designing network layout, and construction supervisors for the actual construction. But residents' needs and concerns are not so easily broken into discrete, isolated phases.

This is another reason why multi-disciplinary implementation teams are important - if they are going to be present for all stages of implementation, they must have the skills to perform the various tasks involved.

Both of these factors - using local contractors, and continuity of agency implementation staff - contribute to better quality construction. Both provide better conditions for channeling community concerns, which are ultimately what drive accountability mechanisms. The central question is how to achieve responsive and accountable implementing agencies and contractors. Neighborhood associations, activated by the condominial system's process of neighborhood mobilization, play a key role in this by participating in mobilization, monitoring construction, and holding agencies accountable for the infrastructure they have built. Neighborhood associations increase agency accountability by fostering a form of "constructive competition" among agencies (see box 3).

Neighborhood associations' supervisory and regulatory roles extend to establishing workable financing and operating arrangements and offsetting staff biases for specific service level options. Although their active involvement may slow down project implementation, the outcome is better and more sustainable. In addition, associations often negotiate for solutions that redefine project rules and parameters to make them more appropriate for the actual needs of the residents. In Recife, neighborhood associations raised concerns about financing and cost recovery arrangements with the implementation staff. They wanted the system to be affordable for all residents, rather than just those who could produce an up-front contribution of cash or materials. They tried to organize bingo games and other revenue-generating activities, but were unable to come up with

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**Table 4. Performance indicators from Petrolina**

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Sidewalk</th>
<th>Front Yard</th>
<th>Backyard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free and Flowing</td>
<td>100%</td>
<td>97%</td>
<td>98%</td>
<td>97%</td>
</tr>
<tr>
<td>Collection Box in Good Condition *</td>
<td>61%</td>
<td>85%</td>
<td>89%</td>
<td>80%</td>
</tr>
<tr>
<td>Sanitary Wastes Connected</td>
<td>99%</td>
<td>96%</td>
<td>95%</td>
<td>98%</td>
</tr>
<tr>
<td>No Prior Blockages</td>
<td>77%</td>
<td>62%</td>
<td>68%</td>
<td>44%</td>
</tr>
<tr>
<td>One Blockage or Less per Year</td>
<td>90%</td>
<td>79%</td>
<td>89%</td>
<td>72%</td>
</tr>
</tbody>
</table>

Source: Franca Engenharia 1994. (See Watson, forthcoming, for complete survey data.)

* Manholes and collection boxes were buried or paved over in 33 percent of conventional and 6 percent of sidewalk systems.
Box 3: Private constructive competition

In the Cuiabá neighborhood of Caniça, the lack of mobilization efforts and an initially passive neighborhood association allowed shoddy construction to go unchecked. The neighborhood association only became active after project completion, when construction problems became apparent. Association members linked up with city-wide health activists who helped them formulate their demands and supported their efforts. At the same time, the association contacted the municipal public health board, which was sympathetic to the neighborhood’s problems. Because of their more direct experience with poor residents, the public health staff were also better equipped than the municipal and state engineers to understand resident complaints and recognize legitimate concerns. Public health staff mediated between residents and implementation staff, working to reestablish a dialogue between the residents and engineers. After months of letters, petitions, and demonstrations, the association finally convinced the State Water Company (which had taken over the system from the municipality) to return to the neighborhood and repair the network.

sufficient funds. After some months of project delay, the implementation staff responded to association concerns by proposing a mutually beneficial arrangement where residents receive construction materials in return for collecting and sorting recyclable trash in their neighborhood.

This was an innovative adaptation of an existing municipal program that exchanges recyclable garbage (glass, metal, and cardboard) for basic food staples (telephone interviews: Silvia Arrais, Recife 1993 and Crescencia Maurer, North Carolina 1994). The municipality gains by “contracting” to the neighborhood association for services it would otherwise have to pay for out of its budget, and the community gains by having a non-cash form of contributing to their new system.

Financial Investments

One of the critical issues that is yet to be resolved for all sewerage systems in Brazil, including condominial systems, is that of financing and cost recovery. In all condominial cases studied, cost recovery was not pursued due to political expediencies, which is also true for conventional water and sanitation projects. Politicians find it difficult to charge for services that benefit mostly poor people, especially when better-off customers have historically been subsidized.

When networks have operation and maintenance problems, are incomplete, or are constructed at the same time as other new fee-for-service infrastructure, charging for sewers becomes difficult politically (see table 5). In Joinville, for example, though the system functions well, water service has been intermittent for the past eight years. Because water and sewer charges come on the same bill, and the users get unsatisfactory water service, state politicians and water company administrators feel it is inappropriate to charge for sewerage.

The most successful solution is that of Natal, where the tariff structure was calculated in 1982 to amortize implementation costs over the useful life of the project: 40 years for the main trunk lines and 20 for the block collector lines (Sinnatamby 1992). Today, new customers are charged a connection fee that can be spread over a 12-month period in equal installments corrected for inflation.

One financing method, tried in Petrolina and Recife, is to ask customers to make an up-front contribution covering the cost of the feeder network. The cost of public street lines are not recovered. This approach significantly delayed project implementation in both cities, though the municipalities had no other option because of limited resources. In Petrolina, residents organized themselves to raise funds for their feeder lines and household connections. Community representatives collected funds, which were deposited in an inflation-adjusted bank account until enough money had been raised. The delays discouraged people, however, who asked for their contributions to be returned for emergency needs. Other residents lost faith that the sewers would be built and thought their money was being used by the representative or municipality to build sewers elsewhere.

In Recife, the Mangueira neighborhood association’s arrangement with the municipality for collecting and sorting trash (described earlier) has more promise, and has been used successfully in other kinds of urban services project throughout Brazil. It builds the collaborative skills the municipalities and associations can draw on in future interactions.

In general, unless funds are collected up-front, political pressures have consistently
Table 5: Tariffs and connection fees actually charged in study cities

<table>
<thead>
<tr>
<th>City</th>
<th>Conventional</th>
<th>Tariff (1)</th>
<th>Connection Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Backyard</td>
<td>Front yard</td>
</tr>
<tr>
<td>Petrolina&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Natal&lt;sup&gt;b&lt;/sup&gt;</td>
<td>200</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Brasilia&lt;sup&gt;c&lt;/sup&gt;</td>
<td>100</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Itapissuma&lt;sup&gt;a&lt;/sup&gt;</td>
<td>n/a</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Joinville&lt;sup&gt;d&lt;/sup&gt;</td>
<td>100</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Recife (2)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>200</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Cuiaba&lt;sup&gt;f&lt;/sup&gt;</td>
<td>100</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

(1) - Percentages refer to the portion of the water bill that is charged for sewer service.
(2) - In Recife, residents are only charged for sewer service when the state water company, COMPESA, provides maintenance service, or in roughly 20 percent of all condominial connections.

Interfered with capital cost recovery efforts, jeopardizing the sustainability of service expansion to new areas and the financial viability of operation and maintenance services. There are few, if any, systematic studies of actual operation and maintenance costs for the condominial system which would guide utilities in setting tariffs and financing mechanisms at sustainable levels. Tariffs for condominial sewerage, in three states where they are charged, were set at arbitrary levels based on what politicians and agency administrators deemed fair and defensible (Franca, 1993, Melo 1993, Eruson 1993).

Subsidies for investment costs are often deemed justifiable for public health, productivity, and urban development. They are for these reasons, the norm throughout the developing world.

The division of labor between the municipality and the state water companies further complicates cost recovery for both initial and recurrent costs. In many cases the municipalities have built systems and turned them over to the state for operation. Municipalities have been reimbursed occasionally when outside funding was available. In general, however, the state water companies have received condominial systems without compensating the municipalities.

In theory, burden, should fall to the state water companies. Yet municipal governments are often unwilling to wait for the state water companies to respond to citizen demands for new services, and have initiated service extension themselves. State water companies theoretically hold the concession for service in most Brazilian municipalities, and in all but one of the cases examined here, but new services, particularly those for previously excluded low-income neighborhoods, have resulted from municipal initiatives in the face of inaction by state water companies. Typically, the municipality will acquire funding to construct new water or sewer networks from sources outside traditional sector financing, and will turn the network over to the state water company to operate once completed.

Municipalities frequently perform operation and maintenance tasks on condominial systems without receiving any portion of the tariffs collected for that purpose. The city of Petrolina<sup>c</sup> maintains feeder lines, and the state water company, COMPESA, maintains the trunk lines. Tariffs are paid to COMPESA. For more than ten years there were no formal agreements either for compensating the city for investment costs of the network that was donated to COMPESA, or for revenue transfers to cover the costs of feeder line maintenance. In 1994, the city threatened to municipalize all water and sewerage services, if COMPESA did not transfer 75 percent of sewerage revenues to the city. Petrolina is now using these funds to make counterpart payments on financing for new condominial system construction.

Because municipalities are politically closer to their populations, they are more likely to be accountable to residents than large state agencies. At the same time, municipalities find it harder to secure transfer funds to bail out unsustainable recurrent cost structures as state water companies have been able to do. Because of their internal fiscal constraints, municipalities are more likely than state water companies to provide and charge for services in a way that is consistent with their resource base. In theory, these fiscal constraints can counteract the politically motivated lax cost recovery performance of state water companies.

There is currently a movement among entrepreneurial mayors throughout Brazil to regain control over water and sewer operations from state water companies. In at least three of the seven study cities, Natal, Petrolina, and Cuiaba, mayors have discussed this intent. Given municipalities’ activist role in new service production, this could be a healthy development.
The condominial system devolves maintenance responsibilities for feeder lines from agencies to residents. Agencies continue to maintain trunk lines and treatment facilities. Yet this arrangement has not worked well even in the best cases. Residents lack the skills and knowledge to perform complex maintenance tasks and often fail to cooperate, making blockage removal impossible. Agencies often perform their maintenance on trunk lines inadequately and do not provide sufficient training or technical assistance to residents. While many residents maintain their feeder lines without external assistance, others can not. Simple blockages can be resolved by most residents, but construction flaws, damaged networks, and problems in the trunk line are beyond residents' capacity.

