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Lee Kuan Yew School of Public Policy
National University of Singapore

Good Practices in Urban Water Management

Decoding Good Practices for a Successful Future

Edited by

Anand Chiplunkar
Kallidaikurichi Seetharam
Cheon Kheong Tan

ADB

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Printed in the Philippines.

ISBN 978-92-9092-740-2 (Print), 978-92-9092-741-9 (PDF)
Publication Stock No. BKK102333

Cataloging-In-Publication Data

Chiplunkar, Anand, Kallidaikurichi Seetharam, and Cheon Kheong Tan.
Good Practices in urban water management: Decoding good practices for a successful future.
Mandaluyong City, Philippines: Asian Development Bank, 2012.

1. Urban water. 2. Water management. 3. Asia. I. Asian Development Bank.

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Fax +63 2 636 2648
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Printed on recycled paper

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Foreword

Asian economies have shown impressive growth. But Asia is also passing through a period of rapid urbanization. By 2050, more than half of Asian population—close to 3 billion—will be living in towns and cities, particularly in secondary cities. This is roughly twice the current population of 1.6 billion. The demands on water, land, and ecosystems as resources pose tremendous challenges in the delivery of commodities like food, energy, and water for municipal and industrial purposes. The expected impacts of climate change will further exacerbate the challenges facing planners and providers of such services.

Delivery of sustainable water supply and sanitation services in growing towns and cities remains an issue. One can derive satisfaction that the Millennium Development Goal of halving the proportion of the population without sustainable access to safe drinking water between 1990 and 2015, was met in 2010, 5 years ahead of schedule. Over 2 billion people worldwide gained access to improved water sources, of which almost half live in India and the People's Republic of China (PRC). But it is unlikely that the world will meet the sanitation target by 2015 although 1.8 billion people have already gained access to improved sanitation facilities. Four out of 10 people who gained access to improved sanitation since 1990 live in India and the PRC. With these same trends, it is expected that 605 million people in 2015 will be without an improved drinking water source and 2.4 billion people will lack access to improved sanitation facilities.

The task of reaching the unserved and delivering water and sanitation services to those who are covered, may only grow more challenging. Many parts of Asia and the Pacific region are in a water crisis. Accessible freshwater in the region has become scarce. Annual per capita water endowments have been declining at alarming rates indicating water stress. The gap between demand and supply is widening.

These will put huge pressures on service providers' ability to manage available water resources effectively. There are questions about the equity and quality of services, and many utilities suffer from chronic mismanagement and poor governance. The current levels of nonrevenue water, as high as 60%, is unacceptable in the face of these challenges. Financing also remains a problem, mainly because the poor performances of these utilities attract little money.

There is an absence of comprehensive analyses of urban water management systems in the developing world. Concrete strategies for utilities to translate good principles into practice are often missing in discussions on water governance. Few positive models of urban water management have been identified and valuable lessons and experiences often are not shared.

To address this shortcoming, the Asian Development Bank has commissioned case studies— through the Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore—to look into examples of good practices in urban water management in eight Asian cities. These are Bangkok, Thailand; Colombo, Sri Lanka; Jamshedpur, India; Kuala Lumpur, Malaysia; Manila, Philippines; Phnom Penh, Cambodia; Shenzhen, PRC; and Singapore.

This book presents an objective and critical analyses of urban water management practices in these cities to provide an understanding of some good practices at the utility level that have worked, some aspects that have not worked, and the challenges faced by the eight cities and how they have tried to overcome them. There are common elements for success. I hope that local leaders throughout the developing world can use these cases to help craft their own solutions for their specific local circumstances.

Bindu N. Lohani
Vice President
Knowledge Management and Sustainable Development
Asian Development Bank

Preface

The 21st century will be the Asian century. Similarly, it will also be the first urban century. From the year 2008, for the first time ever in human history, more people lived in cities than in rural areas. As the grain of human history is changing significantly on several fronts, the time has come for the world to understand and absorb new perspectives on several major global challenges.

Water remains a major global challenge. Since Asia is home to more than half of the world's population and is also producing the biggest surge in urban populations, what Asia does in meeting this major global challenge of water should be of global interest. This is why this book is both timely and valuable. It provides significant new insights into urban water management in eight selected Asian cities.

There can be no doubt that the world can learn a lot from the Asian experience in this area. Certainly, the Singapore water miracle is a story that the world needs to understand better. Even though Singapore is the most densely populated country in the world, it is moving successfully toward developing self-sufficiency in water. This is a result of a combination of many ingenious policies. This is also why the Public Utilities Board (PUB) of Singapore won the prestigious Stockholm Industry Water Award at the World Water Week in Stockholm in 2007. Equally significantly, Prof. Asit Biswas, a Distinguished Visiting Professor at the Lee Kuan Yew School, also won the Stockholm Water Prize for "his outstanding and multi-faceted contributions to global water resource issues" in 2006. In short, there is a lot of expertise on water in Asia that the world can learn from.

This is also why the Lee Kuan Yew School of Public Policy set up the Institute of Water Policy (IWP) in 2008. We felt that there was a pressing need to study in depth Asia's record in water management practices and to share best practices in a two-way flow of understanding between Asia and the world. More information on the IWP and its contributions can be found on the website of the school: www.spp.nus.edu.sg/iwp/Home.html

This book provides a good example of the kind of contributions that the IWP can make. It is an ambitious attempt to draw lessons from eight Asian cities in addressing the challenges of urban water management. It contains key studies written by

experts. It will be useful to scholars, researchers, professional practitioners, and students of water policy and governance in three regards.

Firstly, the chapters offer comprehensive reviews and concise analyses of the performance of the eight cities in urban water management and the key factors that contribute to the progress. The book contains statistics that are often difficult to find in one source. Secondly, while the chapters highlight the successes of these cities, they also examine the continuing challenges that the cities have faced and the responses to these challenges. Not all the responses have been smooth-sailing. This allows readers to learn from real experiences. Thirdly, the book could also inspire other developing countries that also face huge challenges in water management to overcome their respective difficulties and to better serve their people.

Significant studies are the result of significant human effort. Hence, I would like to thank and congratulate the three editors, Anand Chiplunkar, Kallidaikurichi Seetharam, and Cheon Kheong Tan; and the many authors of this volume. I would also like to thank the Asian Development Bank (ADB) for funding the IWP to undertake this project to co-produce this book. This is another example of a fruitful partnership between the school and the ADB.

The mission of our school is to inspire leaders, improve lives, and transform Asia. There is no doubt that the work of the IWP, supported by the PUB, and studies such as this one, have helped the school to carry out its noble mission. We hope, therefore, that this volume will encourage scholars from around the world to work more closely with our school as we go about realizing our mission.

Kishore Mahbubani
Dean, Lee Kuan Yew School of Public Policy
National University of Singapore

Acknowledgments

This book is the outcome of a research initiative titled Case Studies of Good Practices for Urban Water Management in Asia, undertaken by the Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore, through a Letter of Agreement between the school and the Asian Development Bank (ADB) in September 2008. Signatories were Kishore Mahbubani, dean and professor of the Practice of Public Policy, on behalf of the Lee Kuan Yew School of Public Policy; and Xianbin Yao, director general of the Regional and Sustainable Development Department, on behalf of ADB.

Anand Chiplunkar provided overall direction and guidance to the project, while Kallidaikurichi Seetharam and Cheon Kheong Tan led the study team to develop the case studies.

This book offers a set of good practices in urban water management for wider adoption and replication across developing countries in Asia and beyond. As such, the style of the book is meant to keep it accessible to an audience beyond academia, such as policy makers and practitioners in the water sector.

As editors, we are indebted to the many organizations and individuals who have provided invaluable contributions and support to make this book possible.

First, we would like to express our gratitude to the Singapore Totalisator Board and ADB, which jointly funded this research initiative.

Second, we are thankful to the authors who wrote the case studies and patiently responded to our queries during the editorial process of the book.

Third, we are grateful to Woochong Um, deputy director general of the Regional and Sustainable Development Department of ADB, for his support. We sincerely thank Bindu Lohani, vice president of Knowledge Management and Sustainable Development of ADB for the foreword; and Prof. Kishore Mahbubani for his preface.

Fourth, many country participants, researchers, nongovernment organizations, private sector entities, and development partners provided us with valuable inputs in the course of the study. Key inputs were also provided during three workshops.

These workshops, organized by the Institute of Water Policy, with support from ADB, consisted of an inception workshop in October 2008, an interim workshop in June 2009, and a final workshop in December 2009.

We sincerely thank the following organizations that provided information for the case studies and/or participated in the final workshop held at the Lee Kuan Yew School of Public Policy:

Bangkok, Thailand
- Metropolitan Waterworks Authority
- Department of Drainage and Sewerage, Bangkok Metropolitan Administration

Colombo, Sri Lanka
- National Water Supply and Drainage Board

Jamshedpur, India
- Jamshedpur Utilities and Services Company Limited

Kuala Lumpur, Malaysia
- Indah Water Konsortium Sdn. Bhd.
- The Malaysian Water Association
- Suruhanjaya Perkhidmatan Air Negara
- Syarikat Bekalan Air Selangor Sdn. Bhd.

Manila, Philippines
- Manila Water Company, Inc.
- Maynilad Water Services, Inc.
- Metropolitan Waterworks and Sewerage System–Regulatory Office

Phnom Penh, Cambodia
- Phnom Penh Water Supply Authority

Shenzhen, People's Republic of China
- Shenzhen Water Group

Singapore
- Public Utilities Board

Special appreciation goes to Tan Sri Rozali Ismail, executive chairman of the Syarikat Bekalan Air Selangor Sdn. Bhd.; Dato' Teo Yen Hua, chief executive officer of Suruhanjaya Perkhidmatan Air Negara; and Vasan Ramachandram, manager at Syarikat Bekalan Air Selangor Sdn. Bhd.

Finally, we also express our appreciation to the many reviewers who provided comments on the case studies. We sincerely thank Theresa Audrey O. Esteban, water resources officer at the Regional and Sustainable Development Department of ADB, for providing technical and research support. We also thank our colleagues at the

Institute of Water Policy and the Lee Kuan Yew School of Public Policy for their administrative support during the three workshops. Our deep appreciation goes to the Department of External Relations of ADB for publication advice, editorial assistance, and production of this book. Our special thanks to Corazon P. Desuasido for providing editorial assistance, and to Ellen Pascua and Gino Pascua for their coordination of all efforts that made the timely publication of this book possible.

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Abbreviations

ADB	—	Asian Development Bank
AGM	—	assistant general manager
AGOS	—	Attaining Goals on Sustainable Water Supply and Sanitation
AIADA	—	Adityapur Industrial Area Development Authority
AIT	—	Asian Institute of Technology
ANAC	—	Adityapur Notified Area Committee
ATAT	—	actual turnaround time
BIS	—	Bureau of Indian Standards
BMA	—	Bangkok Metropolitan Administration
BOD	—	biochemical oxygen demand
CAGR	—	compounded annual growth rate
CAPEX	—	capital expenditure
CERA	—	currency exchange rate adjustment
CMC	—	Colombo Municipal Council
Col	—	coliform
COP	—	Committee on Privatization
CPIB	—	Corrupt Practices Investigation Bureau
DANIDA	—	Danish International Development Agency
DBKL	—	Dewan Bandaraya Kuala Lumpur
DBOO	—	design–build–own–operate
DDS	—	Department of Drainage and Sewerage
DEG	—	*Deutsche Investitions und Entwicklungsgesellschaft*
DENR	—	Department of Environment and Natural Resources
DIW	—	Department of Industrial Works
DMA	—	District Metering Area
DMCI	—	D. M. Consunji Holdings, Inc.
DO	—	dissolved oxygen
DOH	—	Department of Health
DOPA	—	Department of Provincial Administration
DPWH	—	Department of Public Works and Highways
DSM	—	demand-side management
DTSS	—	Deep Tunnel Sewerage System
EPC	—	engineering, procurement, and construction
FCC	—	Flood Control Center
FCDA	—	foreign currency differential adjustment

GCFC and EIP	—	Greater Colombo Flood Control and Environmental Improvement Project
GDP	—	gross domestic product
GIS	—	Geographic Information System
GOCC	—	government-owned and controlled corporation
GPOBA	—	Global Partnership on Output-Based Aid
GSM	—	global system for mobile communication
GST	—	goods and services tax
ha	—	hectare
hr	—	hour
IEAT	—	Industrial Estate Authority of Thailand
IEC	—	International Electrotechnical Commission
IPCC	—	Intergovernmental Panel on Climate Change
ISO	—	International Organization for Standardization
IT	—	information technology
IWA	—	International Water Association
IWK	—	Indah Water Konsortium
JBAS	—	Jabatan Bekalan Air Selangor (Selangor Water Supply Department)
JICA	—	Japan International Cooperation Agency
JNA	—	Jamshedpur Notified Area
JNAC	—	Jamshedpur Notified Area Committee
JSK	—	JUSCO Sahyog Kendra
JUA	—	Jamshedpur Urban Agglomeration
JUSCO	—	Jamshedpur Utilities and Services Company Limited
kl	—	kiloliter
km	—	kilometer
km^2	—	square kilometer
kPa	—	kilopascal
KPSB	—	*Kabuhayan Para Sa Barangay* (Livelihood for the Community) Program (of the Manila Water Company, Inc.)
kWh	—	kilowatt-hour
LGU	—	local government unit
LLDA	—	Laguna Lake Development Authority
lpcd	—	liters per capita per day
LTA	—	Land Transport Authority
LUAS	—	Lembaga Urus Air Selangor (Selangor Water Management Authority)
m^3/s	—	cubic meter per second
MCA	—	meter consumption analyst
mcm	—	million cubic meters
MDT	—	Manpower Development and Training
MEWC	—	Ministry of Energy, Water and Communications
MEWR	—	Ministry of the Environment and Water Resources

mg	—	milligram
MIS	—	Management Information System
ml	—	milliliter
ML	—	million liters
MLD	—	million liters per day
mm	—	millimeter
MMDA	—	Metropolitan Manila Development Authority
MNAC	—	Mango Notified Area Committee
MOF	—	Ministry of Finance
MOH	—	Ministry of Health
MOI	—	Ministry of Interior
MOU	—	memorandum of understanding
MPIC	—	Metro Pacific Investments Corporation
MTSP	—	Manila Third Sewerage Project
MWA	—	Metropolitan Waterworks Authority
MWCI	—	Manila Water Company, Inc.
MWh	—	megawatt-hour
MWSI	—	Maynilad Water Services, Inc.
MWSS	—	Metropolitan Waterworks and Sewerage System
MWSS-CO	—	Metropolitan Waterworks and Sewerage System–Corporate Office
MWSS-RO	—	Metropolitan Waterworks and Sewerage System–Regulatory Office
NABL	—	National Accreditation Board for Testing and Calibration Laboratories
NEQA	—	Enhancement and Conservation of National Environmental Quality Act
NHA	—	National Housing Authority
NHDA	—	National Housing Development Authority
NParks	—	National Parks Board
NRW	—	nonrevenue water
NWRC	—	National Water Resources Council
NWSDB	—	National Water Supply and Drainage Board
O&M	—	operation and maintenance
OBA	—	output-based aid
OIC	—	officer-in-charge
P&D	—	planning and design
PAAB	—	Pengurusan Aset Air Berhad (Water Asset Management Company)
PHIVOLCS	—	Philippine Institute of Volcanology and Seismology
PPP	—	public–private partnership
PPWSA	—	Phnom Penh Water Supply Authority
psi	—	pound per square inch

PUAS	—	Perbadanan Urus Air Selangor Berhad (Selangor Water Management Corporation)
PVC	—	polyvinyl chloride
PWD	—	Public Works Department
R&D	—	research and development
RCC	—	reinforced cement concrete
RID	—	Royal Irrigation Department
RPH	—	river pump house
SCADA	—	Supervisory Control and Data Acquisition
SEAWUN	—	Southeast Asian Water Utilities Network
SEZ	—	special economic zone
SIDA	—	Swedish International Development Cooperation Agency
SLE	—	service level expectation
SLG	—	service level guarantee
SLLRDC	—	Sri Lanka Land Reclamation and Development Corporation
SLP	—	service level performance
SLRe	—	Sri Lankan rupee
SMART	—	Stormwater Management and Road Tunnel
SPAN	—	Suruhanjaya Perkhidmatan Air Negara (National Water Services Commission)
SPWN	—	small-piped water network
STP	—	sewage treatment plant
SYABAS	—	Syarikat Bekalan Air Selangor Sdn. Bhd
SZDRC	—	Shenzhen Development and Reform Commission
SZMWAB	—	Shenzhen Municipal Water Affairs Bureau
SZPB	—	Shenzhen Price Bureau
SZREC	—	Shenzhen Residential Environmental Committee
SZSASAC	—	Shenzhen State-Owned Assets Supervision and Administration Commission
SZWG	—	Shenzhen Water Group
SZWRB	—	Shenzhen Water Resource Bureau
TOR	—	terms of reference
TPM	—	total productive maintenance
TPSB	—	*Tubig Para Sa Barangay* (Water for the Poor) Program (of the Manila Water Company, Inc.)
UASB	—	Upflow Anaerobic Sludge Blanket
UFW	—	unaccounted-for-water
UNEP	—	United Nations Environment Programme
URA	—	Urban Redevelopment Authority
USEPA	—	United States Environmental Protection Agency
VAT	—	value-added tax
WB	—	World Bank
WCT	—	water conservation tax
WHO	—	World Health Organization

WQMO — Water Quality Management Office
WRP — water reclamation plant
WSIA — Water Services Industry Act
WTP — water treatment plant
WWF — World Wide Fund for Nature
WWTP — wastewater treatment plant

CHAPTER 1

Introduction

Anand Chiplunkar, Kallidaikurichi Seetharam, and Cheon Kheong Tan[1]

Challenges in the Water Sector

The water problems in Asia's cities are similar. These include sources and uses of raw water, the large proportion of water loss in distribution networks, intermittent supply, and the quality of tap water. In some cities, the excessive use of groundwater resources has caused serious environmental problems, including rapid depletion of groundwater, deterioration of water quality, and land subsidence. Many cities suffer from inadequate sewerage networks and wastewater treatment systems while a large majority still depends on septic tanks and other on-site sanitation facilities. As a result, pollution loads in freshwater bodies and groundwater sources have increased substantially.

For several reasons, cities have to struggle to provide clean and reliable water supply to their residents. These include the physical scarcity of water, lack of investment funds in the water sector, unwillingness of authorities to charge the poor for their water consumption, and the lack of capacity of service providers in the public

Box 1 Common Water Utility Challenges

- Only a portion of the urban population is covered by the water utility.
- Rapid urbanization results in inadequate water supply.
- Water supply provided by the utility is intermittent.
- Nonrevenue water is high.
- Water is often not potable.
- Asset management is poor or lacking.
- Low tariffs hamper water supply connections to the poor.

Source: ADB (2007).

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sector. All of these are symptoms of the fundamental reasons for these problems—which are inadequate leadership and governance.

In addition, heavy seasonal rains and frequent cyclones have led to massive flooding across Southeast Asia affecting over 8 million people (UNICEF 2011). The affected countries included Cambodia, the Philippines, Thailand, and Viet Nam. During such emergencies or natural disasters, the most urgent need is clean, potable water. To arrest the spread of diseases, sanitation is also more pronounced. For these reasons, utilities are required not only to be "emergency-ready" to provide water and sanitation but also must be able to mitigate the impact of floods through flood control measures that safeguard water installations and minimize damages. More often, however, this is not the case.

Therefore, the Asian water crisis is, in fact, a crisis of governance (ADB 2007).

Setting the Context

The Asian Development Bank (ADB) entered into a partnership with the Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore to undertake a project for "Improving Water Governance in the Asia–Pacific Region." In September 2008, a Letter of Agreement was signed by the partners to undertake a study on "Good Practices for Urban Water Management in Asia," among other activities. The objective of the study was to identify a community of good practices in the areas of water, wastewater, and storm water management from eight selected urban centers in Asia. The urban centers were selected based on their significant improvements in urban water and/or wastewater management during 1998–2008 and their willingness to be reviewed independently by experts not associated with their work, or by funding agencies that have supported them. The other considerations included availability of data and information and potential replicability of such good practices in other Asian urban centers.

An inception workshop was conducted in Singapore on 9 October 2008 to discuss the coverage of the case studies, the cities to be selected, and the methodology to be applied. The cities and utilities were to be selected from East Asia, South Asia, and Southeast Asia with an objective to reflect the striking socioeconomic variety across Asian cities. The eight selected cities were Bangkok, Thailand; Colombo, Sri Lanka; Jamshedpur, India; Kuala Lumpur, Malaysia; Manila, Philippines; Phnom Penh, Cambodia; Shenzhen, People's Republic of China; and Singapore. Each city was analyzed by one or two experts on urban water and wastewater management who were knowledgeable about the Asian conditions. They collected the necessary information on their assigned cities to come up with an objective analysis. A detailed assessment of the urban water management practices and processes was carried out.

While conducting this research initiative, the experts noted the rapid progress in performance improvement and service delivery achieved by the selected Asian water utilities relative to their historical and national or regional contexts. However, academic research on water utilities was largely focused on benchmarking and outcome dimensions, which provided limited insights on the underlying drivers for this progress.

Second, the experts also noted the heterogeneity of the socioeconomic contexts in which these utilities operate, thereby challenging the notion of a "one-size-fits-all" approach to defining good practices among water utilities. For instance, Singapore and Phnom Penh achieved significant reductions in unaccounted-for-water (UFW) over the years, but they did so in very different socioeconomic contexts.

Third, although these utilities have made impressive strides along certain dimensions, they still face challenges in other aspects of water management. For instance, some have not paid adequate attention to sanitation, until recently.

A final workshop was held on 11 December 2009 to discuss the research findings with the officials of all the cities concerned to ensure correctness of the data and for a cross-city fertilization of learning and conclusions.

Certain Asian utilities have made rapid progress in selected dimensions of water management. It is, therefore, beneficial to draw insights on the underlying factors driving their progress and on the socioeconomic and historical contexts in which these changes were taking place. Rather than look at these successes as exceptions, a few crosscutting good practice themes should be identified from these relatively better-performing utilities for universal adoption and replication.

The performances of the water utilities are compared in the concluding chapter of this book. While the authors recognize that a cross-city comparison framework—particularly in Asia—tends to be simplistic, it is useful to evolve a threshold level of performance benchmarks for urban water and sanitation in Asian cities. More importantly, this book attempts to evolve a framework to define a set of good practices for wider adoption and replication across Asia and in similar contexts worldwide.

Although the success achieved by some of these utilities in specific spheres of water management is indeed remarkable, much remains to be done. The United Nations estimates that 13% of the world's population still relied on unimproved water sources for its drinking needs, and 39% still did not have access to improved sanitation facilities in 2008 (United Nations 2011, 54–55). However, this book seeks to reinforce the positive actions taken by some utilities to bridge these gaps. Hopefully, these actions can lead the way for Asia and the rest of the developing world.

As Arjun Thapan, former special senior advisor (Infrastructure and Water), Office of the President of the ADB, noted: "Big victories have little beginnings. We hope

that this book shows conclusively that securing world-class urban water solutions in Asia is eminently doable. And that these cases inspire city managers and urban water leaders to craft their own solutions to deliver the kind of high-quality water services their citizens deserve and are willing to pay for."

Table 1 provides highlights of the key indicators in water management in the eight cities and nine water utilities studied. The idea is not to decipher what constitutes a well-performing or a poorly performing utility, but to evolve benchmarks for critical outcome indicators, based on the experience of what has been and can be achieved in the Asian context by the various water utilities covered in this initiative.

Water Governance and Good Practices

To overcome the challenges in the water sector, policy makers and water agencies must first understand the underlying principles of good water governance, especially in the light of water scarcity and climate change. Sound governance can help create a favorable environment to increase both public and private sector investments and to ensure that much-needed investment is used correctly and efficiently.

Good governance is one of the three pillars of ADB's Poverty Reduction Strategy (ADB 2004).[2] ADB's approach to governance, established as a Core Strategic Area of Intervention under its Long-Term Strategic Framework (2008–2020) (ADB 2008), recognizes the importance of capacity development and identifies four key interrelated elements (namely accountability, participation, predictability, and transparency) that are considered necessary to sustain efforts and ensure results. All of these elements feature prominently in successful water utilities. It is here, at the junction where sound governance principles meet utility practices, that this book is focused. As shown in Table 2, good practices drawn from case studies detailed in the succeeding chapters will be outlined in a number of areas, including the following:

(i) **Fundamentals.** Among other lessons, regulation is required to place water agencies at arm's length from governments and to make them accountable to the public. Ideally, these water agencies will cut across multiple agencies and maintain links with all stakeholders. In addition, well-functioning public utilities throughout the world indicate that a corporate approach to water supply—but not necessarily private ownership—is essential to reliable, efficient, and equitable operations. Such an approach can help ensure the financial sustainability of water systems and protect the long-term value of water resources. It can also open doors to external expertise and finance from the private sector.

[2] The other two pillars are pro-poor, sustainable economic growth and inclusive social development.

Table 1 Key Indicators in Water Management

	Unit	Bangkok	Colombo	Jamshedpur	Kuala Lumpur	Manila		Phnom Penh	Shenzhen	Singapore
						MWCI	MWSI			
Year		2008	2008	2009	2008	2008	2008	2008	2008	2008
Area	km^2	1,569	1,197	64	242	1,400	540	375	1,953	710
Population	'000	5,711	3,765	860	1,629	6,000	9,100	1,326	8,768	4,800
Water Supply										
Piped coverage	% of population	99	92	81	100	92	62	91	100	100
Average availability	Supply hours	24	24	7	24	24	18	24	24	24
Metered connections	% of connections	100	100	26	100	100	100	100	NA	100
UFW/NRW	% of total supply	30.2	35.7	9.9	33.9	21.0	63.8	6.2	13.5	4.4
Wastewater										
Sewerage coverage	% of population	54	14	67	90	6	5	63	NA	100
Financial and Human Resources										
Operating ratio	Op. exp./ Op. rev.	0.69	0.62	0.82	0.86	0.49	0.55	0.39	0.77	0.86
Revenue collection efficiency	Collect/bill (%)	97	98	99	91	99	89	100	99	100
Staff members	Per 1,000 connections	2.2	3.9	4.0	1.9	2.27	2.42	3.3	NA	2.5

km^2 = square kilometer, bill = annual billings, collect = annual collections, NA = data not available, NRW = nonrevenue water, Op. exp. = operating expenses, Op. rev. = operating revenue, UFW = unaccounted-for-water.

Notes:

1. There are two main water utilities in Manila: the Manila Water Company, Inc. (MWCI) in the East concession zone and Maynilad Water Services, Inc. (MWSI) in the West concession zone.
2. Area: For Jamshedpur, data refers to the lease area only, of which the Jamshedpur Utilities and Services Company is legislatively responsible.
3. Population: (i) For Bangkok, data refers to its registered population. An estimate of the population including nonregistered population in Bangkok was 8.96 million. The total registered population of Bangkok, Nonthaburi, and Samut Prakan was 7.9 million. (ii) For Jamshedpur, data refers to the population in the lease area.
4. Water supply coverage: (i) For Bangkok, data refers to piped water coverage in the Metropolitan Waterworks Authority's entire service area of Bangkok, Nonthaburi, and Samut Prakan. The precise number of people who obtained water in bulk delivered by trucks was not known. (ii) For Jamshedpur, data refers to piped water coverage in the lease area.
5. Unaccounted-for-water (UFW) and nonrevenue water (NRW): The data for Phnom Penh and Singapore are UFW. All others are NRW. UFW comprises physical water losses due to leakages, and apparent water losses due to illegal connections and meter inaccuracies. NRW comprises UFW and legitimate water consumption that is unbilled, such as free supplies to tenement gardens and fire hydrants.
6. Sewerage coverage: (i) For Jamshedpur, data refers to coverage in the lease area and peripheral areas. (ii) Data for Kuala Lumpur and Phnom Penh are estimates. (iii) For Manila, sewerage coverage was estimated based on the water supply coverage and the number of sewer connections billed expressed as a percentage of the number of water service connections billed.
7. Financial and human resources: The indicators were computed based on the data of the Metropolitan Waterworks Authority (Bangkok), National Water Supply and Drainage Board (Colombo), Jamshedpur Utilities and Services Company (Jamshedpur), Syarikat Bekalan Air Selangor Sdn. Bhd. (Kuala Lumpur), MWCI and MWSI (Manila), Phnom Penh Water Supply Authority (Phnom Penh), Shenzhen Water Group (Shenzhen), and Public Utilities Board (Singapore).
8. Operating ratio: Operating ratio refers to the ratio of annual operation and maintenance costs to annual operating revenue.
9. Revenue collection efficiency: (i) Revenue collection efficiency refers to annual collections expressed as a percentage of annual billings. (ii) For Singapore, data applies to potable water users.
10. Staff members per 1,000 connections: For Singapore, data refers to the number of staff members per 1,000 customer accounts for potable water and NEWater.

Sources: Data are from the water utilities of the eight cities presented in Chapters II-IX of this book.

Table 2 Summary of Good Practices Drawn from City Case Studies

Good Practice	City or Utility
Fundamentals	
Having dynamic leadership at the top	Bangkok, Phnom Penh, Singapore
Use of integrated water management policy	Shenzhen, Singapore
Corporatization of water utilities	Bangkok, Jamshedpur
Regulating private sector participation effectively	Manila, Shenzhen
Service Delivery	
Increasing coverage and improving water availability	Bangkok, Colombo, MWCI, Phnom Penh, Singapore
Reducing nonrevenue water	Jamshedpur, MWCI, Phnom Penh, Singapore
Securing clean, safe, and reliable water supplies	Bangkok, MWCI, Phnom Penh, Singapore
Improving service to the poor	Bangkok, Jamshedpur, MWCI, Phnom Penh, Singapore
Adopting the practice of demand-side management	Singapore
Improving wastewater and sewerage systems	Jamshedpur, Singapore
Monitoring and reporting effectively	Bangkok, Jamshedpur, Singapore
Financial and Human Resources Management	
Improving staff productivity	Bangkok, Jamshedpur, MWCI, Phnom Penh, Singapore
Pricing water for efficiency and sustainability	Jamshedpur, MWCI, Phnom Penh, Singapore
Improving revenue collection	Bangkok, Colombo, Jamshedpur, MWCI, Phnom Penh, Shenzhen, Singapore
Setting wastewater tariffs	Colombo, Jamshedpur, Kuala Lumpur, Shenzhen, Singapore

MWCI = Manila Water Company, Inc.
Sources: Chapters II–IX of this book.

(ii) **Efficient and effective service delivery.** Good water governance requires that utilities take an integrated, holistic service delivery approach that includes not only water supply management, but also demand management, wastewater management, research and development, and where applicable, public–private partnerships (PPPs). A robust system of reporting and monitoring is also needed to help set priorities in water policy interventions and to strengthen the responsiveness of institutions and processes.

(iii) **Financial and human resources management.** Improving internal governance is essential to providing efficient service delivery. This requires that utilities

strive to be financially self-reliant by operating as independent, business-like institutions with emphasis on improving their revenues and effectively managing their cash flows. It is also important for utilities to attract, nurture, and retain talent, so that they will have capable staff to carry out their responsibilities.

Good Practices

The case studies were comprehensive in their review of utility performance and lessons learned. The following five case studies offer several examples of good practices.

Bangkok, Thailand

The Metropolitan Waterworks Authority (MWA), a state enterprise under the Ministry of Interior, has made significant improvements in water supply management in Bangkok and neighboring provinces in Thailand. These include improvements in service coverage, water quality, service efficiency, and financial performance.

As of 2008, 99% of the population in Bangkok, Nonthaburi, and Samut Prakan received reliable and safe tap water through MWA. However, further improvements are needed in water demand management and to address water quality perceptions. The Bangkok Metropolitan Administration, which is in charge of wastewater and storm water management, needs to make further progress in wastewater treatment and to involve the public in implementing flood alleviation measures.

Jamshedpur, India

The Jamshedpur Utilities and Services Company (JUSCO) is an integrated urban water service provider managed under a corporate framework. It was set up as a wholly owned subsidiary of Tata Steel and became operational in 2004 with the transfer of employees from Tata Steel's Town Division. Within a few years, JUSCO achieved substantial improvements in service delivery and operational efficiency. It has evolved into a one-stop, integrated utilities provider in a range of areas, including water and wastewater management, construction, municipal solid waste management, power, and integrated facility management.

This case study provides lessons for other utilities attempting to leapfrog from mediocre to moderate levels of performance to better service delivery standards. It offers encouraging insights for replication in governance, operations, technology, and management practices to provide equitable and affordable services in a commercially and environmentally sustainable manner.

Manila, Philippines

In 1997, the privatization of the Metropolitan Waterworks and Sewerage System in Manila was the largest water privatization effort in the world. From a single water utility run as a government corporation (subject to government accounting,

auditing, and civil service rules), the operation of Metro Manila's water supply and sewerage services was bid out into two concessions and won by the Manila Water Company, Inc. for the East concession zone and the Maynilad Water Services, Inc. for the West concession zone.

By 2003, the two concessionaires' fortunes were in sharp contrast to each other. The Manila Water Company, Inc. performed well, managing to become profitable as early as 1999. The Maynilad Water Services, Inc., on the other hand, declared bankruptcy in 2003. The government reclaimed the West concession zone and, after a period of interim restructuring, conducted a successful rebid for a qualified replacement operator, which took over in 2007. The privatization of water services in Metro Manila thus provides some useful points of comparison from which urban water management lessons can be drawn.

Phnom Penh, Cambodia

The experience of the Phnom Penh Water Supply Authority (PPWSA) is a valuable example for other urban centers of the developing world. From a near-bankrupt, demoralized, and corrupt institution, it has transformed itself into a viable institution that can be placed in the same league as the best water utilities in the world.

Within just 1 decade (1993–2003), it developed a new mindset and team spirit. It continuously expanded its network, improved its management and operating efficiency, became financially self-sufficient, and progressively increased its net annual profit. Its incredible progress within such a short time frame shows that providing a clean and drinkable water supply is possible with political will, dynamic leadership, and noninterference in the policies and management of utilities. PPWSA, under the leadership of General Director Ek Sonn Chan, won the Stockholm Industry Water Award 2010, for its world-class performance in water supply management and self-sufficiency (Stockholm International Water Institute 2010).[3]

Singapore

After it obtained independence in 1965, the small city-state of Singapore faced the challenges of water scarcity and vulnerability. In response, the country adopted an integrated and innovative approach to water management, which, together with careful planning and hard work over more than 40 years, enabled it to attain sustainable and cost-effective water management solutions. Singapore was included in this study to provide lessons on how it could transform its water management from that of a developing country in 1965 to one of the best among developed countries today. The Singapore experience shows that a public sector-owned water utility, with a high degree of autonomy to carry out its role, can be as efficient as a private organization.

[3] Established in 2000, the Stockholm Industry Water Award recognizes contributions to sustainable water management. It may be given to any sector of business and industry.

Specific Lessons

The following three case studies focused on specific lessons learned in certain areas. From these case studies, some examples of good practices were drawn.

Colombo, Sri Lanka

The National Water Supply and Drainage Board (NWSDB), the statutory body responsible for drinking water supply and sewerage systems in Sri Lanka, is among the few South Asian utilities that have achieved more than 99% of metered water connections and a continuous water supply in its service areas. Servicing a large part of the Greater Colombo area, NWSDB achieved a substantial improvement in water supply coverage during 1998–2008. Its ability to keep pace with the rapid population growth in Greater Colombo, as well as a substantial increase in its area of responsibility, was remarkable. However, efficiency improvements are still badly needed, considering that levels of nonrevenue water (NRW) are still high. The low water tariffs and lack of periodic revision in tariffs have been major constraints in generating revenue and recovering operation and maintenance costs.

Kuala Lumpur, Malaysia

Kuala Lumpur has a full coverage for safe drinking water and a continuous water supply with minimal interruptions. Privatization has improved the delivery of water services. However, greater service efficiency could have been achieved had it been complemented by appropriate legal and institutional reforms. The government has also realized from its experiences that a privatization model, which relies completely on the private sector to finance water infrastructure, may not be the best practice. In response, the government is pursuing a new PPP model, in which it shares the financial responsibility of infrastructure development with the private sector.

Shenzhen, People's Republic of China

The city of Shenzhen is leading in the reform of local water management in the People's Republic of China (PRC). It has established a relatively complete legal system for water management and is one of the first cities in the country to combine all water-related government functions into one government agency, the Shenzhen Municipal Water Affairs Bureau.

It also completed market-oriented reform in the water sector, having promulgated the first set of measures in the PRC for the administration of concessions of municipal public utilities. In 2004, the Shenzhen Water Group, the main water service provider in Shenzhen, completed its transformation from a wholly state-owned enterprise to a joint venture approved by the Ministry of Commerce. Today, it is the largest water supply and wastewater services enterprise in the country.

Meanwhile, the integrated management of water supply and drainage helped Shenzhen's wastewater treatment sector improve substantially over a short period of time. It has made rapid development since the integrated management reform that began in 2001. The wastewater treatment rate in the Shenzhen Special Economic Zone increased from 56% during pre-integration to 88% in 2008, ranking first among large and medium-sized cities in the PRC.

The subsequent eight chapters of this book contain the case studies on the eight cities. This is followed by a concluding chapter, which first compares the performance of the utilities and then offers a success framework to conceptualize a set of good practices for possible replication across Asia and the developing world.

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CHAPTER II

Bangkok, Thailand

Mukand Singh Babel and Aldrin A. Rivas[4]

Introduction

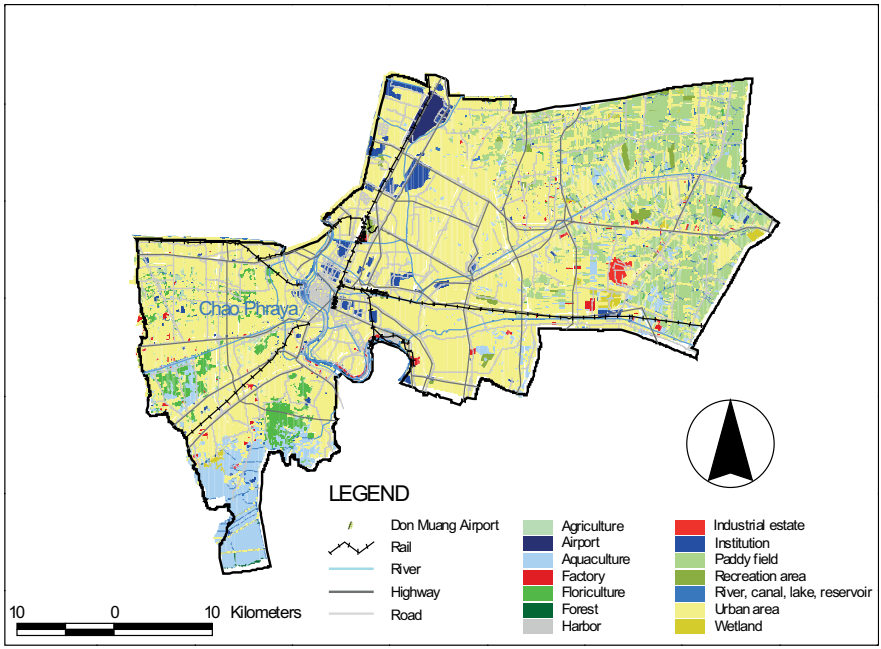
Bangkok, the capital of Thailand, is situated on the flat deltaic plain of the Chao Phraya River, which extends to the Gulf of Thailand. The Bangkok metropolis is located at latitude 13.45° North and longitude 100.28° East, with a total area of 1,569 square kilometers (km^2) and a mean elevation of 2.31 meters (m) above mean sea level (BMA and UNEP 2004). Approximately 60% of the city land area is built-up, while 29% is utilized for agriculture, located largely in the periphery of the metropolis (Figure 1). Areas used for aquaculture activities cover around 5% while water bodies account for about 1%, with other land use types covering the rest.

The metropolis has a registered population of approximately 5,711,000 in 2008, an increase of less than 1% from a decade ago, indicating a low growth rate (DOPA 2009). The actual population of Bangkok may not be known exactly as many people commute to work in Bangkok or live in the city without registration. Estimates by the Bangkok Metropolitan Administration (BMA) showed that in 2007, the non-registered population of Bangkok was 57% of total registered population (Panya Consultants 2008). If this proportion is used for 2008, the total 2008 population of Bangkok was approximately 8.96 million. For the greater Bangkok area, with an approximate size of 7,760 km^2 covering the five adjacent provinces of Samut Prakan, Nonthaburi, Nakhon Pathom, Pathumthani, and Samut Sakhon, the registered population in 2008 was around 10.2 million.

Bangkok has a monsoon type of climate, which is classified into three main seasons: rainy (May–October), cool (November–January), and hot (February–April). Its average annual rainfall is approximately 1,500 millimeters (mm) (Thai Meteorological Department n. d.). About 25% occurs in September. Rainfall is minimal to negligible in the dry months of November to April.

[4] Babel is associate professor while Rivas is research associate, both of water engineering and management at the School of Engineering and Technology, Asian Institute of Technology, Thailand. The information and analysis presented in the water supply part of this chapter have been published in Babel, M., A. Rivas, and K. Seetharam, 2010, Municipal Water Supply Management in Bangkok: Achievements and Lessons, *International Journal of Water Resources Development*, 26 (2), pp. 193–217 with permission.

Figure 1 Bangkok Metropolis and Its Land Use



Source: Land use data (2007) from the Land Development Department, Thailand.

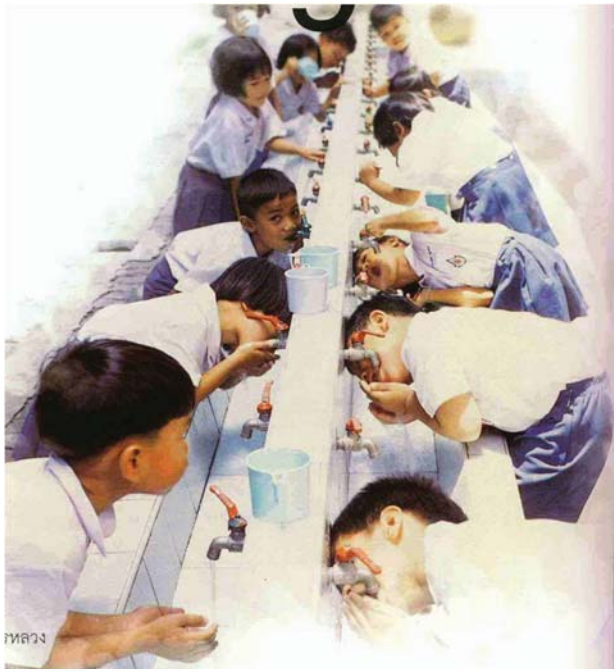
Domestic and industrial water supplies in Bangkok are provided by a combination of surface water and groundwater, the latter being mainly used in the outskirts of the metropolis. The main sources of raw surface water are the Chao Phraya and Mae Klong rivers. In 2006, the Metropolitan Waterworks Authority (MWA) supplied piped water at about 4.66 million cubic meters (mcm)/day (equivalent to 91% of total demand) to residential, industrial, and commercial sectors from surface water sources. The remaining 9% of the water demand (about 0.5 mcm/day) was met by abstracting water from deep wells (Polprasert 2007). This was largely done by industries, which prefer and are allowed by the Department of Groundwater Resources to use groundwater.

Institutional Setting and Governance

Institutional Arrangements

Water Supply

In accordance with the Metropolitan Waterworks Authority Act of 1967, the MWA was established on 16 August 1967 as a state enterprise. Its mandate was to survey, procure, and acquire raw water and to produce, supply, and distribute treated



Students in Min Buri District, Bangkok drink water directly from the tap.
Photo courtesy of Corporate Communication Department, Metropolitan Waterworks Authority.

water to the public in Bangkok and in two adjacent provinces—Nonthaburi and Samut Prakan. The MWA's area of responsibility covers approximately 3,195 km^2 with around 8 million people. To function efficiently, MWA divided its service area into 15 areas, which are served correspondingly by 15 branch offices in terms of water provision, customer service, pipe and valve repairs, meter replacement, meter recording, bill collection, and other related services.

Being a state enterprise, MWA generally has considerable autonomy in its operation and management. The Board of Directors is given full authority to make decisions to manage the state enterprise (MWA 2000). In performing its functions, MWA coordinates with several agencies including the Office of National Economic and Social Development Board for its development plans, the Ministry of Interior (MOI) as its regulating agency, the Royal Irrigation Department (RID) for raw water sources, the Ministry of Public Health for the quality of tap drinking water, and with provincial government administrations of Bangkok, Nonthaburi, and Samut Prakan, among others (Babel et al. 2010).

Wastewater and Storm Water

Wastewater and storm water management in Bangkok falls under the responsibility of the local government, i.e., the Bangkok Metropolitan Administration

(BMA). In particular, the Department of Drainage and Sewerage (DDS), one of the 14 departments of BMA, takes care of both storm water discharge and wastewater and sludge disposal (Suwarnarat 2000; Polprasert 2007).

The Water Quality Management Office (WQMO) within DDS is the entity focusing on municipal wastewater management. WQMO was established as the Wastewater Treatment Plant Division in 1977 to manage water quality in Bangkok and to resolve specific pollution problems. It is, therefore, responsible for proper wastewater disposal and the management of central and community wastewater treatment plants (WWTPs) in Bangkok. It also cooperates with the Department of Industrial Works (DIW) in the Ministry of Industry for industrial water quality management in Bangkok.

DDS is responsible for all planning, monitoring, and control of all flood control structures in Bangkok. It implements flood protection, management, and remediation schemes with the support of its Flood Control Center (FCC), which utilizes computer technology for systematic and efficient management of the operation and administration of flood protection facilities. FCC was established in 1990 with the purpose of implementing a centralized storm water and flood management system in Bangkok in coordination with other departments within BMA and line government agencies. It covers an area of 1,050 km^2 in the central part of Bangkok, spreading on the right and left banks of the Chao Phraya River (Sawano 1999). As a center of information, FCC is comprised of one master station located at the DDS office and 75 remote stations scattered in Bangkok.

Regulatory Bodies

The MOI is the main regulatory agency for both MWA and BMA. MWA is required to seek approval from the MOI for major projects or those related to budgets and investments. The Cabinet of Ministers also has a significant role in MWA as it appoints the members of the MWA Board for 4-year terms (Babel et al. 2010).

The Ministry of Finance (MOF) monitors the performance of MWA and all state enterprises through the State Enterprise Performance Appraisal process. Financial aspects of MWA operations, measures, and projects are subject to reviews by the MOF, while large projects are reviewed by the National Economic and Social Development Board for further approval by the Cabinet.

BMA, on the other hand, is subject to national procedures for transparency, as required of local governments under the Decentralization Act (Decentralization Act 2006). While BMA/DDS has been conferred the authority to operate independently, it still needs the approval of large projects from the MOI.

Urban Water Governance

Legislation Related to Water Supply

Water supply management is guided by several national policies, acts, and regulations that were instrumental in the creation of MWA or that significantly regulate its functions. Apart from the MWA Act of 1967 (with amendments in 1973, 1979, 1987, and 1992), these legislations include the following:

- The Conservation of Public Water Supply Canals Act of 1913 (amended in 1983), which prohibits some activities in canals intended for water supply, such as boating and navigation, garbage dumping, washing, bathing, fishing, and others.
- The Groundwater Act of 1977 (amended in 1992 and 2003 and followed by several ministerial regulations), which regulates the abstraction and use of groundwater in the country, with more stringent provisions for critical areas such as Bangkok and surrounding provinces.
- The Cabinet Resolution on "Remedial Measures for the Mitigation of the Groundwater Crisis and Land Subsidence in Bangkok" issued in 1983, which instructed the MWA to terminate its abstraction and use of groundwater for tap water supply.

There are also local regulations and ordinances implemented by MWA. These mainly address the classification of user types, guidelines for installation and fees for new connections, water tariff for the poor, and water sales and distribution through branch offices. The level of success in the enforcement of these ordinances can be deduced from MWA's performance, which will be discussed in the later parts of this chapter.

Legislation Related to Wastewater and Storm Water

In support of the national policy for maintaining environmental quality, a comprehensive law on environmental protection and conservation called "The Enhancement and Conservation of National Environmental Quality Act (NEQA)" was first passed in 1975 (revised in 1978, 1979, and 1992). The enactment in 1992 of NEQA was described by the then Prime Minister Anand Punyarachun as "the dawning of a new era for the environment of the country" (Tilleke and Gibbins International 2007).

Considered the most significant environmental legislation to date, NEQA includes important provisions on environmental quality management, including provisions that are especially relevant to water quality management and pollution control (Babel and Rivas 2008). Based on this act, sub-laws and ministerial regulations and notifications have been put in place for domestic, industrial, and agricultural wastewater treatment and effluent standards. Water quality standards were also set to protect water resources from pollution. For instance, water quality standards

for the Chao Phraya River were set by the National Environmental Board in 1986. The wastewater quality standards cover industrial and building effluents to agricultural and aquaculture activities. Accordingly, the government regularly prepares a medium-term Environmental Management Plan. Preparation of an Action Plan for Environmental Quality Management at the *changwat* (or provincial) level is also based on the Environmental Quality Management Plan prescribed in this act. Moreover, the Industrial Estate Authority of Thailand (IEAT) released the Wastewater Discharge Criteria for Factory Situated in Industrial Estates to ensure proper discharge of wastewater pursuant to the Industrial Estate Authority Act of 1979 (Babel and Rivas 2009).

Other laws address the control of pollution that may be brought about by the use and disposal of harmful, toxic, or hazardous substances. Two of the most important acts are the Factories Act of 1992 and the Hazardous Substances Act of 1992. Other relevant acts for the protection of water resources are the Public Health Act of 1992 (amended in 2007), the Cleanliness and Tidiness of the Country Act of 1992, the Building Control Act of 1979 (amended in 1992), the Navigation in Thai Waterways Act of 1913, the Penal Code of 1956, the Fisheries Act of 1947, and the Royal Irrigation Act of 1942.

BMA also developed master plans for storm water and water quality management in Bangkok. The recent Public Administration Plan (2005–2008) of BMA emphasizes maintaining water quality in canals and ditches in Bangkok by requiring all private properties to have some form of wastewater treatment facility. The BMA Environmental Management and Energy Conservation Strategies laid out the road map for flood prevention and water quality improvement. The goals for 2005–2008 include greater than or equal to 1 milligram per liter (mg/l) average dissolved oxygen (DO) in targeted canals, no more critical areas during rainy season, and no more flooding around the river's edge (BMA 2006).

Political and Government Commitment and Leadership in the Utilities

MWA and BMA enjoy strong support from the national government and from the Thai Royal Family. Measures implemented to address specifically storm water and wastewater management in Bangkok showed the assistance provided by government ministries or departments and by the King of Thailand himself. The diversion of flood waters to agricultural areas in the north and east of Bangkok during the 2006 flood that spared the city from huge damage, as part of RID's approach to flood management, indicates the high importance given by the national government for the protection of Bangkok as the economic and political capital of the country as approximately 35% of the total gross domestic product (GDP) of Thailand is generated in Bangkok (Babel et al. 2007).

The achievements and notable performance of MWA could not be attributed to a single individual but rather to a group of decision makers (the MWA Board) and executives, and to the bold initiatives of Dr. Arthit Urairat who provided the foundation for the favorable enabling environment at MWA. As the governor who headed MWA for a few years (1984–1987), he introduced operation and management methods that turned MWA from a typical government or semi-government entity into a business entity committed to public service. He was able to obtain support from the national government for MWA's projects, activities, and management measures, some of which had not normally been supported in the past. Bonuses for employees were initiated, which was perceived to have contributed to improving the performance and efficiency of MWA staff. Three revisions and adjustments to the water tariff made during 1984–1987 also contributed to the improved financial status of the utility.

MWA continues to improve its policies, strategies, and management approaches toward fulfilling its vision and mission, with due consideration to emerging challenges and opportunities. The implementation of transparency management is noteworthy and measures related to improving governance at MWA are discussed in detail by Babel and Rivas (2009). The main features of these measures are the strong internal control system and the preparation and publication of annual reports with substantial information on finance and service performance, among others. As a result of improving its management, MWA received awards on best practices in corporate governance from the MOF—Best Practice of Board of Directors (2005) and Best Organizational Management (2006 and 2008).

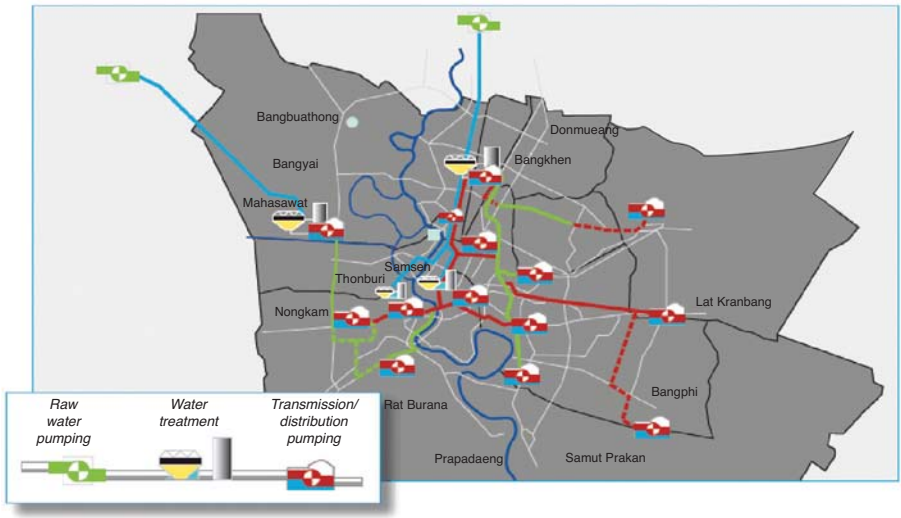
Supply Management

Water Resources

Although rainfall in Bangkok is modest, this does not significantly influence water supply as the city meets its water needs from the Chao Phraya and Mae Klong rivers and underlying aquifers that are fed or recharged from other areas receiving significantly higher rainfall. From its peak use in the late 1990s, groundwater extraction has since been controlled to mitigate negative impacts such as groundwater depletion, quality deterioration, and land subsidence (Babel et al. 2007). While some private establishments still use groundwater, raw water sources for MWA's water supply are solely from surface water with groundwater wells being kept as back-up sources since 2005.

Domestic water supply is a priority in the allocation of surface water resources under the authority of RID (Molle 2001; Khon Kaen University 2006). RID allocates water as per agreement with MWA, which has no direct authority over water resource planning (Suwarnarat 2000). The maximum abstraction from the Chao

Figure 2 Major Water Supply Facilities of the Metropolitan Waterworks Authority



Source: Babel et al. (2010), p. 200. Reprinted with permission of the publisher.

Phraya River is 60 cubic meters per second (m^3/s) and from the Mae Klong River through interbasin transfer is 45 m^3/s, and could be lower under conditions of constrained availability.[5]

As of 2009, MWA has four treatment plants (Bangkhen, Mahasawat, Thonburi, and Samsen), with a total production capacity of 5.52 mcm/day. Treated water is supplied to the distribution system through a network of 16 pumping stations in different branch offices (Figure 2). With the continuing expansion of the service area of MWA, water production increased by approximately 13% from 4.26 mcm/day in 1998 to 4.82 mcm/day in 2008, which corresponds to 0.62 m^3/day per person. Along with this increase, it should be noted that savings of approximately 10% due to reduction in water loss have been achieved during the same period and thus should be taken into account when assessing the amount of water in the distribution system.

To meet future water demands, the original MWA Master Plan 2017 prepared in 1990 was revised as of 2008 with the following projections for its production capacity: 6.72 mcm/day in 2017, 7.12 mcm/day in 2020, and 7.92 mcm/day in

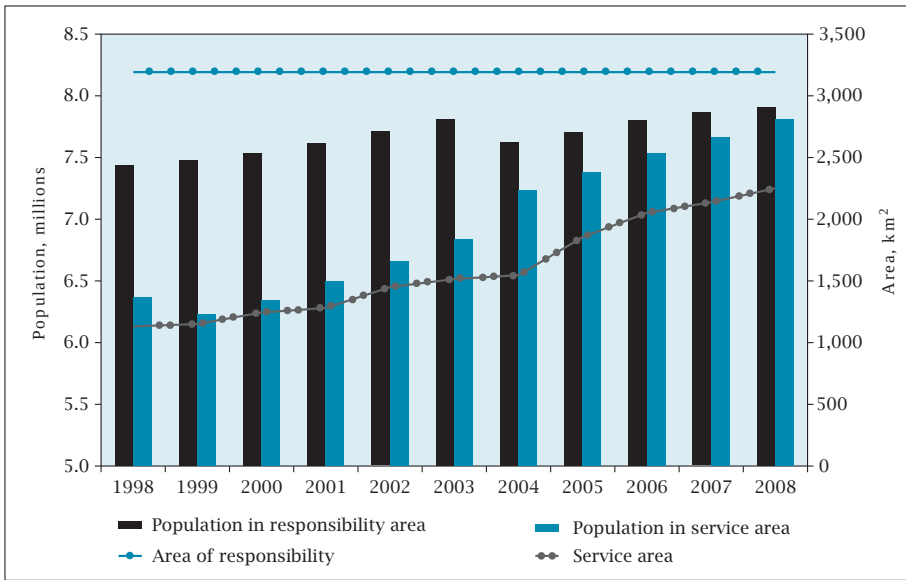
[5] RID has been charging B0.50 per m^3 of water from the Mae Klong River since 2006, but levies no charges for the Chao Phraya River water.

2027. The figure in 2009 corresponds to 92 m^3/s of water supply, which is not too far from the limit (105 m^3/s) that MWA can obtain from the Chao Phraya and Mae Klong rivers combined. This clearly indicates MWA's focus on the expansion of its production capacity (supply) to meet the demand, suggesting that it relies heavily on the sustained availability of its water sources, although climate change may significantly affect this.[6]

Water Supply Coverage

Within a decade, MWA's service area doubled from around 35% (1,129 km^2) in 1998 to 70% (2,251 km^2) of its area of responsibility in 2008 (Figure 3). In Bangkok alone, its service area increased by 63% in the same period from 726.3 km^2 to 1,182.8 km^2, which is 75% of the city area. This reflects the enormous investment made by MWA for service expansion. While service coverage did not encompass the whole responsibility area, coverage reached 98.8% of the total registered population in 2008 (an increase of 23% from 1998). The service area population coverage in Bangkok in 2008 was 5.55 million (97.2% of the registered city population), an increase of about 19% from

Figure 3 Service Coverage of the Metropolitan Waterworks Authority



km^2 = square kilometer.

Note: The decrease in population between 2003 and 2004 is due to the updating of number of persons per house certificate.

Sources: Annual reports, 1998–2008 of the Metropolitan Waterworks Authority (MWA 1999, 2000, 2001a, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009); Department of Provincial Administration. This was first published as Figure 1 in Babel et al. (2010), p. 199. Reprinted with permission of the publisher.

[6] The region is expected to receive less rainfall (annually) as a result of climate change (Bates et al. 2008).

1998. The significant increase in service coverage is due to the commitment of the utility to expand its services as guided by its master plan, the implementation of its expansion projects, and the availability of funds for such investment, which is supported by the positive financial performance of the utility. The availability and subsequent tapping of a new source (i.e., Mae Klong River) for water supply was also critical in meeting the increasing demand.

Metering and Connections

An essential part of water supply management is the use of meters to monitor and measure consumption. Meter installation is an integral part of the standard procedures for the installation of a new connection. Information from MWA and other reports indicate that all connections in MWA's service area are metered and that all meters are in operation (McLay 2005).

MWA's service connections increased by 36% from 1998 to 2008 (Table 1). In particular, residential connections increased by 37%, indicating the extent of the increase in coverage. The large increase in government connections could be due to changes in the classification of types of connections. The increase in industrial and other types of connections is difficult to assess because beginning in 2007, MWA used a new classification for water connections other than residential and government connections that resulted in the abrupt increase in industrial connections. This reclassification is in preparation for a new tariff structure that is being studied by MWA. Taking together connections other than residential and government connections as a group indicates an increase of 31%. Service connections in Bangkok alone accounted for 76% of the total of MWA's service connections in 1998, while it was 71% in 2008. This indicates that the expansion of the service area during the period occurred largely in the other two provinces—Nonthaburi and Samut Prakan.

MWA has a specific regulation for supplying piped water to the urban poor and slum dwellers, in which MWA provides partial financial support (Babel et al. 2010). Accordingly, appropriate measures are in place to discourage wastage or unnecessarily high consumption of water provided at low rates. Local governments of Bangkok, Nonthaburi, and Samut Prakan cooperate with MWA for the expansion of water supply services to villages located far from the existing network.

Water Quality and Service Reliability

MWA is committed to providing safe drinking water and implements quality control measures on three fronts: raw water sources, produced water, and water in the distribution system and taps. To ensure that tap water is safe for drinking, MWA has adopted strictly the World Health Organization (WHO) 2006 criteria and standards as its own (Dai 1997; Babel et al. 2010).

Table 1 Water Service Connections of the Metropolitan Waterworks Authority

Water Service Connections	As of 30 September										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of residential connections (RC)	1,032,117	1,045,969	1,065,009	1,090,961	1,123,409	1,161,569	1,201,652	1,244,422	1,285,911	1,335,807	1,410,324
Average number of people per RC	NA	NA	NA	NA	5.9	5.9	6.0	5.9	5.9	5.7	5.5
Number of government/ institutional connections	906	2,743	2,920	3,044	3,157	3,261	3,430	3,590	3,609	7,293	7,350
Number of commercial connections	336,544	336,093	341,030	348,401	359,777	373,044	400,164	433,651	456,556	454,273	435,877
Number of industrial connections	160	152	150	148	190	140	133	20	123	6,951	6,023
Number of bulk connections (residential)	NA	NA	859	1,722	1,935	2,005	2,263	2,490	2,546	NA	NA
Number of bulk connections (commercial, government, state enterprise, and industrial)	NA	NA	132	169	170	184	278	333	268	NA	NA
Total Number of Service Connections[a]	1,369,727	1,384,957	1,410,100	1,444,445	1,488,638	1,540,203	1,607,920	1,684,506	1,749,013	1,804,324	1,859,574
Total number of service connections in Bangkok only[b]	1,038,661	1,043,422	1,057,463	1,074,365	1,101,952	1,132,721	1,173,782	1,220,902	1,259,609	1,290,334	1,322,129

NA = not available.

Notes:

[a] Data refer to the number of connections in Metropolitan Waterworks Authority's (MWA) entire service area of Bangkok, Nonthaburi, and Samut Prakan.

[b] Figures are MWA's estimates only, as the MWA system is not particularly configured to easily distinguish information between different provincial (political) boundaries.

Source: Data were collected directly from the MWA.

Consequently, MWA implements rigorous procedures for the treatment of water at different stages of production. Raw water from the Chao Phraya and Mae Klong rivers is subjected to a Bio Monitoring System to determine if water is free from toxic substances.[7] Produced water passes through several treatment processes (precipitation, filtration, and disinfection) before reaching consumers. Along with treatment, MWA also conducts monitoring of around 50 water quality parameters (physical and chemical components, heavy metals, carcinogens especially the trihalomethanes group, bacteria, and algae) at different stages starting at the raw water sources until the final stage at the customer's premises. The level of quality control measures implemented by MWA is indicated in the International Organization for Standardization (ISO) certifications (ISO 9001, 9002) it received for its treatment plants for the continued improvement in the treatment system (MWA 2002). MWA also received an ISO/International Electrotechnical Commission (IEC) 17025 certification in 2004 for the quality of the laboratories where water samples are analyzed.

Results of the analysis of water quality in treatment plants and distribution system are publicly available on MWA's website (www.mwa.co.th). In 2007, analysis results of water quality parameters surpassed WHO standards (*Bangkok Post* 2007). Real-time water quality data are also available online for 20 automatic sensor equipment stations installed in the MWA service area. The system collects data on two critical parameters (free residual chlorine and turbidity) every 10 seconds.

In addition, MWA rehabilitated its water supply distribution system since 1998 to ensure safe potable water. Subsequently, the Ministry of Public Health had certified that the piped water is safe for drinking. However, even if the water in the distribution system is clean and safe, water from the taps may still be of inferior quality if the plumbing system in the house or establishment is not properly maintained—such as the case in the MWA service area. Factors identified for poor tap water quality include storage tanks in individual houses and/or establishments that are never or rarely cleaned; rusted old pipes in the plumbing system; and filters full of bacteria, dust, and sediments (MWA 2000). MWA customer satisfaction surveys between 1996 and 1999 revealed that only a very small percentage of the population drank water directly from the tap due to people's lack of confidence that the water is safe enough (Dai 1997; MWA 1999).

MWA has implemented campaigns starting in 19.98 to improve water quality at user's end and to encourage consumers to drink tap water. MWA sought the cooperation of government offices such as the BMA, the Ministry of Public Health, the Mahidol University, and other agencies and institutions. One notable endeavor is the Drinkable Water Projects in schools, hotels, government offices, private establishments, and others in which MWA offers free assistance in surveying individual

[7] This is composed of an aquarium with live fishes installed in MWA's laboratories and monitored around-the-clock.

household pipe systems to identify causes of deterioration in water quality, water quality testing, and providing recommendations to improve the quality of tap water. MWA awards certificates on safe and drinkable tap water to establishments that meet the standards. From financial year (FY) 1999 to FY2008, over 1,500 establishments received such certification (Babel et al. 2010).[8]

However, such efforts have not yet resulted in clear positive outcomes in terms of increasing the percentage of the population that drinks water directly from the tap. While the public generally rejects direct tap water consumption, income and education were found to have some effect on the attitudes of consumers toward alternatives (Dai 1997). Thus, the capabilities of the population to purchase bottled water as their alternative source of drinking water cannot be discounted given that per capita income in Bangkok is the highest among all 76 provinces and 2.3 times the average for the entire country (Babel et al. 2007).

Water Availability

MWA's consumers are, to a large extent, satisfied with its 24-hour supply of water (McIntosh and Yñiguez 1997; McLay 2005). The supply is interrupted locally only when there are pipe breaks in the mains, during maintenance work, or during power substation preventive maintenance by the Metropolitan Electricity Authority.

The typical water pressure at the mains was approximately 59 kilopascal (kPa)[9] (McLay 2005). This is equivalent to about 6 meter (m) head of water, the MWA level of service (Babel et al. 2007). However, there seems to be a concern about water pressure as indicated by the number of water pump units installed by consumers in their premises.[10] MWA intends to increase the level of pressure in the entire system as this is one of its key performance indicators. In FY2008, the average pressure throughout the service area was 6.57 m, which is equivalent to 64.4 kPa (MWA 2009). On the other hand, while the number of monitored locations with an average monthly pressure of less than 6 m has decreased from 11 to 7 locations, this also indicates that there are still areas with average pressure of less than 6 m, which could have forced the residents to install pumps.[11] Thus, measures to increase water pressure, especially in these areas, should be implemented.

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8 Financial year: 1 October to 30 September (e.g., FY2008 is 1 October 2007 to 30 September 2008). Currency conversion: $1 = B34.

9 A 1-meter head of water at 4 °C is equal to 9.81 kPa.

10 Figures for 1999 revealed that 29.3% of connections used water pumps, with 17.1% of this pumping water directly from the pipes (MWA 2000). This figure increased in the customer satisfaction survey conducted in 2008, wherein approximately 60% of respondents used pumps.

11 MWA has installed pressure monitoring devices in over 100 locations in various areas within the system, and the data from these devices are also used for considering pumpage amounts in corresponding pumping stations. These pressure monitoring devices register information around the clock (MWA 1999).

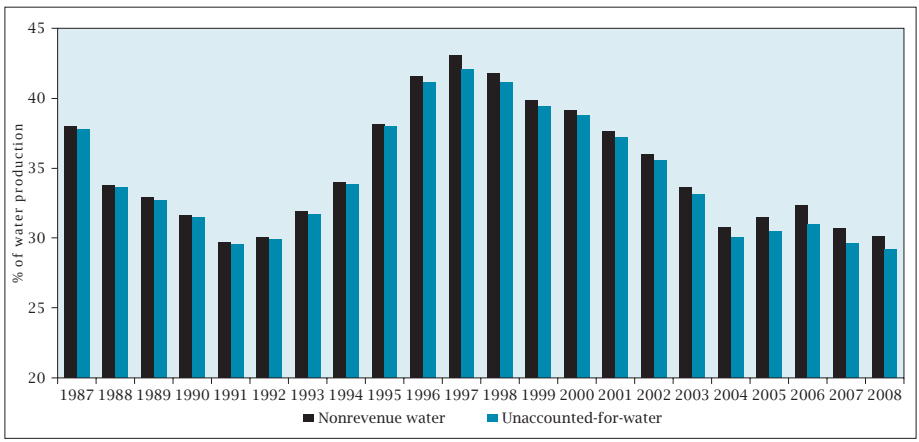
Nonrevenue Water

At the time the MWA was established in 1967, water loss was reportedly 75% of water production. A major factor was pipe leakage, which was attributed mainly to limited budget for targeted service expansion, resulting in the use of low-quality pipes and poor workmanship (MWA 1998). Other factors include illegal connections and connections without meters.

By adopting reduction of water loss as one of its policies, MWA was able to bring down unaccounted-for-water (UFW) to 29.6% of water produced in 1991 (Figure 4). However, due to an increase in production and service expansion to meet the increasing demand for water along with shortages in annual budget allocations and other obstacles, UFW steadily increased again and reached a peak of 42.1% of water produced in 1997.

