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China
Urban Environmental Service Management

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CURRENCY EQUIVALENTS
(January 1, 1995)

Currency	=	Renminbi
Currency Unit	=	Yuan (Y)
Y 1.00	=	100 fen
Y 1.00	=	$0.12
$1.00	=	Y 8.5

FISCAL YEAR

January 1 - December 31

WEIGHTS AND MEASURES

Metric System

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

As	-	Arsenic
BOD	-	Biological Oxygen Demand
BOT	-	Build-Operate-Transfer
Cd	-	Cadmium
CPI	-	Consumer Price Index
COD	-	Chemical Oxygen Demand
COPD	-	Chronic Obstructive Pulmonary Disease
Cr	-	Chromium
CWSA	-	China Water Supply Association
EIA	-	Environmental Impact Assessment
EPB	-	Environmental Protection Bureau
GDP	-	Gross Domestic Product
Hg	-	Mercury
ISW	-	Industrial Solid Waste
m^3	-	Cubic Meter
MCon	-	Ministry of Construction
mg	-	Milligram
MSW	-	Municipal Solid Waste
NEPA	-	National Environmental Protection Agency
NO_x	-	Nitrogen Oxide
NPC	-	National People's Congress
O&M	-	Operation and Maintenance
Pb	-	Lead
SO_2	-	Sulfur Dioxide
SOE	-	State-Owned Enterprise
SSB	-	State Statistical Bureau
TSP	-	Total Suspended Particles
TVE	-	Township and Village Enterprise
UfW	-	Unaccounted-for Water
UN	-	United Nations
WHO	-	World Health Organization

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PREFACE

This report is based on the work of a team staffed by Lee Travers (Task Manager), Edouard Motte, Andrew Hamer, Sun Chongwu, Guillermo Yepes, Jeremy Warford, Jodi Felberg (Bank), David Jackson, Ma Xiaoying, Li Qun and Michael Einhorn (Consultants). Valuable assistance and insights were provided to the team by the staff of the Ministry of Construction, the lead Chinese counterpart agency, especially Mr. Zhang Yaoru, Director, and Ms. Liu Yuming, Engineer, and by the staff of the National Environmental Protection Agency, including Mr. Liu Chunyu, Deputy Director, and Mr. Tang Dingding, Division Chief. Missions in October 1993 and March 1994 visited the cities of Kunming and Wuhan and express their appreciation for the contribution of the governments of those cities and of Yunnan and Hubei Provinces for their support of this effort. With Norwegian government support, gratefully acknowledged, the consulting firm Norplan A.S, analyzed the delivery of urban environmental services in the cities of Kunming and Wuhan, providing additional insight into the issues addressed in this study.

Working papers on Chinese practices, copies of which are available in the files, were prepared on (a) The Financing of Urban Infrastructure Services, (b) The Environmental Protection System, (c) Solid Waste Management, and (d) Public Utility Services.

EXECUTIVE SUMMARY

i. China must strengthen government intervention to protect the environment as the transition to a market economy continues, for markets alone fail to reflect the social costs of pollution. Environmental deterioration will be avoided during this period of rapid industrial growth only if the government can continue to improve and implement environmental regulations and pricing, credit control, and direct investment. For urban environmental management, this report recommends augmenting existing strategies in the following ways:

(a) increase the financial and social cost of violating environmental standards, while strengthening public participation and environmental education;

(b) assert effective regulatory control over township and village enterprises (TVEs);

(c) enact and enforce hazardous waste legislation;

(d) expand collective treatment of wastewater and solid waste; and

(e) charge tariffs for water supply, wastewater treatment, and solid waste disposal that encourage careful use and provide resources for sustainable, high quality, service delivery.

ii. This report finds Chinese urban environmental services generally to be underpriced, resulting in excess demand, unsustainable levels of pollution, and inadequate funds to meet investment needs. To meet social and individual service needs, this report recommends:

(a) adjusting water tariffs to produce positive real rates of return on revalued assets, an action that would double average tariffs but would also save Y 4.5 billion per year in investment costs by the year 2000;

(b) adjusting sewerage use fees for full cost recovery from domestic, commercial, and enterprise users. For cities requiring primary treatment, this would add approximately Y 0.40 per m^3 to water bills; and

(c) setting solid waste collection and disposal fees to cover the cost of collection, properly designed landfills, or other safe disposal methods. This would increase the typical household solid waste charge by about Y 3 per month.

iii. Urban Chinese residents and enterprises have the financial resources to meet the full cost of environmental services. However, this report emphasizes the need to deliver these services with the highest possible level of managerial efficiency and draws on international experience with incentive regulation to suggest means of enhancing that efficiency.

A. Background

iv. China's increased spending on pollution control, from 0.40 percent of GDP in 1980 to 0.67 percent in 1992, coupled with improved environmental regulation, has allowed advances in some areas of pollution control, yet remains insufficient to deal with the nearly threefold increase in the output of heavy industry over the same period. Dangerous levels of total suspended particulates (TSP) have been reduced, as have state-owned enterprise (SOE) discharges of heavy metals to rivers and lakes. Nevertheless, these achievements have only slowed, not stopped, deterioration of highly industrialized urban areas. TSP levels remain well above levels considered unsafe by the World Health Organization (WHO), sulfur dioxide (SO_2) concentrations exceed the lowest Chinese air quality standard, few urban rivers reach the lowest acceptable Chinese water quality standard, groundwater quality continues to fall at an alarming rate, and petroleum discharges to surface waters are increasing after an initial decline. Growing pollution from TVEs lacks effective regulation and, perhaps most troubling, rates of industry compliance with environmental regulations appear to be dropping.

v. Institutional responsibility for urban environmental management rests with two groups: the municipal EPBs, which implement national and local environmental policies under the guidance of municipal government and the National Environmental Protection Agency (NEPA); and the city bureaus and companies responsible for water supply, sewerage, wastewater treatment, and solid waste collection and disposal under the guidance of the Municipal Construction Commission and the Ministry of Construction (MCon). However, these institutions have not been given sufficient authority or permitted sustainable financial arrangements to efficiently manage China's urban environment. Efficient urban environmental management requires a policy environment that provides rules and incentives to control pollution at source (through cleaner production processes and in-plant treatment of pollutants) or, if more economic, to collectively treat waste streams (through wastewater treatment plants, landfills, etc.), and institutions powerful enough to enforce the rules.

B. Urban China

vi. China has the world's largest urban population, at over 324 million people, and is growing at 4.6 percent annually. Thirty-two cities have populations of over 1 million, while the largest, Shanghai, has 8.8 million. Chinese cities have long had powerful, stable administrative structures responsible for planning and implementing urban development. This power has grown markedly over the past decade, as national and provincial governments decentralized expenditure authority to city administrations, which resulted in an 11 percent annual increase in real municipal expenditures per capita. At the

same time, real urban incomes per capita grew at 6 percent per year, making Chinese cities and citizens much wealthier than they were a decade ago.

vii. Although the ongoing reforms have strengthened cities, new pressures have required frequent adjustments to urban strategies. Several reforms will directly impact the environmental sector, including the further separation of state-owned enterprises (SOEs) from government control, hardening SOE budget constraints, greater regulatory control by EPBs, and tax reforms to shift an increasing share of revenues from cities to the central government. Under the new reforms, township and village enterprises (TVEs) have grown rapidly and have created special regulatory difficulties. Moreover, the failure to reform prices for urban environmental services, such as water supply and wastewater treatment, have slowed investment and quality gains in these critical areas, whereas price reforms for energy have aided environmental management efforts. This report recommends several market reforms to improve the management of key environmental services.

C. Environmental Management

viii. Ineffective regulatory control and economic disincentives undermine environmental management in urban China. This report recommends several policy improvements to address these weaknesses:

ix. **Raise the Cost of Violating Standards.** SOE water pollution control equipment operates at about 50 percent efficiency because low fines, low monitoring rates, and hardening budget constraints make pollution violations an attractive alternative for plant managers. Pollution fees and fines, if levied at all, total no more than Y 0.40/m^3, whereas in-plant wastewater treatment costs Y 0.70-0.80/m^3. Chinese firms will have no economic incentive to improve pollution control efficiency unless the expected cost of violations is raised through substantially higher fines and more frequent monitoring.

x. **Strengthen Public Participation and Environmental Education.** China must encourage citizen monitoring of polluters and broadly publicize how cases of firms caught violating standards are resolved. Citizen monitoring complements EPB monitoring by increasing the social cost of polluting to enterprises. Pollution already draws public complaints: 130,000 complaints against polluters were filed at EPBs in 1991, and this number is growing. However, effective implementation of environmental controls will require more than just citizen monitoring—it will require public understanding and support. Education can play a role in explaining how compliance with regulations and increased costs for environmental services can protect the environment; publicity campaigns can equate good corporate citizenship with effective pollution abatement. International experience shows that education and campaign efforts work best when accompanied by increasing financial costs of noncompliance. Furthermore, to enhance public participation and education, the government must continue to give EPBs a high level of political legitimacy. Although some provinces are considering reducing the EPB rank in the government hierarchy as part of their restructuring efforts, this report finds that such action would send the wrong message to urban residents and firms about government priorities.

xi. **Assert Effective Regulatory Control Over TVEs.** Small, dispersed TVEs concentrate in peri-urban areas and pollute the same air and watersheds as urban industries. TVE industrial growth and pollution are rapidly increasing. TVEs produced 37 percent of industrial output in 1992, and are estimated to produce 22 percent of wastewater output and 19 percent of air pollution. However, unlike urban enterprises, TVEs remain essentially unregulated because they are difficult to monitor. But because TVE pollution is concentrated in a few industries (such as coke production, leather tanning, chemical production, electroplating, and pulp and paper production), this report recommends that NEPA publish expected pollution coefficients for the few alternative technologies that these industries use. In the absence of specific abatement technologies, EPB authorities could levy presumptive pollution fees based on production rather than on direct monitoring. If firms believe they outperform the presumptive benchmarks, they can be given the option to pay for direct monitoring to establish that fact. Municipal and county EPBs must collaborate to develop a mass-based pollution permit system for implementation in urban and peri-urban areas. Moreover, county EPBs will need institutional strengthening, a process that will be facilitated by working with the municipal EPBs.

xii. **Approve and Implement Hazardous Waste Legislation.** Chinese industry is required to process or safely store 50 million tons of hazardous waste which it generates each year. But no agency is responsible for hazardous waste monitoring and, as a result, violations become known only after an accident results in injury or immediate economic loss. In 1991, 2,800 recorded pollution accidents resulted in nearly 1,900 injuries. But these numbers pale in comparison to the potential damage that could be done to the ambient environment and human health by hazardous waste pollution. Draft legislation which gives EPBs regulatory authority over hazardous wastes should be implemented with no further delay.

xiii. **Develop Municipal Wastewater Treatment.** Many urban lakes and rivers are condemned to serve as waste sinks because of excessive volumes of municipal wastewater and inadequately pretreated industrial wastewater. Only 4.5 percent of combined municipal and industrial wastewaters receive collective treatment, and 15 percent receive pretreatment. Collective treatment works can economically treat municipal wastewater and may be the most efficient means of treating many industrial waste streams. This report recommends that treatment plants, which must continuously monitor their influent, are better placed to enforce discharge standards than the EPBs. Treatment tariffs based on waste loads, with surcharges for violations of agreed levels, will encourage treatment plants to accurately measure loads. Treatment plants, in turn, should be monitored by the provincial EPB to ensure compliance with discharge standards.

D. Municipal Services

xiv. Municipal environmental services—which need not be municipally owned—provide community access to and control of natural resources, and collectively treat pollutant discharges within the community. Efficient management of these services supplies them at or near the socially optimal level. However, this is not the case in urban China. Low water prices encourage excess demand and result in financially unsustainable

water companies that must be subsidized to remain operational. Low prices for sewerage, wastewater treatment, and solid waste handling and treatment lead to excess effluent and insufficient revenues. Unlike water, these services do not receive correspondingly large municipal subsidies to meet investment and operational needs. Correct pricing of municipal services will manage demand and reduce pollution, while improved sector organization and incentives will encourage efficient service delivery.

Water Supply

xv. Municipalities directly provide about 80 percent of piped domestic water and 30 percent of enterprise water, with the remainder supplied by enterprises themselves. Nearly 90 percent of the urban population is served by water systems (97 percent in large cities), 24-hour supply is common and water plant output generally meets quality guidelines. Building-level metering is universal and customer arrears are extremely low, as are commercial losses through illegal connections or malfunctioning meters. However, low construction and material quality, combined with inadequate plant and system maintenance, substantially reduce system service life and increase the long-run cost of supply.

xvi. **Overexploitation and Falling Real Prices.** China has per capita raw water supplies below international averages, yet total industrial and domestic per capita urban consumption rivals that of water abundant countries like Canada. Enterprises consume water at levels two to three times international best practice, despite water quotas and increased recycling. Per capita domestic consumption, which rose 35 percent over the 1980s, and industrial use levels have been sustained in part by the very striking fall in the real price of water since 1980. By 1989, inflation had driven the real price of water to half the 1980 level. At the same time, supply costs rose. By the late 1980s, many cities had overexploited or polluted nearby raw water sources and the need to tap distant sources drove up the real costs of new supply by over 7 percent per year. Recognizing an imminent water crisis, some cities began tariff increases in the late 1980s and recaptured some, but far from all, of the real revenue losses. On the whole, current water prices remain about half the average level needed for self-sustaining water company operations, and even farther below the socially optimal price, itself equal to the rapidly rising long run marginal cost of supply.

xvii. **Managing Water Demand.** The estimated 10 million m^3/day shortfall in urban water supply can be reduced, future investment needs constrained, efficient industrial water use encouraged, and system quality and quantity improvements financed if Chinese cities aggressively use price as a water demand management tool. Little research has been done on Chinese household water price and income elasticities of demand. However, one study estimated domestic water demand in Shanghai and found a price elasticity of -0.38 and an income elasticity of 0.22, both consistent with international experience. Industrial demand elasticities have not been estimated because binding water use quotas, rather than price, have heretofore determined consumption for most firms. Until prices rise to the point where they balance enterprise supply and demand, their price elasticities will be low; however, above that point, they can be expected to be large. International experience

shows that firms typically have long-run price elasticities of demand for water well above those of households. To be sure, price increases will not end the need for new investment in water supply. The severe water shortages in North China, where 1992 domestic supplies fell below 40 liters per day in 18 cities, can be effectively addressed only by a combination of improved pricing and investment in supply.

xviii. Water quotas are economically inefficient and should be abandoned in favor of price-based water demand management. As the first step toward socially optimal pricing, this report recommends a demand management policy that sets water tariffs to ensure a positive rate of return on revalued assets and enable capital market access for investment needs. Ground and surface water must be protected from overexploitation by increasing enterprise raw water extraction fees to a level that, on average, equates their self-supply costs to municipal supply costs. A water demand management program of this type would reduce sector investment needs by an estimated Y 4.5 billion annually by the year 2000, free enterprises from input quotas, and allow cities to reallocate the 12 percent of municipal urban infrastructure budget that currently finances water investments.

Sewerage and Wastewater Treatment

xix. **Inadequate Protection.** Low sewerage system coverage and inadequate treatment levels result in contaminated groundwater and polluted urban surface water. Nearly 40 percent of urban China is unserved by sewers, with wastewater going directly into lakes and rivers. According to current municipal investment plans, 30 percent of urban China will still remain unserved in the year 2000. Only 4.5 percent of municipal wastewater flows receive treatment of any kind, while industrial pretreatment raises overall treatment rates to 17 percent. The year 2000 goal is a modest 25 percent. Low sewerage coverage and inadequate treatment levels destroy ambient water quality, and, based on international experience, disproportionately burden the poor, who are less likely to have access to safe water supplies.

xx. **Lack of Funding**. Chinese cities have little incentive to invest in sewerage and wastewater treatment because they receive little or no income for handling wastewater discharges. Current regulations permit enterprises to be charged for sewerage use, but not households, and the recommended fee does not allow full recovery of operational and investment costs. Only half of China's cities have assessed sewerage use fees, most at the recommended rate of Y 0.08/m^3 (based on 80 percent of water use). EPBs have recently been authorized to charge enterprises a separate wastewater damage fee of Y 0.08/m^3 (unless they are already paying more under the pollution levy fee system). However, the latter fee cannot be used for sewerage system maintenance, construction, or operations because EPB charges remain within the environmental protection system. Perhaps because untreated wastewater affects downstream cities more than the producing city, municipal wastewater handling and treatment have lagged behind national needs.

xxi. **A Program of Intervention**. Given the low quality of urban surface waters, known downstream effects, and widespread aquifer pollution, the national government should require the 203 largest and medium-size cities to provide primary treatment (with provision for expansion to secondary) within ten years for any discharge that reduces receiving water quality to below irrigation use standards. Such treatment would reduce

pollution loads by some 30 percent from those cities, which account for over 80 percent of total loads. All cities should be required to design and develop sewerage systems that facilitate the later addition of treatment works, and which provide immediate treatment if receiving water quality cannot meet either irrigation use standards within 3 kilometers of wastewater discharge points, or standards for domestic raw water at the nearest downstream community extraction point.

xxii. The estimated cost of this wastewater investment program is Y 4.3 billion per year ($490 million) over the next 10 years, or about three times the current annual investment in sewerage systems. The implied 15 percent increase in the annual urban infrastructure construction program would be offset by the drop in water supply investment resulting from the new water demand management program. Under the wastewater treatment program, user fees would cover all costs, with the possible exception of storm drainage services, which could be covered from general revenues. Sewerage tariffs for households and small enterprises would continue to be levied against 80 percent of water use but charges for larger enterprises would be based on metered loads. Water users in untreated parts of the system would also pay the full treatment fee to reflect the damage caused by untreated wastewater. User fees in a primary treatment system would total about Y 0.40/m^3 of water consumed, a level close to the current average price of water. The combined impact of the water and sewerage tariff increases would triple average effective water prices. That new price would accurately reflect the true cost of delivering safe water and collecting and treating wastewater. It would encourage water-saving behavior, postpone investment in new supply, and promote sewerage and treatment systems that are economically sized. Any delay in implementing the program will simply force the construction of larger and more costly systems in the future.

Solid Waste

xxiii. **Good Collection, Poor Disposal.** Solid waste collection operations are run well for a country at China's income level. Municipal and district governments, and neighborhood committees, share responsibility for domestic solid waste collection and disposal services, with districts generally responsible for transportation and disposal. Households carry wastes to neighborhood collection points, with pickup 3 to 7 times per week in core urban areas. Private and municipal recycling firms recover much of the marketable waste, but estimates of individual city recycling rates range widely from 5 to 35 percent. Recycling aside, disposal services in urban China are poor. Most municipal solid waste is disposed of in unmanaged dumps that have no provision for leachate control or methane flaring or use. Leachates from these dumps have contaminated surface waters and aquifers in many cities.

xxiv. The improper disposal of industrial solid wastes exacerbates these problems. In 1992, industries dumped over 10 million tons of solid waste into urban rivers and lakes. Because industries make their own disposal arrangements, effective regulation is difficult. While continuing to allow free contracting for waste hauling, mandatory use of licensed sanitary landfills would protect society from random dumping.

xxv. **The Sanitary Landfill Response.** While some landfills are well run, most are poorly controlled, fail to meet government standards, and inadequately handle leachates

and methane. The single largest improvement in solid waste handling would be the provision of adequately engineered and managed landfills, and the requirement to use them. Landfill operations enjoy large economies of scale, which argues for municipal operation in large cities and regional landfills near concentrations of smaller cities. Land availability largely determines landfill costs. In Tianjin, for example, the cost of pickup, transfer, and disposal to a high-standard landfill is Y 55/ton, or about Y 16/capita/year. If these costs are representative, then the typical charge for domestic waste of Y 5/capita/year would have to triple to fully fund proper solid waste handling and disposal. Industrial waste disposal fees would also rise as unmanaged dumps are closed. Intensive education, careful monitoring of illegal dumping, and high fines imposed on violators will encourage acceptance of these solid waste policies.

Paying for an Improved Environment

xxvi. Tariffs supporting improved environmental services will reassign the costs of treatment to polluters and, in the long run, reduce social costs by improving the quality of water and land. Much of the relocation of raw water supplies going on today would have been avoided had wastewater and solid waste been handled properly over the past two decades. Still, the suggested tariffs will substantially increase the cost of water, wastewater, and solid waste handling to enterprises and consumers. For enterprises, the impact on production costs will depend on current water use efficiency and management's ability to adjust to the new price regime. In most urban industries, water contributes a very small proportion of total production cost, usually under 1 percent, and the impact of even large price increases need not have a large impact on output prices. Solid waste cost increases would have an even smaller impact.

xxvii. Analysis shows that urban consumers are well positioned to absorb both the indirect and direct costs of an improved environment. Under current pricing policies, the water bill takes only 0.4 percent of total income for the *poorest* 5 percent of urban households. Their total utility bill, which includes water, fuel, electricity, and waste collection, takes 4.6 percent of total income. The recommended water, wastewater, and solid waste charges would increase the total utility outlay among this income group to about 5.8 percent of total income. By comparison, on average they spend 6.3 percent of their income on cigarettes, alcohol, and tea. Moreover, real income growth rates for the poorest 5 percent households have matched those of their wealthier counterparts for most of the past decade. Therefore, the proposed cost increase for environmental services could be recaptured through real income growth in a single year. The one group that may need special protection from the proposed tariff increases is the 0.5 percent of China's urban population that lives below the poverty line. They generally rely on government income supplements for their subsistence and this report recommends that the supplements be increased to maintain their consumption levels.

Increasing Sector Efficiency

xxviii. The proposed tariff increases would provide the means for a substantial increase in the quality of services, but rising costs will put pressure on cities to simultaneously improve operating and managerial efficiency. An important step toward increasing sector efficiency will be to operate all municipal services on an independent

accounting basis. Simultaneously, managers must be trained on cost accounting techniques, so that they can make use of China's new enterprise accounting system to identify cost savings in their operations.

xxix. International experience provides valuable lessons for increasing sector efficiency. Companies must be provided a stable regulatory environment that uses pricing as the basis for demand management. Regulators must allow efficient companies to maintain their real income even in periods of high inflation. To reduce political pressure, municipal regulators should avoid case-by-case tariff increases in favor of pricing formulas that include automatic inflation adjustors. The formulas can be based on agreed investment and management goals and structured to encourage efficiency gains rather than simply pass costs through to consumers. As the market economy matures, cities may want to experiment with a competitive bidding process to contract out the management of water systems. In Shanghai and other cities, BOT (build-operate-transfer) operations of new water plants are being considered to mobilize capital and managerial expertise.

xxx. The operation of sewerage and solid waste systems by government bureaus generally suits the current level of system development. However, managerial demands will increase as systems expand, treatment plants are built, and independent accounting is adopted. In larger cities, enterprise organization and an incentive-driven regulatory environment will be justified. In most countries, urban solid waste operations tend to remain under municipal bureau control. However, these bureaus often play only a coordinating role, contracting out collection, and sometimes disposal services, to independent firms. Many Chinese cities already have experience in contracting out for nightsoil collection, and the principles are no different for solid waste. However, the operation of landfills requires special attention because the social cost of improper management is high. Privately run landfills must be carefully regulated, an expensive process that leads many cities to opt for self-operation to ensure proper control.