Agencies must be flexible enough to assist these residents — either through direct service provision, repairs of inoperable network links, or technical assistance. In some neighborhoods studied, residents developed informal mutual assistance practices or collected funds to hire a plumber or mason to remedy blockage problems. Still, even in these exceptional cases of resident collaboration, customers need service agencies to fulfill their part of the agreement.

Good operation and maintenance was achieved when customers and service agencies increased their interaction. Service provider accountability was achieved when organized customers learned to engage effectively with service providers and play a regulatory role. The theory, the division of labor between residents and agencies, builds on the comparative advantage of both and takes management to the lowest appropriate level. In practice, the separation of tasks leaves a large grey area between resident's inability to fully assume their new role, and agencies' continued poor performance of operation and maintenance tasks. The cases where operation and maintenance works well (Petrolina and Natal show that increased resident responsibility requires increased interaction with agencies, not less.

The division of labor is important, though not in the sense of completely devolving responsibilities to beneficiaries. By retreating from feeder portions of the network, the agencies studied created a void of service provision. While residents were not initially organized to fill this void, in many cases the obvious need pushed neighborhood associations to develop a more interactive relationship with agencies. As with the implementation process, maintenance arrangements of the condominial system activated previously dormant neighborhood associations. This generated a dynamic of customer complaints and agency responses that ultimately improved agency performance. Customer complaints also generated lateral pressure within and among public agencies — constructive competition — that was instrumental in producing good performance.

This chapter describes (1) the difficulties of customer operation and maintenance, (2) individual solutions, (3) third-party solutions and the role of neighborhood associations, (4) obstacles to good public agency performance, and (5) mechanisms for generating good agency performance.

Difficulties of Customer Operation and Maintenance

As the condominial system was conceived, neighbors in each block are responsible for any blockages occurring on their property, including their household connections and the condominial lines. In some cities, each block is provided with lengths of rigid wire to help dislodge solids stuck in the lines. Sidewalk customers, like conventional customers, are only responsible for their household connec-
In order to locate blockages, neighbors must open a series of inspection boxes. Once the problem is discovered, clearing is done by prying loose the blockage and fetching it out as it passes by. In addition to being dirty and unpleasant, this procedure becomes difficult when neighbors build walls around their yards, and can be a source of conflict if neighbors do not allow others onto their lots. This is no minor nuisance: neighbor disputes often cause residents to relocate to other houses or move out of the neighborhood altogether. Though not widespread, this extreme scenario points to a more generalized problem of neighbor cooperation.

Blockage removal is difficult, too, because the source of the backup is often in the trunk line. Trunk line slow-downs will increase feeder blockages because slower flowing effluent allows solids to settle and accumulate. Further, it is not clear which are trunk lines and which are condominial feeder lines, particularly where housing density is high, house layout is irregular, and the distinction between public streets and private pathways is not obvious. In sum, residents' maintenance tasks are difficult and conflict-ridden.

Neighborhoods in Transition

The condominial system has been installed in high density, relatively low-income neighborhoods that are in the process of becoming consolidated, working-class neighborhoods. Introducing urban services contributes to this process, because housing values increase. Poorer residents can sell their houses at higher prices, and better-off residents are stimulated to make improvements they often felt were risky when land tenure was precarious and the lack of services made permanent housing investments less attractive. As a consequence, these neighborhoods have high resident turnover and high rates of house expansion and construction. Both of these phenomenon contribute to maintenance problems in the condominial system. New residents are not always aware of the network's existence, or are not advised properly about operation and maintenance.

Problematic Collective Maintenance

Each block is supposed to select a condominial manager to help resolve blockage problems. In very few blocks visited, however, could residents identify that person five or ten years later. In Natal, a city where this issue was given considerable attention during project implementation, block representatives were given the long length of wire for blockage removal. Only four percent of residents, however, knew who the representative was ten years later (Formiga 1993). Sometimes the person had moved or had never performed any function, so residents simply forgot about the intended role. Instead, individual residents turned to the state water company, in this case CAERN, to perform blockage removal—a problem too widespread for them to resolve efficiently.

The anecdotal and survey evidence of collective maintenance breakdown is consistent across all cities examined. While having each block organize itself as the basic unit of condominial management is, in theory, a good idea, blocks are not necessarily a natural form of association or cooperation in urban neighborhoods in Brazil. Rather, residents tend to resolve their problems individually when they can—either by doing it themselves, calling on a private plumber or the service agency, or reverting to on-site and ad-hoc solutions. When they cannot, they turn to their neighborhood association.

Uneven Impact of Maintenance Problems

The brunt of maintenance problems tends to fall on a few households that are in a low-lying part of the block, where there is some construction error increasing blockage incidence. Low-lying residents often obstruct the network in some way: building on top of it, plugging it, or bending their lines, thereby reducing flow. The rest of the block usually functions relatively well, while effluent backs in up low-lying areas and flows out of the collection boxes, toilets, and kitchen sinks in the affected households.

Individual Solutions

Most households prefer to resolve their problems on their own, if they can. When households are too poor to afford a plumber, the residents do their own maintenance. In the majority of households visited, the women are more familiar with the maintenance history of their systems and perform maintenance tasks. In many households, young sons remove blockages because they are small and can fit into the narrow collection boxes to manually retrieve blocked debris.

A household survey in Petrolina revealed that backyard and front yard customers perform
blockage removals themselves most of the time, but still rely on public agency support for some of their needs. Interestingly, sidewalk customers do less of their own blockage removal than conventional sewerage customers (see table 6). This could reflect a higher blockage rate among sidewalk customers relative to conventional customers, or higher incomes among conventional customers, who can afford to pay a plumber to remove blockages. It may also reflect different expectations among conventional and sidewalk customers about the extent of their responsibilities.

Maintenance performed by customers works well when the trunk line functions properly and blockage problems are relatively simple—a stuck plastic bag or rag—and are on the affected household’s lot. Significantly, very few residents, however, report sharing blockage information with neighbors (that a blockage occurred, and what they found) to reduce repeat problems, much less working with neighbors to remove the blockage.

Sewerage technology is not as easily understood as other urban infrastructure such as water networks and electrical lines. In squatter settlements where public services are not provided, residents routinely make illegal, make-shift connections to these services. They erect wooden poles and string electrical wires to run domestic appliances, and they steal water from nearby water lines through long stretches of plastic pipes that criss-cross foot paths. Residents manage to install, operate, repair, and upgrade their own water and electricity with little collective action and no outside technical assistance.

Yet sewerage systems prove to be difficult for residents to manage. When condominial systems begin to break down, many residents revert to individual solutions like pit latrines and open drainage ditches in front of their houses. While no data is available on the prevalence of this response, it appears to be limited to those areas hardest hit by chronic sewer back-ups, or to residents who have significant conflicts with neighbors over maintenance issues. In Joinville, for example, one particularly testy resident refused to allow anyone on to her property to look for blockages, and finally redirected her effluent to a street storm drain when the block line stopped working. A study of the Ilha de Santana area of Olinda, Pernambuco, a squatter settlement located outside the historic city near Recife, documents how nearly all residents rapidly reverted to individual sanitation solutions when the poorly constructed condominial system there began backing up just months after construction (Alcantara 1993).

<table>
<thead>
<tr>
<th>Type of Sewerage System</th>
<th>Percent of Residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>59</td>
</tr>
<tr>
<td>Sidewalk</td>
<td>25</td>
</tr>
<tr>
<td>Front yard</td>
<td>63</td>
</tr>
<tr>
<td>Back yard</td>
<td>85</td>
</tr>
</tbody>
</table>

Source: Franca Engenharia 1994. Based on a stratified random sample of 425 households selected from a universe of 12,729 households, or 3.3 percent.

**Third-Party Maintenance**

Third-party maintenance is provided by someone other than the service agency or resident. The originators of the system envisioned individual and collective block-level maintenance arrangements, believing all condominial feeder problems could be resolved this way. They did not foresee the difficulties of resolving more complex problems, particularly those resulting from construction flaws and trunk line blockages.

Unable to resolve these more difficult problems, or unwilling to perform their own routine maintenance, residents call on third parties to assist them. In better-off neighborhoods it is common for residents to hire a local plumber. When residents are poorer, they can sometimes find a generous and mechanically-inclined neighbor to help them out. These approaches are effective unless the problem has some underlying construction cause that cannot be resolved by simply clearing the line.

Neighborhood associations are also involved in third-party maintenance, sometimes as service providers, very occasionally as organizers of collective action, and most significantly as advocates pressing public agencies to provide condominial feeder maintenance and repair services.

**Neighborhood Associations**

Neighborhood associations work to resolve neighborhood problems. They are representative bodies that are typically elected on an annual or bi-annual basis, serving at the pleasure of residents. In return, they are expected to produce tangible benefits by mobilizing resources—public agencies, NGOs, or the resi-
Box 4: Neighborhood association as advocate and regulating agency: Petrolina

One block in the neighborhood of Jardim Maravilha in Petrolina, had chronic blockages for over five years because of a construction flaw in the condominial line. Residents were never able to resolve the problem on their own and did not work together. Users on one side of the block hardly realized there was a problem, because their sewer lines always functioned well. Effluent continued to flow, however, spilling out over one unfortunate neighbor's lot and down the street on the other side of the block. The residents were not particularly poor, nor were they strangers. Yet, because the blockage had affected just a few residents, it was never seen as a shared problem to be resolved collectively. The affected residents suffered high personal costs rather than mobilizing their neighbors to help them.

Residents had gone individually to the state water company, COMPESA, and to the municipal public works agency, but no solution was offered. Finally, after years of putting up with the problem, they went to their neighborhood association. The association got a commission of neighbors and association representatives together and wrote up formal demands. They presented them to the state water company, the municipal department of public works, and the mayor simultaneously.

The association knew they had to pit the agencies against each other if they were going to get results. "We were so tired [of the run-around] that we played hard ball with them" (association leader, 1993). The association and the neighbors' commission threatened not to pay their water bills if no resolution came in one month. Their demands were: (1) replace the damaged network, (2) no new connection fee, since they had already paid once, and (3) tariffs remain at subsidized rate though the new network was to be upgraded from backyard to sidewalk lines.

Once organized, and making demands collectively, residents were finally able to get their demands met. The neighborhood association's involvement was crucial. The association was also able to facilitate interaction between agencies and residents by organizing resident complaints into coherent demands agencies could meet. The newly elected municipal administration responded, replacing the entire block network. This garnered much praise for the new mayor, and gave a boost to the dormant neighborhood association, which is now beginning to act as a channel between residents and municipal and state agencies for other problems with the network.