Based on studies conducted in 1997 (MWA 1998) and 2000 (MWA 2001b), the main cause of UFW (81% of total loss) is leakage in the distribution system due to broken pipes or fittings. Other reasons are improper functioning and reading of meters (14%) and illegal connections (5%). To reduce water loss, MWA implemented a number of measures that included (i) improving the distribution system and leakage control, (ii) establishing the Water Transmission and Distribution Control Center to enhance water allocation efficiency, (iii) putting up District Metering Areas (DMAs)[12]

Figure 4 Nonrevenue Water and Unaccounted-for-Water in Metropolitan Waterworks Authority Service Area, 1987–2008



Sources: Annual reports, 1996–2008 of the Metropolitan Waterworks Authority (MWA 1997, 1998, 1999, 2000, 2001a, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009). This was first published as Figure 3 in Babel et al. (2010), p. 201. Reprinted with permission of the publisher.

[12] DMAs are discrete parts of a water distribution system separated by means of closed sluice valves. As such, the quantity of water entering and the difference between that amount and quantity consumed can be measured to determine leakages.

covering the entire service area, and (iv) adopting the Water Leakage Application System for integrated water leakage management (Babel et al. 2010).

Moreover, MWA regularly replaces old pipelines to keep the average age of pipes to about 20 years. While the total length of the distribution network increased by 64.5% from 18,775 kilometers (km) in FY1998 to 30,894 km in FY2008, the number of pipe breaks and leaks per 100 km decreased by 43.3% from 222,304 km to 126,053 km in FY1998, and by 65.5% from 1,184 km to 408 km in FY2008. Aside from pipe replacement, another factor for the reduced number of pipe breaks could be the application of transmission and distribution controls, which minimized the occurrence of excessive pressure in the system that could have caused pipe breaks.

To maintain the effectiveness of water meters, the Water Meter Department of MWA and its branch offices replace meters every 8 years (the average working life of meters). On illegal water use, MWA has an inspection unit that conducts investigation in the field and studies bill trends. Penalties for illegal water use are imposed depending on the type of offense (Babel et al. 2010). Individuals who report illegal connections receive 30% of the fine and the MWA officer who acts upon it receives 20% of the fine as an incentive.

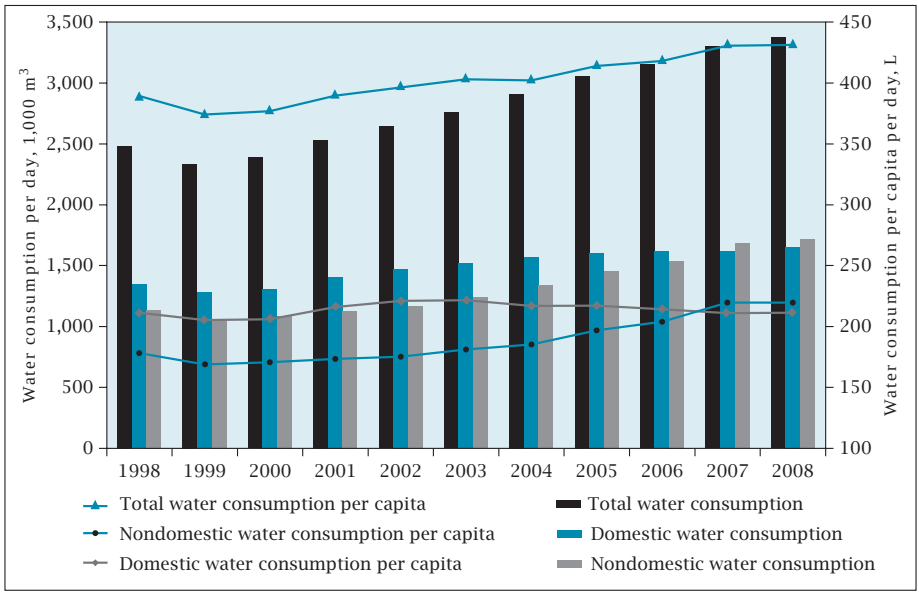
The above measures have resulted in UFW reduction and, subsequently, nonrevenue water (NRW) falling from 41.8% in FY1998 to 30.2% in FY2008. The latter figure is close to MWA's target of keeping UFW at not more than 30% of produced water (MWA 2003), which was based on the average NRW of 30% in Asian cities (McIntosh 2003). However, UFW level in FY2008 remained high and can still be reduced. Considering that population coverage is almost 100%, MWA can focus on further reducing UFW more aggressively than its current plans of reducing it by only 0.2% per year.

Demand Management

Water Consumption

MWA has essentially followed the supply-oriented approach to meet the demand for water. This is clearly reflected in the trend in domestic water consumption per capita (Figure 5), which had not changed much and remained high (approximately 211 liters per day, both for Bangkok and the entire MWA service area) compared to most cities in the region and beyond (SEAWUN and ADB 2007; Tortajada 2006; McLay 2005). This indicates that the water consumption behavior of residents in the MWA service area has not changed significantly and suggests that much remains to be done, particularly on demand management, to reduce per capita water consumption.

Figure 5 Water Consumption by Type in the Metropolitan Waterworks Authority Service Area, 1998–2008



L = liters, m^3 = cubic meters.

Source: Data collected directly from the Metropolitan Waterworks Authority. This was first published as Figure 4 in Babel et al. (2010), p. 206. Reprinted with permission of the publisher.

The increase in the average daily total water consumption could be attributed to the increasing population coverage and commercial activities, such as businesses and industries.[13] This increase in commercial activities, largely concentrated in Bangkok, is evident in the rise of per capita nondomestic consumption, given that the served population has increased and some industries[14] and other commercial establishments[15] have adopted water saving, reuse, and/or recycling technologies in their operations and other water use activities.

Water Pricing

MWA has implemented a progressive tariff structure since 1981. Authorized by the 1992 amendment of the MWA Act to set its water tariff independently, MWA has revised its water tariff structure several times and the current tariff structure has been applied since December 1999 (Table 2). The tariff structure is supposed

[13] The total water consumption in Bangkok alone in 2008 comprised 74% of total consumption in the MWA service area.

[14] A survey among industries in Samut Prakan showed that 59% of respondent industries adopt water reuse or recycling (Babel et al. 2007).

[15] Some large-consuming water customers have implemented some conservation measures to reduce consumption and corresponding costs (Dhungana 2002).

Table 2 Water Tariff Structure of the Metropolitan Waterworks Authority

December 1999–Present			
Residential		Nonresidential: Commercial, Government Agency, State Enterprise, and Industries	
Minimum Charge	B45.00	Minimum Charge	B90.00
Bulk	B10.50/m^3	Bulk	B13/m^3
Amount (m^3/month)	Rate (B/m^3)	Amount (m^3/month)	Rate (B/m^3)
0–30	8.50	0–10	9.50
31–40	10.03	11–20	10.70
41–50	10.35	21–30	10.95
51–60	10.68	31–40	13.21
61–70	11.00	41–50	13.54
71–80	11.33	51–60	13.86
81–90	12.50	61–80	14.19
91–100	12.82	81–100	14.51
101–120	13.15	101–120	14.84
121–160	13.47	121–160	15.16
161–200	13.80	161–200	15.49
Above 200	14.45	Above 200	15.81

B/m^3 = baht per cubic meter, m^3/month = cubic meter per month.

Note: Currency conversion: $1 = B34.

Source: MWA (2002). This was adapted from Babel et al. (2010), p. 207.

to encourage consumers to conserve water as lower consumption is charged at a lower rate. However, the generally low water tariff compared to income levels is considered a factor that makes demand management by MWA inefficient as water users are not motivated to reduce their demand and consume water efficiently.

The first consumption block of the tariff structure for residential users (at B8.50) does not cover the full cost of production and supply of water based on total cost per unit of water sold.[16] However, the government has a policy to keep the water tariff at a reasonable and affordable level to help people with their living expenses. While this measure is intended to help the lower-income groups, it also benefits the middle- or higher-income groups who are capable of paying at a higher rate but who consume water within the 30 m^3 range. A revised mechanism for assisting the poor may be considered, such as the one used in Singapore, where the government provides specially targeted assistance to lower-income families (Tortajada 2006). Alternatively, the current first block of 0–30 m^3 per month may be divided

[16] The cost of water per unit sold was B8.69 (2005), B8.62 (2006), B8.62 (2007), and B9.16 (2008), as reported in the annual reports (MWA 2007, 2009).

into two or more blocks with progressive rates so that only basic household water needs are directly supported.[17]

In addition to the financial support provided to poor people in obtaining a water supply connection, MWA participated in the government's subsidy program for utilities, wherein water consumption was made free under some limit of usage applicable to all residential connections. It was first implemented from August 2008 to January 2009, in which connections using less than 50 m^3 were not required to pay and if consumption exceeded the amount, they needed to pay for the total amount consumed. The subsidy program was extended from February–December 2009, wherein connections using less than 30 m^3 were not required to pay, and finally extended up to March 2010 for connections not using more than 20 m^3. While this program had no financial impact on MWA as the MOF paid the bills to MWA and there was no observed significant increase or decrease in consumption, this might have a negative influence on the behavior of consumers and, consequently, on water conservation efforts.

Public Education and Water Conservation

MWA promotes water conservation through the media and internet, by distributing brochures, and by implementing a number of public awareness activities, which are implemented under its public relations programs and other projects (MWA 2000; Babel and Rivas 2009).

A demand-side management (DSM) study carried out during 1995–1996 identified 18 programs that were potentially feasible in Bangkok (Dhungana 2002). The implementation of two very effective programs, system leak detection and repair of plumbing fixtures, could lead to 8.5% reduction in water use with reference to base production in 2015. If the recommended DSM master plan were implemented, Bangkok would save about 1.46 million m^3/day, or 21% of production by 2015. While DSM programs were found to be financially and environmentally beneficial to the operation of MWA, the activities of MWA seem to focus mainly on water conservation campaigns, public awareness activities, and reduction of losses. Although MWA also promotes the installation of water-saving fixtures or sanitary equipment in households and villages, current plumbing codes in Thailand do not require such installations in residential and commercial establishments (Phuaprasert 1998). Thus, water users do not install these devices since water fees are low. However, such a measure, which requires the creation of appropriate policies or the revision of existing laws (e.g., Plumbing Code), is significant given that domestic water

[17] Considering only basic household water needs, the first block may be 0–7 m^3 per month—which is good for about 100 liters per capita per day (lpcd) for a household size of 2.5 persons (based on 2003–2008 population and household data from DOPA for Bangkok, Nonthaburi, and Samut Prakan), although Gleick (1996) and Abrams (2001) reported that 50 lpcd is sufficient.

consumption accounts for about half of total water use, and 50% of domestic consumption is utilized in toilets and bathrooms (Otaki et al. 2008).

Wastewater Management

The Chao Phraya River and the *klong*s (canals) were major sources of income for the people in Bangkok, who used water for household activities, sports, aquaculture, and for transport. However, these water bodies were also used as sewerage or natural wastewater treatment systems where domestic, commercial, and industrial wastes were discharged without treatment (Kitakyushu 2002). Prior to 1990, there was virtually little or no treatment of municipal wastewater in Thailand (McIntosh 2003). This was due to the presumption that most, if not all, households used on-site sanitation systems and to the attenuation functions of the canals. With population growth and urbanization, water quality in these water bodies worsened with increased contamination and water pollution.

Several structural (WWTPs) and nonstructural (policies and legislation) measures were implemented to address water quality problems in Bangkok. The nonstructural measures (discussed in the section on Urban Water Governance, p. 15) created the enabling environment for implementing the much-needed structural measures. Domestic or municipal wastewater treatment in Bangkok started with the construction of community WWTPs in the mid-1970s by the National Housing Authority (NHA). In the mid-1980s, a total of 14 community WWTPs were completed. However, the capacities of these plants were very limited, ranging from 400 to 6,500 m^3/day, which were largely insufficient to address the water quality problems of the city. Thus, in the early 1990s, BMA embarked on a major program of treating wastewater to improve water quality in the *klong*s and in the Chao Phraya River. As of 2009, there were 22 WWTPs for municipal wastewater in Bangkok under the supervision of the WQMO. Among these, seven were central WWTPs with a treatment capacity of 992,000 m^3/day, and 12 were small community WWTPs with a treatment capacity of 24,800 m^3/day.[18] The operation of these community WWTPs had been transferred to the WQMO for their improvement due to a lack of technical capacities and operators in the NHA. All these WWTPs are located primarily in the central part of the metropolis. Moreover, two WWTPs are oxidation ponds—one located in Makkasan to treat canal water of Klong Lad Phrao, and another in Rama IX to treat canal water of Klong Samsen. A WWTP in On Nuch is dedicated to treating leachate from the On Nuch Solid Waste Transfer and Disposal Center.

Bangkok has adopted a combined sewer network for surface runoff and wastewater. Thus, whenever a WWTP is constructed and ready for operation, the wastewater

[18] Two of the original 14 community WWTPs were decommissioned in 2004 and 2007. Their respective service areas are covered by central WWTPs.

collection pipe is connected to the existing public sewer, through an interceptor chamber, to carry domestic wastewater to the treatment plant without requiring any connection fees from households or establishments.

Table 3 shows that within a decade, the service area for wastewater treatment has increased from 4 km^2 to 196 km^2, due largely to the construction of central WWTPs. However, wastewater treatment coverage was only approximately 12% of the responsibility area, serving a little more than 3 million people or about 54% of Bangkok's population. This population coverage does not reflect the proportion of the population with isolated or separate on-site sanitation systems. It was reported that 65% of Bangkok's population had on-site sanitation system in the early 1990s (Stoll 1995). Figures for 2008 are not available, although local authorities claim that most, if not all, of those not covered by the sewer network in Bangkok have their own sanitation systems, such as a septic tank. This is attributed to the passage of the Public Health Act in 1941 that required the construction of disposal systems for human excreta (JICA 1981).

The coverage of existing WWTPs can still be expanded as the volume of treated wastewater in Bangkok (excluding the two WWTPs that treat canal waters) in 2008 was about 26% of the estimated volume of wastewater generated (Figure 6), while the capacity of WWTPs was about 38% of the estimated volume of wastewater generated (for 2007 and 2008). Moreover, if three future plants (Klongtoey, Thonburi, and Bangsue) were taken into account, with a total treatment capacity of

Table 3 Coverage of Wastewater Treatment in Bangkok

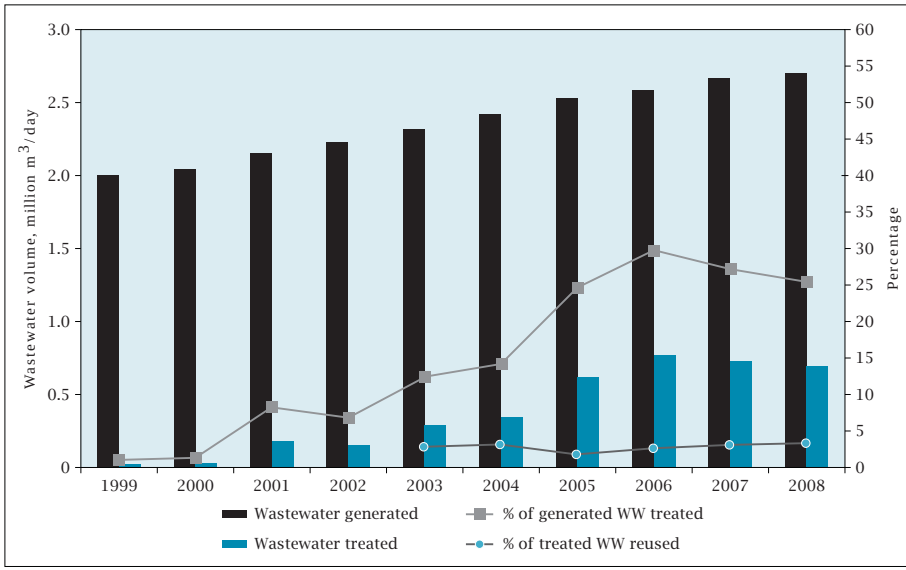
Utility's Area of Responsibility and Service Area	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Size of service area (km^2)	4.15	6.85	6.85	39.49	39.49	125.49	125.49	195.89	195.89	195.89	195.89
Population of area of responsibility (million)	5.65	5.66	5.68	5.73	5.78	5.84	5.63	5.66	5.70	5.72	5.71
Population of service area (million)	0.13	0.25	0.25	0.90	0.90	1.60	1.60	3.11	3.11	3.11	3.11
Proportion of population with access to an urban sanitation system (%)	2.34	4.45	4.44	15.75	15.60	27.36	28.38	54.99	54.63	54.43	54.49

km^2 = square kilometer.

Note: For community wastewater treatment plants (WWTPs), data are available only after WWTPs have been transferred administratively to the Bangkok Metropolitan Administration (BMA).

Source: Department of Drainage and Sewerage website (in Thai): http://dds.bangkok.go.th

Figure 6 Municipal Wastewater Generation and Treatment in Bangkok



m³ = cubic meter, WW = wastewater.

Note: The amount of wastewater generated was estimated based on approximate total water consumption in Bangkok (data from the Metropolitan Waterworks Authority [MWA]).

Sources: Data collected directly from the Department of Drainage and Sewerage, Bangkok Metropolitan Administration, and MWA.

785,000 m³/day, 67% of wastewater volume in Bangkok would be covered theoretically. One plant (Bang Sue WWTP) is set to be completed in 2011, while feasibility studies had been completed for the other two. This seemingly slow pace of development of wastewater treatment infrastructures could be attributed to the corresponding high costs and the difficulty of finding suitable locations for the treatment plants, especially given that land in Bangkok is very expensive.

Industrial wastewater accounts for 25% of wastewater generated in Bangkok (BMA 2006). Information gathered from DIW shows that in 2007, there were a total of 9,970 industries or factories in Bangkok. These industries or factories, excluding those within industrial estates that are under the responsibility of IEAT, release a total of approximately 81,100 m³ of treated wastewater per day.

Wastewater and Surface Water Quality

Data on the quality of treated wastewater (2005–2008) from central and community WWTPs show that wastewater effluent in essentially all WWTPs meet the standards for selected water quality parameters (Babel and Rivas 2009). Of the total amount of treated wastewater, only a small proportion (approximately 3%) is being reused mainly for cleaning machines, floors, roads, and watering plants in

the treatment plants. It is also collected by BMA trucks for watering plants in public parks and along the roads in the city.

The impact of the treatment of wastewater on the quality of water in *klong*s is not apparent with respect to maintaining water quality at an acceptable level.[19] In terms of two important water quality parameters—dissolved oxygen (DO) and biochemical oxygen demand (BOD)—annual (2005–2008) and monthly (2008) averages show that water quality in the *klong*s is poorer than Class 4 (fairly clean, fresh, surface water) almost throughout the year. Meanwhile, the water quality in the Chao Phraya River is within Class 4 for DO but poorer than Class 4 in terms of BOD.[20] Average monthly concentrations of total coliform (Col) in *klong*s and in the Chao Phraya River within or close to the boundaries of Bangkok are very high (in the order of 10^7–10^8 and 10^3–10^7 Col/100 ml, respectively), indicating that the waters are suitable for navigation only (Babel and Rivas 2009). On the other hand, it was observed that after the start of operations of two WWTPs in 2005, a decreasing trend in total coliform was apparent from 2006 to 2008 in the *klong*s of Bangkok and in most sampling locations along the Chao Phraya River.

Storm Water Management

Bangkok is highly prone to flooding. Prior to its development as a metropolis, Bangkok was a lowland area with swamps and numerous canals that were usually flooded by the annual overflowing of the Chao Phraya River. While the modest amount of annual rainfall does not pose water supply issues, the distribution and intensity of rainfall is a significant concern as about a quarter of annual rainfall falls in a single month (September). This presents challenges for discharging excessive runoff during the rainy season when high rainfall intensity is common.

The causes of flooding in Bangkok can be grouped into two categories: primary and secondary (Lekuthai 2003; Panya Consultants 2008). Primary factors include direct precipitation, inflow from surrounding areas, overflow from the Chao Phraya River, and tidal effects from the Gulf of Thailand. Secondary factors include poor or insufficient internal drainage capacity, insufficient flood protection systems for the city, change in land use conditions, land subsidence due to overextraction of groundwater affecting flow directions, and the insufficient capacity of river networks (leading to bottlenecks). These factors have contributed to several flood events in the past decades (e.g., 1980, 1983, and 1995), which caused huge damages not just in Bangkok but throughout the Chao Phraya Basin.[21]

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[19] Based on annual (2005–2008) and monthly (2007, 2008) data from canals (173 points = 2005, 180 points = 2006, 271 points = 2007, 274 points = 2008), and the Chao Phraya River (5 points).

[20] Class 4 standard in Thailand is DO = 2 mg/l, and BOD = less than 4 mg/l.

[21] Damage incurred reached B1 billion in 1975 and 1978, B2 billion in 1980, B6.6 billion in 1983, and B600 million in 1995 (data taken from DDS).

DDS is constructing and improving flood protection and drainage structures to achieve a complete and sustainable system to prevent flooding and increase the drainage efficiency within a polder.[22] Flood barriers along the Chao Phraya River, Bangkoknoi Canal, and Mahasawat Canal, with a total length of 77 km and with height ranging from +2.5 m to +3.0 m above mean sea level, were constructed. On the eastern side of Bangkok, DDS is increasing the elevation and coverage of the existing King's dyke to protect the city from flows from the northern and eastern parts.

Bangkok has an extensive and complex drainage system. As of 2009, it had a total of 2,625 km of *klong*s and drainage tunnels, as well as 5,900 km of sewer line. There were 369 main pumping stations, a number of small pumping stations, and hundreds of movable pumps to help in draining runoff. With this, the capacity of the Bangkok drainage system was 1,531 m^3/s (1,057 m^3/s on the eastern side and 474 m^3/s on the western side).[23]

Among the major undertakings of BMA/DDS are the construction of drainage tunnels (24 km) and locating more Monkey Cheeks on privately owned lands.[24] DDS has established Monkey Cheeks in 21 locations with a total storage capacity of 12.75 million m^3, which comprised 6.75 million m^3 on the eastern side and 6 million m^3 on the western side of the city. These include three in private establishments with an estimated total capacity of 346,000 m^3. BMA is working on convincing the private sector to contribute in alleviating flood problems in Bangkok.

Flood Monitoring Devices and Information Dissemination

The Flood Control Center (FCC) at DDS employs information technology to efficiently prevent and resolve flood problems in Bangkok. In addition to radar monitoring for rainfall alerts, all data required for flood protection, such as water levels in the canals and the Chao Phraya River, rainfall, pump status, and others are collected automatically at 75 remote sites and transmitted to the master control center via a telemetry system. Real-time data can be monitored through a computer screen, a video projector, or a Mimic board for instantaneous decision making. Alarms and events are displayed and printed. All historical data are stored for later analysis (Panya Consultants 2008).

FCC also utilizes the Green Bangkok WiFi internet service to send information to the public and the system is trunked for contacting relevant organizations by radio. In addition to information provided directly to people calling the FCC for

[22] A polder protects the space inside against inflows from the outer area and rainfall inside the polder is discharged through drainage facilities installed inside the polder (JICA 1985).

[23] Based on discussions with DDS officers in 2009.

[24] A Monkey Cheek project is a retention pond in which part of the runoff is stored for a while and then gradually drained into the waterways. This is similar to a monkey holding banana pieces in its cheeks.

information, other means of information dissemination include FM radio stations, websites (real-time monitoring), mobile phones (short messaging service), and television.

Drainage Requirements for Building and Construction Permits

As of 2009, there were no specific drainage requirements for acquiring a permit for the construction of buildings and other facilities. The BMA Act on Building Control of 1979 mainly focuses on structural and architectural requirements. All that is required is for establishments to connect their drainage system to the drainage sewer network. BMA still has to act on relevant recommendations provided by previous studies (NEDECO et al. 1996). These include modification to allowable space in front of buildings and the imposition of land use proportions, such as the ratio of constructed area to land area in real estate developments in order to use land area as retention storage, and others.

Effectiveness of Storm Water Management

While it is difficult to evaluate the effectiveness of the improved drainage system compared with previous years due to different amounts of rainfall or storm characteristics, it is reported that a significant improvement has been observed. Earlier investigation on 14 frequently flooded areas in Bangkok showed that flood duration (time required for flood to subside) has been substantially reduced by 72% for storms with a return period of 2 years, and by 64% for storms with a return period of 5 years. Other observations also confirm the decrease in duration of flooding. However, flooding is still observed in areas even where drainage network capacity is sufficient to drain storm water. This is due to lack of maintenance causing inefficiency in drainage (BMA 2006).

Private Sector Participation

Water Supply

Due to the unfavorable financial performance of public utilities and to the increasing cost of services, the national government deemed it essential to involve the private sector. This led to the enactment of the Act on Private Participation in State Enterprises of 1992, which provides the legal framework for private sector participation. Since then, the private sector has played a growing role in providing public infrastructures in many sectors of the economy.

The financial crisis of 1997 further pushed the country toward privatizing its state-owned enterprises, including MWA. The Cabinet approved the Master Plan for State Enterprise Reform (Privatization Master Plan) in September 1998, and the State Enterprise Corporatization Act was enacted in 1999. Following these developments, there was initial progress toward the privatization of MWA, including

studies on how to go forward with the privatization and what kind of privatization arrangement could be implemented. However, privatization plans suffered a serious setback in early 2004 when thousands of striking workers protested the government's privatization policy. While the privatization of MWA has been stalled since then and MWA remains as a state enterprise, improvements in MWA's operations have taken place toward a more business-like approach to its operations.

While private entities were involved in the past in concessions for water supply provision in selected areas not covered by the network, the recent involvement of the private sector in the operation of mobile plants and water loss reduction projects was mainly through outsourcing activities.[25] These outsourced activities contributed to the efficiency of MWA's services and to its financial performance by increasing efficiency and reducing salaries and benefits allocation through a reduction in permanent personnel.

The current strategy of MWA for private sector's participation includes encouraging direct investment for the expansion of MWA activities, involving the sector in activities aimed at improving financial structures to be more capital-based than dependent on loans, improving efficiency in water loss reduction efforts, and extending water supply services to remote areas not yet served or under MWA jurisdiction, among others (MWA 2009).

Wastewater and Storm Water Management

On the management of domestic and municipal wastewater in Bangkok, the private sector is mainly involved in surveying, designing, and constructing treatment plants and sewage interceptor and transmission lines; plant and equipment installation and repair; and canal and retention pond dredging (Nippon Koei 1999). The contracts are awarded by BMA to successful bidders, including international companies. Individual industries or industrial estates are responsible for treating their wastewater. The private sector is also involved in the operation and maintenance (O&M) of BMA's WWTPs on a 5-year contractual basis. As of 2009, four treatment plants were being run by private companies and one more was under bidding for transfer to the private sector from BMA's management. Private sector entities are paid according to the amount of wastewater treated.

Private sector participation in storm water and/or flood management is mainly in carrying out the studies addressing flood problems in Bangkok and the design and construction of flood protection and drainage facilities. In addition, maintenance work that requires highly specialized skills (such as tunneling or using specialized equipment) is also delegated to private entities. BMA/DDS is also pursuing the

[25] Outsourced activities include gardening, security, meter reading, new service connections, system maintenance for main server computers, meter replacements, software monitoring, inspection for the remote area network, and others (MWA 2003).

establishment of water retention ponds in private lands, including Moo Baan (village) and housing estates. This is an important aspect of private participation and if sufficient support is obtained, the private sector will make a significant contribution to easing flood problems in Bangkok.

Customer Satisfaction

Customer satisfaction surveys for water supply services have been conducted since 1996 following the criteria for evaluation of state enterprises (State Enterprise Performance Appraisal). Until 2002, the frequency of surveys was once every 2 years, but starting 2005, it was conducted annually. The gap (2003–2004) was due to changes in the criteria for evaluation. Following MWA Board's direction, surveys have been conducted by independent consultants since 2007. From 2008, the annual survey of customer satisfaction has been included as part of the MWA Management Strategy Plan.

Surveys from 2005 to 2008 show that consumers are generally satisfied (above moderate satisfaction) with MWA's services, probably partly due to the establishment of service standards that appear to be satisfactorily enforced (Babel et al. 2010). In particular, consumers declared their greater satisfaction in terms of new connections, available modes of payment, water availability, pipe repair, and maintenance. In contrast, moderate satisfaction was indicated in terms of water quality, drinking tap water campaigns, and announcements of water service interruption. Public awareness among most of the respondents (63% in 2008) is known to be best achieved through television.

The surveys also revealed that only less than 5% of MWA's consumers drink water directly from the tap. Consumers that drink boiled or filtered water increased from 59% in 1998 to 72% in 2008, whereas customers that consume bottled water decreased from 37% in 1998 to 26% in 2008. While these figures may indicate increasing confidence in tap water, this should be taken with caution given differences in the scope of the surveys, particularly in the numbers sampled and in possible differences in the methodology as surveys were conducted by different entities. Clearly, such figures suggest that much still needs to be done to encourage consumers to drink water directly from the tap.

A more positive development is observed in the payment services, in which the number of respondents paying water bills directly at MWA's branch offices has decreased (from 82% in 2005 to 18% in 2008). Meanwhile, the number of those paying through counter services (including convenience outlets, at least 153 post offices in Bangkok and its periphery, and other agencies) rose from 17% in 2005 to 56% in 2008 and through bank accounts (including via internet, telephone,

and mobile phone) from 0.8% in 2005 to 16% in 2008. This reflects increased payment convenience for MWA's consumers that contribute to higher revenue collection efficiency.

Financial Resource Management

Water Supply

The overall financial performance of MWA was on a positive trend in 1998–2008, with an operating ratio of around 0.70 and consistently high revenue collection efficiency (mostly slightly over 100% due to arrears and penalty for nonpayment of water bills on time) (Table 4). Such figures indicate the sustainability of utility operations as O&M costs are comfortably covered by revenues. This was confirmed by the fact that no funds were provided by the government to MWA since 2001.

Since 2005, MWA has strongly pursued a more business-like approach to its operations, subsequently contributing to its positive financial performance. Along with measures in other management aspects, MWA has applied several finance management tools, such as applying the principle of Economic Value Management (EVM) since 2006, along with quarterly Economic Profit (EP) analysis and seamless linking

Table 4 Financial Performance of the Metropolitan Waterworks Authority[a]

Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Capital expenditure (B million)	5,482	3,801	4,890	4,924	5,067	5,438	5,640	5,154	5,525	5,092	4,327
Annual operation and maintenance cost (B million)	7,500	7,616	8,107	8,826	9,026	9,062	9,970	10,184	10,448	10,848	11,457
Annual operating revenue (B million)	9,420	9,731	11,181	11,968	12,639	13,262	14,285	15,154	15,587	16,234	16,661
Operating ratio	0.80	0.78	0.73	0.74	0.71	0.68	0.70	0.67	0.67	0.67	0.69
Accounts receivable (in month's equivalent)[b]	0.95	0.64	0.59	0.62	0.58	0.52	0.47	0.34	0.38	0.32	0.66
Annual billings (B million)	9,427	9,919	11,426	12,041	12,706	13,350	14,382	15,157	15,659	16,448	16,912
Annual collections (B million)	9,731	10,281	11,454	12,169	12,737	14,453	14,453	15,268	15,608	16,476	16,379
Revenue collection efficiency (%)	103.22	103.66	100.25	101.07	100.25	108.27	100.50	100.73	99.67	100.17	96.85

B = baht.

Notes:

[a] Figures in millions have been rounded off from actual numbers. Currency conversion: $1 = B34.

[b] Accounts receivable (in month's equivalent) is accounts outstanding at the end of the year divided by monthly billings. It is denoted in terms of number of months. It is a measure of the time it takes to collect water bills.

Sources: Annual reports, 1998–2008 of the Metropolitan Waterworks Authority (MWA 1999, 2000, 2001a, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009). This was first published as Table 4 in Babel et al. (2010), p. 210. Reprinted with permission of the publisher.

of financial and operational key value drivers with the Balanced Scorecard Principle (BSC) (MWA 2008). MWA has also implemented measures to address currency exchange rate risks through an active policy of depending more on revenue and local loans rather than on foreign loans for investment.

Wastewater and Storm Water Management

Financial resources for wastewater and storm water management are derived from an annual budget provided by the local government or BMA. Additional funds for storm water management are provided as per request by the national government. The total O&M costs of DDS, which covers both storm water and wastewater management, were approximately B1.33 billion in FY2008. Of this amount, B316 million was for O&M costs related to wastewater management including treatment.

The NEQA 1992 provides the legal basis for wastewater tariff collection as it authorizes penalties for noncompliance with the provisions for wastewater treatment and disposal of waste from point sources. For Bangkok, the MOI already issued a ministerial regulation, published in the *Royal Thai Government Gazette* on 31 May 2004, for the imposition of wastewater tariff starting on 1 June 2004.[26] However, the decision to implement the regulation was left to the governor of Bangkok. As of 2009, no decision had been made for the implementation of wastewater tariff collection.

Human Resource Management

Water Supply

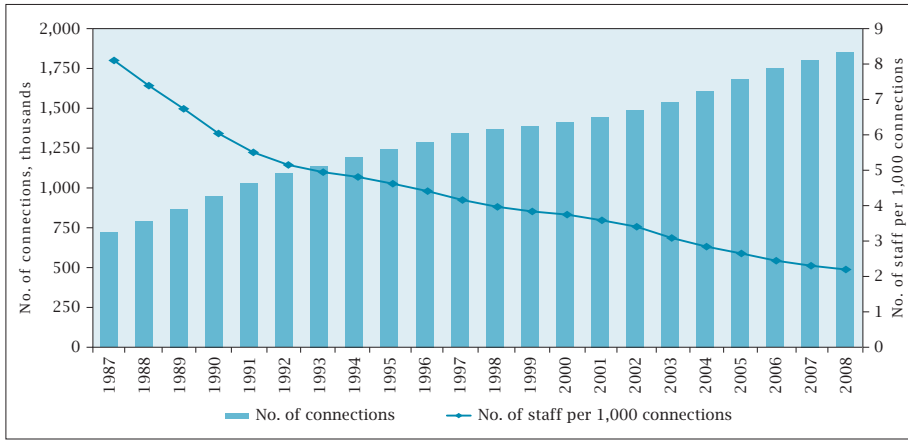
Even with increases in service area and connections, MWA has been able to manage its services efficiently with a decreasing number of staff. The number of staff per 1,000 connections decreased significantly from 4.0 in 1998 to only 2.2 in 2008 (Figure 7).[27] This decrease in staff numbers is partly due to the (i) outsourcing of some MWA functions; (ii) increase in the technical capacities of staff being able to handle various tasks; (iii) recruiting new staff with high levels of education, skills, and experience; (iv) introducing early retirement schemes and limiting new hiring relative to the number of employees who retired; and (v) use of technologies that are less manpower intensive (MWA 1999).

Salaries for MWA's management and staff continue to be competitive to attract talents, particularly for the position of governor that has been widely advertised for interested individuals. In 1997, salaries of MWA employees were already among the highest out of 50 water utilities in 31 countries in Asia assessed by ADB, only behind Singapore; Taipei,China; Hong Kong, China; and Seoul (McIntosh

[26] Proposed residential rate is B2.0 per m^3, lower than what the residents are willing to pay (Roomratanapun 2000, 2001).

[27] MWA's target is to keep total personnel at not more than 1 per 400 connections.

Figure 7 Human Resource Efficiency of the Metropolitan Waterworks Authority, 1987–2008



Sources: Annual reports, 1996–2008 of the Metropolitan Waterworks Authority (MWA 1997, 1998, 1999, 2000, 2001a, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009). This was first published as Figure 5 in Babel et al. (2010), p. 212. Reprinted with permission of the publisher.

and Yñiguez 1997). As of 2008, the average salaries for the top[28] and full-time[29] management personnel remain highly competitive. Moreover, the MWA Act of 1967 provides that officials of MWA may receive bonuses as determined by the Council of Ministers. The size of the bonus and salary increases depends on the profits made by MWA (MWA 2000).

Along with downsizing the organization, MWA continues to upgrade the knowledge and skills of its personnel through training within and outside the country. Its commitment to personnel development is evident in the ISO certification for training and seminars received by the Human Resource Development Department in July 2002. The training programs implemented by MWA are specifically designed for needed skills development that will enable personnel to adapt to current technological advances. The increasing number of staff undergoing training is reflected by a fourfold increase in funding within 5 years (FY2003–FY2008).

Wastewater and Storm Water

In terms of compensation, DDS management personnel receive reasonable salaries at approximately $20,000 annually.[30] The average salary of all full-time employees

[28] $63,000 annually; at least twice the maximum salary (and allowances) received by those in executive positions at higher level in the government (e.g., heads of government departments), based on the Civil Service Act of 2008. Currency equivalent: $1 = B34.

[29] At least 1.5 times the maximum compensation that can be received by government officials in managerial positions.

[30] In the range for higher-level managerial positions stipulated in the Civil Service Act of 2008 but well below the $35,600 received by their counterparts in MWA.

is about half of the aforementioned figure. WQMO personnel, in particular, receive an average annual salary of about $4,250.[31]

DDS similarly continues to improve the capacity and skills of its personnel by training its staff. The proportion of DDS staff that underwent training is relatively high, at 75% in 2006 and 2007. However, the figure is much smaller (30%) for WQMO personnel. Given the importance of technical skills and know-how in order to properly manage or supervise the maintenance of sewerage and wastewater treatment plants, BMA needs to increase the funds for capacity development activities.

Lessons

Information and analyses presented in this chapter show that, despite the physiographic, demographic, and financial challenges, significant improvements have been observed in the management of urban water in Bangkok during 1998–2008. Lessons learned are summarized below.

Water Supply

(i) **Master plan.** Master plans are essential components of service expansion. MWA's service coverage in 2008 was almost 99% of the population in its responsibility area. This is due to the investment programs and improvement or expansion projects based on the MWA master plan of 1990. MWA also revises its master plan to suit projected future demand and supply conditions.

(ii) **Nonrevenue water reduction.** NRW reduction in a large water supply system needs sustained commitment and investments. While MWA has been able to reduce NRW due to its commitment to address it and the subsequent allocation of a sizable amount of investment for the implementation of suitable measures, NRW is still considered high (30.2% at the end of FY2008) and can be further reduced.

(iii) **Consumer behavior.** Safe and drinkable tap water does not necessarily result in having consumers drink water directly from the tap. Although water in MWA's distribution system has been certified safe and the number of participating establishments in the water quality improvement program has increased, surveys showed that only a very small percentage of consumers drink water directly from the tap. Important reasons could be the financial capacity of Bangkok's residents to use bottled water and the lack of confidence that tap water is safe enough. While this indicates that much remains to be done to gain the consumers' confidence, the positive impacts of MWA's projects and campaigns may have yet to be observed as it could take time for

[31] This is within the range stipulated in the Civil Service Act of 2008.

residents to change their attitude and/or behavior and get used to drinking water directly from the tap.

(iv) **Financial resource management.** A positive financial performance by a state-run water utility is possible even with a tariff structure (low fees for up to 30 m^3 consumption) that could not cover production and distribution costs completely. This can be achieved through efficient revenue collection and lower O&M costs. MWA has been a financially self-sustaining utility, with no budget support from the government since 2001. Such commendable financial performance is due to reduced O&M costs and consistently high revenue collection. The availability of various consumer-friendly payment methods and/or channels and implementation of a penalty system (Babel et al. 2010) contributed to high collection efficiency, whereas O&M costs have been reduced partly due to the reduction in NRW and through outsourcing of some functions.

(v) **Human resource efficiency.** Maintaining the quality of services with reduced but competent personnel is attainable. Despite the reduced staff per 1,000 connections, the efficiency of MWA's services has improved based on customer surveys. This was made possible by improvements in work efficiency and the use of technologies that are less labor intensive. At the same time, the capacity of MWA personnel is continuously being developed through training.

(vi) **Supply management.** Supply-oriented approach needs a revisit in the light of projected impacts of the changing climate. MWA has so far largely depended on a supply-oriented approach in meeting the demand. It has tapped resources from another basin, bringing the total allowed diversion of 105 m^3/s from two rivers for its water supply needs. However, the revised MWA master plan indicates that this total amount is sufficient only to meet demand until around 2030, beyond which MWA may need to find other sources or other ways to meet demand. Considering the effects of global climatic changes, especially on reduced river flows, such an approach will need to be revisited and implementation of demand management will need to be emphasized more strongly.

(vii) **Demand management.** To obtain substantial and meaningful outcomes in demand management, more concrete measures need to be enforced with the cooperation of relevant government agencies. MWA has implemented several demand management tools, yet the success of such measures is not evident in the trend of water consumption per capita. Hence, concrete demand management practices, such as the installation of water-saving plumbing fixtures should be emphasized. To maintain a positive financial performance, the implementation of demand management measures should be complemented with measures aiming at cost reduction (e.g., further reduction in NRW) and increased revenue (e.g., targeted financial support for the

low-income population instead of uniform support for a minimum range of water use, upward change in water tariff, and others).

(viii) **Corporate governance.** Implementation of good corporate governance practices facilitates remarkable performance and achievements. Enjoying considerable autonomy in performing its functions, MWA has taken bold initiatives and has adopted transparent management, among others. It has also implemented a range of measures to expand its services and improve its overall service efficiency and the competence of personnel. Through these measures, MWA's performance has improved, resulting in significant achievements. Such successes were recognized through the several corporate governance awards received by MWA from the MOF.

Wastewater and Storm Water

(i) **Investments, law enforcement, and cooperation.** Improving water quality in a metropolis with a complex network of canals requires huge investments, stringent enforcement of applicable laws, and cooperation from the public. Although wastewater treatment and sanitation coverage have improved and other measures were implemented, these are not adequate to address water quality problems in Bangkok. Coupled with the lack of cooperation from the population and poor enforcement of applicable laws for the disposal of untreated wastewater, water in the canals and the Chao Phraya River is still of poor quality and only suitable for navigation. Considerable improvements are, therefore, necessary to improve the quality of canal and river water in Bangkok.

(ii) **Wastewater tariff.** Imposition of a wastewater tariff is a significant measure for addressing financial constraints in wastewater treatment efforts. With limited funds available to the local government and the difficulties in finding suitable locations for WWTPs due to the high cost of land, additional funds from the collection of a wastewater tariff are a much welcome solution. BMA has not yet implemented the wastewater tariff approved by MOI. A bold political decision for the imposition of a wastewater tariff is required, which could help provide the needed funds for expanding the sewerage system and for constructing, operating, and maintaining WWTPs.

(iii) **Private sector participation.** Private sector participation is essential for efficient storm water management. Improvements in flood protection and storm water management have been observed in Bangkok, yet challenges remain—especially considering the uncertainties in future climate. While structural measures are essential, the significance of private sector participation for effective storm water management could not be disregarded. Such participation can take place by increasing the number of retention ponds in private properties and revising the existing plumbing codes to pave the way for imposing drainage provisions especially in large establishments to avoid the aggravation of overflow in the drainage system.

Challenges

Water Supply

The supply-oriented approach of MWA to meet increasing demand should be revisited given the limit on water allocation from its raw water sources and the challenge of global changes including climate change. A balanced combination of supply and demand management should be pursued. On the other hand, MWA's efforts in demand management may have been constrained by the fact that the utility needs to keep its revenue high while providing water at partly subsidized rates to poor people. This is because the utility's performance is evaluated based on profit, upon which the bonuses and salary increments received by MWA personnel depend, as in all other state enterprises in Thailand. Such a profit is dependent on revenue generated from water sold to consumers.

However, demand management may still be vigorously pursued without compromising financial performance by further increasing revenue and reducing costs. Revenue may be increased either by raising the water tariff or by providing targeted financial support (which is uniform, as of 2009, to all residential connections consuming less than 30 m^3 per month) only to those who are poor and genuinely need support, or a combination of both. The FY2008 data shows that approximately 65% of residential connections consumed less than 30 m^3 per month (accounting for about 30% of the volume of residential consumption). Meanwhile, O&M costs could be reduced by further lowering NRW, which is rather high at 30.2%. Detailed investigation would be needed to determine the economic level of leakage and to lower NRW further, especially when other utilities in the region, such as in Singapore and Phnom Penh, can bring NRW down to less than 10%. A concrete and more promising demand management measure is the imposition of regulation for the installation of water-saving fixtures at the household level. Cooperation with relevant authorities and consumers, however, is important for its successful implementation.

Moreover, rigorous efforts are needed to convince the public of the quality of water supplied by MWA, which could lead to behavioral changes. Further measures aimed at improving water quality may be based on consumers' concern on poor water quality immediately after water interruptions. This indicates the need for measures to keep pipes clean during pipe repairs and the corresponding efforts to prevent and control leakage and minimize water interruptions.

Wastewater

With inadequate capacity of existing WWTPs, it is difficult to maintain good quality of water in the canals and the Chao Phraya River in Bangkok. Poor water quality stems from lack of funds to construct needed infrastructures, lack of support from the public in protecting the canals and rivers from garbage and untreated wastewater, and lack of strict implementation or enforcement of applicable laws.

One promising measure to address this problem is the implementation of a wastewater tariff, which has already been approved by the MOI. Surveys have indicated the willingness of Bangkok residents to pay for wastewater discharge (Roomratanapun 2000, 2001). Collection of a wastewater tariff would help provide the funds needed to cover O&M costs and to expand the coverage of the sewerage system to improve water quality in waterways in Bangkok. The challenge, then, is making the bold political decision to impose a wastewater tariff.

Another route is the strict implementation of laws and regulations for the protection of water bodies from illegal disposal of wastes, as it was found that having wastewater plants will not solve the pollution problem without change in the sources of pollution and/or the behavior of polluters (Storey 2005). Furthermore, implementation of an appropriate decentralized wastewater management system could lessen the water quality problems in the metropolis.

Storm Water

The challenges facing storm water management in Bangkok are the impacts of hydrological changes associated with global climatic changes.[32] Noting that BMA seems to focus more on structural measures in addressing storm water issues, aggressive implementation of measures involving the general public including the private sector would be essential. Possible measures that may be considered include requiring drainage provisions (such as retention ponds or rainwater harvesting) especially in large private and public establishments as this should help in easing flooding in Bangkok. Even individual residential areas may also contribute to alleviating storm water management problems in Bangkok through rainwater harvesting installation in private houses, water that could be used in flushing toilets or recharging of groundwater bodies. The above measures would entail necessary amendments in the existing building and plumbing codes, hence, the need for cooperation by the relevant agencies.

This chapter demonstrates that substantial progress has been made during 1998–2008 in terms of expanding water supply and wastewater treatment services and alleviating flood problems in Bangkok. However, there exists a huge potential for further improvements in water demand management through suitable water pricing, NRW reduction, level of service in terms of water pressure in the distribution lines, wastewater treatment and tariff, and flood-retention ponds, among others. Sustained efforts, appropriate policies and institutions including improved coordination among the entities responsible are indispensable to achieve integrated and efficient urban water management, especially in the light of global changes including changing climate conditions.

[32] A rise in sea levels is among the impacts cited in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (Cruz et al. 2007), while more intense rainfall (although with a reduced annual amount) could be observed in the region in the future (Bates et al. 2008).

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CHAPTER III

Colombo, Sri Lanka

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Introduction

Colombo is located on the western coast of Sri Lanka and is the country's largest city. It was originally a small seaport used by Moor, Arab, Persian, and Chinese sailing vessels. Sri Lanka was, over time, ruled by the Portuguese, Dutch, and British. It became an independent nation in 1948. Being its commercial capital, Colombo contributes significantly to the Sri Lankan economy. There is a high concentration of manufacturing activities in Colombo.

Based on Census 2001, the total population of the Western Province (comprising the districts of Colombo, Gampaha, and Kalutara) was 5.38 million, with the urban population having a 30% share (Department of Census and Statistics 2006). The population of Colombo city grew from 587,647 in 1981 to 637,865 in 2001, translating to a compounded annual growth rate (CAGR) of 0.41%. The Colombo Development

Table 1 Key Statistics of Greater Colombo Area

Province	Western	Area (2008)	1,197 km^2
GC area population (2008)	3,765,000	Average household size (2008)	5
Population density (2008)	3,145 persons per km^2		
Year	2001	2006	2007
Sri Lanka population	18.7 million	19.8 million	20.0 million
GC area population	2.7 million	3.25 million	3.3 million
GC area population as a % of Sri Lanka population	14.4%	16.4%	16.5%

GC = Greater Colombo, km^2 = square kilometer.

Source: National Water Supply and Drainage Board, Sri Lanka.

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Plan has estimated the population of the area of the Colombo Municipal Council to reach 1 million by 2010. This growth is due to the rapid urbanization experienced by Colombo city, triggered by the concentration of economic activities within the Western Province. In fact, population growth is not contained within the Colombo city but has spread to its periphery. This has necessitated a structured, holistic, and regional approach to urban development, resulting in the government's efforts toward planning for the Colombo Metropolitan Region as a whole rather than just the existing Colombo city area.

The Greater Colombo (GC) area is an urban agglomeration of Colombo city and part of the larger Colombo Metropolitan Region. The GC area, spread over approximately 1,197 square kilometers (km^2), constitutes more than 30% of the Colombo Metropolitan Region and comprises close to 60% of the population of the Western Province.

The population of the GC area grew from 1.89 million in 1998 to 3.77 million in 2008, translating to a CAGR of 7.13%. This growth was largely driven by a progressive increase in the area of GC from 620 km^2 to 1,111 km^2 in 2003, and subsequently reaching 1,197 km^2 in 2008 (Table 1).

Institutional Structure and Legal Framework

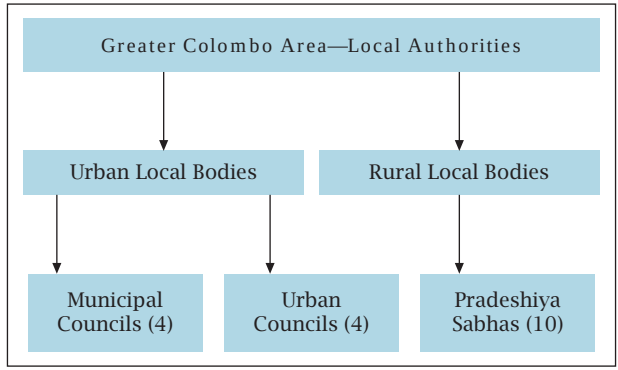
The focus of this chapter is the water management practices in the GC area. The National Water Supply and Drainage Board (NWSDB) is the authority responsible for water supply services in Sri Lanka, including the GC area. However, there are multiple agencies with varied service delivery functions and areas of jurisdiction in the GC area. This section provides a broad institutional and regulatory overview of the entire urban agglomeration of Greater Colombo.

Institutional Structure

Sri Lanka is divided into administrative divisions called provinces, and each province is further divided into districts. The country has a total of nine provinces; seven of them have had provincial councils since inception. The administration at the local level is separate for rural and urban areas. As of 2008, there were three types of local authorities in Sri Lanka: municipal councils (MC) and urban councils (UC) at the urban level, and Pradeshiya Sabhas (PS) at the rural level. In general, municipal councils are established for cities and large towns, urban councils for less urbanized areas, and PS for rural areas. In all, there are 18 MCs, 42 UCs, and 270 PS in this island country.

The GC comprises the Colombo Municipal Council and 17 other urban and/or municipal councils and Pradeshiya Sabhas (Figure 1). The GC area includes the

Figure 1 Composition of Greater Colombo Area



Source: National Water Supply and Drainage Board, Sri Lanka.

MCs of Colombo and Dehiwala–Mount Lavinia, in addition to two more MCs and four UCs within the GC area. It also includes 10 PS, namely, Wattala, Kelaniya, Mahara, Biyagama, Kotikawatta–Mulleriyawa, Kaduwela, Maharagama, Kesbewa, Homagama, and Panadura.

Delivery of urban services in the GC area is managed through a fairly complex institutional structure. The management of water supply and the sewerage system of the GC area is handled by NWSDB. However, the Colombo Municipal Council is responsible for the sewerage and storm water drainage systems for Colombo city. While the respective local authorities manage storm water drains in other areas, the Sri Lanka Land Reclamation and Development Corporation (SLLRDC) is responsible for the management of canals and flood control. Table 2 provides details of the institutional responsibility for the provision of basic water-related services based on area of jurisdiction.

Given the interplay of multiple institutions, the quality and division of urban services provided by these separate agencies also vary. The following subsections present the structure and responsibilities of these agencies in the delivery of urban water services.

National Water Supply and Drainage Board

NWSDB is the statutory body responsible for drinking water supply and sewerage systems in Sri Lanka. It provides end-to-end water value-chain service delivery, which means that it is responsible for the planning, investigation, design, construction supervision, operation of water treatment plants, and maintenance of water distribution systems.

It is the principal authority for providing safe drinking water and facilitating the provision of sanitation in Sri Lanka. In accordance with the Board Act, several

Table 2 Institutional Responsibility for the Delivery of Water Services in Greater Colombo Area

Service Delivery	Planning, Design, Execution		Operation and Maintenance	
	Area	Institutional Responsibility	Area	Institutional Responsibility
Water supply	GC area—for piped water supply	NWSDB	GC area—for piped water supply	NWSDB
Sewerage	Colombo city area	Colombo Municipal Council	Colombo city area	Colombo Municipal Council
	Other areas of GC	NWSDB	Other areas of GC	NWSDB
Storm water drainage	Colombo city area	Colombo Municipal Council	Colombo city area	Colombo Municipal Council
	Other areas of GC	Respective local authorities in the GC area	Other areas of GC	Respective local authorities in the GC area
	Management of canals and flood control	SLLRDC	Management of canals and flood control	SLLRDC

GC = Greater Colombo, NWSDB = National Water Supply and Drainage Board, SLLRDC = Sri Lanka Land Reclamation and Development Corporation.

Source: National Water Supply and Drainage Board, Sri Lanka.

Ambatale Water Purification Plant in Colombo.
Photo by A. G. A. N. S. Kumara.

major urban water supply schemes operated by local authorities were taken over by NWSDB to provide more coverage and better service. During the past 30 years, the organization has considerably expanded its scope of activities. The number of NWSDB employees increased ninefold from 1,000 in 1975 to 9,006 in 2008.

In 2008, NWSDB was operating 309 major, minor, and small water supply schemes in cities, towns, and villages across Sri Lanka, providing 34% of the population with piped water and another 10% of the population with water from hand-pumped tube wells (NWSDB 2009, 14). NWSDB's immediate target is to increase access to piped water supply to 40%. It expects to meet the United Nations' Millennium Development Goal for safe drinking water by achieving 85% coverage by 2015.

Colombo Municipal Council

The Colombo Municipal Council (CMC), which is responsible for Colombo city, is the largest local authority in Sri Lanka and one of the oldest in South Asia. Established in 1865, it has grown into a large organization catering to various needs of the city's population.

It is mainly responsible for the provision of urban services, such as public health and curative services, solid waste management, maintenance of roads, street lighting, water and drainage, and veterinary services. In addition, it has a number of departments providing social services, sports and recreation services, library services, and public assistance. It also has other departments such as Finance, Secretarial, and Training (CMC n.d.).

The CMC drainage division manages the entire CMC drainage system, including the sewer network and sewage pumping stations in the city. It is also responsible for cleaning and emptying septic tanks where sewerage services are not provided, and this service is currently being provided free of charge.

CMC also maintains the rainwater drainage system in the city, which includes open drains, underground drains, and outfalls. However, the main canals in the city are owned and maintained by the SLLRDC.

Sri Lanka Land Reclamation and Development Corporation

SLLRDC was previously known as the Colombo District (Low-Lying Areas) Reclamation and Development Board, which was established in 1968 with two objectives:

- To reclaim and develop marshy and low-lying areas; and
- To retain the custody, management, and control of such vested lands (SLLRDC 2010).

At its inception, the activities of the organization were initially limited to the Colombo District, but since 1979, its coverage expanded beyond the district, thus extending the benefits of planned reclamation to the entire country. SLLRDC has been empowered to take legal action against unauthorized reclamation activities and against pollution of water bodies. Its powers are as follows:

- To acquire, hold, or lease any property or mortgage, pledge, sell, or otherwise dispose of any property;
- To prepare and execute development schemes in reclamation and development areas;
- To formulate or execute any scheme of work in connection with the infrastructure development of such areas;
- To construct harbors and anchorage and to undertake work in the field of irrigation, sea reclamation, and coastal development in such areas;
- To cause the construction of roads in such areas;
- To cause the construction of works for the provision of public services in such areas including surface water drainage, sewerage and disposal of sewage, and water supply;
- To carry out building, engineering, and construction work, including the manufacture of any material required for such building, engineering, or construction work;
- To provide advisory and consultancy services on engineering and technological matters; and
- To enter into any contract with any person for the execution of land development projects and schemes as may be approved by the government (SLLRDC 2010).

Urban Development Authority

Since the GC area is a part of the Colombo Metropolitan Region, its regional master plan governs the overall urban and land use planning of the GC area. The Urban Development Authority prepares the master plan for the Colombo Metropolitan Region.

Legal Framework

Due to the interplay of many institutions with varying responsibilities across different areas, the legal framework behind each institution also differs.

National Water Supply and Drainage Board

Originally, NWSDB was a subdepartment under the Public Works Department for Water Supply and Drainage. In 1965, it became a division under the Ministry of

Local Government, and then in 1970, this division was re-situated as a separate department under the Ministry of Irrigation, Power and Highways. NWSDB was established in January 1975 by an Act of Parliament. It presently functions under the Ministry of Water Supply and Drainage, Government of Sri Lanka.

Colombo Municipal Council

CMC is the highest policy- and decision-making body in the Colombo city. The mayor, who is an elected representative, is the chief executive officer. CMC has 53 elected councilors, and its administrative wing has 15 departments (CMC n.d.).

Local Bodies

The organizational structure of local governance comprises three legal instruments, as follows:

- For municipal councils—the Municipal Council Ordinance
- For urban councils—the Urban Council Ordinance
- For Pradeshiya Sabhas—the Pradeshiya Sabhas Act

Section 40 of the Municipal Council Ordinance lists the general powers of municipal councils, while the powers of urban councils are specified in the Urban Council Ordinance. Local elections are held under the Local Authority Elections Ordinance.

In all local authorities, the administrative structure is similar, although the designations differ. The mayors head the municipal councils, assisted by the deputy mayors and members of the councils in making policy and policy implementation decisions. A municipal commissioner, who is a senior public official, assists the mayor. Depending on size, complexity, staff availability, and resources of the municipality, there may be several departments under its administration (UNESCAP 2004).

Sri Lanka Land Reclamation and Development Corporation

The Colombo District (Low-Lying Areas) Reclamation and Development Board, which was the predecessor of SLLRDC, was established by Board Act No. 15 of 1968. This was amended by Law No. 27 of 1976, which strengthened the organization by granting it the power to sell the land that it reclaimed. In 1982, the organization was re-designated as SLLRDC, when Act No.15 of 1968 was amended to become Act No. 52 of 1982. This act was further amended to Act No. 35 of 2006, which empowered SLLRDC to take legal action against unauthorized reclamation activities and against pollution of water bodies. The main objectives and powers of SLLRDC are specified in Sections 8 and 9 of Act No. 15 of 1968 and as amended by Law No. 27 of 1976, Act No. 52 of 1982, and Act No. 35 of 2006 (SLLRDC 2010).

Urban Service Delivery in Greater Colombo

This section presents an overview of the existing water supply, sanitation, and storm water drainage facilities within the GC area.

Water Value Chain

NWSDB operates over an area of responsibility of 1,197 km^2 in GC, which has a population of approximately 3.76 million people. It provides water supply through more than 498,000 connections. The water value chain adopted by NWSDB in the GC area is shown in Figure 2.

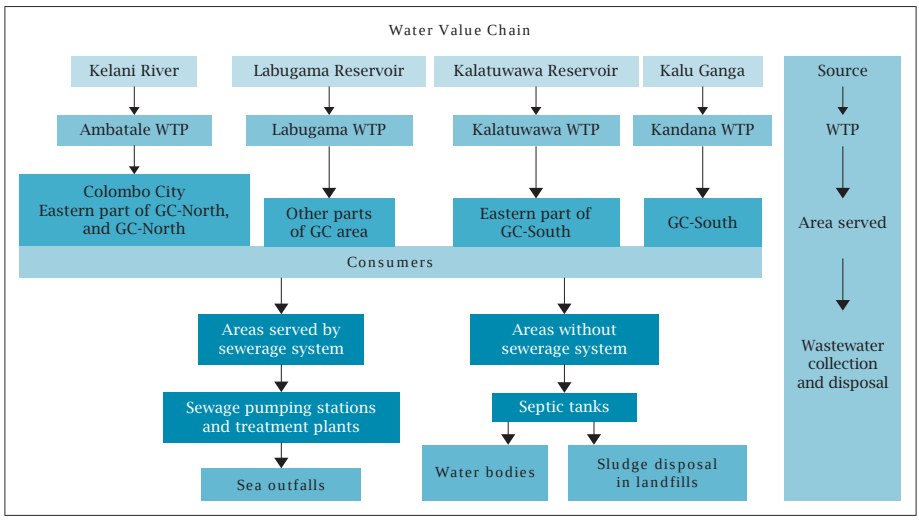
Water Supply System in Greater Colombo

The GC area obtains water from three main sources: the Kelani River, the Labugama Reservoir, and the Kalatuwawa Reservoir. A new source added to this list is the Kalu Ganga River, which was developed and augmented with the support of the Japan International Cooperation Agency (JICA) (Figure 2).

Water Source Development and Availability

The pipe-borne water supply system of the GC area was initiated in Colombo city in 1886. This was completed in 1924 with the completion of the detention reservoir in Labugama, situated at the eastern part of the Colombo district, 50 km away

Figure 2 Water Value Chain of Greater Colombo Area



GC = Greater Colombo, WTP = water treatment plant.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

from Colombo city. A transmission main (made of cast iron [CI] that had a diameter of 500 millimeters [mm] [20"]), was laid to supply water under gravity to the Maligakanda Reservoir, which is at the higher elevation in the center of the city. In 1905, the transmission capacity was increased by laying another CI pipeline of 500 mm (20") in diameter up to the Elie House Reservoir in the northern part of the city. In 1917, another pipeline of 750 mm (30") in diameter was laid up to Maligakanda.

In 1958, the Kalatuwawa Reservoir (located close to Labugama) was commissioned, and water was conveyed to Colombo city with a 750 mm (30") pipeline leading to Maligakanda. Another pipe of 850 mm (33") in diameter leads to the Dehiwala Reservoir, supplying water to the southern part of Colombo. In 2008, the combined supply of Labugama and Kalatuwawa was 113 million liters per day (MLD).

The first stage of Phase I of the Kalu Ganga Water Supply Project (which was undertaken in two phases) was completed in October 2006, in which 60 MLD of treatment capacity was added. The objective was to develop Kalu Ganga as a new water source to meet incremental water demand in the southern part of the GC area and the smaller towns and areas in the Kalutara District (NWSDB 2009, 24).

Treatment Pumping Storage and Supply

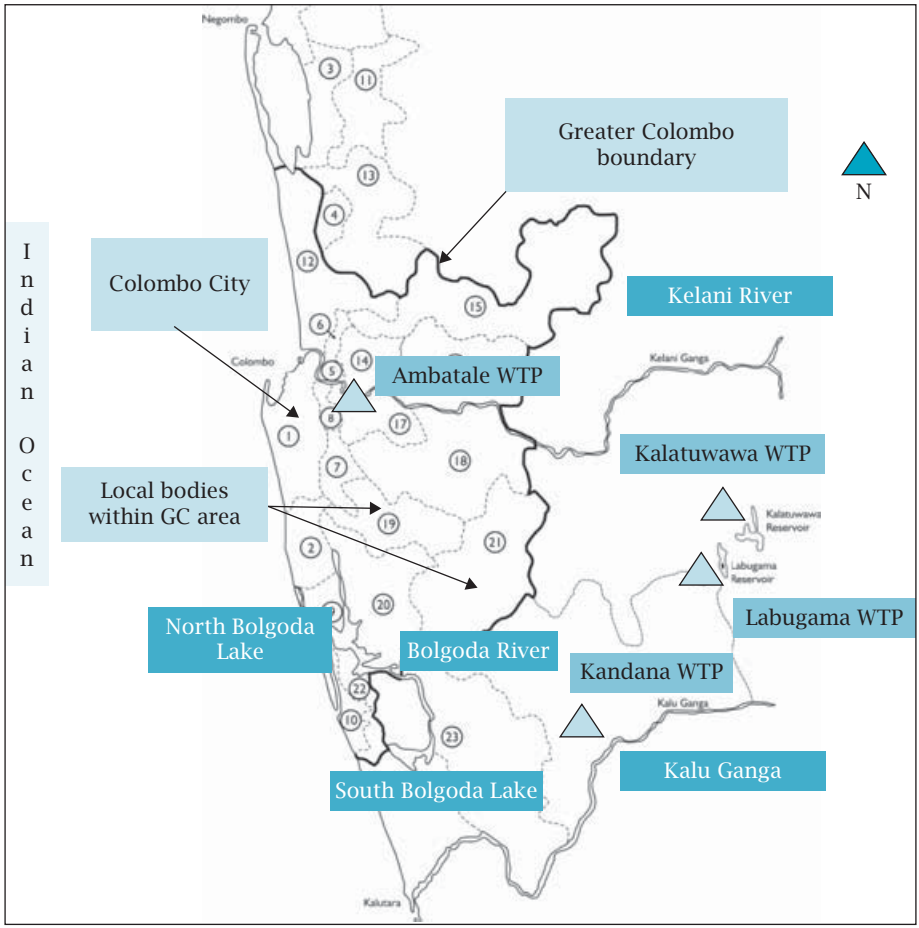
As of 2008, there were four water treatment plants (WTPs) servicing Greater Colombo (NWSDB 2009, 16). Their total treatment capacity was 702 MLD. Of this, 529 MLD could be treated at the Ambatale WTP. Another 113 MLD could be treated at the Labugama and Kalatuwawa WTPs. A fourth WTP at Kandana, which NWSDB augmented in 2006, supplies water to the southern part of the GC area (i.e., GC–South). The Kandana WTP has a treatment capacity of 60 MLD (NWSDB 2009, 24). It treated 53 MLD, including about 2 MLD supplied to some areas outside the GC area, in 2008.

The Ambatale WTP supplies water to Colombo city, GC–North, and the eastern part of GC–North, while the Kalatuwawa WTP supplies water to the eastern part of GC–South. Water from the Labugama WTP is supplied to the rest of the GC area.

The Ambatale treatment plant uses water from the Kelani River. It was commissioned in 1958 with a capacity of 122 MLD. Subsequently, the plant was expanded in 1966 by 181 MLD, in 1994 by 181 MLD, and again in 2004 by 45 MLD. Out of the total capacity of 642 MLD from the three treatment plants at Ambatale, Labugama, and Kalatuwawa, 300 MLD were supplied to Colombo city in 2008. This supply was significantly higher than Colombo city's actual consumption, given that water losses were estimated at 42.4%.[34]

[34] The losses were estimated by NWSDB, as provided in NWSDB (2009), p. 14.

Figure 3 Water Supply System of Greater Colombo Area



WTP = water treatment plant.
Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Water Supply and Distribution System

Despite continuous increases in the population and area of the GC urban agglomeration, NWSDB has been able to maintain a 24-hour, seven-days-a-week water supply within the entire GC area.

The total length of the distribution network in Colombo city is about 870 km. More than 45% of the distribution network is over 70 years old and made of CI pipes. The largest part of the nonrevenue water (NRW) is water loss through leaks of old CI distribution pipelines and service connections.

Wastewater Treatment

The GC sewerage system comprises of two catchments—the Southern Catchment and the Northern Catchment. These catchments provide only preliminary treatment (screening and grit removal) before sewage is discharged via long sea outfalls. During 2005–2008, the main sewers of the Northern Catchment were rehabilitated (with funding from the Danish International Development Agency) along with the connection of a new sea outfall pumping station at Madampitiya.

NWSDB's Greater Colombo Sewerage Section is responsible for the operation and maintenance of the sewerage systems of Dehiwala–Mount Lavinia Municipal Council area and Kolonnawa Urban Council area, as well as the sewage pumphouses and pumping mains of some National Housing Development Authority (NHDA) housing schemes and several government institutions within the GC area.

The Colombo municipality's area sewerage system was constructed in the early 20th century. The main sewage collection system was built between 1906 and 1913, and it combined varying sizes and types of pipes. The horseshoe- and egg-shaped large-brick sewers of typical British design were features of the sewer system. There are 11 sewage pumping stations spread over the city.

Dehiwala–Mount Lavinia Sewerage Scheme

This system was constructed between 1980 and 1987. It consists of two pumping stations and a 32 km-long sewer network. It was designed to accommodate 5,000 property connections. There were 2,032 property connections in 2008.

Kolonnawa Sewerage Scheme

This system was also constructed during 1980–1987. It consists of four pumping stations and a sewer network of about 20 km in length. In 2008, the system could accommodate 1,009 property connections, with an ultimate design to accommodate some 3,900 property connections.

Sewerage Systems in Housing Schemes and Government Institutions

NWSDB is also responsible for providing sewerage services within several large housing schemes built by the NHDA in the GC area, as well as some government institutions outside the Colombo municipal limits but within the GC area.

The discharge of domestic and industrial effluents is governed by Sri Lanka Standards, such as the following:

- Tolerance Limits for Industrial Effluents Discharged into Inland Surface Waters,
- Tolerance Limits for Industrial and Domestic Effluents Discharged into Marine Coastal Areas, and

- Tolerance Limits for Industrial Effluents Discharged on Land for Irrigation Purposes.

The Central Environmental Authority is a statutory institution functioning under the Ministry of Environment and Natural Resources. It manages the environment and the prevention, abatement, and control of environmental pollution.