Conclusion

xxxi. China now has an urgent need to reorient the provision of urban environmental services toward the market economy. The failure to do so would condemn urban residents to a deteriorating environment and poor quality, but increasingly expensive, services that do not protect them from the growing stream of urban domestic and industrial pollutants. While the imposition of user fees may be politically difficult, city leaders must recognize that the costs will be paid directly or indirectly, and that the current choice to rely on indirect payment leads to excess demand, on the one hand, and an inability to meet needs, on the other. The result in the end is greater pollution and higher total costs for the service provided. The avoidance of adequate user fees also denies city leaders full use of a powerful and efficient tool, collective treatment of pollutants, as they seek the most cost-effective means of sustaining an environment supportive of economic growth.

1. URBAN CHINA: THREATENED ENVIRONMENT

A. INTRODUCTION

1.1 Efficient urban environmental management complements the control of pollution at source with the collective treatment of particular waste streams to hold overall pollution loads to sustainable levels. Because markets alone will rarely induce firms or consumers to restrict sufficiently their polluting outputs, governments turn to regulation, taxation, or other instruments to provide the needed signals. In many cases, and here wastewater and solid waste stand out, the most efficient control may require a combination of source and collective treatment of the waste stream. In other cases, such as air pollution, collective treatment options are generally uneconomic and government relies on source control alone.

1.2 A 1992 Bank sector study, *China: Environmental Strategy Paper* (Report No. 9669-CHA), analyzed China's rural and urban environmental problems, environmental management systems, and the mix of command and control and economic instruments used to control pollution at its source. That study identified opportunities to improve management strategies and move closer to the least-cost mix of policy instruments. In response to those opportunities, the Chinese government developed a program of policy research and experimentation and ecological monitoring funded by an IDA credit (Credit 2522). The policy work focuses on improving economic instruments, particularly pollution taxes, and experimenting with cleaner production alternatives to end-of-pipe treatment for pollution abatement. Other recommendations of the strategy paper, particularly in support of local environmental master planning, have been incorporated in Bank- and IDA-funded urban environmental projects such as the Beijing Environmental Project (Loan 3415/Credit 2312) and the Shanghai Environment Project (Loan 3711).

1.3 The current study revisits, for urban China, a subset of the source-control issues, but concentrates on the collective treatment of wastewater and solid waste that was outside the scope of the previous study. Because water supply and policy influence wastewater outcomes so directly, that sector, too, has been included in this study.[1] Chapter 1 highlights features of urban China critical to regulation and collective service provision, particularly municipal organization and financial resources. It then characterizes the changes in ambient environmental indicators over the past decade and concludes by noting recent economic reforms expected to strongly influence urban environmental regulation or collective services. Chapter 2 analyzes urban environmental regulation, recommends measures to improve regulation of township and village enterprises (TVEs); and calls for approval and implementation of pending hazardous waste legislation; increased investment in sewerage and wastewater treatment; strengthened environmental monitoring; and increased public education and participation. Chapter 3 shows the

importance of price-based demand management in improving and sustaining water, sewerage, and solid waste services and discusses organizational and incentive regulation strategies cities can use to increase service efficiency.

Box 1.1: Urban Populations, Towns, and Cities

In 1992, 746 million people, or 64 percent of the national population, lived within the political boundaries of China's 517 cities. However, the cities incorporate rural hinterlands of varying size and only 164 million of the city population held the coveted "nonagricultural residence permit" that gave them full rights to residence and services in urban neighborhoods. The others retained use rights to agricultural land and settlement rights in associated villages and were defined as rural, regardless of the type or location of their employment. Both population concepts differ from the Chinese census definition of urban, which yields an official urban population of 324 million, the 28 percent of the population noted in this report.

Urban people live in either towns or cities. Towns, which may be located within city boundaries, numbered over 14,000 in 1992 and held about a third of the registered nonagricultural population and a larger proportion of people working in nonagricultural employment. Designation as a town or city increases a jurisdiction's financial and administrative power, with cities having much more autonomy than towns. The seat of county government automatically gains town status, while villages with over 10 percent of their population, at least 2,000 people, holding nonagricultural residence status can request town designation. Towns fall under county government jurisdiction for planning and other administrative purposes.

Cities become such through State Council approval. Towns may confidently seek city status if their nonagricultural population exceeds 80,000, their total output value exceeds Y 600 million, and they function as the center of the local economy. Cities have either county-level, prefectural-level, or provincial status. The prefectural-level cities, which numbered 191 in 1992, incorporate rural counties and, in the urban core, city districts, each with county-level government status. County-level cities are smaller, less wealthy, and have less concentrated populations. They also have fewer administrative and financial powers than prefectural-level cities.

China's three largest cities, Shanghai, Beijing, and Tianjin, with nonagricultural populations of 8.8 million, 6.6 million, and 5 million, respectively, have provincial-level status. This gives them legislative independence and fiscal powers not enjoyed by other cities.

The large migrant population holding official residence status in one place (usually a rural area) and living and working in another (most often urban or peri-urban), boosts actual urban populations above reported levels. Recent estimates put the migrant population at about 100 million, although many live and work in peri-urban areas, rather than in the urban core.

B. Urban China

1.4 **Population.** China has the world's largest urban population, at 324 million in 1992, but an urbanization rate of only 28 percent (Box 1.1). The low urbanization rate is a relic of the urban policy in place from the late 1950s through the mid-1980s that sought to maximize resources available for industrial investment by increasing labor force participation rates while holding down urban infrastructure investment. The policy had as its centerpiece the careful control of population movement through residence permits coupled with grain rationing. The latter gave cities sufficient power over both housing and

grain markets that unsanctioned migration became very difficult. With accelerating economic growth and a relaxation of control on migration, urban growth rates averaged 4.2 percent through the 1980s, lagged with the economic slowdown from 1989 to 1991, and then jumped to nearly 6 percent with the economic boom in 1992. With the recognition that cities are functioning as growth poles, and with the need to find jobs for an estimated 100 million underemployed rural people, the debate in China has shifted from whether to allow urban growth to how to accommodate it. Over the next two decades, urban jobs are expected to absorb most of the increment to the national labor force.

1.5 The 517 Chinese cities range widely in size. The largest, Shanghai, with a nonagricultural population of 8.8 million, is one of 32 Chinese cities with populations over 1 million people. The smallest city, Wanding in Yunnan Province, has but 3,500 nonagricultural residents and gained city status because of its strategic, international border location. The cities are concentrated in the eastern half of China, particularly on the seaboard and lower Yangtze River Valley. Their overall size distribution is shown in Table 1.1.

Table 1.1: SIZE DISTRIBUTION OF CHINESE CITIES, 1992

Population	>2 million	1-2 million	500,000 - 1 million	200,000 - 500,000	< 200,000
Number of Cities	10	22	30	141	314

Source: Ministry of Construction (MCon).

1.6 **Administration**. China's development strategy from the 1950s through the late 1970s sought to create locally self-sufficient economies centered on industrial cities. Based on the expectation of large-scale nuclear war, this strategy fostered stable, powerful administrative structures. Local leaders were given broad latitude in the execution of relevant national and provincial policy and local administrations were expected to plan and undertake their own development. National plans and budgets aggregated and complemented those local plans. Enterprise tax and profit flows passed through municipal or county government coffers, with municipalities retaining a local share of about one third and remitting the remainder to the provincial governments, which in turn remitted the central government share.[2] Centrally and provincially owned enterprises, as well as poorer areas, were supported through operating or investment reflows from the center and provinces, funded by surpluses from more prosperous areas. In poorer regions, greater dependence on higher-level funding reduced administrative independence, but the latter nonetheless remained substantial.

1.7 Although China's development approach changed over the 1980s and now supports economic integration and the flow of resources to higher-return areas, municipal power has not weakened. Of the Y 361 billion in 1991 nationwide budgetary revenue, Y 140 billion accrued to the central government and Y 139 billion accrued to the then 479 city governments (the remaining Y 82 billion went to county, prefectural, and provincial

governments).[3] By 1991, municipal governments retained two thirds of their on-budget revenues and, directly or through their subordinate enterprises, now remain responsible for the bulk of all new investment and control most urban employment.

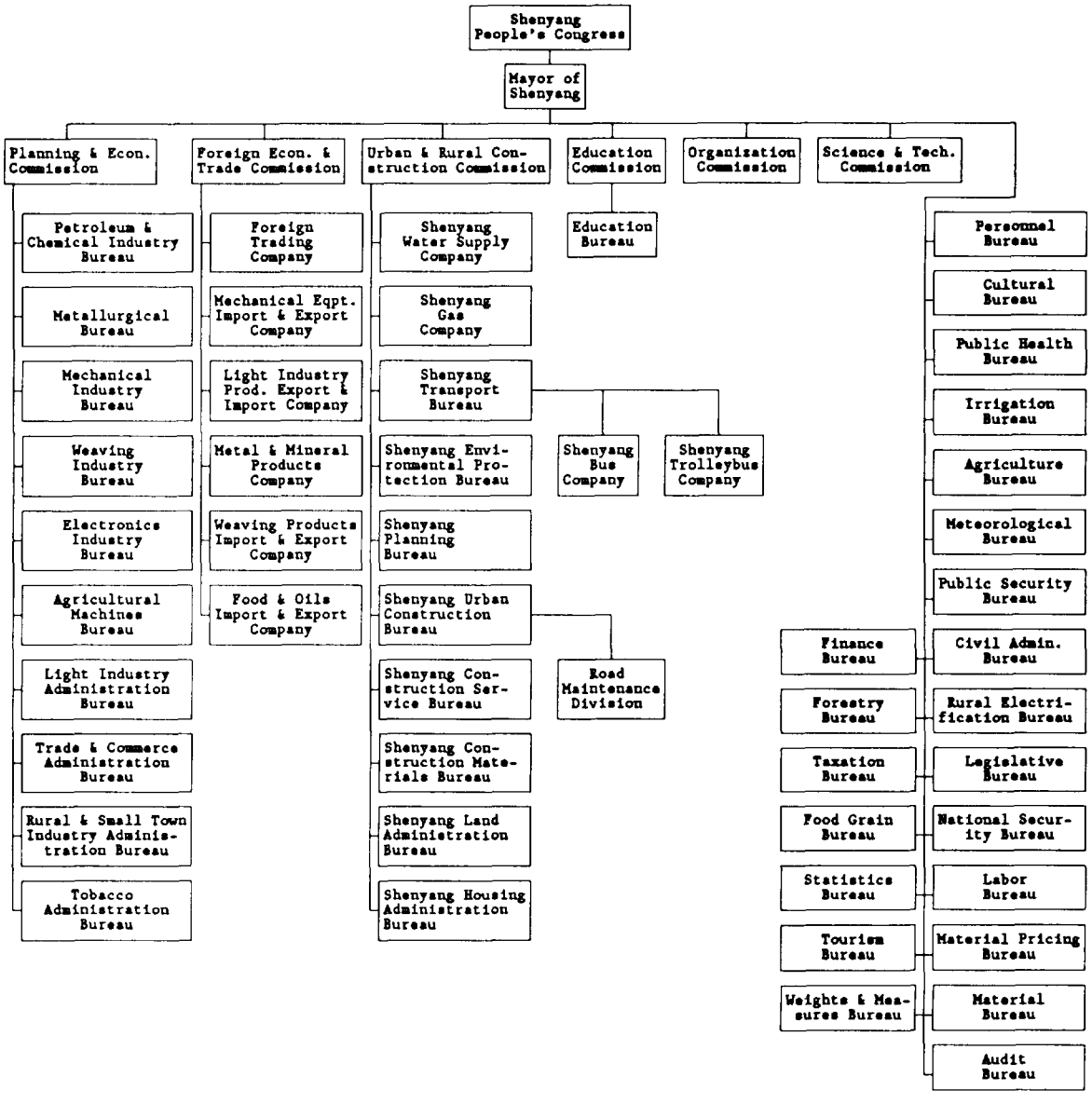
1.8 Cities have well-staffed administrations. In addition to employing staff to undertake the regulatory, police, and administrative work typical of cities everywhere, Chinese cities must staff bureaus that supervise city industrial and commercial enterprises as well as manage the flow of new investments (see Figure 1.1). Some environmental services, particularly water and gas, are provided by municipally owned corporations supervised by the Construction Commission or Public Utility Bureau, while others such as municipal solid waste disposal are provided directly by city bureaus. Municipal Environmental Protection Bureaus (EPBs) oversee enterprise compliance with environmental laws and regulations and manage the use of pollution levy fee loans and grants for pollution control investments.

1.9 To ease administration, medium and large cities are divided into districts, each with its own government and budget. In turn, districts are divided into neighborhood committees, which have elected leaders and very modest budgets, but are considered citizen organizations rather than government offices (hence neighborhood committee employees are not on the city payroll). District organization parallels that of the city, with district counterparts to the city's legal, administrative, public utility, and other organizations. District offices undertake much of the daily work of government, including, among the environmental services, drainage and sewerage, and solid waste collection and disposal. District governments themselves rely on neighborhood committees for some services, such as street sweeping. District governments may run businesses and earn revenue through fees for their services.[4] The degree of district financial self-sufficiency varies throughout the country, with some districts wholly self-financing and others needing transfer payments.

1.10 Counties under cities operate with independent budgets, controlling their own revenues and expenditures, although revenues typically include transfers from the urban core. For strategic planning purposes, the counties are subordinate to the urban core, which can help cities solve transboundary problems. However, the urban core control is not absolute and county officials may successfully demand offsetting investment or other privileges if they forgo opportunities on behalf of the urban core. For example, after Shanghai decreed an industrial exclusion zone along the upper Huangpu River to protect water supplies, they assisted Qingpu county with industrial investment outside the exclusion zone to offset lost investment opportunities within it.

1.11 **Wealth and Income**. Table 1.2 shows the remarkable consistency of the per capita stock of industrial capital across city size, and that capital is somewhat more profitable in cities with over 1 million people. The latter cities generated 48 percent of all profit and tax revenue from 40 percent of the capital base in 1992. As a consequence, their on-budget financial revenue share ran over 24 percent above their population share. By contrast, the 314 smallest cities averaged per capita on-budget financial revenues less than two thirds those of the larger cities.

Figure 1.1: MUNICIPAL GOVERNMENT ORGANIZATION (SHENYANG, LIAONING PROVINCE)



1.12 Higher municipal income translates into higher levels of urban services. In the nine largest cities, 97 percent of urban residents have access to tap water, but in smaller cities, tap water supplies reach only 75 percent of the population and average domestic water use was barely half large-city levels.[5] In the largest cities, 56.6 percent have access to gas for cooking, but in the smallest cities only 6.3 percent have gas (most use coal). Residents of smaller cities do have 16 percent more living space per capita and use more electricity than residents of the largest cities.[6] All city sizes showed significant increases in service levels over the past 15 years.

Table 1.2: CAPITAL, PROFITS, AND FINANCIAL REVENUE IN CHINESE CITIES
(as a percentage of all cities, 1992)

Population	>2 million	1-2 million	500,000 - 1 million	200,000 - 500,000	< 200,000
Nonagricultural population	22.5	18.5	13.1	24.4	21.5
Enterprise Capital	21.3	18.4	14.4	27.9	17.9
Enterprise Profits plus Taxes	27.5	20.6	13.5	20.8	17.6
City On-Budget Revenue	30.9	20.0	10.9	21.5	16.6

Note: The enterprise capital totals do not reflect depreciation.

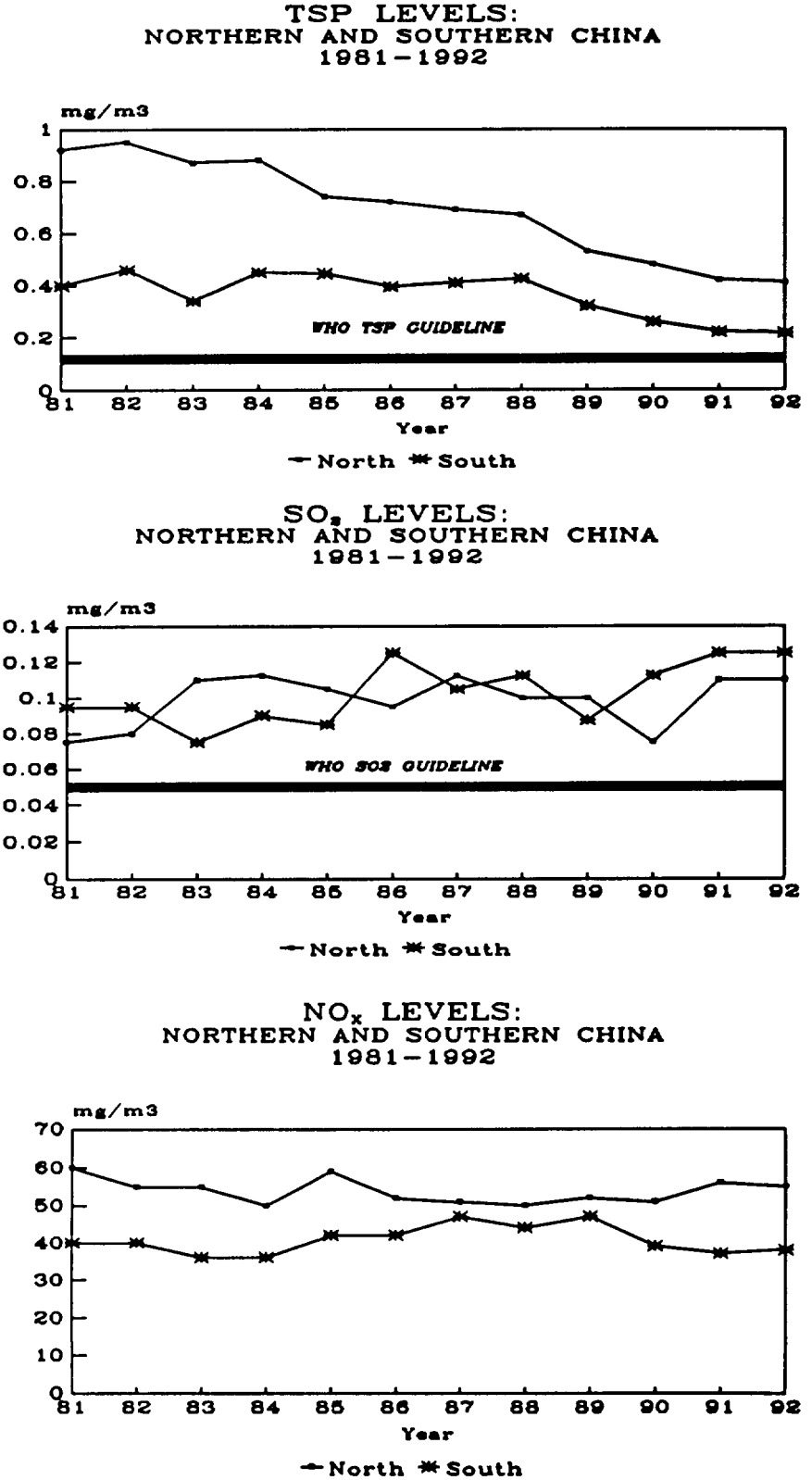
Source: SSB, *Zhongguo Chengshi Tongji Nianjian, 1992*, SSB Publishing House, Beijing, 1992.

1.13 Urban residents enjoy incomes reflecting the high national income share generated in cities. Urban Chinese incomes average 3.1 times those of rural people, a gap that has been growing in recent years. And in-kind income and subsidies boost urban income another 50 percent above average nominal wages.[7] Urban Chinese own an average of 74 color televisions per 100 families, have 52 refrigerators, and 83 washing machines, while rural households have only 8, 2, and 12, respectively. Urban personal savings account balances totaled Y 1,558 per capita in 1991, a cushion equal to 91 percent of annual average cash income.[8] Housing space is tight, with only 7.1 m^2 per capita, but has doubled since 1980.[9] The relatively high and rising incomes and assets of urban people make the application of beneficiary financing to collective urban services both practical and necessary.

C. THE URBAN ENVIRONMENT

1.14 The 9.2 percent annual growth of urban industrial output since 1981 has created much of the wealth reported above. Over the same period, a very active pollution source control program coordinated by the National Environmental Protection Agency (NEPA) has allowed the growth to occur without equally rapid increases in ambient pollution loads. Although some important types of pollution have been reduced, many ambient indicators remain at unacceptably high levels and much remains to be done in each of air, water, and solid waste pollution.

Figure 1.2: URBAN TSP, SO_2 AND NO_x LEVELS, NORTHERN AND SOUTHERN CHINA, 1981-92



1.15 **Air Pollution.** As Figure 1.2 shows, urban air pollution has remained high over the past decade. China has defined acceptable air quality levels in three grades, which match the World Health Organization (WHO) guidelines for sulfur dioxide (SO_2), but are less strict for total suspended particulates (TSP).[10] The lowest level, grade 3, specifies maximum TSP of 0.5 mg/m^3; sulfur dioxide (SO_2) of 0.10 mg/m^3; and oxides of nitrogen (NO_x) of 0.15 mg/m^3. The Chinese standard defines grade 3 quality as that within which the human population can avoid acute or chronic pollution-induced illness and all "except sensitive" plants and animals can maintain normal growth.[11] Above grade 3, pollution levels put the human population at risk of acute or chronic pollution-related ailments. China's significant achievements in TSP reduction, attributable to industrial stack gas controls and switching to cleaner household fuels, have brought TSP generally below dangerous levels. NO_x levels have not deteriorated over the past decade, remaining generally grade 1 in southern cities and grade 2 in northern. Only one city, Wuhan, falls outside grade 3 and another 4 cities have just moved into grade 3.[12] Unfortunately, SO_2 levels do not display the same progress and leave Chinese cities with pollutant concentrations generally above grade 3. The government expects ambient SO_2 levels to continue increasing through the decade and, given the rapid increase in motor vehicle miles and lack of effective abatement, NO_x can be expected to increase as well in major cities.