Residents themselves – into action. Often associations have political patronage ties to city councilmen or mayors, who press agencies to act. In return, the association must deliver political support. The client-patron relationship can exist not only between the association leadership and elected officials, but between residents and leadership as well. Other associations are more autonomous, and accountable to residents. They rely on mobilizing residents and outside support from religious and advocacy groups to achieve their aims.

Neighborhood Associations as Service Providers

Neighborhood associations have often found themselves in a difficult position with the condominial system because residents demand not only representation and advocacy, but also immediate physical resolution of their sewer problems, i.e. blockage removal. In part, this comes about because implementation staff tell residents to go to their association if problems arise. Many residents interpret this as a suggestion that the association has become the maintenance service provider, not an unreasonable assumption given the associations' active role in demanding new services and in project implementation. But this goes against the associations' roles within the matrix of community life: "It's our role to make demands, but when it comes time to actually do things, that's not our job. That's the public agencies' and the people's part," (see box 4, neighborhood association leader, Petrolina 1993).

Nevertheless, in many neighborhoods residents look to the neighborhood association to resolve routine blockage problems. Association representatives perform blockage removal, not wanting to lose their prominent positions within the community. While this maintenance arrangement seems to work fairly well in some poor neighborhoods, it also serves to reinforce a form of community organization that is less than democratic or representative. The trend is instructive, however, because it indicates that residents want to turn over their on-site maintenance responsibilities, and that there is a "market" for this service – in this case the privileges of political patronage. In one Cuiabá neighborhood, the neighborhood association collected money from residents to hire plumbers to clear their lines.
Neighborhood Associations as Organizers of Collective Action

In some cases neighborhood associations organized maintenance activities themselves, mobilizing resident efforts. In Recife's Sky Lab neighborhood, for example, the neighborhood association has organized community-wide line clearing campaigns. The association, using bingo receipts, prepared beans and rice, bought a lot of cachaca (grain alcohol), and called the community together. The food attracted the people, and once the men had consumed enough cachaca, they began to clear the sand out of their main collector lines by hand, a task no one was willing to do without somehow numbing themselves to the stench and distaste of direct contact with fecal wastes. Because the association has since run out of funds, the lines continue to fill with sand through poorly connected ceramic pipes, and the system has again stopped working. This was the only example of common blockage removal encountered in the seven cities, and more than 20 neighborhoods visited.

Neighborhood Associations as Advocates and Regulators

By far, public agencies are the most common third-party maintenance providers. When users are unable to resolve complex technical problems, neighborhood associations can sometimes mobilize enough pressure to bring in municipal or state water company staff to perform repairs. Neighborhood associations identify and articulate problems that are not being addressed by public agencies and force these agencies respond. In this sense, they play a regulatory role, ensuring ongoing service accountability.

Neighborhood associations are successful when they are able to express common problems (chronic household blockages) as collective demands. But they are only able to do this when they (1) are accountable to residents, (2) are feisty enough to take on public agencies, and (3) have the sophistication to translate externalities into collective demands.

Third-Party Maintenance Conclusion

Third-party maintenance works relatively well, whether collectively organized or procured by an individual, depending on the income of the residents, and the activities of the neighborhood association. Public agency third-party maintenance also works well, though it violates the original condominial model. The instances of feeder line breakdowns are sufficiently widespread, however, to indicate that leaving this up to the communities has left a large area of unspecified responsibility, resulting in poor system performance.

To date there have been no coordinated studies to evaluate different forms of third-party feeder network as well as trunk line maintenance. Two local NGOs, however, are currently designing a study to do just this, in conjunction with the Recife municipal government and the university. Clearly third-party maintenance of some sort is already going on, and it is the choice of most residents when they can afford it. The next section examines the role of public agencies in both trunk and feeder line operation and maintenance.

The Role of Agencies

In order for the condominial system to work as intended, service agencies must do three things: (1) perform operation and maintenance on trunk infrastructure, keeping it in optimal working order; (2) resolve chronic problems in both trunk and condominial feeder lines resulting from design or construction flaws; and (3) perform on-going education of condominial customers about proper usage, simple maintenance procedures, and how to make alterations to household connections. While all cases have at least some periodic blockage removal services for trunk lines (and often feeder lines as well), only two cities, Natal and Itapissuma, provide continuing education and technical orientation to residents, and only two cities, Natal and Petrolina have developed systematic programs for network maintenance, repair, and modification. In Recife and Cuiaba, the service agencies were slow to assume trunk line maintenance responsibilities, and performed them poorly when they did.

The mixed, but generally disappointing record of service agency operation and maintenance — mostly on the part of state water companies — reflects their poor performance with conventional sewerage operation and maintenance, and their historic neglect of low-income urban residents. It should not be confused with the nature of condominial sewerage, though many observers of condominial sewerage see agencies’ poor performance and the havoc caused and concluded that condominial sewerage is a bad idea. The record from Petrolina, Natal, Itapissuma, and to a lesser degree Brasilia and Joinville, does not support this conclusion (see table 7 for comparative operational indica-
Table 7: Maintenance arrangements in study cities

<table>
<thead>
<tr>
<th>Private City</th>
<th>Implementing agency and division</th>
<th>Operating agency</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrolina</td>
<td>Municipality- Public Works</td>
<td>Municipality/SWC- Operations</td>
<td>SWC maintains trunk network, municipality operates within lots, at resident request.</td>
</tr>
<tr>
<td>Natal</td>
<td>SWC- Construction</td>
<td>SWC- Operations</td>
<td>Initial five-year period of poor maintenance or repair of trunk network, despite major construction flaws. SWC now operates trunk end feeder lines, effects routine repairs of damaged network, &amp; has ongoing educational program.</td>
</tr>
<tr>
<td>Brasilia</td>
<td>SWC- Construction</td>
<td>SWC- Operations</td>
<td>SWC operates trunk network. System is quite new, and information regarding feeder network too preliminary to evaluate.</td>
</tr>
<tr>
<td>Itapissuma</td>
<td>Municipality- Public Works</td>
<td>Municipality- Public Works</td>
<td>Municipality operates trunk and feeder network, performs routine surveys of functioning and provides continuous education and technical assistance to residents.</td>
</tr>
<tr>
<td>Recife</td>
<td>Various Municipal Agencies/SWC- Construction, special projects team/state agencies</td>
<td>SWC- Operations</td>
<td>SWC has not accepted 80 percent of condominial systems in the city. When the effluent discharges to a communal septic tank, or other local treatment, the SWC does not operate. The SWC does operate some trunk network in the other cases, sporadically.</td>
</tr>
<tr>
<td>Joinville</td>
<td>Municipality- Social Services</td>
<td>SWC- Operations</td>
<td>SWC operates trunk, and, sporadically, feeder network.</td>
</tr>
<tr>
<td>Cuiabá</td>
<td>Municipality- Public Works</td>
<td>SWC- Operations</td>
<td>The SWC accepted seven of the nine neighborhood systems, but did not operate them for the first three years after construction. Currently performs sporadic operation of trunk infrastructure, though much of the network has been damaged beyond repair through neglect.</td>
</tr>
</tbody>
</table>

**SWC** - state water company

It is important to understand why many state water companies find it difficult to provide adequate operation and maintenance services for condominial systems, and what factors have contributed to good operation and maintenance in the five better-performing cases reviewed.

Operations divisions are usually well-equipped for performing isolated blockage removals, but they rarely have funds to make significant repairs, even though the majority of chronic feeder blockage problems are caused by underlying construction flaws and damage in trunk lines, which must be repaired or replaced. Conventional maintenance divisions within state water companies typically receive little support within the agency, and are widely perceived as the lowest rung on the professional ladder within the agency. With condominial systems this presents particularly serious problems because customers are expected to perform services which the lack of trunk line maintenance and repair makes difficult if not impossible. As the trunk network begins to fail and condominial customers are unable to resolve recurrent feeder line blockage problems on their own, operations staff tend to fall back into stop-gap service routines of clearing blocked feeder lines, while leaving trunk line blockages and construction flaws unresolved. This response is driven by agency administrators and politicians reacting in a piecemeal fashion to individual appeals from disgruntled condominial customers. Yet the root cause of the problem persists, reappearing in the form of chronic blockages. Meanwhile, agency staff begrudge residents who request their help with
blockage problems.

Inter-agency disagreements about who is responsible for the network have been the most significant barrier to good operation and maintenance, leading to long delays in assuming maintenance responsibility. Most projects were built by one agency (such as a municipal public works department) or a division within an agency (such as a construction division within the state water company), and turned over to the state water company operations division for maintenance and operation (see table 6). In many cases, however, the state water company determined that the system was faulty and refused to accept it. If the company did accept it, subsequent maintenance was so lacking that the effect was the same as if the system had never been accepted. Even Natal, one of the best cases, experienced a long period of stop-gap feeder maintenance and little or no trunk line maintenance before reforms were made.

By separating construction from operation and maintenance, the skills, sensitivities, and experience gained through project implementation are lost. Operations divisions, already at the bottom of the institutional totem pole in state water companies, are asked to take on tasks for which they are ill-prepared, because of lack of experience interacting with residents. Even in the ideal situation, where operations staff only perform maintenance on trunk lines, effective service provision requires monitoring chronic blockage problems in condominial feeder lines, which necessarily involves a good deal of contact with residents.

This section discusses some of the reasons behind these problems, and points to strategies for addressing them.

Non-Maintenance as Sabotage

Non-maintenance can be a form of passive sabotage. A receiving agency that has not been included in the construction of (or the credit for) the new system has no stake in its success. The condominial system is sometimes perceived as a threat because it increases the operation division’s service load and requires staff to work with poor residents, a task most agency engineers and administrators fear will be difficult. As a result, operations divisions often resist providing services, even when the engineering review division has formally accepted the new network for maintenance.

In three of the cases, Natal, Recife, and Cuiabá, the state water company operations divisions neglected their maintenance responsi-

ilities, resulting in significant operational problems for customers. In Natal, the operations division eventually did take on trunk, and even feeder, maintenance contributing to the significant success of the system. How this came about will be described in the next chapter, in the discussion pertaining to adoption and dissemination.