Storm Water Drainage

The GC area is basically served by two drainage systems—a sewerage system that drains water into the sea via two outfalls, and a storm water drainage system that drains inland surface water. In flat geographical areas, the overflow of septic tanks and ingress of sewage into storm water drains is common during heavy rains. Only Colombo city has a proper storm water drainage system, while most of the other parts of the GC area have either open drains or no facility to drain storm water.

There is large expanse of low-lying land with a ground elevation below 1 meter of the mean sea level. The bulk of low-lying land is spread across Parliament Lake, Heena Ela, Kolouna Ela, and Kotte Ela, which function as storm water retention basins. The total area of low-lying land has decreased due to land filling for development. The rest of the GC area's drainage system consists mainly of small drainage basins along the coast, or belongs to the Bolgoda Basin.

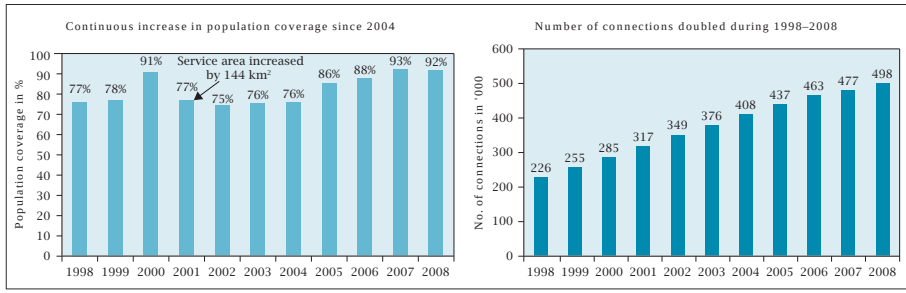
Supply Management

Improvement in Coverage

Population coverage of water supply in the GC area improved significantly from 77% in 1998 to 92% in 2008 (Figure 4). The dip in the population coverage in 2001 was due to an increase in NWSDB's service area by 144 km^2. Given the increase in its service area and a doubling of the population within this service area from 1.6 million in 1998 to 3.2 million in 2008, NWSDB's ability to extend continuously its coverage is noteworthy.

In 2000, NWSDB initiated a scheme to convert public taps to individual taps at a connection fee that could be paid in installments. This helped improve the living standard of residents and minimize water wastage through common outlets. Over 19,000 individual connections were provided and more than 1,500 public taps were disconnected during the course of this program.

Figure 4 Growth in Water Supply Coverage and Number of Connections



Note: These include public standposts. There were 4,208 public standposts in 2008.

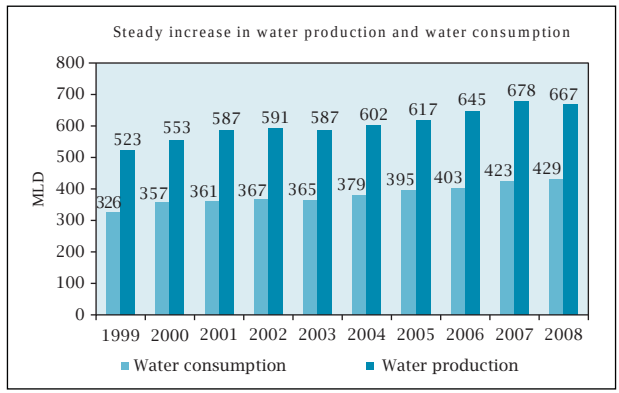
Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Production, Availability, and Per Capita Consumption

NWSDB has the distinction of maintaining the water supply 24 hours a day, seven-days-a-week in the entire GC area since 1998, despite increases in its area of responsibility and related increases in population and demand for water.

Water production increased from 513 MLD in 1998 to 667 MLD in 2008, representing an increase of 30%. Figure 5 shows the trend in total water production and total water consumption in 1999–2008.[35] Annual water consumption exhibited a steady rise over the years and stood at 429 MLD in 2008, of which metered consumption was 412 MLD. Per capita domestic consumption was 126 liters per capita per day (lpcd) in 2008.

Figure 5 Water Production and Water Consumption, 1999–2008

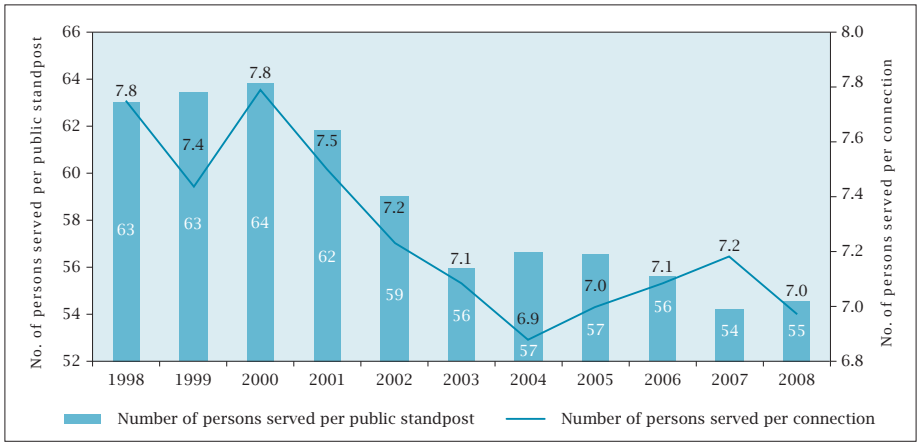


MLD = million liters per day.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

[35] Total water consumption is an estimated total of metered consumption and unmetered consumption.

Figure 6 Decline in Population Served Per Public Standpost, 1998–2008



Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

The major gap between production and consumption was NRW, which stood at 35.7% in 2008. Since 2000, NWSDB has adopted the policy of providing individual connections to tenement garden residents, instead of supplying water by standposts, to minimize losses due to wastage of water and to enable the volumetric measurement of actual consumption.

Dependency on Public Standposts

The number of persons served per public standpost fell from 63 in 1998 to 55 in 2008 (Figure 6). At the same time, the number of persons served per connection dropped from 7.8 to 7.0 due to efforts in increasing the number of individual connections and cutting down on public standposts over this period.

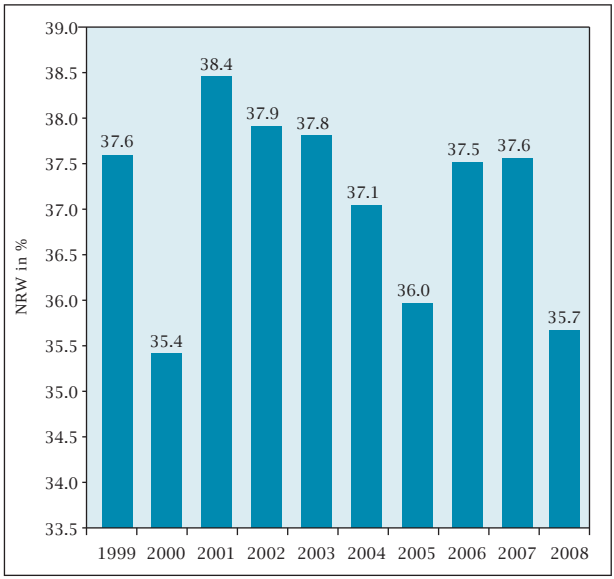
Water Losses

Reduction of Nonrevenue Water

Although the number of public standposts was reduced, there was no substantial decline in NRW (Figure 7). NRW declined marginally from 37.6% in 1999 to 35.7% in 2008, but the decline was inconsistent over the period. Large water losses in the Colombo city area due to a dilapidated and legacy network resulted in little overall progress in NRW reduction.[36]

[36] Colombo city accounts for one-third of the whole of GC and is served with nearly 44% of the water produced.

Figure 7 Inconsistent Declines in Nonrevenue Water, 1999–2008



NRW = nonrevenue water.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Data on individual components (such as losses in distribution and rising mains) of NRW are unavailable. However, according to NWSDB, water losses in the transmission system are not more than 10%. Besides, it was estimated that 14% of the volume of water transmitted to the city was supplied free for legitimate uses (such as unbilled supplies to tenement gardens and fire hydrants), which do not earn revenue for NWSDB.

NWSDB has initiated various programs to reduce NRW. These include the following:

(i) **Randiya program.** A program to disconnect common outlets (i.e., bathing taps, toilet taps, and public standposts) and provide new individual connections with concessions in connection fees has been implemented in tenement gardens. Through this program, consumers are held accountable for the water that they consume and wastage can be reduced substantially. Special provision has been made for the urban poor and tenement garden residents to pay the connection fee in 36 monthly installments.

(ii) **Colombo NRW reduction program.** Domestic connections in the GC area constitute almost 80% of the total connections in the Western Province and 44% of the total connections in Sri Lanka. A substantial number of connections are linked to a very old and dilapidated distribution network, resulting in a high level of NRW in Colombo city. The interconnected network with more

than one supply point was a major constraint in hydraulically isolating the network. Due to this situation, NWSDB had been unable to plan and implement district metering areas (DMAs) to reduce NRW. Another factor contributing to a high level of NRW is that in densely populated areas such as tenement gardens, the use of public standposts is greater in Colombo city as compared to other areas in the GC.

NWSDB recognized the need to push constantly the reduction of NRW and, hence, introduced this program. As part of the program, illegal connections would be removed from the system. During the first phase, approximately 40 km of the water supply distribution network of Colombo city would be replaced.

NWSDB has a twinning arrangement with Jamshedpur Utilities and Services Company (JUSCO, India) to implement a pilot project of NRW reduction in a selected area. Under this twinning arrangement, NWSDB will get technical support from JUSCO on various aspects of NRW reduction, such as formation of DMAs, programs for the reduction of leakages and losses, and implementation of step tests.

(iii) **Training programs.** NWSDB has also planned training programs on the reduction of water losses and management of the distribution network for its engineers, as part of their skill enhancement program.

In these NRW reduction programs, various activities have been initiated (Box 1). These include metering at the DMA and consumer levels, eliminating illegal connections, replacing smaller dual pipes with larger ones, and monitoring the number of leakages on a monthly basis. For effective management, Colombo city is divided into 12 zones and each zone is divided into two DMAs. The creation of DMAs has improved problem identification, service delivery, and resource conservation. The NRW programs aim to resolve two major areas of water losses—leaks and illegal connections.

Besides, NWSDB inspects government-owned multistoried flats to detect defects in their internal plumbing systems that contribute to unaccounted-for-water (UFW). To make the condominium management authority or the residents' association of these apartments accountable for the loss of water due to leaks in their internal networks, arrangements have been made to charge the difference between the water supplied to such flats and the water consumed.

The quantity of water supplied to every manager's area in the GC area is also measured by demarking and hydraulically isolating the distribution system under their purview and bulk meters are installed at suitable locations to assess water losses. Box 2 provides an overview of an NRW reduction program that is implemented in the Colombo Metropolitan Region in 2007–2012.

Box 1 Randiya Program and Colombo Nonrevenue Water Reduction Program of the National Water Supply and Drainage Board

Randiya Program

- Reduction of public standposts
  - Providing individual connections to all residents
  - Installing meters to ensure accountability and reduce wastage
  - Allowing connection fee payment in 36 monthly installments

Colombo Nonrevenue Water Reduction Program

- Replacement of old distribution network
  - In the first phase, 40 kilometers of network would be replaced
- Elimination of illegal connections
  - Laying of new lines in place of dual lines
  - Replacement of old pipes to eliminate illegal connections
- Reduction of unmetered connections
  - Metering of all bulk and/or commercial consumers
  - Installing meters at all existing authorized connections
- Elimination of incorrect measurements
  - Replacing and/or repairing meters

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Metering

In Sri Lanka, consumer metering and billing commenced in 1982. In 2008, the GC area had 99.6% of connections metered and 96.4% of the meters were in operation. Every year, about 5% of the meters are replaced or repaired. The proportion of metered connections increased marginally from 96.6% to 99.6% during 1998–2008 (Figure 8).

The objectives of this initiative are to identify and reduce losses stemming from leakages and unauthorized tapping, and to improve efficiency in service delivery to establish water balance.

Proposed Arrangement to Verify Nonrevenue Water Quantities

NWSDB has proposed an arrangement to verify the quantities of NRW. The verification would be done by hydraulically isolating and metering various water supply operations. It would first involve the identification of main feeding lines to Colombo city and then metering them. The second step would involve hydraulically isolating the areas under the management of area engineers within Colombo city. This would be followed by metering of the areas of officers-in-charge to quantify the supply and further develop DMA zones to monitor closely UFW reduction activities.

Box 2 Nonrevenue Water Reduction Program in Colombo Metropolitan Region, 2007–2012

Over the years, the National Water Supply and Drainage Board (NWSDB) has adopted different routine programs to minimize water losses. A program called "A Strategic Approach for Nonrevenue Water Reduction in the Colombo Metropolitan Region" was prepared in 2007 that aimed to reduce nonrevenue water (NRW) over a period of 5 years. An eight-point action plan was formulated under this program with the following activities:

(i) In the first year, reorganize and rehabilitate the Colombo city distribution management;
(ii) Implement pilot projects to enhance capacity and create awareness among the staff;
(iii) Replace old distribution pipes that are beyond economical repair;
(iv) Strengthen NRW management effectiveness by detecting invisible leaks, monitoring system pressure management, monitoring water districts, implementing a pilot zone program through officers-in-charge, and controlling illegal consumption;
(v) Adopt preventive approaches to reduce system leaks, theft, and administrative losses;
(vi) Review the specifications of materials used for water supply to maintain quality; and standardize specifications for fixtures and fittings used for water supply in procurement documents to prevent cheap, poor quality items from being used;
(vii) Strengthen the Legal Section to speed up pending court cases; and
(viii) Review incentives given for providing information to NWSDB on water theft.

Work on this action plan has already commenced and the experience will be replicated across Sri Lanka. To strengthen the billing and collection system, and for better management, various activities comprising the following have commenced in 2008:

- Decentralization of billing and collection,
- Updating of specifications for materials to ensure acceptable quality,
- Implementing the computerized Asset Management Program under the ongoing enterprise-wide information technology project in NWSDB to track the system's condition to facilitate timely repair and/or replacement works, and
- Survey and measurement of consumption at common water outlets in tenement gardens and wayside standposts.

Greater Colombo has also reorganized the management of Colombo city by decentralizing the authority and delegating responsibility to the middle management level. A 5-year work plan has been prepared, aiming to reduce NRW in Colombo city to 30%.

Colombo city employs two separate managers to look after the commercial and maintenance activities. The manager (Colombo city) is responsible for all the commercial activities including minor repairs and consumer complaints. For the purpose of commercial activities, the entire Colombo city has been divided into three area engineer offices—Colombo Zone I, Colombo Zone II, and Colombo Zone III. However, all maintenance activities are handled by the Managers' Office for Operational and Development at Maligakanda. Hence, responsibilities have not been decentralized to the officer-in-charge level or zonal officer level, and no zonal management system is practiced in Colombo city.

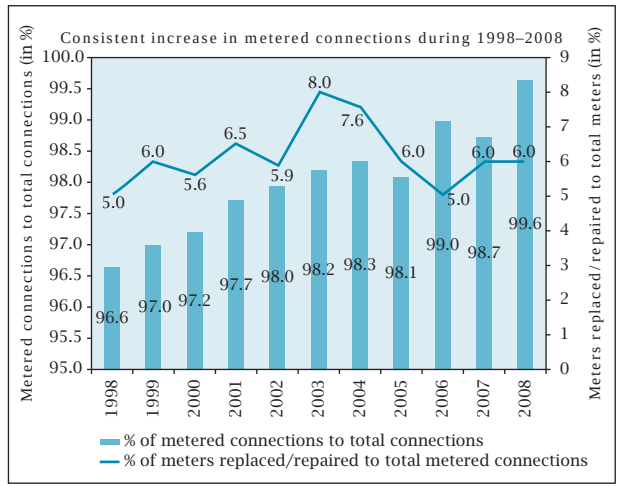
Due to this set-up, the following setbacks have arisen:

- Effective work time is limited due to long travel time.
- For overall maintenance activities in a particular zone, responsibility had not been properly assigned to an engineering assistant.
- There is delay in attending to consumer complaints.
- It is inconvenient for consumers from other areas to travel to Maligakanda.
- There is delay in organizing leak repair work.
- There is failure in paying attention to illegal activities.

To achieve the NRW target, Colombo city management will be reorganized with a zone concept to make engineering assistants more responsible, to replace deteriorated cast iron pipes, and to implement effective NRW management by the NRW Section.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Figure 8 Metered Connections to Total Connections and Meters Replaced or Repaired (%)



Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Wastewater Management

In 2008, the Greater Colombo sewerage network covered merely 14% of the population of the GC area. It was estimated that 343.20 MLD of wastewater was generated in the GC area.[37] Of these, 152.05 MLD was collected by the sewer network, while 3.28 MLD was treated by sewage treatment facilities with a combined capacity of 8.90 MLD. Of the untreated sewage, 148.77 MLD was discharged. There is, therefore, much potential for improvement in wastewater management.

NWSDB started levying sewerage service charges since 1 January 2008 in Sri Lanka. In 2008, there were 80,000 sewerage house connections in the entire GC area, out of which Colombo city alone had 71,000 connections. Table 3 shows the sewerage service charges, which are based on the monthly water consumption levels.

Industrial Effluent Treatment

There are five industrial areas within the GC area: Biyagama, Avissawella, Panadura, Horana, and Katunayake. Each of these industrial areas has effluent treatment facilities to treat wastewater from industries and then discharge it into streams. The effluent from the industries is diluted at a ratio of 1:8 before discharge. A study was conducted in 2008 to evaluate the need for increasing the treatment capacity, considering future requirements.

[37] Authors' estimate, based on the assumption that 80% of water consumed became wastewater.

Table 3 Sewerage Service Charges

Monthly Water Consumption (cubic meters)	Monthly Sewerage Service Charge (In Sri Lankan rupee[a] per cubic meter)
Domestic	
Up to 10	1.0
More than 10 and up to 15	1.5
More than 15 and up to 20	2.0
More than 20 and up to 25	2.5
More than 25 and up to 35	4.0
More than 35 and up to 40	6.0
More than 40 and up to 50	8.0
Commercial	
1 to 10,000	12.0
More than 10,000	15.0

[a] Currency conversion: $1 = SLRe115.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Customer Satisfaction

Consumer Complaints

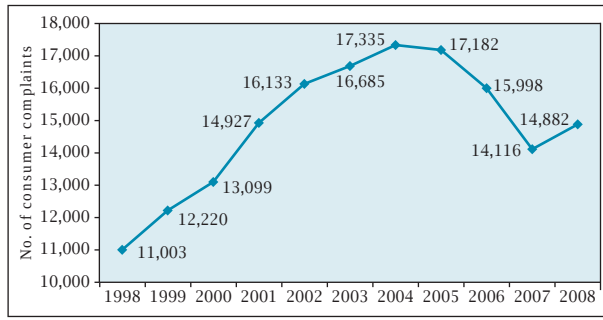
In 2008, NWSDB established a call center with a dedicated 4-digit toll-free telephone number offering 24-hour island-wide service. The service is available in two languages, Sinhala and Tamil, so that the consumer has a choice of language for registering a complaint. The center mainly addresses complaints regarding low pressure, no water, service leaks, road leaks, illegal consumption, billing, and others. Each complaint is allocated a registered number to facilitate tracking and follow up on its progress. NWSDB is continually working to improve this service and make it more effective and efficient.

The number of consumer complaints decreased from 17,335 in 2004 to 14,882 in 2008 (Figure 9). Response time also improved, from an average of 2–3 weeks in 2007 to an average of 1–2 weeks in 2008. Repeat complaints have been in the range of 50–125 per annum, mostly in areas with old and dilapidated networks.

Customer Satisfaction Surveys

NWSDB has not carried out large-scale surveys to evaluate customer satisfaction in the GC area, but small-scale surveys have been carried out from time to time, primarily with a focus on NRW.

Figure 9 Consumer Complaints, 1998–2008



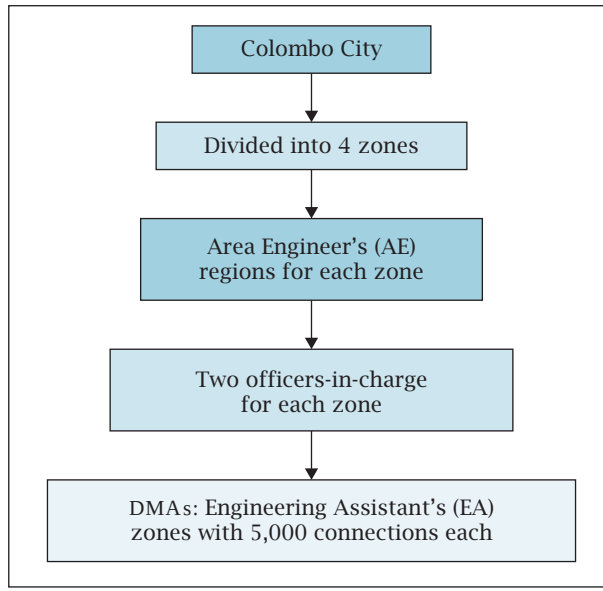
Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Decentralization of Administrative Powers

NWSDB has proposed to restructure its customer complaint management system to decentralize decisions and delegate powers to middle-level management, making managers more responsible in delivering customer satisfaction. This is expected to resolve consumer complaints more quickly.

The entire Colombo city is divided into four Area Engineer's (AE) zones—Colombo City North, Colombo City South, Colombo City East, and Colombo City West (Figure 10). Each AE zone has two officers-in-charge (OICs). Thus, all maintenance

Figure 10 Restructuring of Colombo City's Operation and Management



DMAs = district metering areas.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

and commercial activities are handled by eight OIC divisions spread across the city—Mattakkuliya, Kotahena, Maligakanda, Borrella, Timbirigasyaya, Pamankada, Slave Island, and Hulfsdorf.

The OIC divisions would be further reduced into engineering assistant's (EA) zones that comprise approximately 5,000 connections each. Decentralized authority and responsibility would be given to each EA in these zones, which are district metering areas (DMAs).

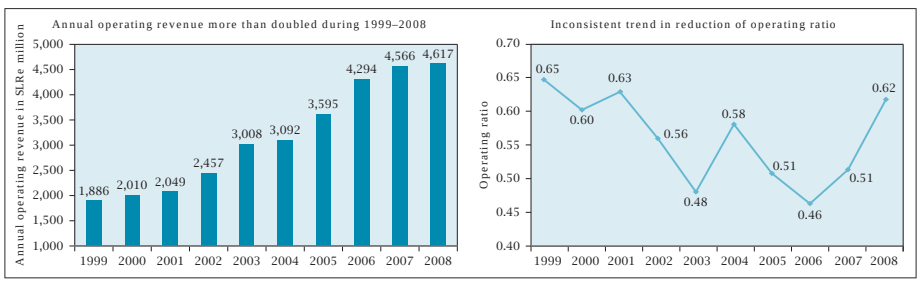
The advantages of the zone proposal include (i) easy attention to consumer grievances, (ii) water savings by attending to leaks with minimal lead time, (iii) improvement of the level of service, (iv) close monitoring and auditing of meter readings, (v) effective reduction of estimated bills, (vi) more attention for consumers and illegal activities, (vii) more new connections, (viii) responsible officers are easier to identify, and (ix) availability of a reliable information system.

Financial Resource Management

Revenue and Operating Ratio

Operating revenue from water-related services grew at a compounded annual growth rate (CAGR) of 9.4% during 1999–2008 with more than twofold increase in value. Operating ratio marginally improved from 0.65 in 1999 to 0.62 in 2008, but the improvement was inconsistent over the period (Figure 11). This is due to difficulties in effecting tariff increases periodically for revenue to match increases in operation and maintenance (O&M) costs, although almost 100% of connections are metered.

Figure 11 Annual[a] Operating Revenue and Operating Ratio



[a] Financial year is from January to December (e.g., FY1998 is January 1998 to December 1998).

Source: National Water Supply and Drainage Board, Colombia, Sri Lanka.

Revenue Collection Efficiency and Accounts Receivable

NWSDB's collection performance mirrors its revenue performance. It achieved a revenue collection efficiency of 98% in 2008 and nearly 100% in 2007 (Figure 12). Collection efficiency was more than 100% during three consecutive years (2003–2005) due to a drive initiated by NWSDB to collect outstanding arrears, especially from government organizations.

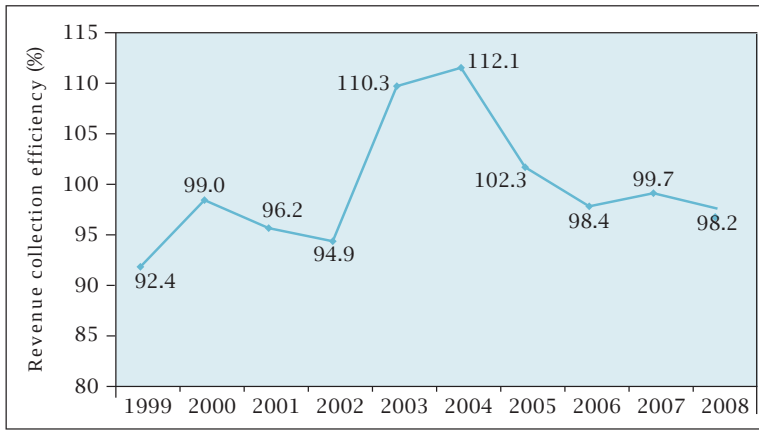
This drive has been continued with government agencies being served notice for payment (known as Red Letters) within 15 days, followed by a Disconnection Notice for failure to comply with the first notice. In cases of "no responses" from the agencies concerned, a notice is issued to their headquarters. Due to these efforts, the average time taken to collect payment from government organizations fell.

Figures on accounts receivable for the GC area were unavailable. Accounts receivable for Sri Lanka is shown in Table 4 as a proxy indicator for the GC area. As illustrated, accounts receivable for Sri Lanka is within the average credit period of 1–2 months, which is comparable to other Asian cities.

Cost Recovery

Figure 13 provides a comparison of revenue realization versus costs incurred on a per kiloliter (kl) basis.

Figure 12 Improvement in Revenue Collection Efficiency, 1999–2008



Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Table 4 Accounts Receivable for Sri Lanka

Accounts Receivable in Month's Equivalent[a]		Achieved
2004		60 days
2005		60 days
2006		60 days
Accounts Receivable for 2008[b]	Target	Achieved
Domestic and commercial institutions	60 days	60 days
Government institutions	60 days	65 days

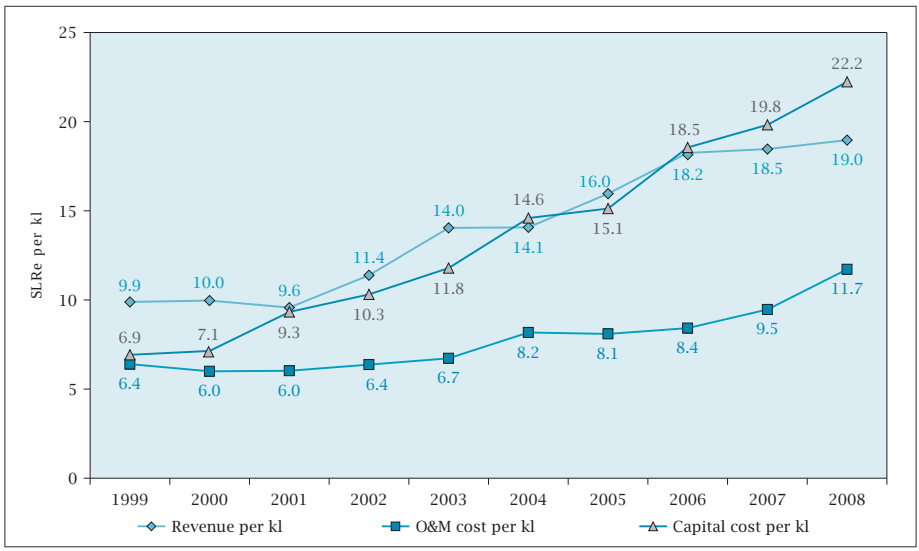
Sources:

[a] National Water Supply and Drainage Board, Colombo, Sri Lanka.

[b] NWSDB (2009), p. 7.

Revenue per kl rose over time, driven by increased population coverage of water supply and metering of connections. The steep rise in capital cost was due to the implementation of various source augmentation schemes, especially foreign funded ones. It is therefore important for NWSDB to formulate strategies to increase periodically water tariffs so it can further invest in its network and improve its level of service.

Figure 13 Cost Recovery: Revenue per kl versus Cost per kl[a]



kl = kiloliter, O&M = operation and maintenance, SLRe = Sri Lankan rupee.

[a] Capital cost per kiloliter (kl) was calculated by dividing the total capital expenditure incurred in producing water by the total amount of water produced. This expenditure is the cumulative cost incurred by both foreign and locally funded projects to produce water. O&M cost per kl was calculated by dividing the total O&M expenditure incurred in producing water by the total amount of water produced. Revenue per kl was calculated by dividing the revenue from water sales by the total amount of water supplied for sale.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Water Tariffs and Connection Fees

Prevailing volumetric charges for domestic users, at various water consumption levels, are shown in Table 5. The minimum usage charge is SLRe1.25 per cubic meter per month. Apart from the volumetric usage charge, there is a service charge that is also based on the quantum of consumption.

Usage and service charges for the supply of water through public standposts and garden taps are provided in Table 6.

Table 5 Usage and Service Charges for Domestic Users

Consumption (cubic meter per month)	Domestic Samurdhi Consumers		Domestic Non-Samurdhi Consumers	
	Usage Charge (SLRe/cubic meter)	Service Charge (SLRe)	Usage Charge (SLRe/cubic meter)	Service Charge (SLRe)
00–05	1.25	50.00	3.00	50.00
06–10	1.50	50.00	7.00	65.00
11–15	3.00	50.00	15.00	70.00
16–20	30.00	80.00	30.00	80.00
21–25	50.00	100.00	50.00	100.00
26–30	75.00	200.00	75.00	200.00
31–40	90.00	400.00	90.00	400.00
41–50	105.00	650.00	105.00	650.00
51–75	110.00	1,000.00	110.00	1,000.00
Over 75	120.00	1,600.00	120.00	1,600.00

SLRe = Sri Lankan rupee.

Notes:
1. "Samurdhi" is a national program introduced by the Government of Sri Lanka in 1994 to alleviate poverty.
2. A discount of SLRe20.00 or the total monthly usage charge, whichever is lower, is granted to consumers whose monthly consumption is 15 cubic meters or less.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Table 6 Usage and Service Charges for Public Standposts and Garden Taps

Consumption (cubic meter per month)	Usage Charge (SLRe/cubic meter)	Service Charge (SLRe)
00–25	10.00	250.00
26–50	10.00	500.00
51–100	10.00	1,000.00
101–200	10.00	1,600.00
Over 200	10.00	2,500.00

SLRe = Sri Lankan rupee.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Table 7 shows the usage and service charges for government schools, government-assisted schools, religious institutions, and charitable institutions. These institutions pay a minimum usage charge of SLRe6.00 per cubic meter per month.

Usage for commercial and other users are charged at uniform rates (Table 8), unlike those for domestic users where tiered rates are employed based on consumption levels. However, service charges for these users vary in accordance with consumption levels (Table 9).

The tariff for the supply of water through bowsers is SLRe65.00 per cubic meter. This charge excludes costs incurred for transport and other overheads, which are recovered based on actual costs.

One-time connection fee for new connections varies from SLRe4,000 (approximately $36) to SLRe24,000 (approximately $218), depending on the type of users (Table 10). The fee charged is lowest for tenement garden residents and low-income group settlements, and has remained unchanged during 1998–2008. The connection fee was raised from SLRe14,000 to SLRe24,000 in 2008 for other domestic consumers.

Table 7 Usage and Service Charges for Government Schools, Government-Assisted Schools, Religious Institutions, and Government-Approved Charitable Institutions

Consumption (cubic meter per month)	Usage Charge (SLRe/cubic meter)	Service Charge (SLRe)
00–05	6.00	50.00
06–10	6.00	65.00
11–15	6.00	70.00
16–20	6.00	80.00
21–25	6.00	100.00
26–30	6.00	200.00
31–40	6.00	400.00
41–50	16.00	650.00
51–75	16.00	1,000.00
Over 75	16.00	1,600.00

SLRe = Sri Lankan rupee.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Table 8 Usage Charges for Commercial and Other Users

Category	Usage Charge (SLRe/cubic meter)
Commercial institutions	65.00
Tourist hotels and guest houses	65.00
Other commercial and private institutions	65.00
Industrial institutions	53.00
Export processing zones of the Board of Investment	53.00
Government institutions	53.00
Shipping	400.00
Supply in bulk to local government institutions	16.00
Supply in bulk to rural water supply schemes maintained by community-based organizations	16.00

SLRe = Sri Lankan rupee.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Table 9 Service Charges for Commercial and Other Users

Consumption (cubic meter per month)	Service Charge (SLRe)
00–25	250.00
26–50	500.00
51–75	1,000.00
76–100	1,000.00
101–200	1,600.00
201–500	2,500.00
501–1,000	4,000.00
1,001–2,000	7,500.00
2,001–4,000	12,500.00
4,001–10,000	25,000.00
10,001–20,000	50,000.00
Over 20,000	100,000.00

SLRe = Sri Lankan rupee.

Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

Table 10 Connection Fee for New Consumers

User Type	Per New Meter (SLRe)
Domestic consumers	24,000.00
Low-income group	4,000.00
Tenement garden residents	4,000.00

SLRe = Sri Lankan rupee.
Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

The mean monthly household income in Sri Lanka is SLRe26,286 while it is SLRe41,928 in urban areas and SLRe24,039 in rural areas.[38] This means that the domestic connection fee of SLRe24,000 constitutes 57% of the monthly household income in urban areas, while it is almost equal to the monthly household income in rural areas.

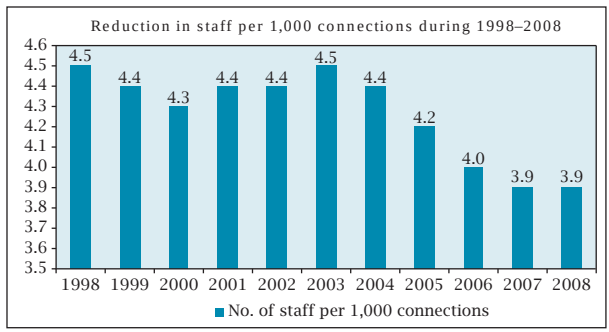
There is a provision for consumers to pay the connection fee through an initial 25% down payment and the balance with interest in six installments. Experience shows that most consumers make a lump sum payment for water connections and very few opt for the installment scheme.

Human Resource Management

Staff Productivity

As shown in Figure 14, staff productivity improved during 1998–2008. The number of staff per 1,000 connections declined to 3.9 in 2008. Although the number

Figure 14 Staff Productivity, 1998–2008



Source: National Water Supply and Drainage Board, Colombo, Sri Lanka.

[38] Excluding the Northern province and the Trincomalee district in the Eastern province (Department of Census and Statistics 2008).

of staff employed fell, the number of water connections increased. The increase in staff productivity over time points toward an overall improvement in the efficiency of the use of human resources and manpower rationalization.

Training and Human Resource Development

Human capacity and knowledge enhancements are important elements in the overall development philosophy for employees of NWSDB. It undertook 63 internal training programs for technical staff, 57 training programs for nontechnical staff, and over 30 programs for computer applications in 2009. These programs were distributed across the four quarters in a year, and program duration varied from 1 day to 3 days depending on the type of programs. The training programs were linked to actual ongoing projects, such as the pilot NRW reduction program of the twinning arrangement with JUSCO. Engineers in this pilot area gained experience through working with a utility like JUSCO, and eventually engaged in knowledge sharing.

Some of the topics covered in the technical programs were construction and maintenance of groundwater intakes, maintenance of pipe systems, awareness on electronic devices in water treatment plants, tender evaluation and reporting, and leakage testing procedure after pipe-laying work.

The nontechnical programs covered awareness of accounting standards, budgetary control and maintenance of ledgers, office organization and management, human resource development through proper disciplinary management, awareness of supplies and store procedures, and refresher courses on commercial activities and consumer relations.

NWSDB also encourages its staff to undertake advanced courses at various government-recognized institutes and universities. These courses include master's and postgraduate diplomas in business administration with various specializations; postgraduate diplomas in construction, environmental engineering, and water engineering; and Master of Science in Chemistry and other relevant disciplines.

Initiatives for Sustainable Water Supply and Sanitation

NWSDB has contributed significantly toward improving health, economic conditions, social well-being, and the livelihood of the people of the GC area. Over the last few years, there has been a definitive shift in its overall approach from being "just a service provider" to focusing on providing sustainable water and sanitation facilities. A large number of initiatives have been taken by NWSDB to ensure adequate, sustainable, and safe water supply and sanitation facilities to all users.

This section presents a brief overview of the recent initiatives taken by NWSDB in the water and sanitation sectors in the GC area for sustainable development, though technical support from international agencies.

Water Supply Improvement Initiatives

NWSDB faces several challenges in supplying adequate water within the GC area, such as saline water intrusion into the river, continuous increases in water demand due to population growth, higher NRW due to old and dilapidated distribution networks, and a less efficient centralized system for the operation and maintenance of distribution networks. Hence, NWSDB has initiated projects and programs for a more integrated water supply system within the GC area.

(i) **Kalu Ganga Water Supply Project (Stage II of Phase I).** This project is technically supported and funded by the Japan International Cooperation Agency (JICA). One of the objectives is to reduce NRW by eliminating illegal connections, reducing water losses, and anticipating future demand. One of the components is to replace 120 km of deteriorated pipes with new ones. In the initial phase, pipes within the 56 km network of the Colombo city distribution system with a diameter of less than or equal to 6 inches will be replaced. This will help in the hydraulic isolation of the network for the formation of DMAs and in the reduction of NRW. This project also covers water supply schemes for the Panadura and Kesbewa areas.

(ii) **Greater Colombo Water Rehabilitation Project.** This is a JICA-funded project for the construction of two service reservoirs at Elie House and Maligakanda, and for the building of water supply facilities at the Kotikawatta–Mulleriyawa and Kolonnawa areas. It also includes the provision of 1,000 new house service connections to low-income settlements.

(iii) **Master Plan Study.** NWSDB has also initiated the preparation of a comprehensive water supply master plan for the entire Western Province. The salient features of this 40-year duration plan are identification of alternate sources of water, the conduct of an adequacy study of the existing transmission system, making plans for future demand, and rearrangement of the entire system based on changing development patterns. JICA provides technical support and funds for the preparation of the master plan.

Wastewater Management Initiatives

The sewerage network covered only 14% of the population of GC in 2008, of which the majority of the population lived within the Colombo Municipal Council area. NWSDB has begun to improve the sewerage system of the entire GC area, through various projects and schemes supported by multilateral development agencies. One of the objectives is to provide proper drainage and sewage disposal facilities

to minimize source pollution and improve the living conditions of the residents. Projects that are implemented or planned include the following:

(i) **Within the Colombo Municipal Council area**
- Colombo wastewater management project (implementation period: 2009–2013), ADB-supported project
- Provision of sewer connection and off-network sanitary solutions in the GC area (implementation period: 2010–2014), World Bank-supported project
- Rehabilitation of the Southern Catchment of Colombo Sewerage System (implementation period: 2007–2010); Government of Austria-supported project

(ii) **Rest of Greater Colombo area**
- Sri Jayawardenapura Kotte Sewerage Project
- Ja-Ela/Ekala and Ratmalana/Moratuwa wastewater disposal projects (implementation period: 2006–2012), Swedish International Development Cooperation Agency (SIDA)-supported project

Storm Water Drainage and Flood Management Initiatives

As part of its sustainable water management strategy, Colombo is committed to provide an improved drainage system throughout the GC area. Hence, the following schemes were implemented:

(i) **Kelani Ganga Flood Protection Scheme, Swedish International Development Cooperation Agency (SIDA).** To protect downstream areas from critical floods, a series of flood banks (dikes) were constructed since 1924 and strengthened thereafter. In this project implemented in 2002, flood banks were constructed along the southern bank of Kelani Ganga to prevent the city of Colombo from flooding.

(ii) **Greater Colombo Flood Control and Environmental Improvement Project (GCFC & EIP).** In Phase I of this project, the major canal system in and around the city of Colombo was improved. The drainage basin, with an area of 85 km^2, mainly covers a major part of the Colombo Municipal Council (CMC) and some parts of the Sri Jayawardenapura Kotte Municipal Council and the Dehiwala–Mount Lavinia Municipal Council areas. Feasibility assessment for Phase I was completed in 1988 under a study of canals and drainage in Colombo conducted by NWSDB, and updated in 1992 with an extension of the study area to include the GC area. This scheme was implemented during 1992–1998. During the first phase, major canals comprising 44 km in length were improved.

In Phase II, the alleviation of local floods (inundations), which were habitually observed in the CMC project area, was implemented during 1998–2001 by SLLRDC. The project included five drainage schemes covering about 560 hectares and located in highly built-up areas within the CMC. The total

length improved during this phase was 7 km. All the trunk drains were either connected to main canals improved under Phase I, or allowed to directly discharge storm water into the sea.

Ongoing drainage projects include Phase III of the GCFC & EIP. The large urbanized areas of the Dehiwala–Mount Lavinia Municipal Council are not provided with adequate storm water drainage. Unlike the CMC area, there is no systematic drainage network in the area. The system of storm water drainage in the area consists of natural streams as trunk mains partly lined with masonry or concrete works, and smaller open drains collecting and leading storm water to the trunk drains. To improve the drainage condition in the urban area to the south of the CMC, five solid waste disposal improvement schemes were proposed. These schemes were designed based on a rainstorm event with a 2-year return period to alleviate the frequent inundation. The scope of work includes provision of trunk main channels and construction of secondary drains and roadside ditches. About 40 km of drainage channels would be constructed.

Groundwater Pollution

Causes of groundwater pollution include fecal contamination by seepage of domestic wastewater from sanitation facilities, chemical contamination by seepage of wastewater from industries, solid waste dumping, and seawater intrusion into groundwater due to over extraction of wells. The implementation of planned sewerage projects and other measures to prevent source pollution would help in reducing groundwater pollution.

Challenges and the Way Forward

NWSDB's efforts in improving the water supply system of the GC area during 1998–2008 are creditable, especially for expanding coverage and ensuring access to a 24-hour, 7-days-a-week piped water supply. More importantly, it has operated the water supply system satisfactorily, while addressing a number of constraints and challenges including a continuing increase in service area and water demand, legacy issues as a result of managing an old and dilapidated network, and pollution of water sources.

The continuing efforts and initiatives of NWSDB indicate its determination to resolve head-on some of its persistent challenges. These challenges include

(i) **Confronting water losses and nonrevenue water head-on.** NWSDB introduced the Randiya and Colombo NRW reduction programs to address the two major areas of water losses—leakages and illegal connections. Specific DMAs have been created within Colombo city to improve leakage identification, deliver consistent water services, and conserve water.

(ii) **Commitment to a continuous supply and metering.** Despite increases in service area and water demand, NWSDB has maintained a 24-hour, 7-days-a-week water supply across its service area. Moreover, large-scale metering initiatives have led to almost 100% of connections being metered, which achieved the goal of improving efficiency in service delivery and water conservation.

(iii) **Organizational response for excellence in customer service.** To achieve the goal of becoming a more responsive organization that provides customer service with a quick turnaround time, NWSDB realized the need to restructure its customer complaint management system. This resulted in the delegation of administrative powers to middle-level management, leading to decentralized decision making. The new system, which is more responsive, provides quick attention to customer grievances and generates reliable information for more effective decision making.

(iv) **Recent focus on wastewater management.** Although sewerage coverage has lagged behind, there is a renewed focus on wastewater management through the introduction of various schemes to provide proper drainage and sewage disposal facilities.

(v) **Sustainability of water resources.** There is a keen realization of the need to maintain the sustainability of water resources, which is evident in efforts to prevent source pollution and avoid saline water intrusion from the sea. The implementation of planned sewerage projects and construction of barrages across rivers are encouraging efforts in that direction.

Despite the above improvements, there is scope for improvement in the efficiency of service provision, considering that reduction in water losses and NRW have been marginal during 1998–2008. There is also a need to accord significantly higher priority to extend sewerage facilities beyond Colombo city into the rest of the GC area. Despite the rapid strides made by NWSDB in extending piped water supply in the GC area, inadequate sewerage facilities could result in significant pollution and environment degradation.

To achieve the goal of providing sustainable water and sanitation facilities, NWSDB has to adequately plan and implement improvement schemes in a comprehensive manner. To keep pace with development, the priorities and issues that NWSDB will have to face in the future are as follows:

(i) **Water supply system.** The GC area is facing the problem of seawater intrusion into the Kalu Ganga River and the Kelani River, up to a distance of almost 24 km from the seashore, leading to the salinization of freshwater sources. Although NWSDB supplies adequate and continuous water to the GC area, the old and dilapidated state of the distribution network of Colombo city and the uncontrolled supply of water to public standposts have resulted in high levels of NRW. The continuing expansion of NWSDB's service area and the growth

of the population have led to an increasing demand for water and pressure to improve service coverage. Hence, NWSDB needs to adopt a greater focus on tariff rationalization for adequate cost recovery and greater investments in the rehabilitation of water distribution systems.

NWSDB has planned various schemes of source augmentation, distribution network rehabilitation, and prevention of water pollution. There are plans to construct a barrage across rivers to prevent the salinization of river water. Moreover, with the commissioning of the Kalu Ganga project, the issue of availability of water sources to serve the increasing demand due to growth in population and expansion of networks will be alleviated.

A comprehensive approach to the planning and implementation of these water and sanitation projects is needed to ensure a safe and healthy environment. More focus should be given on sustainable delivery of a continuous water supply across the service area through a well- established network that minimizes water losses and thus prevents water wastage. Long-term planning should consider the rising demand of water with an increasing population. At the same time, sustained investment needs to be made for the rehabilitation of the distribution network, which can be attained through tariff rationalization that aims for O&M cost recovery. Moreover, capacity building of NWSDB's staff should not be compromised for the proper management of distribution networks and for the minimization of water losses.

(ii) **Wastewater management.** The GC area is inadequately covered by a proper sewerage network. Most parts of the area still depend on septic tanks and other on-site sanitation facilities. With an increasing population, pollution of fresh water bodies and groundwater sources has increased substantially. The seepage of sullage water causes pollution, in addition to the challenge of saline water intrusion from the sea.

An immediate focus should be to increase the sewerage network coverage from the existing level of 14%. While doing so, integrated planning should be undertaken for the proper implementation of wastewater management projects. It is important to put good hygiene and improved environmental conditions on high priority. A holistic approach that "closes the loop" in the water value chain—from water supply to proper wastewater disposal—should be adopted to minimize groundwater pollution and ensure compliance to pollution control norms.

The rapidly developing GC area will emerge as a metropolitan city in the coming years, and this will increase the demand for water and sewerage services. At the same time, Colombo will face issues of deteriorating environmental conditions due to pollution and increased extraction of groundwater, if these concerns are not properly addressed. NWSDB will thus face major challenges ahead to ensure adequate service delivery while maintaining quality standards across its existing and expanding service area.

As the pace of development will be faster than the current rate at which improvement in service delivery is taking place, there is an urgent need for a regional-level plan to improve water and sanitation facilities as a whole rather than adopting a piecemeal approach. This forward-looking, integrated approach needs to put water conservation as a priority while simultaneously addressing the challenges of changing rainfall patterns and the effects of global warming.

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CHAPTER IV

Jamshedpur, India

Anand Madhavan and Supriya Sahai [39]

Introduction

Jamshedpur is located in the East Singhbhum district of Jharkhand, India. It is one of the country's oldest and largest industrial towns. The city owes its origins to Jamset Nusserwan Tata's vision of setting up India's first private iron and steel company, Tata Iron and Steel Company (currently known as Tata Steel). His vision was realized when a little-known region formerly called Sakchi, at the confluence of the Subarnarekha and Kharkai rivers, was chosen for setting up the steel plant of the new company in 1907. The town that came into existence around the steel plant was named Jamshedpur in 1919 by Lord Chelmsford in honor of the late Jamsetji Tata, who passed away in 1904.

The general manager of JUSCO explains a planned water system to a local government official.

Photo courtesy of Jamshedpur Utilities and Services Company Limited.

[39] Madhavan is head of Energy and Urban Infrastructure at the ICRA Management Consulting Services Limited, India; and Sahai was manager of Urban and Infrastructure Finance, also at the ICRA Management Consulting Services Limited, India.

Julin Kennedy Sahlin, an American from Pittsburgh, prepared the first layout of the town. In 1920, Frederick Charles Temple, who was then the sanitary engineer of the Government of Bihar and a town planner, was engaged as the chief town engineer. In 1936, Maj. P.C. Stokes, who was connected with the Quetta earthquake reconstruction, was invited by Tata Steel to give advice on town planning and development. Dr. Keonigsberger prepared a master plan for the city in 1943 (National Informatics Centre n.d.).

Tata Steel invested in several modern facilities. Within a couple of years, the township had a pump house that supplied a million gallon of water daily, as well as neat rows of brick houses. Jamshedpur is also equipped with other facilities such as the Tata Main Hospital, primary schools, colleges, specialized institutions including medical and arts colleges, and recreational facilities (Tata Steel 2007).

Today, Jamshedpur is home to industries such as iron and steel, commercial vehicles, tinplate, and cement. It is supported by an ancillary base of small- and medium-scale industrial units. Large manufacturing units other than Tata Steel include Tata Electric Companies, Tata Motors, Indian Steel and Wire Products, Jamshedpur Engineering and Machine Manufacturing Company, Tata Tinplate, Usha Martin Industries, Tata Steel Processing and Distribution, and Uranium Corporation of India. The development of Jamshedpur has been guided by a master plan for the period 1986–2010.

Table 1 provides some details of the Jamshedpur Urban Agglomeration (JUA). Urbanization has spread beyond the catchment of Tata Steel, originally created to serve the steel plant. The broader JUA extends over an area of 149.23 square kilometers (km^2). It includes three notified areas (Jamshedpur, Adityapur, and Mango); the Jugsalai Municipality; and eight village *panchayats* (Parsudih, Ghorabandha, Chotagovindpur, Gadhra, Sarjamdah, Haldubani, Kitadih, and Bagbera).

Table 1 Key Statistics of Jamshedpur Urban Agglomeration, 2001

State	Jharkhand
District	East Singhbhum
Area	149.23 km^2 [a]
Population	1.1 million [a]
Average household size	5.26 [a]
Population density	9,013 persons per km^2 [a]
Literacy rate	72.9% [a]

km^2 = square kilometer.

[a] 2001 Census.

Source: Ministry of Urban Development, Government of India (2007).

For three generations, Sarojini's family has depended on public tap. Now, her household has direct access to regular water supply.

Photo by Rakesh Sahai.

JUA is expected to be among the fastest-growing urban areas in India. While the population of JUA was a modest 1.1 million in 2001, its population was forecasted to grow annually at 5% between 2001 and 2031, with a significant share of this growth expected to be driven by immigration from adjoining rural areas (Ministry of Urban Development 2007).

Institutional and Regulatory Framework

This section presents an overview of the institutional and regulatory framework in the Jamshedpur Notified Area (JNA) and the wider JUA. While this chapter focuses on the JNA, a broad overview of the entire urban agglomeration of Jamshedpur is needed to set the context.

Unique Municipal Legislation

The city of Jamshedpur has a unique legal and governance framework. The Bihar Municipal Act 2007, which provides the legal framework for Urban Local Bodies in Bihar and Jharkhand, makes an exception for industrial towns. Under the 2007 act, such towns where civic services are provided by the industrial unit are declared as "industrial townships" by the state government and do not come under the purview of the legal framework for Urban Local Bodies in the state (Urban Development and Housing Department 2007, 94). Thus, Jamshedpur is a privately managed city from a legal perspective.

Institutional Framework in the Jamshedpur Urban Agglomeration

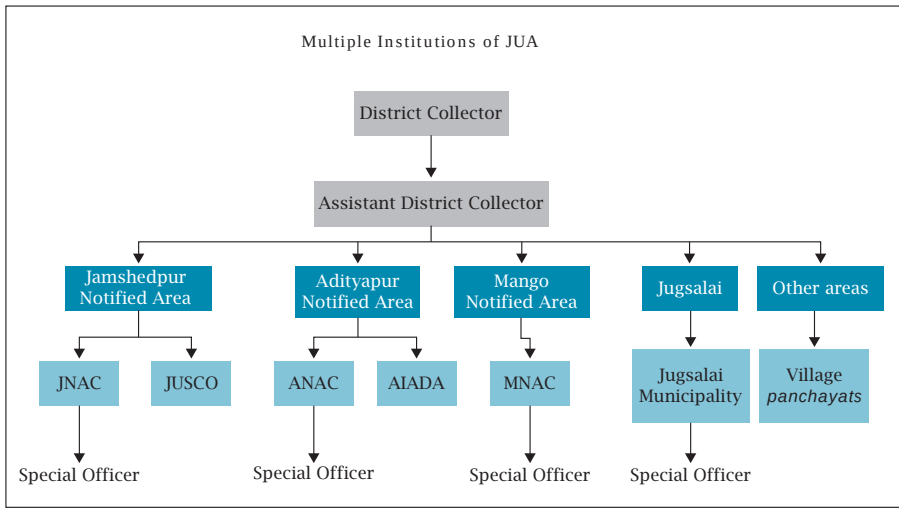
The larger JUA is managed by multiple authorities, with each administering their designated areas (Figure 1). JUA is under the governance of one municipality (Jugsalai Municipality); three notified area committees (NACs)[40] (Jamshedpur Notified Area Committee, Adityapur Notified Area Committee, and Mango Notified Area Committee); eight village *panchayats* (Parsudih, Ghorabandha, Chotagovindpur, Gadhra, Sarjamdah, Haldubani, Kitadih, and Bagbera); an industrial area development authority (Adityapur Industrial Area Development Authority); and a private utility (Jamshedpur Utilities and Services Company Limited [JUSCO]).

The quality and division of urban services provided by these multiple institutions differ. The institutional responsibility for the provision of water-related services is presented in Table 2.

The highest civic authority of Jamshedpur is the district collector, who is supported by an assistant district collector. A major part of JNA is covered by Tata Steel, Tata

[40] A notified area is a settlement with a population of 10,000–20,000. A community of over 20,000 is considered a town. An area is designated an NAC when it does not yet fulfil all the conditions necessary for the constitution of a municipality but is considered important by the state government. Generally, such an area is fast developing with new industries being set up. An NAC is not created by statute but by a notification in the government gazette. The state government constitutes the committee to administer the area. All members of this committee, including the chairman, are nominated by the state government. The criteria for establishing a committee differ across states. This was adapted from Arora and Goyal (1996), p. 268.

Figure 1 Institutional Structure of Jamshedpur Urban Agglomeration



AIADA = Adityapur Industrial Area Development Authority, ANAC = Adityapur Notified Area Committee, JNAC = Jamshedpur Notified Area Committee, JUA = Jamshedpur Urban Agglomeration, JUSCO = Jamshedpur Utilities and Services Company Limited, MNAC = Mango Notified Area Committee.

Source: Adapted from the Ministry of Urban Development, Government of India (2007).

Table 2 Institutional Responsibility for the Delivery of Water Services in Jamshedpur Urban Agglomeration

Service	Planning, Design, Execution, Operation, and Maintenance
Water supply	• JUSCO—for designated area of JNA for piped water supply
	• Public Health Engineering Department (PHED)—for MNA, ANA, Jugsalai Municipality, and remaining areas of JNA
	• Other areas have no piped water supply
	• Water treatment plants (WTPs)—JUSCO for parts of JNA, AIADA in ANA, and PHED in Jugsalai Municipality and remaining areas of JNA
Sewerage	• JUSCO—for designated area of JNA, for sewerage network and sewage treatment plants
	• For other areas of JNA, MNA, ANA, Jugsalai Municipality, and other areas, sewage is disposed into soak pits, septic tanks, or open drains
Storm water drainage	• JUSCO—for designated area of JNA: About 40 km of roads have drains, of which about 75% are *kutcha* drains
	• Storm water is disposed through natural open drains in MNA, ANA, Jugsalai Municipality, and in remaining areas of JNA

AIADA = Adityapur Industrial Area Development Authority, ANA = Adityapur Notified Area, JNA = Jamshedpur Notified Area, JUSCO = Jamshedpur Utilities and Services Company Limited, km = kilometers, MNA = Mango Notified Area.

Source: Adapted from the Center for Environmental Planning and Technology University (2007).

Box 1 Origin and Status of the Jamshedpur Notified Area Committee

In the early years of the previous century, the state government acquired land under the Land Acquisition Act and leased it to Tata Iron and Steel Company (currently Tata Steel). The provision of civic amenities and development of the town of Jamshedpur has continually been the responsibility of Tata Steel for this leased area.

In 1924, the Jamshedpur Notified Area Committee (JNAC) was set up by the state government, under the provisions of the Bihar Municipal Act. Its role was confined to only certain areas and the levy of taxes, since all municipal services were provided by Tata Steel. Tata Steel and JNAC functioned in close collaboration with each other. The head of the town division of Tata Steel was always nominated as the chairman of JNAC, and the majority of the members of this committee were nominees of Tata Steel.

The problem arose with the vesting of Tata Steel's proprietary interest in its acquired land under the Bihar Land Reforms Act. Litigation lasted for nearly 3 decades but eventually the state of Bihar and Tata Steel came to an amicable settlement. The state government agreed to continue to allow Tata Steel to provide civic amenities and municipal services as part of its responsibility. A certain part of the acquired land was used by the government to build courts, police stations, post offices, branches of the state bank, and public hospitals. The rest of the land was leased to Tata Steel to enable the company to discharge its functions with regard to the municipal services at its own cost and mode of management.

Source: Chattoraj (2006).

Engineering and Locomotive Company, and the Tata Nagar Township. This part of JNA is managed by JUSCO, and it is also referred to as the lease area. The remaining area is separately administered by the Jamshedpur Notified Area Committee (JNAC).

JUSCO is guided by the rules and regulations of JNAC. It needs the approval of JNAC for various aspects of water service, such as the use of raw water, treatment of water, expansion of distribution networks, and layout of maps. Box 1 provides details of the origin of JNAC.

Need for Change: Factors for the Formation of the Jamshedpur Utilities and Services Company Limited

Urban Services in Jamshedpur, 1900s to 2004

From the inception of Tata Steel in 1907 until 2004, a time frame spanning nearly 100 years, municipal services in Jamshedpur were provided by the Town Division of Tata Steel. The Town Division operated as a cost center under Tata Steel and provided essential services such as water supply and wastewater management. During those years, the division maintained a decent level of customer satisfaction and provided consistent quality of water to the city.

However, population growth and increasing urbanization in the peripheral areas pushed up the demand for tap water services in Jamshedpur. This social pressure exposed the Town Division's constraints, including operational, human resources, financial capacity, and a lack of exposure to modern technologies and processes that hindered effective provision of essential services. In particular, the Town Division faced the following operational and financial challenges:

(i) **Population growth and demand beyond served areas**

While the Town Division had primarily focused on the Tata Steel township areas, urbanization beyond these areas led to a disparity in water access levels. Coverage of water supply within JNA shrunk to below 65%. As the population grew in the vicinity, the Town Division also had to contend with a decline in the water table and quality due to increased usage of hand pumps and deep borewells.

(ii) **Operational constraints**

Being managed under a division of Tata Steel, the Town Division had limited exposure to modern technologies and management practices for tackling issues in a growing urban water supply system. The division faced several operational problems even within its limited networks:

Water losses. Nonrevenue water (NRW) was as high as 36.0% in financial year (FY) 2005 due to high physical losses in the supply network and a large number of illegal connections.[41]

Energy cost. As overall network performance dipped and water losses mounted, energy consumption went up. In FY2005, energy consumption was as high as 349 kilowatt-hour per million liters (kWh/ML) of potable water supplied and 332 kWh/ML of raw water produced.

Low productivity. Staff productivity declined with stagnating water access levels and lack of exposure to modern network management practices.

(iii) **Ineffective redress of complaints and weakly defined service level standards**

A manual and decentralized customer complaint management system was in place. This was supported by 15 different customer help lines, with different units handling varied services. This constrained information compilation. Data obtained from the system could not be used effectively for managerial decision making and performance improvement. Moreover, there were no specific service delivery standards to track the service quality or time taken in resolving complaints.

(iv) **Financial constraints**

Customer-level metering was still in a nascent stage. A fixed flat tariff structure, based on area, had to be administered instead of a volumetric tariff

[41] Financial year: 1 April–31 March (e.g., FY2009 is 1 April 2008 to 31 March 2009).

system. This was inconsistent with the principles of "pay as per use" and water conservation. By the early part of the decade, Tata Steel faced a growing gap between its cost and its level of revenue recovery, incurring a deficit of about Rs400 million[42] (or $8.0 million) annually in operating various municipal services (Agrawal 2006).

The cost-center approach and limited exposure to technologies and management practices hindered operational and financial performance. These constraints provided the trigger for executing a new way of doing things.

Corporatization of the Town Division and Formation of Jamshedpur Utilities and Services Company Limited

To address these challenges head-on and move toward a sustainable service delivery model, Tata Steel decided to shift to a corporatized model. With the objectives of improving services and achieving financial sustainability, a separate service company, JUSCO, was carved out of the Town Division of Tata Steel. JUSCO was charged with the mandate of improving the quality of civic services in Jamshedpur. Set up as a wholly owned subsidiary of Tata Steel, JUSCO was incorporated on 25 August 2003 under the Companies Act 1956, with the mission of providing "*Quality Services for Life*." JUSCO became operational on 1 April 2004 with the transfer of 1,375 employees from the Town Division.

JUSCO was established to evolve into a one-stop integrated utilities provider whose gamut of services would include water and wastewater services, construction services, management of municipal solid waste, power services, horticulture services, customer services, and integrated facility management. Its vision is to be the preferred provider of civic and allied services not just within Jamshedpur but to emerge as a national leader in the water and sanitation business.

JUSCO's civic and municipal services were managed by a team of qualified professionals and monitored by its board of directors. JUSCO has since ventured beyond Jamshedpur to create new water facilities, and to modernize and maintain existing ones, across India. The range of its services covers operation and maintenance of the entire water cycle from intake to treatment, conveyance, and distribution. Service offerings include operation and maintenance of water treatment plants, sewage treatment plants and distribution networks; building water treatment plants and sewage treatment plants on engineering, procurement, and construction (EPC) or build-own-operate-transfer (BOOT) contracts; technical and management support to improve performance; control of unaccounted-for-water (UFW) or NRW; creation of 24-hours, 7-days-a-week municipal water supply systems; Geographic Information System (GIS) for asset management; and customer support services including call center facilities for prompt handling of complaints (JUSCO n. d. [a]).

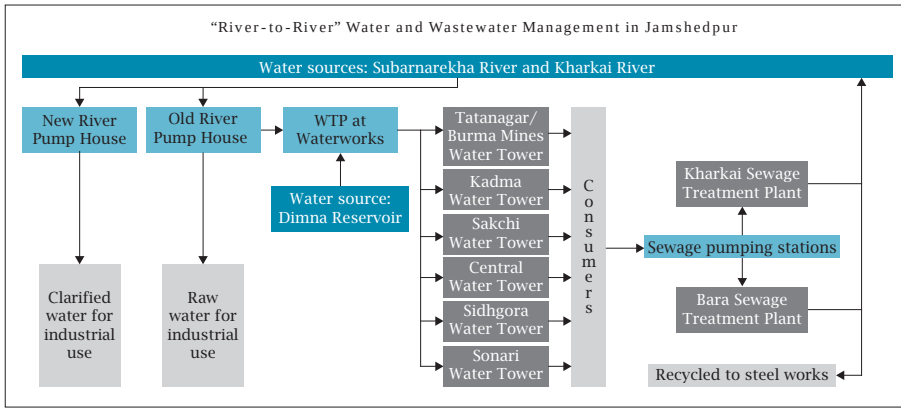
[42] Currency conversion: $1 = Rs50.

Since its inception, JUSCO has won several awards. These include a "highly commended" certification as "one of the most effective water service providers on the Indian subcontinent" at the international Global Water Awards 2008 organized by Global Water Intelligence, India's National Urban Water Award 2009 for excellence in citizen services and governance. It also received awards for excellence in human resource management and total productive maintenance (TPM) (JUSCO n.d. [d]).

Water Value Chain

JUSCO is legislatively responsible for providing water and wastewater services over an area of 64 km^2 (which is also referred to as the lease area) in Jamshedpur. It supplies water to a population of approximately 700,000 through more than 48,000 direct water connections in a distribution network of 550 km.[43] According to JUSCO, more than 20,000 connections serve Tata Steel's employees and the rest cater to other residents. JUSCO adopts what it calls "river-to-river" management, which starts with the treatment of raw water and continues through to the treatment of effluent and wastewater, both of which meet international effluent quality standards. Its water value chain in Jamshedpur is illustrated in Figure 2.

Figure 2 Water Value Chain of Jamshedpur Utilities and Services Company Limited



WTP = water treatment plant.

Source: Adapted from JUSCO (2008a).

[43] JUSCO supplies water to 700,000 people, out of the lease area's population of about 860,000. The coverage is more than 80% of the population, and JUSCO hopes to increase this over the coming years.

Water Sources and Availability

Raw water is extracted from surface water sources, mainly from Subarnarekha and Kharkai rivers. While Subarnarekha is the prime source of water, Kharkai is a tributary of Subarnarekha and acts as a divider between JNA and ANA. The Subarnarekha River is a perennial water source, and it is jointly used by both JUSCO and the Public Health Engineering Department (PHED).

During times of low water levels in the Subarnarekha River, particularly during years of poor monsoon, JUSCO can utilize the water in its own standby reservoir at Dimna. This reservoir was constructed in 1944 at a distance of 8 km from the city. It has a capacity of about 34,000 ML (Ministry of Urban Development 2007).

Treatment Pumping Storage and Supply

Water is supplied from the rivers through two pumping stations: the New River Pump House and the Old River Pump House. The New River Pump House produces clarified water for industrial use. The Old River Pump House, established in 1934 and upgraded several times over the years, produces raw water for industrial use and for the town's waterworks, from where potable water is supplied to JUSCO's customers after being treated at a water treatment plant (WTP). The Old River Pump House has a raw water pumping capacity of 272 million liters per day (MLD), and the New River Pump House has a clarified water pumping capacity of 136 MLD (Agrawal 2006).

The WTP at the town's waterworks was first commissioned in 1921 with a capacity of 11 MLD and was upgraded subsequently. It currently has a potable water production capacity of 190 MLD, with potable water quality conforming to the Bureau of Indian Standards (BIS) and World Health Organization (WHO) norms. Seven water towers, with a combined capacity of 46 ML spread across the town, supply potable water to Jamshedpur (Agrawal 2006).

Wastewater Treatment

Wastewater is collected through a sewerage network of 512 km across the city.[44] Ten sewage pumping stations pump wastewater from the city to two sewage treatment plants located at Kharkai and Bara. These treatment plants, with a combined capacity of 61 MLD, treat the wastewater and exceed the environmental standards laid down by the Jharkhand State Pollution Control Board.

[44] Data from JUSCO.

Supply Management

Improvement in Coverage

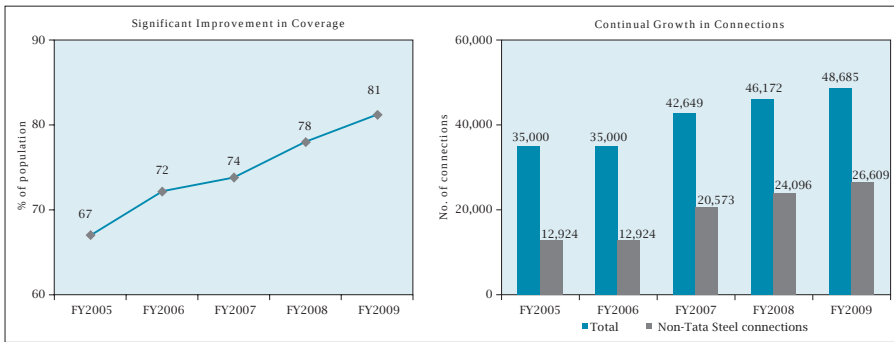
The first 5 years (2004–2009) following the creation of JUSCO have been nothing short of transformative. Access to water supply improved significantly from 67% of the population in the lease area in FY2005, to 81.2% in FY2009 (Figure 3).[45] Apart from continuing to service the connections for Tata Steel's employees, JUSCO steadily expanded coverage to non-Tata Steel employees or colonies. Today, it caters to more than 48,000 connections in its service area and is expanding to other areas.

JUSCO initiated a unique cost-sharing model to expand piped water coverage to non-Tata Steel customers and to address the needs of erstwhile unserved customers and low-income households (Box 2). This initiative provided close to 13,000 water connections in FY2005–FY2009, covering a population of 90,000 people across low-income households that were deprived of such service for more than 50 years (JUSCO 2009b). The success of this venture has encouraged JUSCO to replicate the people–private partnership model across the low-income households of the city.

Water Production

In FY2009, JUSCO's water production capacity was 730 MLD. Annual water production was 135,291 ML. This includes raw water, potable water, and clarified water, and translates to an average daily water production of 376 MLD. Raw water

Figure 3 Increase in Water Supply Coverage and Number of Connections



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

[45] According to JUSCO's definition of coverage, a person is considered "covered" by the water supply system if one is within easy access to water services (either with a direct service connection, or within 200 meters of a standpost, or is served by other sources of potable water, such as overhead storage or tanks, provided by the utility). This was adapted from CRISIL Infrastructure Advisory, et al. (2008), p. 51.