1.16 High air pollution levels exacerbate chronic obstructive pulmonary disease (COPD). One review of Chinese epidemiological studies concluded that particulates were responsible for over half of all cases of upper respiratory inflammation, chronic bronchitis, asthma, and emphysema in urban areas.[13] Based on those and other studies, another researcher estimated the particulate-induced annual health impact on urban China and found it very high (see Table 1.3). Recent work conducted for the World Bank has also shown a surprisingly strong relationship between outdoor SO_2 concentrations and mortality, although impact estimates comparable to those for TSP have not yet been made.[14] In addition to health costs, high air pollution levels hasten the deterioration of buildings and other structures and can reduce crop yields on suburban farms. Coal burning creates the bulk of air pollution in China. A 1991 Bank sector study, *China: Efficiency and Environmental Impact of Coal Use* (Report No. 8915-CHA), discusses strategies to reduce such pollution.

Table 1.3: ANNUAL HEALTH IMPACT OF TSP IN URBAN CHINA

Restricted Activity Days	3 billion
Annual Premature Deaths from:	
--Chronic Obstructive Pulmonary Disease	100,000
--Lung Cancer	3,000
--Child Lung Inflammation	50,000

Source: K. Florig "The Benefits of Air Pollution Reduction in China," mimeo, 1993.

1.17 **Water Pollution.** China's ambient water quality standards also accord with international practice. The government defines five ambient water quality levels, of which the top three permit direct human contact and use as raw water sources for potable water systems. Level 4 is restricted to industrial water use and recreational use not involving direct human contact and level 5 to irrigation. In the most recently published water quality survey (1991), at least some sections of rivers in 54 of 58 reporting cities failed to meet even level 5 standards.[15] Because of their pollution loads, these waters have few economic uses—except as waste sinks.

1.18 Phenol and petroleum were the water quality index components most often responsible for the failure to meet minimum acceptable standards. A decade earlier, heavy metals posed an equally large threat, but through pretreatment requirements, China has made substantial progress in limiting heavy metal discharges from SOEs, as can be seen from Table 1.4. Although petroleum discharges have increased since 1985, all other listed pollutants decreased significantly. Unfortunately, NEPA does not include TVE pollution, an important and growing pollution source, in their accounting of discharges.

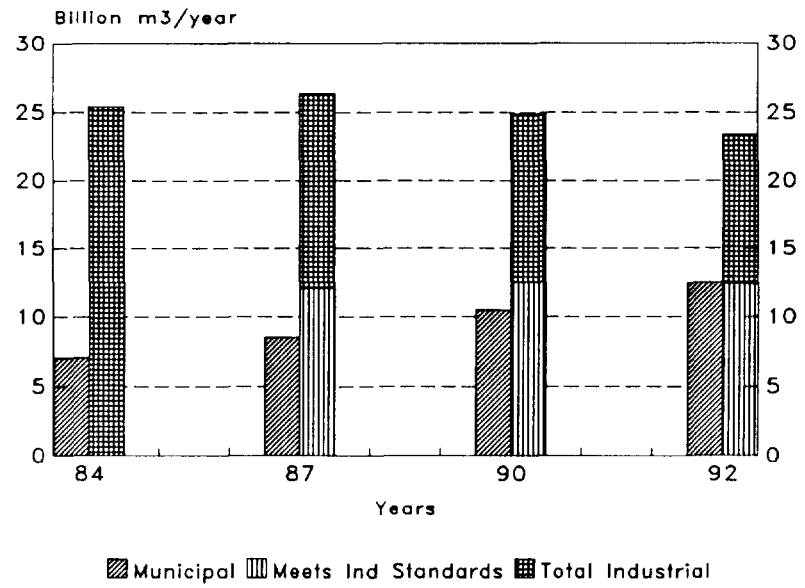
Table 1.4: POLLUTANT DISCHARGES FROM SOEs, 1981-92
(tons/year)

	1981	1985	1992
Mercury (Hg)	62	33	22
Cadmium (Cd)	236	184	138
Chromium (Cr)	2,367	1,547	383
Lead (Pb)	3,006	1,825	973
Arsenic (As)	1,200	1,119	872
Phenol	21,297	11,242	6,361
Cyanide	8,692	6,689	3,484
Petroleum	131,408	62,433	65,076

Source: 1981 and 1985: *Dili Xuebao*, Vol. 45. No. 2, June 1990, pp. 178-186, reported in JPRS-TEN-91-003, February 5, 1991, p. 23. 1992: National Environmental Protection Agency (NEPA), *Zhongguo Huanjing Nianjian 1993* (Environmental Yearbook of China 1993), p. 67.

1.19 While industrial water usage per unit of output continues to be very high by international standards, water use quotas and water recycling requirements have kept industrial wastewater quantities from growing in recent years and discharges failing to meet standards have fallen. By contrast, urban domestic and commercial wastewater discharges have climbed rapidly (see Figure 1.3).

Figure 1.3: MUNICIPAL AND INDUSTRIAL WASTEWATER DISCHARGES
(Billion m^3/year, Selected Years)



Note: Industrial standard data is not available for 1984.

1.20 Chinese analyses of surface water describe small urban streams and rivers as more highly polluted than the larger rivers tested in the 1991 survey. That finding is consistent with the use of many such streams as sewers, the very low 4.5 percent treatment rate for wastewater captured by sewerage systems in Chinese cities, and the fact that only 50 percent of industrial wastewater discharges meet standards. Lakes and ponds serve as repositories of pollutants carried by rivers and are therefore even more highly polluted.

1.21 Groundwater, too, has suffered badly from pollution. That pollution has several possible sources, primary among them being recharge from polluted surface waters and leachate from thousands of uncontrolled solid waste dumps. MCon reports that 45 percent of urban aquifers now suffer from pollution. Groundwater quality is steadily worsening; in 1983, 20 percent of wells tested failed to meet drinking water standards, while in a 1986 retest, 33 percent failed. This trend is particularly alarming given the massive overextraction from urban aquifers, very slow recovery rate from aquifer pollution and the very high cost of remediation.

1.22 Problems with water pollution and falling water tables have forced cities to move to increasingly distant and hence more expensive raw water sources. Some examples of this problem include the need to close existing wells after pollution rendered water undrinkable in Jinzhou, Liaoning Province, and construct a replacement well field expected to cost $18 million; and to move Shanghai's primary water intake at a cost of $300 million before the current intake is overwhelmed by industrial pollution. After farmers in Qujing City, Yunnan province, had to stop drinking river water because of upstream urban pollution, a new, well-based water system was installed for them. But not even that

allowed them to resume irrigation, which had also to be abandoned after pollutants in the local river water poisoned their crops.

1.23 The loss of existing potable water sources is the most readily quantified cost of water pollution. Other costs include damage to agriculture and aquaculture, the additional treatment costs for water drawn from sources not meeting the highest standard, increased morbidity and mortality for users of polluted water, and the loss of amenity value in rivers and lakes fouled by pollution. Estimates have not been made of the sum of such losses, but they would appear to be large and growing.

1.24 **Solid and Hazardous Waste.** Solid and hazardous wastes have an impact that may not be apparent for decades. Leachate (or, for liquid hazardous wastes, leakage) pollutes the land, surface water and underlying aquifers. Landfills with the very high organic content common in China emit substantial amounts of methane, which in a well-designed landfill is collected and flared or used for power generation. MCon statistics for 1991 state that only 11.9 percent of the combined solid waste and nightsoil load that year was disposed of in a way that posed no future threat to the environment. That same year, enterprises dumped some 10 million tons of industrial solid waste directly into lakes or streams. The impact of such solid waste handling has not been estimated, but it clearly contributes to the water quality problems described above.

1.25 Hazardous waste, by definition, poses a greater threat than other municipal and industrial wastes. NEPA estimated that in 1991, SOEs generated 50 million tons of hazardous waste, including 23 million tons of chemical industry residues. In the absence of a system to track the generation and handling of such wastes, municipalities face substantial uncertainty as to what wastes may affect them and how they are being handled. However, the impact of some mishandling is known, in the form of 2,800 recorded pollution accidents in 1991 causing Y 75 million in direct damages and injury to some 1,900 people. Although no analysis was provided of which pollutants caused the damage, presumably hazardous wastes were the major cause.

1.26 **Ranking Pollution Damage.** Qualitative description of damage associated with air, water, and solid waste pollution can be done much more easily than quantitative evaluation. The latter is beginning with Bank support under the auspices of environmental master planning in a small number of Chinese cities.[16] That work will yield information on which pollutants have the worst impact on specific environments. The results will be location-specific, for geography plays a large role in determining the external costs of any given pollution load and who will bear those costs. Clearly air, water, and solid waste pollution sources already generate a substantial financial and economic burden. To determine which to give primacy in an urban abatement program will require a careful analysis of relative risk and the existing ambient loads and the dynamics of those loads.

D. Reform and Urban Governance

1.27 China's high environmental stress is an outcome not simply of the high growth rates of the last 15 years, but also of government choices about the nature of that

growth. Government at various levels has utilized regulatory and pricing power, credit control, and direct investment to influence enterprise handling of potential pollutants. The level of municipal infrastructure investments in, and pricing policies for, collective environmental services has also played an important role in determining municipal environmental quality. The roles played by various levels of government and by the enterprise sector have themselves varied over time and influenced the choice of instruments. As noted in para. 1.7, the reform program has generally strengthened cities by increasing their control of locally-based enterprises and locally generated revenues. However, some of the latest reforms have been designed to redistribute power to enterprises or the central government. Recent reforms likely to play particularly important roles in urban environmental management performance include those in enterprise management, tax policy, and price policy.[17]

1.28 **Enterprise Management**. A consistent goal of enterprise reform, critical to the successful transformation of the economy, has been to force enterprises to increase efficiency by producing for the market rather than to the government plan, and to manage inputs to maximize profit under a hard budget constraint. Concurrently, enterprise managers have been given increased power and autonomy. The reforms imply a weakening of enterprise management bureau authority—authority that, by the mid-1980s, resided primarily in city governments. To encourage that change, the central government has led a movement to restructure government by significantly reducing employment in bureaus that manage SOEs. The guiding principle is to change the government role from direct management of the economy to indirect management through transparent regulation. But this transition is far from complete, with administrative intervention continuing in such key areas as credit allocation. The incomplete transition has particular impact on the work of EPBs and on the efficiency of municipally provided collective environmental services.

1.29 **Tax Policy**. The large annual real expenditure increases enjoyed by the large and medium cities over the past 15 years were financed primarily by increasing their revenue retention rate, which rose for the 15 largest cities from 26 percent in 1981 to 63 percent in 1991, while their on-budget revenue increased only 1.6 percent annually in real terms. In January 1994, the central government restructured the tax system. In the old tax system, receipts flowed via local government, as the collection agent, to the central government. The flow was controlled in different ways for different provinces, with contracts ranging from fixed transfers to percentage sharing schemes over a fixed base. All of the arrangements gave considerable discretionary authority, and the bulk of incremental income, to local government. The new tax system categorizes taxes as those reserved to central government or shared with local government, both of which are to be collected directly by central government tax offices, versus those reserved to localities and collected by them. The new system seeks to raise the elasticity of central tax revenue to economic growth and, although local government tax revenues should continue to rise, increases will likely be slower than under the old system.

1.30 **Price Reform**. In the late 1970s, the central and local governments controlled some 95 percent of all prices. Prices have been gradually decontrolled, until, by 1991, only 30 percent of consumer goods and 42 percent of raw material prices

remained under either central or local Price Bureau jurisdiction. Urban planners estimate that in terms of the urban consumer price index, large cities now control the prices of perhaps 20 percent of the market basket.[18] The prices remaining under administrative control include many critical to urban environmental services. In particular, water, gas, sewerage, and similar services are kept under a combination of national, provincial, and municipal price controls. The government has yet to put in place a pricing mechanism for urban environmental services that sustains service levels and adequately manages demand.

2. URBAN ENVIRONMENTAL MANAGEMENT

A. INTRODUCTION

2.1 The ambient air and water quality figures cited previously suggest a record of mixed success in urban environmental management. As discussed in this chapter, the chief obstacles to effective environmental management are significant gaps in regulatory control and problems in SOE implementation of existing regulations. The solutions proposed here include institutional innovations and new instruments to improve regulatory control over TVEs; broadening the mandate of municipal EPBs to include hazardous waste control; shifting wastewater management strategies toward greater reliance on sewerage companies; increasing the cost of noncompliance with agreed standards; and encouraging citizen participation to lower monitoring costs, while increasing public education to bolster political support for environmental protection.

B. MUNICIPAL EPB STRUCTURE AND FUNCTIONING

2.2 **The National Context: Organization and Instruments.** The National Environmental Protection Agency (NEPA), which is the executive arm of the State Council Environmental Protection Committee, drafts and interprets national environmental legislation and standards, tracks sectoral and local environmental regulations, maintains environmental data bases, and conducts research on environmental policy and performance. However, NEPA does not have implementation authority. That authority resides in the provincial and local governments and their environmental protection bureaus.

2.3 China uses a familiar set of command and control instruments to reduce industrial pollution, complemented by fees and fines for effluents over the limit. The command and control instruments include environmental impact assessments at the project feasibility stage; a licensing system for new projects that prohibits their construction prior to EPB approval of the planned environmental safeguards or their operation unless those safeguards are installed and maintained; and pollutant concentration limits on effluents from all enterprises. NEPA is now leading experiments in the use of location-specific, mass-based discharge permit systems designed to overcome the shortcomings of the concentration-based system.

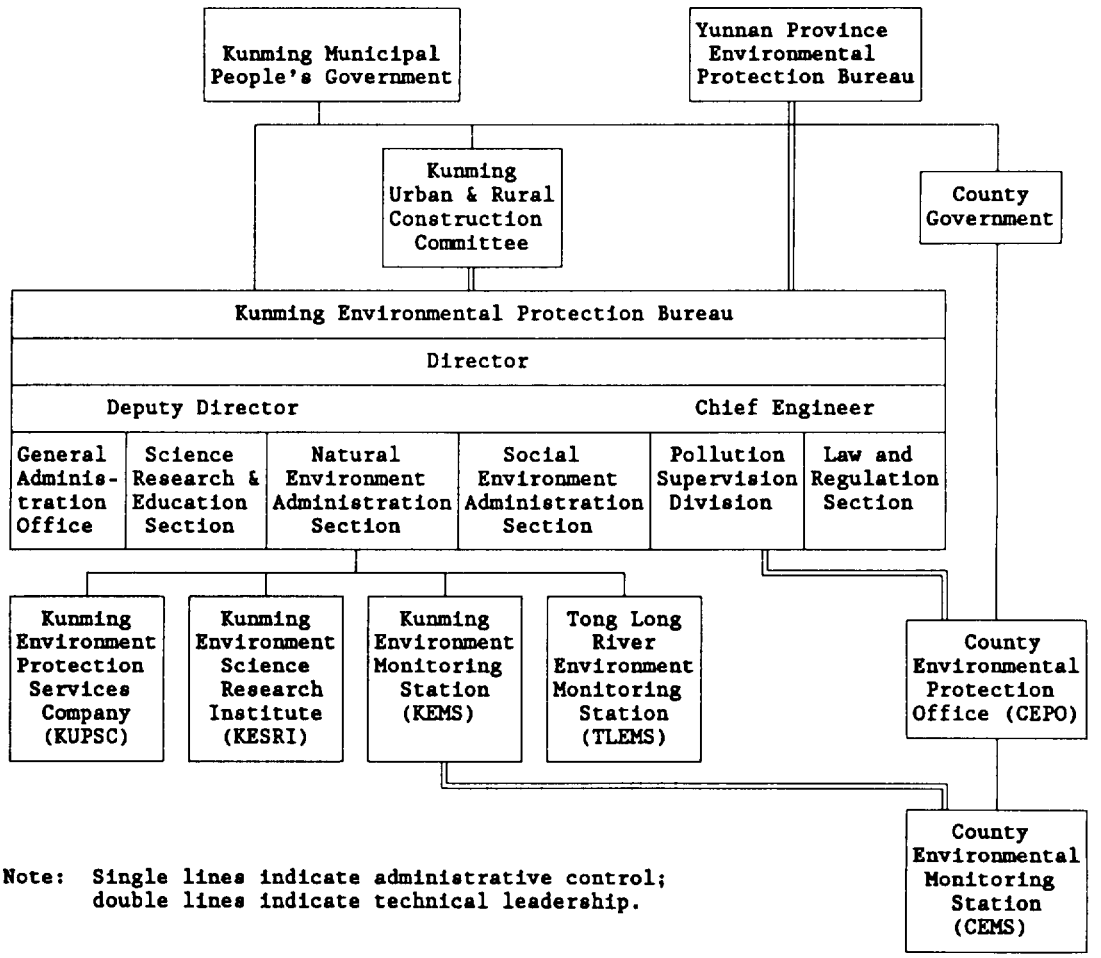
2.4 Economic instruments have become increasingly important in Chinese pollution control. The most important instrument is the "overstandard pollution levy fee" for enterprise air or water effluents. Firms and production lines established since the environmental regulations went into force must meet pollution standards. But operations established before the regulations may, with a license, continue to discharge above the standard at the cost of paying a concentration-based "overstandard pollution levy fee."

Although regarded as too low to induce abatement on its own, the fee produced Y 2.4 billion in income for the EPB system in 1993, with nearly 80 percent of that earmarked for pollution abatement projects and the rest funding local EPB administrative, research, and monitoring systems. EPB licenses permitting overstandard effluents may incorporate a requirement to meet standards within a stipulated period of time. An enterprise violating standards or its license may be fined or shut down in addition to paying fees. *China: Environmental Strategy Paper* (Report No. 9669-CHA) analyzes these instruments in detail.

Box 2.1: The Organization and Staffing of EPBs

An organization chart is shown below for the EPB system in Kunming, a city of 1.5 million people that serves as the capital of Yunnan Province. The EPB itself has a staff of 51, 40 of whom have technical qualifications. The research institute has 38 staff and the environmental monitoring station has 66. Between them, those two units have 58 engineers. The county EPBs (here labeled Environmental Protection Offices) and monitoring stations each have between 5 and 8 staff, few of whom are technically qualified. These groups must monitor the more than 5,000 factories within Kunming City boundaries and the 50,000 TVEs within the municipal boundaries.

Organization of the Kunming Environmental Protection Bureau



Note: Single lines indicate administrative control; double lines indicate technical leadership.

2.5 **EPB Structure**. Some of the implementation challenges facing EPBs derive from their place in the governmental hierarchy. In a situation common to local government agencies in China, EPB staff work under the dual leadership of a central government ministry and local political leaders (see Box 2.1). NEPA, through provincial EPBs, guides municipal and county EPB work in professional matters such as environmental testing protocols. But the municipal government controls EPB budgets, staffing, and other administrative functions. The EPB subordination to the local government marks the national political intent that these bureaus, and environmental goals, be integrated fully into the local development process. To further strengthen the integration, monitoring and implementation responsibilities are shared with staff in other municipal bureaus and enterprises. For example, most local bureaus of industrial ministries have environmental sections responsible for monitoring regulatory compliance by industries under that ministry. In 1992, staff engaged in environmental work but employed by non-EPB bureaus and enterprises were estimated to number 250,000, compared to the 75,000 people working within the EPBs. A local government committed to environmental goals can thus bring considerable talent to bear to ensure a healthy environment, but few checks exist on a local government that chooses to temporarily ignore environmental concerns in favor of industrial growth.

2.6 As one check on local government, central and provincial governments must maintain the EPB system at a high level of political legitimacy. This legitimacy comes when political leaders support EPBs enforcing national and provincial environmental laws, when they ensure EPBs a rank in the bureaucracy at least equal to those they must regulate, and when they provide adequate budgets for effective operation. The very necessary efforts now underway to streamline bureaucracies in China need not exempt the EPB system. Yet, it must be recognized that the reforms make environmental work more difficult by weakening the industrial ministries that once took much of the responsibility for ensuring compliance with environmental laws. Failure to strengthen the EPB system as the market economy grows will increase the difficulty of effective environmental regulation.

C. Issues

TVE Regulation

2.7 The remainder of this chapter discusses four major issues now confronting urban environmental managers. These are (a) ineffective regulation of TVE pollution; (b) the failure to enact hazardous waste control legislation; (c) inadequate use of municipal sewerage and wastewater treatment; and (d) noncompliance with environmental regulations.

2.8 **TVE Pollution**. EPBs have failed to vigorously apply existing regulations to the most rapidly growing industrial sector—township and village enterprises. In 1980, when the current regulatory system was being developed, TVEs accounted for only 8.6 percent of industrial output, but by 1992 that had jumped to 36.8 percent and the growth rate has not slowed since.[19] Although township and village industry includes a higher proportion of less-polluting light industry compared to the SOE industrial sector,

a 1985 study showed the TVE contribution to national pollution loads to be nonetheless substantial. In 1984, TVEs accounted for 18.8 percent of industrial output and generated over 10 percent of water pollution, over 9 percent of air pollution and 11 percent of solid waste loads. With no major shift in the TVE industrial structure, by 1992, the total TVE pollution loads must have grown substantially (see Table 2.1).[20]

Table 2.1: TVE CONTRIBUTIONS TO NATIONAL POLLUTION LOADS
(Percent)

	Water	Air	Solid Waste
1984 actual	10.7	9.3	11.1
1992 estimated	22	19	23

Note: 1992 estimates based on 1984 ratio of total output to pollution. Solid wastes include an unspecified amount of hazardous waste. Source: 1984: Ministry of Agriculture.