In Recife, in the few places where the state water company, COMPESA, has constructed some condominial sewers over the past two years, its operations division is providing maintenance, unlike in the rest of the condominial network, which COMPESA did not build (80 percent of the systems). COMPESA’s operation division is under pressure from the construction division, which has recently invested in the new networks, to maintain the system. The rest of the systems are in various states of disrepair. The municipal public works department is now trying to recuperate some of these smaller systems.

In Cuiabá, non-maintenance as sabotage was successful. The municipality never built any more condominial systems. The same mayor who originally built the system has returned to office, but plans to construct conventional sewerage.

Good Agency Performance

There are elements of good operation and maintenance in every case, though they coexist with periods or generalized lapses into less satisfactory performance. This section describes the institutional structures that led to good agency performance in the cases examined. The key elements are: (1) staff continuity between the construction and operations phases; (2) a specialized condominial maintenance crew; (3) face-to-face contact with residents; and (4) ongoing network monitoring and repairs and customer education.

Continuity Between Construction and Operation

While most systems are built by one agency and maintained by another, it is still possible to build in some continuity between the two phases. Staff transfers between implementing and operating agencies and continuing collaboration are two ways to achieve this. In Natal and Petrolina, inter- and intra-agency staff transfers were instrumental in applying institutional learning from the construction experience to the operation of the system. In Natal, transfers have occurred between the construction and operations divisions within the state water company, CAERN. In Petrolina, where most of
the network has been built by the municipality, and the state water company has performed most of the operation and maintenance tasks over the past ten years, the high degree of staff borrowing between the two has allowed skilled workers to follow the main activities as they shift between construction to maintenance. In each of these cases, there has been continuity of key staff from construction to maintenance.

The Petrolina case illustrates how collaboration between agencies can occur over a period of time. Because the municipality has taken a leadership role in constructing condominial systems, and has continued to build new network over the past decade, there is a constant interaction between municipal and state water company administrators about design standards and operating procedures. On the one hand, the state water company must provide good trunk line maintenance, because if it does not, the mayor’s image, so closely associated with the system, will be harmed. Because Petrolina’s mayors hold powerful positions within state politics, they are able to use their influence with state water company district office administrators. On the other hand, the municipalities must build networks that are up to state water company standards, or the state will not accept them. The ongoing interaction ensures that both agencies monitor the other’s performance (see Watson, forthcoming, for a detailed examination of the Petrolina case).

Specialized Condominial Maintenance Teams

Just as condominial implementation is different from that of conventional sewers, operation and maintenance requires special skills: relating to predominantly poor customers and developing innovative technical solutions to problems as they arise. Conventional operating procedures work for most problems, but not all. As in implementation, the best condominial maintenance has been done by small multi-disciplinary teams dedicated exclusively to condominial systems.

There are a number of ways that specialized condominial maintenance teams develop. In Itapissuma, the small municipal public works department both builds and operates the system, so the same people are involved in both tasks. In Petrolina, the skilled condominial construction team members now work in the state water company operations division, performing both conventional and condominial maintenance. Because of their prior experience, they are able to respond to the distinct needs of condominial customers, fitting this into their normal service routine. In Natal, which is five times larger than Petrolina, and nearly fifty times larger than Itapissuma, having a specialized, multi-disciplinary team has been key for good maintenance performance. The single focus on the condominial system allows them to approach problems in a broader and ultimately more effective way. For example, they have discovered that over time the rate of rainwater connections has risen from around four percent shortly after implantation, to nearly 20 percent today. In response, they have developed a targeted education campaign to counteract the problem. They have also identified and quantified a serious rat problem, and have worked with the municipal health agency to resolve the problem. Staff continuity has also been key in Natal, though only a portion of the current team originally worked in condominial construction. Once the team was established, trained, and given a mandate by the core condominial construction team, it was able to run essentially on auto-pilot, innovating and perfecting its service approach.

Having a specialized team that only does condominial work helps to counteract the lack of accountability common in conventional operations divisions, without sacrificing some of the efficiency and economy-of-scale benefits. Smaller cities naturally have more face-to-face contact between agency staff and residents, and thus more accountability. In larger cities, maintaining the efficacy of maintenance teams can be difficult because interactions become highly impersonal. The smaller, specialized teams are more sensitive to the specific needs of condominial customers and are both accessible and accountable to them. Specialized condominial teams typically have more autonomy and discretion, enabling them to adapt to problems, learning and reorganizing their service approach as they gain experience.

Face-to-Face Contact With Customers

Daily contact with residents makes condominial operations personnel accessible to residents, allows them to identify problematic areas, and enables them to develop more customized maintenance approaches for specific problems. This is unusual in conventional maintenance procedures, where mechanization means that maintenance crews rarely have any direct dealings with customers.

In Natal, once the operations division created the specialized condominial mainte-
nance team, crew members noticed that almost all exit lines from the blocks exhibited frequent blockages. After some experimentation, they discovered that if they substituted 150 diameter lines for 100 mm diameter exit lines, the blocks had virtually no more problems and residents were able to resolve most problems on their own. In other cities, such as Cuiabá and Recife, where operations crews have had almost no direct contact with residents, these intermediate types of modifications have not happened, and blockage problems have worsened progressively.

Unless operations staff are accessible to residents in some way, they are not able to identify problems, much less resolve them. This does not necessarily mean that operations crews must perform feeder maintenance, though this is the most direct way for them to have contact with residents and learn about chronic problems. The key is having some channel for relaying information about the chronic blockages and getting them resolved.

**Systematic Blockage Monitoring and Customer Education**

Monitoring network performance is crucial for identifying chronic problems. By tracking blockage removals and service calls, agencies can investigate and identify whether a section has become damaged in some way. In theory, block representatives are supposed to communicate chronic problems to state water companies, but block representatives have not performed this role consistently. This deprives service providers of information about network performance. The only other way service providers could learn about problematic networks is direct service provision, where maintenance crews have an opportunity to observe performance. While block representatives have not done well at relaying information about problem areas, neighborhood associations have pointed out problems to operations staff. In doing so, associations reduce the transaction costs operations division staff face in dealing with individual residents, and they act as regulators, ensuring good operations and maintenance performance. This kind of facilitated system monitoring cannot happen, however, unless neighborhood associations have contacts in the operations division, and operations staff are responsive. Repeated experiences with nonresponsive operations staff will eventually dissuade community groups from attempting to relay information because they will see it as a futile effort.

Operations staff must have the autonomy to respond to the information they gather through their monitoring efforts. If they cannot remedy chronic problems, their legitimacy with customers erodes, and customers will seek other channels—usually protest—for getting their concerns addressed. Natal provides a good example of how operations maintenance crews can be responsive. The operations division has the autonomy, discretion, and budget to contract small construction firms to perform minor block exit line replacements and resolve chronic blockages. At a very low cost, the team is able to repair and upgrade the system on an ongoing basis, significantly reducing their daily service call load. Although the current practice of providing blockage removal services to customers is lamented by the originators of the condominial system as distortion of the maintenance arrangement, it allows operations staff to identify and correct chronic blockage problems, reducing overall blockage incidence. Without some contact with the feeder network, the operations department would have no way of detecting and resolving these chronic problems.

Because condominial systems are almost always built in rapidly changing neighborhoods with high turnover rates, agencies must provide education and technical orientation on a continual basis. In the small township of Itapissuma, municipal staff do this by making weekly rounds of the project area. They talk with residents, monitoring new construction, and making sure customers know how to move their network if they are expanding their homes. They advise residents not to let solids enter the network, and suggest ways to keep children from playing with the inspection boxes—a common source of blockage problems. But in large cities, this kind of individualized attention is next to impossible. In Natal, the operations division of the state water company has created a permanent educational campaign, distributing "comic strip" fliers that illustrate how to use the network and avoid damaging it during subsequent household expansion and construction (see annex 2).

**Operation and Maintenance Conclusion**

The condominial experience in Brazil has shown that the original division of labor between public agencies and residents has not worked as well as intended. Spontaneous collective maintenance of feeder lines has not come about in practice. Instead, residents have developed
Box 5: Receptive agency subgroups, Natal

The state water company, CAERN, built Natal's first condominial connections between 1980 and 1982 in the sandy beach-front low-income settlements of Rocas, Santos Reis, and Vietnr. By 1984, a few areas experienced chronic blockage problems in the feeder network. Individual residents demanded that CAERN clear their household lines, which was contrary to the maintenance agreement they had made with the implementation staff. Operations staff nevertheless felt compelled to respond to requests. When the operations division staff cleared condominial lines, the network functioned well for a time, but soon backed up again. "We only did palliative work. We got branches flowing again, but never did general trunk cleaning, and no repairs" (Former metropolitan district manager, CAERN 1993).

By 1988 residents affected by the problematic trunk line were so fed up that they demanded the whole system be removed. Organized en masse behind the neighborhood association, residents pressed the mayor, health officials, and CAERN to address the mounting health problems they attributed to the faulty sewers. Staff in the operations division were not responding, but construction division staff who originally built the system felt responsible for the network. Construction staff realized operations' non-responsiveness would ultimately discredit the system, and resolved to fix it themselves.

The construction division did a hydraulic study in 1988 that revealed a large amount of sand in a few critical trunk lines, affecting 50 percent of the project area. The study identified the cause of rapid accumulation of sand in the system: a large section of the trunk line had zero or negative slope. The construction division removed and replaced the line, provided positive slope, and built a new pump station with a sand collection box.

The construction division then turned the repaired network back over to operations in good working order. Their assumption was that no more within-block service would be required, and the original maintenance pact with residents could be restored.

But by this time, five years after the system was first built, both residents and operations staff were accustomed to the redefined maintenance arrangement with operations staff performing blockage removals on condominial feeder lines. What did change after 1988, is that operations began making intermediate-level repairs of chronically problematic networks, and performing routine trunk maintenance.

At the same time that the main trunk line was being replaced, some of the original condominial construction staff were transferred to operations. These people soon became the torch bearers of condominial maintenance, pioneering new repair practices, and developing a specialized condominial maintenance crew. Many have since left operations, but their trainees carry on with their work program.