Box 2 People–Private Partnership to "Connect" Unserved Customers

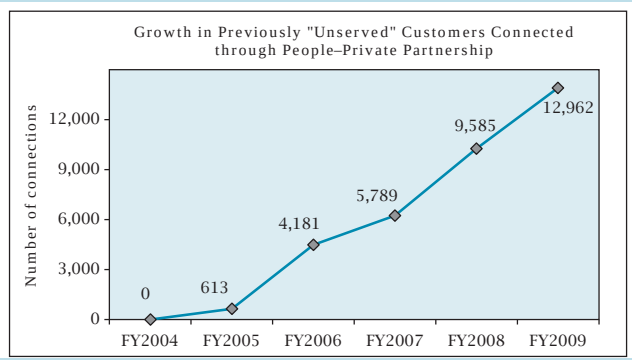
The Jamshedpur Utilities and Services Company Limited (JUSCO) initiated a unique cost-sharing model to expand piped water coverage to non-Tata Steel customers, including low-income households.

The back-end investment (covering the enhancement of treatment and pumping capacity and the conveying facility to the nearest water tower at the target site) was undertaken by JUSCO at its own cost. The investment in local networks is borne by the consumer based on actual cost. This cost is converted to a connection charge per consumer by dividing the total actual cost among the total number of consumers. Consumers thus pay for an initial water connection and subsequently based on metered water usage.

The partnership was built through several engagement processes between JUSCO and community stakeholders. Following citizen buy-in, a memorandum of understanding was signed with representatives of the areas.

This service has been introduced in unserved areas, mostly comprising the urban poor, who otherwise depend on groundwater. The initiative has therefore helped prevent overexploitation of groundwater. Furthermore, a metered tariff regime has enabled demand management. This is evident from a lower domestic consumption level of 170 liters per capita per day (lpcd), compared to 193 lpcd in JUSCO's service area in Jamshedpur in general.

Figure 4 People–Private Partnership



Key Features

Nonrevenue water reduction
- Reduced NRW by over 80%
- Close to 13,000 new connections added
- Annual groundwater accretion of 3.7 billion liters

Service levels
- 24/7 customer care solution
- Water service equipped with NABL (ISO 17025) accredited laboratory

Payment options
- Payment of connection fee in easy installments
- Tariffs to cover operation and maintenance costs

NABL = National Accreditation Board for Testing and Calibration Laboratories, NRW = nonrevenue water.

Sources: JUSCO (2008b); and data provided by JUSCO.

production from the Old River Pump House was 200 MLD, out of which 117 MLD was supplied to the WTP for further treatment to become potable water. Clarified water production from the New River Pump House was 118 MLD, and potable water production from the WTP at the town's waterworks facility was 175 MLD.

Water Quality

JUSCO takes pride in being among the few utilities in India to assure and meet a "drink directly from the tap" level of potable water quality in its network. It has managed to achieve continual improvement in water quality. More than 99% of potable water samples tested for bacteriological quality and free chlorine conformed to BIS norms (Figure 5).

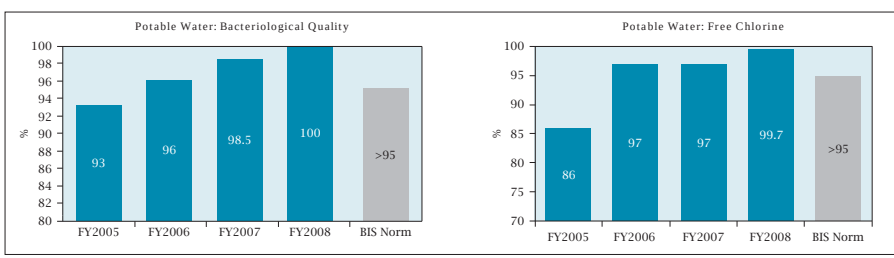
JUSCO initiated a number of systems and process-related initiatives that played an important role in improving its water quality and environmental management. It is the first private civic services provider in India to have its environmental management system certified to conform to the ISO 14001 standard. Moreover, its water laboratory in Jamshedpur is the first among India's water utilities to be certified by the National Accreditation Board for Testing and Calibration Laboratories (NABL).

JUSCO analyzes over 5,000 water samples from customer taps, storage tanks, treatment works, and water tankers annually to ensure that its water quality conforms to BIS and WHO guidelines. Water quality parameters are monitored regularly.

Toward a Continuous Water Supply

Average daily availability of water supply improved from 6 hours in FY2007 to 7.24 hours in FY2009. This was a result of the implementation of continuous water supply in phases. The goal has been to provide a higher level of supply in summer months. JUSCO supplies about 160 MLD of water, twice a day (4.5 hours) during the winter season (November–April), and about 182 MLD, three times a day (7.5 hours) during the summer season (April–October) (JUSCO 2009c).

Figure 5 Water Quality



BIS = Bureau of Indian Standards.

Source: JUSCO (2008b).

Following a pilot project on identifying district metering areas (DMAs) in 2006, the implementation of a 24-hour, 7-days-a-week water supply across the city is in progress. Several pilot areas in Jamshedpur, such as C-Town Area, Teachers Colony, Sonary, Sashtri Nagar, Anand Nagar, and Kailash Nagar have been covered to provide a continuous water supply. As of 2009, about 20 of the 74 DMAs identified, constituting nearly 25% of the population, were covered to provide a 24-hour, 7-days-a-week water supply.

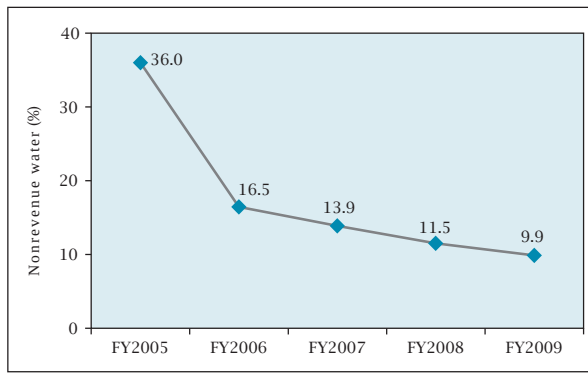
Nonrevenue Water

Another of JUSCO's significant achievements is its reduction of NRW from 36.0% to 9.9% during FY2005–FY2009 (Figure 6). JUSCO recognizes the need to constantly reduce NRW to cut wastage and increase revenue. It diligently manages its potable water distribution networks through flow management, leakage detection, and proactive network maintenance.

JUSCO's NRW reduction program includes installation of DMA meters and consumer meters, disconnecting illegal connections to convert them to authorized connections, and monitoring the number of leakages per month (Box 3). The city is divided into 74 DMAs for effective management through better problem identification, service delivery, and resource conservation. To monitor flows in the distribution network, 124 electromagnetic meters have been installed, which log data at 15-minute intervals in distribution mains and 10-minute intervals in rising mains (JUSCO 2009c).

NRW is calculated, monitored, and reported on a monthly basis. JUSCO monitors NRW in both rising mains and the distribution network. NRW of rising mains is calculated based on meter readings at WTP outlet, tower inlets, and various branch

Figure 6 Improvement in Nonrevenue Water



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Box 3 Nonrevenue Water Reduction Program of the Jamshedpur Utilities and Services Company Limited

Leakage reduction
- Rising main
  - Sectional unaccounted-for-water (UFW) analysis using insertion probes
- Distribution network
  - Creation of district metering areas (DMAs)
  - Consumer metering
  - Step test
  - Checking metering using ultrasonic flow meters

Eliminating illegal connections
- Regularization of connections through partnership models

Reducing unmetered connections
- Metering of all bulk/commercial consumers
- Installing meters at all existing authorized connections

Resolving incorrect measurements
- Verification by insertion probes
- Replacement with electromagnetic flow meters
- Verification by ultrasonic flow meters

Metering of public consumption
- Sample metering of standposts

Source: JUSCO (2008a).

meters originating from these rising mains. NRW of the distribution network for potable water is calculated based on meter readings at tower outlets, and the consumption registered by sample meters installed across all categories of consumer holdings and meters installed at commercial and institutional connections (Basu and Mahadev 2008).

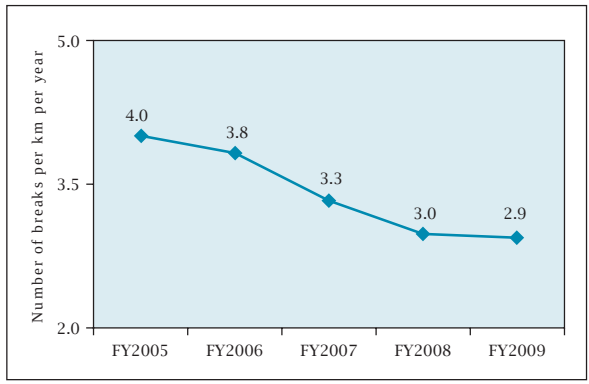
The NRW program aims to focus on addressing leakages and illegal connections, which are the two key areas of water losses.

(i) **Leakage identification.** The number of pipe breaks declined during FY2005–FY2009 (Figure 7). Typically, JUSCO resolves pipe breaks within 3 days.

Leak detection equipment helps detect the exact location of leakages and identifies underground leakages. Proactive leak detection is carried out regularly by way of "walk-through surveys" along the network, using leak detection equipment. The Minimum Night Flow as a technique has been introduced to identify physical water losses. If Minimum Night Flow in a DMA comprising close to 1,000–1,500 connections is in the range of 5–6 kiloliter per hour (kl/hr), then the chances of losses through leakages are close to zero. JUSCO has implemented this in all supply areas where regular monitoring takes place.

Supervisors and tower operators carry out frequent visits to DMAs and rising mains for leak detection. While leakages are monitored daily and reported

Figure 7 Decline in Pipe Breaks



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

weekly, reactive leak detection is carried out through complaints logged at the JUSCO *Sahyog Kendra*, JUSCO's 24-hour call center (JUSCO 2009c). These efforts have led to a decline in the number of leakages. Nevertheless, the number of leakages is still high as compared to cities with more developed water systems, such as Singapore, which registered 7.1 leaks per 100 km in 2008 (PUB Singapore 2009, 8–9).

(ii) **Illegal connections.** JUSCO also initiated a major disconnection drive to reduce illegal connections. Illegal connections are disconnected, and consumers are forced to pay a fine and get authorized connections. If the entire area is taking water illegally, then new networks are laid down to provide authorized consumption under the people–private partnership program (Basu and Mahadev 2008).

Metering

JUSCO has undertaken an initiative to meter water connections in Jamshedpur. The objective is to identify and reduce losses in terms of leakages and unauthorized tapping to improve efficiency in service delivery and to establish water balance. Metering is carried out in three phases (Basu and Mahadev 2008).

In the first phase, 46 electromagnetic meters were installed at bulk locations. These include the metering of raw water from river pump houses (RPHs), rising mains from the WTP to water towers, and pipe networks that receive water directly supplied from rising mains. These meters assess instantaneous flow, pressure, velocity, and totalized flow. The data is stored in a data logger, which is downloaded periodically.

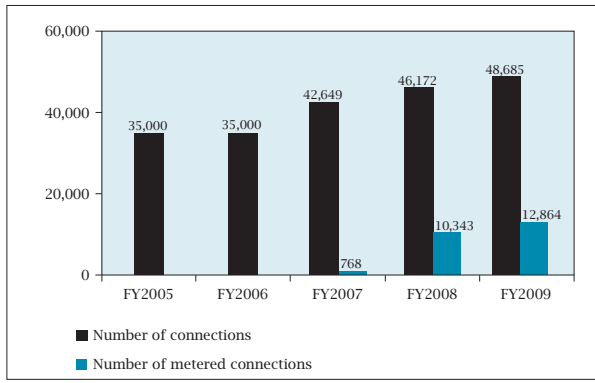
In the second phase, 78 electromagnetic flow meters were installed at the outlet of towers. Each outlet feeds into a district area, which is further maintained and assessed for NRW. About 40 bulk meters were installed at strategic locations to monitor flow and reduce losses in the system.

The third phase involves metering at the consumer's end. Although all industrial connections are already metered, JUSCO has introduced a new metering policy that aims to increase the metering of domestic connections. It has also planned to periodically retrieve a representative sample of meters in use and test them for malfunctioning. The test results will be processed to calculate the weighted average error and standard deviation, which will be used to optimize and modify a 10-year replacement policy.

While a large proportion of the connections provided by JUSCO are still unmetered, the proportion of metered connections has increased from negligible levels to 26.4% of the total number of water connections in FY2009 (Figure 8), corresponding to more than half of water consumption. Metered connections mainly comprise industrial and bulk domestic connections.

For Tata-owned residential buildings, where employees of Tata companies live, it is the prerogative of the respective company and not the utility to decide on the individual metering of its employees' connections and also the tariff to charge. As a utility, JUSCO supplies water in bulk to these companies and charges them with industrial tariffs, on a volumetric basis. The respective company subsequently distributes the water to its employees at its own cost (JUSCO n.d. [b]). For other

Figure 8 Gradual Rise in Metered Connections



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

water users, JUSCO offers different options for metering connections, to minimize consumer's financial burden (Box 4).

Demand Management

Water Consumption

As shown in Figure 9, annual water consumption in JUSCO's service area in Jamshedpur increased over the years and reached 322 MLD in FY2009, of which metered consumption was 230 MLD. Industrial and commercial usage accounted for more than half of the water consumption.[46]

The reported per capita domestic consumption of water in JUSCO's service area in FY2009 was 193 lpcd, which was among the highest in India. The decline was marginal from the 203 lpcd observed in FY2008. While the reasons for this dip have yet to be ascertained, this could be due to metering and demand management measures, including volumetric pricing implemented in phases.

Water Tariffs and Connection Fees

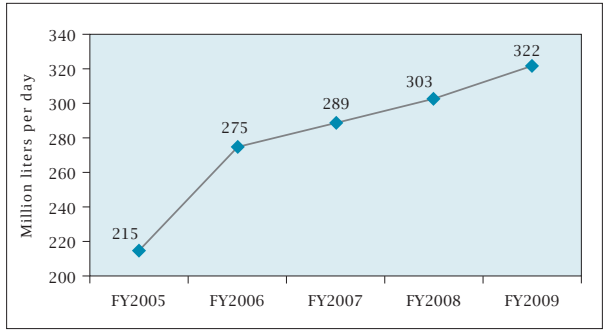
JUSCO is the first utility in the eastern part of India to progressively move toward metering and volume-based tariffs. It has undertaken metering of its connections in a phased manner and has implemented a telescopic volume-based tariff structure for its metered connections (Table 3). To overcome resistance to metered volume-based tariffs, JUSCO has priced lifeline supply in such a manner that households consuming lifeline levels actually get a monthly bill that is comparable or less than under the flat area-based tariff system used for unmetered connections.

For unmetered connections, JUSCO charges user fees based on the area of the property for which the connection is provided. The area-based flat tariffs are shown in Table 4.

For new water connection fees, JUSCO charges Rs1,000 (approximately $20) and a separate meter cost if a network already exists. If local network infrastructure does not exist in the community, JUSCO charges the infrastructure cost as a connection charge, which varies from Rs9,000 (approximately $180) to Rs14,750 (approximately $295) per connection, including meter cost. Although this connection fee is high, people are willing to pay it for consistent and reliable service, as reflected in the success of JUSCO's cost-sharing model explained in Box 2. To minimize the financial burden on consumers, JUSCO offers them the option of paying the connection charge in installments (i.e., a 50% up-front payment and the

[46] Total water consumption is an estimated total of metered and unmetered consumption.

Figure 9 Increases in Water Consumption[a]



[a] Total water consumption is an estimated total of metered and unmetered consumption.

Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Table 3 Volumetric Water Tariffs, FY2008

User Type	Consumption per Month	Rate (Rs/kl)
Domestic	Up to 30 kl	5.00
	31 kl–50 kl	6.00
	51 kl–70 kl	8.00
	Above 70 kl	10.00
Bulk domestic	Up to 30 kl × no. of units	5.00
	31 kl–50 kl × no. of units	6.00
	Above 50 kl × no. of units	10.00
Commercial	Up to 50 kl	8.00
	51 kl–100 kl	10.00
	Above 100 kl	12.00
Industrial	Up to 500 kl	12.50
	Above 500 kl	15.00

kl = kiloliter, Rs = Indian rupees.

Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

balance in three equal monthly installments). Furthermore, JUSCO provides some payment options for the cost of metering, based on the metering preference of the consumer (as explained in Box 4).

Box 4 Water Metering Policy of the Jamshedpur Utilities and Services Company Limited

A water metering policy that offers options for consumers to choose from to minimize their financial burden was implemented by the Jamshedpur Utilities and Services Company Limited (JUSCO). This new policy is applicable to all new and existing connections.

Options I and II were first offered to consumers. Based on the requirements of certain sectors of the society and requests of various nongovernment organizations, JUSCO introduced Option III. Consumers can choose the option best suited to them.

Options	Applicability	Meter Cost	Operation and Maintenance
Option I: Up-front payment option	Domestic consumers	Borne up front by consumer	• All future repairs or replacement costs will be borne by JUSCO • Consumer pays a meter service charge as follows: – For 15 mm size: Rs25 per month – For 20 mm size: Rs50 per month
	Bulk domestic / institutional/ commercial/ industrial consumers	Borne up front by consumer	Meter service charge is fixed as per agreement with the consumer
Option II: Installment option	Only domestic consumers	Consumer pays meter cost in installments	• All future repairs or replacement costs will be borne by JUSCO • Consumer pays a meter service charge as follows: – For 15 mm size: Rs25 per month – For 20 mm size: Rs50 per month
Option III: Meter rental option	Only domestic consumers	Borne by JUSCO	• Consumer pays meter rental and maintenance costs as follows: – For 15 mm size: Rs500 up front and Rs50 per month – For 20 mm size: Rs1,000 up front and Rs65 per month

Unauthorized additional water connection: Many of JUSCO's authorized consumers advertently or inadvertently possess additional water connection(s) that are not in JUSCO's records. This situation is usually exposed when JUSCO approaches them to provide a water meter, and hence, are penalized with a 36-month bill. JUSCO had offered a 15-day amnesty to such consumers to declare their unauthorized connections to JUSCO to avoid payment of the penalty. The scheme was open until 26 March 2008.

mm = millimeters.

Source: Adapted from JUSCO n.d. (b).

Table 4 Water Tariffs for Unmetered Connections, FY2008

Area (square feet)	Monthly Flat Rate			
	Domestic (Rs)		Nondomestic (Rs)	
	Single-Storey	Additional Floor	Single-Storey	Additional Floor
Up to 1,600	120	110	450	350
Up to 2,500	240	180	540	360
2,500 to 4,000	450	300	600	400
Above 4,000	540	360	600	400

Rs = Indian rupees.

Sources: ADB and Ministry of Urban Development, Government of India (2007), p. 54; and data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Water Conservation and Public Education

Rainwater harvesting

In Jamshedpur where groundwater resources are scarce and rainfall is uneven across the year, special attention is given to the establishment of rainwater harvesting systems. JUSCO has implemented various rainwater harvesting systems in several locations, including local schools, residential colonies, and housing complexes. Roof runoff is collected through downcomers and ground runoff through underground collection chambers. From the recovery chambers, water is pumped to head tanks on top of buildings that are isolated from potable water tanks. The collected rainwater is used to flush toilets, maintain garden lawns, and wash cars, thus saving a large amount of potable water (Sustainable Cities™ n. d.).

Public education

JUSCO has been involved in creating mass awareness programs on water and environmental issues as part of its commitment to social and environmental sustainability. Public exhibits, media campaigns, water theme marches on World Water Day, quiz and science shows on water in schools, and seminars and workshops on water conservation and rainwater harvesting, have been organized under the awareness programs (Sustainable Cities™ n. d.).

In association with the Society for Promotion of Professional Excellence, JUSCO launched the “Clean Up Jamshedpur” campaign. Some 20 schools of the city have pledged support to this program with the active involvement of students, faculty, and parents. The campaign’s objectives are to bring together corporations, citizens, and school children in a simple activity that will help in improving the local environment; act as a catalyst to bring about a permanent change in attitude and practices; share experiences on the “Clean Up Jamshedpur” campaign through group discussions, presentations, and site visits; and focus media attention on

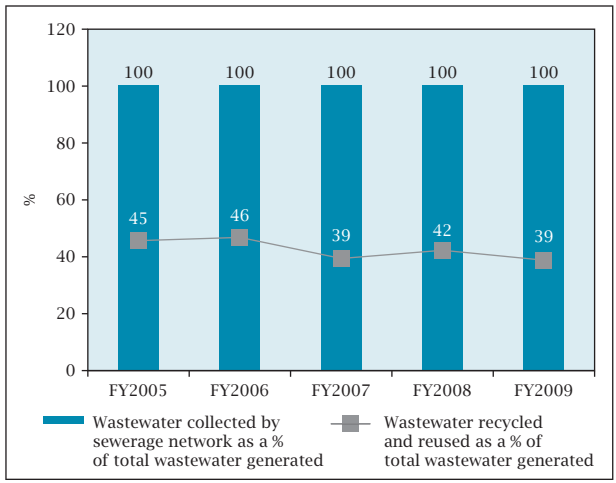
clean-up activities to raise awareness among the local government, industries, and communities on environmental issues (JUSCO 2008b).[47]

Wastewater Management

Under JUSCO, there is 100% sewage collection and treatment before disposal within the lease area (Figure 10). The treatment is based on Conventional Activated Sludge Process and Extended Aeration Process. The treated effluent exceeds the standards of Jharkhand State Pollution Control Board. As part of JUSCO's "river-to-river" philosophy, a portion of the treated wastewater is reused within the industrial units in Jamshedpur and the balance is released into the river downstream. A portion of the solid sludge is sold as fertilizers to serve the adjoining rural and agricultural areas.

In FY2009, 53 MLD of sewage was generated and collected by the sewerage network within the lease area, and then treated by JUSCO's two sewage treatment plants. Of the treated wastewater, 20.54 MLD was reused by Tata Steel for its industrial purposes.[48]

Figure 10 Sewage Generation and Treatment within Lease Area (%)



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

[47] Under the JUSCO Education Mission Foundation, JUSCO also initiated the "Ek Mouka" (which means "One Chance") program. The program aims to provide young adults from impoverished and economically challenged families in Jamshedpur the opportunity to acquire the requisite skills for employment. Courses are conducted specifically for them. The youths who were trained have been successfully employed in various organizations.

[48] Data from JUSCO.

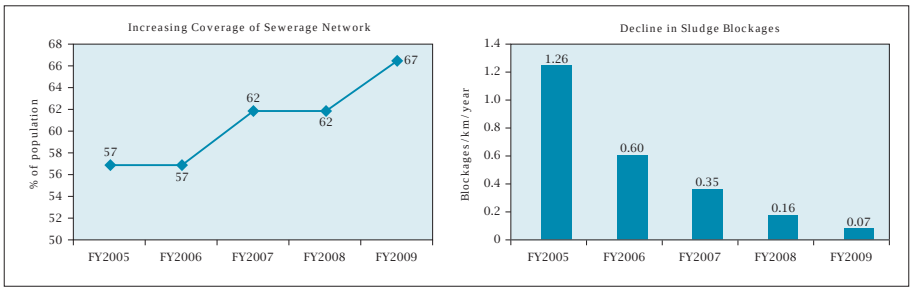
JUSCO's sewerage network covered 67% of the population of the Jamshedpur city (extended beyond the lease area to include the peripheral areas) in FY2009, up from 57% in FY2005 (Figure 11). This increase in coverage was a result of the increases in sewerage connections and the length of the sewerage network, which grew from 40,000 to 43,636 connections and from 500 km to 512 km, respectively, during FY2005–FY2009.

Customers pay a deposit to obtain a connection to the sewerage network. For a new sewerage connection within the lease area, a customer can request JUSCO to provide an estimate of the cost involved. This estimate varies and depends on local conditions and the proximity to the sewerage network. After the consumer pays the deposit, JUSCO provides the sewerage connection. No additional user charges are imposed for the provision of sewerage services. Instead, sewerage service costs are built into overall water costs and water usage charges are imposed accordingly.

The use of modern technology, such as cleaning machines, is necessary to maintain the network and keep street drains clean. This resulted in declines in the number of sludge blockages over time (Figure 11). Efforts were also made to promptly resolve customer complaints, which also led to the decline in the number of sludge blockages. In FY2009, 99.4% of sewerage-related complaints were addressed within the service level guarantee (SLG)—the maximum time complaints are expected to be resolved—that JUSCO had set.

JUSCO is exploring new frameworks to further extend coverage of sewerage services beyond the lease area. Lack of access to sewerage services is a cause for concern, in view of issues relating to health, hygiene, and river pollution. However, JUSCO faces challenges in this respect, given the capital-intensive nature of extending sewerage access and the limitation of using the cost-sharing model that it has successfully adopted for extending water supply services.

Figure 11 Sewerage Network Coverage and Decline in Sludge Blockages



km= kilometer.

Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Storm Water Management

JUSCO recognizes that it is important to ensure that storm drains, culverts, manholes, temporary drains, and sewer lines are clean and well maintained. It proactively addresses flooding and overflows. When necessary, channels are also cut and connected to outlets to clear stagnant water that may become mosquito-breeding sites (JUSCO n.d. [c]).

The major rivers flowing through Jamshedpur are the Subarnarekha and Kharkai rivers. Storm water is discharged into these rivers through 14 major *nallahs* (which means "open drains") that facilitate the drainage of storm water from the area. However, due to significant silting and obstructions in these *nallahs* and other secondary drains, the natural flow is hampered, leading to backflow of water from the river system and flooding during the monsoon season.

The drainage system spans approximately 356 km in length and is generally of the open-drain type, but closed conduits are also used at some places. The different types of drains used include open masonry or boulder surface drains, alley and front side drains, brick conduit drains, Reinforced Cement Concrete (RCC) conduit drains, RCC Box conduit drains, open *kutcha nallahs*, and culverts. The main storm water drainage and flood management arrangements include the following:

(i) In the JUSCO township, it is mandatory to provide rainwater harvesting arrangements along with building plans for newly established multistoried buildings. However, for the approval of building plans, compliance with drainage requirements is not mandatory. This should be made compulsory for effective storm water management.

(ii) Of the sluice gates, 14 have been provided at the Kharkai and Subarnarekha river banks to prevent flooding in the township. When the river water level rises during heavy rains, sluice gates are closed to prevent river water from entering the city.

(iii) Jamshedpur intends to develop a master plan for the drainage system that is within JUSCO's jurisdiction, with JUSCO enlisting the services of a consultant to develop a master plan that spans 25 years (2009–2034) (Box 5).

Efficiency Gains from Technology and Management Practices

Adoption of Technology

Figure 12 shows the significant improvements in JUSCO's operational efficiencies—in terms of declines in water system failures and energy consumption in its water system—following its adoption of modern management and technological practices.

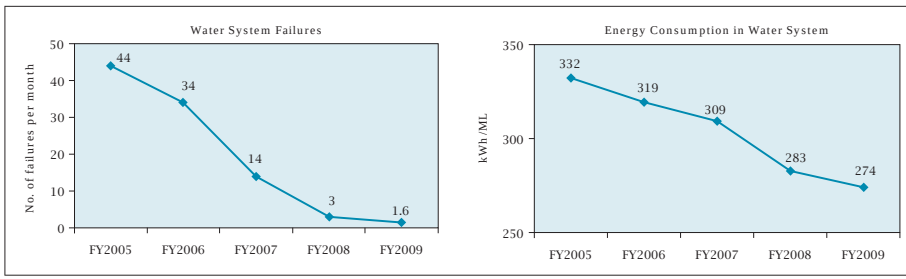
Box 5 Master Plan for Storm Water Drainage, 2009–2034

Components of the Proposed Master Plan for Storm Water Drainage and Flood Management

- Study of topographical features and drainage pattern of the entire city and review of previous drainage plans or designs carried out for the city to ascertain if any of the proposals could be included in the master plan.
- Identification or demarcation of drainage zones depending on the topographical features, man-made boundaries (such as railways and roads), and natural boundaries like water bodies.
- Study of land use pattern of the project area to determine the runoff coefficient.
- Study of rainfall data and runoff data for at least the last 15 years over the project area.
- Hydrological analysis and development of Depth-Duration-Frequency Curve for the project area.
- Estimation of quantity of runoff in the different drainage zones and in specific drains.
- Finalization of the design parameters and design basis.
- Study of the existing storm water drainage system to assess the carrying capacity and the structural stability (based on reconnaissance survey), and review of the usage of the system for any other purposes.
- Study of areas prone to frequent flooding and remedial measures to prevent flooding.
- Identification of a natural water body for final disposal of storm water; rehabilitation or preservation of existing natural water bodies.
- Hydraulic design of proposed major and minor storm water drains with the parameters as identified, such as drainage zones, runoff coefficient, quantity of runoff, and the location of the receiving body.
- Identification of rehabilitation measures for remodeling of existing drains.
- Preliminary designs of storm water drain sections and all related structures.

Source: Jamshedpur Utilities and Services Company Limited.

Figure 12 Declines in Water System Failures and Energy Consumption



kWh = kilowatt-hour, ML = million liters.

Sources: JUSCO (2008b); and data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Some of the technologies that JUSCO has adopted in its operations are the following (JUSCO 2009c):

(i) **Supervisory Control and Data Acquisition system for water treatment plants.** JUSCO has implemented the Supervisory Control and Data Acquisition (SCADA) system. Online instruments for turbidity, free chlorine, inflow, and outflow enable plant operators to take quick decisions during plant operations. Information from the Management Information System (MIS) and backwash trends also allow the plant manager to take decisions to reduce chemical and power costs.

(ii) **Energy audit and conservation measures.** An energy audit was conducted at all of JUSCO's pumping stations in 2006. JUSCO implemented a number of energy conservation measures including impeller trimming, replacement of motors with high-tension (HT) energy-efficient Class-1 motors, and use of variable frequency drive for motors catering to variable demand zones. Other technologies such as online voltage or power factor monitoring are used to monitor electrical characteristics at different facilities.

(iii) **Metering and flow monitoring.** Electromagnetic meters have been installed at 22 bulk metering points (comprising outlets of the WTP and RPHs); inlets and outlets of elevated service reservoirs and rising mains; strategic locations and sub-DMAs; and for all commercial, institutional, and industrial consumers. Insertion probes and ultrasonic flow meters for temporary flow monitoring and pressure loggers for pressure monitoring are in use. Automated meter reading and billing was implemented in 2009. The web-enabled global system for mobile communication (GSM) technology is being implemented for meter reading.

(iv) **Trenchless technologies.** A labyrinth of underground water, sewer, gas, electric, and telecommunication lines exists underneath city streets. JUSCO uses instruments that make use of trenchless technologies to detect underground pipelines and cables, to locate these underground networks, and to detect leaks in the pipelines.

(v) **Ground penetrating radar.** Ground-penetrating radar profiles are used for evaluating the location and depth of buried objects and to investigate the presence and continuity of natural subsurface conditions and features.

(vi) **Electronic pipe locator and leak detection instruments.** Electromagnetic and radio frequency line locators operate either in "passive" mode by locating a background signal or in "active" mode by locating a signal introduced into the utility line using a transmitter. These are used to locate underground pipes along with ground microphones, which are used to detect leaks.

(vii) **Geographic Information System.** JUSCO has developed GIS maps for the entire water network of the city, with datasets covering pipe networks, valves,

tank locations, and customer information. These help to improve operation and maintenance of the network.

(viii) **Hydraulic modeling.** Hydraulic modeling is a mathematical tool to predict flow and pressure in water distribution networks. JUSCO uses hydraulic modeling softwares, such as Water GEMS and EPANET, for designing, operating, and maintaining its network.

Benchmarking: Balanced Scorecard

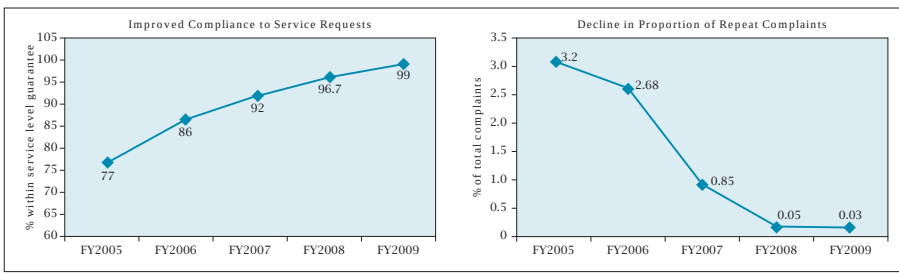
JUSCO undertakes monthly benchmarking of its operational performance. This is done through a Balanced Scorecard framework that helps JUSCO monitor its performance in five key aspects: financial, service delivery, internal business processes, learning and growth of employees, and community concerns. Each aspect is defined through an objective that is to be achieved on a yearly basis as part of a business operating procedure, with specific indicators or strategic measures to be monitored. Each indicator is monitored against the previous year's data and also against yearly target levels that are set by JUSCO based on the best-in-class standard (Agrawal 2006).

Customer Satisfaction

To ensure that it serves customers well, JUSCO measures and improves customer satisfaction primarily through three initiatives: tracking through a customer satisfaction index computed from customer survey responses, providing SLGs and monitoring compliance, and tracking and resolving customer complaints through the JUSCO *Sahyog Kendra*.

Collectively, these initiatives have enabled JUSCO to closely monitor complaints and identify operational inefficiencies in its service departments, and have led to continual improvement in compliance with SLGs and declines in repeat complaints (Figure 13).

Figure 13 Compliance with Service Level Guarantees and Repeat Complaints



Sources: JUSCO (2008b); and data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Customer Satisfaction Surveys

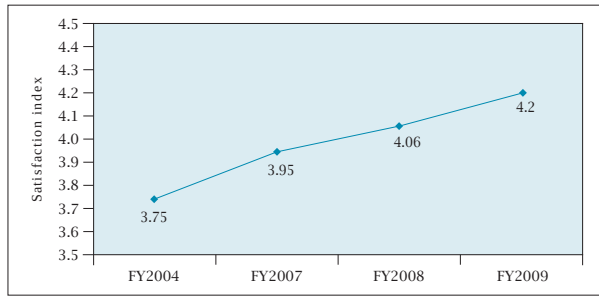
JUSCO engages an international market research company, ACNielsen ORG-Marg, to conduct an annual survey in Jamshedpur to capture the satisfaction level of citizens with regard to services provided by JUSCO. Customers' responses in the survey are used to compute a customer satisfaction index, and the results are benchmarked against other well-managed utilities on civic and municipal services. The customer satisfaction index for Jamshedpur has improved consistently since FY2004 (Figure 14).

The survey responses are also used to analyze the customer satisfaction score separately for different services provided by JUSCO, such as piped water supply, wastewater, power supply, street lighting, road maintenance, and green zones. JUSCO's piped water and wastewater services have been rated well (Figure 15).

Service Level Guarantees

JUSCO has well-defined service delivery standards with parameters presented in Table 5. JUSCO's customer management and complaint redress system lays out explicit service delivery standards that are time-bound, relevant, accurate, measurable, and specific. JUSCO reports compliance with the SLGs against service delivery standards. A survey is conducted to find the service level expectation (SLE) against each of the services. Based on the findings and capability of the service delivery mechanism, SLGs are decided. Every year, the SLGs are revisited and changes based on compliance percentage are incorporated into the system (JUSCO 2009a). As observed in Table 6, SLGs for a number of services were improved between 2007 and 2008, depending on a combination of customers' expectations as reflected in their feedback and JUSCO's improved capability to meet those expectations.

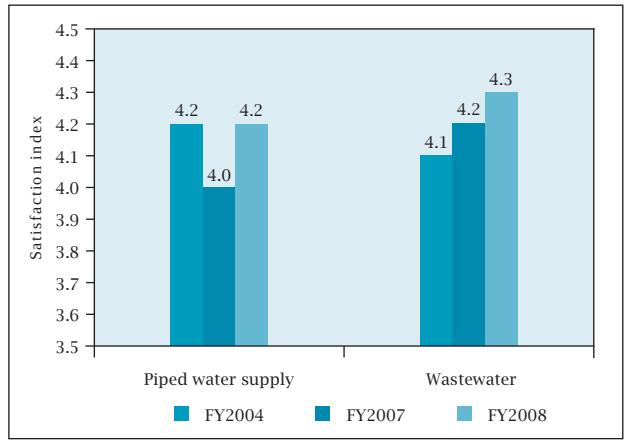
Figure 14 Consistent Improvements in Customer Satisfaction Index[a]



[a] Measured on a 5-point scale.

Sources: JUSCO (2008b); and data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Figure 15 Customer Satisfaction Indices[a] for Piped Water and Wastewater Services



[a] Measured on a 5-point scale.

Source: JUSCO (2008b).

Table 5 Standards for Service Delivery

Indicator	Definition
Service level guarantee (SLG)	Expected compliance time by a service department
Service level performance (SLP)	Actual performance against SLG. SLP = Number of complaints within SLG/Total number of complaints with defined SLG
Service level expectation (SLE)	Average time a customer can tolerate before his complaint is addressed
Actual turnaround time (ATAT)	Time taken by JUSCO to resolve a complaint
Capability gap (CG)	Inability of JUSCO to promise a service level that matches customer expectation CG = SLG-SLE
Service gap (SG)	Gap between ATAT and SLG; also called compliance beyond time SG = ATAT-SLG
Quality gap (QG)	Sum of capability gap and service gap QG = ATAT-SLE

JUSCO = Jamshedpur Utilities and Services Company Limited.

Source: Adapted from Agrawal (2006).

Table 6 Annual Amendments to Service Level Guarantee Based on Customer Feedback

Job Description	SLG 2007 (days)	SLG 2008 (days)
Overflow from overhead tank	3	1
Drinking water scarcity	3	2
Inlet pipe leakage coming from outside the house	3	3
Pipe leakage or pipe burst outside the house	3	3
Sullage water, wastewater back side drain	15	10
Cleaning of overhead tank	3	1
Storm water, rainwater, front side drain repair	15	10

SLG = service level guarantee.
Source: JUSCO (2009a).

JUSCO *Sahyog Kendra*

The JUSCO *Sahyog Kendra* (JSK) (which means "JUSCO Assistance Center") was established to provide customers with a single point of complaint lodging and follow-up. Customers only need to call a single phone number for all complaints. JSK provides real-time data for decision making, analytical support for solving issues, and a transparent and easy interface with customers to improve customer experience (Box 6).

This center helps create a centralized database that stores information about service levels, such that any service lapse can be isolated and then improved upon. It enables effective follow-up of customer complaints, along with constant tracking of feedback so that continuous improvements can shorten the time it takes to redress complaints.

Box 6 Jamshedpur Utilities and Services Company Limited *Sahyog Kendra*

Features of the center:

- Single point of contact. Single phone number for all complaints.
- Creation of zones. Operating area is divided into seven zones and 22 job card printing stations, backed by a Geographic Information System (GIS) map.
- Standards for service delivery. Time-bound, relevant, accurate, measurable, and specific standards are laid down.
- Complaint registration process. Computerized process where all service nodes are connected to a centralized server to improve tracking of complaints.
- Job prioritization. Automatic escalation of priority, in case complaint is pending beyond service level guarantee (SLG).

Source: Adapted from JUSCO (2009a).

A typical service delivery process at JSK is as follows and is illustrated in Figure 16:

(i) The customer calls a centralized phone number and is required to provide his or her customer identification number, phone number, and location.

(ii) The location is mapped through GIS to the appropriate consumer complaint zone. The customer lodges complaint by giving details of the problem, along with the code of the complaint as stated in the JSK code book.

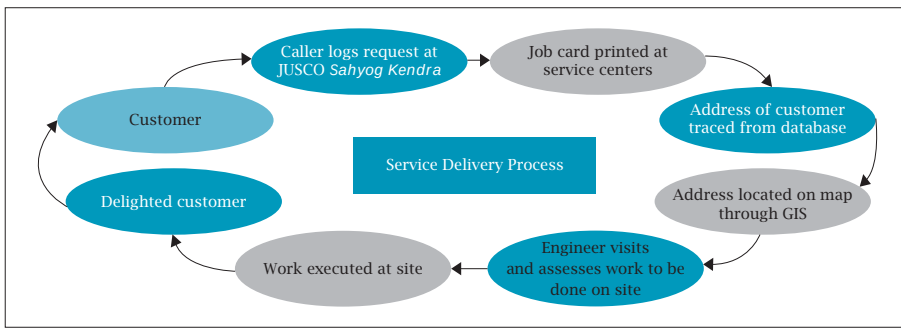
(iii) The customer is given a complaint reference number to check on the status of his or her complaint. An SLG, which is the maximum time expected for the complaint to be redressed, is also issued to him or her.

(iv) JSK registers the complaint in its central database and sends it to the department concerned for consideration. At the same time, a job card is printed at the relevant zone and sent to the employee to whom the job is allocated.

(v) After the complaint is addressed, the customer must fill in the job card to specify whether or not he or she is satisfied with the remedy. The job card is signed by the employee, who must then submit it to the department responsible for review.

Service standards are constantly tracked. To ensure that complaints are addressed within SLG, a system of job prioritization has been introduced. JSK maintains a follow-up list for coordinating and ensuring timely redress of complaints. In the event of complaints pending beyond SLG, automatic escalation takes place. Wherever services are outsourced, complaint data is aggregated by vendors and jointly analyzed with the relevant service department. Actionable points emerging from such analysis are reviewed regularly for effectiveness (JUSCO 2009a).

Figure 16 Service Delivery Process at JUSCO *Sahyog Kendra*



GIS = Geographic Information System, JUSCO = Jamshedpur Utilities and Services Company Limited.
Source: Adapted from JUSCO (2008b).

Financial Resource Management

Revenue and Operating Ratio

JUSCO's operational improvements have contributed to improvement in its financial performance. Revenue from water-related services grew at a compounded annual growth rate (CAGR) of 30% during FY2005–FY2009, and its operating ratio improved from 1.07 to 0.82 during the period (Figure 17).[49]

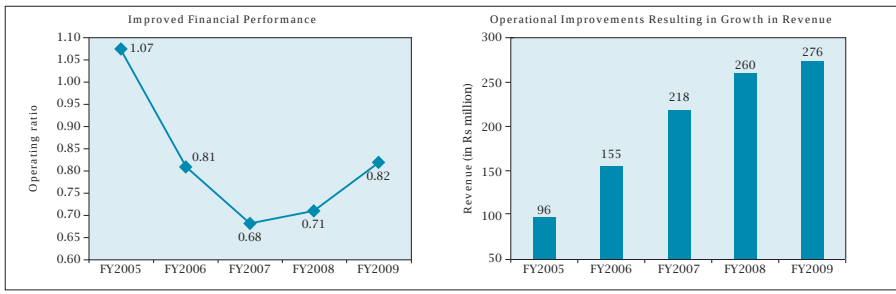
Revenue Collection Efficiency and Accounts Receivable

As JUSCO's revenue grew, its revenue collection efficiency also improved. The latter ranged from 95%–99% over FY2005–FY2009 and reached 99.2% in FY2009 (Figure 18). This was particularly remarkable given that JUSCO added a sizeable number of non-Tata Steel customers to its network during this period. But accounts receivable increased from 2.57 months in FY2005 to 3.40 months in FY2009, reflecting a higher cost of extending credit to customers. However, an accounts receivable of 2–3 months is considered reasonable, given that the average for 20 selected Indian water utilities analyzed in an Asian Development Bank's (ADB) study was 4.9 months, with 60% of those utilities having an accounts receivable of more than 3 months (ADB and Ministry of Urban Development, Government of India 2007, 3).

Cost Recovery

In Figure 19, JUSCO's revenue realization and cost incurred on a per kiloliter (kl) basis are compared. Revenue per kl increased steadily during FY2005–FY2009, due to a combination of increased supply coverage, metering of connections, and tariff rationalization. Unit cost of production fell initially until FY2007, due

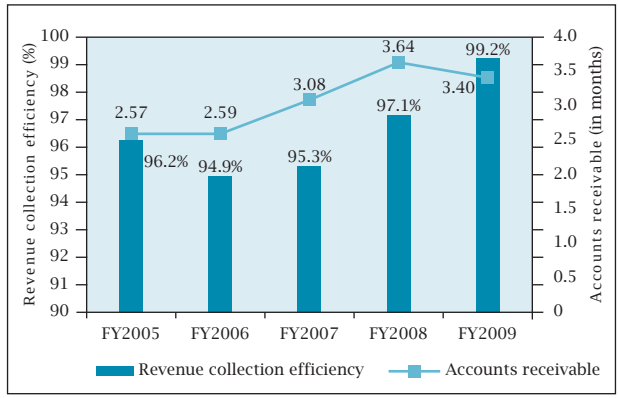
Figure 17 Annual Revenue and Operating Ratio



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

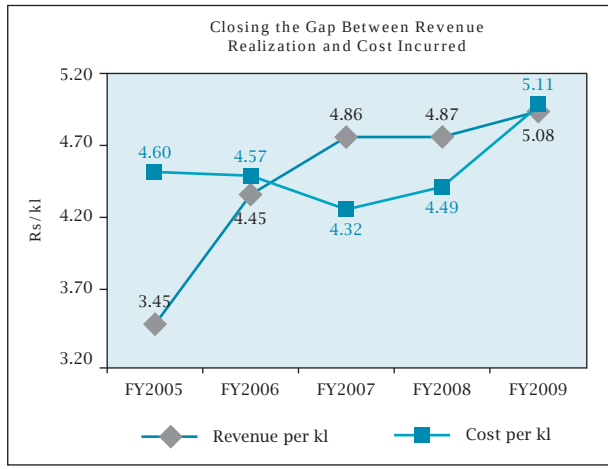
[49] Operating ratio has been defined as the ratio of annual operation and maintenance costs to annual revenue. JUSCO does not have a component of non-operating revenue. Hence, its total revenue equals operating revenue.

Figure 18 Revenue Collection Efficiency and Accounts Receivable



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

Figure 19 Cost Recovery: Revenue per kl vs. Cost per kl[a]



kl = kiloliter.

[a] Cost per kl was calculated by dividing the total expenditure incurred in producing water by the total amount of water produced. This expenditure is the cumulative cost incurred by both Tata Steel and JUSCO to produce water. Revenue per kl was calculated by dividing the revenue from water sales by the total amount of water supplied for sale. The revenue from water sales is the income earned by Tata Steel on the sale of water to both industrial and domestic consumers. Total water consumption includes both captive consumption by Tata Steel workers and water supplied for sale to other industries or individual customers.

Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

to economies of scale with respect to costs as the overall coverage increased. However, since FY2008, unit costs have risen. Moving forward, JUSCO will have to work out strategies for periodic tariff increases to ensure that it continues to be in a position to invest in its network and maintain its service levels.

Human Resource Management

Staff Productivity

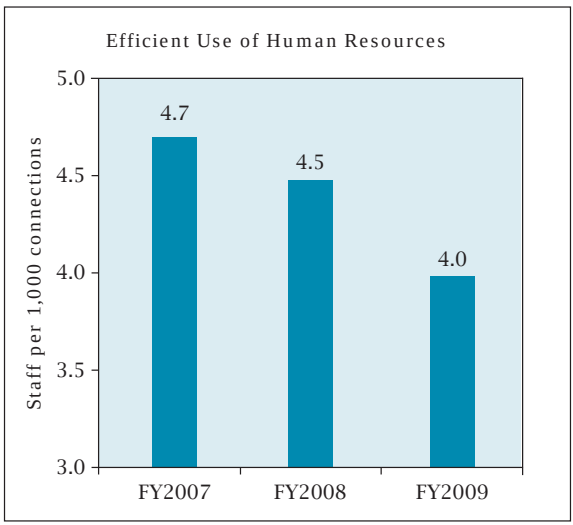
Staff productivity increased during FY2007–FY2009. The number of staff per 1,000 connections fell to 4.0 in FY2009 (Figure 20).[50] Fewer staff members were employed despite an increase in the number of water connections, reflecting higher efficiency in the use of human capital and the effect of rationalizing manpower.

JUSCO realizes that to meet its vision of becoming a preferred provider of civic and allied services, it is essential to have a committed and engaged workforce. It therefore adopts progressive human resource practices to attract and engage employees. This includes remunerating employees well and placing high emphasis on training and human resource development.

Management Salaries

The combined annual managerial remuneration for JUSCO's managing director and other non-executive directors in FY2008 was Rs5,202,537 and represented an increase of 17% over the previous year (JUSCO 2008b, 26). As JUSCO is a

Figure 20 Staff Productivity, FY2007–FY2009



Source: Based on data provided by the Jamshedpur Utilities and Services Company Limited (JUSCO).

[50] Staff members consist of those engaged in waterworks, water distribution, river pump houses, and water laboratory in JUSCO.

private utility, it is not governed by the government's pay scales, which are lower than the compensation of JUSCO's managerial staff. Corporatization at JUSCO has not only led to higher operational efficiency but has also enabled it to use compensation as a tool for attracting, motivating, and retaining talent.

While several government-owned utilities may not be able to match such salary increases in absolute terms, they could learn from JUSCO's experience and should progressively move closer to market in terms of salary. They should also find ways to link compensation increases more closely to performance (rather than seniority alone) to effect improvements in employee motivation and productivity.

Training and Human Resource Development

Workforce development

To achieve sustainable growth, the competencies of the employees of an organization need to be constantly upgraded. JUSCO believes that the best person to assess training requirement is the employee himself or herself. Hence, the training desired is captured as part of one's competency assessment process, which is a component of JUSCO's performance management system. Competency requirement of the position is done based on the needs arising from targets, improvement requirements, and technological changes. An individual's competency is assessed for present and future positions. Training needs are identified based on the gap between competency needs of the position and the competency of the employee, as well as the employee's aspirations.

Leadership development

JUSCO adopts a leadership development process that comprises tools for identifying, assessing, and developing leadership talent. It is based on strategic challenges, strategic objectives, long-term and short-term plans, human resource action plans, and personal aspirations. Senior officers are provided exposure through external training programs, management development programs, seminars, workshops, conferences, and industry visits where they acquire knowledge and share these with employees at different levels. These help in importing best practices and understanding competitive practices. Internal job rotations, including postings to other locations, provide officers with challenging assignments, which help in developing their competencies and careers. JUSCO deploys its experienced officers in technical areas, such as quality control, total productive maintenance (TPM), and Six Sigma, to impart specialized knowledge and skills to other employees.

Career progression

At JUSCO, the performance management system forms the basis for career progression of officers. Its promotion policy links eligibility to performance ratings in the current and previous years. Eligible officers are interviewed by a committee

comprising senior leaders, and recommended candidates are promoted. Job rotations also provide horizontal career progression. Succession planning is done for key executive positions based on ratings of officers on performance and potential. Supervisory positions are filled by a selection process where eligible candidates fulfilling prescribed minimum qualification and experience requirements are interviewed and seniority of employees is given due weight. Enhanced competency requirements of individuals are fulfilled by training them on functional and behavioral aspects, for instance through diploma courses at external institutes. Worker positions of higher grades are filled by seniority-based promotions of employees who have passed prescribed trade tests or interviews. Workers are also provided special skill training and off-duty modular training programs to acquire higher competencies.

Decoding the Transformation: Key Drivers and Lessons

JUSCO stands out vis-à-vis other water utilities in India, where access to piped water supply and wastewater management continues to be a challenge for urban utilities. A significant part of JUSCO's transformation, particularly on NRW reduction, customer service focus, and adoption of technology, was achieved within a short period of time. In this aspect, JUSCO holds lessons for other utilities attempting to leapfrog from mediocre-to-moderate levels of performance to better service delivery standards.

Table 7 provides a summary of some key challenges that Indian water utilities face and JUSCO's approach in dealing with them.

Several enabling factors appear to have contributed significantly to this transition, and more importantly, these factors can be used as points for improvement in other utilities.

Independence and autonomy

An autonomous governance structure became a critical trigger for scaling up company vision and service delivery. Although the erstwhile Town Division of Tata Steel ran a fairly reliable operation for almost 100 years, it appeared to be limited by a "peripheral department" mindset and a "cost center" orientation. Corporatization energized service delivery and catalyzed improvement orientation.

Articulating a larger vision

The autonomy of the new corporatized entity was backed by the articulation of a larger mission of providing "Quality Services for Life." The intent of corporatization was to unlock value by making the entity amenable to tapping opportunities beyond Jamshedpur. To succeed elsewhere, JUSCO had to first improve standards within. There was, thus, an incentive to tackle local challenges and meet international

Table 7 Challenges Faced by Indian Water Utilities and JUSCO's Approach

Challenges Faced by Indian Utilities	JUSCO's Approach
Low cost recovery due to populist pressures and the need to service the urban poor	Even as JUSCO moves progressively toward volumetric tariffs that are based on metering, it already has in place differential tariffs, based on the area of the property of the household served by the connection, to reflect the economic status of the connection's owner. This ensures cost recovery, and lower tariffs for the urban poor through a cross subsidy from other higher-paying residential and commercial connections.
Intermittent supply	Following a pilot project to identify district metering areas (DMAs) in 2006, the implementation of a 24-hour, 7-days-a-week water supply across the city was initiated. As of 2009, 20 of the 74 DMAs identified, constituting nearly 25% of the population, were covered to provide a continuous water supply. The average availability improved from 6 hours in FY2007 to 7.24 hours in FY2009.
High level of water losses that are often above 30%	A focused nonrevenue water (NRW) reduction program led to the division of the city network into 74 DMAs. Efforts to address leakages and illegal connections led to a decline in NRW from 36.0% in FY2005 to 9.9% in FY2009.
Weak focus on customer satisfaction	JUSCO established the JUSCO *Sahyog Kendra* to provide customers with a single point to lodge complaints. It also introduced a feature of setting and meeting service level guarantees (SLGs) for domestic consumers. SLG compliance increased from 77% to 99% of customer requests during FY2005–FY2009.

JUSCO = Jamshedpur Utilities and Services Company Limited.

Source: Authors.

service delivery standards within Jamshedpur, as the company set out to expand its services and presence outside the city.

Meticulous benchmarking and information-based improvement

A relentless focus and shift toward capturing and analyzing information across a range of performance yardsticks and parameters paid dividends. The use of a Balanced Scorecard and defining holistic measures of performance contributed greatly to positive results.

Sharp focus on the consumer

JUSCO moved quickly to having a sharp focus on customer satisfaction. "Listening to the customer" through the JUSCO *Sahyog Kendra* enabled the capture of real-time data for decision making. It also provided analytical support for solving issues

through a bottom–up approach. A commitment to set and meet SLGs for domestic consumers was a commendable feature. Accordingly, SLG compliance increased to 99% of customer requests, while repeat complaints dropped to negligible levels.

Recognition of the need to "close the loop"

JUSCO adopts "river-to-river" management that closes the water loop. Jamshedpur is among the few cities in India to have a fairly comprehensive sewerage network in the area that JUSCO manages, with about 20 MLD of treated wastewater being recycled for industrial reuse. Furthermore, its storm water drainage network facilitates water harvesting, groundwater recharging, and draining of excess water into the river stream.

Technology and management practices

A cornerstone of JUSCO's efforts is the adoption of technology and management practices, leading to operational improvements and cost savings. The use of SCADA with online monitoring and control for its treatment plants, comprehensive bulk and DMA level metering, phased consumer level metering, along with GSM-based 24-hour, 7-days-a-week automated meter reading and billing system, made the water network operations efficient. Besides, the use of trenchless technologies and leak detection equipment, GIS, and hydraulic modeling have contributed significantly in JUSCO's efforts to build a reliable water network and to progressively move toward higher service delivery benchmarks.

JUSCO also saw value in energy conservation measures from the beginning. Its innovative adaptation of TPM, considered to be a manufacturing practice, in a utility context contributed to significant efficiency gains. The use of TPM helped reduce energy consumption in its raw water system—from 332 kWh/ML in FY2005 to 274 kWh/ML in FY2009.

Tackling nonrevenue water

JUSCO has tackled NRW head-on, with measures such as establishing DMAs and using leak detection equipment to conduct "walk-through surveys" along its pipe network to detect leakages. These were complemented by efforts to disconnect illegal connections and give such consumers authorized connections. As a result, NRW declined significantly.

Demand management and volumetric tariffs

A volumetric tariff regime (including a lifeline tariff rate of Rs5 per kl for the first 30 kl per month) has been implemented to encourage water conservation. Wherever customer level metering is not in place, JUSCO uses an area-based differential flat tariff structure for water supply. Domestic consumer level metering is being implemented in phases. JUSCO is continuously working to overcome political resistance on this initiative.

Unique people–private partnership to expand water access sustainably

JUSCO conceptualized a unique cost-sharing model to service previously unserved low-income households. This approach added about 13,000 water connections covering 90,000 people across low-income households. With metering, these connections have tended to have a lower per capita consumption compared to connections in other parts of Jamshedpur. The model dispels the myth that the poor cannot afford services and shows that people are willing to pay for assured and reliable services.

Partnerships and collaborations

JUSCO's openness to engage in partnering opportunities and adopt modern technology and "best" management practices has contributed significantly to its success. Tata Steel's partnership with Veolia Water in 2003 for the latter to provide management and technical consultancy helped JUSCO in several areas including metering; analysis of water networks; upgrading of laboratories; customer management systems; implementation of GIS; and staff training on jar tests, leakage detection, hygiene, and safety. JUSCO also partnered with Ranhill Malaysia to win a 25-year concession contract for providing the water supply in Haldia City. As part of an ADB's twinning program, JUSCO has an arrangement with the National Water Supply and Drainage Board, Sri Lanka, where it is helping the latter with leakage reduction and water loss management.

The Tata factor

The Tata Group is a respected and trusted brand in India. The Tatas, through Tata Steel, were the first employers in India to introduce the 8-hour working day (1912), free medical aid (1915), a workers' provident fund scheme (1920), and many other welfare schemes even before they were legislated, some even before they were introduced in western countries (Tata Steel 2007). Tata Steel went on to serve as a model for other industrial townships such as Bhilai and Duragpur. Even as people–private partnerships in water supply continue to draw emotive responses, JUSCO has been able to achieve initial successes in generating trust among non-Tata Steel customers, particularly low-income and unserved customers, to seek and take water connections on a commercial basis including paying a connection fee. The Tata Group and Tata Steel's reputation for being a compassionate private organization seems to have contributed in no small way to JUSCO's initial successes.

Challenges and the Way Forward

Jamshedpur presents an inspiring example of an integrated urban water management that has eluded a number of Indian and Asian cities. There is scope for other

utilities across India and other developing countries to adopt and adapt several of the actions taken by JUSCO.

While it has some way to go to fully attain global standards (given that only about 25% of its customers received continuous water supply in 2009), JUSCO's first 5 years have been transformational. As JUSCO continues to build on its successes, its future will be shaped by its continued efforts to build internal capabilities to raise the bar and meet higher expectations. This will involve managing a twin set of challenges arising from the need to address (i) opportunities for JUSCO beyond Jamshedpur, and (ii) needs of Jamshedpur beyond JUSCO.

Opportunities for JUSCO beyond Jamshedpur

JUSCO has been actively pursuing opportunities for providing urban services in water supply, wastewater, and solid waste management outside Jamshedpur. During 2005–2009, JUSCO secured two public–private partnership (PPP) concession contracts for implementing water supply projects in Salt Lake City of Kolkata and in Haldia, a management contract in Mysore, and water supply construction projects in Bhopal and Indore. This appears to be a logical path for JUSCO, to move toward a wider scale of operations and greater sustainability. While this diversification places greater challenges on organizational scalability, including the need to add capacity in project development, financing, marketing, and commercial efforts, it would enable JUSCO to grow and also attract talent.

Needs of Jamshedpur beyond JUSCO

While it seems likely that service levels in Jamshedpur Notified Area (JNA) will continue to improve, service delivery in the rest of Jamshedpur Urban Agglomeration (JUA) remains a challenge, given the multiplicity of authorities, diffused governance, and a lack of adequate master planning.

The following observations from the City Development Plan for JUA, prepared under the Government of India's Jawaharlal Nehru National Urban Renewal Mission, highlight the issues at hand:

- While the area under Tata Steel has developed in a planned manner based on expert inputs, the outside areas have continued to grow at a fast pace, which one would expect to see near a major industrial center. This growth was generally organic in nature as the state or the region did not have a proper plan or development control rules. This has resulted in the present urban agglomeration. As a result, the disparity of the level of infrastructure and services is large, which is not good for the overall growth of the city (Ministry of Urban Development 2007, 15).
- The area coverage of water supply in JUA is less than 50%. Even within the covered area, only 55% of the population gets water through piped water connections (Ministry of Urban Development 2007, 49).

- The sewerage system is one of the least-developed infrastructures in JUA. Organized sewerage system is not available in the city, except for areas that are under JUSCO (Ministry of Urban Development 2007, 55).

It seems to make sense to leverage JUSCO's experience in the extended areas of JUA, given its track record and the requirements of the region. There have been some recent initiatives in this regard, but more could be done. Even as JUSCO has achieved some initial successes toward implementing water supply projects outside Jamshedpur, there appears to be a case for JUSCO to collaborate with the Government of Jharkhand and the local governments to help minimize the growing disparity in service delivery in the extended urban outgrowths of Jamshedpur.

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CHAPTER V

Kuala Lumpur, Malaysia

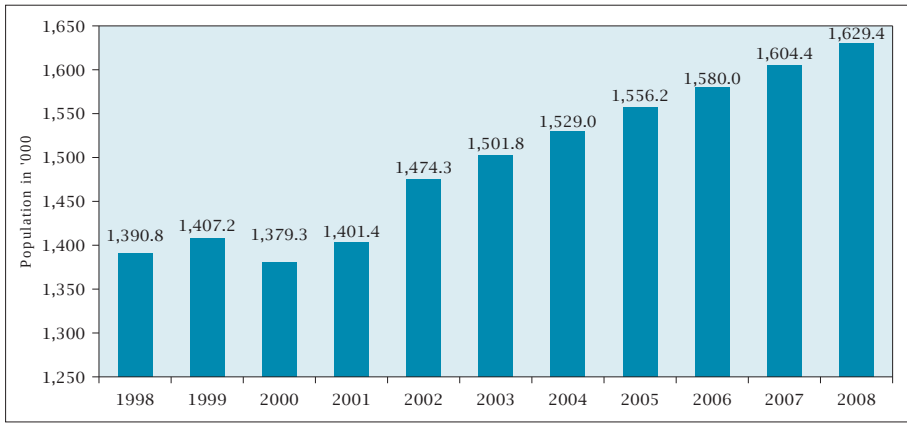
Singaravelloo Kuppusamy and Siew Hooi Tan[51]

Introduction

Water supply in Kuala Lumpur is closely linked to Selangor state through one water utility company that serves both states. This is because the city of Kuala Lumpur has close historical origin from Selangor, being its capital from 1880 to 1978. In 1974, Kuala Lumpur became a federal territory under the federal government.

Kuala Lumpur is not large at 242 square kilometers (km^2) but more than half is built up, resulting in a high population density of 6,678 persons per km^2 that is almost 80 times that of the national average in 2008. The city population was then 1.6 million (Figure 1) and by 2020, its population is expected to be 2.2 million (DBKL 2004). Higher population growth means increasing future demand for water. Kuala Lumpur is entirely dependent on Selangor for its water supply.

Figure 1 Population in Kuala Lumpur, 1998–2008



Source: Department of Statistics, Government of Malaysia (various years).

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Institutional Setting and Governance

Under the Federal Constitution, state governments are responsible for the development, operation, and maintenance of water supplies. In the 1990s, structural changes in the water services industry occurred across the country with the corporatization of water supply agencies in some states, full privatization in others, and adoption of a dual system of public control of distribution and privatization of water treatment services in some. Selangor opted for full privatization.

State governments were trying to upgrade and expand their water networks, turning to the federal government for grants or loans. Many were unable to increase revenue collections to repay the loans. A water crisis in 1998 and a National Water Resources Study in 2000 led the federal government to intervene directly in the state water industry (MEWC 2008, 54 and 77). The study recommended reforms and identified various issues, among which were water shortages in some states. At that time, water supply services were managed and regulated by the respective state governments. With the implementation of the reforms, there is now separation between governance and policy decisions by the National Water Resources Council (NWRC) and the industry regulatory role of Suruhanjaya Perkhidmatan Air Negara (SPAN).[52]

The reforms were in two parts. First, the Federal Constitution was amended to place water services into the Concurrent List.[53] Second, water-related agencies would be consolidated and placed under federal jurisdiction. Water sources, water catchment areas, and river basins remain under the control of state governments, which would receive royalties from the water utility companies and federal assistance (Parliament of Malaysia n. d.).

The management of water supply in Kuala Lumpur is in accordance with the Water Supply (Federal Territory of Kuala Lumpur) Act 1998 (Act 581), which provides for the supply and distribution of water in Kuala Lumpur. However, it merely supports all laws affecting water supply and distribution in Selangor. Two major legislations in 2006 govern the water services industry in Selangor. They are the National Water Services Commission Act 2006 (i.e., SPAN Act 2006) and the Water Services Industry Act (WSIA) 2006 (i.e., WSIA 2006). The latter regulates water supply and sewerage services in Peninsular Malaysia and the Federal Territory of Labuan.

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[52] NWRC consists of representatives from the federal and state governments, with the Ministry of Natural Resources and Environment and the Ministry of Energy, Water and Communications (MEWC) being the secretariat. MEWC was restructured to form the Ministry of Energy, Green Technology and Water in 2009. NWRC plans, develops, regulates, and manages water resources throughout Peninsular Malaysia, supported by the state governments.

[53] This refers to the term specified in the Federal Constitution in reference to functions that are jointly provided by federal and state governments.

Under the SPAN Act 2006, the National Water Services Commission or SPAN was established in 2007 as a water regulatory body for Peninsular Malaysia and the Federal Territory of Labuan to address issues like poor water quality, water supply, nonrevenue water (NRW), leaks, water pilferage, arrears in unpaid bills, as well as interstate disparity in water tariffs, enforcement, and performance of water utility companies (MEWC 2008, 60). SPAN is empowered to issue licenses to operators and contractors, and to regulate them. Each license is subject to renewal every 3 years. Each operator is required to submit a 3-year rolling plan and a 30-year business plan to SPAN that show the operator's road map toward full cost recovery, water demand and supply forecasts, capital development and its expenditure, expected tariffs, actions on NRW, water conservation plan, and a plan on how it intends to integrate water supply services with sewerage services (MEWC 2008, 100–101).

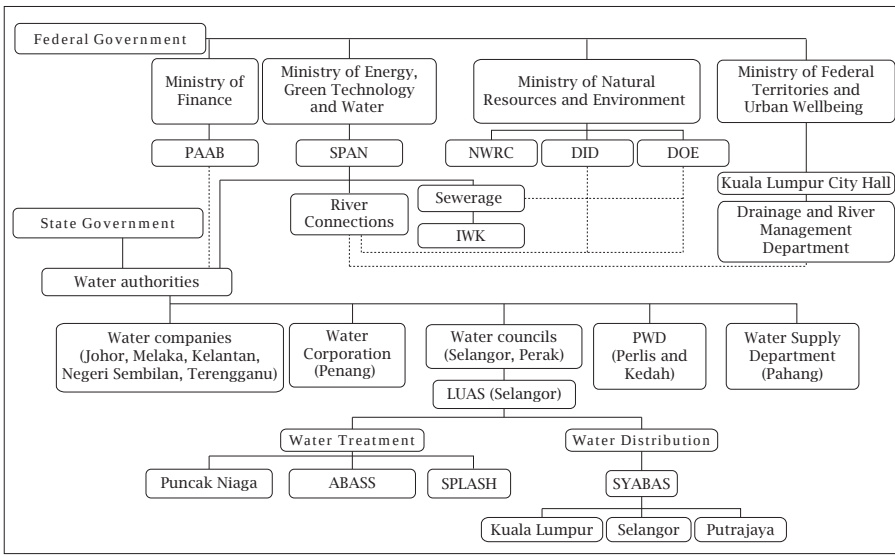
Besides, the WSIA 2006 requires that all other players in the industry—such as plumbers, engineers, contractors, and material suppliers—are registered with SPAN. SPAN serves as a one-stop agency with the right to penalize offenders. For revisions of water tariffs, SPAN is entrusted with the task of drawing up appropriate water tariffs for the approval of the Minister of Energy, Green Technology and Water after consultations with consumers via a water forum, which is a nongovernment organization designated by SPAN to represent consumers' interest. With the introduction of SPAN, Lembaga Urus Air Selangor (LUAS) or Selangor Water Management Authority remains as a state water regulatory body, while SPAN performs the regulatory role at the national level.

Meter replacement: Ensuring accurate billing through replacement of aging meters in Kuala Lumpur. Photo by Abdul Raof Ahmad, Corporate Communications and Public Affairs Division, SYABAS.

The WSIA 2006 governs the water services industry from treatment of raw water to discharge of wastewater. It transfers the supervision of all water services to the federal government (Figure 2). The underlying reasons are the federal government has the financial resources to finance the high cost of infrastructure, and water services would be standardized throughout Peninsular Malaysia (Figure 3). Pengurusan Aset Air Berhad (PAAB) or Water Asset Management Company was established in 2006 as a wholly owned federal company to take over all water assets of state governments, refurbish and upgrade existing water infrastructure, and construct new infrastructure. Water operators can lease the water assets from PAAB for a stipulated period of time. PAAB is not a profit-oriented organization, and lease rentals charged are expected to be based on the operators' ability to pay.

The WSIA 2006 and SPAN Act 2006 allow for the existing private sector players in Selangor (and Kuala Lumpur) to continue to operate. Private water treatment and distribution companies in Selangor are to carry on except under a different mandate and are now accountable to the federal government.