2.9 TVE polluting outputs would be less worrying if they were uniformly distributed in China's vast rural hinterland, but they are not. TVEs cluster tightly around the markets they serve, which are primarily in medium and large cities. Thus, TVE effluents burden the same air and watersheds as urban industry. A 1989 NEPA study found a large urban impact from TVE pollution in coastal provinces from Zhejiang north to Liaoning.[21] Such an impact was also noted in a study done on water quality at Shanghai's proposed new raw water intake site. The intake on the Huangpu River is being moved upstream to Da Qiao to escape pollution from a major urban industrial zone adjacent to the current intake. Water quality at the new site is good, but testing identified some industrial pollutants, which prompted an effort to locate and control the sources. The Shanghai municipal EPB has a good data base on SOE polluters within the municipality and found that of the hundreds of SOEs in the upper Huangpu, 12 industrial enterprises collectively contribute the bulk of SOE phenol and oil pollution and a significant share of other pollutants (see Table 2.2). However, a modeling study showed that those SOEs account for a far lower percentage of the total pollutants actually measured at Da Qiao. The remaining pollution load comes from a variety of sources, including TVEs and agricultural runoff. Those potential threats to the new municipal water intake fall outside the traditional scope of municipal EPB control.[22]

2.10 **TVE Control Problems.** Most TVEs are found in counties, not cities, and city EPBs lack direct authority over them even when TVE effluents harm the city environment (Box 2.1, above). This is no less true for the large Chinese municipalities, whose administrative boundaries incorporate suburban counties. As noted in Chapter 1, despite being subject to general municipal control, suburban counties have a large measure of autonomy. TVEs provide an important source of employment and township government revenue within counties. Unlike SOEs, TVEs work under hard budget constraints and have sustained their growth through flexible, market-oriented management. Those managers, while rapidly increasing their market share over the past decade, have avoided

Table 2.2: POLLUTION LOADS AT DA QIAO

Pollutant	From 12 SOEs as a percentage of all SOE industrial pollution in the Da Qiao area	From 12 SOEs as a percentage of all pollution measured at Da Qiao
COD	29	4
BOD	18	13
Phenol	88	11
Oil	71	8
Ammonia	30	3

Source: Consultant's studies for the Shanghai Environment Project.

coming under many of the regulatory controls applied to SOEs in the same markets. Although some county governments now apply environmental regulations to TVEs, most lack the staff to implement the regulatory system used in the cities. NEPA staff estimate that 40 percent of excess pollution discharge taxes go uncollected, the bulk of them from TVEs.

2.11 **Effectively Controlling TVE Pollution: Presumptive Taxation.** The TVE regulation problem can no longer be ignored. Local governments commonly attribute the regulatory lapse to two factors: weak county EPBs and the difficulty of effectively monitoring dispersed small enterprises. Yet, those constraints can be dealt with. Monitoring can initially focus on the small number of well-studied industries—including coke and chemical production, leather tanning, electroplating, and pulp and paper—that produce the bulk of TVE pollution. Firms within those industries utilize a very small number of alternative technologies, the pollution loads from which have been or can easily be established.[23] Based on the production processes used, NEPA can publish performance tables for each industry linking pollution to the firm's output and the presence of specified abatement technologies. Those tables in turn can be used as the basis for a mass-based pollution load permit system dependent on enterprise location. Once mass-based permits are issued, county EPBs would levy presumptive pollution fees based on production rather than direct environmental monitoring. If firms believe they outperform the presumptive benchmarks, they can be given the option of paying for an extended period of monitoring to establish that fact. Superior performances would then be rewarded with either lower fees or permission to expand output. County EPBs may need additional staff and technical training to carry out their expanded work program, but equally important will be the role of the municipal EPB, which must lead an effort to analyze the overall distribution of pollution within the larger municipality and establish a municipality-wide mass-based permit system. If county EPBs have difficulty implementing the permit system, they could centralize county pollution levy fee collections and associated abatement investments under

the municipal EPB. This expanded work program suggests the need for reassessing the staffing levels and skills mix of the municipal EPBs as well as those of the county.

Hazardous Waste

2.12 **Hazardous Waste Generation.** The second major gap in EPB control has been the lack of hazardous waste regulation. Industrial enterprises generate an estimated 50 million tons a year of hazardous waste in China, including 23 million tons of chemical industry residues. Existing regulations require enterprises to safely store or recycle those wastes, but without detailed tracking or reporting requirements, the government lacks accurate knowledge of waste quantities or handling. Of the total, NEPA estimates that 30 million tons are disposed of after treatment, another 13 million tons are recycled, and 7 million tons are either stored waiting disposal or discharged to the environment. In preparation for hazardous waste regulation, Beijing, Shanghai, and other major cities have conducted hazardous waste inventories in recent years. Working with Beijing and Shanghai under Bank-funded projects, international consultants are assisting with the development of strategies for handling hazardous waste. They have found that enterprises aggressively seek profitable recycling opportunities and have documented many cases of appropriate treatment. However, inappropriate uses, such as fueling low-temperature boilers with chemical residues, occur frequently enough to cause alarm. In 1991 NEPA recorded over 2,800 water, air, and solid waste pollution accidents, most presumably associated with hazardous waste discharges, which caused direct economic losses of Y 75 million and nearly 1,900 injuries.

2.13 **Regulatory Needs.** In the absence of clear regulatory authority, most municipal EPBs pay little attention to hazardous wastes until damage causes citizen complaint. However, much of the damage that does occur, especially to soil and aquifers, may not be obvious for years, so total damage must be well above reported figures. NEPA understands the importance of improved hazardous waste regulation and has drafted a law that reflects international practice, utilizing a tracking system that follows the wastes from the point of generation to final disposal. Ratification of the law has been delayed, reportedly because of industry concern over compliance costs. *But damages are already high enough that the national government must now ratify and implement the hazardous waste legislation to avoid what will otherwise be enormous long-run costs of improper hazardous waste-handling.* Once passed, EPBs will face a monitoring challenge more daunting than for other pollutants and they will need to develop the expertise to help develop the specialized disposal facilities needed to handle hazardous wastes.

Wastewater Treatment and Monitoring

2.14 **Causes of Degradation.** The continued failure of most urban surface water to reach minimum acceptable quality and the rapid degradation of aquifers noted in Chapter 1 have a number of causes. These include the TVE pollution discussed above, as well as rapid growth in untreated municipal wastewater and the persistent failure of SOEs to meet effluent standards. On the latter point, random inspections of enterprise wastewater treatment facilities over the years have turned up high violation rates. A large-scale NEPA

investigation in the late 1980s showed only 36 percent of the units operating at greater than 80 percent efficiency and only half at more than 50 percent efficiency. EPB chiefs in individual cities and provinces report similar results for recent spot checks of equipment. Consistent with this experience, NEPA statistics show very little increase since 1987 in the amount of SOE wastewater discharges meeting standards (see Figure 1.3). Inadequate sewerage reticulation systems and the meager 4.5 percent coverage of municipal wastewater treatment plants contribute to low water quality.

2.15 **The Need for Municipal Treatment Plants.** A rapid increase in municipal wastewater treatment plants and associated sewerage systems is key to improving ambient water quality. Such treatment plants are the only effective means of dealing with the growing domestic and commercial wastewater loads, which will continue to increase as people move to housing with flush toilets and farmer preference for chemical fertilizers over nightsoil leads to increased nightsoil disposal into sewers (or worse, waterways). Furthermore, treatability studies conducted under Bank-funded projects have shown that wastewater from enterprises meeting Chinese standards for discharges to sewerage systems can be successfully treated in combination with domestic wastewater, even when the industrial component reaches 50 percent or more of total load, allowing those waste streams to also enter the municipal treatment plants.[24] Studies in Fushun and other cities have also shown collective treatment at municipal plants to be more cost-effective than in-plant treatment for many industrial enterprises. Chapter 3 reviews the design and financing requirements for this proposal, while the changes in the regulatory framework needed to make the proposal work are described here.

2.16 **A Shift in Monitoring and Charging Responsibilities.** The construction of municipal treatment plants creates two sorts of problems under the current regulatory environment. First, treatment plants are not exempt from EPB effluent discharge standards, so may be monitored and charged by EPB, despite the fact that their sole function is to ameliorate pollution. In essence, they are responsible to EPB for pollutants flowing into their plant despite the fact the contributing upstream enterprises should have already been regulated within acceptable levels by EPB. Second, enterprises themselves face duplicate charges for effluents. EPB now levies two water effluent fees, the "wastewater discharge fee" applied to all discharges meeting effluent discharge standards, and a second, higher, fee "the overstandard pollution levy fee" for licensed discharges not meeting standards. In addition, municipal sewerage systems charge an "urban wastewater treatment facility use fee" for discharges to sewers, with the fee level city-determined and dependent on treatment provided. Clearly, the current regulatory system has been structured for an environment in which municipal treatment plants play little role in assuring adequate quality discharges.

2.17 EPBs must continue as the primary regulator of water quality. However, where municipal treatment plants operate, responsibilities must be rebalanced to allow effective treatment plant operation and financing. Municipal treatment plants may need to set stricter discharge limits than those required by EPB, and need the authority to monitor enterprise discharges and enforce standards. Given that treatment plant operations require constant testing of the waste stream and that load-based treatment fees encourage load monitoring by the treatment plant, treatment plants have a stronger incentive than EPBs

to monitor aggressively. This suggests that enterprise water effluent monitoring responsibilities should shift to treatment plants from EPB. EPB would continue to monitor treatment plant effluent and collect the overstandard pollution levy fee for any discharges not meeting standards. In a change from current practice, this study recommends that the provincial, rather than the municipal, EPB assume responsibility for municipal treatment plant monitoring. Such a change would politically separate the regulator from the municipal owner of the treatment plant and would encourage more explicit concern with downstream impacts of the wastewater.

2.18 Enterprises should not have to pay two agencies for their wastewater discharges to municipal treatment plants. The enterprise water effluent fee (discussed further in Chapter 3) should include treatment costs and an additional fee for any polluting component unlikely to be removed by the treatment plant (for example, a primary treatment plant would not remove phenols). The additional pollution fee would be passed on to EPB through municipal treatment plant overstandard pollution levy fee payments.

2.19 **Competitive Treatment Options.** The proposed approach would leave connection to the municipal system optional for one class of enterprises. To encourage global treatment efficiency, enterprises with a history of fully meeting current discharge standards, which discharge to water bodies meeting at least the minimum acceptable (Class 5) water quality standard and which cause no degradation of the quality of the receiving water below the discharge point, would be permitted to opt out of the municipal system.[25] Such enterprises would continue to be monitored and regulated by the municipal EPB. This option would be attractive only to enterprises generating large wastewater volumes, but would allow such enterprises to tailor their internal treatment to the specific composition of their waste load and may provide an efficient alternative to use of the municipal system.

Noncompliance with Regulations

2.20 **Treatment Costs Versus Levy Fees.** Chinese cities cannot wait for the completion of the wastewater treatment plant building program before improving enterprise performance in meeting effluent standards. Unfortunately, enterprises have a powerful financial incentive to idle in-plant treatment works. Case studies in Guangdong Province and elsewhere found that in industries where in-plant wastewater treatment costs ranged from Y 0.70 to Y 0.80/m^3, the pollution levy fee was but Y 0.04 to Y 0.20/m^3.[26] NEPA has acknowledged that fee levels have never been high enough to encourage treatment, and, indeed, that fee levels are often below the operation and maintenance (O&M) costs for installed treatment plant.[27] But higher fees will be effective only if they are vigorously enforced.

2.21 Although EPBs conduct random compliance inspections, staff and equipment constraints keep the frequency of such inspections low. Furthermore, when measuring air pollution, inspections usually require advance notice because EPB needs enterprise assistance in placing and powering monitoring equipment. When violations are discovered, sanctions are weak. Fines are typically levied only after repeated violations or serious

environmental accidents. Hubei Province's Wuhan City, with 3.8 million people, a concentration of heavy industry and industrial pollution, and a low compliance rate in enterprise abatement facilities, levied only Y 160,000 in fines in 1992. The single largest fine, Y 10,000, was laid against a nightclub for noise and odor problems. Yunnan Province's EPB leaders explained their low fines as reflecting a combination of the offender's inability to pay and administrative intervention to protect profits. In Kunming in 1992, the largest fine, Y 20,000, was assessed for a paper mill accidental wastewater discharge that killed farm animals and destroyed crops.[28]

2.22 **Increasing the Cost of Noncompliance.** Both theory and international experience show that a combination of infrequent monitoring and low fines for violations encourages noncompliance.[29] In the past, China used a strategy in which compliance with environmental regulation was one of a broad set of social and financial concerns to which SOE managers were expected to respond. Responsive managers were rewarded with access to capital and other markets, status, and other benefits. However, with the move to a market economy and reduced enterprise social roles, the state has fewer rewards to offer and the strategy appears to be losing effectiveness. To offset this, the expected financial penalty for noncompliance must increase, which requires some combination of increased fines and an increased inspection rate. Note that increasing inspection rates implies much higher administrative costs than increasing fines, due to the need for staff and equipment sufficient to carry out the inspections. Increased fines are therefore a key element of the strategy. To increase the social cost to enterprises of violations and strengthen the consensus for environmental management, increased citizen participation should also be encouraged.

2.23 **Increasing Citizen Participation.** In its environmental protection law, China recognizes and encourages citizen participation in environmental management.[30] Citizens do, in fact, take advantage of the opportunity to bring violations to the attention of EPBs. In 1991, EPBs at various levels received over 55,000 letters and 82,000 visits complaining about pollution of various types. Air pollution was most commonly reported, although water pollution and excessive noise also received much attention. NEPA reports that about 90 percent of the letters and 75 percent of the visits were acted on during that year. Public pressure can be a powerful tool. A Bank mission visiting one large Chinese city was unable to meet the vice-mayor in charge of environmental work, for he had been summoned to the provincial capital to explain why a persistent solid waste problem remained unresolved. The summons came after affected villagers had written many letters to the provincial government complaining of inaction by the city.

2.24 Community participation will be most effective if successful efforts are widely publicized. This already happens on a sporadic basis, but municipal EPBs should consistently publish accounts of the major cases brought to them and their handling of those cases in order to educate people both about environmental problems and the potential to solve them. EPBs should also regularly publish the results of their own monitoring program, naming noncomplying firms and agreed remedies, and encouraging citizen monitoring of future compliance. EPB leaders in some cities have successfully used the threat of such publicity as a tool to induce compliance.

2.25 *NEPA should encourage broader use of the media through specific guidance to local EPBs on the topic.* NEPA itself has managed several impressive national publicity campaigns to strengthen the consensus for environmental action. In one ongoing effort that has stimulated mayors to take a more direct interest in environmental issues, major cities undergo an annual environmental assessment, rankings from which are published in national and provincial newspapers. NEPA also runs special campaigns, such as one that publicly identified the nation's 3,000 worst polluting enterprises, producers of an estimated 65 percent of SOE pollution, and demanded action to abate their pollution. And the National People's Congress (NPC) has begun an inspection campaign to assess the quality of environmental regulation in various localities. Experience in other market economies has proven the value of sustained, well-publicized attention of this type in fostering the public support needed to invest in a sustainable environment.

D. Conclusion

2.26 Environmental managers in China have drafted legislation to regulate hazardous waste, a major gap in regulatory control. It is now imperative to ratify and implement that legislation. The largest gap in regulatory implementation, that of TVEs, will be perhaps harder to address, but the need is now compelling and the study has recommended an approach that will focus on large polluters and minimize regulatory demands. The difficult problems surrounding compliance with current regulations need to be addressed through a multifaceted strategy. For wastewater, treatment services must be provided citywide. Once treatment plants begin operating, they need corresponding regulatory power over the effluents they must treat and can assume this responsibility from municipal EPBs. In turn, provincial EPBs can monitor treatment plant output and ensure compliance with ambient quality standards. For air pollution and wastewater discharges outside the sewerage system, financial and social incentives for regulatory compliance must be increased. Higher fines, coupled with greater use of citizen participation in monitoring violations, will help EPBs realize this goal.

3. URBAN ENVIRONMENTAL SERVICES

A. INTRODUCTION

3.1 Urban environmental services and environmental regulation strongly complement one another, an observation particularly true of the water, sewerage, and solid waste services analyzed in this sector study. The quality and cost of urban water will be determined in part by how effectively regulation prevents or minimizes wastewater or solid waste discharges that pollute raw water sources.[31] Wastewater quality will be much affected by the level of pretreatment before industrial discharge, although, as this study argues, at economically viable pretreatment levels, the residual industrial loads may still require centralized treatment when added to domestic and commercial wastewater. Wastewater volume and quality will in turn be influenced by water pricing and other demand management policies. And, the constituents and handling of solid waste depends on regulation as well as on municipal collection strategies.

3.2 These relationships are illustrated in the following analysis of urban environmental services, which demonstrates that the regulatory and financing strategies now being pursued will not allow sector needs to be fully met. Increased water prices are needed in a program of water demand management which will substantially reduce the need for new water supply and sewerage investments and generate funds for service quality improvements. Sewerage and wastewater treatment investments must nevertheless increase appreciably if water costs, and surface water and aquifer pollution are to be reduced. Much greater investment in solid waste disposal is also needed. The chapter concludes by showing that people can afford the proposed program and recommending organizational changes to foster more efficient service delivery.

B. URBAN ENVIRONMENTAL SERVICES: ORGANIZATION AND FINANCING

3.3 **Organization and Regulation of Municipal Services.** The Ministry of Construction (MCon), which reports directly to the State Council, regulates the provision of urban water, sewerage, and solid waste services. The Ministry sets performance standards, including physical and financial performance, for the various services. To help guarantee adherence to standards, major investments in the sector require independent appraisal by the Ministry. Municipalities also look to the Ministry for guidance in implementing new management approaches. The provincial analog of the Ministry is the Construction Bureau, with functions analogous to those of the Ministry. The Bureau ensures that Ministry regulations are observed in the province, and has the power to regulate areas not addressed by the Ministry and to set more stringent standards than those set at the national level. The Bureaus play a key role in the allocation of provincial funds to urban infrastructure projects. Finally, at the municipal level, the Construction

Commission manages sector service delivery. As Figure 1.1 (p. 5) shows, the Commission coordinates a number of bureaus and companies that actually deliver the services. While responsibilities and bureau and company names vary somewhat across cities, all urban environmental services are the responsibility of municipal government and are provided either at the municipal or district level, directly or through city-owned companies.

3.4 In medium and large cities, water and gas are supplied by municipal companies, while drainage and sewerage services are provided by district governments.[32] Sewage treatment plants covering more than one district are city-run and, if needed, the city helps districts finance both initial sewerage investments and operating costs. Small cities operate without district governments and, there, the city itself takes responsibility for services provided by district governments in the larger cities. Municipal solid waste pickup and disposal are typically a district responsibility, although neighborhood committees in some places arrange the pickup and transfer to district vehicles and cities may run major transfer stations and landfills. Enterprises take responsibility for their own solid waste disposal, often by contracting with the district solid waste agency for that service. Municipally-owned service companies maintain segregated accounts and have, since July 1, 1993, used accounting systems quite similar to international practice.[33] A distinct advantage of managing services through a company rather than a government agency is that unlike government agencies, companies may borrow from banks. This has become important since 1988, when cities began to abandon the practice of covering capital costs entirely through municipal grant funding. However, capital grants continue and, in exchange for access to municipal funds, companies remit negotiated shares of their depreciation funds and operating profits to the city.

3.5 **Financial Performance.** Nominal municipal company profits have long been artificially increased by applying unrealistically low depreciation rates and manipulating tax payments, but even then performance has been unimpressive (see Table 3.1). Bank analysis of nominally profitable water companies in project cities has shown all but one to be suffering negative returns on revalued capital.[34] Where companies suffer losses, operating subsidies are provided by the municipality. In 1991, 80 percent of total water company operating subsidies were paid in the five cities of Beijing, Tianjin, Dalian, Qingdao, and Jinan. All are in water-short areas of North China with a very high marginal cost of supply. Gas company subsidies were more common. Only 7 of the 56 cities with town gas operations and 36 of the 167 liquid petroleum gas companies reported a profit.

3.6 **Municipal Budgets: Past Growth and Potential Constraints.** Rapidly growing fiscal resources have given cities the means to substantially increase their infrastructure and other investments over the past 15 years. From 1981 to 1991, the 15 largest cities had on-budget real per capita expenditure growth rates averaging 11.3 percent a year, while the next largest 59 cities had expenditure growth rates of about 15 percent per year. On-budget per capita real revenue growth rates were lower, at 1.6 percent annually for the 15 largest cities and 4.6 percent annually for the next 59 largest. With lagging revenue growth, much of the increased expenditure was financed by higher on-budget revenue retention rates. In 1981, retention rates averaged 26 and 29 percent,

Table 3.1: MUNICIPAL SERVICE COMPANY PERFORMANCE (1991)
(Y million)

	Water	Gas
Production value	4,680	2,850
Total profits	386	(532)
Operating subsidies	304	588

respectively, for the two groups of cities; by 1991 they had risen to 63 and 70 percent. Off-budget revenues (see Box 3.1) accruing to local government finance bureaus grew at less than the inflation rate over the period, but those to administrative bureaus soared at an 18 percent annual real rate, equaling 31 percent of local government on-budget revenue by 1991. These figures testify to the rapid decentralization of expenditure authority during the first decade of reform.[35]

BOX 3.1: ON-BUDGET VERSUS OFF-BUDGET REVENUE AND EXPENDITURES

The Chinese government defines revenues and expenditures as either on-budget or off-budget. The budget figures approved by the national and local People's Congresses are in the on-budget category, although central government rules guide the use of both types of funds and require that their use be included in local plans.

On-budget revenues include taxes of all kinds; SOE profit remittances; and assorted other revenue such as that from repayments of finance bureau capital construction loans. On-budget expenditures include infrastructure investment (including that in enterprises made through the budget); government administration; national defense; and public health, education and safety.

Off-budget revenues include local surtaxes; some local bureau income such as road maintenance fees; and enterprise retained earnings held in designated funds such as the enterprise social welfare fund. Off-budget expenditures are typically earmarked by revenue source and include enterprise investment; urban infrastructure maintenance; administrative expenses; and some transfers to higher-level governments such as budget-balance funds.

Off-budget funds equaled 59 percent of on-budget in 1982, a figure that grew to 94 percent by 1991. Fully three quarters of the off-budget funds accrue to enterprises and their sector bureaus, and nearly half of the expenditures are used for fixed-capital investments or major overhaul expenses. The next largest claimant, with less than 10 percent, is worker social welfare expenses.

3.7 The central government recently moved to halt any further erosion of its expenditure share. The tax reforms implemented in January 1994 restructured the tax system and bolstered the central government share, while guaranteeing local governments their 1993 nominal revenue level in 1994. If the new tax system meets its goals, municipal revenue growth will become less elastic to overall economic growth. Off-budget revenue

will assume greater importance in cities, and municipal service subsidies will be harder to finance.

3.8 Municipal expenditures in China cover not only the administrative, public safety, social welfare, and urban infrastructure costs common in all countries, but also substantial public housing and enterprise investment.[36] The high GDP growth rate creates demand for massive investments in urban infrastructure. As a result of these exceedingly diverse demands on municipal government resources, and with expectations rising as quickly as GDP, municipal governments continue to face difficult trade-offs among elements in their investment programs. Many municipalities divert money from operations and maintenance needs to fund new investments, which themselves may be launched before full funding has been identified.