The condominial maintenance crew works somewhat independently from the rest of operations, with less sophisticated -- and less expensive -- maintenance equipment than is used with conventional sewerage. One small pick-up truck carrying a long length of flexible plastic tubing to dislodge debris, a bucket of cement for rescaling concrete inspection boxes, one driver, and one assistant are all that is needed.

This contrasts sharply with the expensive and cumbersome "jet-vac" trucks used for conventional systems and on main trunk lines. In addition to being less expensive, the pick-up can be used for other tasks and is small enough to enter the narrow streets common in upgraded squatter settlements and low-income subdivisions. One condominial maintenance team member monitors resident needs through surveys and community meetings, and distributes educational materials on proper network usage and maintenance.

different forms of individual and third-party maintenance to address high and repeated transaction costs. State and municipal agencies have also assisted customers with feeder line maintenance. But in most cases these agencies have not developed effective or efficient service routines — either for feeder or for trunk maintenance — without some form of outside pressure. Accountability has been achieved, in the two better-performing cases, through constructive competition from outside agencies as well as through state and municipal politicians, agencies, and subgroups heavily invested in the system's long-term success (see box 5).

These agencies, politicians, and subgroups have been fueled by organized customers' protests and interaction with service providers. Neighborhood associations have played key roles by formulating and articulating collective demands when agencies have been unresponsive, thus initiating the process of service improvement.
While there are still a number of problems associated with project implementation, ensuring effective operation and maintenance is the primary challenge facing condominial systems today. Unless condominial systems work well, no politician, engineer, or neighborhood group is going to advocate building more. Helping agencies adopt the condominial approach as a viable, legitimate system—and operate it properly—is crucial to its expansion. This chapter outlines the key factors that contribute to successful adoption of the technology and its implementation on a large scale.

The condominial system is likely to be accepted and become institutionalized within cities when: (1) it is built and expanded gradually over a period of years, allowing agencies and customers to develop technical and negotiating skills; (2) agency accountability is created by a constituency of customers, politicians, competing agencies, and receptive subgroups within the agency itself pressing for better performance; and (3) a large portion of all sewer connections are condominial.

**Scaling Up Gradually Within Cities**

Planners often assume that there is a trade-off between participation and scaling up, believing that expanding services requires centralization and speeding up the process. But the condominial cases that worked well do not bear this out. In each of the most successful large scale cases, Petrolina, Natal, and Brasilia, condominial connections were gradually installed, expanding only when residents pushed project staff to speed up the process. The project teams treated each neighborhood as a new market, where potential customers required some time to learn about the product, express their interest, and negotiate project details with agency staff. Indeed, where this gradual approach was not taken, as in the Cuiabá–Canjica neighborhood, residents did not have time to assimilate the new technology, much less develop the service arrangements needed to make the system work.

Agency implementation and operational staff also benefit from a gradual expansion process. An abrupt shift from conventional to condominial sewerage can alienate agency engineers who have spent entire careers designing and building conventional systems. A gradual approach allows them to adjust, finding new niches within the condominial system implementation process. In Brasilia, for example, designing and building large trunk and interceptor lines and treatment facilities remained the responsibility of traditional design engineers, while a special project team was responsible for community mobilization and feeder network construction. This served to allay agency engineers’ fears of being marginalized by the new system. High-level state water company administrators in most large cities report that resistance to the condominial system from traditional civil service engineers is one of the more formidable obstacles to the new system. State water company presidents and upper level administrators change with each new gubernatorial administration, but most engineers are in career positions. Their resistance can persist and ultimately subvert changes introduced earlier. Bringing them on board through the gradual introduction of the condominial system, then, is crucial.

**Service Provider Accountability**

A second factor in getting agencies to adopt the condominial system is pressure from powerful constituents, either within or outside the responsible agency. The roles of Petrolina’s mayors and Natal’s construction division are emblematic of this. In both cases, pressure from organized customers was channeled through
Box 6: External pressures to perform: Petrolina

In Petrolina, the municipality provides maintenance service to residents, but the trunk network is sufficiently well-maintained by the state water company, COMPESA, so that residents can resolve most blockage problems on their own. COMPESA has incorporated condominial maintenance into its standard operations without creating a specialized condominial maintenance team. This is surprising, given that the same agency, in its headquarters in Recife, has largely refused to accept condominial systems built there by municipal agencies.

Unlike its counterpart in the state capital, the regional COMPESA office in Petrolina is vulnerable to pressure from Petrolina’s mayors, who have a lot at stake in the condominial system working well. Petrolina is the second largest city in the state, has produced a number of powerful state politicians, and generates a large portion of COMPESA’s revenues. Because of this unusually favorable position, Petrolina’s mayors are able to influence COMPESA district office administrators. In the first phase between 1983 and 1987, the municipality built nearly 3,000 connections, which represented 37 percent of all sewer connections in the city at the time. Although COMPESA administrators at the state headquarters in Recife were skeptical, regional COMPESA administrators were under intense pressure from the mayor to accept and operate the system. If they did not perform as the mayor wished, he could, and would, have them removed. This power was sufficient to force COMPESA to send engineers out to Petrolina to learn how to run the system and prepare local staff to operate it. Today, condominial connections outnumber conventional connections two-to-one in Petrolina.

Politicians and agencies sensitive and responsive to their needs. Once activated, outside municipal agencies and internal competing divisions engaged in a form of constructive competition that spurred the nonresponsive agency or division into action.

In Natal, ongoing pressure from the construction division, the transfer of original construction staff to operations, and repeated pressure from residents pushed operations staff to operate and maintain condominial network connections.

Pressure from the CAERN’s construction division, committed to the system’s success, provided the push needed to get operations to take on condominial maintenance in a natural, systematic way in Natal. Their actions were fueled by their own dedication, but also by ongoing resident protests. The construction division staff were able to foster reforms from within CAERN, responding to resident’s problems with simple, practical solutions. Their efforts demonstrated to Natal’s operations division that condominial maintenance is not only easy, but less expensive than conventional maintenance.

In Petrolina, activist mayors were able to forge reforms within the district office of the state water company (see box 6). As in Natal, protests by residents have been instrumental in generating lateral pressure on the state water company’s operations division. In this case, pressure came from Petrolina mayors sensitive to their constituents’ needs because of the clear political advantage to be gained by providing relevant and reliable services.

Not every mayor in Petrolina has been receptive or responsive to resident needs. But the political capital generated by being responsive to resident preferences has begun to affect electoral choices: the mayor elected in 1993 came into office on a platform supporting more condominial construction. Even mayors who are not condominial system advocates have continued to construct them because residents have come to associate condominial sewers with good municipal performance. Association with the condominial system also contributed to 1993 mayoral victories in Brasilia, Natal, Itapiai, Recife, and, Cuiaba. In Joinville, where the one condominial system covers a small and isolated neighborhood, this has not been true.

Significantly, political pressure on the sector agency did not exist in Cuiaba, where agency performance was unsatisfactory. As soon as the system was completed in Cuiaba the municipal administration left office, and the next mayor had no interest in promoting his predecessor’s project. The state water company, SANEMAT, which had no involvement in implementation, other than perfunctory construction review, had no political stake in making the system work well. The mayor, Dante de Oliveira, had built the system in a highly personalized campaign, to the extent that today, even after years of neglect, residents whose sewerage continues to function still refer affectionately to their sewers as the “Oliveria’s Sewers.” The governor was similarly uninterested in promoting the mayor’s project. Even though the municipal implementation staff transferred to SANEMAT with the
change in administration, they were isolated within the agency and unable to influence the construction division, much less the operations division. With no external support, and resistance from within SANEMAT's operations division, core staff were unable to develop an effective or responsive maintenance program for the system.

**LARGE PORTION OF CONDOMINIAL SEWER CONNECTIONS**

The third factor in the successful institutionalization of condominial sewerage comes from the large scale of condominial projects (as opposed to small demonstration projects). Having a large portion of condominial connections relative to conventional connections helps overcome resistance from the state water company engineers, and the operations division in particular. It is difficult for agency staff and administrators to dismiss the condominial system as a one-time experiment that can be stopped from further expansion by not operating the existing lines, if there is a large and growing number of condominial connections. Successful institutionalization, however, depends primarily on the first two factors: political constituency and gradual expansion.

Politicians are likely to push for good maintenance if they believe they will be hurt by an angry resident backlash whenever the system is not maintained. The larger the number of condominial customers, the more intense this pressure becomes.

Except for Cuiabá, where there was no formal political constituency for the system after it was built because the mayoral administration changed, there is a clear relationship between better-performing agencies and a large portion of condominial connections (see figure 9). In Petrolina, even in the early stages, the number of condominial connections was significant, at 37 percent, and could not be dismissed by the state water company as some experiment not worthy of their attention. Yet in Cuiabá the condominial connections put in between 1986 and 1988 represented 58 percent of all sewer connections, and still the state water company there did not operate it for the first three years. Therefore, a large portion of condominial connections alone is not enough. There must be a built-in constituency as well, driving service provider accountability, and both residents and agency staff must have sufficient time to learn how to interact effectively.

**SUCCESSFUL ADOPTION CONCLUSION**

Good operation and maintenance is key to the successful long-term adoption and expansion of the condominial system. In order to foster good operation and maintenance, there must be a constituency that backs the system. Ideally, satisfied customers are at the heart of this constituency, but dissatisfied customers also drive service accountability. Politicians, outside municipal and state agencies, and receptive internal subgroups respond to customer needs, and directly press service agencies to provide quality operation and maintenance services. Condominial systems must be introduced gradually to allow agencies and customers to develop the technical and negotiation skills necessary for effective interaction.

A critical mass of condominial connections is also important. Building only a few or isolated condominial connections fails to generate an influential constituency. While it may be impossible to create the political will that first leads to the introduction of the condominial system in a new location, the above conditions can foster the adoption, expansion, and long-term operational sustainability of the system once it is introduced.
PART VI
CONCLUSION

As urban environmental issues and the need to foster sustainable and self-financing sanitation investments have come to the fore, the condominial system has attracted considerable attention. It is one of the few systematic efforts to address the urban sewerage service deficit in squatter and working-class neighborhoods. The system’s technical flexibility, low cost, and negotiation service approach make it unusually well suited to the irregular physical layout, narrow streets, problematic soils and terrain, and low incomes typical of these neighborhoods. The lessons about what makes condominial systems work are relevant not only for other forms of non-conventional urban services, but also for the dynamics of agency-customer relations in service provision more generally.