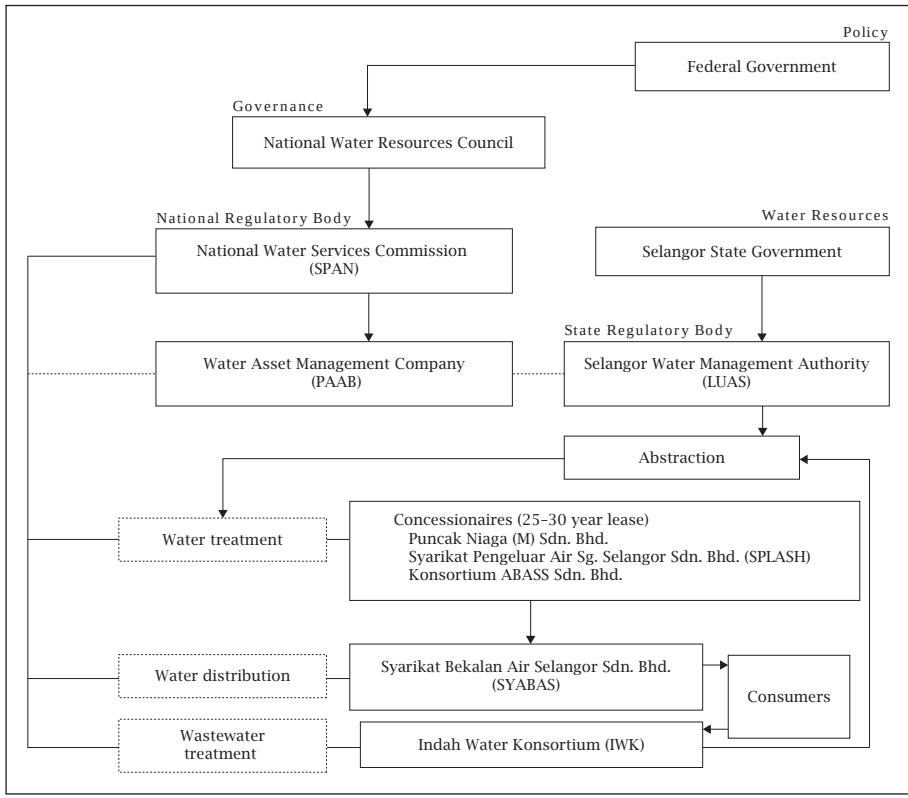
Figure 2 Malaysia—Institutional Hierarchy in Water Management



ABASS = Konsortium ABASS Sdn. Bhd., DID = Department of Irrigation and Drainage, DOE = Department of Environment, IWK = Indah Water Konsortium, LUAS = Lembaga Urus Air Selangor, NWRC = National Water Resources Council, PAAB = Pengurusan Aset Air Berhad, PWD = Public Works Department, SPAN = Suruhanjaya Perkhidmatan Air Negara, SPLASH = Syarikat Pengeluar Air Sungai Selangor Sdn. Bhd., SYABAS = Syarikat Bekalan Air Selangor Sdn. Bhd.

Source: Authors. Information as of 2010.

Figure 3 Institutional Setup of Water Services Industry, Kuala Lumpur and Selangor



Source: Authors, in consultation with Suruhanjaya Perkhidmatan Air Negara (SPAN).

A major criticism leveled at recent policy changes is their failure to address water conservation. To address this, SPAN, as part of its standard licensing conditions, requires licensees to develop and implement, at their own costs, a water conservation program as a move to overcome the concern.

The migration process under the WSIA 2006 for Selangor (and Kuala Lumpur) is not finalized. The restructuring of the water services industry in Selangor was not concluded by 2011. The State Government of Selangor is negotiating to purchase the water assets from the concessionaires in the state (Yeow 2009). The fiasco has also delayed the plan to transfer raw water from the neighboring state of Pahang to Selangor.

Supply Management

Water Resources

The supply of water to consumers in Kuala Lumpur began in 1896 under the Public Works Department (PWD). The first public water supply scheme was established in Gombak, Selangor.[54] Further expansion continued in 1906 and 1928, all in Gombak. Water supply to Selangor and Kuala Lumpur was subsequently decentralized to the Selangor Water Supply Department or Jabatan Bekalan Air Selangor (JBAS) in 1972.

Selangor has seven major rivers and/or river basin systems and six impounded reservoirs, which supply water to Syarikat Bekalan Air Selangor Sdn. Bhd.'s (SYABAS) entire service area of Selangor, Kuala Lumpur, and Putrajaya. A water scheme was developed in three stages at Sungai Selangor to meet long-term demand although water shortages could continue to occur.

Total water treatment capacity per day in the service area rose from 3.43 million cubic meters (mcm) in 2000 to 4.48 mcm in 2005. Total water production per day was 86.8% of the treatment plant capacity in 2008 (Table 1). There is a possibility that a new treatment plant would be built once the interstate raw water transfer from Pahang to Selangor is completed. Per capita production was in the range of 0.58–0.59 cubic meters (m^3) per day during 2005–2008.

SYABAS buys treated water from the three water treatment operators in Selangor. Of this, it receives 672,000 m^3 of treated water a day from the treatment plants to supply to Kuala Lumpur and part of Petaling, Klang, and Gombak. On average, this is equivalent to 0.42 m^3 per capita per day. Production from the water treatment plants is metered. Monthly joint meter readings are monitored with the plant treatment operators to avoid disputes. For better management control, the volumes of water that enter and exit reservoirs are also metered.

Table 1 Total Water Treatment Plant Capacity and Production, 2000–2008

	2000	2005	2006	2007	2008
Treatment plant capacity (mcm/day)	3.43	4.48	4.48	4.48	4.48
Production (mcm/day)	2.86	3.73	3.78	3.81	3.89
Average production per capita per day (m^3/day)	0.51	0.59	0.59	0.58	0.58

mcm = million cubic meters, m^3/day = cubic meters per day.

Note: Information on other years is unavailable.

Source: The Malaysian Water Association (various years).

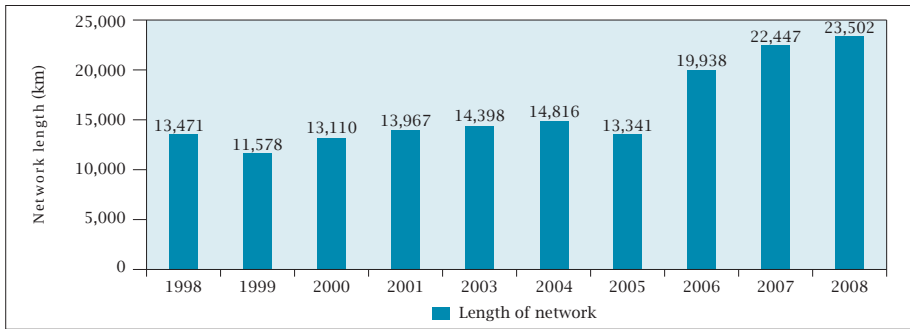
[54] See Syarikat Bekalan Air Selangor Sdn. Bhd. at www.syabas.com.my

Water Quality and Water Service Reliability

Water quality in Malaysia is set to meet the National Standard for Drinking Water Quality of the Ministry of Health (MOH), which adheres to the World Health Organization (WHO) guidelines. MOH carries out surveillance on water quality at treatment plants and distribution systems. Private water treatment plants are subject to stringent controls over quality monitoring, air scouring of reticulation mains, and cleaning of reservoirs. They undertake sampling at points along the pipes and at meter points as a precautionary measure. On the distribution side, SYABAS carries out monitoring and continuous improvement works on the distribution system, replaces old pipes, cleans its reservoirs, and installs computerized systems to check on dead ends that need immediate action.[55]

The entire Kuala Lumpur has access to piped water, available around the clock, 365 days a year. Tankers are only used when there is an unscheduled major disruption to water supply for more than 24 hours. The total length of the water supply network in Kuala Lumpur has risen since 2005, reaching 2,326 kilometers (km) in 2008. This represented 9.9% of the total network under SYABAS management (Figure 4). Water pipes in Kuala Lumpur are old; some are at least 35 years old. This explains the large number of recorded water pipe breaks. The aging pipes also caused leaks that, in 2008, numbered 497 per 100 km of potable water pipeline.

Figure 4 Length of Water Supply Network in Selangor, Kuala Lumpur, and Putrajaya, 1998–2008



km = kilometers.

Note: Data for 2002 is unavailable.

Source: The Malaysian Water Association (various years).

[55] For instance in 2009, Puncak Niaga (M) Sdn. Bhd. had to close the Salak Tinggi Water Treatment Plant due to raw water contamination by ammonia, which exceeded the approved level. This occurred three times in 2009. SYABAS further proposed that a new dam be built in Sungai Ampang (*The Star* 2009).

Table 2 Metered Connections in Kuala Lumpur by Type, 2005–2008

	2005	2006	2007	2008
Domestic				
Number of house connections	136,697	136,031	134,693	140,824
Number of bulk connections (apartments/condominiums)	834	842	841	852
Total (domestic)	137,531	136,873	135,534	141,676
Nondomestic				
Number of commercial/industrial connections	32,366	31,237	31,089	32,336
Number of institutional connections	447	446	430	1,739
Total (nondomestic)	32,813	31,683	31,519	34,075
Total number of service connections	170,344	168,556	167,053	175,751

Notes:

(i) Figures for 2005–2007 are estimates based on population size.
(ii) Fluctuations in the figures between 2005 and 2007 were due to measures adopted by SYABAS against consumers who defaulted on their water bills for over 3 consecutive months. In such instances, disconnections are taken but upon appeal, defaulters are allowed to pay arrears by installments.
(iii) Figures exclude Selangor and Putrajaya. Including the entire service area, there were 1.5 million connections in 2008.

Source: Syarikat Bekalan Air Selangor Sdn. Bhd. (SYABAS).

Water metering is mandatory for all consumer connections. All residential, commercial, and industrial premises in Kuala Lumpur are served by direct individual tap connections or bulk connections in high-rise buildings. For bulk connections, the building management charges fees based on bulk meter readings and the floor space occupied by each unit. The number of connections in Kuala Lumpur rose from 170,344 in 2005 to 175,751 in 2008 (Table 2).

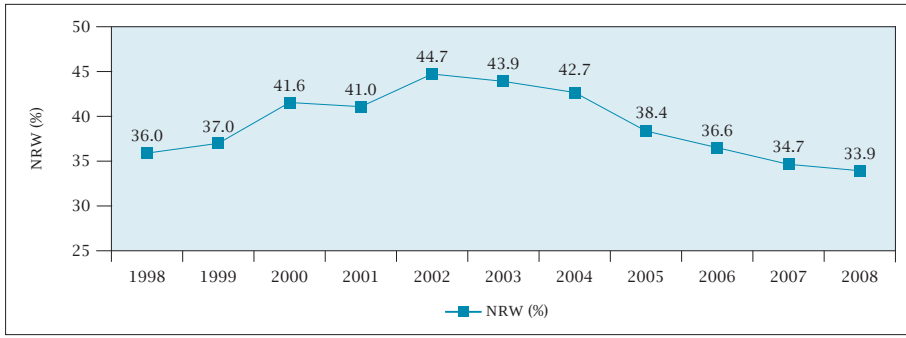
Nonrevenue Water

Of the 175,751 connections in Kuala Lumpur in 2008, 167,512 connections, representing 95.3% of total connections had operating meters. The remaining 8,239 meters had defects and of these, 6,591 units were repaired within the year, yielding an 80% performance in terms of responsiveness to defaults by SYABAS.

NRW affects the revenue of a water utility and the recovery of capital and operating costs (Kingdom, Liemberger, and Marin 2006). Under JBAS, NRW was 36% in 1998 and 37% in 1999. Under the Perbadanan Urus Air Selangor Berhad (PUAS), it peaked at 45% in 2002 and 44% in 2003 (Figure 5). After privatization in 2005, SYABAS was able to reduce NRW to 34% by 2008. It has set a target of 15% by 2015.[56]

[56] In Penang, the Perbadanan Bekalan Air Pulua Pinang (PBAPP) or the Penang Water Supply Corporation achieved NRW of 19% in 2005.

Figure 5 Nonrevenue Water in Selangor, Kuala Lumpur, and Putrajaya, 1998–2008



NRW = nonrevenue water.
Source: The Malaysian Water Association (various years).

NRW in Kuala Lumpur is caused by several factors, which include consumption via legal connections of public facilities that could not be billed; physical loss of water caused by leaks, bursts, damages to pipes, and faulty fittings; and illegal uses such as non-endorsed diversions and pilferages.

Demand Management

For Kuala Lumpur and part of Petaling, Klang, and Gombak, domestic water consumption was estimated at 60.6% of total water consumption in 2008 (Table 3). Per capita domestic consumption was 148 liters per day compared to the national average of 185 liters per day.[57] The total average per capita consumption was 244 liters per day compared to 420 liters per capita per day supplied by water treatment plants (Figure 6).

Water Pricing

Water tariffs for domestic households are nonlinear and structured to penalize those who use more water (Table 4). Differential rates apply to residential, commercial, and industrial users. The differential tariff is highest for commercial and industrial users. Social considerations are built into the tariff structure. Welfare and religious institutions, as well as low-cost housing, pay lower rates.

[57] See MEWC (2008), p. 119. The difference between supply and consumption includes excess water in the network and water that is lost in the network.

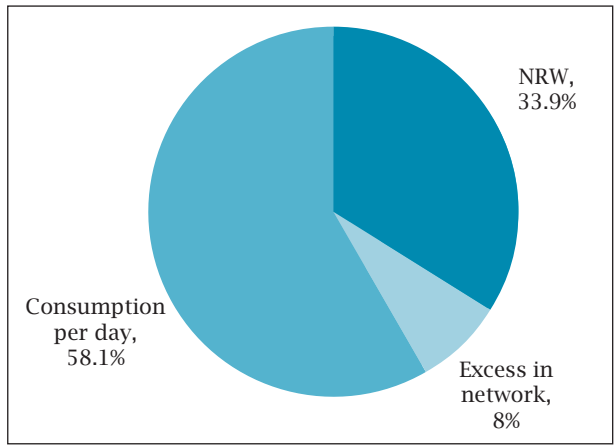
Table 3 Daily Water Consumption, Kuala Lumpur

	2005	2006	2007	2008
Domestic use[a]				
Consumption per day (m^3/day)	224,281	229,467	236,684	241,278
Consumption per capita per day (l/day)	144	145	147	148
Nondomestic use[b]				
Consumption per day (m^3/day)	186,893	193,396	207,203	157,004
Total consumption per day[c] (m^3/day)	411,174	422,863	443,886	398,282
Total consumption per capita per day[d] (l/day)	265	277	287	244

m^3/day = cubic meters per day, l/day = liters per day.

Sources: [a] to [c] are from the Syarikat Bekalan Air Selangor Sdn. Bhd. (SYABAS) and [d] are estimates by authors.

Figure 6 Water Consumption and Water Supply Per Day, Kuala Lumpur, 2008



NRW = nonrevenue water.

Source: Computed from Table 3 of this chapter and estimates by authors.

Tariff rates remained unchanged in Kuala Lumpur from 1989 to 2001. Revisions took place in 2001 and 2006. Both revisions were attributed to privatization exercises. The 2001 revision was linked to the corporatization of JBAS. The 2006 revision was in accordance with the concession agreement of SYABAS, which allowed for revision every 3 years. The increase averaged 15% across all consumer groups (Table 5) (*Government of Selangor Gazette* 2006). It led to a positive impact on SYABAS's revenue. Another revision was scheduled for 2009 but did not take place because the State Government of Selangor did not approve it, and SYABAS

Table 4 Water Tariff Rates in 1989, 2001, and 2006

Category	1989 (RM/m³)	2001 (RM/m³)	2006 Onward (RM/m³)
Residential			
Less than 20 m³	0.42	0.57	0–20 m³ : 0.57
20–50 m³	0.65	0.91	21–35 m³ : 1.03
More than 50 m³	1.05	1.70	More than 35 m³ : 2.00
Commercial and Industrial			
0–35 m³	1.20	1.80	2.07
More than 35 m³	1.20	1.92	2.28
Shipping companies	2.10	3.68	4.23
Government	0.80	1.40	1.61
Welfare bodies	0.42	0.50	0.58
Religious bodies	0.33	0.40	0.46

m³ = cubic meters, RM/m³ = ringgit per cubic meter.

Note: Financial Year (FY) is from January to December (e.g., FY2006 is January to December 2006).

Sources: *Government of Selangor Gazette* (1989, 2001, and 2006).

had filed a case against the state government for not honoring the provision of the concession agreement.

Consumers in Kuala Lumpur and Selangor also pay connection fees, made up of a refundable deposit and a fixed installation charge. The deposit and installation charges have to be paid in one lump sum. Domestic users are required to pay a minimum deposit of RM100; nondomestic users pay a minimum deposit of RM500. The rates of the installation charge vary with the meter size.

Public Education and Water Conservation

There is no national policy on water conservation. The tariff structure with differential rates is intended to penalize heavy water users. This represents an indirect approach to promote water conservation. The 49th National Council for Local Government had agreed that subsidiary legislations at the state level should be enacted to mandate installation of dual flush systems in all buildings and new housing from June 2002 but this was not implemented.

However, SPAN has started to address this issue. SPAN is formulating a new set of uniform Water Supply Rules to replace the existing State Water Supply Rules. The rules cover, among others, provision for water conservation measures and regulation of plumbing to accommodate rainwater harvesting. SPAN has mandated that commencing 1 January 2012, all new housing units are required to install dual flush WC cisterns.

Table 5 Water Tariff by Type of User, 2006[a]

Type of Consumer	Tariff Grades	Minimum Payment per Month
Individual meters		
Any residential premise	RM0.57 (0–20 m^3) RM1.03 (21–35 m^3) RM2.00 (> 35 m^3)	RM6.00
Government premise	RM1.61 per m^3	RM17.00
Commerce/industries, public swimming pool, private institute of higher learning, shop lots, service apartments	RM2.07 (0–35 m^3) RM2.28 (> 35 m^3)	RM36.00
Estate (domestic individual meter)	RM0.57 (0–20 m^3) RM1.03 (21–35 m^3) RM2.00 (> 35 m^3)	RM6.00
Religious bodies	RM0.46 per m^3	RM6.00
Shipping	RM4.23 per m^3	–
Welfare organization	RM0.58 per m^3	RM6.00
Low-cost housing	RM0.80 per m^3	–
Bulk meters		
Government quarters	RM1.00 per m^3	RM12.00
Estate	RM1.00 per m^3	RM12.00
Luxury condominium/apartment	RM1.38 per m^3	RM173.00
Low-cost apartment	RM0.80 per m^3	RM35.00

m^3 = cubic meters, RM = ringgit.

[a] Financial Year (FY) is from January to December (e.g., FY2006 is January to December 2006).

Source: SYABAS (n.d.).

Wastewater Management

Traditionally, local authorities were responsible for sewerage services but most were underperforming. The federal government, concerned over inefficiencies and pollution, took over sewerage services in Peninsular Malaysia and turned them over to Indah Water Konsortium (IWK). The 1994 privatization exercise entailed payment of sewerage fees based on the total volume of water usage, and billing was to be made directly through the water utility companies. Water meters were to be disconnected if sewerage payments were not settled.

In the absence of any statutory regulation, there were high incidences of nonpayments. This affected IWK's revenue flows, and eventually, the mode of incorporating

sewerage charges into the water bill had to be abandoned. In addition, the federal government reduced the sewerage charges three times during this period, causing IWK to lose revenue. In 2000, IWK had to be taken over by the Minister of Finance Incorporated.

With a renewed mandate and access to federal funds, the restructured IWK started a program to educate the public, create awareness, and take proactive actions to upgrade and improve sewerage services. IWK issues half-year bills to users but continues to face problems with defaults and nonpayments. It has to rely on civil suits to recover outstanding debts, a process which is lengthy and protracted. With the implementation of the WSIA 2006, IWK began to operate with statutory power to take actions against defaulters, under the authorization of SPAN.

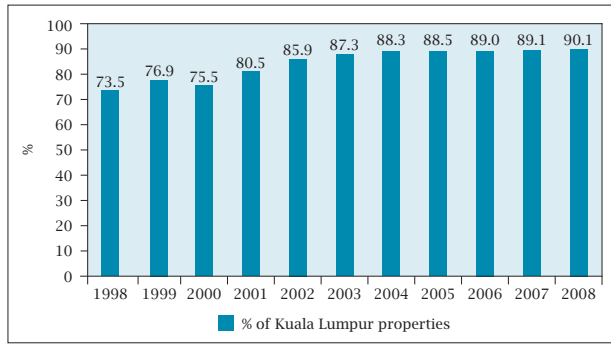
IWK has more than 5,750 sewage treatment plants and 13,000 km of sewer pipelines. In Kuala Lumpur, it has eight regional plants and 227 multipoint plants, and also maintains 57,232 individual septic tanks. In addition, there are 95 private plants and 5,000 pour flushes that do not come under IWK's jurisdiction.[58] In such cases, IWK provides service to these locations on a per need basis. Some premises such as hotels and hospitals have their own private sewage treatment plants that are not linked to IWK's sewerage system.

The proportion of commercial and residential premises in Kuala Lumpur with access to IWK-operated sanitation system rose from 73.5% in 1998 to 90.1% in 2008, leaving 10% uncovered (Figure 7). IWK's wastewater treatment capacity in Kuala Lumpur increased at an average annual rate of 6.5%, especially after 2000 when its rate of expansion averaged 7% per annum (Table 6). However, its increase in capacity was still lower than the expansion in the volume of wastewater discharged in the city, which stood at an average of 8.6% in the same period. In 1998, IWK's treatment capacity in Kuala Lumpur was only 140 mcm but the volume of wastewater discharged was lower. Its overcapacity peaked in 2001 and continued until 2003 but by 2004, IWK's capacity could not match rising demand. While it expanded capacity, the volume of wastewater discharged in the city continued to rise. By 2008, although all its plants were operating at full capacity, IWK could only treat 91% of the volume of wastewater discharged into its system.[59]

IWK faces several challenges. A major constraint is finances as its budgets were in deficits, and it has limited funds to upgrade and improve its services. It has to oversee nonoperating, under-loaded and overloaded plants. In addition, illegal discharges into the sewers by industries overload its plants, pushing up maintenance costs, and causing blockages and disruptions in the system.[60] It does not have full

[58] Interview by the authors with IWK Information Center staff in Kuala Lumpur in September 2009.
[59] Industrial wastes are treated by the respective industrial facilities.
[60] Once identified, IWK would report the case to SPAN for action.

Figure 7 Proportion of Properties in Kuala Lumpur Connected to Indah Water Konsortium's Network, 1998–2008



Notes: Figures were estimated based on the number of billings and population equivalent counts of five persons per residential unit and from 25 to 36 persons per commercial unit. The sum of these figures was compared to the total population equivalent given by IWK. No data is available on the total number of residential and commercial units with access to IWK's network.

Source: Indah Water Konsortium (IWK) estimates derived in 2008.

control over the entire sewerage system. Hence, when private plants violate the Environmental Quality Act 1974 and pollute the rivers, IWK is frequently blamed, a problem that would hopefully be resolved with SPAN taking over the regulation of water and sewerage services.[61]

Privatization of sewerage services does have positive impacts on sewerage services in Kuala Lumpur. Although the number of disruptions increased from 4,347 in 1998 to 5,477 in 2008, the number of disruptions per 1,000 km of sewer line declined by 50% to 1,672. This is because the length of sewers increased more rapidly (Figure 8).

Storm Water Management

Flash floods are a problem in Kuala Lumpur but not major floods. The last recorded major flood was in 1971. Although the common factor is heavy rainfall that contributes to floods in the city, other causes include intensive development, blockages in urban drains by pollutants, and sedimentation of rivers. The infrastructure development of main rivers in Kuala Lumpur is managed largely by the Federal Territory Department of Irrigation and Drainage with support from the Drainage and River Management Department of Dewan Bandaraya Kuala Lumpur (DBKL). It is DBKL's responsibility to manage urban drainage in the city including small rivers and storm drains that link to the main rivers in the city. It sets up rubbish

[61] Industrial wastewater treatment remains under the industries.

Table 6 Wastewater Treatment Indicators, Kuala Lumpur, 1998–2008[a]

	1998	1999	2000	2001	2002	2003	2004
Volume of wastewater generated (mcm)	126.52	131.74	137.25	142.59	147.61	157.14	205.09
Wastewater treatment capacity (mcm)	139.94	141.68	150.40	170.04	172.64	176.21	177.95
Volume of wastewater collected by IWK's sewer network and treated (mcm)	108.17	109.44	112.90	118.41	123.16	131.42	179.51
Volume of wastewater not treated by IWK (mcm)	18.35	22.30	24.35	24.18	24.45	25.72	25.58
Volume of wastewater not treated by IWK (%)	14.50	16.90	17.70	17.00	16.60	16.40	12.50
Over/under capacity of treatment facilities[c] (%)	110.60	107.50	109.60	119.30	117.00	112.10	86.80

	2005	2006	2007	2008	AAGR[b] 1998–2008 (%)
Volume of wastewater generated (mcm)	212.83	236.77	251.34	288.42	8.60
Wastewater treatment capacity (mcm)	180.06	194.40	230.24	262.44	6.50
Volume of wastewater collected by IWK's sewer network and treated (mcm)	187.19	211.22	226.16	262.20	9.30
Volume of wastewater not treated by IWK (mcm)	25.64	25.55	25.18	26.22	3.60
Volume of wastewater not treated by IWK (%)	12.10	10.80	10.00	9.10	
Over/under capacity of treatment facilities[c] (%)	84.60	82.10	91.60	91.00	

IWK = Indah Water Konsortium, mcm = million cubic meters.

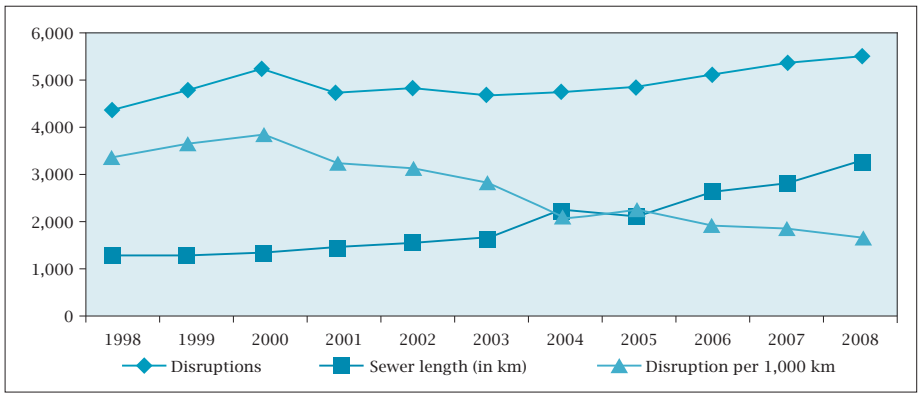
Notes: [a] IWK only handles domestic wastewater. Wastewater not treated by IWK could include industrial wastewater but no known figures are available.
[b] AAGR = Average annual growth rate.
[c] Over or under capacity refers to wastewater treatment capacity expressed as a percentage of volume of wastewater generated.
[d] Planning work to upgrade overloaded facilities has been completed. It is expected that these work will be implemented in the near future.

Source: Central Planning Unit, IWK obtained in 2009.

traps at 15 locations in the small rivers under its care. It also carries out desilting, upgrading, and maintenance works spanning about 350 km of minor rivers and storm water drains. Despite these, flash floods continue to occur during heavy downpours in Kuala Lumpur.

Faced with the need to address frequent flooding from heavy downpours, the federal government went into a partnership with a private firm to construct the Stormwater Management and Road Tunnel (SMART) as a demonstration project to curb flash floods in Kuala Lumpur. SMART is a RM1.93 billion project to redirect

Figure 8 Disruptions to Indah Water Konsortium's Sewerage Services in Kuala Lumpur, 1998–2008



km = kilometers.

Note: Disruptions refer to consumer complaints on defects such as blockages, overflows, and sewer collapses.

Source: Central Planning Unit, Indah Water Konsortium.

excess floodwater from Sungai Klang and Sungai Ampang into holding ponds. It was developed on a cost-sharing basis, with the federal government absorbing about 70% of the cost and the rest by a private concessionaire (Yusof 2009). It is an example of a public–private partnership (PPP) project.

At other times, SMART serves as a motorway on its upper deck for light motor vehicles. But during heavy storms, the tunnel is closed to road traffic and it channels excess floodwater into retention ponds. SMART operates on four modes in response to the volume of floodwater discharged. It is an ordinary motorway under Mode 1 and Mode 2. But when it rains heavily, Mode 3 is activated and the tunnel is closed to traffic for about two hours to discharge the excess water. When it is in Mode 4, the floodwater level is high, and the tunnel needs to be closed for a longer period of up to 4 days.

Since commencement of operations in 2007, SMART has managed to avert at least 114 flood events (Sivanandam 2010). The tunnel, however, was designed to prevent flash floods from the overflow of the two rivers and does not prevent flooding throughout the entire city. But it is a good example of how effective PPP can tackle the city's problems.

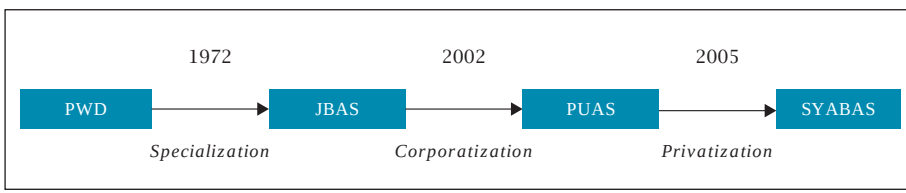
Private Sector Participation

In Malaysia, the State Government of Selangor was among the pioneers in using privatization as a tool to improve the management of water services when it

corporatized JBAS into PUAS in 2002. It also privatized its reservoirs and treatment plants, under 30-year concession agreements, to three firms, namely, Puncak Niaga (M) Sdn. Bhd., Syarikat Pengeluar Air Sungai Selangor Sdn. Bhd. (SPLASH), and Konsortium ABASS Sdn. Bhd. On 15 December 2004, the state government signed an agreement with SYABAS and the federal government to transfer the responsibilities of PUAS to SYABAS,[62] a private firm in which the state government holds equity together with Puncak Niaga Holdings Bhd. (Figure 9). SYABAS was also given a 30-year concession to distribute water to more than 7.3 million domestic, industrial, and commercial consumers through 1.52 million consumer accounts, making it the largest privatized water supply scheme in the country.

In Kuala Lumpur, the provision of water, water treatment, and sewerage and storm water services is gradually privatized under federal jurisdiction through the WSIA 2006. The privatization model evolves from full privatization where the private sector is fully responsible for all costs of infrastructure to one that favors PPP. This shift toward a PPP model reflects a change in the federal government's policy to focus on making privatized services more efficient and cost effective and to address public complaints on rising prices and poor services. Earlier examples in the privatization of IWK and the corporatization of JBAS into PUAS have revealed weaknesses in the full privatization model. Even when the privatization of water distribution to SYABAS appeared to work, there were concerns over the firm's ability to undertake expensive capital investment given its financial constraints. The private firms have to borrow heavily and usually from the private capital markets to finance costly infrastructure. If they are unable to repay such loans, the water services industry could be disrupted.

Figure 9 Chronology of Events in Privatizing the Water Services Industry in Selangor



JBAS = Jabatan Bekalan Air Selangor, PUAS = Perbadanan Urus Air Selangor Berhad, PWD = Public Works Department, SYABAS = Syarikat Bekalan Air Selangor Sdn. Bhd.

Source: Authors.

[62] SYABAS was incorporated in 1996 to undertake privatized water supply services in Selangor and in the Federal Territories of Kuala Lumpur and Putrajaya. Its shareholders are Puncak Niaga Holdings Berhad (70%), Kumpulan Darul Ehsan Berhad (15%), and Kumpulan Perangsang Selangor Berhad (15%). The federal government, through the Minister of Finance Incorporated, holds one Golden Share (Pua 2010, 113).

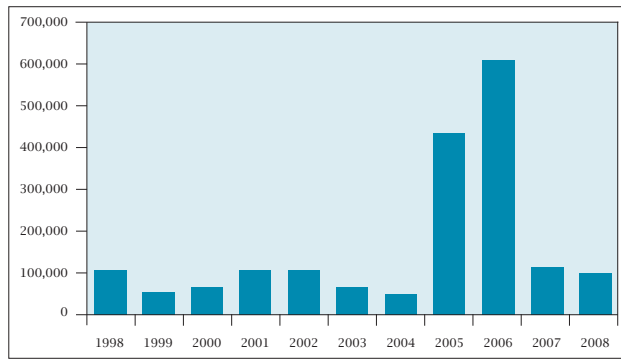
Furthermore, previous privatization efforts in Kuala Lumpur and elsewhere in Malaysia are perceived by the public to have undertones of political involvement and questionable motives. In the water services industry, heavy infrastructure investments are required, and private firms, as a norm, would not have adequate resources to fund such capital investments without assistance. The Kuala Lumpur PPP experience is still relatively new to be touted as a better model but indications are a PPP model may serve the industry better in the long term than a full privatization model.

Customer Satisfaction

Among the public utility firms in Kuala Lumpur, there is no policy compelling them to monitor consumer satisfaction. Among them, SYABAS is the only one known to have put in place a dedicated 24-hour call center, PUSPEL, to receive public complaints. For water distribution service, the number of public complaints fluctuated during 1998–2008 (Figure 10). Under JBAS and subsequently PUAS, the number of complaints was stable at about 100,000 a year. However, immediately after the privatization of PUAS's responsibilities, the number of complaints increased by five to six times. Possible reasons for this could be a general discontent among the public over the privatization exercise, higher expectations, underreporting by the previous management, and an improved system of collecting and collating public complaints that included newspapers and other media, which were not done previously. SYABAS took steps to reduce the complaints to 100,000 a year but in absolute terms, this remained high.

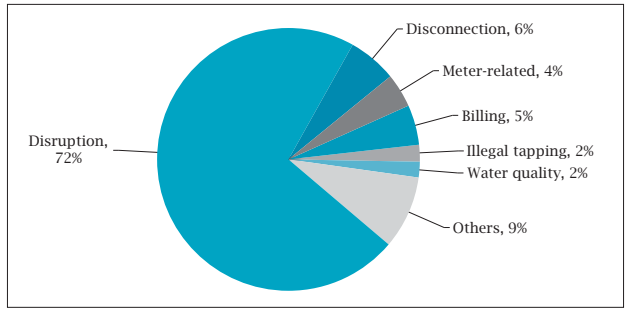
In Kuala Lumpur, SYABAS received 40,253 or 40.4% of its total number of complaints in 2008. Almost three-quarters were on disruptions of water services, water

Figure 10 Number of Public Complaints on Water Supply, 1998–2008



Source: The Malaysian Water Association (various years).

Figure 11 Complaints on Water Supply in Kuala Lumpur by Category, 2008



Notes: Disruptions are mainly based on consumers reporting on pipe bursts and pipe leaks. "Others" include complaints on inefficiency, staff attitude, road reinstatement, status of application, reservoir overflow, and consumers' expectation of immediate reinstatement of disconnected meters once payment is made.

Sources: The Malaysian Water Association (various years), and data from Syarikat Bekalan Air Selangor Sdn. Bhd. (SYABAS).

tankers, leakages, broken pipes, and low pressure (Figure 11). The remaining complaints comprised dissatisfaction over meter disconnections, billings, meter-related issues, and others. SYABAS's records for 2008 showed that 99.9% of such complaints were resolved.

Financial Resource Management

During 1998–2008, revenue growth of the water supply service provider was strong, reaching an average annual rate of 14%. In absolute terms, annual revenue increased from RM399 million in 1998 to RM1.5 billion in 2008 or almost four times the amount in the base year (Table 7) because of expansion of new accounts in both Kuala Lumpur and Selangor. Operating revenue rose significantly in 2002 after corporatization, reaching RM811 million, which was more than double the amount in 1998. Another marked increase was in 2005 after privatization when SYABAS's annual collections rose above RM1 billion. Annual billings also increased although after 2006, these declined largely because of a reduction in repeat billings to recoup arrears.

Revenue collection efficiency, estimated from 2003 to 2008, showed an improvement from 78% to 91%. There were fluctuations in the efficiency rate but the decline was likely due to changes in management during the period reviewed. When SYABAS took over in 2005, the efficiency level dropped but after the transition period, it reverted to reach a high of 91% in 2008.

Annual debts arising from nonpayment of billed water consumption declined as revenue collection efficiency increased. On a monthly basis, improvements were

Table 7 Financial Performance of Utility That Supplies Water, 1998–2008[a]

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Capital Expenditure (RM million)	382.2	314.5	209.3	411.7	472.1	467.3	414.7	1,175.3	1,263.6	n.a	n.a
Annual Operation & Maintenance Costs (RM million)	366.5	462.0	689.0	961.5	1,322.1	1,628.8	1,799.9	947.5	1,089.7	1,131.1	1,194.8
Annual Revenue (RM million)	399.1	442.2	490.8	628.0	826.8	874.2	1,084.0	1,147.9	1,351.6	1,414.2	1,476.5
Annual Operating Revenue (RM million)	388.1	436.2	485.7	620.0	811.0	847.5	994.8	1,070.3	1,265.9	1,331.7	1,394.8
Operating Ratio	0.94	1.06	1.42	1.55	1.63	1.92	1.81	0.89	0.86	0.85	0.86
Annual Accounts Receivable (RM million)	n.a	n.a	n.a	n.a	n.a	326.7	264.6	330.3	436.4	301.0	210.3
Accounts Receivable (in month's equivalent)	n.a	n.a	n.a	n.a	n.a	3.61	2.52	2.83	3.08	2.21	1.64
Annual Billings (RM million)	n.a	n.a	n.a	n.a	n.a	1,084.5	1,259.4	1,400.6	1,702.3	1,632.7	1,542.0
Annual Collections (RM million)	388.1	436.2	485.7	620.0	811.0	847.5	994.8	1,070.3	1,265.9	1,331.7	1,394.8
Revenue Collection Efficiency (%)	n.a	n.a	n.a	n.a	n.a	78.1	79.0	76.4	74.4	81.6	90.5

n.a. = not available.

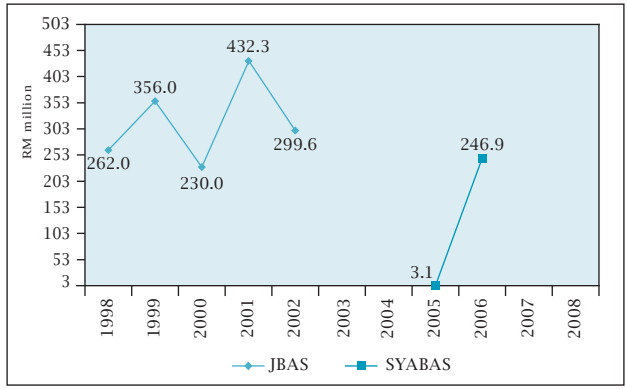
[a] From 1998 to 2002, management was under JBAS; from 2003-2004, it was under PUAS; and from 2005 onward, it was under SYABAS. This reflects a shift from a public agency to a corporatized structure under PUAS, and then to a private limited company, SYABAS, in which the State Government of Selangor holds shares through two state subsidiaries—Kumpulan Darul Ehsan Berhad and Kumpulan Perangsang Selangor Berhad.

Sources: PUAS (2005), and based on SYABAS annual reports from 2005 to 2008 gathered during a research conducted at the Companies Commission of Malaysia.

observed after privatization, with accounts receivable in month's equivalent declining from about 3.5 months during the transition period to less than 2 months in 2008. This was because SYABAS enforced the law to disconnect water supply on errant accounts and to charge reconnection fees.

The increase in revenue was accompanied by rising annual operation and maintenance costs. While operating revenue increased to more than 3.5 times the base year's level by 2008, annual operation and maintenance costs increased more moderately to slightly more than 3 times. The gap resulted in a better operating ratio of 0.86 in 2008 (Table 7).

Figure 12 Government Grants to Water Utilities



RM = ringgit, JBAS = Jabatan Bekalan Air Selangor, SYABAS = Syarikat Bekalan Air Selangor Sdn. Bhd.

Sources: PUAS (2005), and based on SYABAS annual reports from 2005 to 2008 from a research conducted at the Companies Commission of Malaysia.

Grants were used to help the state water utilities. JBAS received development grants from the State Government of Selangor; it also borrowed from the federal government to finance capital expenditure. Grants awarded by the state government often did not exceed RM500 million. In 2001, JBAS took a grant of RM432.3 million to construct the Sungai Selangor Dam. When water services were corporatized in 2002, the state government stopped the grants (Figure 12). However, when SYABAS took over the water distribution services, it managed to negotiate for a one-off grant from the federal government amounting to almost RM250 million to help resolve the NRW issue.

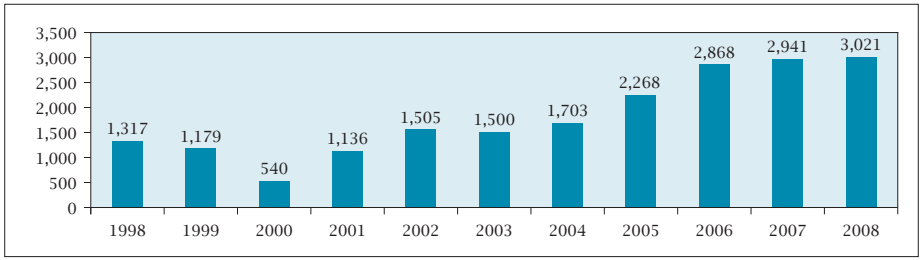
Human Resource Management

Total staff strength of the water services industry (excluding water treatment and sewerage services) increased significantly from 1,317 in 1998 to 2,268 in 2005 when the service was privatized.[63] SYABAS's staff strength was 3,021 in 2008 (Figure 13).

The number of employees in the water distribution services almost trebled when total connections in the service area increased. This affected the ratio of staff to connections. The number of staff per 1,000 connections rose from 1.5 in 2005 when SYABAS absorbed 95% of PUAS employees, to 1.9 in 2008 (Figure 14). This implies that more employees were hired after the SYABAS takeover. Total staff cost

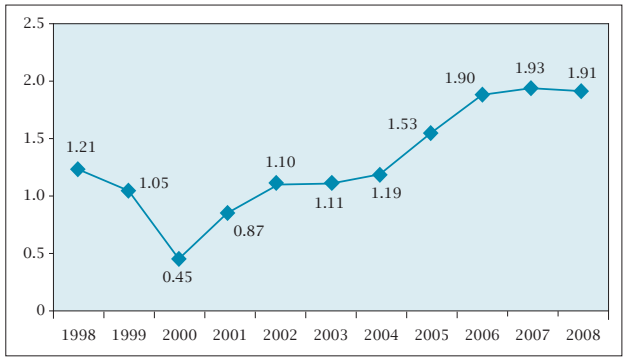
[63] Total staff refers to all people employed by the water utility for Selangor, Kuala Lumpur, and Putrajaya. No disaggregated data for each area is available.

Figure 13 Number of Staff Employed by Water Utilities, 1998–2008



Sources: The Malaysian Water Association (various years); and data from SYABAS for 2005–2008.

Figure 14 Number of Staff Per 1,000 Water Connections in Water Utility's Service Area, 1998–2008



Notes:
(i) Staff refers to all the people employed by the utility that supplies water.
(ii) Connections refer to all the connections in the entire service area of the utility.

Sources: Computed from Figure 13; and The Malaysian Water Association (various years).

rose at an average of 21.5% per annum during 2003–2008. The rise was significantly marked immediately after privatization in 2005, due to an expansion in the employment size of SYABAS (Figure 15).

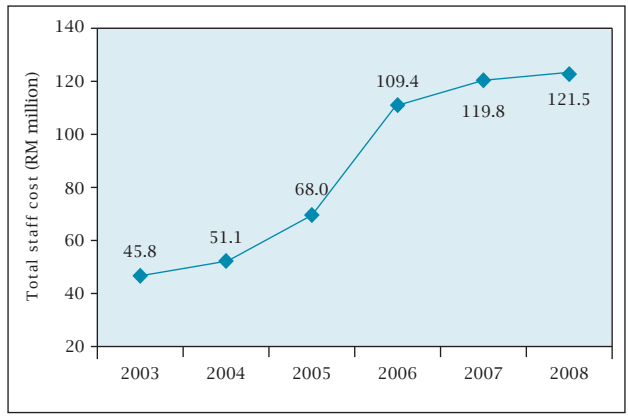
The average annual salary of employees was estimated to be in the range of RM30,000–RM41,000 during 2003–2008 (Figure 16).[64] The large number of workers means that the ratio of nonmanagement and/or field staff to professional

[64] Annual salary includes all monetized benefits, including bonuses. It is assumed that all staff referred here are full-time employees of the water utility. The absence of information on the breakdown of employees is a constraint in the analysis. The large number of workers suggests that the proportion of nonmanagement staff is very high. In the private sector, the average monthly salary of nonmanagement and/or semi-skilled staff is likely to fall within the range of RM2,000–RM2,500, and unskilled workers receive RM1,200–RM1,800 per month, depending on their service tenure.

SYABAS's customer service center: Providing customers with prompt and efficient service.

Photo by Abdul Raof Ahmad, Corporate Communications and Public Affairs Division, SYABAS.

Figure 15 Total Annual Staff Cost of Water Utilities, 2003–2008



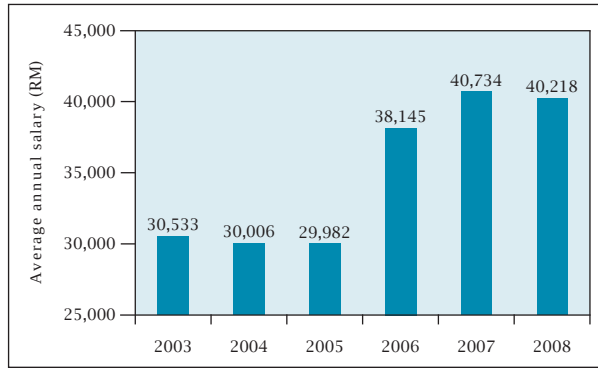
RM = ringgit.

Source: The Malaysian Water Association (various years).

staff is very high and if so, this means that the implied monthly salary of RM3,000 would be relatively high when compared with that in the public sector where the average monthly salary for medium-skilled workers is below RM3,000.

In the case of highly skilled professionals, the gap in remunerations tended to favor the private sector. The annual remunerations of the four top management staff (executive directors) in SYABAS averaged RM115,500 per person in 2007. In 2008, the average remuneration was RM186,100 per person. Compared to other large national private firms, this might not be very competitive but against the public sector, it was. However, comparing the staff cost of the four top management

Figure 16 Average Annual Salary of Staff in Water Utilities, 2003–2008



RM = ringgit.

Sources: Computed from The Malaysian Water Association (various years); and Figure 13 of this chapter.

staff to total annual staff cost, the share was quite low at 0.6% in 2008. In absolute terms, there remained a marked discrepancy between the average pay of an ordinary worker and that of a top management personnel.

Lessons

The key lessons in this chapter are as follows:

(i) **Public–private partnership as a preferred model.** The Kuala Lumpur experience shows that privatization has positive impacts on the delivery of water services. When SYABAS took over as the water service provider, it faced problems over high NRW and poor water quality in Kuala Lumpur. The privatized company installed a 24-hour helpline to receive public complaints, embarked on a pipe replacement program, and reduced NRW from 38% to 34% within 4 years.

Privatization of water and wastewater services in Malaysia started with a complete reliance on the private sector to finance major infrastructure. But there had been obstacles, among which was the difficulty in raising funds, especially in the private money market. The borrowing terms could be relatively stringent and the private utilities were unable to guarantee payments of debts.

To overcome this, private utility firms focused on improving revenue collection and reducing operating costs. This approach, however, was not sustainable nor were they able to raise sufficient amounts to cover the cost of heavy capital investment. In the case of IWK, the situation was even more precarious as

it was operating in the absence of a legal framework to allow it to change the tariff structure or take actions against defaulters.

While private sector participation is a way forward for the water services industry, it is important to consider that the industry involves major capital infrastructure investment, the costs of which are very high and often are beyond the private firms' financial capacity. It may be better to look into a PPP model as a potential alternative for privatization. The PPP model brings the government into a partnership with the private sector not only to undertake and complete major infrastructure projects but also to promote efficiency and accountability.

(ii) **Establishing an appropriate legislative and institutional framework.** In the Kuala Lumpur experience, the privatization of water services had proceeded with negligible federal regulation. There was no federal oversight of the concessionaires in terms of their performance, revenue generated, cost ratios, tariffs, and investment.

The WSIA 2006 is thus an important legislation for the water services industry in Peninsular Malaysia. For the first time, an encompassing legal framework is available to regulate the industry.

Previously, each state had its own water arrangements as water is land-related and falls directly under its jurisdictions. The result was different water arrangements and tariff structures. For states that had corporatized or privatized water supply services, tariff increases were built into agreements that allowed for periodic revisions of water tariffs without corresponding checks on the utility's improvement of efficiency and cost savings. There are many variations in tariffs across states. With the WSIA 2006 and SPAN Act 2006 coming into play, it is hoped that the disparity in water tariffs among states would narrow and become more uniform over time.

The exercise of drawing up the appropriate legislative and institutional framework is referred to as the nationalization of the water services industry in the country. In a federal structure like Malaysia, it is a "delicate" matter because it involves the states' position in the Constitution. The restructuring and centralization of the water services industry in Malaysia is necessary mainly because many state governments and private concessionaires are unable to invest heavily in the requisite infrastructure to address NRW—a major water problem in almost all states.

Although reforms in the water services industry are in place, there are still criticisms leveled at the reforms for not doing enough to encourage water conservation, especially in changing consumer behavior. Water cost does not feature significantly in the average consumer's household bill and yet there is a general reluctance among state governments to raise water tariffs. The new reforms try to consider this concern indirectly by introducing water forums to

open up dialogues on water issues (including tariff hikes) between SPAN and consumer groups.

(iii) **Providing a workable funding mechanism for water infrastructure investments using PPP.** The Kuala Lumpur experience shows that a privatization model that relies completely on the private sector to finance water infrastructure is not sustainable in the long term. For example, the pipe replacement program of SYABAS will cost at least RM2.6 billion. It borrowed on the open bond market to raise funds. It is facing difficulty in meeting debt repayment because it has used tariff reviews that are scheduled in the concession agreement to support payment. A 37% increase in the water tariff scheduled for 2009 did not proceed, resulting in SYABAS seeking legal discourse. The federal government is considering financial assistance to SYABAS to enable it to meet its debt obligations.

In the case of IWK where its earlier privatization exercise failed, its new PPP model where both the government and the private sector work jointly to finance the heavy investment helps IWK address its earlier funding problems and improve its services.

Another example of PPP in Kuala Lumpur is the SMART project. It was expensive and had it been financed entirely by the private sector, it would be difficult to do. The cost-sharing arrangement, with the private sector financing only a third of the total cost, had worked to make the flood control project a reality.

The restructuring of the water services industry by the federal government shows a recent trend toward the PPP model in the water sector and in other major infrastructure projects. Through this, the government has created a special funding vehicle for infrastructure investment. In the water services industry, it has set up PAAB to rationalize all water assets in Peninsular Malaysia. In a largely fragmented industry, PAAB will take over the water assets of 11 states (excluding Sabah and Sarawak) and the Federal Territories of Kuala Lumpur, Putrajaya, and Labuan. PAAB will repay the owners of the assets, take over, and then lease the water assets to private operators, which will be licensed by SPAN to carry out their tasks. The lease terms will take into consideration the cost of assets and funding, viability of the water business, future profitability, incentive for operations, and maintenance of assets. PAAB will invest in new infrastructure, where needed. Essentially, PAAB, although a government-owned company, will operate like any private firm.

This rationalization of assets is a complex process, made more complicated by the fact that some states are under different political parties, and others like Johor and Selangor have long-term concessions in the water services industry that must be negotiated. By 2009, only three states—Johor, Melaka, and Negeri Sembilan—had completed the migration to the new model with

the assets transferred to PAAB.[65] Among the other states, Selangor's situation is the most fragmented with four concession-based private operators, and a state government with a different political philosophy from the federal government.

Challenges

The water services industry in Kuala Lumpur faces numerous challenges, as follows:

(i) **Long-term solutions to water shortages.** Selangor has been identified as a water-scarce state and is expected to face a water shortage after 2011. Current capacity will not be able to meet future water demand, and some water treatment plants have reached the limit of their capacities. The federal government, under the Ninth Malaysia Plan (2006–2010), has implemented a project on interstate raw water transfer from Pahang to Selangor, which would bring 2,260 million liters of water per day into Selangor (Raja Zainal Abidin 2004). There are fears that the completion of the project would be delayed by the prolonged water dispute in Selangor between the state government and the water concessionaires.

(ii) **Moving toward a demand approach instead of a supply-driven approach.** Traditionally, when water shortages are expected, new sources are found and developed. Water conservation campaigns are ongoing but impacts are limited. During the 1998 water crisis, conservation campaigns were launched to educate the public on water-saving measures, but the campaigns have stopped. Public concerns over the lack of emphasis on water demand management in planning and development of water resources in Selangor were raised but not sustained over time. Previous efforts in water conservation were piecemeal and failed due mainly to a lack of continuity and enforcement. Under the WSIA 2006, SPAN would likely spearhead a move to put more attention on water conservation in future planning and development of water resources.

(iii) **Tackling poor water quality and replacing aging water pipelines.** Over the years, there has been dissatisfaction with the water supplies in Kuala Lumpur. Water that leaves treatment plants complies with world standards but gets contaminated in its transmission to users. While SYABAS had initiated an effective complaints management system, dissatisfaction on water quality was only registered by 2% of complaints in 2008. Many consumers take it on their own to install home water filter units.

[65] By 2011, Penang and Perlis have been added to this list.

To continually assure the public on water quality, the MOH relies on its water surveillance program. But as 40% of the distribution system in Selangor and Kuala Lumpur are made up of old asbestos cement pipes, some of which are more than 35 years old, this problem could not easily be solved through surveillance only. There are a host of problems associated with poor water quality. Rust in the old water pipes also contributes to the poor water quality in Kuala Lumpur. The service reservoirs were found to be poorly maintained; there are too many interconnections of different supply systems, resulting in frequent reversal flows in the pipes; and designs of the distribution system are poor. It is further aggravated by consumer premises having old galvanized iron pipes and storage tanks. To resolve these problems would require massive investments in upgrading and new infrastructure by the public and private sectors.

The replacement of aging water pipelines has been identified as a priority at the national level to reduce NRW. SYABAS was to implement the pipe replacement program in Selangor and Kuala Lumpur. However, the project has been put on hold since April 2009 pending the restructuring of water services.

(iv) **Reducing the high rate of nonrevenue water.** Another major area of concern is NRW. In Selangor and Kuala Lumpur, NRW is caused by a number of factors. This affects the revenue of the utility firm and the recovery of capital and operating costs. To reduce NRW, SYABAS had used pressure-reducing valves in its networks. This has been acknowledged as an innovative measure, especially in aging pipelines (Kingdom, Liemberger, and Marin 2006, 13). Between 2002 and 2004, the reported NRW was very high—in the range of 43%–44%. By 2008, SYABAS had reduced it to 34%. It is further obliged to reduce it to 15% by 2015 under its concessionaire agreement. The pipe replacement project is expected to reduce NRW significantly in Kuala Lumpur and Selangor. But with the new institutional arrangements taking place, the project has been put on hold, and the eventual target on NRW remains uncertain.

(v) **Removing gaps in the coverage of sewerage services.** The public sewer network does not cover the entire city, in particular, the residential areas that still use individual septic tanks. Aging sewer pipelines have to be replaced, requiring heavy capital investment. Recovery of costs from fees charged to consumers is still a challenge for IWK. IWK wants to pool all sewerage services in Kuala Lumpur into a centralized system to improve wastewater management and to address river pollution. To do this, it needs a legislative and regulatory framework to operate effectively. This may be possible when the WSIA 2006 is fully implemented throughout Peninsular Malaysia.

(vi) **Managing flash floods.** Floods in the center of the city are caused by excessive downpours and overflows of the rivers. To address floods in the city, the SMART project was initiated and implemented as a PPP scheme. The tunnel has successfully demonstrated its objective but other parts of the city continue to face flash floods. Constraints over the availability of land and financial resources have limited the expansion of this demonstration model in Kuala Lumpur.

Conclusion

Resolving the challenges in the water services industry in Kuala Lumpur will take time but they are not insurmountable, especially when the federal government has made a commitment to transform the industry. Among the industry reforms are the two legislations passed in Parliament in 2006. The WSIA 2006 and SPAN Act 2006 have empowered the federal government to move into an area that has always been under the state jurisdiction provided for in the Malaysian Constitution. Over the years, the water services industry under state governments was not always well-managed, and the Kuala Lumpur experience is not an exception. While privatization has helped to resolve some issues, problems continue to beset the industry.

Through reforms, the federal government has begun to address the challenges in the water services industry, including reducing NRW, improving efficiency, and attaining full cost recovery. The industry reforms are undertaken without causing major structural changes that would disrupt water services. The emphasis now is on performance and efficient delivery of services. The federal government has found the PPP model to be more practical. Under PPP, the federal government injects funds to cover capital outlay, thus enabling the water service providers to focus on the efficient provision of water services. This signals Malaysia's move away from the privatization model adopted in the 1980s and 1990s, reflecting a paradigm shift in its approach in managing the water services industry. As this partnership strengthens, it is believed that water services in Kuala Lumpur will benefit and continue to strengthen and improve in the future.

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CHAPTER VI

Manila, Philippines

Juan Miguel Luz and Maria Lynn Paladio-Melosantos[66]

Introduction

Metro Manila is the smallest region of the Philippines in terms of land area, covering 636 square kilometers (km^2), or 0.21% of the country's total land area.[67] It is the most populated region, with over 11.5 million inhabitants or 13% of the country's total population. The population density is estimated at over 18,000 persons per km^2 (Figure 1), making it one of the most densely populated cities in the world (NSO 2008). The proportion of its informal settlers is estimated to be as high as 40% of the total population (Osakaya 2002).

Topographically, the region is divided into four physiographic elements (Figure 2):

(i) a central plateau, 5–70 meters (m) above sea level, occupying 62% of the land area;

(ii) the coastal lowland bordering Manila Bay to the west;

(iii) the Marikina Valley to the northeast, bordered by the Sierra Madre Mountains; and

(iv) the lakeshore lowland bounded by Laguna de Bay (also called Laguna Lake) to the east and southeast.

Metro Manila is drained by two rivers, the Marikina and Pasig rivers. The Marikina River drains 506 km^2 of basin area down to the Pasig River and finally to the Manila Bay during normal river discharge. A network of 290 kilometers (km) of natural *esteros* (estuarial network of narrow tidal creeks) and man-made canals, fed by approximately 50 km of primary drains and 1,200 km of secondary drains serve as the storm water management system for Metro Manila except those areas that directly discharge water to the Pasig River or the Manila Bay (ADB 2010). Laguna de Bay serves as a natural detention reservoir to 21 subbasins, including Metro Manila's basins (Felizardo 2006).

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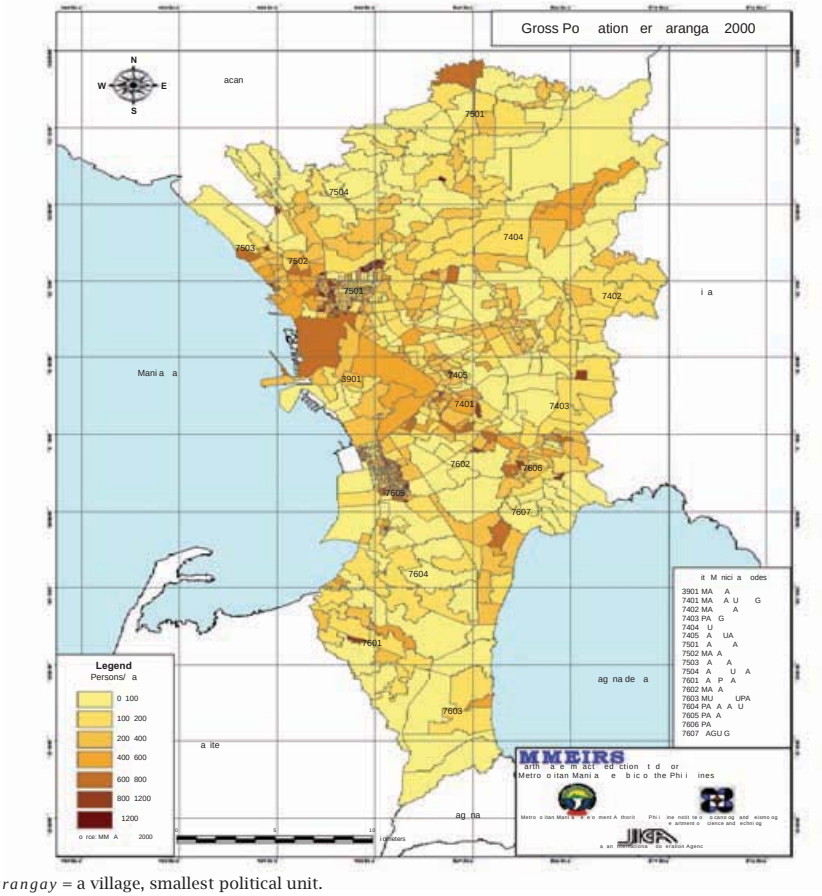
[67] Metropolitan Manila (Metro Manila) is the national capital region of the Philippines. It is composed of 16 cities and one municipality.

Figure 1 Density of Population per *Barangay*



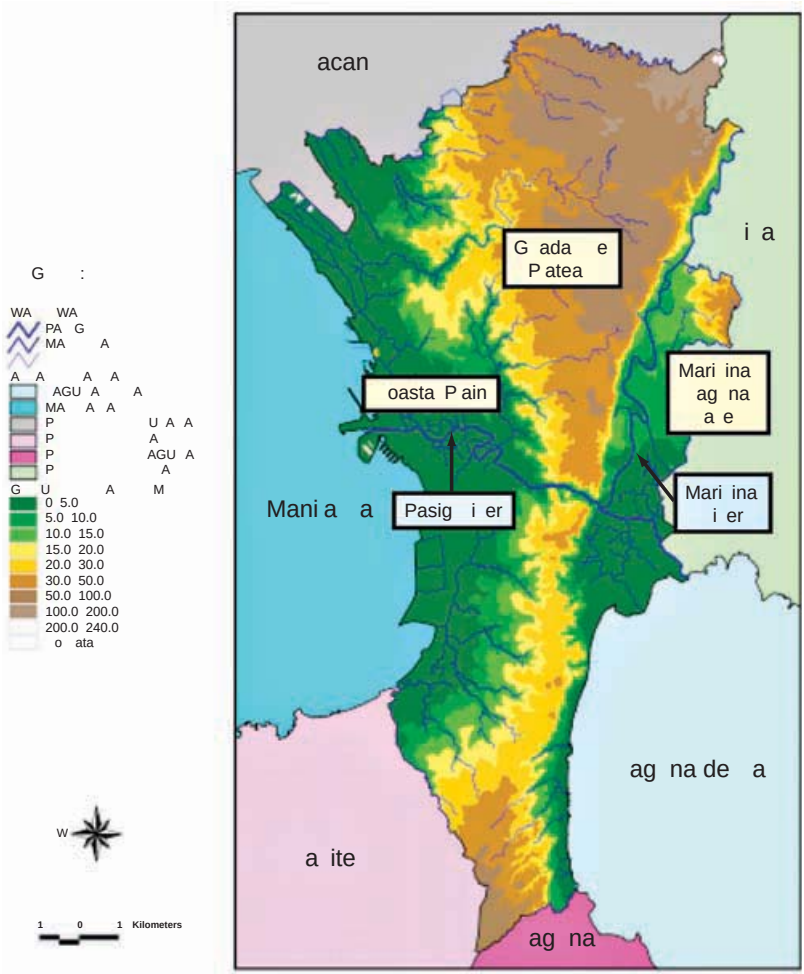
Barangay = a village, smallest political unit.

Source: JICA, MMDA, and PHIVOLCS (2004), pp. 8–9. Cited with permission from MMDA.

Metro Manila is vulnerable to natural disasters such as typhoons (average of 3–5 typhoons per year). High population density, the deteriorated infrastructure, and land use pattern worsen Metro Manila's vulnerability to natural disasters. Urbanization and growth have been rapid, and the provision of infrastructure, enforcement of building codes, and adherence to development standards have lagged. As a result, there has been flooding of the main rivers and drainage system, the most recent flooding being due to typhoon Ondoy[68] (international name Ketsana) in September 2009, which inundated an area of at least 20% of Metro Manila.

[68] During the 12-hour period starting at 8:00 a.m. on 26 September 2009, the total rainfall recorded at the Manila Observatory was approximately 450 millimeters (mm), which relates to a rainfall event that statistically occurs once every 180 years. The peak rainfall intensity for the storm was recorded between 10:00 a.m. and 11:00 a.m. at 60 mm/hr.

Figure 2 Topography Map of Metro Manila



Source: ADB (2010).

Major flood mitigation programs have been carried out since the 1970s. However, drainage projects need to be sustained because once drainage channels are constructed or rehabilitated, they require ongoing maintenance to prevent their degeneration, or from becoming blocked with debris, or being built over by informal settlers (ADB 2010).

Institutional Setting and Governance

In 1995, the Metropolitan Manila Development Authority (MMDA) was created by virtue of Republic Act 7924 to "perform planning, monitoring and coordinative

functions, and in the process exercise regulatory and supervisory authority over the delivery of metro-wide services within Metro Manila without diminution of the autonomy of the local government units concerning purely local matters" (Government of the Republic of the Philippines 1995). MMDA is an administrative set-up tasked with oversight over specific infrastructure within Metro Manila.[69]

MMDA is headed by a chairperson appointed by the President of the Philippines and has no supervisory powers over the local government unit (LGU) chief executives. MMDA resolutions apply only to major infrastructures operated under its management and have no prior claim over LGU ordinances outside these areas.

MMDA is responsible for the formulation and implementation of policies, standards, rules and regulations; programs and projects for an integrated flood control, drainage, and sewerage system; dredging and unclogging of drainage channels; operation and maintenance of pump stations and floodgates; and operation of flood warning systems. It is also responsible for securing solid waste landfill sites for Metro Manila to support LGUs' solid waste programs. Other water management functions are carried out by several governing entities, as follows:

(i) LGUs, which are responsible for solid waste management and the maintenance of local creeks and canals (*esteros*), keeping these free of garbage for storm drain purposes.

Contractors at work during an interconnection activity in Sta. Mesa, Manila.
Photo by Federico Juane.

[69] The MMDA is not a political unit but a development authority.

(ii) The Department of Public Works and Highways (DPWH), which is responsible for the construction of major flood control works affecting cities or the region as a whole. It functions as the engineering and construction arm of the government.

(iii) The Pasig River Rehabilitation Program, which involves the clean-up of the Pasig River from mouth to source under the supervision of the Department of Environment and Natural Resources (DENR). The program has been supported by the Danish International Development Agency (DANIDA) since the early 1990s.

(iv) The Laguna Lake Development Authority (LLDA), which has jurisdiction over the Laguna Lake, including the licensing of fisheries and fish pens, environmental management, and transport use.

Privatization of Metropolitan Waterworks and Sewerage System

Historically, the Metropolitan Waterworks and Sewerage System (MWSS) was the main corporation providing water and sewerage services in Metro Manila. The footprint of MWSS, however, is much larger than Metro Manila (636 km^2), covering 1,940 km^2 extending north to cover small portions of the province of Bulacan, east to include the province of Rizal, and south to include towns in the province of Cavite. The population of the utility area is 15.1 million.[70]

However, due to rapid urbanization and industrialization, Metro Manila experienced high demand for water and sewerage services, and deterioration of existing infrastructure. This prompted the then President Fidel V. Ramos to reorganize MWSS and to encourage private sector participation in the reform of MWSS' operations and facilities. From being a government service provider, MWSS was transformed into a corporate office (MWSS-CO) and a regulatory office (MWSS-RO) as a result of the privatization of the system. Under the terms of the concession agreement, MWSS now plays two roles—asset owner and regulator.

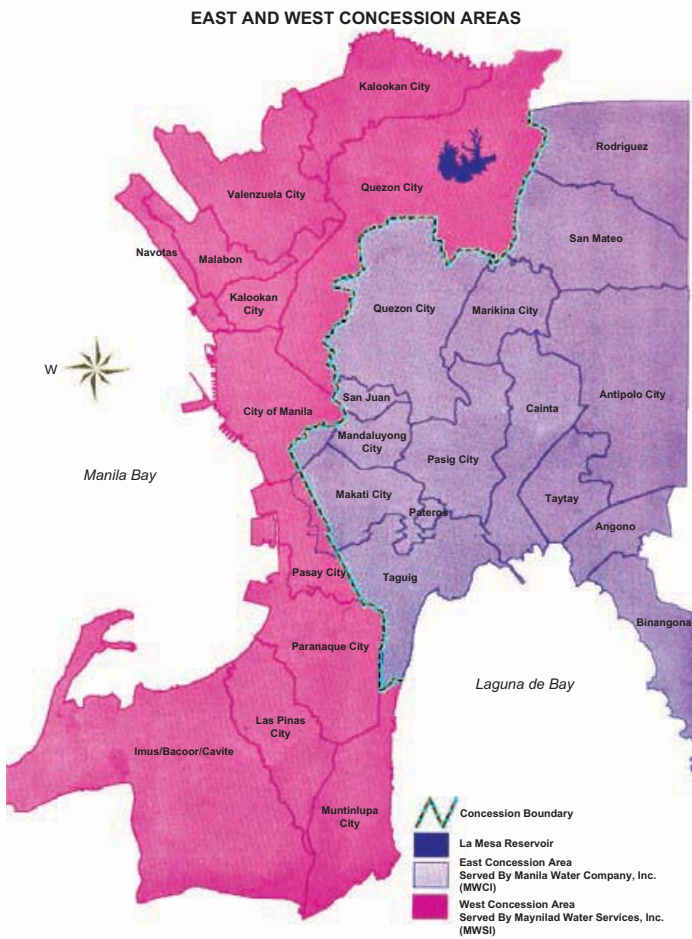
The privatization of MWSS in 1997 was led by President Ramos, showing the political and government commitment to improve service delivery to the population. It was the largest privatization exercise of water utilities in the world. From a single water utility run as a government corporation subject to government accounting, auditing, and civil service rules, the operation of Metro Manila's water distribution

[70] Population estimated by the MWSS-RO. The figure combines the population estimates used for the East and West concession areas. The latter two estimates are the denominators used in determining population coverage under the Concessionaires Service Performance Information.

and sewerage system was divided into two concession areas emanating from the left and right banks of the Pasig River.