3.9 **Sources of Infrastructure Funding**. Total funding for municipally provided urban services reached Y 26.6 billion in 1991. This amount equals 27 percent of municipal on-budget expenditures, but a much smaller proportion of *total* municipal expenditures. The latter, like funding for urban services, comes from many more sources than municipal on-budget revenue. Table 3.2 summarizes on- and off-budget funds used for all urban maintenance and construction activities performed by municipal governments in 1991. The table does not consolidate income and expenditures of municipally owned companies such as the water and gas companies, but does include profits and certain other remittances from those companies to the cities. Those are included in "other revenue," as are sewerage fees. The income of water, gas, and district heating companies would add another 31 percent to the totals in Table 3.2, an indication of their relative importance in overall financing.[37]

3.10 The table illustrates the great diversity in structuring local finance and the widely varying access to central government and other external resources. The funding ranges were taken from averages for all cities in a province; if individual city data were available, the ranges would be even greater.

3.11 **Application of Infrastructure Funding**. Although municipal companies operate under independent budgets, many of their capital costs are paid from municipally-generated resources (including domestic and foreign loans and grants). Of expenditures for urban construction and maintenance, fully 22 percent supported water and gas supply companies (see Table 3.3). That support went primarily to capital construction, which took 43 percent of all expenditures. Maintenance claimed another 37 percent and operations only 20 percent.

3.12 Reporting categories for revenue and expenditures do not permit ready analysis of financing strategies for specific services. A comparison of Tables 3.2 and 3.3 shows only three categories—housing, parks and environmental sanitation—that appear to define equivalent services. Each of those cases shows subsidies for the service, with that for environmental sanitation substantially larger than those for parks and housing.[38] But even that conclusion may be wrong, for in many cities the neighborhood committee plays an important role in moving solid wastes, compensated through user fees, and neither their

Table 3.2: SOURCES OF FUNDS FOR URBAN MAINTENANCE AND CONSTRUCTION, 1991

	Contribution to total funds (%)	
Source of Funds	National Average	Provincial Range
Urban Maintenance and Construction Tax and Public Utilities Surcharge	36	15-73
Local Government Grant	10	2-24
Domestic Loan	9	0-28
Central Government On-Budget Investment	3	0-35
Central Government Financial Grant	1	0-6
Water Resources Fee	1	0-6
Foreign Grant or Loan	4	0-14
Housing Rental Income	7	2-19
Park Income	3	1-9
Environmental Sanitation Income	1	0-4
Other Revenues	24	6-38

Note: Cities in Tibet have a unique funding pattern and have been excluded from the range. The national average does not sum to 100 due to rounding. The provincial range shows the low and high provincial average values.

Source: MCon.

income nor expenditures are recorded here. Many other services also rely on diverse income sources that are not consolidated in one budget, preventing urban leaders from knowing the true relative cost of services.

3.13 **Tariffs for Urban Services.** Most urban services operate under conditions of excess demand, but municipalities usually lack the authority to regulate demand through tariff increases. The central government, through the Price Bureau system, controlled key urban tariffs until 1991, when that right was granted to the provinces. Some provinces then gave cities pricing authority, but most did not. The central government itself continues to interfere in service pricing. In a 1993 ruling, the central government forbade the application of sewerage tariffs to households and capped enterprise sewerage tariffs at a rate well below handling and treatment costs. Then, in early 1994, in response to growing inflation, the central government declared a moratorium on price increases for 20

Table 3.3: Application of Funds for Urban Maintenance and Construction, By Type of Service, 1991

Type of Service:	Claim on total (%)
Housing	11
Water Supply	12
Town Gas	10
Public Transport	3
Other Public Infrastructure Construction	34
Parks	8
Environmental Sanitation	9
Other	13

Note: Drainage and wastewater treatment capital construction fall in the "Other Public Infrastructure Construction" category, as do roads and bridges.

Source: MCon.

urban services, among them gas and water. The practice of underpricing urban services encourages excessive consumption and creates pressure for overinvestment.

3.14 Economically optimal tariffs can play a powerful role in managing demand in a market economy. Unlike other areas of the economy, in urban services China continues to rely on the planned economy methods of quotas, supply cutoffs, and exhortation to control demand. But abundant evidence exists that in a market economy, prices control demand more efficiently than the alternative methods. Quotas and supply cutoffs play a useful role in emergencies, but distort development if used continuously. Education complements proper tariffs by explaining why demand must be managed and by showing consumers how to make the best use of scarce resources.

3.15 How effective are prices in regulating demand? That depends on current incomes, use levels, the weather, and other factors. Price regulation will not be successful if consumers cannot control their utility bill by controlling their consumption. Here, the widespread practice of metering provides Chinese cities with a prerequisite for management of water, wastewater, and gas demand. Because consumers need time to adjust their consumption patterns, the short-run response to a price increase may be less than the long-run response. This pattern was seen in developed market economies after the oil shocks of the 1970s, where the long-run elasticity of demand for petroleum was much greater than the short run.

3.16 **Interpreting the Data.** Before turning to the analysis of specific environmental services, two cautions are in order. First, the analysis cites official statistics on environmental service coverage. Chapter 1 noted the various ways in which the Chinese count the urban population (Box 1.1). Most city service obligations extend only to nonagricultural residents, who in 1991 totaled 149 million people compared to the 305 million "urban" population shown in the statistical yearbook that year. Therefore, the figures for percent of population covered should be interpreted as coverage for the built-up urban core, not that area plus the city suburbs. To the extent that services such as sewage treatment and domestic gas protect water and air quality, the coverage figures overstate the protection provided by city investments. Second, the number of cities grew from 233 in 1981 to 479 in 1991. Where growth in total supply is reported, it has not been normalized to reflect the growth in city numbers.

C. Water Supply

3.17 **Supply Trends.** Among possible environmental investments, Chinese municipal leaders give top priority to adequate supply of potable water. Of the urban environmental services listed in the Seventh Five-Year Plan (1985-90), only water supply fully met its target. In contrast to water, expansion of sewerage, sewage treatment capacity, town gas, roads, and public transport all fell well below target. A lack of comparable statistics makes it difficult to track the coverage of municipally provided water since the early 1980s. But per capita domestic supply increased rapidly over the period (see Table 3.4).[39]

Table 3.4: Per Capita Supply of Domestic Water from Municipal Systems

	1980	1985	1988	1991
Supply (liters/capita/day)	128	151	163	174

3.18 Rising average supply levels mask high variability of supply across the country. Northern Chinese water resources generally are far below those available in the south. In 1991, 18 cities, all in north China, reported that daily average per capita domestic water consumption from enterprise and municipal sources fell below 40 liters. In recent decades, to meet increasing water needs, many areas in north China have consumed water well above sustainable levels by exploiting previously untapped aquifers. Extraction fees, if charged at all, were no higher than those in water-abundant areas and municipal water was delivered at prices near the national average. This pricing strategy supported increasing consumption and short-term growth, but has also resulted in massive drawdown of aquifers in many places. Damage from pollution has exacerbated the problem. The overextraction of groundwater has led to significant land subsidence in 45 of China's medium and large cities. In Taiyuan, one of north China's major industrial cities, the water table was lowered by some 50 meters over 20 years. Subsidence now affects 300 km^2 in the city, reaching 2 meters in some places. A water transfer project

designed to sustain growth in Taiyuan and Datong, another large industrial city, would require an estimated investment of $1.4 billion plus the large annual costs associated with lifting the water 600 meters. Unsustainable extraction over much of north China has begun to require radical, expensive intervention, and a shift away from the agricultural and industrial production structures fostered by a cheap water policy.

3.19 **Diverse Sources**. City governments share water supply responsibilities with enterprises, which have built small systems to supply their own needs and those of their workers.[40] In 1991 enterprises pumped 54 percent of total urban supply. The municipal systems concentrate on household and commercial service, supplying 85 percent of all domestic users, but only 31 percent of enterprise consumption. Domestic water is supplied via standpost, communal taps, or the increasingly dominant household connection. The combination of municipal and enterprise systems in the largest cities provides nearly complete coverage to their nonagricultural population and supports domestic consumption levels that are high by international standards (Table 3.5). Smaller cities leave some residents dependent on private or collective wells, surface water, or other sources, but typically provide good supply volume to those served.

Table 3.5: WATER SUPPLY BY CITY SIZE, MUNICIPAL AND ENTERPRISE SYSTEMS, 1991
(479 Cities)

	All Cities	> 2 million	1 - 2 million	500,000-1 million	200,000-500,000	< 200,000
Percentage of population served	88.6	99.0	94.7	93.2	83.8	75.3
Average daily per capita domestic consumption (liters)	205	293	163	188	204	154

Source: SSB, *Chengshi Tongji Nianjian*, 1992, pp. 32, 33.

3.20 **Quality Supply**. Chinese drinking water standards match international practice and, at least in the medium and large cities, water plant output generally meets those standards.[41] Even when plants meet output standards, problems can arise due to groundwater infiltration of the delivery system. However, little evidence exists of health problems related to drinking water. Here, the Chinese tradition of boiling their drinking water serves as an effective safeguard against system failures. Surveys of urban residents have shown water quality to attract little notice except in Shanghai, where phenols in the raw water cause taste problems, and occasionally in other cities when high chlorine dosing has been needed. In medium and large cities, 24-hour water supply is generally achieved, although some small cities fail to reach this goal.

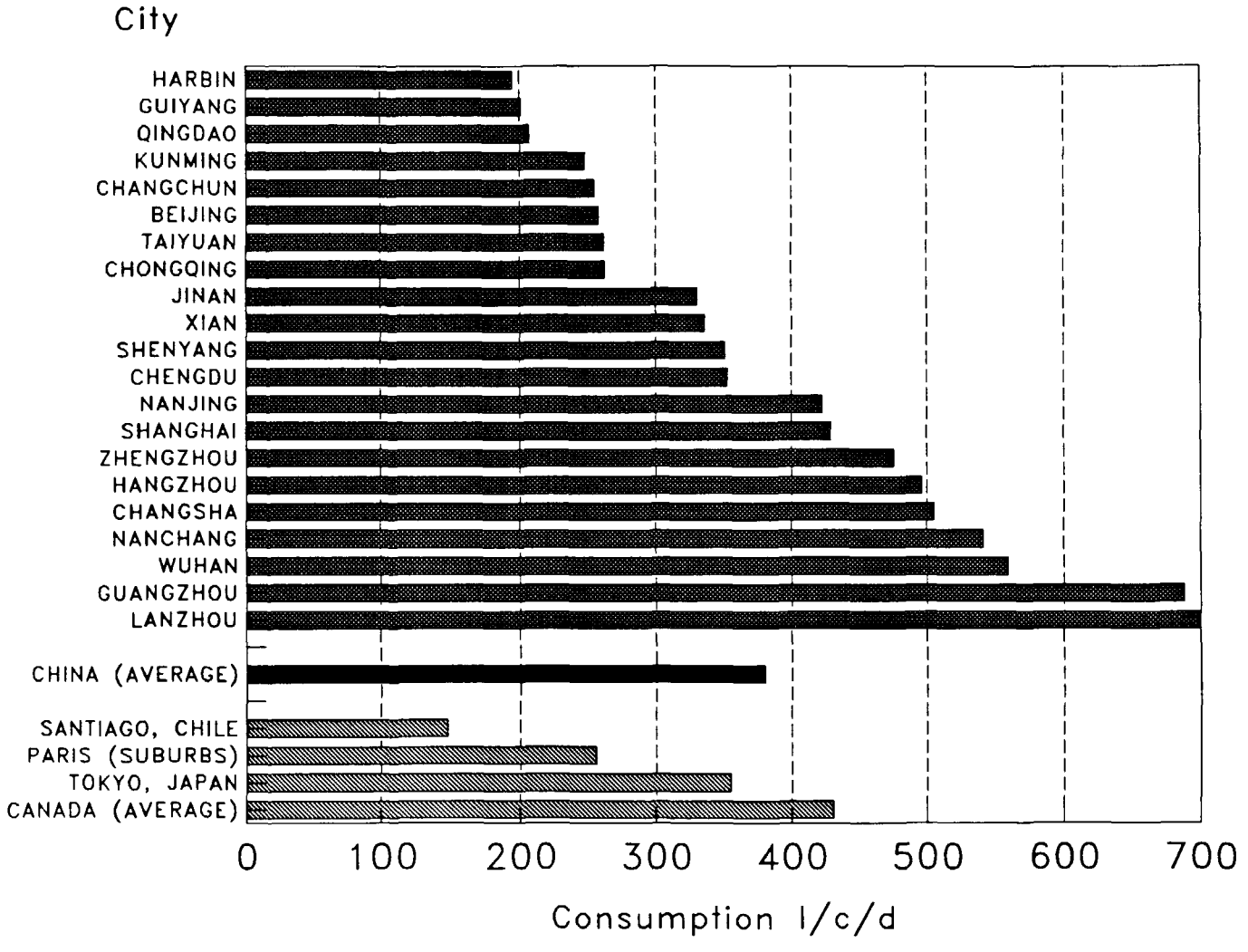
3.21 **System Management Quality.** Chinese water utilities report excellent unaccounted-for water (UfW) rates, one of the most common measures of water supply system physical and administrative quality. UfW measures the difference between water delivered from plants and that billed to customers. Differences arise due to leakage, unmetered legal uses (such as fire hydrants), malfunctioning meters and illegal connections. Singapore is generally credited with the best performance of any country, with about 7 percent UfW. Well-run European and North American urban systems have UfW from 15 to 25 percent and in developing countries figures above 40 percent are common. Chinese cities reported average leakage at 8.4 percent in 1991, which, if correct, would represent exceptionally good performance. However, municipal pipe breakage rates and pipe and pipe joint quality call into question the low reported rates. The low leakage rates apparently are reported in response to national operating guidelines that penalize high UfW, but rather than encouraging good management the guidelines may simply encourage false reporting. China performs well in other aspects of UfW, with very high metering rates and low illegal and unbilled connections. Accurate UfW figures are critical for managers designing maintenance programs. UfW of 10 percent leaves little room for cost-effective increases in maintenance effort, while a 40 percent rate may justify such an effort.[42]

3.22 **Excessive Consumption.** The domestic supplies reported in Table 3.5 are high by developing country standards and the increases since 1980 parallel the rising real income of the urban population. Despite repeatedly voiced government concern over water shortages, when enterprise consumption is included, per capita consumption in Chinese cities compares well with that in other countries (see Figure 3.1). In fact, consumption is so high, the real cost of additional supply are rising so quickly, and budgetary constraints are sufficiently tight that China's water demand management policy needs a radical overhaul. The basis of the new policy must accord with the reformed market organization of the economy and rely much more on price to guide enterprise and household consumption choices.

3.23 The current demand management policy sets quotas for industrial water use and recycling rates. It complements those rules with experimentation on new water saving technologies and some earmarked financial support for their installation. Water reuse rates have risen significantly, yet numerous studies continue to show Chinese industry using water far above international best-practice levels, with the worst-performing industries at three to four times those levels. Moreover, the need to meet additional demand through more distant or difficult-to-access sources has driven up the cost of new supply. In the three years from 1988 to 1991, the average investment cost for an m^3/day of new supply in China rose 23 percent *in real terms*.[43] This increase is consistent with international experience and the rate of increase can only be expected to grow over time.[44]

3.24 **Valuing Water.** Maximizing water use efficiency in a market economy requires setting the price of water at its long-run marginal supply cost, the cost of water from the most expensive supply source, valued at current prices.[45] At any price below that, users at the margin will pay less than the cost of production, encouraging overuse of the resource. Furthermore, in the OECD countries, China, and other nations using the

Figure 3.1: URBAN WATER CONSUMPTION, 1990: SELECTED CITIES (POPULATION: > 1 MILLION) AND SOME INTERNATIONAL COMPARISONS



Sources: China Water Supply Association;
Water Utilities Performance Indicators

"polluter pays" principle to determine responsibility for pollution damages, dischargers of wastewater must also be charged a fee equal to the marginal cost of the damage caused by their pollution. Again, a lower fee will encourage excessive wastewater discharges. Current water prices fall far below the price needed to induce consumers to use water efficiently. A new pricing policy is therefore needed that moves in stages toward the optimal price and has the advantage of managing demand increases to lower sector investment needs.[46]

3.25 Municipal water prices are too low. Most Chinese cities not only charge below the cost of marginal supply but below the *average* cost of supply, if that were properly measured. This forces water companies to look to municipal grants for new investment and major overhauls. Although national water pricing policy calls for a profit of 15 percent on the production cost of water, in 1991 the average water company profit rate on production cost reached less than 2 percent.[47] Even then, the recorded production cost was held down by deferring maintenance and depreciating historically valued capital at rates well below those common in market economies. Use of the historic cost of capital to establish a public utility rate base is not uncommon in other economies, but it proves to be particularly damaging in a period of high inflation in any economy. A preferred measure of enterprise welfare is the rate of return on revalued assets and that, for most Chinese water supply companies, has been negative in recent years. However, a very small number of Chinese cities have moved boldly to place their water operations on a self-sustaining basis, generating sufficient revenue to meet their own capital needs (see Box 3.2).

3.26 The practice of enterprise self-supply has helped cities limit municipal investment in the water sector. However, enterprises have been charged, if at all, raw water extraction fees of no more than Y 0.04/ton. Marginal delivered water costs to the enterprises vary substantially, but are reported to be below current municipal tariffs and well below the average incremental cost of new supply in virtually all cities. Whether enterprises self-supply or take supply from municipal systems, most cities must constrain demand through water use quotas. If additional supplies permit larger quotas, enterprises have willingly made use of them at current prices. This demonstrates a willingness-to-pay that exceeds current tariffs and, based on market economy experience that shows large efficiency gains from using price rather than quotas to allocate inputs, suggests that prices should be raised to the point where quotas can be abandoned.[48] For self-supplied water, this can be achieved by raising the raw water abstraction fee until average enterprise self-supply costs approach the new municipal tariff. Such a fee will be location-dependent, and can be set for each city by analyzing water production costs at representative enterprises. By using industry average production costs, individual enterprises are encouraged to operate efficiently, because they capture any cost savings.

3.27 The proposed sector pricing strategy follows that of Jinzhou, Shanghai, and other model operations by moving as a first step to water tariffs that provide a positive rate of return on revalued assets. Although this constitutes pricing based on average, not marginal, cost, where new water supply can be acquired at a cost close to current average costs as, for example, in Wuhan, the price adjustment will be very close to the optimal

BOX 3.2: WATER PRICE REFORM IN JINZHOU

The city of Jinzhou in Liaoning Province has become a pioneer in water company finances. At a time when municipal finances were strained by other infrastructure development demands, Jinzhou was faced with the need to serve the growing port city of Jinxi and to replace raw water supplies contaminated by industrial pollution. Jinzhou decided to raise prices sufficiently to make water operations self-supporting and to generate the funds needed for the new investment. A water price increase of 50 percent in early 1992 did not slow the growth of industrial or residential demand, which had not been met in previous years due to supply constraints. In May 1993, industrial water prices were raised an additional 42 percent to Y 0.84/m^3 and, in July 1993, household prices were raised by two thirds to Y 0.50/m^3.

With the latest increases, block tariffs were introduced for industry, with water at the Y 0.84/m^3 rate for consumption up to 90 percent of the previous year's consumption. From 90 to 100 percent, prices are Y 1.24/m^3, and from 100 to 110 percent, Y 1.64/m^3. Industry has been operating under consumption quotas for some years and water company officials predicted that neither industrial nor domestic consumption would fall in response to the latest price increases. They report that experience in the first months bears out their prediction. Jinzhou has moved incrementally, yet quickly, to discover enterprise and domestic willingness-to-pay for increasingly scarce water. The average price has now reached the marginal cost of supply and the company had a before-tax net return on revalued assets of nearly 8 percent in 1993. That will drop in 1994 as assets increase with the construction program financed under a Bank loan. But, critically, the company will be able to generate sufficient revenue to finance that loan with no recourse to city subsidies. The only risk in the strategy is that long-run price elasticities of demand may be higher than short-run, leaving new supply underutilized.

system price. In cities such as Kunming, utilizing several supply sources of widely varying costs, tariffs based on the average supply cost will produce excess consumption. For most, the adjustment to cover average cost will require a substantial real tariff increase. The average cost approach has the advantage of being readily understood by and easily justified to consumers. As consumers are educated to the new demand management policies, have time to adapt to them, and their demand response becomes known, companies can move toward fully optimal marginal pricing.

3.28 Raising water prices sufficiently to permit unsubsidized water company operation, and increasing raw water extraction fees enough to discourage overuse of self-supplied water, will reduce demand and provide the financial resources water companies need to increase maintenance and service quality and expand system coverage. Cities will then be able to reallocate the 10 percent of the infrastructure budget that now goes to water and will enjoy substantial increases in water extraction fee income. Both changes will provide resources to finance critical municipal needs or permit a reduction in the less efficient indirect taxes.

3.29 **Demand Impact**. The impact of tariff changes on total investment needed in the water and wastewater sectors will be very substantial in the long run. A tool used to help estimate the impact of change is that of the elasticity of demand. Price elasticity of demand measures consumer demand response to a price change. Numerous studies of

household price elasticity for water in developing countries show it to range from about -0.10 to -0.45. A study of Shanghai data showed a value of -0.38, consistent with international experience. The interpretation of the Shanghai value is that for a 10 percent increase in the real price of water, demand will fall by 3.8 percent. Similarly, if the real price falls by 10 percent, demand will rise by 3.8 percent. A second elasticity is simultaneously at work: the income elasticity of demand. This concept is based on the observation that purchasing decisions are affected by income as well as price. In an economy such as China's, with rapidly rising real incomes, this can have a powerful additional effect on demand. In Shanghai, the income elasticity was estimated at 0.22. Thus, if real incomes rise by 10 percent in a year, water demand will rise 2.2 percent in addition to any price effect.