Good agency performance results not from "strengthening" sector agencies, but from increasing their responsiveness to customers. Condominial customers play an informal regulatory role, pushing for improved service provision. The condominial system activates residents by engaging them during project implementation, when service level, layout, maintenance arrangements, and cost recovery mechanisms are negotiated. This fosters an active, vocal constituency that puts in motion the accountability mechanisms needed for good agency performance. Condominial customers and their neighborhood associations pressure service-providing agencies directly and also mobilize indirect support from receptive politicians, other local public agencies, and subgroups within non-responsive agencies that in turn press for better service on behalf of customers.

Intensive interaction and negotiation with customers takes time, but the long-term benefits - more appropriate network design and increased agency accountability - outweigh the up-front investment. Indeed, where there has been little negotiation with customers, the condominial system has performed poorly. Neighborhood associations often take on a managerial role during project implementation that reduces an agency’s up-front transaction costs incurred by negotiating with customers. Recruitment of neighborhood representatives during negotiations improves local capacity for bargaining with service providers, resulting in more efficient decision making and more appropriate service level choices.

During construction and after project completion, neighborhood associations act like regulators, informally monitoring construction quality, informing supervisory staff of shoddy workmanship, pointing out chronic blockage problems to operations staff, and pressing for responsive service provision.

Of course, negotiatory skills must be learned, and both customers and agency staff require time to develop their abilities. A few elements, however, facilitate successful and meaningful negotiations. First, negotiations must be transparent. This means that agency staff must be clear on the "rules of the game" - what services will be provided by whom, what services residents will pay for, how maintenance will be organized, and how the plan is to be presented to residents at the outset of negotiations. If residents take issue with any basic aspect, these issues must be resolved early. Second, the learning process is facilitated if residents have access to easily understood information, including pilot projects that provide a physical referent for understanding the new system. This allows residents to understand the complex technical issues, and develop modifications that will make the system most appropriate for them.

Implementation teams need multi-disciplinary skills - both technical and social - and do
best when they include a large number of lower-level paraprofessionals. These paraprofessionals – often recent sanitation vocational school graduates – are usually accessible to residents, good at explaining the system in simple language and negotiating with residents, easily trained, and cost much less than highly trained engineers, sociologists, and social workers. Beginning condominial projects with pilot experiences and accelerating gradually only as residents and agency staff gain negotiation skills provides time for both to learn and hone their new abilities.

Low-quality construction and lax operation and maintenance are two of the most significant problems in all kinds of infrastructure projects. Not surprisingly, the majority of operational problems in condominial systems stem from construction flaws in trunk lines, exacerbated by inadequate operation and maintenance. The cause is rarely a design flaw, since all condominial sewer designs are reviewed by design engineers in the receiving agency, as with any conventional system. The cause, rather, is insufficient supervision during construction and the failure to remedy the problem once it is detected. Trunk line blockages affect feeder line performance, making maintenance difficult or impossible, directly affecting residents. Unlike conventional sewerage projects that do not engage residents directly during project planning or implementation, condominial sewerage creates accountability that offsets the tendency toward faulty construction and lax operation and maintenance.

Most sector agencies perform operation and maintenance tasks poorly and are ill-equipped for the customer contact-intensive service condominial systems require. While condominial customers are supposed to collaborate on maintaining their feeder lines, concerted maintenance practices rarely develop the high resident turnover rate, and inexperience in long-term communal tasks make them unlikely. Instead, residents resolve blockage problems individually or seek outside assistance from plumbers, neighborhood associations, and, frequently, from public agencies. The failure of collective feeder line maintenance, the constant pace of household construction and upgrading, and the need for agencies to provide ongoing education to condominial customers are all strong arguments for continued agency involvement with feeder line maintenance, if only to provide back-up technical assistance. Furthermore, agencies must monitor feeder line performance in order to detect chronic blockage problems originating in trunk lines. If network operation and maintenance is to be performed well, then agency staff must have a significant amount of contact with customers. Operations division staff, however, often engage in a passive form of sabotage by not performing maintenance in order to reduce their service load and to discredit the system, thereby ensuring that no new condominial systems are built.

Agencies can avoid negligence problems by structuring the maintenance approach with the same care taken in structuring the implementation process. Specialized multi-disciplinary condominial maintenance teams made up largely of lower-level paraprofessionals and technical staff are effective at detecting and resolving chronic blockage problems. Like condominial implementation teams, specialized maintenance teams are made accessible to residents by having face-to-face contact with them. Daily contact with customers allows them to carry out ongoing educational and technical assistance work necessary in these transient neighborhoods. With sufficient operational autonomy and budget discretion, teams can perform routine maintenance tasks on the trunk line and make intermediate-level repairs, enabling them to respond to blockage problems rapidly and at far less expense than conventional maintenance services. Serious construction flaws and trunk line damage may be beyond the scope of maintenance teams, but they can detect major problems and point them out to the construction division or the original implementing agency.

Condominial system adoption and expansion requires creation of a constituency that ensures agency accountability and provides an incentive for building more networks. Unlike conventional systems, which are supported by large construction firms seeking contracts, the condominial system's constituency consists primarily of condominial users. Customers are either satisfied clients or voice their concerns to agencies. Satisfied clients create a strong incentive for politicians to continue building condominial systems. Although sewerage is "invisible" because it is underground, politicians are discovering that residents value it highly. Dissatisfied clients, especially when they are numerous, are an effective inducement for politicians to act on their behalf. City councilmen, mayors, and state governors have all begun to push for new condominial systems and proper maintenance of existing ones in their districts. Municipal public works, public health, and social service departments are often more
responsive to customers' needs than large sector agencies, and also they press for improved service provision — either by lobbying the agency, or performing the service themselves.

The number of condominial systems built over the past ten years in Brazil — representing a sixth of all sewerage construction in Brazil, and the majority of all new sewerage in squatter and low-income neighborhoods — demonstrates that a system’s constituency can be powerful enough to off-set institutional resistance and bring about improved performance. Significant innovations achieved in system design, implementation approach, and operation and maintenance arrangements have increased the system’s effectiveness and legitimacy as a viable alternative to conventional systems. While much work remains to be done on cost recovery, lower initial and recurrent costs make the condominial system accessible to populations that have historically been excluded from service coverage. The most significant advance, however, is its ability to engage residents and agencies in negotiations that ultimately improve both the quality and appropriateness of services and the performance of service providers.
Each of the seven cities examined has systems with aspects that work well and aspects that work less well. The cases presented are in descending rank order of "good" G, "average" A, and "less satisfactory" L, based on a composite analysis of physical performance (portion of the network in good working condition), the quality of maintenance arrangements (formal and non-formal), the level of institutionalization of the system within municipal and/or state agencies, the numbers of condominial connections, and the portion of condominial connections relative to conventional connections. Many of these indicators are non-quantifiable, and there is no quantitative survey data to compare physical performance across the cases. The ordering was based on a combination of available data, field interviews, and first-hand observations. Profiles for each of the seven cities and systems are presented in annex 1.


2 Population served with Sewer Connections

<table>
<thead>
<tr>
<th>Year</th>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>46,695,000</td>
</tr>
<tr>
<td>1980</td>
<td>25,910,000</td>
</tr>
<tr>
<td>New</td>
<td>20,785,000</td>
</tr>
<tr>
<td>Condo</td>
<td>1,220,000</td>
</tr>
</tbody>
</table>

Condo = 5.9% of all new population served.


3 A separate study has been commissioned by the World Bank to study the financial and technical aspects of the condominial system. The study is being conducted by one of the originators of the condominial system, José Carlos de Melo. In addition, a follow-up case study of the Petrolina project with detailed financial and performance information was commissioned by the World Bank Latin America Technical Division. It is also forthcoming (Watson).

4 Although the purpose of this report was not to evaluate World Bank investments, two of the cases, coincidentally, did involve some Bank funding. The first formal condominial experience was funded through the World Bank's Medium-Sized Cities Project (Loan 1720-BR), a 70 million dollar loan dispersed to 11 urban areas over a three year period between 1979 and 1982.

5 These figures differ from figures presented in the World Bank's 1994 World Development Report, especially for sanitation. The WDR includes on-site sanitation solutions with sewerage in the category of sanitation, and relies on government statistics, which may differ from these and are compiled by the national professional association of sanitary engineers. These are considered the most accurate available.


7 Local sub-basin treatment systems such as oxidation ponds and stabilization ponds have been used in a number of condominial systems. Condominial proponents argue in favor of decentralized treatment as a part of the larger sanitation strategy to reduce costs and make sewerage accessible to more people. Localized treatment facilities, their technical performance, and the institutional process of defining treatment technology is not addressed in this report. (For further discussion of decentralized treatment see Bakalian 1992.)

More often than not, effluent disposal decisions are determined by local constraints and opportunities, rather than as a part of a larger policy on promoting local treatment over centralized treatment. Where unused centralized treatment plant capacity exists, and trunk lines...
are already in place to transport wastes from a condominial system to it, this solution has been used. In general, however, waste treatment is low for both conventional and condominial systems throughout Brazil.

The first condominial experiences in Brazil were modest efforts in the small towns of Currais Novos and Santa Cruz, Rio Grande do Norte. Currais Novos, which had a history of municipal sanitation initiatives dating back to the 1950s, developed a shallow, low incline, communal collection system that passed between residents' lots before reaching the street – the essential basics of the condominial system. Shallow bedrock in the town had made deep trenching impossible, and the resourceful municipal public works staff developed this solution to fit the physical and financial constraints they faced. In April of 1981 there was a major flood in Santa Cruz that left a 500 households homeless. The state stepped in to provide new housing for the residents with full services. The National Public Health Foundation, Fundação SESP, decided to build a system like the one in Currais Novos because it would be much less expensive than conventional sewers. The Santa Cruz experience was concurrent with the construction of the first blocks in the Natal neighborhoods of Rocas, Santos Reis, and Vietnã.