The East concession zone included the entire province of Rizal to the east. The West concession zone extended north into some municipalities in Bulacan Province and south to include portions of Cavite Province. A small portion of the city of Manila to the right side of the Pasig River went to the East concession zone, while the remainder of the city was included in the West concession zone. The demarcation of the concession boundary was largely based on interconnection across the boundary. This is to minimize the number of interconnections and avoid potential disputes over interconnection charges between the two concessionaires (Figure 3).

Figure 3 Delineation of the East and West Concession Zones of the Metro Manila Water System



Source: Metropolitan Waterworks and Sewerage System–Regulatory Office.

The East concession zone was awarded to Ayala Corporation and its international partners—United Utilities (United Kingdom) and Bechtel Corporation (United States). This new company took on the name Manila Water Company, Inc. (MWCI). The West concession zone was awarded to Benpres Holdings of the Lopez Group of Companies together with its international partner, Lyonnaise des Eaux (France). This concessionaire became known as Maynilad Water Services, Inc. (MWSI).

The privatization of water delivery in Metro Manila provides three points of comparisons from which lessons can be derived regarding urban water management.

(i) The pre-privatization situation versus post-privatization results

- Did privatization improve the delivery of water and sanitation to the citizens residing in Metro Manila?
- Did the strategy pay off for the government and society as a whole?

(ii) The initial East versus West concession experience (1997–2002)

- Given the same external conditions and constraints, why did one concession succeed and the other struggled?
- What were the internal factors that led to the success of one and the problems of the other, since the external factors were similar?

(iii) The initial West (old MWSI) versus the successor West (new MWSI) management strategy

- What lessons did the replacement operator learn from the troubles of the initial West concessionaire and were used to turn around the concession?

During the negotiation period of the privatization exercise, several issues emerged. These included issues on (i) how to split the remaining MWSS staff who did not avail themselves of early retirement, (ii) how to split (or share) the MWSS database, and (iii) how to manage interconnection. Interconnection was a particularly contentious issue that MWSS decided to let the two winning concessionaires work out in advance and agree on a transfer price. Based on the division of the coverage area into two concessions, the bid document established that the demand for water was 40% of total production for the East concession zone and 60% for the West concession zone.

Another issue was how to split the existing debt of MWSS. Recommendations were sought from all bidders, and the final ratio agreed by all parties was 90/10 with the West concession zone shouldering the bulk of the debt (Dumol 2000). The agreement formed part of the bid document. The International Finance Corporation, which the government had hired as the lead adviser of the privatization exercise, assumed that the West concession zone covering the older parts of the

metropolis was a "brownfield" where the bulk of the pipe assets of MWSS were laid and would require less capital investment. The East concession zone, on the other hand, was a "greenfield" where new pipes had to be laid in the southern expansion of Metro Manila and for expansion eastward into Rizal Province.[71] This was

Box 1 Key Provisions of the Concession Agreement

Service Obligations

- Provide 24-hour uninterrupted water supply to all connected customers by 30 June 2000.
- Comply with Philippine National Standards for Drinking Water (DOH)[a] within 12 months of the commitment date (1 August 1998).
- Provide free water for fire-fighting purposes and other public purposes as requested by local governments in the concession area.
- Offer septic and sanitation cleaning services in the service area (e.g., emptying of domestic septic tanks and sludge disposal at least every 5 years).
- Provide mandatory household connections to a public sewer.
- Comply with national and local environmental laws related to wastewater treatment.
- Address customer complaints.

Turned Over Common-Purpose Facilities

- Facilities upstream of the Angat Dam[b]
- Facilities downstream of the auxiliary hydropower plant at Norzagaray, Bulacan
- Ipo Reservoir facility
- Ipo–Bicti tunnels
- Bicti basins
- Bicti–Novaliches aqueducts
- Novaliches Portal interconnection facilities
- Magallanes Sewage Treatment Plant (East)
- Central collecting system (West)
- La Mesa Dam and Balara Tunnel (East)

Rate Rebasing

- Rate rebasing schedule: 2003, 2008, 2013, 2018 (1 January)

Failure of Concession

Rules and procedures for the identification and appointment of a qualified replacement operator, to be proposed by the concessionaire lenders, that is also acceptable to the MWSS–Regulatory Office.

[a] Philippine National Drinking Water Standards is the nomenclature of the DOH.

[b] The Umiray Angat Transbasin Project was a major ongoing project to be completed by MWSS before being turned over to the two concessionaires.

Source: Concession Agreement, Metropolitan Waterworks and Sewerage System.

[71] Based on an interview by the authors with Dr. Fiorello Estuar, former president, MWSI, 16 September 2009 at Benpres Building, Pasig City, Philippines. Dr. Estuar was MWSI's president from 2004 to June 2007.

a critical consideration because the debt service of MWSS was to be the major component of the concession fee charged annually to both concessionaires. This assumption became a major burden for the old MWSI after the onset of the Asian financial crisis when the peso depreciated by more than half in 1997–1998 and eventually led to MWSI's demise under Benpres management.[72]

After Privatization

After the privatization exercise, MWSS has remained the owner of its fixed assets (water pipes, filtration plants, and dams). MWSS-CO is mainly responsible for monitoring and reporting the assets in accordance with government accounting and auditing rules.[73] During the duration of the concession agreement, both private utilities could have full use of the MWSS infrastructure, including moving assets, at no charge other than the agreed concession fee. Any new investment undertaken by either of the two utilities, however, will eventually be turned over to MWSS at the conclusion of the concession agreement.[74]

MWSS-RO was created by Article 11 of the Concession Agreement to be a body within the MWSS. Dumol recounted the debates over whether or not an independent regulatory office should be created. Ultimately, the lack of time led to the decision to create a semi-autonomous office within MWSS. Creating an independent RO would require legislation, a process that could drag on indefinitely given the independence of the Philippine Congress.[75]

The MWSS-RO is tasked to oversee the effectiveness of the legal and regulatory framework for water supply, wastewater, and storm water management. The office is also responsible for managing the discussions and rules governing annual rate adjustments (weighted average rate increases) for water and sewerage services. MWSS-RO ensures that standard rates are adjusted annually by an established percentage adjustment factor. If there is a different proposal put on the table by

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[72] Based on an interview by the authors with Rafael Alunan, former president, MWSI, Inc., 16 September 2009 at Benpres Building, Pasig City, Philippines. Alunan was MWSI's president from 1999 to 2004.

[73] The Concession Agreement only refers to MWSS and the Board and treats this as a single entity. The use of the term MWSS-CO is to distinguish this from the regulatory office referred to as MWSS-RO.

[74] When the authors interviewed the concessionaires for this study, MWCI suggested that MWSS-CO's tasks should include ongoing research and policy work related to the operation and management of water supply in the metropolis. Research should include the impact of climate change on the supply and demand for water in Metro Manila. Interview by the authors with Virgilio Rivera, government liaison and regulatory expert at the MWCI, was conducted on 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

[75] The clause in the Concession Agreement states that the MWSS would "cooperate" with the MWSS-RO, Dumol (2000), pp. 56–57.

one or both concessionaires, this is reviewed and acted upon by MWSS-RO.[76] Rate increases are subject to a rate adjustment limit. MWSS-RO is also responsible for rate rebasing to be done every 5 years.

If a concessionaire disagrees with the rate adjustment, an appeals process may be instituted. The concession agreement provides for an international appeals board initially chaired by a nominee of the International Chamber of Commerce with members from among experts residing in the Philippines.[77]

Both MWSS-CO and MWSS-RO are fiscally independent from the national government. Based on the concession agreement, the total annual operating budget of MWSS is to be borne by the two concessionaires at 50% each.

Other Regulators

Both concessionaires are required to comply with environmental standards imposed by the Department of Environment and Natural Resources (DENR) and the drinking water standards set by the Department of Health (DOH).[78] DOH administers regular monthly water samplings across the East and West concession zones.[79] Both utilities are required to file an annual report on water pollution and water standards with MWSS-RO.

While not explicitly mentioned in the concession agreement as regulators, the Environmental Management Bureau (EMB) and the National Water Resources Board (NWRB) under the DENR are the bodies that set and monitor water and wastewater standards at both the national and local government levels. Noncompliance with laws is subject to penalties as determined by regulators.

Supply Management

Freshwater Resources

Figure 4 shows the amount of water produced by MWCI and MWSI in 1998–2008.

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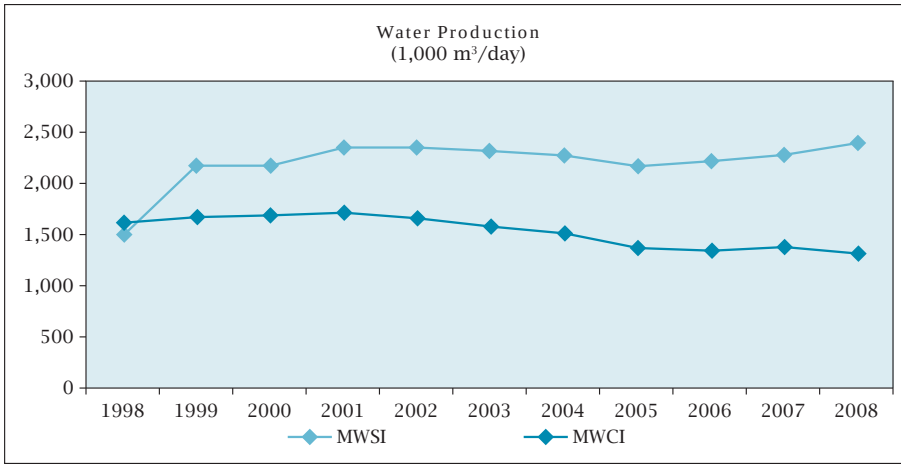
[76] While a proposal is being reviewed, an interim standard rate adjustment is used. If the proposed rate is approved, the weighted average rate increase is recalculated and applied. If the proposal is rejected, the standard rate applies.

[77] This means that experts may or may not be Philippine nationals. As long as they are residing in the Philippines, they can be nominated.

[78] DOH follows the standards set by the World Health Organization.

[79] In December 2011, the Metro Manila Drinking Water Quality Monitoring Committee (MMDWQMC), chaired by the DOH, and included the DENR (EMB and NWRB), MWSS-RO, MWCI, and MWSI reported 100% compliance with national drinking water standards based on 1,405 samples taken from different testing sites. Of this number of samples, 606 were taken from the East concession zone and 799 were taken from the West concession zone (MMDWQMC 2011).

Figure 4 Water Production, 1998–2008



m³/day = cubic meters per day.

Sources: Data collected from the Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI).

The Angat Dam is Metro Manila's primary source of water. The dam is located in a 62,000 hectare watershed in the province of Bulacan, northeast of the metropolis. It has a storage capacity of 850 million cubic meters (mcm) and provides 98% of the water distributed by MWCI and MWSI. Besides water storage, the Angat Dam is also used for power generation and irrigation.[80]

From the Angat Dam, water flows down to the smaller Ipo Dam, which has a storage capacity of 7.5 mcm. From the Ipo Dam, water traverses through three tunnels to the Bicti Basin in Norzagaray, Bulacan, north of Metro Manila. Water from the Bicti Basin is channeled to five aqueducts for a 14-km transfer to the La Mesa Dam within the northeast portion of the metropolis. The La Mesa Dam has a water storage capacity of 50.5 mcm (MWCI 2008b).

While the northern cities in Metro Manila have adequate supply of water due to the presence of the Angat, Ipo, and La Mesa dams, groundwater resources have been used extensively in the south by privately owned and operated deep wells. These private operators supply water to households, industries, and businesses where water connections are unavailable or water pressure is so low that it is difficult to extract water from existing MWSS connections. The over-extraction of groundwater has resulted in the serious depletion of this resource, saline intrusion, and contamination of aquifers (MWCI 2007, 25).

Metro Manila's surface water mainly comes from the Angat and Umiray rivers and their tributaries located north of the metropolis. The Pasig and Marikina rivers

[80] The Angat Dam is owned and operated by the National Power Corporation.

within Metro Manila were heavily polluted with 65%–75% of pollution caused by residential sewage, and the rest from industries such as tanneries, textile mills, food processing plants, distilleries, and chemical and metal plants (Campos 2007). This is further aggravated by solid waste dumped into both rivers, which had rendered both rivers biologically dead or unfit for drinking purposes (Murphy and Anana 2004). While Metro Manila receives sufficient amounts of rainfall, poor watershed management inhibits efficient retention of runoff to the freshwater table.

Development of New Water Sources

Developing new sources of water is a major provision in the concession agreement. One major new source of water for Metro Manila was the proposed Laiban Dam in Tanay, Rizal Province. The project, scheduled to be developed and brought on-stream in 2012, was intended to provide a steady supply of water as a backup to the Angat source.

In 2009, MWSS attempted to enter into an agreement with a third party, San Miguel Bulk Water Company, to build the dam. Both MWCI and MWSI questioned the project on a number of fronts including the scale of the project and the bidding process. The question of why the dam project was being bidden out by MWSS when both utilities were responsible for water production under the concession agreement raised issues on the role and intentions of MWSS-CO. Furthermore, there was a controversial "take-or-pay" provision in the proposed dam project that would have to be passed on as an additional cost to consumers even if water was not consumed.[81] Both concessionaires agreed that the Laiban Dam project was a good project that would provide a second major source of water in Metro Manila.[82] However, they opposed the project design that called for the construction of a single complete unit rather than making the dam scalable over time. By the end of 2009, the project was put on hold.[83]

In the interim, MWCI is implementing the Taguig Wellfield Project, which will supply 5 million liters per day (MLD) of water in the southern portion of the East concession area. Besides, a new water treatment facility was built in Taytay to supply 3 MLD to the Rizal Province (MWCI 2008b). Meanwhile, MWSI began the construction of a water pumping station in Muntinlupa City in the southern part of Metro

[81] There was an equally controversial "take-or-pay" provision in the independent power supply agreements crafted to address the power crisis in the early 1990s. This has made power rates among the highest in the region.

[82] The Angat Dam provides 98% of the water needed by Metro Manila. From a water security point of view, this is a potential problem. Should anything happen to the Angat Dam (e.g., a major earthquake), Metro Manila residents would lose their single and major source of raw water. Thus, there is a need to develop an alternative source as a backup.

[83] Based on an interview by the authors with Rogelio Singson, president, MWSI, 22 October 2009 at MWSS Complex, Balara, Quezon City, Philippines.

The children of Barangay 123 in Tondo, Manila now enjoy a cheap and reliable supply of drinking water after MWSI mobilized the community to facilitate water connections under the *Samahang Tubig* Maynilad Program.

Photo by Federico Juane.

Manila. The water pumping station will draw water from the Laguna Lake and make water available to expansion areas in the southern part of the metropolis (e.g., the cities of Muntinlupa, Parañaque, and Las Piñas) and the northern portion of Cavite Province.[84]

Management of Metro Manila Water System after Privatization

Initial Impact of Privatization (1997–2002)

For the public, the immediate benefit of privatization was the lowering of water tariffs. Consumers in the East concession zone (MWCI) immediately saw almost 54% taken off their monthly water bills. Those in the West concession zone (MWSI) benefited by a drop of 18%.[85]

The bidders proposed such low water tariffs during the privatization exercise because they believed that they could bring down the high nonrevenue water (NRW) after winning the bid.[86] The thesis was that a reduction in NRW would increase potential revenue (i.e., billable water) and reduce wastage of the product (water). This would increase profitability and improve the return on investment.

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[84] Ibid.

[85] The drop in base tariff was 72% for the East concession zone and 42% for the West concession zone. This reflected the bid prices of the winning bidders before currency adjustments and taxes. With the addition of exchange rate adjustments, environmental charges, and value-added tax, the drop in tariff rates were less pronounced to the consumer and end-user.

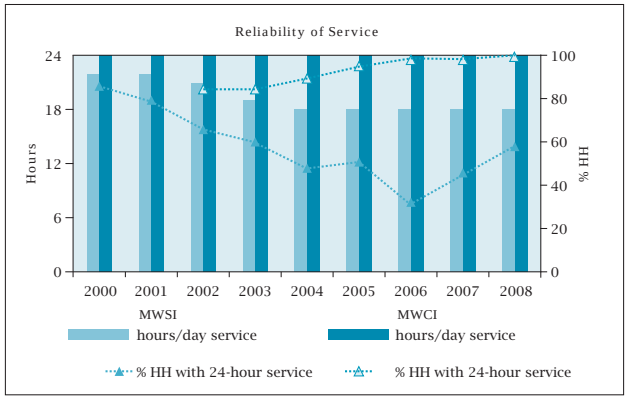
[86] There is no single explanation for the low bids but rather a combination of the confidence in their technology and the aggressiveness to win a bid with no precedent (Dumol 2000, 122).

With larger profits, the concessionaire could reinvest retained earnings to upgrade its network and improve its productivity. In short, the success of privatization and the attainment of welfare benefits were entirely dependent on establishing a new, virtuous cycle of productivity (e.g., billable water) where previously there was only a vicious cycle of resource waste (e.g., NRW). Bringing down NRW was thus critical to the success of the bid in the long run.[87]

In the initial period (1997–2002), there was a marked improvement in a number of key indicators. Water coverage rose from 67% to 79% of the population, increasing further to 84% by 2005 in the East concession zone. Water availability to customers went up from 17 hours of service per day on average to 21 hours, a 23.5% increase over the base year service. Households with access to 24-hour water service in the East concession zone rose from 25% to 99% during 1997–2008. Data on water service reliability from MWCI and MWSI since 2000 is presented in Figure 5. Staff per 1,000 connections dropped from a high of 9.8 in 1996 to 4.1 in 2002 and declined further to 2.6 in the East concession zone and 3.5 in the West concession zone by 2005, closer to the norms in the region (Table 1) (Fabella 2006; Bernardo and Tang 2008).

Water connections for the urban poor—an unserved segment—increased, particularly in the East concession zone with the introduction of innovative social programs to provide for water service connections at affordable rates. The number of service connections also rose in both concession zones as households and businesses were able to shift from using groundwater sources to piped connections.

Figure 5 Reliability of Water Service



HH = households.

Sources: Data collected from Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI).

[87] Based on an interview by the authors with Rene Almendras and Virgilio Rivera, MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

Table 1 Water Service in Manila Compared with Other Major Asian Cities (1996: Pre-privatization, 2002: Prior to the first rate rebasing, and 2005)

City	Population (millions)	Water Availability (hours/day)	Coverage (% of Population)	Nonrevenue Water (% of Production)	Staff/1,000 Connections
1996					
Manila	10.6	17	67	61	9.8
Singapore	3.0	24	100	7	2.0
Hong Kong, China	6.3	24	100	36	2.8
Seoul	10.6	24	100	35	2.3
Kuala Lumpur	1.4	24	100	36	1.4
Bangkok	7.3	24	82	38	4.6
2002					
Manila		21	79	62	4.1
MWCI		21	82	53	4.1
MWSI		21	79	69	4.1
2005					
Manila		21	85		
MWCI		21	84	35	2.6
MWSI		21	85	68	3.5

MWCI = Manila Water Company, Inc., MWSI = Maynilad Water Services, Inc., NRW = nonrevenue water.

Sources: All data, except population data, are from Fabella (2006) and Bernardo and Tang (2008). Population data are from Wu and Malaluan (2008).

While the concessionaires had hoped to lower NRW after winning the bid, NRW remained high in the short term. It then dropped significantly in the East concession zone. Water tariffs rose sharply, albeit from a low base, and continued to be a contentious issue as regards privatization (Table 2).

The two concessionaires' experience is vastly different from each other. MWCI managed to become profitable by 1999. In March 2005, it was listed on the Philippine Stock Exchange. This was a measure of the public's trust in MWCI's ability to deliver results. MWSI, on the other hand, became financially distressed within 3 years from the time the concession was awarded in 1997. In December 2002, MWSI issued a notice of early termination of the concession, which was challenged by MWSS. In 2003, the matter was brought before an appeals panel for arbitration. The panel ruled that neither MWSI nor MWSS could terminate the concession.

MWSI filed a petition for corporate rehabilitation (Chiplunkar et al. 2008).The government reclaimed the concession and carried out a successful rebidding process for a qualified replacement operator. In 2007, MWSI was handed over to its new owners, D. M. Consunji Holdings, Inc. and Metro Pacific Investments Corporation (DMCI–MPIC).[88]

Table 2 Tariff Rates Before and After Privatization (in nominal Philippine peso per m^3)

	Average Base Tariff		Average All-in Tariff[a]	
Pre-Privatization	MWSS		MWSS	
	8.78		11.14	
Post-Privatization	MWCI	MWSI	MWCI	MWSI
1997/98	2.32	4.96	4.02	7.21
1999	2.61	5.80	4.37	8.23
2000	2.76	6.13	4.55	8.63
2001[b]	4.22	10.79	6.32	14.27
2002	4.51	11.39	9.37	19.92
2003	10.06	11.39	13.88	19.92
2004	10.40	11.39	14.01	19.92
2005	13.95	19.72	18.64	30.19
2006	14.94	21.12	19.96	32.34
2007	15.90	22.47	20.68	32.99
2008	19.64	23.05	24.64	31.66

m^3 = cubic meter, MWCI = Manila Water Company, Inc., MWSI = Maynilad Water Services, Inc., MWSS = Metropolitan Waterworks and Sewerage System.

[a] All-in tariff = Base tariff + currency exchange rate adjustment (CERA) + foreign currency differential adjustment (FCDA) + environmental charge (EC) + value-added tax (VAT).

[b] Effective 21 October 2001. Includes the accelerated extraordinary price adjustment.

Notes:

(i) Starting with the 2008 rate rebasing, CERA was bundled in with the base tariff for MWCI.

(ii) CERA is an additional charge of P1.00 per cubic meter of water consumed.[89]

(iii) FCDA is a percentage component of the basic water charge to account for quarterly foreign exchange losses or gains arising from the concessionaire's payment of foreign currency denominated concession fees to MWSS, and loans for its service expansion and improvement.

(iv) EC is a monthly charge imposed on a customer equivalent to 10% of the basic water charge before the 2008 rate rebasing. After the 2008 rate rebasing, the EC and a sewerage charge were harmonized so that all customers would be encouraged to connect to sewer lines once these were made available. The rates since 2008 went up by an additional 2% per year until these settle at 20% in 2013.

(v) VAT is value-added tax set at 12% and imposed since February 2006.

Sources: ADB (2008b), p. 11 and p. 41; MWSS-Regulatory Office.

[88] DMCI is a holding company engaged in construction and related businesses, while MPIC is a holding company engaged in real estate and infrastructure projects. Both companies are incorporated in the Philippines.

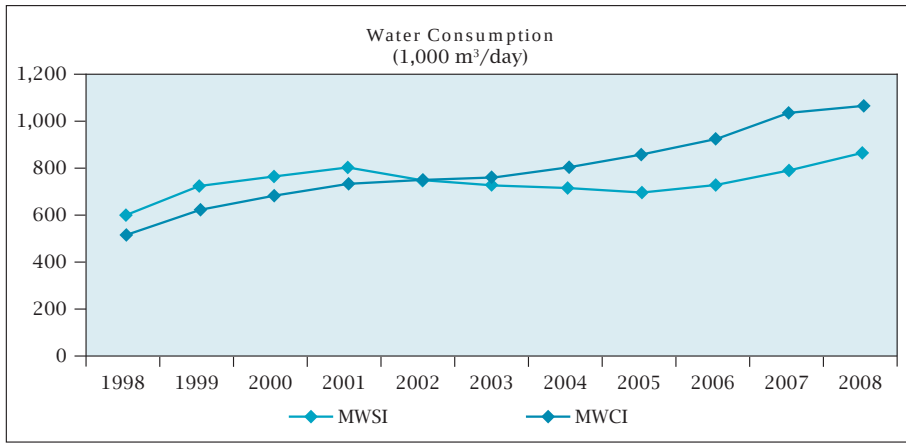
[89] CERA is a special transitory mechanism to enable a concessionaire to recover foreign exchange losses incurred in 2001 and any under-recovery of the accelerated extraordinary price adjustments as of 31 December 2002 (ADB 2008b, 35).

Growth in Utility Coverage and New Connections

The East concession zone has a significantly larger footprint (1,400 km^2) than the West concession zone (540 km^2). In 2000, MWCI served only 8.9% of its area of responsibility. This was expanded to 18.8% by the end of 2008, doubling the service area coverage. As MWCI doubled its area coverage in the East concession zone, the population served grew sharply. While the general population of the entire geographical area (1,400 km^2) grew by 33% from 4.5 million in 1998 to 6.0 million in 2008, the population served by MWCI grew from 3.1 million in 1998 to 5.6 million in 2008, representing an increase of 81%. Over the 10-year period (1998–2008), the company more than doubled the number of household connections—from 311,000 to 641,000.[90] The faster growth in the population served compared to the total population in MWCI's area of responsibility was part of its growth strategy. The company aimed at expanding its services to densely populated new areas and aggressively connected households to generate more revenue.[91]

By comparison, the West concession zone's smaller footprint (540 km^2) already constituted 100% of MWSI's area of responsibility. Therefore, the bulk of the work

Figure 6 Water Consumption, 1998–2008



Sources: Data collected from Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI).

[90] Household size was reported to be smaller in 2008 (5.6 per household) than in 1998 (9.2 per household). While these are assumptions made by MWCI, they also reflect the smaller household size in areas further away from the core of urban Metro Manila. Less expensive land and lower housing costs (amortization or rentals) further away from the core of Metro Manila allows for smaller households to manage costs.

[91] Based on an interview by the authors with Rene Almendras, president, and Virgilio Rivera, government liaison and regulatory expert at MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

was to retrofit and rehabilitate existing pipes rather than open up new areas. Serving the older parts of Metro Manila meant working in more densely populated areas where excavations would be more challenging to carry out. For Dr. Fiorello R. Estuar, last president of the old MWSI under the Benpres/Lopez Group, building new infrastructure is easier to carry out and less costly than replacing old infrastructure. Both involve digging, but laying new pipe is cheaper and more controllable than trying to locate and replace old pipe.[92] For MWSI, the growth in water connections was initially in formalizing meter connections in areas where both households and commercial establishments had illegal or unreported connections rather than new service connections.[93]

The initial 5 years of the concession agreement saw both utilities aggressively working on getting a better understanding of the actual situation of water demand and supply. The first stage was to replace the meters of existing households that were defective or inaccurate. It was important for both concessionaires to identify how much water was actually consumed and how much was nonrevenue. The first step MWCI took was to re-meter existing households and whole areas where meters provided incorrect readings. The quality of data was important to be able to assess the amount of investment needed to initiate rehabilitation of the system.[94]

For MWCI, meter replacement jumped tenfold from a low base; for the old MWSI, the increase was fourfold. Once re-metering was well underway, both utilities began to expand the water network. Over a 10-year period (1998–2008), the East concession zone network grew by 48.1% in pipeline length. The West concession zone, on the other hand, had a slower start with a network growth of 14.8% during 1998–2002. This was due to a lack of investment capital as MWSI experienced financial distress aggravated by the Asian financial crisis.[95] However, during the transition period when the old MWSI was undergoing rehabilitation and immediately after the change of ownership to DMCI–MPIC, the West concession zone pipeline network grew at a faster rate (27.4%) between 2003 and 2008.

Three years after taking over the East concession area, MWCI reported 24-hour water availability in its coverage area. In 2008, the company reported that 99% of households in its coverage area had 24-hour access to piped water. MWSI, on the other hand, maintained water availability at 21–22 hours per day throughout its sector until this decreased in 2003. Since then, it has remained steady at 18 hours per day. Likewise, the percentage of households with access to 24-hour

[92] Based on an interview by the authors with Dr. Fiorello Estuar, former president, MWSI, 16 September 2009 at Benpres Building, Pasig City, Philippines.

[93] Based on an interview by the authors with Rafael Alunan, former president, MWSI, 16 September 2009 at Benpres Building, Pasig City, Philippines.

[94] Based on an interview by the authors with Rene Almendras and Virgilio Rivera, MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

[95] Based on an interview by the authors with Dr. Fiorello Estuar, former president, MWSI, 16 September 2009 at Benpres Building, Pasig City, Philippines.

water fell sharply from a high of 86% in 2000 to a low of 32% in 2006. In 2008, the percentage climbed to 58%, 1 year after the new MWSI management took over the West concession zone.

Turnaround Strategy of the New MWSI

Learning from the past experience of the old MWSI administration, the new MWSI adopted a fivefold strategy. First, MWSI needed to improve operational and network efficiency and to lower NRW significantly. Its target was to halve NRW to 20%–30% over 5 years. This was what MWCI did over the first 10 years of its agreement, which contributed significantly to its current success.

The second strategy was to attain organizational efficiency. In December 2007, at the start of the new administration's takeover, MWSI implemented a redundancy program that led to the voluntary separation of 33% of its workforce at the end of 2008. This allowed MWSI to reorganize and streamline its organization. Business operations, such as its call center for customer complaints,[96] meter reading, and cashless transactions and/or payments[97] were outsourced.

The third strategy was to achieve financial viability. It was important for MWSI to complete the rehabilitation of its organization and operations the soonest after it was handed over to the new administration. After the first year of the new administration, MWSI paid off the balance owed to MWSS as part of the $503.9 million rebid price. This allowed MWSI to move on to rate rebasing only 1 year later in 2009 than the original planned schedule in 2008. With this achievement, the utility could negotiate with the regulator for an increase in tariffs to improve its financial position.

The fourth strategy was to improve customer relations. MWSI would like to ensure that customer complaints are addressed immediately. This was the reason behind its decision to outsource its call center. Complaints received are relayed to MWSI staff, who then respond and provide a solution to the customer's grievances. With the call center arrangement, MWSI employees are able to focus on responding to customer complaints.

Lastly, MWSI aimed to revive its corporate image that it could deliver water services efficiently. It had to change the mindset of its staff to become customer

[96] Metro Pacific is a major shareholder of Philippine Long Distance Telephone Company (PLDT), the telephone company to whom MWSI outsourced its call center operations.

[97] Cashless payments could subsequently be made through banks, ATMs, and a network of neighborhood and small bill collection specialists called *Bayad* (payment) centers, which also provide payment services for telephone, electricity, cable operations, and other service organizations. In addition, MWSI utilized the Metro Pacific connections to SMART Mobile to use SMART payment systems and SMART wireless community services as alternative means of payment and billing.

oriented. This meant changing the old MWSI's way of doing business in favor of a new way that was centered on the customer.

The new MWSI management understands the need to control and allocate water properly. MWSI first focused on refurbishing all 14 reservoirs in its concession area and improving the flow of water from the La Mesa Dam to each reservoir through improved pipeline with pressure reading valves set in strategic locations to allow MWSI to channel water to specific areas at certain times of higher demand (e.g., peak versus off-peak hours or seasonal versus perennial demand).[98] The utility is also active in laying new pipes and using leak detection technology to reduce NRW and sell this to underserved and unserved communities in the West concession zone to improve service levels (Consunji 2012).[99]

New Connection Fees

The concession agreement allows both utilities to charge fees for new connections. Standard fees are set for connections within 25 meters (m) of an existing water line. Additional charges can be levied for connections beyond 25 m that require the utility to provide additional pipe and/or system upgrades. In determining the fee of a typical water connection (e.g., within 25 m), the utilities base these on materials (ferrules and/or main tapping tees, pipes from a main line to the household, the meter, stop taps, and accessories), labor (pre-installation inspection, road work, connection work, plumbing, and installation inspection), and administrative charges (application fee, availability fee, plumbing permit, and deposit against future charges).

During 1999–2008, new connection fees grew faster in the East concession zone than in the West concession zone. Figure 7 shows that from 1999 to 2001, the fee charged by both concessionaires for connecting a household to the system was roughly the same. The divergence in new connection fees started in 2002 when East connection charges were significantly higher than West connection charges. MWCI began charging the real cost of connection, amortizing this over a longer period of time to make it affordable to lower income groups. In contrast, MWSI continued to subsidize the rate as part of its effort to connect similar groups. The result was the opportunity loss of additional revenue that could have helped MWSI's financial status.

Connection fees are particularly salient for the urban poor and informal settler communities. Connecting these low-income groups to the network was important for both utilities. The critical constraint is households' affordability of the cost of metering and connection.

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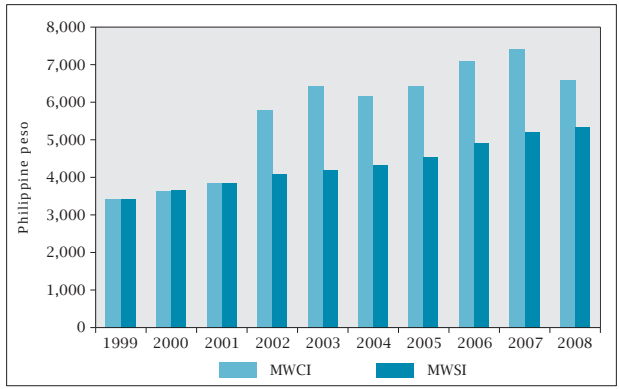
[98] Based on an interview by the authors with Rogelio Singson, president, MWSI, 22 October 2009 at MWSS Complex, Balara, Quezon City, Philippines.

[99] Herbert M. Consunji is chief operating officer of MWSI since January 2007.

Figure 7 Connection Fees, 1999–2008 (in nominal Philippine peso)



MWCI = Manila Water Company, Inc., MWSI = Maynilad Water Services, Inc.
Sources: Data collected from the Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI).

Programs for Low-Income Groups and Institutional Consumers

Pilferage is a major factor of MWCI's NRW problem. It is particularly difficult to control pilferage in informal settlements and such acts by syndicates. The illegal practice also damages the water network.[100]

To address this complex situation, MWCI established the *Tubig Para Sa Barangay* (TPSB) or "Water for the Community" program in 1998. It was the company's flagship social program designed to help households with low incomes and without land tenure gain access to water through direct connections. Many of these low-income households were situated in locations with access problems or on difficult terrain. The major issue raised was the heavy cost of metering and piping, which was unaffordable to the urban poor. To address this, MWCI amortized the cost of metering over a 12-month period. It reported that it had reached 1.5 million people, or 300,000 households, through the TPSB program from 1998 to 2008 (MWCI 2008a, 2008b).

To expand the TPSB program to include institutional consumers, MWCI created *Lingap* (We Care) projects in 2002 that targeted improvement of water and sanitation facilities in public institutions, such as public schools (2002), government hospitals (2004), public markets (2005), city jails (2005), and orphanages (2006), whose facilities are often ill-maintained (MWCI 2008a). The projects involved the installation of drinking facilities and the improvement

[100] Based on an interview by the authors with Rene Almendras and Virgilio Rivera, MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

Box 2 Community-Managed Water Connection

The Case of Durian Street, Quezon City (*Samahang Tubig* ng Durian)

The Manila Water Company, Inc.'s (MWCI) bulk water supply project in Durian Street, Barangay Pasong Tamo, Quezon City involved a metered master connection where a community association acted as a distributor to the residents in the area through individual or shared connections. This form of provision allowed residents to organize and manage water distribution. It served as a local distribution net. The community organization was called the "Samahang Tubig ng Durian (Water Association of Durian [Street])," with 228 member households and individual connections, and was registered in the MWCI accounts as a regular residential connection. Hence, while this connection was technically bulk account supplying water to a whole community, it was not charged the special rates for bulk water, which were different from the rates of a residential connection.

The Durian community chose the bulk water arrangement rather than group taps because MWCI was only willing to install meters at the entrance of the compound. Given the distance from the main road to the compound, the average cost of a connection could reach as much as P20,000 per household, which would be close to six times the actual connection fee charged by MWCI. Given the number of households, there would be too many hoses lying on the ground and crawling toward the household premises. Since the roads inside the compound were only about 4–6 meters wide, the individual taps would mean too many pipes lining, which would even cover the streets. With light and heavy vehicles going in and out of the compound, pipes would be prone to breakage and result to even higher costs.

The Durian community was convinced by MWCI to organize and be serviced as one community through the bulk water arrangement with a single mother meter. A private contractor was hired to install standard pipes, properly laid inside the area. The project cost of P670,000 provided 2-inch diameter pipes feeding water to nodes of four households each. For each node, the connection cost per household was set at P3,854[a] excluding in-house installations, which added an average of P1,000 per household. The installation cost was collected 3 months before the water supply project was carried out.

To be able to pay the water charges to MWCI for the bulk water, the association initially charged households the following water rates:

Consumption Bracket (m^3/household)	Water Tariff (P/m^3)
First 10	5.00
Next 10 (11–20)	6.00
Next 10 (21–30)	7.00
Next 10 (31–40)	8.00
Next 10 (41–50)	9.00
Next 10 (51–60)	10.00
Next 10 (61–70)	11.00
Next 10 (71–80)	12.00

continued on next page

Box 2 *continued*

Next 10 (81–90)	13.00
Next 10 (91–100)	14.00
Next 10 (101–110)	15.00

The association collected payments from households anytime between the 21st and the 26th day of the month. The association's treasurer paid MWCI on the 27th of each month.

The community rate structure was different from the tariff structure of MWCI. In addition to the basic tariff plus the currency exchange rate adjustment (CERA), environmental fee, metering service charge, and value-added tax, the community rates also included provisions for maintenance and repairs, as well as small payments to the meter reader, the community bill collector, and the treasurer, who spent time computing and preparing the individual household bills and kept the community books upon the advice and assistance of MWCI staff working in the area. From May 2001, the rates were increased uniformly by P1.00 for each consumption level. The lowest level (i.e., the first 10 cubic meters [m^3]) was charged at P6.00 per m^3, while the highest was charged at P16.00 per m^3.

The benefits to residents included lower water expenses and improved access to more reliable and safe water. One household that used to spend from P750.00 to P900.00 per month for water supplied via water containers ended up paying only P40–P150 per month for water consumption under the bulk arrangement.

On the downside, because of the bulk water charging, members of the Durian community association paid more than twice the amount that a household with similar consumption but with an individual connection needed to pay. Comparing the two revealed the following differential in cost:

- Two months' water consumption of 6,430 m^3 and 8,143 m^3, respectively, by the whole association implied an average tariff of P6.24–P6.65 per m^3 per household.
- Dividing the total consumption by the number of member households indicated an average consumption of about 28 m^3 and 35 m^3, respectively.
- If households had direct connections from MWCI instead, a household with an average consumption of 30 m^3 would be charged about P92.00 or an average tariff of P3.08 per m^3 at MWCI's rates. In contrast, the association paid P6.65 per m^3 to MWCI under the bulk water arrangement.
- Using the association-established water rates, a household with a 30 m^3 consumption was charged P210.00, implying a unit tariff of P7.00.

As shown by the above computation, the association was charging much more than the MWCI rate. This differential, however, covered the association's own water consumption, the cost of billing and collection, and an additional amount for maintenance and repairs.

m^3 = cubic meters.

[a] This comprised P3,354 (which was each household's share of the project cost) and P500 for the node. For the former, the total project cost was initially divided among the 200 households that were the first to agree on sharing the cost. When other households decided to join the scheme, the cost-sharing amount was not changed and the balance was used for other installation-related costs not included in the contract amount, such as mapping, snacks for the workers, cost of water used for flushing at the beginning of the project, and grills for the bulk meter to protect it from being hit by vehicles.

Source: Excerpted from Inocencio and David (2001) with permission from the Philippine Institute for Development Studies.

of after-the-meter lines and sanitation services. By the end of 2008, these *Lingap* projects had provided improved services to 174 public schools, 22 government hospitals and orphanages, 19 city jails, and 658 market stalls all over the East concession zone. Over 900,000 people had been served by this institution-based program (MWCI 2008b). The program accounts for water used by these institutions, improves water pressure and service, and reduces waste, including water pilferage by neighboring communities and informal settlers.

ADB Small-Piped Water Network Program

In 2006, ADB tested a small-piped water network (SPWN) program in Metro Manila in cooperation with MWCI and MWSI. The project connected 1,700 households in 10 urban poor communities to a water network within a 4-month period (ADB 2007). Under the scheme, ADB advanced the payment of connection fees to both utilities through an interest-free loan. In turn, the utilities introduced an installment scheme for participating low-income communities that spread the payment of connection fees for up to 36 months. Monthly repayments were placed in a revolving fund that would extend the scheme to new communities. After the pilot test, MWCI continued to offer installment schemes spread with 2- or 3-year terms using the proceeds of the revolving fund (ADB 2008a).

MWCI piloted the program in four communities of 1,050 households. In one community, households paid P600.00 for 6 m^3 of water from private water vendors. After service connection, a household's water expenditure fell sharply to between P300.00 and P379.00 per month for an average consumption of 10.09 m^3–16.6 m^3 of water. This was a drastic reduction in unit cost—from P100.00 per m^3 from water vendors to P22.85–P29.75 per m^3, inclusive of the monthly amortization for connection charges. MWSI introduced the same program in five communities with 650 households. Before connection, these communities paid as much as P125.00 per m^3 of water from water vendors. After connection, their water expenditures fell by more than half to P41.63–P45.29 per m^3, inclusive of the monthly payment for connection charges (ADB 2006).

Output-Based Aid Approach to Connections

After working with ADB in implementing the SPWN program in Metro Manila, MWCI entered into an agreement with the Global Partnership on Output-Based Aid (GPOBA) program of the World Bank in 2008 to provide subsidized connection rates, combined with an installment plan for low-income households (Menzies and Suardi 2009). Output-based aid (OBA) is a method of using explicit performance-based subsidies to support the delivery of basic services such as water, sanitation, electricity, telecommunications, transport, health care, and education, where policy concerns would justify public funding to complement or replace user fees.

The key to the success of the OBA approach is the contracting of service delivery to a third party, where disbursement of public funds is tied to the actual delivery of services (Tremolet and Halpern 2006). GPOBA supported MWCI through subsidies to pay for actual water connections and by providing funds for project design and related dissemination (Menzies and Suardi 2009).

From household surveys undertaken by MWCI, it was established that poor households could not afford to pay the full cost of new connections. However, the feedback also indicated that these households could afford the meter and guarantee deposits of P1,620.00 ($36) if these could be paid in installments, prompting MWCI to offer a 36-month installment scheme. The OBA subsidy, at 2007 prices, was set at P5,911.73 ($131) to cover the connection fee (Table 3). It was paid directly to MWCI as a single payment after it had been independently verified that water service had been delivered to the household satisfactorily over a 3-month period (Menzies and Suardi 2009). Figure 8 illustrates the contractual arrangements and funds flow of the scheme.

The target number of households to be served by the GPOBA program was 21,000 or 105,000 people. Twelve months after the commencement of the program, 10,642 connections were completed, serving a population of 53,000 individuals or 50.5% of the target (Menzies and Suardi 2009; MWCI 2008a).

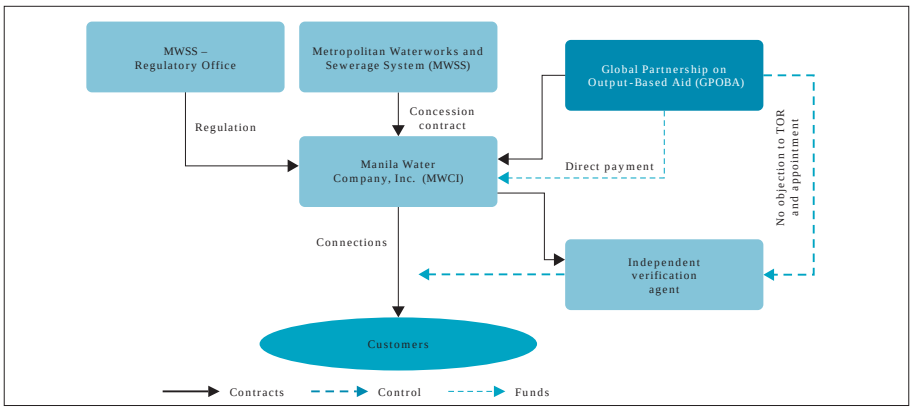
However, if one of the objectives of the program was to change consumer behavior toward water conservation, the evaluation of the project revealed otherwise. Many households continued to use basins and plastic containers to store water from the single faucet installed outside their house as if they were still not connected to the water system. The result was higher than average per capita water consumption. To address this, MWCI embarked on a second phase of the program, which would provide households with internal plumbing to bring the water to kitchens and toilets. This, however, would require wastewater infrastructure that many low-income communities lack. The GPOBA subsidy was therefore expanded to include the provision of sanitation facilities (Menzies and Suardi 2009).

Table 3 Manila Water Company, Inc.'s Connection Charges (at 2007 prices)

	Peso (₱)	$
Meter deposit	1,020.00	23.00
Guarantee deposit	600.00	13.00
Connection fee	5,911.73	131.00
Total	7,531.73	167.00

Source: Menzies and Suardi (2009).

Figure 8 Contractual Arrangements and Funds Flow of Global Partnership on Output-Based Aid Scheme



Source: Menzies and Suardi (2009).

Programs for Low-Income Groups

MWSI also set up social programs to connect more low-income and hard-to-reach communities to its network. The *Bayan Tubig* (Water for Communities) project was initiated in 1999, with a reported 19,000 low-income households served. A year later, an additional 33,000 households were included in the program (Rosenthal 2001). By mid-2009, MWSI reported that over 216,000 households were served through this program (MWSI 2009). The project provides an underground water pipe from a main line to the periphery of a hard-to-reach community. The pipe is then taken above ground, running along walls of buildings or along the road surface, and connects to an array of meters grouped into a cluster. PVC pipes emanate from there and lead to individual households.

To bring down connection cost, MWSI engineers introduced the *Bayanihan Bayan Tubig* (literally, community self-help water) program in 2009 as an offshoot of *Bayan Tubig*. Under this scheme, beneficiaries provide the labor required to build the installations, thus bringing down the set-up cost as well as instilling a sense of ownership of the water network among the residents.

In 2009, MWSI also set up the *Samahang Tubig Maynilad* (Maynilad Water Community Associations) as a water co-management program for communities. The program organizes communities around local water distribution and connections, and builds their capacity to sustain their community water management scheme around public taps. For schools, the *Lingkod Eskuwela* (service to schools) program was established to provide clean water and sanitation services to public schools with connections to the MWSI network. Under the program, water fountains are constructed, water reservoirs and tanks cleaned, water quality regularly monitored, and the schools' septic tanks desludged regularly.

MWSI, under its new management, did not introduce an SPWN or OBA-type program in the initial years after MWSI's change of ownership. Instead, MWSI charged the full meter cost and connection charges amortized over a 36-month period with a 20% discount on monthly charges. The latter served as an incentive for low-income households to connect to the system. In addition to individual household connections, MWSI also operates 295 public taps in low-income communities. It has plans to reduce the number of these public faucets over time and replace them with clustered meters and individual connections.

Nonrevenue Water

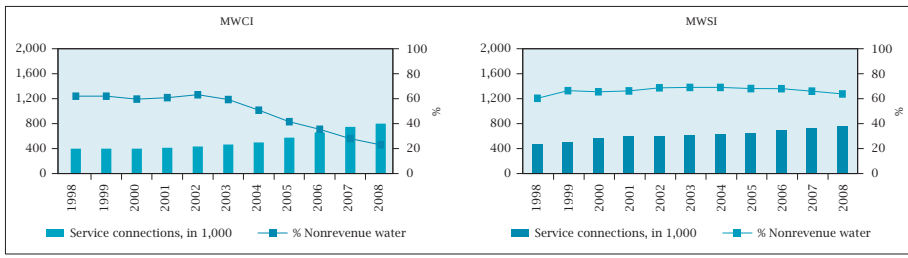
Figure 9 shows the number of water service connections and NRW of MWCI and MWSI in 1998–2008.

Behind the low bids for MWSS and the drastic reduction in the tariff rates immediately after the privatization exercise was the notion that a significant translation of NRW into revenue was vital to the success of the utility in the long run. The high water tariff under MWSS was, in effect, a subsidy borne by paying customers to cover the huge amount of NRW carried by the system.[101] Having established this concept in the winning bids, MWCI and MWSI took very different approaches to resolving the problem of NRW.

MWCI emphasized on building relationships with communities that were pilfering its water with the objective of encouraging them to sign up instead for authorized water connections. It also set up a two-track program aimed at reducing NRW through

(i) commercial oversight to address under-metering, illegal connections, and unbilled accounts; and

Figure 9 Water Service Connections and Nonrevenue Water, 1998–2008
(as reported by Manila Water Company, Inc. and Maynilad Water Services, Inc.)



Sources: Data collected from Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI).

[101] Based on an interview by the authors with Rene Almendras, president, MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

(ii) technical solutions to fix physical defects, including mainline leaks and pipe bursts, in the system.

MWSI, on the other hand, was not able to make any dent in NRW. The Asian financial crisis and the huge increase in peso-denominated concession fees that MWSI had to bear gave it serious cash flow problems. The company also found out during its second year of operations that there were close to 2,000 km of pipe infrastructure not included in the original MWSS inventory for the West concession zone and these had to be rehabilitated. For MWSI, 70% of NRW was due to physical problems (leaks, water bursts, and others), and only 30% was due to pilferage and wrong billing.[102]

Technical Solutions to Address Nonrevenue Water

In MWCI's case, addressing the physical defects of the water network was less complicated than dealing with the problems of illegal connections and under metering, which were linked to human behavior.[103] While replacing rusty underground pipes was a major undertaking that could be capital intensive, it was seen as a fairly straightforward job as opposed to dealing with pilferage.

To repair leaking pipes in the networks, MWCI took advantage of technology provided by its international partners. It began to clean underground pipes without digging them up unless it was absolutely necessary. This initially involved the use of grinding technology to clean the interior of existing steel pipes while they remained underground and coating these with an interior layer of liquefied PVC that would harden, effectively sealing leaks. However, the existing pipe network was in far worse shape than expected and actual pipe replacement became the norm. Over 1998–2008, pipe replacement projects were estimated to have saved about 482 million liters per day (MLD) of water that would have otherwise been lost through leaks (MWCI 2008b).

To improve on equipment performance and ensure that pipes are aligned properly, MWCI invested in laser alignment, thermal imaging, and vibration analysis technology to lessen mistakes in pipe-laying and improve on leak detection. A pump refurbishment program by MWCI has improved pump efficiency from 79% to 84%, reducing power consumption by 5% across the system (MWCI 2008b).

MWSI has invested in advanced leak detection technology and operates the largest membrane-based water treatment plant in the country (Consunji 2012).

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[102] Based on an interview by the authors with Dr. Fiorello Estuar, former president, Maynilad Water Services, Inc., 16 September 2009 at Benpres Building, Pasig City, Philippines.

[103] Based on an interview by the authors with Rene Almendras, president, MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

With inaccurate as-built drawings from MWSS, both utilities found it difficult to determine the actual locations of pipes. To address this, MWCI started to carry out a geographic information system (GIS) mapping at the sub-meter level. With this, a 2-meter wide trench, 1 meter per side, has to be dug to locate a pipe. This eats up too much road space and requires more effort to dig. More accurate maps and documentations down to the sub-foot level are needed to improve service performance.[104]

When the new MWSI administration took over water management in the West concession zone in late 2007, the total population of the utility's area of responsibility was 9.1 million. Of this, MWSI reported serving 6.14 million (6.0 million through direct water service connections; 140,000 through public taps), leaving a balance of close to 3.0 million population obtaining water through other means. Of the population served by MWSI, almost 50% (3 million) were considered underserved with less than 16 pound-force per square inch (psi) in terms of water pressure and less than 24 hours access to water service daily.[105]

A number of subdivisions in Cavite Province and the cities of Parañaque, Las Piñas, and Muntinlupa in south Metro Manila—considered unserved by MWSI definition—had their own community water systems provided by subdivision developers. These community water systems drew water from underground sources and deep wells. Since the provision of water was not a core business of the subdivision developers, many of these systems were inefficient and provided poor quality water. The new MWSI saw this as an opportunity to either sell bulk water or work on direct connections to expand their customer base and billing volume.[106]

A major, unserved sector was informal settler, low-income communities that had no direct connections. This sector was a larger concern for the new MWSI. To obtain water, these communities either tap other lines, which result in higher NRW, or buy water from private water suppliers at high prices. MWSI's position is to connect low-income communities to its water network, instead of having to address the bigger problem of illegal connections and NRW that unconnected communities create.[107]

[104] Ibid.

[105] Based on an interview by the authors with Rogelio Singson, president, MWSI, 22 October 2009 at MWSS Complex, Balara, Quezon City, Philippines.

[106] Ibid.

[107] Ibid.

Consumer Service as the Key to Addressing Nonrevenue Water

For MWCI, its relationship with customers and the community is the key factor toward success in managing NRW.[108] Among the customer-centered innovations applied by MWCI is a redesigned, simple, easy-to-understand water bill that also promotes the company's various programs, as well as a 24-hour customer service hotline (Dial 1627).

Quick turnaround time is critical to stemming water wastage.[109] Information and telecommunications technology have been adopted by the company to keep track of complaints (e.g., burst water pipes). Once a call is made to the 1627 hotline, the customer is asked for his water connection number, address, and the nature of the complaint or report. The system then sends a system-generated text message to the territory manager, specifying the connection number and nature of the complaint. The territory manager has 10 calendar days to resolve the issue and report the action taken on the complaint.

MWSI also adopted a similar system of tracking customer complaints. The company outsourced its call center to the Philippine Long Distance Telephone Company (PLDT), a member of the Metro Pacific Group of Companies.[110]

Wastewater Management

For MWCI and MWSI, the initial priority was water distribution. This was what spurred the water crisis in the first place that led to the privatization of the management of the MWSS system. The schedule for sanitation and sewerage coverage was specified in the concession agreement although both utilities lagged in actual achievements in sewerage and sanitation work (Table 4).

With the extension of the concession agreement (originally scheduled to end by 2022) by 15 years to 2037, the two utilities have agreed to move forward on an aggressive sanitation and sewerage program. MWCI has a "Three Rivers Master Plan" dividing the East concession zone into 29 catchment areas (MWCI 2008b).

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[108] Based on an interview by the authors with Rene Almendras, president, and Virgilio Rivera, both of MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

[109] Based on an interview by the authors with Carla Kim, manager, Sustainable Development, MWCI, held on 3 November 2009 at MWSS Administration Building, Balara, Quezon City, Philippines.

[110] Based on an interview by the authors with Rogelio Singson, president, MWSI, 22 October 2009 at MWSS Complex, Balara, Quezon City, Philippines.

Table 4 Water, Sanitation, and Sewerage Service Targets Specified in the Concession Agreement and Actual Achievements

	Proportion of Population Covered (%)					
Specific Service	1996	2001	2006	2011	2016	2021
Service Targets						
Water service	67	87	98	98	98	98
Sanitation	0	39	40	36	33	29
Sewerage	8	7	15	26	38	54
Sanitation and sewerage	8	46	55	62	71	83
Actual Achievements[a]						
Manila Water Company, Inc. (MWCI)						
Sanitation[b]	NA	1	13			
Sewerage[c]	3	8	7			
Maynilad Water Services, Inc. (MWSI)						
Sanitation[b]	NA	1	14			
Sewerage[c]	3	11	8			

NA = not available.

Notes:

[a] For actual achievements, data for MWCI and MWSI start with 1997.

[b] Sanitation coverage = Cumulative total of septic tanks de-sludged divided by the number of water service connections billed.

[c] Sewerage coverage = Number of sewer connections billed divided by the number of water service connections billed.

Sources: Service targets specified in the concession agreement and summarized by Dumol (2000, 121); actual achievements stated in Metropolitan Waterworks and Sewerage System–Regulatory Office (2011), which was based on submissions by MWCI and MWSI to the MWSS–Regulatory Office.

From De-sludging to Complete Solutions

The old practice of wastewater management in the metropolis was built on septic tanks that would eventually spill into the drainage system and into the Pasig River. The immediate solution provided by MWCI and MWSI has been de-sludging of septic tanks under a sanitation component of their services. A more complete solution is direct household connection to sewer lines rather than the drainage system. Dedicated sewer lines will seal the flow of liquid waste and prevent this from leaking out in the open. This will not be realized until closer to the end of the revised concession agreement schedule due to the large investment required.[111]

In the interim, MWCI is implementing a combined sewerage-drainage solution. Wastewater that would otherwise flow into the rivers in the metropolis through

[111] Based on an interview by the authors with Rene Almendras, president, MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

drainage pipes is channeled into one of 38 sewage treatment plants. Wastewater is treated before being discharged into the Pasig, Marikina, or San Juan rivers or into Laguna Lake. Additional work for the Marikina River catchment is to be done through 2012. Work on the Pasig and San Juan river catchments will take place until 2018 (MWCI 2008b). Critical infrastructure investment by MWCI will raise sewerage coverage to 30% by 2012 and 63% by 2022, from the 7% level in 2006 and 3% in 1997 at the start of the concession (MWCI 2007).[112] By the end of 2010, MWCI had set up 38 sewage treatment plants in different parts of the East concession zone (Metropolitan Waterworks and Sewerage System–Regulatory Office 2011).

For areas not covered by the sewerage network, MWCI has a de-sludging program to empty septic tanks within its service area. It has a fleet of 77 de-sludging trucks. Since it began to offer this service in 1997, over 455,000 households have benefitted from the program. To dispose of the sludge, MWCI operates three septage treatment plants built under Manila Third Sewerage Project (MTSP) and has plans to further expand treatment facilities.[113]

By-products of Sewage Treatment

MWCI has begun to collect biosolids[114] to supply farming areas in provinces such as Pampanga and Tarlac. Biosolids provide organic additives to condition soil and lessen dependency on chemical fertilizers. From 2006 to 2008, the company's sewage treatment plants (STPs) produced 49,000 m^3 of biosolids, which were supplied to farming communities (MWCI 2008b). Similarly under its "Asset from Waste" project, the new MWSI has begun to process sludge into biosolids for use as fertilizers by farmers (MWSI n.d.).

In 2005, recycled water was made available to MMDA for the "greening" of the center islands along the main roads of the metropolis (MWCI 2007). The MWCI-operated Makati South STP in Magallanes provides treated wastewater for this and other purposes at no cost to MMDA.[115] The University of the Philippines (UP) STP in Balara, Quezon City, has began to supply up to 4 MLD of treated wastewater, rated as Class C water, to the UP-Ayala Techno Hub for gardening and toilet flushing since 2008. There are plans to replicate this in other areas (MWCI 2008b).

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[112] Sewerage coverage is measured by the number of sewer connections (billed) divided by the total number of water service connections (MWSS–RO).

[113] Number of trucks and septage treatment plants was provided by MWSS-RO (2011). Of the 90 de-sludging trucks reported (MWCI 2008b), 14 have been retired from service.

[114] These are residues from de-sludging and sewage treatment.

[115] Based on an interview by the authors with Carla Kim, manager, Sustainable Development, MWCI, 3 November 2009 at MWSS Complex, Balara, Quezon City, Philippines.

MWCI has also moved to eliminate its deep well water sources in favor of renewable surface water. Besides, a "Waste to Energy" project was undertaken at the Makati South STP to utilize technology to extract and collect methane, a by-product of sludge treatment, and to convert it into electricity to be used to run the plant (MWCI 2008b).

Financial Resource Management

The financial performance of the two utilities in the initial 5 years of the concession agreement was markedly different, with MWCI having lower operating ratios than MWSI (Table 5). Except for the first year, MWCI was able to keep revenues ahead of operating expenses; unlike MWSI whose operating expenses far outpaced collected revenues throughout the first 4 years.

For MWCI, there was a program to manage investments in smaller, more manageable packages. With the advent of the territory management system, area investment was matched with collected revenue as far as service connections were concerned. MWCI tried to match area investment with potential area business so that no territory or district metering area (DMA) (within a territory) was a cost center. The old MWSI, on the other hand, focused on the wholesale rehabilitation of the

Table 5 Selected Financial Indicators, 1998–2008

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Manila Water Company, Inc. (MWCI)											
Collections (P billion)	0.67	0.85	1.04	1.20	2.55	3.86	4.38	5.89	6.74	7.94	9.59
Revenue collection efficiency (%)	96	92	91	91	95	99	101	100	99	101	99
Operating ratio	1.07	0.92	0.92	0.96	0.79	0.70	0.69	0.66	0.60	0.53	0.49
CAPEX (P billion)	0.69	0.44	0.60	0.62	1.35	1.76	3.54	4.28	4.80	4.70	4.40
Maynilad Water Services, Inc. (MWSI)											
Collections (P billion)	1.68	2.07	2.46	3.08	5.53	5.45	5.22	7.04	7.95	8.74	8.76
Revenue collection efficiency (%)	98	85	94	98	99	101	98	90	95	97	89
Operating ratio	1.47	1.29	1.93	1.36	0.75	0.80	0.88	0.80	0.89	0.58	0.55
CAPEX (P billion)	0.42	0.70	1.93	0.59	1.19	0.84	0.57	1.26	1.35	2.75	6.13

CAPEX = capital expenditure, P = pesos.

Sources: Based on written communications provided by the MWCI and MWSI.

system, a view largely driven by its international partner's experience globally but proved unworkable in the Philippine setting.

To finance operations and investments, the two concessionaires pursued very different financing strategies in the first 5 years. The Ayala Group, which was the major shareholder of MWCI, pursued the local credit market to borrow smaller amounts, principally in Philippine currency.[116] This was crucial in helping MWCI manage its debt at the height of the Asian financial crisis of 1997–1998. But this was not the case with the Lopez Group of MWSI. The Lopez Group went after large offshore US dollar-denominated funding. When the financial crisis hit the Philippines, its currency depreciated sharply against the US dollar. MWSI was unable to service its debt comprising both new loans and the assumed liabilities from MWSS. The heavy debt burden curtailed MWSI's ability to invest in facility upgrades necessary to address the twofold strategy of expanding service connections and billed volume, and reducing nonrevenue water.

The two companies' procurement practices also differed. As a company managed by the Ayala Group, MWCI was not constrained to procure services only from within the Ayala Group of companies. Instead MWCI was free to enter into open bidding with suppliers and develop relationships with them to supply materials and services to its entire system. Transparent bidding brought down operational costs and made suppliers and contractors major stakeholders of the utility. The old MWSI, on the other hand, contracted many of its requirements from other Lopez companies, which kept prices higher than what could be obtained in the market if open bidding were allowed. This explains in large part the higher costs incurred by the old MWSI and its inability to keep its operating expenses within the collected revenues (Wu and Malaluan 2008).

The original concession agreement was flawed, which inadvertently penalized the old MWSI.[117] Since the West concession zone was older than the East concession zone and it was where the bulk of MWSS assets were located, the majority of MWSS debt (90%) was loaded onto MWSI. The debt was incurred by MWSS to pay for the sewerage portion of the business, which was the nonrevenue part. As such, there was no cash flow to service this debt. With no provision for foreign exchange loss on MWSS dollar-denominated foreign debt at that time, the old MWSI suffered extraordinary losses when the Asian financial crisis hit one year into the concession agreement.[118]

[116] As of the end of 2008, about 50% of MWCI's debt was denominated in Philippine peso, and this helped MWCI mitigate foreign exchange risk (MWCI 2008a).

[117] Based on an interview by the authors with Rogelio Singson, president, MWSI, 22 October 2009 at MWSS Complex, Balara, Quezon City, Philippines.

[118] Ibid.

Further aggravating the cash flow problem, the French partners of the old MWSI viewed the old network as an integrated one and wanted to fix the aging system through wholesale pipe relaying and replacement. The problem with this was threefold. First, the as-built drawings did not match the real infrastructure. Many old pipes and valves in the drawings could not be located because of the overlay of roads and sidewalks over several decades. It was not wise to dig if it was uncertain that pipes and valves were located underground.[119]

Second, newer pipes were laid over time and these were not included in the as-built drawings turned over to MWSI. Local construction was often not included in updated drawings. Lastly, Manila (including the other older cities within the West concession zone) has a mixture of pump and gravity-fed water systems. By dividing Metro Manila into two concession zones, the West zone lost its source of water in the center (namely the San Juan Reservoir). A new water highway had to be built from the La Mesa Reservoir in the north to provide water for the older parts of Manila in the south.[120]

As a result of all these, the sources and degree of NRW could not be located and therefore could not be directly addressed, thereby adversely affecting MWSI's financial performance. The new MWSI opted to divide the service area into hydraulic areas that could be isolated and worked on without disrupting service in other areas.[121]

Human Resource Management

Absorption of Workforce

Prior to the privatization of MWSS' water services in 1997, the government of then President Ramos offered early retirement packages to MWSS staff members. Only 30% of the MWSS staff availed of the first and second early retirement packages (Table 6). At the time of privatization, 5,057 employees, accounting for 68.6% of the total workforce, were absorbed by either of the concessionaires. Based on the concession agreement, the concessionaires had the option of regularizing as many of the MWSS workforce as could be absorbed by either utility after a 6-month probationary period. Of the MWSS staff initially absorbed by the two concessionaires, 3,976 were regularized.[122]

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[119] Ibid.

[120] Ibid.

[121] Ibid.

[122] Under the rules of the concession agreement, both utilities placed all MWSS employees on a 6-month probationary period. After the 6-month period, the utility could opt to permanently hire the employee (i.e., regularize the employee within the company) or terminate him or her with the same retirement benefits as offered in the early retirement packages of the government prior to privatization.

Table 6 Distribution and Movement of Metropolitan Waterworks and Sewerage System Personnel During and After Privatization

Period Covered	No. of Employees	% of Original Workforce
Pre-privatization workforce (MWSS)	7,370	100.0
First Early Retirement Program (ERP), before 23 January 1997	2,033	27.6
Second ERP (by 1 August 1997)	190	2.6
Retained by MWSS (as of 1 August 1997)	90	1.2
Absorbed by concessionaires on 1 August 1997	5,057	68.6
• West concession zone	2,982	40.5
• East concession zone	2,075	28.1
Regularized after a 6-month probationary employment[a]	3,976	53.9
• West concession zone	2,333	31.6
• East concession zone	1,643	22.3
Separated from concessionaire	751	10.2
• Voluntary (Third ERP)	649	8.8
• Involuntary	102	1.4

MWSS = Metropolitan Waterworks and Sewerage System.

[a] The 6-month probationary employment period was from August 1997 to January 1998. Data by Cruz (2001) states that 4,306 MWSS employees were regularized by both Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI). The count for both utilities adds up to 3,976 only. This latter figure is used in this table.

Source: Adapted from Cruz (2001).

In MWCI, the majority of former MWSS employees stayed on (Table 7). By the end of 2008, over 80% of MWCI employees were holdovers from the former MWSS. Of the MWCI staff, 47% were rank-and-file employees while 53% were at managerial levels. The latter included two group directors and 63 senior managers (MWCI 2008b).

Performance-Based Incentives and Staff Development

To retain quality staff, MWCI offers a competitive compensation package comparable with other private utilities. In 2008, MWCI reported that it paid an average annual salary of P488,000 to rank-and-file employees. Supervisors took home an average annual salary of P607,000.[123] Besides, MWCI provides employees with local and international training opportunities, a year-round fitness and social-environmental calendar of activities, and a host of incentives and reward schemes. International training programs are offered in partnership with United Utilities, a principal shareholder of MWCI.[124]

[123] Computed from data provided by MWCI.

[124] In 2008, 31 managers attended international training in Australia, Bulgaria, Dubai-UAE, Estonia, and the United Kingdom. This was based on an interview with Carla Kim, manager, Sustainable Development, MWCI, 3 November 2009 at the MWSS Administration Building, Balara, Quezon City, Philippines.

Table 7 Staffing at Manila Water Company, Inc., 2000–2008

Year	Former MWSS Employees at MWCI	Direct Hire	Seconded from Ayala	Seconded from Bechtel and United Utilities	Consultants	Total
2000	1,525	13	6	10	3	1,557
2001	1,476	56	7	8	3	1,550
2002	1,427	109	5	4	2	1,547
2003	1,407	109	5	4	2	1,527
2004	1,383	149	4	2	3	1,541
2005	1,351	219	4	2	3	1,579
2006	1,338	241	3	2	1	1,585
2007	1,320	243	4	2	2	1,571
2008	1,284	258	5	2	2	1,551

MWCI = Manila Water Company, Inc., MWSS = Metropolitan Waterworks and Sewerage System.
Note: The data are as of end of December of each year.
Source: MWCI (2009).

An annual performance-based incentive program provides for awards at three levels, as follows:

(i) the Chairman's Circle is an award for senior managers,
(ii) the President's Pride is awarded to middle managers, and
(iii) *Huwarang Manggagawa* ("Model Employee") award is given to rank-and-file employees.