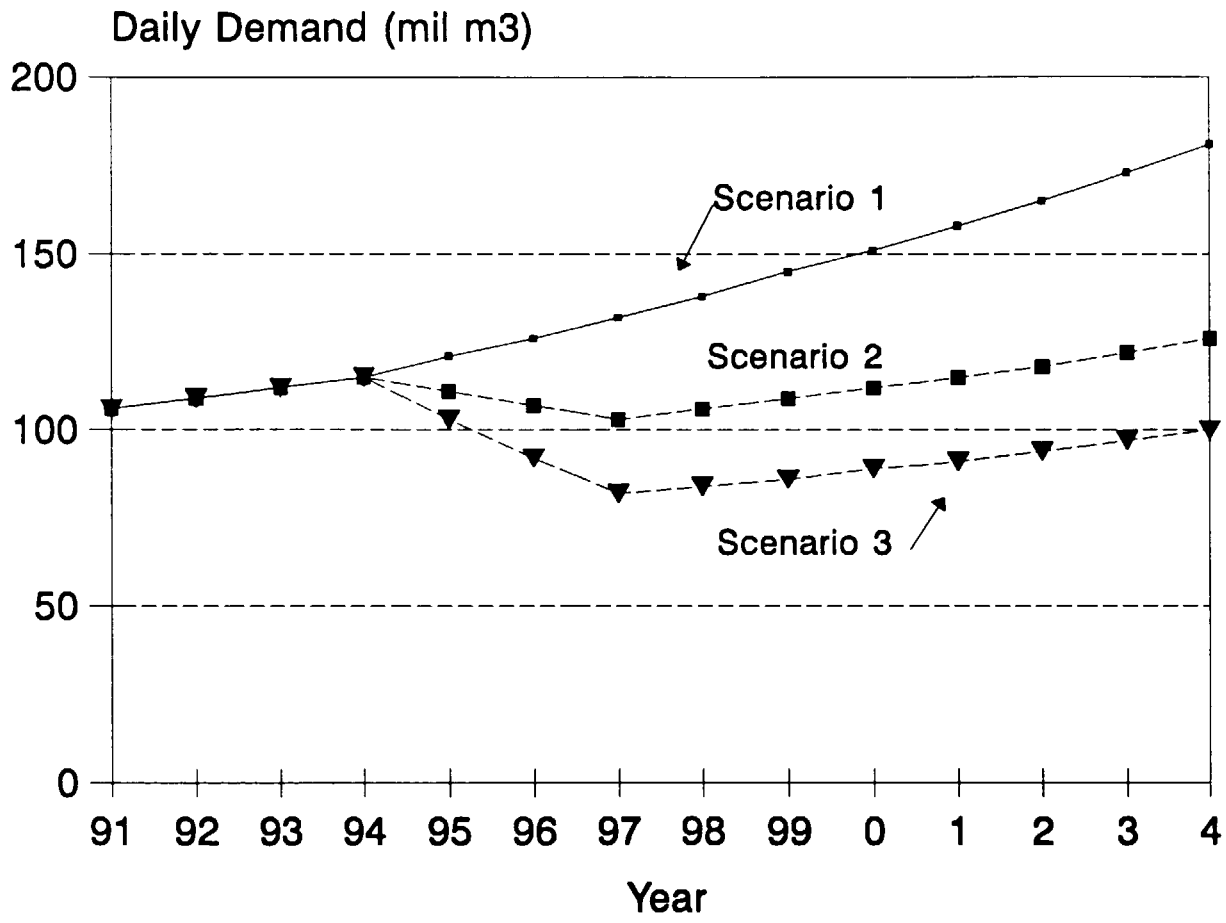
3.30 Enterprises behave analogously to households. If prices increase they adjust water consumption to maximize profits, with actual changes depending on their ability to conserve or recycle water. If their unit sales rise, their demand for water will increase, to the extent that its role in production is directly related to output. Few international studies on industrial water demand have been done, but those done show higher price elasticity than for households. Estimates have not been made for China because firms base water use on quotas rather than price, so elasticities cannot be estimated. However, the price elasticities of industrial demand can be expected to be very low until the water price rises sufficiently that it, rather than quotas, determine firm demand. After that point, a high elasticity can be expected, reflecting the ample opportunities for water saving.

3.31 The industrial response to water price changes raises the issue of short- versus long-run elasticities. In the long run, say over three to five years, a firm can install new, more water-efficient plant and equipment if water price changes make it worthwhile, but in the short run, say the first year, fewer options will be available and the short-run response may thus appear very low. Studies in gasoline markets, for example, have shown short-run price elasticities of -0.32 and long-run of -0.55.[49] A reason to phase in price increases is to allow time for the long-run elasticities to become known.

3.32 Under current pricing strategies, total water sector supply would have to grow by about 56 percent between now and the year 2004 to meet demand. Under a pricing strategy that allows water companies a positive real rate of return and increases raw water extraction fees for enterprises accordingly, total demand would not exceed 1994 levels until the year 2001 (see Figure 3.2).[50] Of course, investment would need to grow somewhat faster than the supply requirements shown because water surpluses are not easily transferred to underserved cities and new water sources must be developed to replace those lost to pollution. But even meeting those requirements, investment can be cut to perhaps a third of the level otherwise required. Operating costs will follow the investment pattern and they, too, will be much lower than otherwise for any given standard of service.

3.33 Recall also that due to the full exploitation of easily used raw water sources, by the late 1980s the real cost of increments to water supply was rising rapidly. The cost of developing new supply in 1991, the last year for which figures are available, was Y 1,575/m^3/day in 1994 yuan. By the year 2004, that is estimated to rise to Y 3,870/m^3/

Figure 3.2: ALTERNATIVE DEMAND SCENARIOS



Scenario 1 is current water demand; scenario 2 is water demand with full pricing; scenario 3 is wastewater demand with sewage tariffs. (See endnote #50 for underlying assumptions.)

day in 1994 yuan. In this, water behaves very differently from the cost of providing roads, bridges, drains, or other elements of the urban infrastructure. The cost of those investments can be expected to change with the rate of inflation for civil works—only water adds the element of increasing scarcity to the underlying inflation rate.[51] If demand is not managed more effectively than it is now, annual development costs for municipal systems will rise from Y 3.7 billion a year now to 8.2 billion in 2000 and 14.5 billion in 2004 (all in 1994 yuan). Price-driven demand management will hold investment below the 1994 level, saving Y 4.5 billion a year by the year 2000. Additional savings will be enjoyed in sewerage investment, discussed below.

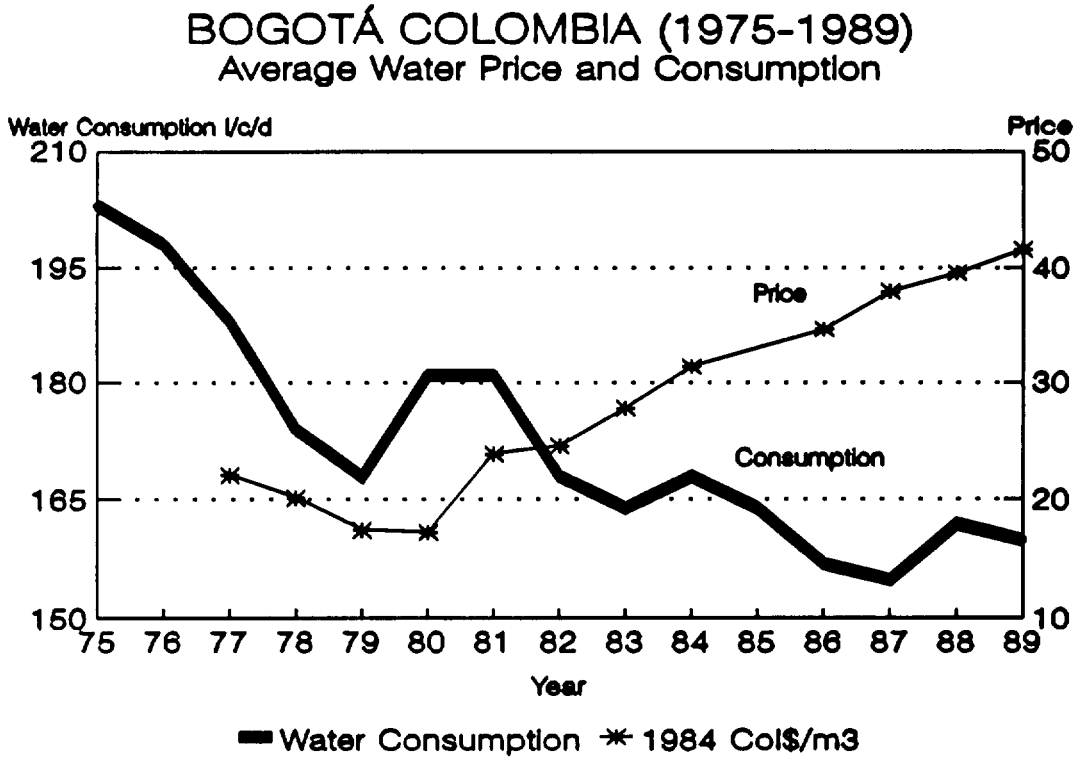
3.34 The recommended demand management strategy has been used successfully in large cities elsewhere. A notable example is Bogotá, Colombia, a city of over 5 million people in a country with per capita gross national product much higher than China's. There, water and sewerage rates (which are billed together, with sewerage charges based on water use) have been steadily increasing in real terms over the past 15 years to meet growing operational and investment requirements. From 1975 to 1990, the price per m^3 of water increased by 88 percent in real terms, while the per capita demand decreased from 203 liters/day to 160 liters/day (see Figure 3.3). Wastewater flows over the period showed a corresponding decrease.

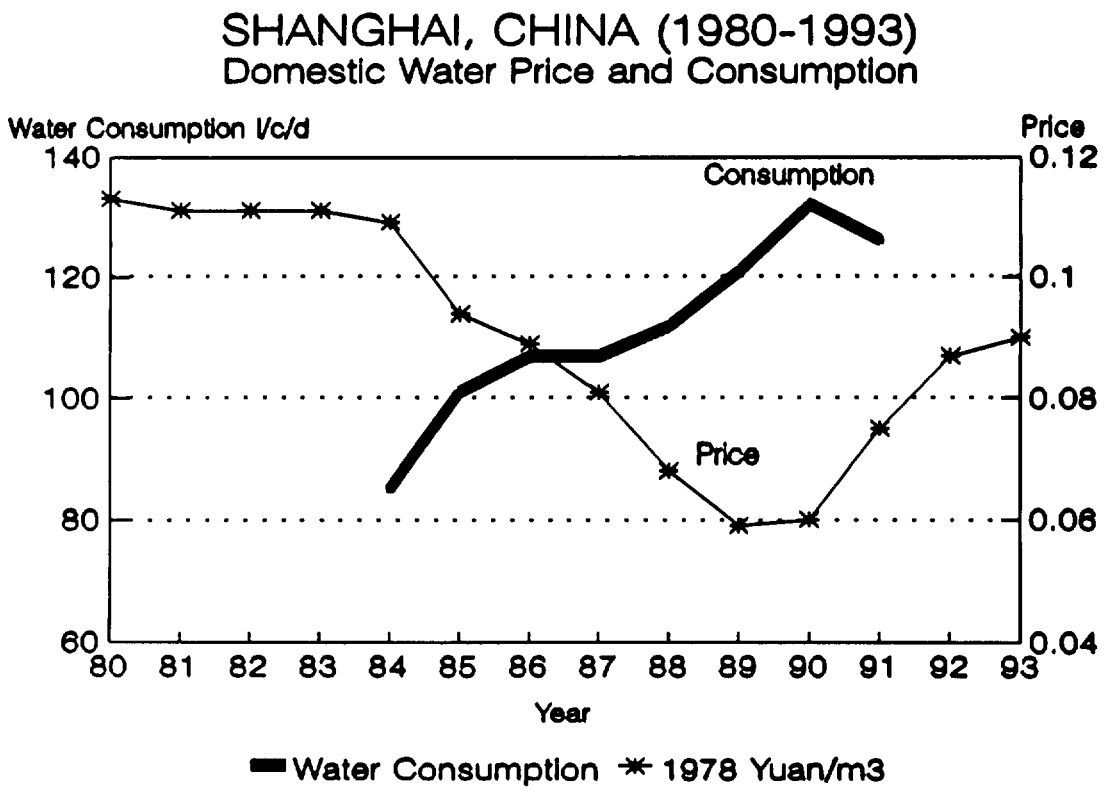
3.35 Over the 1975-90 period, the population served in Bogotá increased from 2.7 million to 5.1 million and enterprises continued to grow normally. The reduction in per capita water consumption represents an aggregate annual water saving by 1990 of nearly 220,000 m^3/day, enough to serve a population of about 1.3 million at 1990 consumption levels. The savings in sewerage facilities have been correspondingly large. Unfortunately, Bogotá has not captured the full benefit of this reduced demand because they expected less response to price and built higher-capacity water supply plants than they now need.

3.36 In contrast to Bogotá, the real price of water in Shanghai (and most other Chinese cities) fell between 1975 and 1990, with some increases beginning the latter year. With the real price of water falling 45 percent between 1984 and 1990 (and incomes rising), Shanghai residential per capita water use increased 55 percent, from 85 liters per day to 132 liters per day. Wastewater flows increased at the same pace over this period. The 25 percent increase in the real water price in late 1990 led to a small decrease in consumption in 1991 (see Figure 3.3).

3.37 At this critical turning point in urban public finance, Chinese cities cannot afford to overlook the great strength of the market economy in using prices, adjusted through a predictable, transparent process, to manage demand. As discussed later, the rapid growth of the economy will permit this to be done without threatening the standard of living of the urban population.

Figure 3.3: BOGOTÁ, COLOMBIA AND SHANGHAI, CHINA: WATER PRICE AND CONSUMPTION





D. Sewerage and Wastewater Treatment

3.38 **Wastewater.** A very high percentage of piped urban water flows on as wastewater (generally, about 80 percent of water used becomes wastewater—the remainder is consumed, evaporates or is absorbed directly into the soil). The manner in which the wastewater drains and how (or if) it is treated has a large impact on the urban environment and on the health of the populace, especially the poor. If receiving waters have sufficient volume to dilute the waste stream and other users are at a sufficient distance from the discharge point, little treatment may be needed to maintain receiving water quality at adequate levels. The water quality of the Yangtze above Shanghai demonstrates the power of dilution and the breakdown of pollutants through natural processes within the water body. Despite absorbing generally untreated discharges from major upstream cities such as Nanjing, Wuhan, and Chongqing; and from tens of medium and small cities; as well as fertilizer, pesticide, and other runoff from thousands of square kilometers of farms, the Yangtze meets Class I standards even in low-flow periods. Plumes of polluted water can be seen at discharge points into the river all along its length, but these are soon dissipated and metabolized within this very large body of water. Shanghai adds a waste load not so easily handled and State Oceanography Bureau patrol vessels have occasionally found algae blooms ("red tides") covering up to 130 km^2 in the East China Sea off the mouth of the Yangtze that they attribute to pollution.[52]

3.39 **Pollution Damage.** Most streams, rivers, and lakes within or below Chinese cities lack the powerful natural treatment capabilities of the Yangtze, leading to the very low water quality reported in Chapter 1. Heavy pollution in such rivers can have high economic costs. Those costs include the need to replace or provide additional treatment for degraded potable water supplies; the loss of agricultural and fisheries production; and the loss of recreational and amenity value. The loss of raw water sources for municipal supply appears to be particularly severe and the main cause of the rapid increase in water supply costs noted earlier. For example, the Hun River in Liaoning Province recharges the aquifer used for drinking water by the provincial capital of Shenyang. However, the Hun passes through the large industrial city of Fushun 20 km above the aquifer and Fushun's industrial and domestic discharges pollute the river and the aquifer, which forced Shenyang to construct a 51 km long, Y 564 million (then $108 million) conveyor to the Dahuofang Reservoir on the Hun upstream of Fushun. That does not solve the pollution problem, for much of Fushun's wastewater discharges to an irrigation canal that farmers continue to use despite its failure to meet irrigation use standards. Fushun has now begun work on a sewerage system upgrade and 250,000 m^3/day primary treatment plant that will cost Y 300 million and substantially reduce the downstream threat from their wastes.

3.40 The one reported Chinese effort to assess the damage from water pollution was a two-year research project completed in 1987 that spanned 20 provinces and 57 cities. The researchers estimated that if effective measures to control water pollution were not taken, wastewater discharges would cause direct losses of over Y 273 billion in the 15 years to 2002.[53] The study itself has not been published, preventing independent assessment of its assumptions and methodology, but the damage estimate averages some

1.5 percent of GDP. Since 1987, municipal wastewater flows have continued their rapid growth, with little increase in treatment. Reported industrial wastewater treatment levels have increased, but the overall treatment level remains about 20 percent.

3.41 **Sewerage Coverage.** Local watercourses continue to serve as both drains and sewers for an estimated 38.5 percent of the area of Chinese cities. Very few cities are completely sewered and almost all sewers are combined, serving as both storm drains and wastewater conveyors.[54] In 1988, the nine largest cities had municipal sewerage coverage of 74 percent, well above the 57 percent national average that year. Only Guangzhou reported complete coverage, with Chongqing second at 90.5 percent. The lowest coverage among major cities was in Wuhan, at about 50 percent. All told, about half of the urban wastewater discharges into sewers, while the other half discharges directly into lakes, rivers and estuaries. Sewerage connection levels have grown slowly over the past decade (see Table 3.6), with growth reaching only half the planned levels over the last half of the 1980s. Expectations were reduced by that experience and planned expansion for the 1991-95 period was set at 20 percent above the 1986-90 actual level. The investment plan to the year 2000 foresees 70 percent coverage in that year, only 8.5 percentage points above the 1990 level.[55]

Table 3.6: Length and Density of Municipal Drains and Sewers

	1957	1980	1985	1988	1991
Sewerage (km)	10,107	21,860	31,556	41,145	50,084
Sewerage (km/100,000 population)	14	24	27	30.8	32.3

Note: For comparison, the United States in 1973 had 453 km/100,000 population.

Source: 1957-85, p. 228 in Zhang Kunmin (ed.), *Zhongguo Huanjing Baohu Touzi Baogao* (A Report on China's Investment in Environmental Protection), Qinghua University Press, Beijing, 1992. 1988, 1991: MCon.

3.42 Part of the growth shown in Table 3.6 reflects the growing number of cities, rather than growth within existing cities. The "sewerage per 100,000 population" indicator in Table 3.6 adjusts in some measure for the growing city numbers and suggests the modest increase over the period. Another density measure shows sewerage per km^2 of built-up area, a measure which reached 4.4 km in 1991 and 4.5 km in 1992, but has not been published for earlier years.

3.43 In sewerage as in water supply, enterprise-controlled infrastructure makes a contribution to the supply of an urban environmental service. Table 3.6 presents only the contribution by municipal systems, as only this data series has been published for the years up to 1985. In 1991, the total length of urban enterprise sewers reached 11,500 km, expanding total urban sewer length by 23 percent above that for municipal sewers alone.

The sewerage coverage rates reported in para. 3.38 include enterprise sewers, which are found within the very large combined industrial and residential compounds typical of large SOEs.

3.44 **Sector Organization and Funding.** For cities organized into districts, that level of government takes responsibility for maintenance of drainage and sewerage works, while planning and construction are handled by the municipal government. And, because drains and sewers run under or along roads, the same bureau typically handles both operations. Just under 9 percent of the 1991 municipal infrastructure construction budget went to drainage, sewerage, and sewage treatment, an 84 percent real increase over the 1988 level. Nearly 11 percent of the smaller overhaul budget went to the same purpose. These two items totaled Y 1.6 billion, but unfortunately operating costs were not reported, so that total system costs are unavailable. In any case, the costs are well above the total sewerage fee collections of Y 750 million in 1991. Only some 300 of the cities collected the fee, which covers drainage, sewerage and treatment. Where the fee is collected, it is usually at the guideline rate of Y 0.08/m^3 charged against 80 percent of water consumption. A central government circular prohibits charging households or schools and other social institutions for sewerage services, removing about 40 percent of total discharge from the tariff base. Full recovery of primary treatment costs in cities studied by Bank missions requires a 1994 tariff of about Y 0.50/m^3 (applied to all users), of which operating and maintenance costs take about Y 0.27/m^3. Improvement to secondary treatment boosts the total to Y 0.77/m^3 for all costs and Y 0.37/m^3 for operations and maintenance alone (see Box 3.3 for treatment definitions). With costs running above those of water production, but without the benefit of correspondingly large charges, wastewater treatment places a heavy burden on municipal budgets.

3.45 Urban drains and combined sewers often collect a level of debris that reduces drainage capacity enough to impair seriously their ability to handle storm loads without flooding. In Kunming, wastewater treatment plant managers attribute wastewater inflows below design levels to siltation of the sewerage system. While design errors may play a role, sewerage system managers generally attribute maintenance problems to their lack of funds to hire work crews. This explanation is consistent with observed shortages of maintenance allocations in other sectors. The problem can be linked directly to the failure to charge adequately for the service and becomes especially serious when wastewater treatment, with its much higher costs, becomes necessary.

3.46 **Municipal Wastewater Treatment.** Where, as is the general rule, municipal wastewater treatment plants are bureau-run, the municipal budget consolidates the capital, operating, and maintenance costs into the overall infrastructure budget. The construction and overhaul budgets cited in para. 3.41 therefore include those costs. The impact of inadequate funding has been greater for treatment than conveyance, as the 1992 treatment rate of 4.5 percent indicates. Not only is coverage low, but extrapolating from the small sample of plants visited, design and management problems have been much more common with wastewater treatment plants than water treatment plants. For two plants, the city failed to provide adequate sewerage connections, leaving substantial idle capacity. Another plant appeared to have not been functioning for some time before being visited by

Box 3.3: Wastewater Pollutant Removal Efficiencies

Conventional wastewater treatment includes primary, secondary, and tertiary treatment, the final level depending on the quality of effluent required. Many alternative treatment technologies can be used. The following describes a system often found in land-short medium and large cities needing to process large wastewater volumes.

Primary wastewater treatment passes the wastewater through screens to remove large matter, through a chamber where grit settles out, into a tank that permits suspended solids to settle out, and then discharges the effluent. The settled sludge is removed periodically, dewatered, and put in landfills (or used as a soil conditioner if free of heavy metals). This process typically removes about 30 percent of the BOD in the wastewater, and most heavy metals.

Secondary treatment follows the primary stage by passing the effluent through a tank or tanks that have large numbers of bacteria that break down the organic particles in the wastewater (the activated sludge process). Typically, the bacteria are aerobic and to sustain the process requires that oxygen be added to the water, usually through paddles, propellers, or air injectors. After a stage of thoroughly mixing the bacteria with the organic matter, the effluent flows into a sedimentation tank where the digested material settles to the bottom. Again, the sludge is removed and dewatered and the effluent is discharged. This process typically brings BOD removal percentages up to about 85 to 95 percent. The large power requirements for adding oxygen and the additional plant raise total treatment costs about 50 percent above those of primary treatment alone. Needed management skills far exceed those for primary treatment and because industrial wastes such as arsenic kill the bacteria, the process requires adequate industrial pretreatment.

Tertiary treatment follows the secondary stage with filtration, typically sand filters or sand mixed with activated carbon, depending on the nature of the effluent. Chlorination or similar processes kill bacteria. Removal percentages climb as high as needed and costs at least double those for primary treatment alone.

a mission. Yet another took nine years to build and put into operation, instead of the planned three years, due to funding shortages. After several years of operation, one plant has never been able to dewater sludge because of faulty machinery and so dumps the sludge directly to the sea. In fact, sludge disposal is a problem for all plants. Most had planned to sell or give away the sludge for use as a soil conditioner, but farmers are reluctant to use it. Although farmer reluctance can be attributed to the low nutritive value of the sludge, if industrial wastewater has been treated, the likely presence of heavy metals also argues against agricultural use.