Technically, such a sewerage system should not be called condominial, because the condominial system is more than just differentiated design configurations. Nonetheless, laying sewer lines under sidewalks is an improvement over traditional conventional sewerage because it permits shallower depths, less trenching, fewer manholes, and fewer pumping stations, at potentially significant cost savings.

This parallels the “learning process approach” observed in successful rural development projects analyzed by the Ford Foundation. According to this research, organizations must have the “capacity for embracing error, learning with the people, and building new knowledge and institutional capacity through action,” and pass through phases of learning how to be effective, to be efficient, and to expand (Kortan 1980).

Few residents reported using protective gloves or plastic bags to minimize contact with wastes. This supports the health and equity concerns raised by community activists and public health workers. A negative effect of poorly functioning condominial maintenance arrangement is to expose the poorest residents to the highest health risks.

This may also be a survey response error, where customers did not understand the distinction between feeder and trunk lines. Sidewalk customers may have thought the questions referred to the sidewalk line, while conventional customers may have thought the question referred to their household connections. This ambiguity is less likely for backyard and front yard customers, where it is clear when agency staff enter the lot to perform maintenance.

This is not to say that neighborhood associations never provide services. In fact, there are many examples of associations that have provided services effectively, and better than public agencies have been able to. In general, however, these examples tend to be limited to one-time efforts, where the association is able to rally sufficient interest in the compelling need for collective action. Neighborhood associations have tended not to be good at recurrent tasks, such as street cleaning, garbage collection, and alike. See especially, Carlos Nelson Ferreira Dos Santos, Movimentos Urbanos no Rio de Janeiro.

In Cuiabá’s Canjica neighborhood, however, a progressive and democratic neighborhood association performed blockage removal, even though they felt it was not their proper role as advocates. They did this as a pragmatic way of increasing resident confidence in them, but with the intention of stopping, once residents had begun to take part in meetings more and become more active in community struggles. This is consistent with the strategic behavior of NGOs elsewhere that seek to increase constituent support for their advocacy activities by branching into direct service provision to meet immediate community needs (Carroll 1992).

In Recife, an entrepreneurial state water company engineer has modified a pick-up for condominial line maintenance. The truck carries its own water tank, permitting autonomous service for one hour without relying on residents’ water, which would increase their water bills. This mini-jet vac is not used in Recife, but similar prototypes are beginning to appear in cities throughout Brazil in response to the condominial system.
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ANNEX I: CASE PROFILES

PETROLINA, PERNAMBUCO

Petrolina was the second large condominial experience, beginning in 1983, one year after Natal’s system was completed. Petrolina is a secondary city of 125,000 in a prosperous agricultural region in the interior of Pernambuco state. Condominial sewers reach nearly half of the city’s population and account for nearly 70 percent of all sewer connections. Since the first condominial experience, no more conventional sewers have been built. The system has become the service norm for the whole city, rich and poor alike.

Both the municipal government and the district office of the state water company, COMPESA, have built condominial sewers over the past ten years, but the municipality built the majority, and continues to take an activist role in promoting both new construction and maintenance of existing lines. Connection fees and tariffs are charged by COMPESA to cover initial and recurrent costs, though connection fees are highly subsidized. None of the municipal agencies or state water companies studied have done a cost-to-revenue evaluation to lean whether tariffs connection fees actually cover all costs.

There have been four distinct phases of condominial construction in Petrolina. First, the municipality built the sewers without any help from COMPESA, using money from its own budget. The public works department, with consultants from Recife and Natal, worked intensively with residents, who raised money for feeder lines and household connections. The completed network was turned over to COMPESA to operate and collect sewer charges.

Second, between 1984 and 1988, the municipality and COMPESA signed an accord whereby the city was responsible for community mobilization and building the feeder network, and COMPESA built the main trunk lines and treatment facilities. Between 1985 and 1988, COMPESA laid a significant amount of line, and the municipality slowly followed with block-by-block mobilization as resources permitted, completing 2,900 condominial connections.

Third, between 1988 and 1990 the munici-

pality received a substantial loan from the National Development Bank, BNDES, and took on all mobilization and construction aspects of the system. COMPESA participated in construction monitoring, and incorporated the completed network into its normal service routine. The municipality constructed 5,600 connections between 1988 and 1990. By 1990 municipal public works staff had become skilled at running community meetings and negotiating service options with residents.

In the fourth phase, after the BNDES project ended, the municipality continued to construct condominial sewers, but at a much slower pace because it was again relying on its own resources. During this period, the municipality only built sidewalk lines, did not hold block meetings, and the connection “agreements” that required residents’ signatures were often signed not by residents, but by municipal technical staff after briefly informing residents of the proposed project.

Nevertheless, that the municipality continued to build condominial sewers at all is testimony to the institutionalization of the system within Petrolina. Not all state and municipal administrators are completely committed to the system, but condominial sewers are the norm in Petrolina – residents expect them and the state and municipal staff is fully trained in building and maintaining them. In 1993 a new mayor was elected who is committed to following the original condominial tradition of community mobilization and giving residents control over layout options and level of service.

NATAL, RIO GRANDE DO NORTE

Natal is a poor northeastern capital city of 600,000 with less than a third of its population served by sewer systems. Since the first pilot experience, Natal’s sewerage coverage has nearly doubled with all new sewerage being condominial, even in upper-income neighborhoods.

Natal is one of the few places where a state water company has taken the lead in developing innovative low-cost technologies and participatory service approaches. The municipality has not played a significant role in building
sewers, though it has often performed a regulatory role, pressing for improved maintenance when this has been lacking. Although some time has been required for condominial sewers to be accepted by engineers within CAERN, the system is now largely institutionalized. No conventional sewers have been built in Natal since the first condominial sewers were constructed. CAERN’s operations division has developed a specialized operation, maintenance, and upgrading system. Connection fees and tariffs are charged at moderately subsidized rates.

Natal went through an initial five-year period when the operations division staff did not embrace the condominial system. The staff neglected the trunk lines, which soon led to a chain reaction of blockages in residents’ feeder lines. Operations staff finally began to perform blockage removals on feeder lines when residents were unable to resolve the problem. Eventually customers and operations staff became accustomed to this arrangement, and it is now the service norm, despite the original agreement that residents should maintain their feeder lines.

By 1988 the system had begun to break down altogether in some critical sections. The construction division stepped back in, realizing operations staff were not going to resolve the problem, and replaced a large section of trunk line. At the same time, some members of the original condominial team were transferred to operations and developed a specialized condominial maintenance crew. A social worker was hired, and the crew began not only maintaining the trunk lines properly, but also monitoring blockage rates in condominial lines, detecting chronic problems, and responding to targeted educational campaigns and minor, intermediate-level system modifications. Today, Natal is the only city that has this kind of customized, rapid-response maintenance approach. The approach turns out to be much less expensive than maintaining conventional systems.

**Brasilia, Federal District**

In Brasilia, as in Natal, the state water company, CAESB, has constructed the condominial sewers. But unlike Natal’s CAERN, CAESB developed an effective streamlined construction process that has allowed it to build a large number of condominial sewers in a short amount of time. Between 1991 and 1993, 12,000 condominial connections were completed, nearly five times Natal’s construction rate.

Brasilia’s poor population lives primarily outside the city in “satellite” cities, many of which are service settlements created for the construction workers who have built Brasilia since the mid 1960s. Over the past five years, the federal district government has implemented large urban service upgrading projects in the satellite cities for street lighting, water service, street paving, and, most recently, condominial sewerage. Condominial sewerage is now spreading to the central urban area with a number of private upper-income housing developments now building condominial sewers on their own and mirroring the satellite city experience. Because the CAESB condominial sewers are being built at the same time that other new urban services and service fees are being introduced, the company and the federal district government have decided not to collect connection fees. Tariffs are collected in addition to water charges.

The actual construction is contracted out to a mixture of medium-sized local firms that build feeder and street lines, and a number of large national and international firms that build the larger trunk and interceptor lines. Working with local contractors for the smaller parts of the network allows the CAESB team to synchronize the mobilization and construction process. Large trunk and interceptor construction can be done ahead of time so that when houses connect they can begin to use their sewers right away.

CAESB engineers learned about the condominial system through engineers’ union workshops and through conferences of the Association of Brazilian Sanitary Engineering (ABES). After visiting Petrolina, CAESB contracted Jose Carlos de Melo’s consulting firm to do community mobilization and train a core group of CAESB engineers and social workers in mobilization and network design skills. After the first two years the contract was terminated, and these tasks were taken over by the CAESB team which is now managing the continuing construction. CAESB’s goal is to complete 100,000 connections over the next few years. Brasilia has now adopted the condominial system as the service norm for the entire city. Residents who prefer conventional sewerage pay the additional cost.

**Itapissuma, Pernambuco**

Itapissuma is an example of autonomous municipal initiative in which an initial small pilot experience with outside technical assis-
tance has led to continued condominial construction that has been entirely self-financed by the municipality over the past eight years. Although the scale of condominial construction has been small in Itapissuma because of the use of other sanitation technologies, the implementation process, the construction quality, and the maintenance and technical performance of the system has been outstanding.

Itapissuma is a small rural town of 14,000 located an hour north of Recife on the coast. The municipal public works department in Itapissuma first started building condominial sewers in 1986 with the help of a statewide Pernambuco condominial technical assistance program. Engineers from the state public works department worked with municipal engineers to train them in condominial construction and help build an innovative, low-cost treatment facility, a septic tank with anaerobic filter, and sludge drying beds. Before 1986, all households relied on self-dug pit latrines, many of which were no longer working because saturated soils were usable to wastes. Fifty condominial connections were built in 1986, complementing a household septic system program for other homes where the water table was lower and soil absorption rates were still good.

Since 1989, under the leadership of a mayor with a medical background and interest in sanitation issues, the municipality has continued to build condominial sewers gradually with municipal funds and labor contributions from residents for trenching. Condominial sewers serve ten percent of Itapissuma’s population, and septic systems serve approximately 80 percent of the remainder. The mayor has increased local tax collection to finance new construction and cover operational costs of the treatment facility and trunk line maintenance, which is performed entirely by the municipality. There have been no tariffs charged to customers and no cost recovery measures for initial construction. The municipality has rejected offers from donors to finance expanded condominial construction because it did not want to generate municipal debt. COMPESA’s only involvement has been to provide periodic technical assistance on treatment plant operation. The municipality did not want COMPESA to take over the system because it felt that COMPESA would not perform maintenance well and continue to charge tariffs.