Promotion of employees is based on performance reviews. In 2007, 275 employees or 17% of the total MWCI workforce were promoted (MWCI 2007). In 2008, MWCI reported that each employee received an average of 7.86 days of training for the year versus 5.07 days in 2007 (MWCI 2008b).

Among the training programs offered were

- Manila Water School for Leaders;
- Customer Service Institute;
- Cadetship Training Program, a 6-month training program for new graduates hired;
- Development courses to transform manual workers into knowledge workers;
- Meter Consumption Analyst (MCA) Course to train meter readers to become higher- level MCAs;
- Course to develop truck drivers into sanitation officers;
- School for Supply Zone Managers;
- Territory-Business Manager Continuing Education Program;

- School for District Officers;
- Business Management Program to develop middle managers into future leaders; and
- Leaders' convergence seminars where respected leaders shared their values.

The Cadetship Training Program

MWCI offers a Cadetship Training Program for all new hires that immerses them in the real-life situation in a DMA. Each cadet has to "walk the line," that is, walk throughout an entire DMA on foot to check each and every water connection. The day and nighttime walks hone their skill in identifying problems on the ground and nurture relationships with stakeholders in a given DMA including paying customers, local government, and the general public.[125]

Cadets follow a "walk-design-walk-redesign-walk-refine" process that is viewed as a combination of textbook engineering and a study in social reality. In addition to daytime walks, cadets do up to 48 hours of night flow reading. Night flow reading is a good time to check for pipeline leaks when service connections are not drawing water yet there is a continuous flow in an area.[126]

Organizational Management

MWCI is organized into 247 territories (Figure 10). Each territory, which is headed by a territory manager, is divided into DMAs and has 3,000–4,000 service connections. DMAs are subdivided into meter reader units (MRUs), with each meter reader having up to 200 connections to monitor and service per month.

The size of a DMA is determined by water usage volume and is organized as a business unit. DMA managers must be entrepreneurial to meet their business targets. This means that they can propose additional investment but must have a business plan to justify full cost recovery and the profitability of the new pipe investment. The principal concern of territory and DMA managers is to reduce NRW and increase billable water.[127]

The MWCI structure is designed to allow DMAs to develop direct relationships with every customer within the metering area. Once an area's demographics reach a certain density or the character of the area changes, a DMA can be reorganized and a new DMA formed. There is no single model for a DMA. Instead, a DMA is

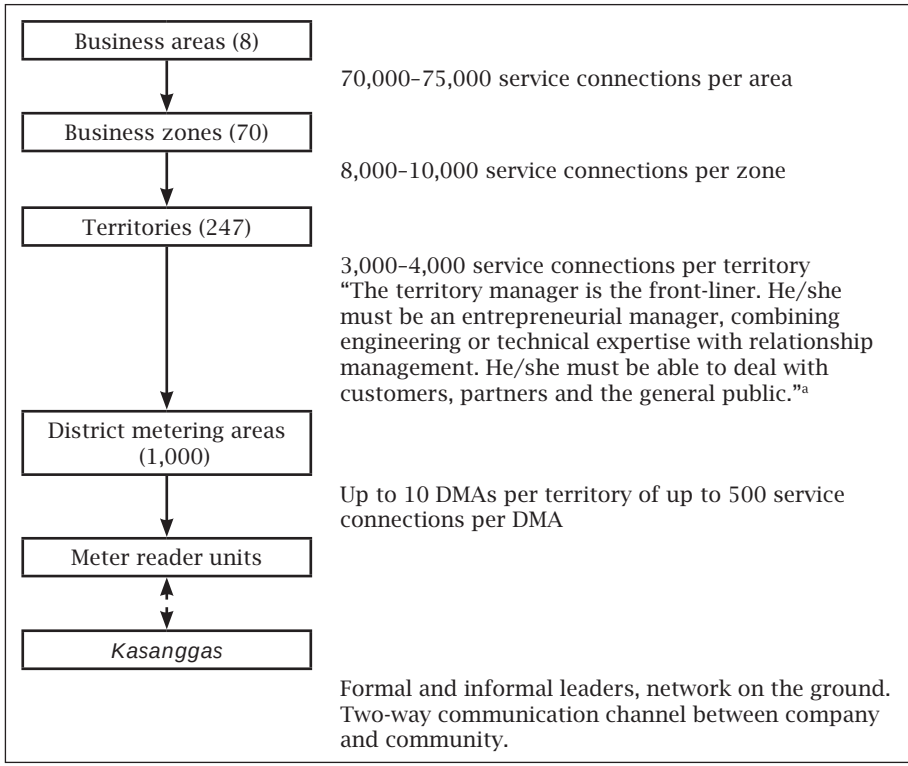
[125] Based on an interview by the authors with Rene Almendras, president, and Carla Kim, manager, Sustainable Development, both of MWCI, 3 November 2009 at MWSS Administration Building, Balara, Quezon City, Philippines.

[126] Ibid.

[127] Based on an interview by the authors with Rene Almendras, president, and Virgilio Rivera, both of MWCI, 23 September 2009 at Hotel Intercontinental, Makati City, Philippines.

Figure 10 Manila Water Company, Inc.'s Field Operations Structure

Total number of service connections in 2008: 683,894
Total number of households connected to the water network in 2008: 1.03 million



DMAs = district metering areas.

[a] Based on an interview by the authors with Rene Almendras, president, and Virgilio Rivera, both of MWCI, 3 November 2009 at MWSS Administration Building, Balara, Quezon City, Philippines.

Source: Based on an interview by the authors with Rene Almendras, president; and Carla Kim, manager, Sustainable Development, both of Manila Water Company, Inc., 3 November 2009 at MWSS Administration Building, Balara, Quezon City, Philippines.

based principally on a reading of the social realities and water volume demand for a given area.[128]

Apart from the DMA managers and meter readers, the most critical members of the organization are the *kasanggas* (street leaders) in the community. These are

[128] Social realities means looking at the main characteristic of an area and/or community, e.g., commercial area, high-rise condominium (high density, small area), informal settlers (high density, large area), and gated subdivision (low density, large area). The characteristic affects water volume demand and consumption as well as meter density. Both impact on pipeline requirements for an area. This was based on an interview by the authors with Carla Kim, manager, Sustainable Development, MWCI, 3 November 2009 at MWSS Administration Building, Balara, Quezon City, Philippines.

formal or informal leaders whom the community members can approach daily. They are people who are trusted by the community. DMA managers are required to develop working relations with any number of *kasanggas*, who will help MWCI identify problems on the ground and help explain the company's local plans and projects to the community.

During tropical storm Ondoy in September 2009, MWCI's *kasangga* partners communicated the situation in their communities to the DMA managers in real-time. The day after the storm, MWCI was able to assess which of the areas were underwater or had no access to clean and potable water. In the succeeding days, MWCI sent in water tankers to areas with no water. Over 200,000 liters a day were distributed free for drinking purposes.

By the end of the week, MWCI had restored tap water, although households feared drinking it because of the risk of contamination. Many neighborhoods in Metro Manila continued to be flooded in ankle- to waist-deep water, and the brown, murky fluid convinced local inhabitants that all unbottled water was similarly dirty. *Kasanggas* reported this to DMA managers in real-time. In response, MWCI created a new product overnight: *baso* (cup) water—regular tap water, vacuum packed, and sealed in recyclable plastic cups. Up to 75,000 cups were distributed free daily to both customers and others in the hardest-hit areas.[129]

Community Partnerships

Public Education and Water Conservation

MWCI's commitment to water conservation and public education can be seen in many of its initiatives. MWCI implemented the Adopt-a-Watershed Program to address two interrelated issues, such as (i) improving the quality of raw water within the watershed area, and (ii) utilizing the same watershed as a carbon sink. This watershed management program was implemented at the Ipo and La Mesa watersheds and managed by MWCI, together with various stakeholders.

To promote public education for water conservation, MWCI involved communities around its treatment facilities when conducting emergency drills for evacuation and situation recovery in case of a major spillage. In 2008, MWCI initiated a project called "Attaining Goals on Sustainable Water Supply and Sanitation" (AGOS),[130] which targets behavioral change toward water and sanitation practices and monitors the company's operational impacts on the environment.

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[129] Based on an interview by the authors with Rene Almendras president and Carla Kim, manager, both of MWCI, 3 November 2009 at MWSS Administration Building, Balara, Quezon City, Philippines.

[130] *Agos* is the Filipino word for "flow."

In 2007, MWCI began developing a climate change policy for the company that includes (MWCI 2007, 45)

(i) the development and implementation of a carbon management plan,
(ii) improved efficiency in energy consumption and increased use of energy from sustainable sources including waste from wastewater plants,
(iii) new mitigating measures such as establishing new water sources, and
(iv) planting of trees to protect watersheds and to combat the effects of global warming.

In 2008, MWCI calculated its carbon footprint (39,903 tons) and used this as a baseline toward managing its carbon emissions in the future.[131]

Community Livelihood

As part of the company's outsourcing program, MWCI entered into partnerships with stakeholders and cooperatives to generate water-related employment and encourage entrepreneurship. The primary vehicle for this is the *Kabuhayan Para Sa Barangay* (KPSB) or "Livelihood for the Community" project, a cooperative-based program in which additional facilities, such as water faucets, drinking fountains, washing areas, and toilets are installed. The KPSB also provides seed capital and training for backyard cooperatives, developing these into suppliers of items used by MWCI and bringing them into the company's supply chain.

A vendor program involving small contractors is supported by MWCI through a loan guarantee scheme for developing their businesses and enhancing the technical, business, and managerial skills of their employees. As a business partner, contractors can progress through a number of relational levels with MWCI—from non-*suki* to *suki* to corporate *suki* contractor levels.[132] A series of company-generated metrics guides the relationship and includes incentives, such as early completion bonuses, to improve productivity.[133] While the value of jobs generated by the KPSB program was still small (P24 million) in its initial years, the relationships were growing in numbers.[134]

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[131] Environmental stewardship has been adopted for all companies in the Ayala Group including MWCI. The calculation of a company's carbon footprint is an internal benchmark in corporate environmental management for each company in the Group (MWCI 2008a).

[132] *Suki* is the colloquial Filipino word for "preferred person" and is used to refer to a favored client or a preferred contractor or vendor.

[133] Time-based service level agreements were introduced. Contractors could finish work over a shorter period of time provided the work meets stipulated standards. Savings could be retained by the contractors as additional profits.

[134] At an exchange rate of $1 = P44.28, the total value is just slightly more than $500,000 (MWCI 2008a).

Lessons

The privatization of water services in Metro Manila offers several lessons in urban water management.

- **Reducing nonrevenue water**

In a metropolis as complex as Metro Manila, reducing and controlling NRW has to be a combination of technical solutions and community organization.

The leading premise behind the low bids during the initial phase of the privatization of MWSS' water services was the private operators' belief that they could bring down NRW and translate this into billed volume and revenue. MWCI and the old MWSI had different approaches to this concern. While both started with technical solutions including re-metering, pipe-laying, and pipe replacement, MWCI soon realized the importance of addressing community behavior that was driving pilferage. This evolved into a field operations structure that had direct contact with communities, where informal leaders (*kasanggas*) helped provide information about pipe bursts, leaks, and water outages.

MWCI was very conscious of NRW from the beginning. Its initial investments were aimed at reducing leaks and pipe bursts and addressing water theft. MWSI, on the other hand, was more interested in expanding service connections. By the end of the first decade of the concession agreement, MWCI's NRW rate dropped by more than 50% while MWSI was unable to similarly bring down NRW, which hurt the company immensely. In the new MWSI, there is more convergence with the MWCI's philosophy of combining technical solutions with community efforts.

- **Engaging the poor**

Connections to the urban poor and low-income communities are critical to helping protect the water network.

The up-front cost of installation and connection is expensive for the urban poor and low-income communities. By finding a way to help them pay for the heavy entry cost of household metering, installation and piping, the problem of pilferage can be controlled, and the network protected. Two business models were introduced by MWCI, as follows:

(i) Output-based aid for water connections (under the GPOBA program), and
(ii) Interest-free amortization to pay for installation costs over an extended period of time (through the ADB–SPWN project)

The GPOBA is a specific program for targeted communities and involved a direct subsidy to low-income households for water connection. The ADB–SPWN project, on the other hand, sets up a revolving fund for lending to low-income communities to cover the amount needed for water service connection. While the SPWN program of interest-free bridging funds may not be as attractive as the direct subsidy of the GPOBA project, it is superior to the traditional requirement of up-front fees, deposits, and installation fees. By using either of the two schemes, MWCI could charge the full cost for connection whether subsidized or amortized over a longer period of time.

The new MWSI has a similar interest in enrolling more of the urban poor in its program. Instead of subsidies, however, MWSI opted to amortize the connection fee over a longer period (up to 3 years) and to discount water bills by 20% as an incentive for households to obtain authorized connections.

- **Conservation and public education**

Conservation and public education helps secure the future of a water utility. The water business is only as good as the quality and quantity of the resource. Despite this reality, conservation was not a major part of the concession agreement. Neither did the agreement contain any provision, whether for social or environmental protection, that would address equity and sustainability issues. Conservation and public education was solely driven by corporate philosophy and business judgment.

The MWCI experience in engaging various stakeholders on water conservation and environmental protection is another way to ensure the long-term sustainability of the company and its network.

- **Business opportunities in wastewater management**

Investing in sewerage, sanitation, and wastewater treatment is capital intensive. However, there are by-products (such as biosolids, methane gas for electrification, and recycled water) that can generate new income for the utility, thereby improving its profitability and contributing to a healthy income statement for the company in the long term.

- **Corporate governance**

Corporate governance sets the tone for how a business will be run at all levels. There are instances when companies that are part of a large conglomerate enter into intracompany transactions. In the case of MWCI, it exercised independence from the other companies of the Ayala Group from the very beginning. This forced MWCI to establish new working relationships with key stakeholders outside the company. The open procurement practices allowed it to keep costs lower because

procurement was not dictated or influenced by intracompany relationships. Ultimately, MWCI had to grow quickly without having to rely on the mother company and its subsidiaries. This was not the case with MWSI, which dealt frequently with companies within the Lopez Group and its international partners in terms of procurement, assignment of managers, and engagement of consultants. This increased costs prevented the company from establishing better working relationships with stakeholder groups.

- **Financial resource management**

Managing cash flow and subsidies are critical to financing a water utility adequately. The capital requirement for a utility is large. However, the entry costs may not be as high as originally expected. If cash flow can be managed and healthy revenue streams maintained, then borrowing from the capital markets or banks may be lower than originally thought. In the case of MWCI, loans were contracted in smaller amounts linked to subprojects rather than to seek financing for the entire system, the preferred route for the old MWSI.

With cash flows in local currency, MWCI matched its capital needs by borrowing more from local banks. In this way, it minimized the foreign exchange risk that went with long-term borrowings for immediate investment, as in the case with many public infrastructure-type projects.

- **Privatization**

Privatization can either succeed or fail depending on how the process was implemented. It can work if certain preconditions are created and the vision for privatization established. On the other hand, a number of factors can cause failure—from external factors to internal weaknesses. While it is relatively easy to set down major goals from a policy perspective, it is less easy to ensure that these goals are met effectively. The privatization of MWSS could be said to have been successful in realizing its end-objectives by looking at the overall welfare benefits.

The success of the privatization of the MWSS lay in the firm belief of the Ramos administration of its objectives in attracting only the most serious of bidders and setting high expectations that included the following:

- Raising the quality and reliability of water services for all consumers in the metropolis,
- Improving service standards,
- Reducing prices to customers, and
- Developing long-term raw water sources.

Dumol (2000) mentioned that it is critical to establish the right steps needed to make privatization a success. These include

(i) defining the problem (behind poor water delivery performance),
(ii) listing the constraints,
(iii) identifying the preferred privatization option and its broad characteristics,
(iv) hiring a lead advisor and managing his/her work,
(v) designing the approval process,
(vi) developing a consensus among all stakeholder groups (including employees) during the implementation of the transaction,
(vii) imposing strict prequalification requirements for bidders, and
(viii) designing a transparent bidding process.

- **Managing regulatory risks**

Managing or minimizing regulatory risks is a key concern of a concessionaire. Understanding the risks in the regulatory framework and concession agreement will protect both private and public parties of the agreement.

One of the reasons for the troubles of the old MWSI was that the government and the private sector did not identify foreign currency adjustments as a risk factor in the original agreement. While this had been addressed since, at least one of the utilities still believed that there was significant risk in the government deciding to forego regulated adjustments for political reasons to the detriment of the private concessionaire. Providing risk mitigation provisions in any concession agreement is vital to a successful concession arrangement.

Challenges

Metro Manila faces a number of challenges. Foremost of this is the reliance of the metropolis on a single, large source of water, the Angat Dam. In a country prone to earthquakes and increasing incidences of drought (the El Niño phenomenon), damage to the Angat Dam or prolonged drought will severely affect Metro Manila and the utility area or responsibility. The threat of depletion of the underground water aquifer due to excessive groundwater extraction makes deep wells less efficient and harmful to the environment (MWCI 2006). The critical challenge is to develop new sources of water.

A second challenge involves the fast-rising price of water. While the older generation can recall the time when water was less accessible and more often, available only during off-peak hours (e.g., late evening), this perspective will change after some time. While the older generation will regard high water prices as

the price for availability of water, a new generation used to continuous 24-hour water may begin to see water prices as excessively high. With the needed capital investment to be made for sewerage and sanitation, customers will be faced with additional charges.

A third challenge is regulatory risk. A case may be made with reference to the MWSS-RO model. A continuing risk to the two utilities is the presence of a two-office MWSS, both of which are paid for by both utilities. Under the concession framework, the regulatory office should be the principal entity with whom the utilities should interface. The corporate office in charge of recording and documenting the assets as per government accounting and auditing rules should be a smaller entity limited to ministerial functions. The role of the corporate office, however, is more pronounced as evident in the Laiban Dam case, where it tried to take a direct hand in contracting for new supply of water that the utilities claim is their responsibility. The mixed signals sent to the private sector are not desirable from a governance point of view.

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CHAPTER VII

Phnom Penh, Cambodia

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Water Supply of Phnom Penh: An Example of Good Governance

Introduction

Cambodia is generally well endowed with water resources. It has a high annual rainfall (up to about 3,000 millimeters [mm] in the highlands), three major rivers (Mekong, Bassac, and Tonle Sap) with many tributaries, and excellent sources of groundwater both in terms of quantity and quality. Until the late 1960s, urban water services in Phnom Penh were similar to what then existed in many of its neighboring countries. Many of the residents of Phnom Penh had an uninterrupted 24-hour water supply of reasonable quality water.

The situation, however, changed dramatically after the late 1960s due to considerable political turmoil, and this condition continued unabated for the next 2 decades. The situation worsened during the 4-year rule of the Khmer Rouge, which captured Phnom Penh in 1975. The Khmer Rouge attempted to make Cambodia a classless rural society by forcing people to work in agricultural communes. Its strong ideology included isolating the country from all types of external influences.

The social, political, economic, and institutional turmoil took its toll on all of Cambodia's development sectors during the decades of the 1970s and the 1980s. Urban water management was not an exception. All forms of social services in the country—from education to health—became totally dysfunctional, and all urban infrastructures were grossly neglected during these 2 decades. There were no new

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investments in water or in any other type of infrastructure, nor was infrastructure maintained and operated at a minimum acceptable level. Skilled personnel were simply not available to properly maintain and operate the existing urban water system, and available records of the urban utilities were mindlessly destroyed during the Khmer Rouge regime.

By the 1980s, the Phnom Penh Water Supply Authority (PPWSA) was in bad shape— institutionally, technically, financially, and in management terms. Years of centralized, top–down management had contributed to a culture of inefficiency, bureaucracy, corruption, and conformity. The staff did the least possible work that was needed. It was estimated that 80% of the staff worked less than 2 hours per day. Salaries were very low, the working environment was poor, proper management was nonexistent, and corruption was endemic.

The lack of clean water and poor wastewater management practices took a heavy toll on the people of Cambodia during this period. During the mid-1990s, diarrheal diseases were endemic in the country, infant mortality rates were one of the highest in the world (115 per 1,000 live births), as were morbidity rates. Water-related diseases accounted for nearly 30% of all hospitalizations. In Phnom Penh, unaccounted-for-water (UFW) routinely exceeded 80% during the late 1980s, and the pressure of water was so low that most households received no supply of water, although they were connected to the system.

By the early 1990s, PPWSA as an institution and its overall management were dysfunctional, and as a result, consumers received very poor service and low level of service delivery. In 1992, PPWSA had only five engineers and most of its staff members were even incapable of reading meters accurately. Fortunately, the institution started to change radically from 1993.

Progress since 1994

The United States (US) lifted the trade embargo on Cambodia in 1992, and the Royal Government of Cambodia was established the following year after a successful election supervised by the United Nations. Shortly thereafter, the Government of Cambodia requested help from various multinational and bilateral aid institutions to rehabilitate its battered urban water systems and to formulate a long-term plan.

Immediately after the trade embargo on Cambodia ended, the Government of France provided a grant to improve the water distribution network. It was promptly followed in 1993 by another French grant to improve the city's water supply facilities. Also in 1993, the United Nations Development Programme (UNDP) provided a technical assistance grant to rehabilitate the water utilities of Phnom Penh and Sihanoukville, which was administered by the World Bank.

One of the early requests of Cambodia for technical assistance was made to the Government of Japan in early 1993 for the rehabilitation of the existing water supply system of Phnom Penh, and for assistance in drawing up a water development plan for the city. Japan carried out a study to develop a master plan and feasibility study of the Phnom Penh water supply system. It was conducted by the Tokyo Engineering Consultants in association with Nihon Suido Consultants (1993a, 1993b) on behalf of the Japan International Cooperation Agency (JICA). The study team arrived in Phnom Penh in February 1993, and within a period of 10 months, it completed the final report and delivered it to PPWSA.

In retrospect, this study turned out to be an important milestone because it served as a road map for the next several years for the development of PPWSA. The plan was developed in close consultation and discussion with PPWSA, hence, it was acceptable to them. This plan became the blueprint for the development of the utility in subsequent years. All projects supported by other donors had to fit within this framework and also comply with its overall philosophy. In retrospect, the plan served as an excellent basis for donor coordination, albeit indirectly. In 1995, JICA provided a grant of $25 million to improve the water supply facilities under Phase I and II of this plan, and another $21.33 million grant in 1997 for Phase II. The other major donors that provided financial and technical support to PPWSA since 1997 included the Asian Development Bank (ADB 1996) and the World Bank. However, as was the case for the initial financial support, these were loans to PPWSA and not grants.

The formulation of this plan and its subsequent implementation by the PPWSA and by the foreign donors—as well as the continuing support from JICA on a long-term basis to assist PPWSA on different aspects of water supply, including infrastructure development, management, and capacity building—have been important elements for the subsequent success of PPWSA. However, it is worth noting that it was only one of the several other important components that occurred concurrently that have contributed to the remarkable and steady improvements in the performance of the utility.

Urbanization

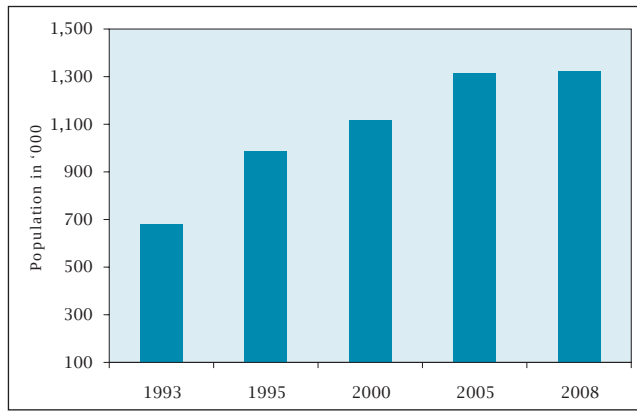
In terms of urbanization, Phnom Penh is truly a unique case. Until the late 1960s, it was a “normal” urban center, coming to grips with decades of French colonial rule and then independence. The population of the city was growing steadily, both due to natural causes and rural-to-urban migration. In contrast with the other ex-colonial capital cities of Asia and Africa, the growth rate was not spectacular. It was manageable. However, when the Khmer Rouge came into power with its strict policy of forcing urban residents to relocate to rural areas for agricultural activities, it became the only city in recent memory, if not in the entire history of mankind, to be massively and immediately depopulated for ideological reasons. Due to Khmer

Rouge policies, the population of Phnom Penh in 1979 was estimated to have declined to about 122,800.

With the fall of the Khmer Rouge, the population started to trickle back to Phnom Penh. After a period of time, the rate of return of the former residents increased. When the situation stabilized, the urbanization process, as in other Asian urban centers, gradually accelerated. The population growth of Phnom Penh between 1993 and 2008 is shown in Figure 1. There was an important difference in the population increase of Phnom Penh after the Khmer Rouge era. Many of the original residents of Phnom Penh had been killed. Also, after the traumatic experience, many families decided not to return to Phnom Penh and chose to settle elsewhere in the country. This loss of population was more than made up by the soldiers who were posted in Phnom Penh and who subsequently brought their extended families to the city from the interior of the country. These migrants had never lived in an urban setting and were more self-reliant. They managed to live without a regular supply of water as was the case when they were living in rural areas. They neither expected, nor received, water from the PPWSA during the transition period.

In supplying water to the residents and industrial users of Phnom Penh, PPWSA faced two critical challenges. First was to restore a reasonable service delivery to a limited geographical area, which was initially considerably smaller than the area before the Khmer Rouge assumed power. The second challenge was to supply drinking water to the entire Phnom Penh city. As PPWSA started to improve, especially since 1994, its service delivery area constantly expanded and drinkable water delivered increased as well. Figure 2 indicates the area to which water was provided between 1993 and 2000 primarily through pipe replacement and the overall supply system that was rehabilitated.

Figure 1 Population of Phnom Penh, 1993–2008

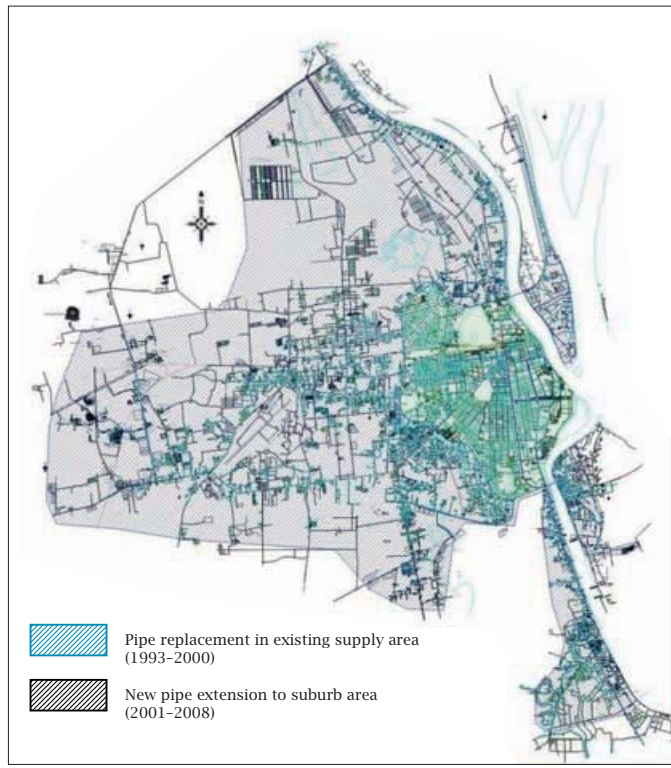


Source: Phnom Penh Water Supply Authority records.

Door-to-door service: Water connection application and payment at the community level in Phnom Penh.

Photo by Oeur Luxe of Phnom Penh Water Supply Authority.

Figure 2 Expansion of Area Supplied with Water, 1993–2008



Source: Phnom Penh Water Supply Authority records.

During 2001–2008, and after the spectacular success of PPWSA in providing clean, drinkable water supply on a 24-hour basis, its service area constantly expanded to include the suburbs of Phnom Penh. Its service area is still expanding.

In 2008, the annual volume of treated water produced was over 85.5 million cubic meters (mcm), which was more than enough to meet PPWSA's needs (Table 1). However, with the increasing per capita water use from the lower base of the earlier years, combined with an increase in its service area, the daily water production had to be increased to 300,000 cubic meters (m^3)/day to meet anticipated demand by 2013. This increase can be met by increasing the capacity of the Chrouy Changwar plant by 65,000 m^3/day by 2013.

Progressive increases in the daily per capita water use in the city of Phnom Penh are shown in Figure 3.

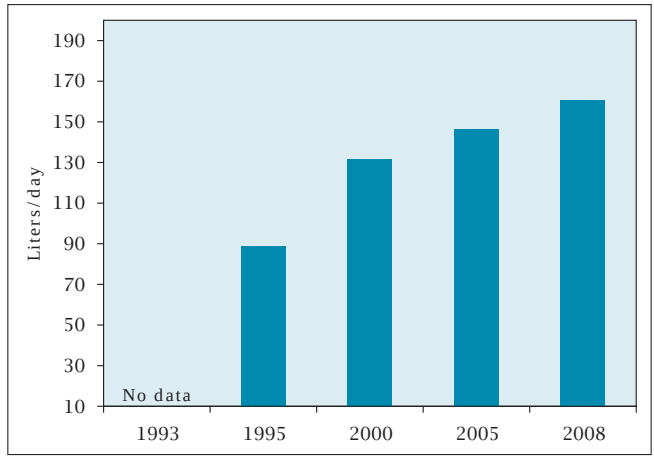
Table 1 Average Annual Water Production

Year	Actual Production (m^3)	Average Daily Production (m^3/day)	Maximum Daily Production (m^3/day)
1993	19,586,000	53,660	No data
1994	25,483,000	69,816	No data
1995	31,651,000	86,715	No data
1996	34,486,000	94,482	No data
1997	39,184,171	107,354	116,646
1998	39,983,794	109,545	113,116
1999	40,622,401	111,294	117,837
2000	39,801,167	109,044	117,586
2001	37,763,547	103,462	103,978
2002	41,793,679	114,503	115,362
2003	46,871,146	128,414	144,405
2004	56,775,305	155,549	182,124
2005	61,857,961	169,474	190,367
2006	79,623,204	193,488	211,605
2007	79,400,031	217,534	240,349
2008	85,513,649	234,284	258,571

m^3/day = cubic meters per day.

Source: Phnom Penh Water Supply Authority records.

Figure 3 Per Capita Water Use, 1993–2008



Source: Phnom Penh Water Supply Authority records.

Unaccounted-for-Water

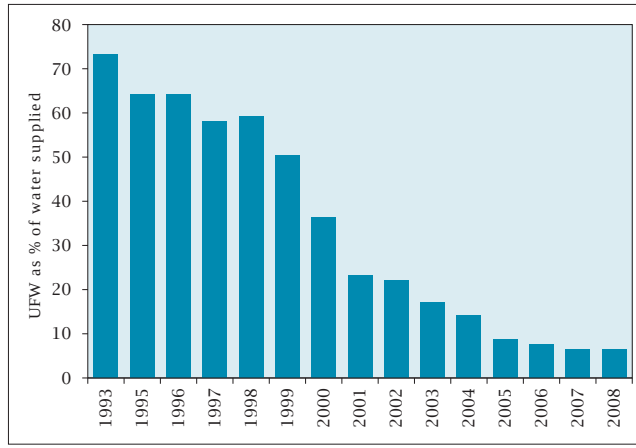
A major problem in 1993 was the substantial losses due to UFW, which was well over 70%. Reducing UFW within a short time frame, which is a process that involved several concurrent tasks, required a strict systems approach. No water supply can be kept at a reasonable and affordable level if the income from the customers does not cover the costs of providing a good service, especially when nearly three-quarters of the water supplied yielded no revenue whatsoever. Thus, a strict regime with several interrelated components had to be planned and implemented.

The progressive reduction in UFW is shown in Figure 4.

No significant UFW reduction is possible without the cooperation and support of a dedicated, competent, and motivated staff. The quality of staff in PPWSA left much to be desired during the early 1990s. Not only were the staff members demoralized, but they had a good reason to be demoralized as they were faced with poor governance, below subsistence pay, lack of discipline, absence of any incentives, and pervasive corruption.

Lethargy, poor working practices, and a “could not care less” attitude to its consumers were the norm. Therefore, the work culture had to be radically changed by enforcing strict disciplines in a sensitive, fair, and transparent manner. This was a difficult task since the rest of the public sector employees in Cambodia were in a similar situation and behaved in a very similar manner.

Figure 4 Unaccounted-for-Water, Phnom Penh, 1993–2008



UFW = unaccounted-for-water.
Source: Phnom Penh Water Supply Authority records.

Changing institutional culture was not an easy task. It had to start with the senior officers who had to become the role models. During the 1980s and early 1990s, one of the perks of the job was employees of PPWSA received free supply of water.

This practice was stopped. Staff members not only had to install meters but also had to pay their water bills in full, like any other citizen, and within the stipulated time period. Otherwise, they were treated exactly as those who were delinquent in paying their water bills.

Water Pricing and Cost Recovery

The global experience is that if consumers have to receive a 24-hour, uninterrupted, and reliable water service, they have to pay for this service directly and/or through taxes.

The Government of Cambodia decided in the 1990s that water was both an economic and a social good. Hence, a responsible, financially viable, and socially sensitive tariff structure should be put in place so that PPWSA could have adequate income to be financially self-sufficient. The objectives were to run the institution in a business-like way and the population to have continuous, good quality, and affordable water supply.

To the credit of the Government of Cambodia, PPWSA has been allowed to operate as an independent business-like institution without any political interference, with checks and balances as stipulated in the landmark Decree No. 52 of 1996. An English version of this decree can be seen in Biswas and Tortajada (2009).

With its autonomous structure and good management, PPWSA decided to maximize its income by

- reducing UFW significantly so that the water produced can be sold to the consumers,
- fixing a tariff structure and implementing it fully with a social conscience,
- preparing and continually updating a roster of customers on a regular basis,
- completely restructuring the billing system so that bills can be produced and delivered on time and in a transparent manner,
- improving the bill collection ratio with appropriate incentives and disincentives for late or nonpayment, and
- increasing the annual profits of PPWSA by making it increasingly efficient progressively.

To achieve higher revenues and thus financial self-sufficiency, PPWSA embarked upon a concurrent five-prong strategy. One of the most difficult components to implement in this strategy was increasing water tariff so that all costs could be recovered without generating any social and political unrest. This was done by ensuring that its customers first experienced and appreciated a much better quality and reliable service before tariffs were increased.

The increase in tariff was very carefully planned. First, a socioeconomic survey of the water supply situation was carried out for the city of Phnom Penh. This survey included collecting information on how much consumers were paying for water from private vendors, and what was their likely reaction if the supplier was replaced by PPWSA. This survey also showed the willingness and capacity of consumers to pay a higher tariff than what they were being charged by PPWSA provided they received a significantly improved service.

The tariff was calculated after considering the total expenses of PPWSA, including operation and maintenance costs and the depreciation of all its assets. This process conforms to the National Water Policy that was approved by the government later. Under this policy, the utility is expected to recover its operating costs with tariffs as well as the depreciation cost of all its assets, except land, which generally increase in value over time. The value of its assets has to be revised every 5 years.

Table 2 Progressive Tariff Structure of the Phnom Penh Water Supply Authority (in KR/m^3)

Until 1983	Free water for every household	
1984	KR166/m^3 (domestic and commercial)	
1993–June 1994	KR166/m^3 (domestic) KR515/m^3 (industrial)	
July 1994–May 1997	KR250/m^3 (domestic) KR700/m^3 (industrial)	
June 1997	Block tariff rates were introduced. All connections were metered.	
	Domestic tariffs (m^3/month)	
	0–15	KR300
	16–30	KR620
	31–100	KR940
	>100	KR1,260
	Industrial tariffs (m^3/month)	
	0–100	KR940
	101–200	KR1,260
	201–500	KR1,580
	> 500	KR1,900
	Governmental institutions (m^3)	
	Flat rate	KR940
2001	Domestic tariffs (m^3/month)	
	0–7	KR550
	8–15	KR770
	16–50	KR1,010
	>50	KR1,270
	Commercial tariffs (m^3/month)	
	0–100	KR950
	101–200	KR1,150
	201–500	KR1,350
	>500	KR1,450
	Governmental institutions (m^3)	
	Flat rate	KR1,030

KR/m^3 = riels per cubic meter, m^3/month = cubic meters per month.
Source: Phnom Penh Water Supply Authority records.

The second increase in tariff was introduced in 2001. Changes in the water tariff structure since 1983 are shown in Table 2.

Having experienced significant improvements in water delivery, including quality of water, consumers willingly paid for the vastly superior service. As the increase was reasonable, it was within their capacity to pay. This included the poor whose bills

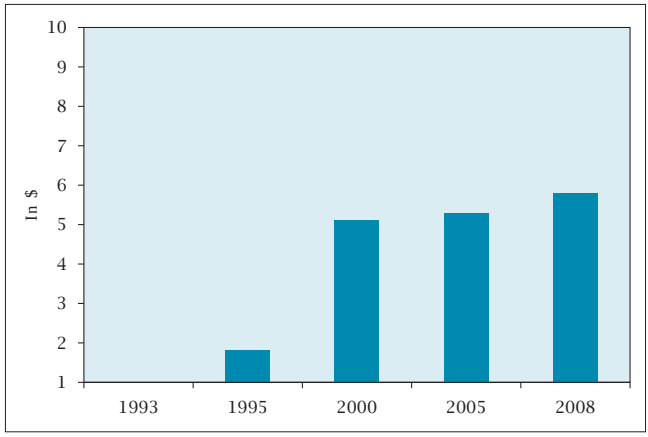
declined by 60%–80% compared to what they used to pay to private water vendors for poor quality water and unreliable service. As a result, private water vendors practically disappeared from PPWSA's service delivery area.

By 1995, 24-hour uninterrupted service was available in Phnom Penh. This also meant that the average monthly household water bills in the city increased significantly between 1995 and 2000. Thereafter, the water bills increased only incrementally (Figure 5).

While it was comparatively easy to convince the general public to pay a higher tariff, it was a different situation with respect to army installations, government offices, and senior officials of the government and the army. They had not historically paid any water bill and not surprisingly, they wanted this free service to continue indefinitely. The army initially refused to have any meter installed to measure its actual water consumption, and refused to be billed for it. Nevertheless, in 1997, the Prime Minister publicly proclaimed that every person and institution had to pay their water bills promptly so that PPWSA could ensure good service delivery. The transition process was difficult.

Figure 6 shows the billing ratio in terms of water quantity that was billed as a percentage ratio of total water volume produced between 1993 and 2008. It shows that in 1993, less than 30% of water produced was billed. By 2005, with very significant reduction in UFW, over 90% of the volume produced was billed. The current situation is even better. In 2008, over 93% of water produced was billed.

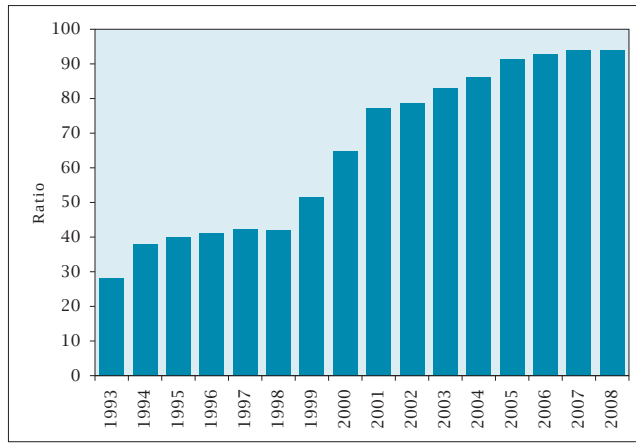
Figure 5 Average Household Water Bill per Month, 1993–2008



Source: Phnom Penh Water Supply Authority records.

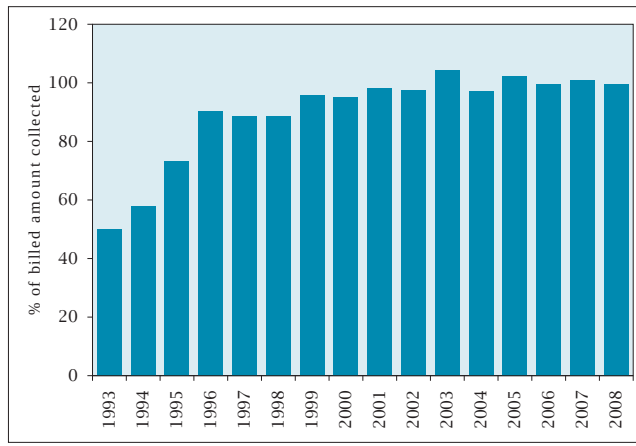
Figure 7 shows bill collection ratios in terms of amount collected and amount billed. Both show that bill collection is close to 100% in 1999, more than double the rate in 1993. This again is a most remarkable achievement in only 6 years.

Figure 6 Billing Ratio: Quantity Billed/Total Production, 1993–2008 (in %)



Source: Phnom Penh Water Supply Authority records.

Figure 7 Bill Collection Ratio: Amount Collected/Amount Billed, 1993–2008 (in %)



Source: Phnom Penh Water Supply Authority records.

Accurate Data on Water Consumers

For a water utility to be functional and efficient, it is essential to have an accurate database of its current users. Without one, it is simply not possible to collect revenue from water users. In addition, this database needs to be kept continually updated, which means keeping relevant information on the people who move into the city, people who move houses but within the city, and also people who leave the city. Such a list is always dynamic, and needs to be continually updated to ensure correct and appropriate billing.

During the Khmer Rouge regime, all information on PPWSA customers and other relevant information were destroyed. After the fall of the Khmer Rouge government, no accurate database was established as to the actual consumers of the water supplied by PPWSA. To establish a proper database, nearly 100 PPWSA staff members visited all houses in the city in 1994 to record if they were receiving water or not. The process took 1 year to complete.

The results were revealing. The survey found that 12,980 households were ostensibly connected to the system, but were not. They were being billed for phantom water supply, and surprisingly, many were paying water bills although they never received any water. In contrast, there were 13,901 customers who were connected and receiving water, but were not in the list and thus were not being billed. In effect, they were receiving free water.

The Government of France gave a grant that enabled PPWSA to establish a fully computerized up-to-date database, which became fully operational in 1996 (Chan 2009). The computerized system was further improved in 2001 to handle all financial transactions and operations at PPWSA. By 2003, a comprehensive financial management information system was in place, which enabled PPWSA to have immediate access to the latest, as well as historical financial data, and access its revenue collection status in real time. An indirect benefit of this automated system has been that corruption and abuse of power were eliminated from the billing and bill collection processes. PPWSA also continued to steadily improve its overall financial management practices, including its financial information management system.

Metering

To ensure that a fair and transparent system exists, it is essential that all connections be measured in terms of their water consumption. Only after each connection is metered can consumers be sent an accurate bill that directly reflects the amount of water they consumed during a specific period.

In 1993, only 3,391 out of 26,881 connections were metered. In other words, more than 87% of the connections received an estimated bill, which often did not reflect the actual quantity of water consumed. With a policy decision to move to a system where all connections are metered as soon as possible, the number of meters installed increased steadily, and the number of unmetered connections started to decline. By 2001, all connections were metered. Over time, more accurate Class C meters replaced less reliable Class B meters, which further increased the credibility and income of PPWSA.

Water for the Absolute Poor

The issue of providing clean water to the poor, or even to the rich, was not a consideration prior to 1994. There were simply no reliable water services available, either for the rich or for the poor. Thus, the first task of the new PPWSA management was to ensure a reasonably reliable water supply system to the people irrespective of whether they are rich, middle class, or absolute poor. Hence, PPWSA's primary focus and concern at the initial stage was to rehabilitate the water system in order to establish a supply system that could deliver clean, potable water to all classes of people.

Once the supply was restored to a reasonable level, the next challenge was how water could be supplied to the poor in a way that PPWSA could justify economically, and how the poor could afford the service. The first approach was to determine specific communities of poor people, who would then elect their community representatives to whom the PPWSA would sell water. In turn, these representatives are expected to resell water to their respective communities at a recommended tariff, which the poor could afford. The installation of community water pipes was initially funded mostly by nongovernment organizations. Thus, from 1995–2000, community representatives were supplied with water. By the end of 1998, there were 53 representatives of the poor communities, with an average total consumption of 15,500 m^3 per month, representing slightly over 1% of the total volume of water sales of PPWSA.

This approach did not perform as initially expected, for two reasons. First, the community representatives mostly sold water to the poor people, not at the recommended tariff but at 10 to 20 times the subsidized rate the PPWSA sold to them. Second, PPWSA received very little income from these transactions. The main beneficiaries turned out to be the community representatives themselves, who pocketed the difference between the two prices.

During the experimental period, PPWSA also realized another important fact. Initially, it expected that the poor might steal water as a result of which its net UFW rate would remain high. Accordingly, meters were installed far from the poor

households, which increased installation costs. In 1999, PPWSA realized that even if the poor stole water, which they did not, their individual consumption rate was so low that the resulting losses were unlikely to be significant.

In March 1998, PPWSA received a soft loan from the World Bank, a part of which was explicitly earmarked for the provision of clean water for the poor.

A task force was created specifically for the implementation of this pro-poor scheme, which was also responsible for the processing and approving of applicants, and implementing installment payments for the connection charges. This arrangement did not work very well, primarily because the necessary information was not properly disseminated to the poor households. Thus, in 1999, only 101 house connections to the poor could be made under this scheme. In contrast, for the city as a whole, 12,059 house connections were installed that year.

Primarily due to a grant from the International Development Association in 2003, and an annual grant of €50,000 from the city of Paris, PPWSA has a much more generous and affordable program for the absolute poor. Poor households are entitled to receive subsidies of 30%, 50%, 70%, or 100% of the connection fee, depending upon their financial conditions. These conditions are jointly evaluated by a committee of the PPWSA with direct help from the local communities. In addition, households that consume a maximum of 7 m^3 per month pay only 60% of the real cost of providing water. This new policy helped poor households to save KR130,000–KR380,000 each year (KR5,000 = $1.20).

As a result of these improvements in pro-poor policies, the number of poor households connected to the system has steadily increased from 101 household connections in 1999 to 17,657 connections in 2008.

Financial Sustainability

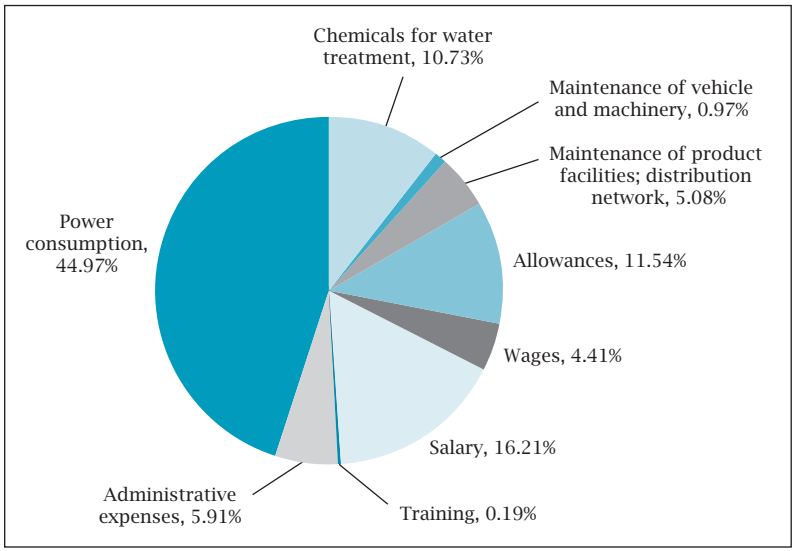
Based on current evidence, the financial sustainability of PPWSA can be summarized by one word: excellent. According to the latest statement from its auditors (Pricewaterhouse Coopers 2009), its operating revenue for the 2008 financial year was KR91.59 billion, on which it made a profit of KR30.58 billion. After paying income tax of KR6.14 billion (20% of the profit) to the Government of Cambodia, it made a net profit of KR24.43 billion. To our knowledge, it is the only publicly managed water utility in the developing world that has consistently increased its net profit since 1993, and also has paid consistently higher income taxes every year to the government. In fact, according to the audit report of 2008, PPWSA actually made a loan of $2 million (about KR8.4 billion) in 2005 to the *Electricité du Cambodge*, which was fully repaid in 2007. In 2008, PPWSA gave a loan of KR675.44 million to the Pursat Water Supply Authority to finance the construction of the main water

supply network in the Kandiang district of Pursat Province. The unsecured loan is subject to 5% interest per year, to be reimbursed to PPWSA in 120 monthly installments, after the construction of the network was completed in 2009.

In 2009, the main components of PPWSA's operating costs were for electricity (44.97%) and chemicals needed for water treatment (10.73%), over which it has no control (Figure 8). Electricity costs are decided by the *Electricité du Cambodge*, and chemical costs are determined by world market prices. Salaries, wages, and allowances for its staff accounted for another 32.16% of the annual expenditure. While PPWSA is becoming increasingly efficient in terms of its staff performance (for example, the number of accounts served per employee has dramatically improved between 1993 and 2008,[136] as shown in Figure 9), it must offer an attractive financial package to its staff in the future in order to recruit and retain a highly motivated staff.

With good efficiency gains, amounts billed and amounts collected became almost the same after 2000. This means that PPWSA's net profit has progressively increased every year since 1998 (Figure 10).

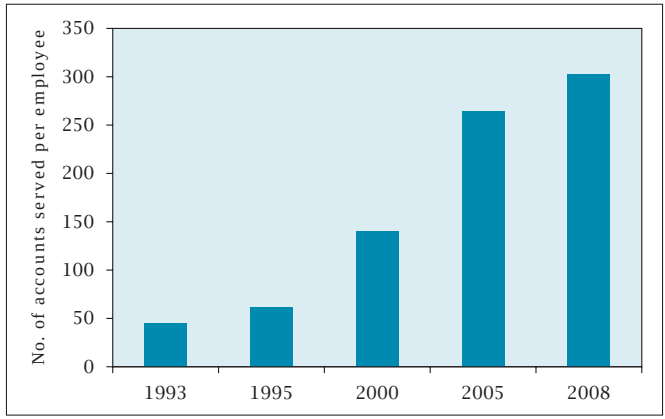
Figure 8 Distribution of Annual Operating Expenses



Source: Phnom Penh Water Supply Authority records.

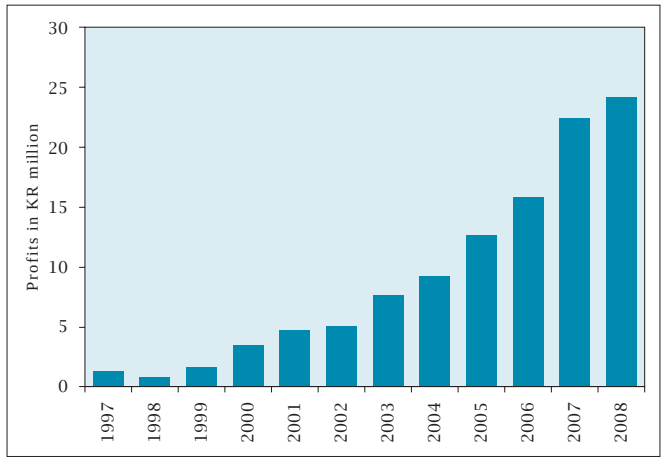
[136] It should be noted that PPWSA does not outsource any activity to the private sector, including pipe-laying. Thus, its staff per 1,000 connections should not be compared to other utilities, which outsource many activities to the private sector, like Colombo or Singapore.

Figure 9 Number of Accounts Served per Employee, 1993–2008



Source: Phnom Penh Water Supply Authority records.

Figure 10 Net Profits of Phnom Penh Water Supply Authority, 1997–2008



KR = riels.

Source: Phnom Penh Water Supply Authority records.

As PPWSA increases its geographical area of coverage, more and more consumers join the system. Even with increasing per capita consumption, it has maintained, and even improved upon its current level of performance. Thus, there is no reason why net profits should not continue to increase steadily, unless political interference reduces performance levels. At the current stage of development, it is highly unlikely that there would be political interference in its management, especially as

it is the only public sector utility that has been consistently delivering good service to the population while concurrently increasing profit each year.

Overall Performance Assessment

In retrospect, if any independent and objective observer had been asked to make a realistic forecast on the future prospect of a near bankrupt, demoralized, and a corrupt institution like the PPWSA in 1993, the most optimistic individual would probably have said "not very good." At best, the prognosis would have been that PPWSA would be able to improve its performance incrementally, and would manage to provide water of uncertain quality to some of the inhabitants of Phnom Penh for a few hours per day, like in vast majority of urban centers in the developing countries of Asia. The most realistic and optimistic forecast would have been that by 2003, the PPWSA would become an average water utility in the region with a mediocre, or perhaps even less than mediocre, performance.

Instead, the actual achievements of PPWSA have confounded everyone, including its most ardent supporters and donors. In only 1 decade, the institution has turned around 180 degrees, with a completely different mindset, a team spirit that is seldom observed in a utility (water, gas, or electricity) in any developing country, and a "can do" attitude, which is very refreshing to observe. From 1994, and every year since that time, PPWSA has made significant progress in all technical, managerial, and financial performance indicators. It has continuously expanded its network, improved its management and operating efficiency, become financially self-sufficient, and progressively increased its net annual profit after paying appropriate income taxes to the Government of Cambodia—as one would expect from any private sector institution.

Within the 15-year time frame, 1993–2008, PPWSA increased its annual water production by 437%, distribution network by 557%, pressure of the system by 1,260%, and customer base by 662%. During the same period, it reduced UFW losses from 72% of treated water produced in 1993 to only 6.19% in 2008. By judicious use of incentives and sanctions for its staff with transparent policies that were consistently implemented, and a strong and determined focus on capacity building for its staff, the number of accounts served per employee increased by 671% during the same period.

During the same period, the number of metered connections has gone up by nearly 5,255%. Although people are now paying for the water they actually consume, per capita daily water consumption has nearly doubled, which must have a positive impact on the health and well-being of Phnom Penh residents.

Concluding Remarks

In terms of good governance, the experience of PPWSA is a salutary example for the urban centers of the developing world. Many reasons are given by water utility managers, political leaders, and members of the water profession as to why it has not been possible to provide clean, drinkable water to the urban centers of the developing world. Among these were the physical scarcity of water, lack of availability of investment funds, inability of the poor to pay for water, and lack of expertise, among many other reasons. In our view, all of these are mere excuses to hide the real and fundamental reason for this shortcoming—poor leadership and governance practices of the urban water sector nearly all over the developing world. Phnom Penh has very clearly shown how it can be achieved under the most difficult circumstances, and in less than 10 years.

Unless the urban water governance practices are improved significantly, as in the case of Phnom Penh, universal access to clean drinking water will remain an unachievable dream, even if hundreds of billions of dollars with no strings attached are made available to this sector each year.

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CHAPTER VIII Shenzhen, People's Republic of China

Miao Chang, Xin Tian, and Dongwei Li [137]

Introduction

As the first special economic zone (SEZ) officially approved by the Government of the People's Republic of China (PRC), Shenzhen is not only leading in the reform of water management in the PRC but also in the country's urban water industry in the direction of marketization.

The Shenzhen Municipal Water Affairs Bureau (SZMWAB) was the first authority to be established in the PRC to take charge of all water management affairs of a city.[138] As an SEZ, Shenzhen is entitled to enact local laws and regulations, thus permitting a relatively complete legal system needed for water management to be established. Meanwhile, water sector reform in Shenzhen resulted in a high degree of separation between the government and enterprises. The Shenzhen Water Group (SZWG), which is a major provider of water supply and wastewater services and has an excellent reputation in the PRC's water sector, completed a reform of its system in 2004. It became a large, joint venture among the government, Veolia Water, and Beijing Capital Group. Veolia Water and Beijing Capital Group provided CNY3.31 billion[139] ($400 million) in funding to acquire a 45% equity stake in SZWG. This was the largest merger and acquisition in the PRC's water sector and the second largest in the world at that time (Fu, Chang, and Zhong 2008, 104). Shenzhen's water management and market operations are thus representative of reform in the PRC and have a strong guiding significance for other cities.

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[138] Before 2009, the SZMWAB was known as the Shenzhen Water Resource Bureau (SZWRB).

[139] Currency conversion: $1 = CNY8.27.

Overview of the City

Population and Administrative Divisions

Shenzhen is a coastal city in southern PRC. It faces the Daya Bay and the Dapeng Bay to the east and in the south, the Shenzhen River connects to Hong Kong, China. Falling under the administration of Guangdong Province, Shenzhen is a separate city at the sub-provincial level, with the Shenzhen Special Economic Zone under its governance.

The total area of Shenzhen is 1,952.84 square kilometers (km^2). The Municipal Government of Shenzhen governs six districts and 51 subdistrict offices. Of these, Luohu, Futian, Nanshan, and Yantian districts are within the SEZ, while Bao'an and Longgang districts are outside it. At the end of 2008, Shenzhen had a population of 8.77 million, of which 2.28 million were registered and 6.49 million or 74% were nonregistered (Shenzhen Statistics Bureau 2009).

Economic Development

Shenzhen is one of the richest cities and one of the three major economic regions and new areas in the PRC.[140] In 2008, Shenzhen's gross domestic product (GDP) was CNY780.65 billion, having increased 12.1% over the previous year.[141] GDP per capita, calculated based on annual average population, was CNY89,814 ($13,153), having increased 10.2% over the previous year. Local revenue increased by 21.6% to reach CNY80.04 billion (Shenzhen Statistics Bureau 2009).

An educational tour to a water plant upgraded with advanced treatment process in Shenzhen.

Photo by Huang Jiwei.

[140] The Shenzhen Special Economic Zone, Shanghai Pudong New Area, and Tianjin Binhai New Area are hailed as the three major growth poles in the PRC.

[141] Financial year: January–December (e.g., FY2008 is January 2008 to December 2008).

Institutional Setting and Governance

Management System

Water Policy and Regulation

Water policy and regulation in the PRC can be subdivided into four levels: laws, administrative statutes, departmental regulations, and local policies and regulations. Administrative statutes are enacted by the State Council in accordance with the Constitution and laws. Departmental regulations are administrative regulations introduced by ministries and commissions under the State Council and national administrative departments. Local policies and regulations are created by the local People's Congress and its standing commissions based on local conditions. Water policy and regulations also include technological policies affecting standards, plans, and criteria.

As an SEZ, Shenzhen has independent legislative rights. This is beneficial for its water sector management. Legislative rights were delegated to the Shenzhen Special Economic Zone by the National People's Congress in 1992. Since then, Shenzhen has always been at a leading position in the PRC in market-oriented reforms and legislative development. More than 20 local water policies and regulations have been issued, covering urban water resource management, water supply management, drainage management, marketization reform of the water sector, and water pollution control. These have taken initial shape as a coherent policy and regulation system covering Shenzhen's water sector management.

The water administration of Shenzhen comes mainly under the SZMWAB. According to the provisions of Decree No. 13 on "Rules for the Supervision of Water Administration" issued by the Ministry of Water Resources in 2000, government administrative departments above the county level that are responsible for water affairs, river basin management institutions affiliated to the Ministry of Water Resources, and other organizations authorized by laws and regulations, should set up teams responsible for the supervision and monitoring of water affairs, establish a water governance system, and implement it accordingly. To enhance the administration and legal enforcement of water affairs, SZMWAB set up a branch responsible for water supervision and monitoring, whose main functions are to

- carry out the enforcement of national, provincial, and municipal laws, rules, and regulations related to water management;
- investigate and punish violations according to the law;
- organize, coordinate, and deal with major municipal-wide activities in law enforcement; and
- guide, coordinate, supervise, and inspect water law enforcement in each district.

Box 1 Typical Water Policy and Regulation in the People's Republic of China

1. Laws

On urban water supply, the Water Law of the People's Republic of China states that it is up to municipal governments to make and revise mandatory plans specifying the water amounts that water supply enterprises are required to supply. Meanwhile, municipal governments should provide financial assistance or enact other measures to help water supply enterprises, and bring the adjustment of water tariffs into the annual commodity price adjustment plan so as to build a reasonable water tariff system. It is also up to municipal governments to examine and approve the adjustment of water tariffs. The methodology for instituting water pricing should be defined by provincial, autonomous regional, or centrally administered municipal governments.

The Law on Prevention and Control of Water Pollution (adopted in 1984, revised in 1996, and most recently revised in 2008) in the People's Republic of China stipulates that governments at the county level and above should arrange for drainage networks and wastewater treatment facilities to be constructed. The central government will formulate the national standards for water environmental quality and pollutant emission, taking the PRC's economic and technological conditions into account. Governments of provinces, autonomous regions, and municipalities may set additional or stricter standards than the national standards. Effluent charges and usage fees for urban drainage facilities have begun to be collected and have been used to construct, operate, and maintain drainage facilities.

2. Administrative Statutes

The Ordinance on Urban Water Supply (No. 158, Decree of the State Council, issued 19 July 1994, effective 1 October 1994) covers the development of cities and water supply, urban water resources, construction of water supply facilities, management and operation of the water supply system, and maintenance of infrastructures. Administrative statutes also include decisions, provisions, opinions, and circulars, such as "Decision on Reform to the Investment Mechanism," and "Circular on Urban Water Supply, Saving Water and Water Pollution Control." The latter has played an important role in the development and reform of the water sector since its publication in 2000.

On 19 April 2004, the Office of the State Council issued a document titled "Circular on Promoting Water Tariff Reform and Improving Water Conservation and Water Resources Protection," which represents the current thinking on national reform and developments in the water sector. The document emphasized price as a market measure and proposed the following five principles for water tariff reform:

(i) linking the adjustment of water tariffs with building a tiered tariff structure,

(ii) linking the pricing of water with constructing water supply facilities,

(iii) making rational use of water resources along with water pollution control,

(iv) linking the development of water supply institutions with the construction of water conservation facilities, and

(v) reforming the pricing mechanism along with the reform of operation and management of water supply institutions.

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Box 1 *continued*

The circular also clarified four components of water pricing, which are the water resource fee for groundwater extraction, fee for supplying water via special infrastructure projects (such as by externally transferring water), tariff of urban water supply, and wastewater treatment fee. It emphasized an integrated plan for water resource management, reaffirmed the use of nontraditional water resources such as reclaimed water and desalinated water, and reinforced the importance of water tariffs in overcoming cost constraints of water supply institutions.

3. Technological Policies

Standards are major measures that governments use to manage industries under a planned system. According to the Standardization Law of the PRC, the country's standards can be divided into four types: national standards, trade standards, local standards, and enterprise standards. National and trade standards can be subdivided into compulsory and voluntary standards. The PRC's environmental standards system can be generalized into five categories and three levels. The five categories are environmental quality standards, pollutant emission standards, basic environmental standards, monitoring and analytical methodology standards, and standards on environmental reference materials. The three levels are national standards, trade standards, and local standards. In addition, there are other standards that are related to the urban water industry. These include standards for construction, operation, and management issued by the Ministry of Housing and Urban–Rural Development, as well as water-related product standards.

In terms of technological development, the former Ministry of Construction issued the document "Technological Development Plan in the Urban Water Supply Sector 2000" in December 1993. Henceforth, each city had made related plans to realize the ministry's overall plan, established measures accordingly, and made serious endeavors to introduce imported advanced technology and equipment to enhance water supply quality and safety. Another document "Technological Development Plan in Urban Water Conservation in [People's Republic of] China 2010," which was also issued by the ministry, stated that the country would make use of water conservation to meet half of the water demand in the cities.

Source: Authors.

Due to intensive development over the years, especially between 2001 and 2005, Shenzhen has encountered problems in water resource management, such as a higher number of violations that are difficult to deal with. Although remarkable success had been achieved in water infrastructure construction in Shenzhen, efficiency in the use of infrastructure was severely constrained, especially in drainage management and water pollution control, due to low competence levels in management and law enforcement. In 2006, the Shenzhen Water Resource Bureau (SZWRB) appointed the Shenzhen Flood Control Administrative Office and eight other units to carry out part of water law enforcement. As a result, the power of water law enforcement was greatly improved. At present, water pollution and water source protection have become the most important issues in water law enforcement.

Tests are conducted to ensure high water quality in Shenzhen.
Photo by Liu Jianli.

The Water Sector's Parent Bureau

In the PRC, governance is divided into four tiers: (i) central level, (ii) provincial level, (iii) municipal level, and (iv) county level. The central government administers provincial governments, while the provincial government administers the municipal governments in the province. The municipal government of a city has two functions:

(i) administration of the city and provision of public services, and

(ii) oversight of and responsibility for the governance of county-level entities within the municipality.

Before 1993, the water supply affairs of Shenzhen were managed by the Shenzhen Municipal Water Conservancy Bureau, Office of Urban Management, Planning and Land Bureau, and Construction Bureau. Since September 2004, the type of organization used in Shenzhen is the second model where water supply and wastewater services are overseen by the same Water Affairs Parent Bureau, namely the SZMWAB. The major municipal water-related government institutions in Shenzhen include SZMWAB, the Shenzhen State-Owned Assets Supervision and Administration Commission (SZSASAC), Shenzhen Price Bureau (SZPB), Shenzhen Development and Reform Commission (SZDRC), and Shenzhen Residential

Table 1 Selected Water Policies and Regulations in Shenzhen

Type	Policy and Regulation	Year Issued	Objective
Water Resource Management	Ordinance on Drinking Water Resource Protection in Shenzhen Special Economic Zone (SEZ)	1994 (modified: 2001)	To protect the water quality of drinking water sources in the Shenzhen SEZ, safeguard human health, and promote sustainable economic development.
	Ordinance on Water Resource Management in Shenzhen SEZ	1994	To strengthen water resource management; rationally develop, use, and protect water resources; and adequately develop the integrated and efficient use of water resources.
	Measures for Collecting Water Resource Fee in Shenzhen	1996	To strengthen water resource management, and regulate the standard and method of collecting water resource fee.
	Ordinance on Maintaining Water and Soil in Shenzhen SEZ	1997	To prevent and control soil erosion, protect and rationally use water and soil resources, alleviate water and drought disasters, improve the ecological environment, and promote the coordination between the development and use of water and soil resources and economic development.
	Measures for Municipal Drainage Management in Shenzhen SEZ	1999	To strengthen municipal drainage management in the Shenzhen SEZ, promote the development of urban drainage affairs, and improve the urban environment.
Water Supply Management	Provisional Measures on Construction and Management of Secondary Treated Wastewater Facilities in Shenzhen SEZ	1992	To strengthen water conservation management in the Shenzhen SEZ; scientifically and rationally use water resources; and build a modern, water-saving city.

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Table 1 *continued*

Type	Policy and Regulation	Year Issued	Objective
	Ordinance on Urban Water Supply and Water Consumption in Shenzhen SEZ	1995 (modified: 2003)	To strengthen the management of urban water supply and consumption in the Shenzhen SEZ, develop water supply, safeguard urban water consumption, and protect the legal rights of both urban water suppliers and consumers.
	Provision on Management of Secondary Drinking Water Supply in Shenzhen SEZ	1997 (modified: 2004)	To strengthen the management of secondary drinking water supply, ensure water quality, and safeguard human health.
	Regulations on Water Saving in Shenzhen	2005	To strengthen water-saving management, rationally and efficiently use water resources, and promote sustainable development of the economy and society.
	Measures on Implementing Water Balance Testing in Shenzhen	2006	To understand the state and composition of water consumption, promote comprehensive water conservation measures among consumers, establish a scientific water usage system, and rationally evaluate water consumption levels.
	Measures on Planned Water Consumption in Shenzhen	2007	To conserve water resources and promote the development of a cyclic economy.
	Measures on Management of Water Consumption and Water Conservation in Construction Projects in Shenzhen	2008	To strengthen the management of water consumption and conservation in construction projects, and rationally use water resources.

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Table 1 *continued*

Type	Policy and Regulation	Year Issued	Objective
Drainage Management	Measures on Collecting, Using, and Managing Wastewater Treatment Fees in Shenzhen	2006	To regulate the management and use of wastewater treatment fees, safeguard the healthy development of drainage facilities, and promote water environmental improvements.
	Ordinance on Drainage in Shenzhen	2007	To strengthen drainage management, safeguard safe and smooth drainage of water, protect the water environment, and promote sustainable development in the economy and society.
Marketization Reform	Ordinance on Public Utilities Concessions in Shenzhen	2005	To regulate public utilities concessions in Shenzhen, safeguard the interest of the public and the legal rights of the concessionaires, and promote the healthy development of public utilities.
Water Pollution Control	Ordinance on Environmental Protection in Shenzhen SEZ	1994 (modified: 2000)	To protect and improve the living and ecological environment, prevent and control environmental pollution and other public hazards, safeguard human health, and promote the coordinated development of environmental protection and economic development.
	Measures on Management of Pollutant Emission Permits in Shenzhen SEZ	1999	To strengthen the management of environmental supervision, prevent and control environmental pollution, and improve environmental quality.
	Ordinance on Prevention and Control of Sea Pollution in Shenzhen SEZ	1999 (modified: 2004)	To prevent and control sea pollution, protect the marine environment and resources, and promote economic development.

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Table 1 *continued*

Type	Policy and Regulation	Year Issued	Objective
	Measures on the Management of Online Monitoring and Control System for Pollutant Sources in Shenzhen	2004	To strengthen the management of the setting up, operation, and maintenance of the online monitoring and control system for pollutant sources, bring the monitoring and control system into play in environmental management, and improve the scientific and automated level in monitoring management of pollutant sources.

Source: Authors.

Environmental Committee (SZREC). The relationships of these organizations are shown in Figure 2.