3.47 Table 3.7 shows the recent development of treatment plants. Of the 87 plants in operation nationwide in 1991, 16 had a capacity under 10,000 m^3/day, with most of those around 5,000 m^3/day. As discussed in Chapter 2, polluting enterprises have an obligation to treat their wastewater and that pretreatment boosts the overall treatment rate to the levels given in Table 3.7. National plans to the year 2000 call for the total urban treatment rate to reach 25 percent and municipal treatment to reach 6.2 percent.

Table 3.7: NUMBER AND CAPACITY OF MUNICIPAL WASTEWATER TREATMENT PLANTS

	1988	1991	1992
Number of cities with treatment plants	41	58	
Number of treatment plants (total/with secondary treatment)	69/40	87/53	100/68
Percentage of municipal wastewater treated Including industrial pretreatment		14.9%	17.3%
Provided to all wastewater once in the system		3.8%	4.5%

Source: MCon; SSB, *Chengshi Tongji Nianjian 1992*, Beijing.

3.48 The damage from wastewater includes direct economic impacts such as increased water system costs for downstream communities and damage to aquatic life and irrigated crops. It also includes less easily measured amenity costs in the loss of value to oily, odoriferous wastes in rivers and lakes. The optimal level of wastewater treatment can be calculated in terms of the cost of averting damage, but will be location and pollutant specific. In turn, the least-cost strategy will be pollutant specific. If current BOD loads can be safely absorbed in surface water, but phenols or petroleum cause problems, an industrial treatment strategy will be needed, whereas excessive BOD will probably require a municipal treatment plant with primary or secondary treatment.

3.49 **A Program of Intervention.** Given the low quality of urban surface waters and known downstream impacts, including growing aquifer pollution, the national government should now mandate rapid expansion of sewerage systems and treatment. From all evidence, the current national goals of 6.5 percent municipal treatment and 25 percent overall wastewater treatment for the year 2000 fail to meet China's needs. All cities should be required to expand their sewerage systems to a minimum of 90 percent coverage of built-up area within five years. Medium and large cities should be required to provide at least primary treatment (with provision for expansion to secondary) in a phased 10-year program unless receiving waters continue to maintain their quality at upstream levels. Treatment should be required for any discharge to receiving waters that already fail to meet the lowest irrigation standards. Primary treatment would reduce pollution loads from medium and large cities, which account for over 80 percent of total loads, by at least 30 percent. As expertise develops in wastewater treatment systems, small cities should be incorporated into the mandatory treatment program.

3.50 The estimated investment cost of such a sewerage and wastewater treatment program would be about Y 4.3 billion per year ($490 million) over 10 years, or about triple recent sewerage investment levels and a 15 percent increment to the annual urban infrastructure construction program. To partially offset that investment increase, the suggested water demand management program would cut investment in the water sector by an amount equaling at least 7 percent of the infrastructure construction program, leaving no more than an 8 percent net increase in urban infrastructure investment.

3.51 Simply building new treatment plants will not solve the problem. Although a formal study of treatment plant operation has not been published, industry sources estimate that funding shortages have forced most treatment plants to shut down operations, in part or full. To avoid that waste of investment, plant construction should not begin absent city implementation of the tariff regime needed to finance operations. However, some Chinese cities that have introduced such tariffs have found them difficult to collect. Resistance is not surprising, given that international experience shows a low willingness to pay for wastewater treatment. One method used to overcome this problem is to bill jointly water and wastewater charges, taking advantage of the high willingness to pay for water.

3.52 User fees should be set to cover all costs, but recognizing that the systems also provide storm drainage services, municipalities may choose to pay that portion of expenses from general revenues. For equity, and to broaden the customer base, all polluters, including households, should pay for treatment. Households and small enterprise tariffs would be levied against 80 percent of water use and for other enterprises against metered loads. Here, China's program of metering all water users offers a double pay-off. Not only can water use be properly attributed, but in any community very consistent relationships exist between domestic water use and wastewater loads. Household wastewater charges can therefore be billed with a high degree of accuracy based on water use, with very low additional billing costs. Jointly issued water and wastewater bills will reinforce for consumers the link between water use and wastewater production and encourage careful water use. For equity, and recognizing the damage caused by untreated wastewater, water users in any untreated part of the system would still pay the full fee. The user fees would raise the effective price of water use to firms and households. Based on data from recent Bank-supported projects, the increase would be close to the current average water tariff. This will further encourage water-saving behavior, again postpone the need for investment in new water supply, and allow sewerage and treatment systems to be designed to smaller, more economical capacities. Figure 3.1 reflects the additional water investment savings that would accompany the user fee strategy for wastewater.

E. Solid Waste

3.53 **Municipal Solid Waste.** Per capita generation of municipal solid waste (MSW) remains low, at an estimated 285 kg/person/year.[56] In 1992, collected urban domestic waste totaled 82.6 million tons and nightsoil 30 million tons, of which 28.3 million tons was placed in MCon-approved landfills, composted, or otherwise treated. The

1992 landfill rate of 25.1 percent follows a trend of growing attention to solid waste handling in recent years (see Table 3.8).

Table 3.8: MUNICIPAL SOLID WASTE AND NIGHTSOIL DISPOSAL

	1988	1991	1992
Total municipal solid waste and nightsoil (million tons)	81.0	104.0	112.6
Percentage landfilled or treated	1.0	11.9	25.1

Source: MCon Annual Reports.

3.54 Municipal and district governments, and neighborhood committees share responsibility for solid waste collection and disposal services. Although the model varies by city, the municipality typically sets policy and may provide centralized transport and landfill services, while the districts collect wastes, operate local transfer stations, and in most cities operate dumps. Neighborhood committees provide street sweeping and may offer house-to-house pickup and disposal to local transfer stations. If the neighborhood committee does not pick up at the household, residents bring their waste to neighborhood bins. Apartment buildings rely on chutes to basement collection rooms. Full service coverage is provided to core urban areas, with collection intervals ranging from daily to once every three days. On the urban fringe, MSW coverage drops to about 75 percent.

3.55 From district transfer stations the waste is hauled to dumps, landfills, or composting centers. Most districts contract with local agricultural villages for the dump land, land which has no provision for capturing leachate or methane. MCon recognizes the environmental threat posed by these dumps and has encouraged the investment in sanitary landfills and treatment plants that has led to much safer handling of wastes in some cities. The policy goal is to raise sanitary landfill or treatment from the current 25 percent level to at least 55 percent by the year 2000.

3.56 **Industrial Solid Waste**. Industrial solid waste (ISW) results in much larger waste streams than the MSW addressed above. Cities estimated that 620 million tons of ISW was generated in 1992, 50 million tons of which was hazardous. Enterprises are responsible for disposal of their own wastes, with the stipulation that hazardous waste dumping sites be controlled and protected from leaching. Enterprises may contract with the district government to collect their wastes or they may deliver with their own vehicles to city landfills. Despite attempts to limit such activities, MCon estimates that industries dumped over 10 million tons of industrial solid waste to rivers and lakes in 1992.

3.57 **Recycling**. The solid waste collection and disposal system is complemented by a waste products recycling industry. Some 40 percent of ISW was recycled in 1992, either by enterprises or municipal recycling agencies. For domestic and small enterprise waste, the recycling industry relies on small scale private and collective enterprises that provide door-to-door collection of, and on-the-spot payment for, any metals, plastics,

paper, or other products for which a market exists. The industry includes scavengers who sort waste at various points in the system, including neighborhood collection points and district dumps. The industry provides good coverage of urban neighborhoods and efficiently manages the marketable part of the waste stream. Reliable estimates of total recycled tonnage have not been made, but individual city studies show MSW recycling rates ranging from 5 percent to 35 percent.

3.58 **Financing.** For collection services, the household pays a monthly fee, typically Y 1.5, about 0.2 percent of average monthly income. In cities surveyed, the fee covers no more than collection costs, with disposal costs borne by the city budget. District sanitation departments often receive an annual subsidy from the city and may earn additional income through fee-for-service collection of industrial solid waste or other activities. In surveyed cities, the combination of income sources permitted adequate financing of collection operations.

3.59 Engineers with wide experience in other countries judge the collection operations adequate. Streets are swept, waste pickups are dependable, transfer stations operate properly and vehicle fleets are maintained. Nonetheless, this service frequently rates as that with which urban residents are least satisfied, primarily because scavengers, overflow, and careless dumping lead to piles of unsightly and malodorous waste around neighborhood bins. These problems would be reduced by replacing existing collection bins with large capacity containers that can be mechanically loaded into collection vehicles. That would end the manual double-handling of wastes that is partially responsible for the current problems.

3.60 **Disposal.** Sanitary engineers and environmentalists do not give China's landfills high marks. While some well-run landfills exist, most are poorly controlled, often failing to meet MCon standards, with inadequate handling of leachates and methane. Because such landfills have been identified as a major source of aquifer pollution, *the single largest improvement in solid waste handling in China would be provision of adequately engineered and managed landfills.* High quality landfills complement wastewater treatment efforts and can safely handle treatment plant sludge. International experience and economies of scale both show the value of operating such landfills at the municipal level in large cities and regionally for small cities. China has a few good examples of such landfills to draw upon, such as Shanghai's, and more are being built, some with foreign financing. As with wastewater treatment, not every locale needs sophisticated solid waste handling and careful analysis of local waste streams, soils, and aquifers is necessary before deciding the standard of construction or whether alternatives such as incineration or composting are attractive.

3.61 Landfill costs themselves are but a part of total handling costs, which all will vary with land availability. A recent study for Tianjin indicates costs of about Y 55 per ton for pickup, transfer, and disposal. At current domestic solid waste generation rates, that equals about Y 16 per capita in annual municipal solid waste costs, compared with charges that now average perhaps Y 5 per capita across Chinese cities. Domestic user fees must therefore rise to finance these costs and industrial waste disposal fees would also rise,

as uncontrolled dumps are closed. Chinese studies show a willingness to pay for domestic solid waste services that is little above current fee levels. Imposition of the new fees will therefore require intensive consumer education on the damage from current practices and anticipated improvements from the new systems.

F. Paying for a Healthy Environment

3.62 To date, Chinese cities have failed to charge the full cost of providing environmental services. But how much does this practice cost cities? Water and gas, the best candidates for full cost recovery, including self-financing of new capacity, together commanded 38 percent of the urban infrastructure construction budget in 1991 and 20 percent of the major overhaul budget. Their substantial operating subsidies were reported earlier. The financial burden of sewage treatment remains light because so few cities practice it. However, the economic costs of that practice may be large indeed, as downstream users suffer, as does groundwater. Solid waste collection costs do appear to be covered by fees. However, the use of unprotected dumps for waste, while cheap, leads to problems with pests, greenhouse gasses, and leachate. The first transmits disease, the second destroys the atmosphere, and the third destroys the groundwater. In brief, cities have chosen a strategy that burdens future generations as well as their neighbors.

3.63 **Tariff Strategy**. Tariffs should be designed to allow full cost recovery in each sector.[57] For the water sector this will lead to consumption based on willingness to pay, the best test of the value of a service. Water tariffs should be the same for all users unless the relative cost of serving them varies. In wastewater treatment and solid waste disposal, willingness to pay is typically below full handling costs, because the polluter does not suffer the full effects of the pollution. In these situations, countries make political judgments about responsibility for the pollution damage. China has opted for the "polluter pays" standard shared by many other countries. Proper implementation of that standard requires accurate measurement of pollution and China's ability to do that has been demonstrated. This approach does not distinguish between households and enterprises in their tariff burden, except as it reflects different pollution loads.

3.64 **Impact on Enterprises**. The suggested tariffs will substantially increase the direct cost of water, wastewater, and solid waste handling to enterprises and consumers. Enterprises have abundant opportunities to save water, but those savings themselves have costs. Production cost increases will vary with the current water use efficiency of the enterprise and managerial talent in adjusting to the new price regime. In most industries, water is a very small proportion of total production cost, usually well under 1 percent, and the impact of even large price increases need not have a large impact on output prices. Solid waste cost increases would have an even smaller impact. The possibility of reducing enterprise profits should not play a role in setting tariffs. Keeping tariffs low to maintain profits simply encourages excess use of water and generation of wastes, while allowing enterprises to avoid the fundamental restructuring they need for long run survival. Urban environmental services must be delinked from problems of enterprise reform.

3.65 **Impact on Households.** For households, two principal reasons for failing to exploit beneficiary financing are often cited in China. One is that when price-setting is politicized, political leaders are held accountable for price increases. No mayor wants to be blamed for "avoidable" tariff or tax hikes. The second is the pervasive belief that urban households are poor and that price increases involved in making public services self-sustaining are flatly "unaffordable." Analysis shows that urban consumers are well positioned to absorb both the direct and indirect costs of an improved environment. Real household income growth has averaged above 5 percent annually for more than a decade. To date, Chinese urban income policies have effectively prevented urban poverty, the rate of which is below 0.5 percent of the urban population. Under current pricing policies, for the *poorest* 5 percent of urban households, the water bill takes only 0.4 percent of total income. Adding other utility and service costs such as household fuels, electricity, and waste collection, the total rises to 4.6 percent. A tripling of the real price of water (which would subsume wastewater treatment) plus solid waste disposal costs, assuming full displacement of other consumption, would increase the total utility outlay to 5.8 percent of income. That compares to expenditures of 6.3 percent of income among the poorest on cigarettes, alcohol, and tea.[58] More important, the real income growth rates of the lowest 5 percent of households have matched those of wealthier cohorts over most of the past decade, allowing the proposed increment in cost to be recaptured through real income growth in a single year.

3.66 Chinese citizen expenditures on urban services are well below those found in market economies, where full cost recovery from beneficiaries of public services is approached. They are also well below rural expenditures for water. A study in 75 counties of six provinces showed village families paying an average of 3.1 percent of their income for water alone.[59] Consequently, there may be a *political* affordability issue but there is no *economic* affordability issue.[60]

3.67 **Strategies to Assist the Poor.** Impoverished households raise the one challenge to these tariff-setting rules. The very poorest urban families, probably not more than 0.5 percent of the population, have not enjoyed the rapid income increases of the rest and many depend on municipal welfare payments for subsistence. These families must be protected from cost-of-living increases and the most effective means of doing so is to increase their welfare payments. Those payments, funded from general city revenues, will not constitute a major demand on the budget. Another approach to protecting poor households is to offer block tariffs (sometimes called lifeline tariffs) that provide for a low tariff on very low volume consumers, followed by compensatingly higher rates thereafter. In water supply and sewerage, for example, the low rate (no lower than the current real tariff level) could apply to the first 5,000 liters per month of household consumption. However, these tariffs become economically and administratively efficient only when a large percentage of users are poor and the city government lacks an effective social welfare subsidy program. As China fits neither of those conditions, the increased welfare payment to compensate for higher tariffs is the preferred approach.

G. Efficient Organization and Regulatory Relationships

3.68 **Introduction.** Based on international experience, citizens accept the legitimacy of user fees that fully cover urban service costs *if* they receive responsive, quality service that they perceive of as efficiently delivered. International market economy experience suggests three fundamental, interrelated factors that encourage efficient service. These are (a) choice of an appropriate organizational form for the deliverer of services; (b) organization of the service delivery market to encourage competition; and (c) regulation of economic activity and the market to provide a stable, dependable framework for economic decisionmaking and environmental protection.

3.69 No one organizational form, be it government bureau, state-owned enterprise, cooperative enterprise, or private enterprise necessarily outperforms others in all possible urban service roles. Which will be best depends on the scale and complexity of the operations, sources of finance, and community tradition. However, one characteristic is important to all of them—an accounting structure that allows clear calculation of service costs. Only when costs can be attributed to particular outcomes will managers know how to adjust operations to lower costs, will the public be able to decide if the service is efficient, and will the service provider be able to charge users an economically efficient tariff.

3.70 The organization of the market in which the service provider works will determine what incentives managers have to discover high-quality, cost-effective solutions. The markets with the strongest incentives are those which are consumer responsive, that is, the consumer has choices and can therefore reject low quality, high cost services. In some markets, such as industrial solid waste collection, competition is easy to foster. The trucks needed for solid waste collection are widely owned, allowing a variety of enterprises to offer solid waste collection and disposal to industries, which can then choose the best combination of price and service. Even when a service is a monopoly in the short run, as might be a municipal water system in its command area, in the long run the provider could face competitive pressure in at least two ways. First, if the state owned the assets, they could contract for management via competitive bidding, a system common in France and used in some developing countries (notably Guinea). The management contract would be rebid at regular intervals to maintain pressure on the current manager to perform well. Second, it may be possible for large users to self-supply services. This happens in water supply in China, where half of the municipal supply is self-supplied by enterprises (although currently not, as shown earlier, under competitive conditions), and can be encouraged in sewerage and wastewater treatment, where large wastewater producers may find it more economic to upgrade in-plant treatment rather than hook up to the municipal system.

3.71 Competitive markets can develop when an economy has clearly defined property rights and transparent, legal means of transferring those rights; when contracts are enforceable; and when actual or potentially competing suppliers face equal access to credit, labor, and other markets. All of those attributes are strengthened when market

participants perceive government as committed to the market and to the value of competition.

3.72 **Bureau Organization.** As noted earlier, solid waste, sewerage, and wastewater treatment services in almost all Chinese cities are managed directly by city government bureaus. Bureau staff are civil servants, with salaries determined through civil service schedules. Civil service rules also determine promotion, transfer and other personnel actions. As government agencies, the service providers do not have segregated accounts, depreciation of capital, and other features of enterprise accounting that allow ready analysis of service costs. While service fees may be charged, any surplus accrues automatically to the municipal budget and any shortfall is covered through a transfer from that budget. Capital investments are financed through the budget and the activity cannot incur debt. As a result, and in a situation not unique to China, attempts at analyzing the financial performance of these sectors have not been wholly successful. This analysis of bureau performance suggests that the current organizational form fails to meet the first of the efficiency criteria, which calls for accounting that permits appropriate pricing that can be fully justified to consumers. Despite this problem, the overall organization of the market does allow competitive forces for some consumers, partially offsetting these problems. This is particularly true in solid waste.

3.73 **Solid Waste.** Improper collection or disposal of solid wastes leads to very high social costs in urban areas. Because of these externalities and because government intervention can lower the transactions costs of organizing efficient service to large numbers of small users, city governments everywhere tend to intervene in the market for domestic solid waste handling. The sector requires regulation, but lacks the scale that would justify city-level independent regulatory commissions. For this reason, bureau regulatory control continues to make sense. Nonetheless, organization to increase accountability or competitive forces can be used to lower costs. China already employs some of these forces, including neighborhood accountability and competition in ISW handling.

3.74 **Neighborhood Accountability.** One critical MSW component with high consumer accountability is the widespread use of neighborhood committees to provide neighborhood street sweeping, and in some cities, waste collection services. The neighborhood committees provide a variety of services. In local sanitation work they typically provide street sweeping and may opt to provide other services, such as door-to-door collection of nightsoil or domestic waste. Where they provide services, they do so with full cost recovery, charging users accordingly. Because service areas are so small and the relatively immobile population is well known to one another, this cooperative service delivery, often hiring workers living in the neighborhood but also free to hire outside labor, maintains a high level of consumer accountability.

3.75 **Competitive Markets in ISW.** The largest part of the market open to competition is in industrial and construction waste collection and handling, which accounts for 85 percent of the tonnage in the urban solid waste stream. Enterprises are responsible for handling their own wastes, which means that they are free to provide the service

themselves or contract for it. In practice, both approaches are used and that part of the market is competitive. Municipal sanitation bureaus in some cities compete for the right to provide these services and, with an existing infrastructure of transfer stations and disposal sites, may be a cost-effective provider. However, they may also have unfair competitive advantages in not properly costing their service and not having to pay directly for their capital. *Therefore, in terms both of bureau service delivery and deepening the existing competitive market in ISW handling, the single most important innovation will be to establish bureau solid waste operations as an autonomous financial entity.* China widely uses this form of organization, termed "administrative unit managed as a company" in other sectors. That first step will allow proper costing of services and therefore give city managers and citizens a basis on which to judge service efficiency. Knowing true costs, managers will also be better placed to lower those costs. As experience with financially autonomous provision of ISW and MSW services deepens, managers may want to move to a completely autonomous corporate form. This would permit a move to broader competition to provide services, in which the newly formed corporation would be just one of the bidders.

3.76 **Contracting for MSW?** One approach gaining popularity in other market economies where municipal provision of MSW services is costly is to contract with enterprises to handle portions or all of the current municipal collection, transfer, or disposal obligation. In fact, many Chinese cities already contract for that entire range of services in nightsoil handling. Building on that experience could lead to cost savings in municipal solid waste. A model contract for district level contracting of MSW services has been prepared under the Bank-funded Shanghai Environment Project and is available for study by other cities. Another element of the MSW process that could be handled through competitive contract is the provision of landfill services. However, this should be done only when the municipality provides careful regulatory oversight. The financial incentive for the operator to cut corners on leachate or gas control can be quite substantial, and hazardous wastes must be kept out of the waste stream unless the landfill has been especially designed for that use. In summary, it is recommended that all cities move bureaus to autonomous accounting for solid waste services, with an eye toward opening up the core MSW collection, transfer, and disposal system to competition and accountability.

3.77 **Sewerage and Wastewater Treatment.** The motivation for government administration of sewerage follows that of solid waste: improper collection or disposal of wastewater leads to very high social costs in urban areas. As with solid waste, government intervention can lower the transaction costs of organizing efficient service for large numbers of small users. In the absence of collective organization, the service is rarely provided. However, unlike solid waste, sewerage services do not lend themselves to competitive supply by a large number of autonomous agencies. This is because of the very large capital costs of the system, capital with little value in other uses. Additionally, integrated reticulation systems and treatment plants enjoy scale economies that imply optimal service by a very small number of suppliers.[61] Furthermore, the master planning needed to realize the scale economies can only be done by an agency with a municipal or,

possibly, regional perspective (though the planning agency and the sewerage system operator need not be one and the same).

3.78 **District Control.** When, as in most Chinese cities, municipal wastewater discharges through combined wastewater/stormwater systems, without treatment to surface waters, the current bureau organization may offer the most efficient management. This is because drainage costs, a large proportion of the total, are derived from indirect revenue sources, and the construction and maintenance of the system is closely connected with road building and maintenance operations.[62] Those services are often provided by the same bureau, allowing ready coordination. At this level of operation, this study affirms the Chinese large city practice of master planning, investment phasing, and design criteria being provided by the city bureau, while districts operate and maintain the system. However, analogous to the solid waste operations, as sewerage operations develop, and particularly as cities begin to charge fees that cover the cost of service, establishing independent accounting for sewerage operations will become critical so that those costs can be known. And, as in other bureau operations, managers may be able to reduce certain costs by contracting for services in a competitive market. In sewerage, such contracted services could include removing debris from storm or combined sewers.