Municipal technical, public health, and social service staff work continuously with residents, ensuring that they are maintaining their feeder lines properly and providing technical assistance when residents want to expand or upgrade their systems so that new connections are done properly. The municipality has provided locally-produced bathroom fixtures and cinder blocks to residents who could not afford them, but the residents themselves have paid for and performed most household upgrades.

Recife, Pernambuco

Recife, a city of 1.2 million inhabitants, has a large number of small, isolated condominial systems throughout the city that were constructed by municipal agencies and in a few cases by COMPESA over the past ten years. Approximately 80 percent of the condominial systems connect to communal septic systems built by the municipality which the state water company has rejected as a non-standard form of treatment. As a consequence, COMPESA has refused to operate the these condominial systems, and most of them function precariously, if at all. The condominial systems that connect to existing COMPESA trunk and interceptor networks are maintained by COMPESA, and function relatively well.

Recife is an unusual case in that it is the headquarters for Jose Carlos de Melo’s consulting firm, which has been involved with the condominial system longer than any other in Brazil. In addition, Melo was directly in charge of COMPESA and served as the state’s Secretary of Public Works for a period during the mid-1980s. Despite this, COMPESA engineers and high level administrators have not been receptive to the condominial system, continuing to favor conventional systems over condominial ones. During Melo’s tenure with the state, he was able to set up the state-wide condominial dissemination and technical assistance program for small municipalities that led to Itapissuma’s first experience. This program has spawned numerous other sustained municipal condominial programs throughout the state independent of COMPESA.

Unlike COMPESA, the municipality in Recife has been relatively active in constructing and promoting the condominial system over the past ten years. In 1993 the municipality drafted a master plan to make condominial sewers the norm for service throughout the city. Whether or not this will alter COMPESA’s policies remains to be seen. The municipal public works and maintenance departments are currently working on new condominial construction and are attempting to recover systems that have been damaged due to neglect. As in a number of
other capital cities throughout Brazil, the Recife municipality has begun to discuss revocation of the concessionary contract under which the state water company provides water and sewer service to the city.

**Joinville, Santa Catarina**

Joinville is a secondary city in the relatively wealthy southern state of Santa Catarina. Joinville is another case of municipal initiative, but unlike in Itapissuma or Recife, the completed network was successfully turned over to the state water company, CASAN, for maintenance and operation. One small and isolated neighborhood was served with condominial sewerage covering 450 households. CASAN has performed this task with relative efficiency, extending service to clear periodic blockages within condominial feeder lines. Although some low-lying areas have chronic blockage problems and require replacement of the trunk line, the network performs quite well in general and residents have been satisfied with it.

In 1986 engineers in an activist municipal social welfare department initiated a condominial project in the poor neighborhood of Profipo, drawing on papers delivered the year before at the ABES conference describing Natal's experience. The project was funded by state and CASAN resources without any cost recovery measures. CASAN imposed some technical modifications on the project design as a condition for accepting operation and maintenance responsibilities after network completion, but did not participate in project implementation.

This single project of 450 connections was completed at the end of the Mayor's mandate, and was not followed up by any further condominial construction by subsequent Mayors. While the technical precepts of the condominial system were applied, the community mobilization process was not fully developed. Although a number of large general meetings were held, block meetings did not take place. As a result, many residents report that they were not aware of the project until they arrived home to find crews digging trenches in their back yards. Nevertheless, construction proceeded rapidly and the entire project was completed in approximately six months. The network and treatment facility were subsequently turned over to CASAN to operate.

CASAN has never charged tariffs because residents were upset at the time of project completion because the local treatment facility, an oxidation ditch, did not work well, emitting offensive odors and breeding insects. Also, residents' water service has been precarious for the past fifteen years; residents frequently go for days without water in their pipes. The treatment facility was repaired shortly after residents protested, threatening to destroy the network, but CASAN is still reluctant to charge sewer tariffs since residents continue to suffer from deficient water service and could rebel against the additional charges.

CASAN is now in the process of upgrading the water supply system, which would assure continuous water service. It is not clear whether the company will begin to charge for sewer maintenance services once water service has been improved. The current municipal government is again interested in pursuing condominial projects, and has begun to discuss collaborative arrangements with CASAN.

**Cuiaba, Mato Grosso**

Cuiabá has a large number of condominial connections executed by the municipality between 1986 and 1988. But the state water company, SANEMAT, accepted the network only reluctantly, refusing outright to accept two of the nine neighborhoods served. Although condominial connections account for over half of all sewer connections in Cuiabá, condominial connections only serve nine percent of the city's population. These figures indicate the relatively low prioritization that sanitation has received from SANEMAT historically and partially explaining the SANEMAT resistance to take on additional sewerage operation responsibilities, much less a radically different system.

Cuiabá municipal engineers also drew on ABES conference papers, visited Petrolina and Natal, and hired a consultant from Recife to advise them on their work. The mayor and his advisors in 1986 received professional training in sanitary engineering and wanted to address the long-standing demand of low income residents for improved sanitary and health services. Like Joinville, however, the project team that implemented the city's condominial project, primarily engineers in this case, focused more on the technical design aspects, and less on the community mobilization process. Shortly after construction was completed in the first neighborhood, the network began to break down and residents revolted, demanding that the engineers return to fix the problems and explain the system better. The municipal implementation team learned from this experience.
and began to hold block-by-block meetings in neighborhoods which subsequently improved both resident satisfaction with the network and the network's design and construction quality.

SANEMAT engineers were not involved in any network construction – financing, supervising, or approving design plans. At project completion, SANEMAT accepted most of the network only grudgingly. Although the municipality's team moved essentially en masse to SANEMAT toward the end of the project and the mayor's mandate, the team was largely isolated within the company and was unable to affect significant changes. SANEMAT's operations division performed almost no maintenance on the condominial systems for the first five years and has only recently begun to organize periodic line clearing “campaigns” on a neighborhood-by-neighborhood basis.

Despite this gloomy picture, residents in the condominial neighborhoods are generally pleased with the sewers and appreciate the mayor whose administration built the sewers. This mayor was reelected in 1993 and has begun to focus on health and sanitation again. But because of the earlier negative experience, he has not proposed building any new condominial sewerage systems.
HOW TO MAINTAIN THE CONDOMINIAL SEWER SYSTEM

Hey Folks, I'm a water drop, and I want to show you the condominium sewer system.

The system is made up of the following parts:

- Condominial Branch Lines
- The Basic Collection Network
- Treatment Plants

The condominium branch lines are laid at the house lots, passing from back yard to back yard...
THE BASIC COLLECTION NETWORK IS BUILT ON SIDEWALKS, STREETS, AND...

THEM RECEIVE WASTES FROM THE CONDOMINIAL BRANCH LINES THROUGH INSPECTION BOXES.

THE TREATMENT PLANTS TREAT THE WASTES AND THEN DISPOSE OF THE WATERS IN RIVERS, LAKES, OR THE OCEAN.
IN ORDER TO AVOID PROBLEMS, WE SHOULD TAKE SOME PRECAUTIONS LIKE:

- Do not throw anything that can clog the lines in the toilet or the wash tank.

- Always keep the inspection box closed to keep sand and rain water out.

- Do not throw paper, sanitary napkins, rags, plastic, metals, left over food.
DON'T PLANT TREES WITH LARGE ROOTS NEAR THE SEWER PIPES.

AVOID DIGGING NEAR THE PIPES. THEY CAN SLIP OUT OF PLACE OR EVEN BREAK.
The kitchen sink should always be connected to a grease trap.

That is connected to the inspection box.

The grease trap retains fats and protects the sewer line from getting blocked.

Grease traps should be cleaned out every week by removing the grease and throwing it in the trash.
SOME TIMES THE CONDOMINIAL BRANCH LINES DEVELOP LEAKS.

IF THIS HAPPENS, YOU SHOULD CAREFULLY DIG IN THE AREA WHERE THE GROUND IS WET, MAKING SURE YOU DON'T BREAK THE LINE, UNTIL YOU HAVE DISCOVERED THE CAUSE OF THE LEAK.
IF THE LINE HAS A LARGE BREAK IN IT, AND YOU DON'T KNOW HOW TO REPLACE IT...

...GO TO CAERN IN ORDER TO GET INFORMATION ABOUT HOW TO DO IT.

BUT IF THE LINE IS ONLY SLIGHTLY CRACKED...

...OR WITH A PIPE JOINT OUT OF ALIGNMENT AND LEAKING...
DIG DOWN DEEPER UNTIL YOU CAN REACH UNDER THE LINE.

IF THE LEAK IS AT THE JOINT, REMOVE THE CEMENT WITH CARE.

THEN, MIX UP SOME CEMENT.

WET THE AREA TO BE REPAIRED AT THE JOINT OR ALONG A CRACK.
PLACE THE CEMENT OVER THE CRACK OR THE JOINT, WHEREVER THE LEAK IS.

PRESS DOWN ON THE CEMENT WITH YOUR FINGERS TO FORM A GOOD SEAL OVER THE LEAK.

AFTER THE CEMENT DRIES, FILL THE HOLE BACK IN WITH CARE.
HOW TO UNCLOG A LINE

Using a mason's spatula, loosen the cement sealing the in lids on the inspection boxes in your house and in your neighbor's.

Then carefully remove the lids, taking care not to break them.

If you see that your box is full and the other isn't...

...and tie on a ball of rags good and tight at one end of the stiff wire...

...grab a thick piece of wire...

...that can reach from the inspection box at your house...

...to the inspection box at your neighbor's house...
STARTING FROM YOUR NEIGHBOR'S INSPECTION BOX, INSERT THE WIRE THROUGH THE CONDOMINIAL BRANCH LINE UNTIL YOU FEEL IT COME UP AGAINST SOMETHING.

CAREFULLY PUT PRESSURE ON THE WIRE UNTIL THE BLOCKAGE IS DISLODGED AND THE WIRE REACHES THE FAR END OF YOUR BOX.
Keep the wire in this position until all the liquid wastes have completely flowed through the line.

Remove the debris and pull out the wire.

For your protection, use plastic gloves.

Replace the inspection box lids, sealing them with cement.