3.79 As wastewater treatment becomes more common, the current sector organization will likely prove inadequate. Coordination problems will develop when treatment plants serve more than one district. As budgets and staff size grow and technical demands multiply, managers will need the increased autonomy that only corporate organization can provide. Small cities with a single treatment plant may continue to find bureau organization the most cost-effective, but for the same reason that all large cities now have independent water companies, they will want sewerage under corporate management. Indeed, Chinese cities may find that the engineering, financial, and administrative demands in sewerage and wastewater treatment resemble those of water closely enough to make it worthwhile to transfer sewerage assets to their water companies. Singapore and many cities in Europe and North America have joint water and wastewater operations. Even if independent companies are formed, large administrative economies can be enjoyed if the sewerage companies use the water companies to bill users charged on a percentage-of-water-use basis. Contracting for billing in that way constitutes another example of out-sourcing to reduce costs, opportunities for which should be aggressively sought.

3.80 **Water Supply.** Chinese cities have long recognized the value of organizing municipal water services under water companies. The large investments in the sector have needed the planning guidance of a city agency and the organizational flexibility of a corporation to provide the best service. Yet, this organizational form has not yet sufficiently matured to capture all major efficiency gains. Most of the problems experienced by the water sector are common to the SOE sector in China (of which water companies are a part). As such, the solutions to many sector problems, such as company social welfare obligations; the lack of long-term capital markets; and the need to go through government bureaus for access to short-term capital markets, will be solved only as part of the general solution to generic SOE problems. Other problems are sector-

specific and revolve around the fact that water companies provide monopoly services, the coverage, quality, and price of which affect the daily lives of municipal residents and are often taken to serve as indicators of able governance. Whether general or sector specific, changes can be made now that improve efficiency and leave water companies well placed to take advantage of improvements in the overall economic environment.

3.81 As enterprises, water companies use accounting conventions broadly consistent with international practice. The move to this accounting system occurred only in mid-1993, when all SOEs made the change. The original system met the needs of SOEs under the planned economy, where economic efficiency took a back seat to meeting physical output targets using a planned physical input stream. Under this system, accountants recorded expenditures and income, but not within a structure that allowed easy analysis of financial flows, which is one of the main objectives of the new system. The new system allows managers to focus on a different target, that of minimizing the expense of producing to meet market demand. Such accounting systems allow managers to accurately analyze their cost structure and the impact on that structure of organizational or other changes. However, few water company managers have adapted to the change in company goals, and indeed lack staff with the experience necessary to undertake analysis in support of those goals. In this, again, water companies exhibit qualities common to all SOEs. However, with the move to the market, most SOEs have been exposed to much more severe competition than have water companies, and thus their managers have a much greater incentive to learn new managerial skills. Below, some means of increasing competitive pressure will be suggested. But those or similar ideas will be of little value before *managers learn to use the accounting and other tools for more efficient management already available to them.* To encourage this, a group such as the China Water Supply Association (CWSA) should develop informational or instructional material that shows managers the power inherent in the new accounting system. These materials could be developed through a program in which MCon or CWSA staff or consultants work closely with one or more water systems that have successfully introduced the mechanics of the new accounting system, to develop guidelines for financial and operational analysis and for the use of analytical results. After demonstrating improvements in the test system, the case study can be prepared along with the technical explanations to give managers specific, successful strategies for using the new system.

3.82 Recent research has shown that services delivered by corporations, even those using modern management tools, will not necessarily be delivered any more efficiently than by a government bureau. A practical precondition for superior performance appears to be that the corporation function within a well-defined, incentive-driven regulatory environment characterized by an arms-length relationship with government.[63] By increasing water prices to full cost-recovery levels, the government will provide water companies the resources to finance their own expansion, recognizing that the capital needs for expansion will be slowed by the relatively higher, but still affordable, price of water. This self-financing capacity will significantly disentangle the enterprise/government relationship, although the government may need to assist with access to bank loans if political criteria continue to govern loan distribution. To foster long-run planning in water companies, municipalities can enter into service contracts with them.

The contracts must specify company obligations with respect to water quality and quantity, service expansion, billing practices, internal funding of the investment program, noncompliance penalties and other variables that the municipality deems relevant. In the contract, the municipality will agree to a pricing formula effective for the life of the contract. Variations on such contracts have been used in France, the United Kingdom, Spain and a variety of developing countries, usually with a contract length of five years or longer. Sample contracts are readily available.

3.83 In some countries, notably France, management firms compete for the right to manage water operations. However, the relative inexperience of the Chinese water sector with market management suggests that for the near future, an alternative approach might be preferred. In this approach, current management will negotiate an operational contract of the type discussed above. The city administration will, as part of that contract, stipulate a pricing formula drawing on lessons in incentive regulation. The base price for the formula must be one allowing an adequate rate of return. The formula should then adjust for the impact of inflation, incorporate expected efficiency gains in the company over time, and make necessary allowances for capacity expansion or quality improvements.

3.84 The inflation adjustment needs to capture the effect of price changes outside of company control. It should not be based on actual company input use patterns, for if it changes with the company input mix, the company will have no incentive to alter the input mix for greatest efficiency. To ease the regulatory burden and enhance public understanding of the pricing system, several countries use their consumer price index (CPI) to adjust prices. To incorporate (and encourage) expected efficiency gains, the pricing formula can include an annual downward adjustment. Efficiency gains can come from many sources, including improved leak detection, increased labor efficiency, and investment in more efficient pumps. If regulators perceive good opportunities for organizational or other changes to substantially reduce costs, the efficiency coefficient can be set at a higher level. In UK water operations, efficiency gains have been expected to hold annual tariff adjustments to 1 percent per year *below* the CPI increase. In telecommunications, with its higher rate of innovation, a reduction of 3 percent a year has been used. Along with inflation and efficiency adjustments, regulators may include an adjustment to finance system expansion or upgrading. Such adjustments will be system specific and negotiated along with the expansion or upgrading obligation.

3.85 **Conclusion**. China now has the opportunity to reorient the provision of urban environmental services toward the market economy. The failure to do so would condemn urban people to poor quality, but nonetheless increasingly expensive, service that does not protect them from the growing stream of urban domestic and industrial pollutants. While the imposition of user fees may appear politically difficult, city leaders must recognize that the costs will be paid directly or indirectly, and that the current choice to rely on indirect payment leads to excess demand, on the one hand, and an inability to meet needs, on the other. It leads in the end to greater pollution and higher total costs for the service that is provided. It also denies city leaders full use of a powerful and efficient tool, collective treatment of pollutants, as they seek the most cost-effective means of sustaining an environment supportive of economic growth.

ENDNOTES

1. Effective urban environmental management involves much more than the activities analyzed in this or the previous study. For example, historic preservation, open space, and noise regulation are among the areas that a comprehensive regulatory strategy will address. Investment strategies, including private or municipal government investments in gas supplies and district heating to help reduce air pollution, also need to be considered. A recent sector study that analyzes the dynamics of urban land use (*China: Urban Land Management Options for an Emerging Market Economy*, Report No. 10692-CHA) addresses the critical issue of industrial location, which has a large impact on environmental outcomes.

2. This simplifies a more complex system in which some revenues, such as customs receipts, went directly to the central government. See World Bank, *China: Budgetary Policy and Intergovernmental Fiscal Relations* (Report No. 11094-CHA), July 1993.

3. For the city income: State Statistical Bureau (SSB), *Zhongguo Chengshi Tongji Nianjian 1992* (Urban Statistical Yearbook of China 1992), SSB Publishing House, Beijing, p. 573. For central and other, SSB, *Zhongguo Tongji Nianjian 1993* (Statistical Yearbook of China, 1993), SSB Publishing House, Beijing, p. 229.

4. In some cities, district governments are allowed to control, and capture the bulk of the proceeds from, land sales in their district. Although they must fund any resettlement from those proceeds, districts can net substantial income through this activity.

5. See Chapter 3 for details.

6. All data from SSB, *Zhongguo Chengshi Tongji Nianjian 1992* (Urban Statistical Yearbook of China 1992), SSB Publishing House, Beijing.

7. Azizur Rahman Khan, K. Griffin, C. Riskin, and Zhao Renwei, "Household Income and Its Distribution in China," *China Quarterly*, 132, December 1992, p. 1035.

8. SSB, *Zhongguo Chengshi Tongji Nianjian 1992* (Urban Statistical Yearbook of China 1992), p. 715; SSB, *Zhongguo Tongji Nianjian 1992* (Statistical Yearbook of China 1992), p. 283.

9. See SSB, *Zhongguo Tongji Nianjian 1993* (Statistical Yearbook of China 1993), SSB Publishing House, Beijing, 1993, pp. 93, 280, 289, 320. SSB, *Zhongguo Chengshi Tongji Nianjian 1992* (Urban Statistical Yearbook of China 1992), p. 32 for 1991 housing. These income and asset figures reflect a sample of the registered nonagricultural population. Unregistered urban migrants would not fare as well.

10. China's guidelines for SO_2 range from 0.02 to 0.10 mg/m^3 (annual average), compared to a WHO recommended 0.05 mg/m^3, while China's TSP guidelines range from 0.15 to 0.50 mg/m^3 (daily average) compared to WHO's 0.12 mg/m^3.

11. Standard GB3095-82 "Air Environmental Quality Standard." Separate standards are given for daily average readings, and one-time peak readings. In addition, an annual average daily standard is given for SO_2. The figures quoted in the text and in the charts for TSP and NO_x are daily averages and for SO_2, annual averages.

12. NEPA, *Zhongguo Huanjing Nianjian, 1993* (Environmental Yearbook of China 1993), Beijing, 1993, p. 265.

13. Z.Y. Xu, Y.P. Feng, and G.H. Yu, "The Health Effect of Air Pollution on Citizens in Liaoning Cities," presented at the International Conference on Environmental Impact of Air Pollution, Beijing, 1991, cited in H. Keith Florig, "The Benefits of Air Pollution Reduction in China," mimeo, 1993.

14. Xiping Xu, "Report of the World Bank Consultation on Air Pollution, Health, and Economic Damage in China," mimeo, 1993.

15. NEPA, *Zhongguo Huanjing Nianjian 1993* (Environmental Yearbook of China 1993), p. 259-263.

16. In Beijing under the Beijing Environment Project (Loan 3415/Credit 2312), Shanghai under the Shanghai Environment Project (Loan 3711) and in Changzhou under the Southern Jiangsu Environmental Project (Loan 3582).

17. Many aspects of the reform program have been analyzed in a series of World Bank publications. These include the 1991/92 Country Economic Memorandum *Reform and the Role of the Plan in the 1990s*; *Urban Housing Reform: Issues and Implementation Options* (9222-CHA); and *Internal Market Development* (12291-CHA).

18. The level of control varies greatly between cities. Small cities that "import" most of their products control less than does a city like Shanghai that produces many of its own consumer goods.

19. SSB, *Zhongguo Tongji Nianjian 1981* and *1993* (Statistical Yearbook of China 1981 and 1993), Beijing, SSB Publishing House.

20. A variety of estimates exist for TVE pollution. The best sources appear to be joint Ministry of Agriculture/National Environmental Protection Agency studies undertaken for 1984 and 1989. The results of both are reported in Ministry of Agriculture, *Xiangzhen Qiye Nianjian, 1992* (Township and Village Enterprise Yearbook), Beijing, 1992. The reported estimates based on the 1989 study are substantially below the 1992 estimates shown in the text, but the 1989 estimates are the sum of pollution from the one third of TVE industry sampled. If the 1989

results are extrapolated to all TVE industry that year, and growth factored in, they are consistent with the estimates presented. The 1992 air pollution estimates also accords with TVE energy consumption estimates for that year. Mr. Zhihong Zhang provided valuable insights into this issue.

21. See NEPA, *Quanguo Xiangzhen Qiye, Huanjing Wuran Duice Yanjiu* (Study of Environmental Pollution Countermeasures in Township and Village Enterprises), Jiangsu People's Publishing House, Nanjing, 1993.

22. Nonpoint sources of pollution, as typified by the agricultural runoff likely responsible for a share of the biological oxygen demand (BOD), chemical oxygen demand (COD) and ammonia loads at Da Qiao, have generally not been on the environmental control agenda in China. The high rates of fertilizer and pesticide use must result in at least localized problems and those deserve closer scrutiny by NEPA.

23. Much of this work was done in NEPA's earlier study of TVIEs.

24. This result depends in part on the highly dilute nature of most industrial wastewater. Changes in water demand management policy recommended in Chapter 3 would reduce dilution and perhaps lower the acceptable ratio of industrial to other wastewaters entering treatment plants.

25. Current discharge standards are based on the ambient quality sought for the receiving waters. No change in that approach is proposed, but the proposal to disallow discharge to water bodies failing to meet Class 5 standards is more stringent than current requirements. The "no degradation" requirement would be established through a monitoring protocol measuring quality at a fixed distance, say 500 meters, downstream of the discharge point.

26. The virtue of the low fee is that it will almost never pay an enterprise to dilute wastewater in an effort to meet the standards.

27. *China Daily*, June 28, 1991, p. 3.

28. When an accident results in injury or the destruction of property, the offending enterprise may be forced to provide compensation to the injured party, as was the paper mill. Such compensation may be settled through direct negotiation, with court or EPB mediation, or through civil suit. In 1991, NEPA reports that the sum of compensation for all pollution accidents that year reached Y 41 million. However, field interviews revealed that a large percentage of compensation claims are settled privately, for sums unknown to EPB. The Y 41 million thus represents a lower bound.

29. Antonio Estache and Kangbin Zhang, "Managing Pollution Control in Brazil," Policy Research Working Papers, WP5929, July 1992, discuss the theoretical issues and their application to Brazil.

30. See Zhang Kunming, Jin Ruilen (eds.), *A Course in China's Environmental Protection Law*. Tsinghua University Press, Beijing, 1992.

31. Water pollution can also result from airborne pollutants, a growing problem with the acid rains of southwest China.

32. One must distinguish in China between an administrative organization managed as and called a "company," with independent accounts but eligible for budgetary transfers and at least some of whose staff are part of the government cadre system (the shiye danwei, qiyehua guanli) and enterprises organized under the company law, which are not eligible for budgetary transfers and whose staff are not in the cadre system.

33. Municipal officials differentiate two types of enterprise that operate with the Chinese word for "company" in their title. The first type, common in medium and large city water supply, operates under SOE rules that give it independent financial status (with no automatic claim on government subsidies if losses are sustained). Nonetheless, the parent municipal bureau reviews budgets, appoints senior management, and directly finances capital investment or arranges bank loans at preferential rates for that purpose. The second type of company, common in smaller cities or for services such as town gas and district heating, functions as part of a city bureau in every way except accounting. Although the company maintains segregated accounts, the parent bureau remains responsible for covering any losses. The bureau role in the daily operations of the company is correspondingly greater than in the first case.

34. A further, and damaging, means of increasing nominal profits has been to delay maintenance work.

35. This paragraph does not capture fully the fiscal relationship between cities and the central government. The higher on-budget revenue retention rates were partially offset by the reassignment of certain taxes and enterprise ownership to the central government. Available data does not allow calculation of the value of the various offsets.

36. With recent reforms, enterprise capital should now come from the financial sector.

37. The 31 percent includes some double counting, as profits remitted to local governments by some companies are included under "other income" in Table 3.1.

38. Note that the housing category includes only municipally-owned housing. Most housing is owned by enterprises and not included here. The expenses shown do not include depreciation, because although housing services are increasingly organized in companies responsible for their own profits and losses, those companies do not take ownership of the capital stock. The environmental sanitation category includes more than trash pickup and disposal. In many cities (though not all) responsibility

for drains and sewers rests with the city bureau handling solid waste and those expenses are then included in this category.

39. Chinese statistics assign water to either production or domestic uses. The domestic supply figures include both household supply and supply to canteens, restaurants, offices, bath houses, and other nonhousehold uses. Evidence from one province shows that in cities with a high proportion of modern housing, some 70 percent of total "domestic" use occurs in the household. In other cities that proportion drops below 50 percent.

40. Larger SOEs often house workers in what can be very expansive company compounds. Thousands of people may be housed by a single enterprise.

41. The one general concern with current practice is the prechlorination of raw water high in organic compounds. Experience in other countries has shown this to result in complex chlorinated organic compounds not easily removed by treatment, difficult to detect, and carcinogenic. If pretreatment is necessary, alternatives such as ozone pretreatment must be explored.

42. The water tariff plays an important role in deciding the level of maintenance effort. Low water prices mean a low return to UfW reduction efforts.

43. Derived from the average cost of new urban supply, as reported by MCon, for 1988 and 1991, deflated by the construction materials index. These are the most recent available supply cost figures.

44. See World Bank, "Development and the Environment," *World Development Report 1992*, p. 102.

45. Maximum efficiency is reached when all pricing is at marginal economic, rather than financial, costs. The financial costs understate economic costs in this sector.

46. This study does not address the very important question of intersectoral water distribution. Current government policy gives primacy of use to urban areas, but that does not answer the need for rural demand management.

47. Based on figures provided by the Chinese Water Supply Association.

48. This pricing strategy also eliminates the monitoring and other enforcement costs of a quota system.

49. For gasoline demand in OECD countries, Robert McRae, "Gasoline Demand in Developing Asian Countries," in *The Energy Journal*, Vol. 15, No. 1, 1994, p. 149.

50. The analysis assumed an underlying urban population growth rate of 4 percent per year, with household real income growth per capita at 5 percent per year. Those factors determine the increase in the domestic demand, assuming an income

elasticity of demand for water is 0.22, the actual value for Shanghai. Industrial demand in the "no change" scenario continues to be quota constrained and was set at the 2 percent per year growth rate of recent years.

To estimate the impact of a price change, household price elasticity of demand for water was assumed to be -0.20. This is about half the -0.38 rate found in Shanghai, but was set at that level because of three considerations. First, to avoid overestimating the positive impact of the new demand scenario. Second, to recognize that the Shanghai demand elasticity was estimated in a period of generally falling prices and that the elasticity may not be symmetrical with respect to direction of price change. Third, that as per capita consumption falls, the elasticity can be expected to fall.

Enterprise real output growth was assumed to be 8 percent annually over the period, with an elasticity of demand with respect to output of 0.2. Enterprise price elasticity of demand was assumed to be -0.20. The latter figure is very low by international experience, but reflects two concerns. First, not to overestimate the positive impact. Second, until prices become more important than quotas, the true elasticity will be close to zero.

Water price changes were assumed to be phased in over three years beginning 1995 for both domestic and enterprise users, with a 100 percent net increase in supply costs to both types of users. In fact, enterprise users will experience an increase lower than that if they use municipal water, which will move to unitary pricing. Enterprise self-supplied prices will rise more than 100 percent, leaving the net water increase shown.

Wastewater price changes were assumed to be phased in over three years beginning 1995 for both domestic and enterprise users. Enterprises will be charged on a load, not volume, basis. Current charges (when applied) average Y 0.16/m^3 (including the NEPA charge). The estimate assumes an increase to Y 0.60/m^3 on a volume basis, or Y 0.44/m^3 increase, which is near current industrial water price levels. Domestic users will be billed against 80 percent of water use, at a price about 150 percent above the current water price, so a net price increase of 120 percent was used in the calculations.

51. All civil works may face increasing real costs from resettlement in China's land-scarce cities. To the extent that land is taken for roads or other projects, they could face increasing real costs.

52. *Renmin Ribao* (People's Daily), September 19, 1987, p. 3. Of course, upstream loads reduce the assimilative capacity below Shanghai, so do contribute to the problem.

53. Reported in the *People's Daily*, Overseas Edition, September 11, 1987, p. 1.

54. Drainage and sewerage have separate functions and very different consequences in urban areas, as drainage deals with storm run-off and sewerage with wastewater. However, the prevalence of combined systems in China and the lack of studies carefully disaggregating the two have led us to discuss them here as if they were one. Investment operations must consider the possibly substantial benefits of completely separating the two systems. The systems can be modelled jointly and separately to test which will maximize net benefits.

55. "Gongcheng Jianshe Yu Jianzhuye, Shinian Jihua he 'Ba Wu' Jihua" (Construction Engineering and the Construction Industry, Ten-Year Plan and Eighth Five-Year Plan), agreed at the December, 1991, National Construction Work Conference, *mimeo*, p. 8.

56. The government estimates average municipal solid waste at 440 kg/person/year. However, a study in Beijing comparing actual tonnage with estimated tonnage based on collection vehicle capacity reduced 1992 estimates there from 3.83 million tons to 1.56 million tons, or nearly 60 percent, and showed average generation at 285 kg/person/year. With its relatively high consumer incomes and northern location, Beijing should be above the national average in waste generation, so that figure is used instead of the government estimate.

57. As discussed earlier, for water the goal is pricing at the long-run marginal cost of supply.

58. Based on a 1990 urban household income survey.

59. World Bank Staff Appraisal Report, *China: Rural Water Supply and Sanitation Project*, Report No. 10028-CHA, Annex 19.

60. The fact that cities like Qingdao in Shandong and Dalian in Liaoning Province have tariffs well above those elsewhere, without experiencing "social unrest" suggests political fears are exaggerated.

61. Clearly, the construction of the systems and operating inputs can themselves be obtained on competitive markets, introducing efficiency on that side. This argues against, for example, sole sourcing pipes from wholly-owned subsidiaries of sewerage operations.

62. Drainage can be funded from user fees or through special assessments for this service. When using the special assessment approach in other market economies, charges are often based on land area ("frontage") or land value, each of which embodies a distinct equity approach. But either of those approaches avoids the difficult issue of attributing possible contributions to storm damage (through the nature of land use) or the likely damage to specific property (through choices about building siting). Those two factors would be incorporated into an optimal tariff model and in their absence and particularly where land markets are seriously

distorted and land use patterns have been determined less by the users than by the state, as owner of all urban land, payment via indirect tax revenue cedes no more on the equity side than would payment based on a frontage or assessed valuation approach.

63. If government itself acts as an aggressive entrepreneur, the same result can be obtained without the arms-length relationship and in a less transparent environment. A number of analysts argue that this approach characterizes the township and village enterprise sector in China (see, for example, I.J. Singh and Gary Jefferson, "State Enterprises in China: Down to Earth from Commanding Heights," in *Transition*, Vol. 4, No. 8, October-November 1993, pp. 9-10).