The government organizations cited in Figure 2 have the following major functions:

(i) The SZMWAB is in charge of integrated water affairs in the entire Shenzhen, including the integrated planning of water supply and drainage, water resource management, water supply management, wastewater discharge, and wastewater treatment management;

(ii) The SZSASAC is responsible for the reform and restructuring of state-owned enterprises and the supervision of state-owned assets;

(iii) The SZPB takes charge of water tariff setting, management, and control;

(iv) The SZDRC maintains records of water projects and determines which projects in the water sector will receive government investment; and

(v) The SZREC (formerly the Shenzhen Environmental Protection Bureau) oversees the quality of effluents of wastewater treatment plants and collects effluent charges.

Shenzhen is one of the first cities in the PRC to combine all water-related government functions into one government agency—the SZMWAB. This has helped the city avoid possible conflicts among government agencies due to overlapping functions and made the responsibilities of each bureau clear. Although some government departments retain several functions related to water management, the functions are unambiguous, and the coordinating mechanism is good enough to allow them to resolve water management problems cooperatively and quickly.

Box 2 The Water Sector's Parent Bureau in the People's Republic of China

All urban water utilities have a "parent bureau" that is responsible for overseeing the utility. The parent bureau appoints and monitors the senior management of the utility and provides service regulation. All issues requiring a decision from the "leading group" (which comprises the mayor and vice mayors) or other municipal government agencies are typically dealt with through the parent bureau, including (i) budget allocations from the Municipal Finance Bureau, (ii) investment approval by the Development and Reform Commission, and (iii) tariff adjustments by the Price Bureau. Decisions by these government agencies are usually discussed and approved by the vice mayor and if necessary the "leading group." There are three common arrangements for parent bureaus, as follows.

- *Model 1: Water and wastewater services are overseen by the same Construction Parent Bureau.*

  This is the most common arrangement for smaller cities. The wastewater and water supply utilities report to the same bureau. The bureau oversees all public works and utility companies in the city.

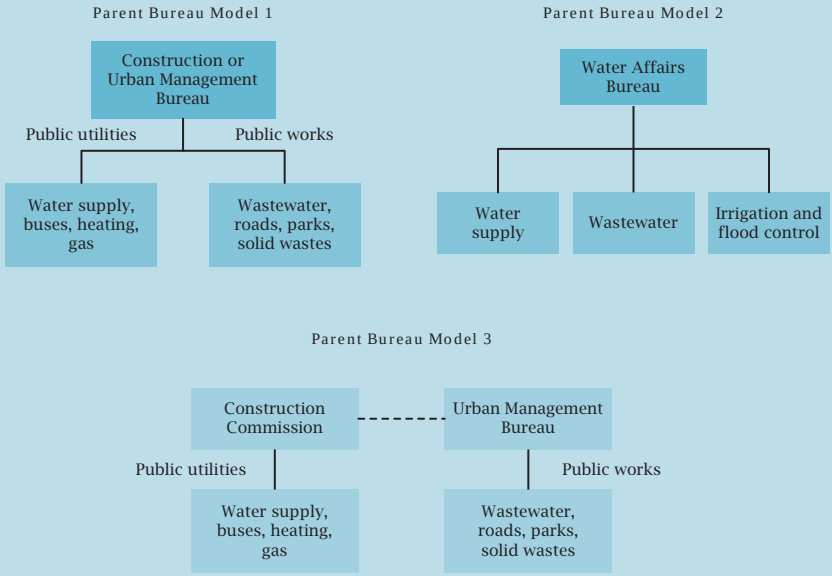
- *Model 2: Water and wastewater services are overseen by the same Water Affairs Parent Bureau.*

  Some large cities, such as Beijing, Shanghai, and Shenzhen have created "water affairs bureaus" that are responsible for all aspects of urban water management, including water, wastewater, flood control, water reuse, and raw water supply.

- *Model 3: Water and wastewater services are overseen by different parent bureaus.*

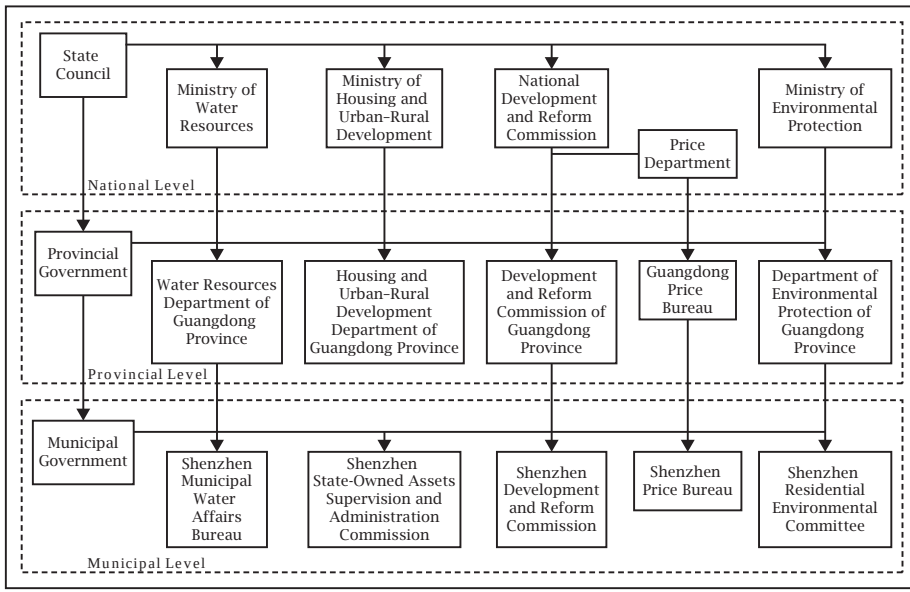
Some large cities have separated into two bodies the policy and implementation functions for urban construction and management. A "construction commission" provides policy and planning, and sometimes directly oversees municipal utility companies. An "urban management bureau" supervises public works departments such as roads and parks, and in some cases, may also supervise water and wastewater utility companies.

Figure 1 Typical Parent Bureau Models



Source: Browder et al. (2007), pp. 71–72.

Figure 2 Organizational Framework of Water Governance in Shenzhen



Source: Authors.

Planning Mechanism and Regulation

Planning for water resources and water services. SZMWAB is the first integrated urban water affairs bureau in the PRC in which the major water management functions are combined into one government agency. It is responsible for all planning associated to water resources, water supply, drainage, and reclaimed water—all of which came under the control of construction bureaus in the past.

Tariff structure and charges. To propose for the revision of water tariffs in Shenzhen, SZWG has to first submit a water tariff adjustment program to SZMWAB. SZMWAB, SZDRC, and SZPB will jointly check the water tariff adjustment program. Finally, SZPB will hold hearings and publish the tariff adjustment program. SZPB is mainly responsible for setting the water tariff. The provincial government does not intervene in the tariff decision-making process but is responsible for keeping records of the tariff reform program approved by SZPB. In discussions between officials of SZMWAB and SZPB, all had agreed that existing regulations on water pricing could only check cost validity but not cost rationality. It is imperative that an effective instrument for cost regulation be developed as soon as possible.

Regulation of service quality of water supply. A management and regulatory system has been formed for the water supply sector of Shenzhen. Since SZWRB—the predecessor of SZMWAB—was established in 1993, government functions were

completely separated from the operation and day-to-day management of SZWG. Today, the role of SZMWAB is more of a regulator with regard to water supply services. Its major functions are concession management for water supply enterprises, cost and tariff regulation, and water quality and service quality monitoring.

Regulation of service quality of wastewater treatment. Compared to the water supply sector, the regulatory system for wastewater treatment has developed more slowly. This includes legislative development.

Through a long-term effort, SZMWAB could separate the provision of water supply services and the government's administrative control into two. But for wastewater services, SZWRB only took over the function of regulating drainage management from the Shenzhen Urban Management Bureau in September 2004. Therefore, the regulatory system for the wastewater sector is still in a transitional phase, and the Sewage Department of SZMWAB still intervenes in the daily wastewater operations of SZWG to a significant extent. Besides, it is SZREC and not SZMWAB that regularly inspects the effluent quality of wastewater treatment plants.

Operators

Before 2001, the Shenzhen Water Supply Company, a subsidiary company of the municipal government, was mainly responsible for the provision of water supply in Shenzhen. In 2001, a large water group—the SZWG—was established by merging the Shenzhen Water Supply Company with the Shenzhen Drainage Management Department of the Shenzhen Urban Management Bureau. In 2003–2004, SZWG was transformed from a solely state-owned enterprise into a Chinese–foreign equity joint venture among three entities: SZSASAC, Beijing Capital–Veolia Water Investment Company (which in turn is a joint venture between the PRC's Beijing Capital Company and France's Veolia Water), and Veolia Water (which is the water division of Veolia Environnement).

Over the years, SZWG has made substantial business progress—both in terms of breadth and depth. Today, it is a large water group whose business comprises not only water production and distribution but also includes wastewater collection, treatment and discharge, investment and operations in the water sector, and water infrastructure design and construction. It is the major water supply and wastewater service provider in the Shenzhen Special Economic Zone. Its service area extends beyond the zone to include other parts of the country. It is the largest water supply and wastewater services enterprise in the PRC. It has a standard of water quality stricter than the national standard.

In its main service area at Shenzhen, SZWG's water supply capacity was 5.91 million cubic meters (mcm) per day and its wastewater treatment capacity reached 1.22 mcm per day in 2008. The latter resulted in wastewater treatment rate to

reach 88.4% of the wastewater discharged in the Shenzhen Special Economic Zone (Shenzhen Water Group 2009). Shenzhen is also a leader in some important operating indexes, such as water supply per capita, wastewater treated per capita, profit per capita, and nonrevenue water.

Supply Management

Water Resources and Pollution

Shenzhen receives relatively heavy rainfall. It has a subtropical maritime climate with an average annual rainfall of 1,830 millimeters. Among the 310 rivers and streams that crisscross Shenzhen, five rivers have drainage areas of more than 100 km^2 each. There are 12 medium-sized reservoirs and 160 small reservoirs, with a total storage capacity of 0.61 billion cubic meters (Shenzhen Municipal Water Affairs Bureau 2011). Although rainfall is abundant, its spatial and temporal distribution is uneven. Moreover, a lack of large rivers and lakes results in poor capacity for water storage. Underground fresh water resources are scarce. Because of the uneven spatial and temporal distribution of rainfall, water pollution, and small rainfall catchment areas of the rivers, the use of local water resources is low in Shenzhen. At present, 70%–80% of its water supply is supported by the external transfer of water from the Dongjiang River to Shenzhen (Xing and Fang 2011a).

At the same time, as the central urban area of Pearl River Delta, Shenzhen requires a huge amount of water for its own use. It faces serious water shortage, partly because of water pollution. Meanwhile, rapid economic development in Shenzhen has had a marked effect on the aquatic ecosystem of the region.

Table 2 shows that Shenzhen has achieved some improvements in environmental water quality in recent years. In 2008, almost 100% of its drinking water sources reached national water quality standard, and the water of the eastern sea reached the Class I national standard for seawater quality. However, the water quality of its main rivers and the western sea was rated to be inferior.

Development and Present State of Water Supply

When the Shenzhen Special Economic Zone was first established in 1980, there was only one water plant that could supply 5,000 m^3 of water daily in Shenzhen. The length of the supply pipelines was less than 10 km, and the area supplied was less than 10 km^2.

With rapid urban development and construction, there was preliminary development in the city's water supply infrastructure by the end of 1998. There were 26 water supply enterprises and 52 water treatment plants. Tap water supply capacity

Table 2 Environmental Water Quality in Shenzhen, 2003–2008

Year	2008	2007	2006	2005	2004	2003
Drinking water source reaching water quality standard (%)	99.87	98.86	98.07	98.1	96.7	97.13
Water quality of main rivers	Inferior to Class V environmental quality standard for surface water					
Water quality of eastern sea	Reached Class I national standard for seawater quality		Reached Class II national standard for seawater quality			
Water quality of western sea	Inferior to Class IV national standard for seawater quality					

Note: Class I represents the highest standard of water quality in the national standard.
Sources: Adapted from Shenzhen Environmental Protection Bureau (various years, 2004–2009).

was 3.39 mcm per day. Total annual water supplied was 795.96 mcm. The water supply coverage of the whole city was 96.5%, with 100% of the SEZ area covered (Shenzhen Statistics Bureau 1999).

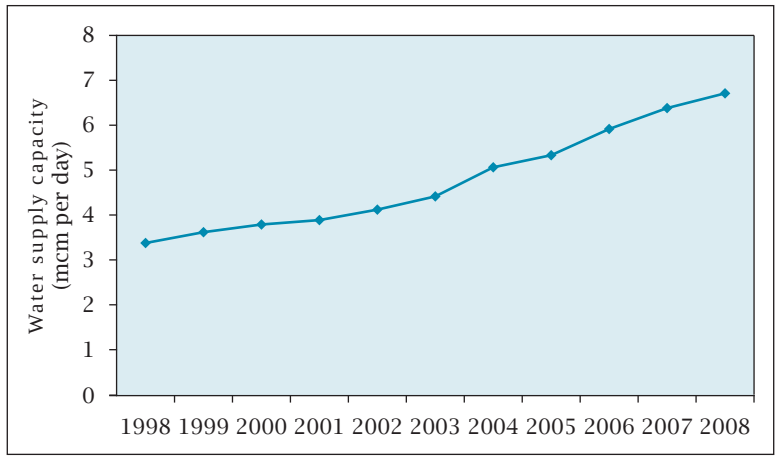
In 2007, Shenzhen significantly integrated water resources outside the SEZ. At that point, there were 27 water supply enterprises in Shenzhen. To accelerate the development of the water sector to improve efficiency, the Municipal Government of Shenzhen led the integration effort. After this consolidation, the water market in Shenzhen was left to be served by three large water supply companies—the Shenzhen Water Group, Bao'an Water Group, and Longgang Water Group—with each having a water supply capacity of at least 1 mcm per day, and by some smaller firms. The SZWG acquired a controlling stake in the Bao'an Water Group and Longgang Water Group and became their largest shareholder. The city's total water supply capacity reached 6.38 mcm per day in 2007 (Shenzhen Water Resource Bureau 2008). This was further increased to 6.70 mcm per day in 2008 (Shenzhen Statistics Bureau 2009).

Figure 3 shows the steady growth in water supply capacity with urban development in Shenzhen in 1998–2008. Water supply coverage has reached 100% since 2006 (Shenzhen Statistics Bureau 2007).

Nonrevenue water in Shenzhen was estimated to be 13.5% in 2008.[142] The length of the water supply pipelines grew and reached 16,873 km in 2008 (Figure 4). However, the construction of the municipal water supply network was uneven.

[142] This was estimated by the authors based on the data of the Department of Planning, Financing, and Foreign Affairs, Ministry of Housing and Urban–Rural Development (2009), pp. 410–411.

Figure 3 Growth of Tap Water Supply Capacity in Shenzhen, 1998–2008



mcm = million cubic meters.

Sources: Adapted from Shenzhen Statistics Bureau (various years, 1999–2009).

For example, the average length of the water supply pipeline per km^2 in Bao'an and Longgang districts was less than one-third of that in the SEZ, indicating that investment in the water supply network in districts outside the SEZ was inadequate (Shenzhen Water Resource Bureau 2008).

Demand Management

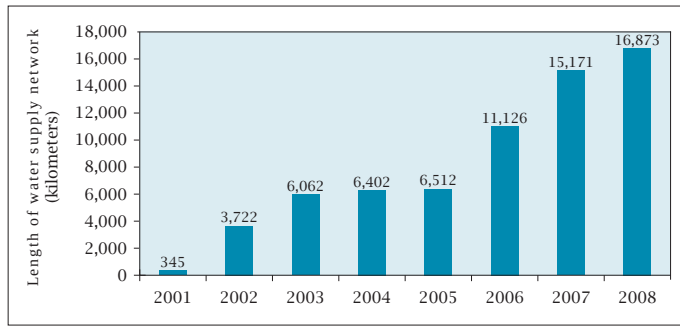
Water Consumption and Its Composition

(i) Total Water Consumption

As the PRC's earliest SEZ, Shenzhen gradually grew from a small border town into a modern international city through the years of development. It is one of the cities in the PRC facing serious water shortage. In the areas of industrial and household water use, the efficiency of water resource utilization and its resulting economic benefits are comparatively higher in Shenzhen than in other cities in the PRC. But because of rapid urbanization, water demand is still growing very quickly in Shenzhen.

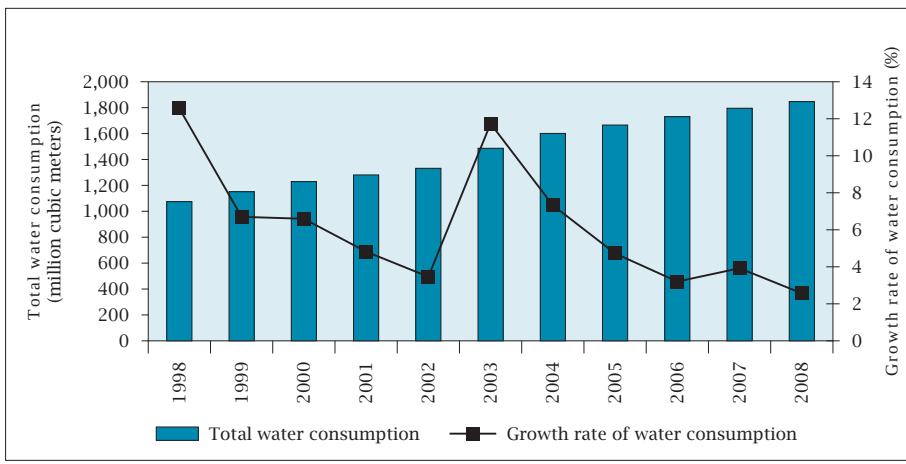
Shenzhen's total water consumption grew steadily in 1998–2008 (Figure 5). The growth rate reached a peak in 2003, and after 2005, it stabilized in the 3%–5% range. This was mainly due to the greater community awareness of the benefits of water conservation and the formulation and implementation of relevant laws and regulations.

Figure 4 Water Supply Network in Shenzhen, 2001–2008



Sources: Department of Integrated Finance, Ministry of Construction (various years, 2002–2007); Department of Integrated Finance, Ministry of Housing and Urban-Rural Development (2008); Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban-Rural Development (2009).

Figure 5 Water Consumption and Growth Rates in Shenzhen, 1998–2008



Source: Adapted from the Shenzhen Municipal Water Affairs Bureau (2009).

The Municipal Government of Shenzhen began to step up water conservation work in 2002, published the "Regulations on Water Conservation in Shenzhen" in 2005, and established the Water Conservation Office of Shenzhen in February 2006. The Water Conservation Office is mainly responsible for promotion, planning, and water balance testing. To promote water conservation, SZWRB adopted a series of measures such as encouraging the use of water-saving technology, equipment, and devices; imposing restrictions on the use of water wasting technology and equipment; and establishing a water-saving incentive system. According to available statistics, the penetration rate of water saving devices in Shenzhen increased from 80% in 2006 to 99% in 2010 (Xing and Fang 2011b). At the same time, the Water

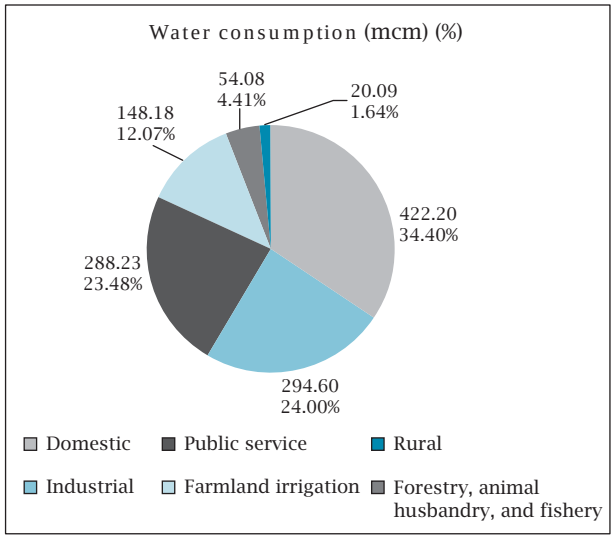
Conservation Office widely publicized the water situation and the urgency of water conservation, strengthened education on water conservation, and promoted water saving in government projects. These efforts have begun to achieve some results.

(ii) Water Consumption Composition

In 2000, total water consumption in Shenzhen was 1.23 billion cubic meters. In terms of composition, urban residents' share of water consumption was 422.20 mcm, accounting for 34.40% of total water consumption. Industrial consumption was 294.60 mcm, or 24.0% of total consumption. Public service water consumption was 288.23 mcm, or 23.48% of total consumption. Water consumption for farmland irrigation was 148.18 mcm, or 12.07% of total consumption. Also, 54.08 mcm of water was used in forestry, animal husbandry, and fishery activities, accounting for 4.41% of total consumption. Rural water consumption was 20.09 mcm or 1.64% of total consumption (Figure 6).

By 2008, total water consumption in Shenzhen reached 1.85 billion cubic meters and the consumption composition had also changed considerably. Water consumption of urban residents was 713.51 mcm, accounting for 38.62% of total consumption. Industrial consumption was 608.36 mcm, accounting for 32.93%. Public service consumption was 353.59 mcm, accounting for 19.14%. Urban environmental water consumption was 89.30 mcm, accounting for 4.83%, and agricultural water consumption was 82.64 mcm, accounting for 4.47% (Figure 7).

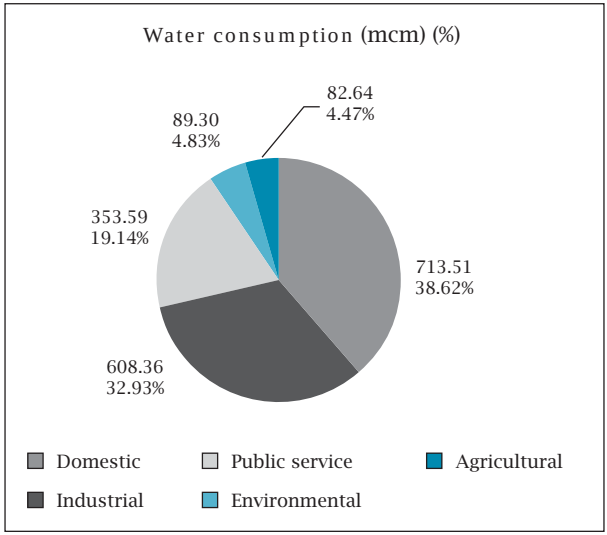
Figure 6 Water Consumption Structure in Shenzhen, 2000



mcm = million cubic meters.

Source: Adapted from Shenzhen Water Resource Bureau (2001).

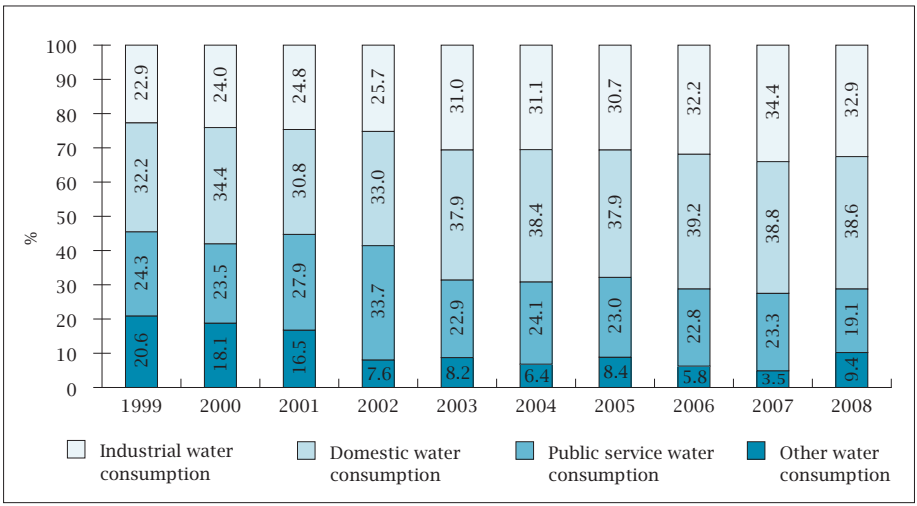
Figure 7 Water Consumption Structure in Shenzhen, 2008



mcm = million cubic meters.

Source: Adapted from Shenzhen Municipal Water Affairs Bureau (2009).

Figure 8 Change in Water Consumption Structure in Shenzhen, 1999–2008 (%)



Source: Adapted from Shenzhen Municipal Water Affairs Bureau (2009).

As shown in Figure 8, the proportion of industrial water consumption increased during 1999–2008. The proportion of agricultural water consumption decreased, leading to a lower share of the "Other water consumption" category. This is an indirect manifestation of the rapid urbanization and industrialization of Shenzhen. Variations in the proportions of domestic and public service water consumption were smaller.

Sales and Number of Water Users

With the increasing demand for water and the development of the supply capacity in Shenzhen, sales of water and the number of customers increased over the years (Table 3).

Water Pricing

The water tariff structure of Shenzhen consists of a water tariff and a wastewater treatment fee. Water tariffs and wastewater treatment fees in past years are shown in Table 4 and Table 5, respectively. To recover operating costs, Shenzhen raised water tariffs in August 2004 and April 2011, and increased wastewater treatment fees in January 2003 and July 2005. After the revisions, the water supply and wastewater treatment charges, taken together, can basically meet the requirements of cost recovery. Tiered charges are imposed on domestic consumption to encourage water conservation. To help the poor, low-income households under the government's minimum living standard assistance scheme are eligible for 8 m^3 of free water monthly and are exempted from paying wastewater treatment fees.

Table 3 Sales and Number of Water Users in Shenzhen, 2001–2008

	2001	2002	2003	2004	2005	2006	2007	2008
Quantity of water sold (mcm)	448.10	454.07	1,210.01	1,215.23	1,251.47	1,271.09	1,342.39	1,395.96
Quantity of free water (mcm)	1.05	14.68	41.70	45.85	2.38	7.86	6.71	6.49
Number of customer accounts	390,185	401,285	686,011	686,011	470,736	343,127	885,318	876,031
Number of households supplied	321,168	330,364	465,902	465,902	401,863	224,102	729,564	724,684

mcm = million cubic meters.

Note: In 2006, the Municipal Government of Shenzhen issued a revised version of the "Methodology for Population Statistics Monitoring in Shenzhen." This influenced the calculation of figures for the number of customer accounts and households supplied that year and in subsequent years.

Sources: Department of Integrated Finance, Ministry of Construction (various years, 2002–2007); Department of Integrated Finance, Ministry of Housing and Urban–Rural Development (2008); Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban–Rural Development (2009).

Table 4 Piped Water Tariffs in Shenzhen

User Category		Water Tariff[1] (CNY/m³)		
		June 2000–July 2004[a, b]	August 2004–March 2011[c, d]	From April 2011[d]
Domestic	Household metering (m³ per household per month)	1.50 (up to 30 m³)	1.90 (up to 22 m³)	2.30 (up to 22 m³)
		2.00 (above 30 m³)	2.85 (23–30 m³)	3.45 (23–30 m³)
			3.80 (31 m³ and above)	4.60 (31 m³ and above)
	Bulk metering (m³ per person per month)	1.50 (up to 6 m³)	1.90 (up to 5 m³)	2.30 (up to 5 m³)
		2.00 (above 6 m³)	2.85 (6–7 m³)	3.45 (6–7 m³)
			3.80 (8 m³ and above)	4.60 (8 m³ and above)
Industrial		1.90	2.25	3.35
Public service		1.80	2.30	3.30
Commercial, service, and construction		2.40	2.95	3.35
Special[2]		3.50	7.50	15.00

CNY/m³ = yuan per cubic meter, m³ = cubic meters.

Notes:

1. The water tariffs presented in this table are those of the Shenzhen Water Group and its predecessor, the Shenzhen Water Supply Company. Other small water supply enterprises in Shenzhen, which have different tariffs, are excluded. Water consumption amounts per month are shown in parentheses.
2. Before August 2004, the special category referred to foreign ships. Subsequently, the special category was expanded to include foreign ships, car washing, commercial dance halls, nightclubs, saunas, and others.
3. The prevailing policy stipulates that low-income households under the government's minimum living standard assistance scheme are eligible for 8 m³ of free water monthly.

Sources:

[a] Shenzhen Price Bureau (1999).
[b] Shenzhen Jinling Water Automation Systems Company (2007).
[c] Shenzhen Water Resource Bureau (2007).
[d] Fang and Xie (2011).

Wastewater Management

(i) Amount of Wastewater Discharged and Wastewater Treatment Capacity

In Shenzhen, the amount of wastewater discharged grew rapidly as a result of industrialization and urban development. During 2002–2003, growth in this area doubled. In 2004, SZWRB was responsible for overseeing drainage and water pollution. Regulations were subsequently introduced to control sewage emissions. The management of sewage discharge was strengthened, the disorderly disposing of sewage was brought under control, and the amount of sewage disposed stabilized.

In December 2001, the Shenzhen Drainage Management Department of the Shenzhen Urban Management Bureau, with more than CNY3 billion ($363 million) worth of assets, merged with the original water supply company (the Shenzhen Water Supply Company), establishing a new group responsible for water supply and wastewater treatment—the SZWG (Yu 2008). Since then, the wastewater

Table 5 Wastewater Treatment Fees in Shenzhen

User Category		Wastewater Treatment Fee[1] (CNY/m³)		
		July 1998–December 2002[a]	January 2003–June 2005[a]	From July 2005[b]
Domestic	Household metering (m³ per household per month)	0.30	0.50	0.90 (up to 22 m³)
				1.00 (23–30 m³)
				1.10 (31 m³ and above)
	Bulk metering (m³ per person per month)	0.30	0.50	0.90 (up to 5 m³)
				1.00 (6–7 m³)
				1.10 (8 m³ and above)
Industrial		0.34	0.60	1.05
Public service		0.45	0.60	1.10
Commercial, service, and construction		0.42	0.70	1.20
Special[2]		–	–	2.00

CNY/m³ = yuan per cubic meter, m³ = cubic meters.

Notes:

1. Fees prior to July 2005 refer only to the fees in the Shenzhen Special Economic Zone. Since July 2005, fees have been standardized across Shenzhen. Water consumption amounts per month are stated in parentheses.
2. The special category refers to car washing, commercial dance halls, nightclubs, saunas, and others.
3. The prevailing policy stipulates that low-income households under the government's minimum living standard assistance scheme, social welfare organizations, and the military are exempted from paying wastewater treatment fees. In areas not covered by the city's wastewater treatment plants, enterprises with private wastewater treatment facilities that meet treated effluent standards are exempted from paying wastewater treatment fees. In areas covered by the city's wastewater treatment plants, enterprises with private wastewater treatment facilities that meet treated effluent standards and do not discharge the effluent into public sewers are exempted from paying wastewater treatment fees.

Sources:
[a] Shenzhen Water Resource Bureau (2007).
[b] Shenzhen Municipal Water Affairs Bureau (n. d.).

treatment capacity in Shenzhen has developed rapidly. The number of wastewater treatment plants increased from 4 in 2001 to 16 by 2008, thus significantly improving the wastewater treatment capacity (Table 6). The treatment rate of wastewater increased from 52.8% in 2001 to 62.7% in 2008 (Figure 9). Nevertheless, the wastewater treatment plants were still underutilized (Figure 10).

(ii) Drainage Network

Along with the development of Shenzhen, the length of the drainage network for wastewater and storm water increased from 3,260 km in 2001 to 6,858 km in 2008 (Figure 11). The development of the drainage network was more rapid between 2002 and 2004. During 2006, the Shenzhen administration took action to rectify poorly connected drainage pipes and a large number of wrongly placed pipes were cleared up, leading to a decline in the length of the drainage network in that year.

Table 6 Wastewater Treatment in Shenzhen, 2001–2008

	2001	2002	2003	2004	2005	2006	2007	2008
Total volume of wastewater discharged [a] (mcm)	362.58	444.25	1,104.30	1,148.03	1,067.07	1,307.04	1,213.46	1,256.00
Number of wastewater treatment plants	5	5	10	12	12	12	14	16
Capacity of wastewater treatment plants (mcm/day)	1.182	1.152	1.871	1.856	1.856	2.046	2.267	2.433
Volume of wastewater treated by wastewater treatment plants (mcm)	191.49	249.10	348.97	528.40	643.57	507.78	600.49	602.13
Capacity of other wastewater treatment facilities (mcm/day)	0	0.021	0.005	0	0	0.830	0.507	0.507
Volume of wastewater treated by other wastewater treatment facilities (mcm)	0	1.87	1.89	0	0	302.95	185.05	185.05
Total volume of wastewater treated (mcm)	191.49	250.97	350.86	528.40	643.57	810.73	785.54	787.18
Wastewater treatment rate [b] (%)	52.81	56.49	31.77	46.03	60.31	62.03	64.74	62.67

mcm = million cubic meters.

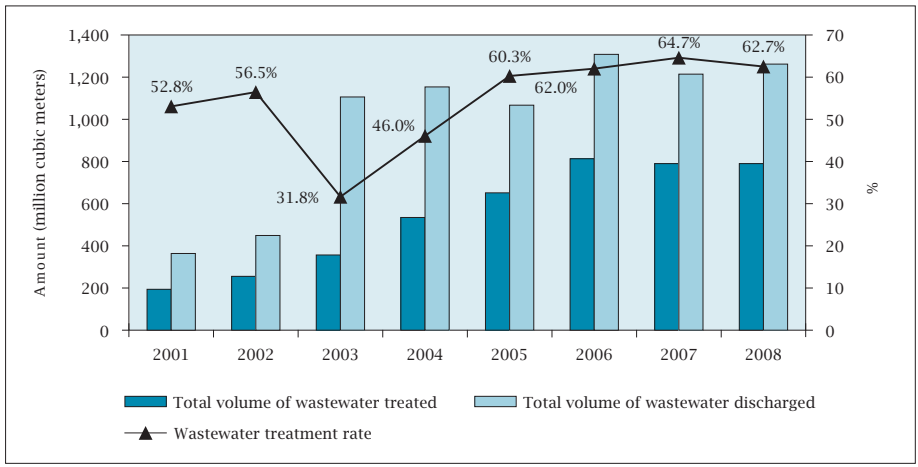
Notes:

[a] Total volume of wastewater discharged refers to the amount of domestic wastewater, industrial wastewater, and rainwater collected by the urban drainage system.

[b] Wastewater treatment rate refers to the total volume of wastewater treated expressed as a percentage of the total volume of wastewater discharged.

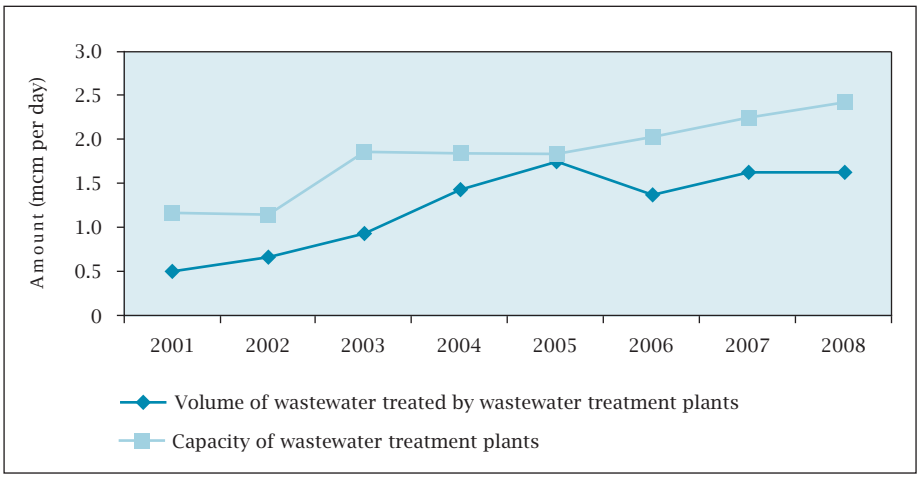
Sources: Department of Integrated Finance, Ministry of Construction (various years, 2002–2007); Department of Integrated Finance, Ministry of Housing and Urban–Rural Development (2008); Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban–Rural Development (2009).

Figure 9 Total Volume of Wastewater Discharged and Treated in Shenzhen, 2001–2008



Sources: Department of Integrated Finance, Ministry of Construction (various years, 2002–2007); Department of Integrated Finance, Ministry of Housing and Urban-Rural Development (2008); Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban-Rural Development (2009).

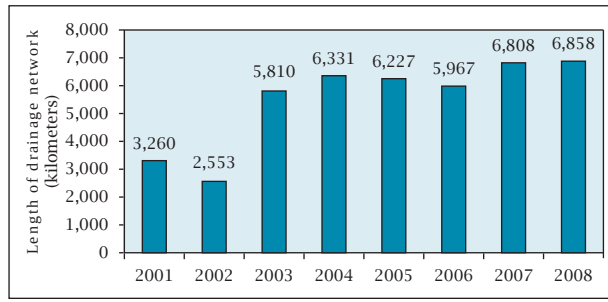
Figure 10 Capacity of Wastewater Treatment Plants and Volume of Wastewater Treated, Shenzhen, 2001–2008



mcm = million cubic meters.

Sources: Department of Integrated Finance, Ministry of Construction (various years, 2002–2007); Department of Integrated Finance, Ministry of Housing and Urban-Rural Development (2008); Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban-Rural Development (2009).

Figure 11 Length of Drainage Network for Wastewater and Storm Water in Shenzhen, 2001–2008



Sources: Department of Integrated Finance, Ministry of Construction (various years, 2002–2007); Department of Integrated Finance, Ministry of Housing and Urban-Rural Development (2008); Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban-Rural Development (2009).

Customer Satisfaction

Water supply companies in Shenzhen have a strong sense of customer service. Individual water enterprises have set up dedicated customer service departments and customer complaint telephone consultation channels. The targets of water supply services, service measures, and water supply performance for the previous year are made public at regular intervals, and these are subject to scrutiny by customers and the public in general. According to a 2007 survey of the water supply industry, results on the service providers' handling of complaints, fault repairs, meter replacement, and customer satisfaction are as follows:

(i) Rate of Processing of Complaints

The industry received 15,556 customer complaints in 2007. All complaints were resolved, achieving a 100% processing rate. A total of 15,336 complaints (98.6%) were dealt with in time.

(ii) Rate of On-Time Repairs

The industry received 34,483 reports of service hitches (such as pipe leakages) from customers in 2007. The water supply companies carried out 34,256 repairs (99.3%) within the specified time.

(iii) Replacement Rate of Water Meters

Water meters register consumers' water usage and are the tools to record how much consumers need to pay. The interests of both parties will be affected by the accuracy of these meters. The former Ministry of Construction specified that large-bore water meters had to be replaced once every 4 years, and small-bore

meters once every 6 years.[143] Only six water supply enterprises in Shenzhen met this standard in 2007. This means that not enough attention has been paid to the management of water meters. If a water meter is used for too long, its speed will be slow due to deposits in the water. This will lead to measurement errors and affect actual water consumption readings and water revenue.

(iv) Customer Satisfaction Survey

A total of 4,431 survey forms were completed and returned by consumers in the water industry. Consumers evaluated the following eight aspects: (i) water quality, (ii) water pressure, (iii) timeliness and accuracy of meter reading-based billing, (iv) water supplier's service attitude and quality, (v) efficiency, (vi) honesty and self-discipline, (vii) information disclosure, and (viii) handling of complaints. If a customer was not satisfied with any of these aspects, he or she was regarded to be dissatisfied as a whole, in the statistics. Results showed that 78.4% of customers were satisfied or very satisfied, 94.3% were at least basically satisfied, and dissatisfied customers accounted for 5.7%. The main aspects that the consumers were dissatisfied with were water pressure and water quality (Shenzhen Water Resource Bureau 2008).

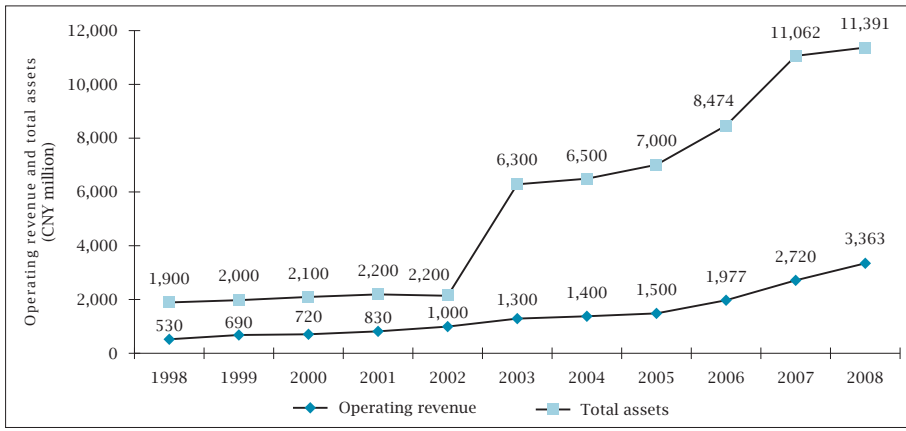
Financial Performance

In the early days of its formation in 1979, the Shenzhen Water Supply Company, SZWG's predecessor, supplied 2.32 mcm of water for the entire year. At that time, it had only about 6,000 m^3 in daily water supply capacity, served 32,000 people, and generated an annual operating revenue of no more than CNY800,000. After it was reformed to run as an enterprise in 1995, it supplied 310 mcm of water per year, provided service to 1.2 million people, generated operating revenue of CNY400 million per year, and held CNY1.3 billion in total assets. From 1979 to 1995, its annual water supply and operating revenue rose by more than 130 times and 500 times, respectively (Wu 2008, 24).

By the end of 2008, SZWG's water supply capacity nationwide grew to 7.28 mcm per day and the annual volume of water supplied was 1.20 billion cubic meters. Its wastewater treatment capacity reached 1.86 mcm per day and the annual volume of wastewater treated was 522 mcm. Its annual operating revenue was CNY3.36 billion while total assets were worth CNY11.39 billion (Figure 12). Its operating ratio was 0.77 (Shenzhen Water Group 2009).

[143] The Ministry of Construction was subsumed into the newly created Ministry of Housing and Urban–Rural Development in 2008.

Figure 12 Annual Operating Revenue and Total Assets of the Shenzhen Water Group and Its Predecessor, 1998–2008



Sources: Data for 1998–2006 were adapted from Wu (2008), p. 25. Data for 2007–2008 were adapted from Shenzhen Water Group (2009).

Reform of the Water Sector in Shenzhen

Analysis and Evaluation of the Reform Toward Integrated Water Management

Motivation for Integrated Water Management

During the last decades, the division of management in the water resource management system in the PRC was a particularly thorny issue, leading to a series of problems. These included water resource allocation that could not be unified in urban and rural areas; surface water and groundwater that are managed separately; water resources, water supply, drainage, water pollution control, water reuse, and water conservation were managed by different departments; and policies were made by different departments. Such a situation exacerbated tensions of water use in cities. This segmentation in water resource management not only runs counter to the dynamic nature of the water cycle, water reuse, and storage, but also to the general social management principle followed by most countries supporting the unified management of important natural resources related to people's livelihood and social development.

Amidst the recurring droughts and floods occurring in Shenzhen, the city recognized the disadvantages of the segmentation of water resource management and the importance of a unified management. The municipal government therefore decided to learn from successful experiences in water management in Hong Kong, China and promoted integrated water management reform. Hong Kong, China manages and protects its water resources directly and indirectly through laws and

regulations, and all related operations are managed by its Water Supplies Department, including water resources development, design, building, maintenance, and operation of the water supply system. Shenzhen and Hong Kong, China are only separated by a river, and the condition of their water resources is very similar. It is therefore appropriate for Shenzhen to learn from Hong Kong, China's successful experiences in water management.

Key Processes in Integrated Water Management Reform

In 1982, Shenzhen abolished its water resource administrative authority at the municipal level. From 1984 to 1989, water affairs were managed by the Shenzhen Three Defense Office and the Water Conservancy Administrative Office that was later established. During this period, Shenzhen developed from a backward small town into a modern city, with a resulting increase in domestic and industrial water consumption, while a shortage of water resources impacted the economic and social development of the city. During the early years of the Shenzhen Special Economic Zone, the closure of the Shenzhen Municipal Water Conservancy Bureau made water management in Shenzhen difficult and the reestablishment of municipal water agencies imperative. In 1990, the Municipal Government of Shenzhen reestablished the Shenzhen Municipal Water Conservancy Bureau, which implemented comprehensive water supply planning to address the problem of water shortages in Shenzhen.

In 1993, historic changes in the organizational structure and administrative functions of water management in Shenzhen took place. To reform the water supply management system, the municipal government closed the Shenzhen Municipal Water Conservancy Bureau and combined the functions of water resource management of the Water Conservancy Bureau, Office of Urban Management, Planning and Land Bureau, and Construction Bureau into SZWRB. This was the first time that an integrated water management authority was set up in the city, with the aim of solving the problems caused by a multi-sector water management system and creating an example of integrated urban and rural water management in the PRC.

Regulatory development in the water supply and wastewater treatment sectors in Shenzhen has not occurred simultaneously. At the beginning of the process, the regulatory responsibility in drainage, water reuse, and related areas were not assigned to SZWRB due to the complexity of the reform. The water management system experienced problems in areas such as raw water, tap water, drainage, and wastewater management systems in some locations, while the flood control and drainage systems were not coordinated. Therefore, the reform of Shenzhen's water system had to be deepened. In September 2004, the Shenzhen government transferred the drainage management and water pollution control functions to SZWRB, and fully implemented integrated water management. This removed the boundaries among different areas and departments, made possible the unified

management of all water-related matters including surface and groundwater, industrial and household water consumption, water quality and water quantity, water supply and drainage, water consumption and water conservation, and wastewater treatment and reuse. It thus promoted the rational development and effective use of water resources, integrated management, optimization, comprehensive conservation, effective protection, and the sustainable use of water resources.

Evaluation of Integrated Water Management Reform

Water management reform in Shenzhen experienced frequent changes at the early stages. It was in 1993 when integrated management was gradually introduced under the guiding principle of integrating the management of water supply and drainage. Evidence showed that Shenzhen's urban water management system achieved effective results, and the integrated urban water management system promoted the development of urban water infrastructure and raised management standards. The new urban water management system has the following advantages:

(i) It is beneficial for the unified planning and implementation of water resources development. The integrated management system charges SZMWAB with the functions of planning, construction, and management—from water resources development to the construction of water supply infrastructure—thereby achieving the overall planning of water resources development, simultaneous construction of water works and distribution systems, and promoting improvements in coordination and speed in the construction of water works.

(ii) It is conducive to water conservation and the sustainable use of water resources. As SZMWAB oversees all the water supply service providers in Shenzhen, it can develop water use plans based on the scale of the city's total water resources and set water conservation measures in a unified manner to make the use of water resources more sustainable.

(iii) It is conducive toward more coordination in the development of the water sector. As SZMWAB considers the price of raw water and the formulation of tap water tariffs and sends this to SZPB for its approval, it can take into account the interests of the different water management entities. It is possible for water management units at the grassroots level to achieve integrated control of construction, management, and provision of water supply, which helps resolve the long-standing issue of a lack of coordination among investments in the water sector, construction management, and water supply operations and helps the water management units at the grassroots level grow their economic strength, contributing to rapid growth in the whole water sector.

Analysis and Evaluation of Market-Oriented Reform in the Water Sector[144]

Motivations for Market-Oriented Reform in the Water Sector

As the first SEZ established in the PRC in 1980, Shenzhen has stronger motivations to implement more open, direct, and flexible economic policies than other cities. The sound market-based economic system provides Shenzhen with an excellent foundation for market-oriented reform in the urban water sector. Reform of public utilities began in 2002, with international tenders conducted to introduce strategic investors in the water, gas, public transport, electricity, and other utility sectors.

Meanwhile, a series of measures to reform the water sector through legislation, enterprise reorganization, and reform of government institutions were attempted by the Government of Shenzhen. To some extent, these reforms also promoted the market-oriented reform of the urban water sector throughout the PRC.

Process and Key Features of Market-Oriented Reform in the Water Sector

(i) Process of the Market-Oriented Reform in the Water Sector

In 1998, the 100th Standing Committee of the Municipal Government of Shenzhen determined that the city's tap water investment system would be changed from being a government-oriented investment to an enterprise-oriented one, and that a trans-regional operation strategy should be implemented.

In 2001, led by the Municipal Government of Shenzhen, a large water group, the SZWG, with CNY6 billion ($726 million) in assets, was established by merging the Shenzhen Water Supply Company with the Shenzhen Drainage Management Department. The first ordinance on municipal water supply was promulgated to clearly define the legitimate rate of return for water supply enterprises. The Municipal Government of Shenzhen also issued measures for the administration of concessions of municipal public utilities in Shenzhen, and these gave an impetus to the promulgation of the version issued by the Ministry of Construction. The SZSASAC has taken over the management of water assets and played a leading role in the reform. SZWG is the first enterprise to provide both urban water supply and wastewater services, and the first water enterprise to conduct enterprise-wide reorganization.

To promote the reform of the diversified ownership of state-owned enterprises, the Municipal Government of Shenzhen decided to choose five state-owned enterprises—in the fields of energy, gas, food, public transport, and water services—as pilot enterprises that sought strategic investors from all over the world through international public bidding.

[144] Adapted from Fu et al. (2008), pp. 102–107.

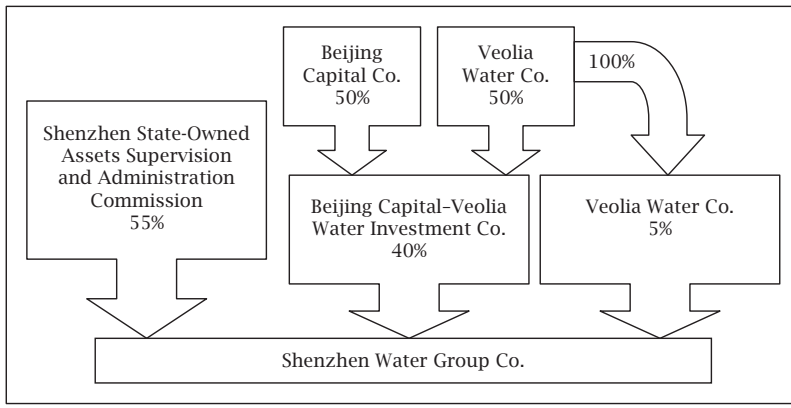
On 22 December 2003, following ownership diversification exercises for the Shenzhen Energy Group, Shenzhen Gas Group, Shenzhen Food General Company, and Shenzhen Public Transportation Group, SZWG held a state-owned equity trading signing ceremony, which marked the successful completion of international public bidding for the first pilot batch of five large state-owned enterprises in Shenzhen. Veolia Water and Beijing Capital Group provided CNY3.31 billion ($400 million) in funding to acquire a 45% equity stake in SZWG (Figure 13). This was the largest merger and acquisition in PRC's water sector and the second largest in the world at that time. On 23 August 2004, SZWG completed its transformation from a wholly state-owned enterprise to a joint venture approved by the Ministry of Commerce.

(ii) Granting Concession Rights

In accordance with the measures covering the administration of concessions of municipal public utilities in Shenzhen, SZWRB, appointed by the Municipal Government of Shenzhen, conferred concession rights to SZWG (Figure 14). In line with concession requirements, SZWG was to ensure that the wastewater treatment rate in the Shenzhen Special Economic Zone reached 80% in 2005 under the precondition of strictly controlling costs and improving management expertise. Water should also be drinkable directly from the tap by 2010.

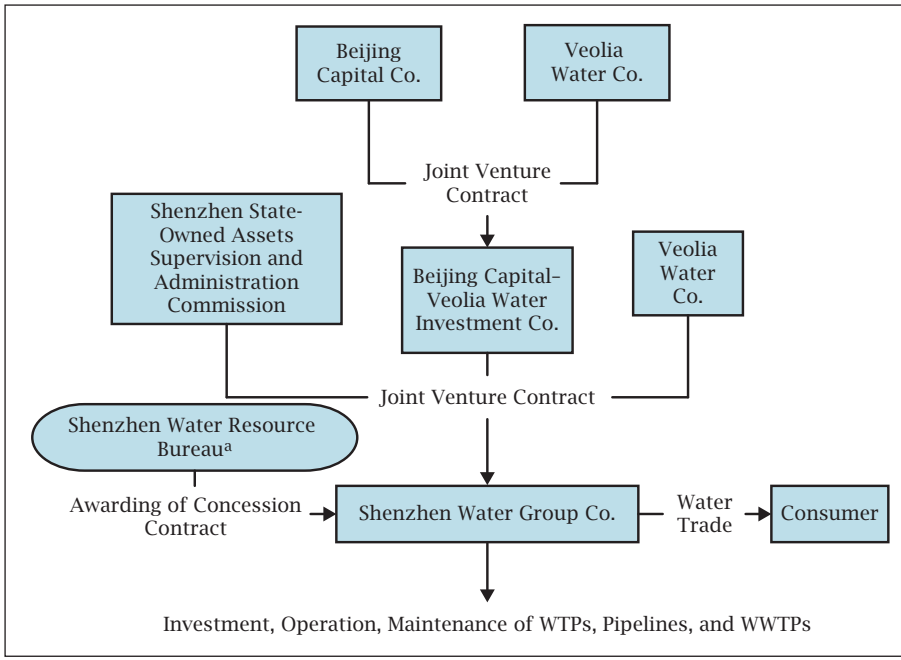
Based on the agreement, the joint venture company would also expand its market share of the rapidly growing Chinese water service market by strengthening external investment in the sector. Both partners expect the joint venture company to become the leading enterprise in PRC's water sector within 5–10 years.

Figure 13 Equity Structure of Shenzhen Water Group



Source: Adapted from Fu et al. (2008), p. 103.

Figure 14 Concession Model for Shenzhen Water Group



WTPs = water treatment plants, WWTPs = wastewater treatment plants.

[a] Renamed Shenzhen Municipal Water Affairs Bureau since 2009.

Source: Adapted from Fu et al. (2008), p. 105.

Evaluation of Market-Oriented Reform in the Water Sector

For a long time, Shenzhen had been exploring the possibility of a market-oriented reform in the water sector. Although SZWG itself was also actively exploring ways of diversifying its ownership structure to remove the constraints in place before this reform, it failed to make a breakthrough in this area.

The market-oriented reform in the water sector in Shenzhen has the following characteristics:

(i) The equity transfer of SZWG diversified its ownership and led to progress in the transformation of the government's role. The success in separating government interventions from business operations, and government functions from asset management was conducive to the improvement of the regulatory system. A relatively clear regulatory relationship has been set up between regulatory departments and enterprises. The government has been an effective regulator. Developed from the former Shenzhen State-Owned Asset Management Corporation, SZSASAC had many years of experience in asset management. Exercising its power as a fund provider, it realized the separation of

asset management from the government's administrative control. This separation allows SZMWAB to regulate the industry without interfering with the normal operations of the water enterprise. This is a highly suitable model for the reform of the PRC's water sector.

(ii) The equity transfer project for SZWG was carried out in parallel with the implementation of legislations for concessions in Shenzhen. To ensure the success of the SZWG concession and offer institutional safeguard, the Government of Shenzhen promulgated the first set of measures in the PRC for the administration of concessions of municipal public utilities. Shenzhen's promulgation of these measures played a critical role in the larger context of setting up a system for concessions under the marketization reform process of the PRC's water sector. Further progress was made with the promulgation of an ordinance for the administration of concessions of municipal public utilities in Shenzhen at the end of 2005.

Reform in Integrated Management of Water Supply and Drainage

Motivations for Reform

By the end of 2000, the Municipal Government of Shenzhen promoted a new round of reform in state-owned enterprises, including water supply and wastewater treatment companies. In the meantime, problems faced by the wastewater treatment sector in Shenzhen needed to be resolved urgently. These included depending largely on government investments and resulting in a major fiscal burden, and the poor operational efficiency in the wastewater treatment sector, which was too low to meet the needs of the public. Thus, the Government of Shenzhen asked related bureaus to carry out research on the marketization of the wastewater sector.

Based on in-depth reflection over the water sector, SZWG took the realization of integrating water supply and drainage management as one of the main ideas for reform and development, and put forward suggestions for reform based on the existing Shenzhen Water Supply Company and merging it with the Shenzhen Drainage Management Department in order to establish a water company with integrated management of water supply and wastewater treatment, as described above. The integrated management of water supply and wastewater treatment has been implemented and obtained good results in a number of countries. The integration has been shown to be appropriate to the operating characteristics of the water sector. In the case of the PRC, the central government attaches great importance to the use of water resources and the implementation of sustainable development strategies. Moreover, leaders of the former Ministry of Construction had also repeatedly stressed the importance of integrated management in the water sector. Besides, reform leading to the integration of water supply and wastewater

management could provide enterprises with opportunities to enter the wastewater treatment industry, thus speeding up their development.

Process of Reform

In August 2001, the 36th Executive Meeting of the Municipal Government of Shenzhen affirmed the integrated management of water supply and drainage as the right approach. It decided to merge the wastewater treatment plants and drainage system managed by the municipal government into the responsibility of the Shenzhen Water Supply Company and to form a new group under the principle of integrated water management. In December 2001, the former Shenzhen Drainage Management Department, with more than CNY3 billion ($363 million) assets, merged with the original Shenzhen Water Supply Company, thus formally establishing SZWG—a new water group responsible for water supply and drainage services (Yu 2008). This marked the point at which Shenzhen took the lead among cities across the country and achieved the integrated management of water supply and drainage services.

Evaluation of Reform

The reform leading to the integration of water supply and drainage management has created a new model for reforming the investment and financing mechanisms in the water sector, and the strategic restructuring of the water industry. This model enables drainage services to be operated by a mature enterprise as soon as possible and shortens the process of transformation. The wastewater treatment sector in Shenzhen has developed rapidly since the reform. The wastewater treatment rate in the Shenzhen Special Economic Zone increased from 56% during the pre-integration period to 88% in 2008—an increase of more than 30 percentage points, ranking first among large and medium-sized cities in the PRC (Chen 2008). The reform has resulted in the following benefits:

(i) Integrated management of water supply and drainage could facilitate the optimal allocation of the water industry's resources.

There are similarities between water and sewage in terms of operation and management. Hence, the integrated management of the two can result in the optimal allocation of resources and exploit synergies between management and technology, thus realizing integration benefits in areas such as water quality testing, pipeline inspections, fee collections, customer service, and maintenance and material procurement—all of which are conducive to reducing operating costs and improving operational efficiency.

(ii) The integration of water supply and wastewater management provides an ideal solution for driving the successful transformation of the wastewater sector.

Running wastewater operations as an enterprise is the appropriate direction for the urban wastewater treatment sector to take, and the integration of water supply

and wastewater management can permit wastewater operations to be run commercially without the need to increase wastewater treatment fees significantly. This is because profits from the water supply business can make up for losses in wastewater operations. Thus, the service provider can withstand low wastewater treatment fees in the early years. In addition, integration can optimize the allocation of resources and reduce costs significantly. At the same time, the original Shenzhen Water Supply Company was a healthy business with a mature operational model. It was conducive to use it as the basis to form SZWG and to drive the transformation of wastewater operations into one that is run like an enterprise on a commercial basis.

(iii) Integrating water supply and drainage management will promote the sustainable development of the water sector.

Water, wastewater treatment, and drainage constitute a complete water cycle. Integrating water supply and drainage management is good for coordinating the efficient use of limited water resources, especially wastewater reuse as it is in line with water recycling and sustainable development. The integration plays an important role in improving urban environmental quality, and conserving water resources to cope with possible water shortages in the future.

Lessons

Based on the analysis of the development of Shenzhen's water sector, it can be seen that its development and reforms are moving forward continually while learning from experience. The development of water affairs in Shenzhen is of great significance not only in the PRC. It also offers lessons for other cities across Asia.

With the rapid development of the water sector in Shenzhen, significant change occurred during the past decade. In its water supply industry, total annual water supply increased from 795.96 mcm in 1998 to 1.57 billion cubic meters in 2008. Meanwhile, tap water supply capacity grew progressively, increasing from 3.39 mcm per day in 1998 to 6.70 mcm per day in 2008 (Shenzhen Statistics Bureau 1999, 2009). Full water supply coverage was achieved since 2006. In the wastewater treatment industry, the amount of wastewater treated annually increased from 191.49 mcm in 2001 to 787.18 mcm in 2008, and the treatment rate increased from 52.81% in 2001 to 62.67% in 2008 (Department of Integrated Finance, Ministry of Construction 2002; Department of Planning, Financing and Foreign Affairs, Ministry of Housing and Urban-Rural Development 2009).

Shenzhen has set up an excellent integrated urban water management system. As earlier discussed, there are three common arrangements for parent bureaus in the water sector in the PRC. Shenzhen has adopted the type of organization in which water and wastewater services are overseen by the same Water Affairs

Parent Bureau. SZMWAB is in charge of integrated water affairs throughout Shenzhen. As a result, the city can avoid possible conflicts among government agencies due to overlapping functions and make the responsibilities of each bureau clear. Although some government departments retain several functions related to water management, the functions are unambiguous, and the coordinating mechanism is good enough to allow them to resolve water management problems cooperatively and quickly. After several years of efforts, Shenzhen has formed a legal system and an advanced operating system for water management. The former has provided the foundation and safeguard for reform and development in its water sector.

Shenzhen's water management reform has met with considerable success. Besides resolving the problems of authority overlap and conflicts among government departments, integrated water management has also led to other positive results. It has promoted the development of urban water infrastructure and raised management standards. It has been beneficial to the unified planning and implementation of water resources development. It is conducive to water conservation and the use of water resources in a sustainable manner. It is also conducive for greater coordination in the development of the water sector.

Market-oriented reform in the water sector in Shenzhen has diversified the ownership of state-owned enterprises and led to progress in the transformation of the government's role. This success in separating government interventions from business operations and government functions from asset management made Shenzhen the city with the best regulatory mechanism for the water sector in the PRC. A relatively clear regulatory relationship has been set up between regulatory departments and enterprises. The success of the equity transfer of SZWG has attracted domestic and global investments into the PRC's water sector. After SZWG was established, it was subsequently granted concession rights. Today, SZWG is not only the most important water operator in Shenzhen but has become the largest water supply and wastewater services enterprise in the PRC.

The reform leading to the integration of water supply and drainage management has created a new model for the reform of investment and financing mechanisms in the water sector and the strategic restructuring of the water industry. The integration of water supply and drainage management provides an ideal solution for driving the successful transformation of the wastewater treatment sector along enterprise lines, and it can facilitate the optimal allocation of water resources. Furthermore, it will promote the sustainable development of the water sector.

Challenges

Shenzhen has achieved much progress in water management through continual reform and innovation. However, it still faces several challenges.

First, river pollution is still a serious problem in Shenzhen. There are weaknesses in the city's natural and geographical conditions. Most of its river channels are short and have limited self-purification capacity. Water pollution load is beyond the bearing capacity of the water environment. Meanwhile, comprehensive river management was only carried out for a short time in Shenzhen, and the construction of wastewater treatment facilities lagged behind the city's economic and social development. To control river pollution, Shenzhen needs to further expand the construction of wastewater treatment plants, the implementation of advanced treatment projects, and the construction of decentralized treatment facilities in small towns and rural areas to serve the needs of their smaller populations. It also needs to strengthen ecological protection and ecological restoration of the water environment, as well as promote integrated river management.

Second, the construction of the sewerage network is inadequate, leading to mixed drainage of rainwater and wastewater. The construction of the sewerage network lagged behind the construction of wastewater treatment facilities. Meanwhile, mixed drainage of rainwater and wastewater, as well as wrongly placed drainage pipes, made transformation difficult. The inadequacy of the sewerage network outside the Shenzhen Special Economic Zone limits the actual amount of wastewater that treatment plants could treat. The Municipal Government of Shenzhen needs to accelerate the construction of the sewerage network, renovate and improve the existing drainage system, reduce the extent of mixed drainage of rainwater and wastewater, and fully adopt separate drainage systems for rainwater and wastewater. In the Shenzhen Special Economic Zone, it needs to focus on improving the sewerage network (such as rectifying misplaced pipes) and retrofitting separate drainage systems for rainwater and wastewater in existing built-up areas. Outside the Shenzhen Special Economic Zone, it also needs to expand the construction of branches of the sewerage network to achieve effective wastewater collection based on its existing trunk sewerage reticulation system. With these improvements, water management will be further strengthened in Shenzhen.

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CHAPTER IX

Singapore

Cheon Kheong Tan [145]

Introduction

Singapore is a city state in Asia, with a population of about 5 million in 2008 and a land area of 710 square kilometers (Department of Statistics 2009a, 9). It is located in the tropics where rainfall is abundant. The country receives about 2,400 millimeters (mm) of rainfall annually, with rainy days accounting for about 50% of a calendar year (Department of Statistics 2009a, 17). However, it has limited land for catchments to collect and store sufficient rainwater for its domestic and industrial needs. Together with the lack of groundwater, Singapore faced the enormous challenge of water scarcity and vulnerability as its population grew rapidly, after it obtained independence in 1965.

However, Singapore adopted an integrated and innovative approach to water management, which, together with careful planning and hard work over more than 40 years, enabled it to overcome water supply constraints and attain sustainable and cost-effective water management solutions. Today, its entire population enjoys access to modern sanitation and high-quality piped water on a 24-hour basis daily.

Singapore's ability to manage its water supply, using it wisely to support its economic activities to become a city with a high standard of living, is impressive. Since 2003, Singapore succeeded in using innovation to enlarge its water supply. It turned wastewater into high-grade reclaimed water and produced the end product on a large scale to enhance self-sufficiency in water. Wastewater was renamed "used water" in Singapore, to reflect its value for reuse. The country's achievement in water reuse has made it stand out in the industry. Some countries that struggle with water scarcity and pollution have begun to look to Singapore's experience for solutions.

In recognition of its excellence in water management, the Public Utilities Board (PUB), was named the Water Agency of the Year 2006 at the international Global

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Water conservation: Installing water-saving devices in residents' homes in Singapore.

Photo courtesy of the Public Utilities Board.

Water Awards organized by Global Water Intelligence (PUB Singapore 2006). In 2007, the coveted Stockholm Industry Water Award was conferred on PUB for being "an exemplary model of integrated water management in a framework of good policy and innovative engineering solutions" (PUB Singapore 2007b).

Selected indicators of Singapore's achievements in water management are shown in Table 1.

Singapore's experience in sustainable water management offers lessons that other cities in Asia and beyond could apply to solve their water woes.

Political and Government Commitment

Singapore has placed high priority on the environment since the early days of its independence. The government invested substantially on environmental infrastructure, even at a time when the country was poor and had to attend to pressing economic, social, and security development needs. Achieving environmental and water sustainability is a strategic goal.

Water is an issue of national security that the Government of Singapore takes seriously. Singapore's founding father, Lee Kuan Yew, was instrumental in ensuring that the country overcame its vulnerability in water and achieved water sustainability. When he became the Prime Minister of newly independent Singapore, one of the first things he did was to give water top priority—setting up a unit in his office

Table 1 Performance Indicators, 2008

Water supply duration per day	24 hours
Access to drinking water	100%
Access to modern sanitation	100%
Wastewater collected and secondary-treated	100%
Drinking water quality (meeting WHO standard)	100%
Proportion of water consumption metered	100%
Unaccounted-for-water	4.4%
Number of leaks per 100 km of potable water pipelines	7.1
Number of sewerage service disruptions per 1,000 km of sewer maintained	19
Flood-prone areas	79 hectares (0.11% of land area)
Domestic water consumption per capita per day	156 liters
Number of accounts served per PUB employee[a]	400
Proportion of PUB employees who attended training	96%
Proportion of annual payroll spent on training	3.1%
Operating ratio	0.86
Revenue collection efficiency[b]	99.8%
Monthly bill collection efficiency (days of sales outstanding)[c]	28

km = kilometer; PUB = Public Utilities Board, WHO = World Health Organization.

Notes:

[a] Number of accounts refers to the number of customer accounts for potable water and NEWater.

[b] Revenue collection efficiency refers to annual collections expressed as a percentage of annual billings for potable water consumption.

[c] Monthly bill collection efficiency (days of sales outstanding) refers to the time taken to collect bills.

Sources: Data collected from PUB Singapore in 2009; Ministry of the Environment and Water Resources (2009).

to coordinate this at the whole-of-government level. As he recalled at a dialogue session with delegates of the inaugural Singapore International Water Week in June 2008:

> This [water] dominated every other policy. Every other policy had to bend at the knees for water survival (Tan et al. 2009, xxiii).

As Dr. Yaacob Ibrahim, Singapore's minister for the Environment and Water Resources from 2004–2011, also explained at the Fifth World Water Forum in March 2009:

> Extending modern sanitation to 100% of [Singapore's] population took years of commitment and careful planning. Upon independence in 1965, proper sanitation was available to only 45% of the population. [...] A Sewerage Master Plan was conceived in the late [19]60s to guide the development of used water facilities alongside unfolding land use

> developments. Only in the [19]90s was 100% of Singapore served by a modern sanitation system, following decades of disciplined and significant investment programs.
>
> The willingness to undertake these hefty investments, even when Singapore was a poor fledgling nation, reflected the high priority Singapore placed on ensuring that development was not at the expense of our environment. This commitment continues into the future. [...] The government has recently updated the vision for a sustainable Singapore and charted a blueprint on how we intend to keep Singapore economically and environmentally sustainable for future generations (Ibrahim 2009).

Singapore's firm commitment to placing water and sanitation high on the nation's agenda is a key factor in its achievements in water management.

At the same time, the Government of Singapore does not tolerate corruption. Established in 1952, a Corrupt Practices Investigation Bureau (CPIB), which is directly responsible to the Prime Minister, is empowered to investigate corruption in the public and private sectors. Anticorruption regulations are strictly enforced. Corruption is severely dealt with, regardless of the offender's status and background. To prevent corruption, CPIB also reviews the work procedures of public sector organizations to identify administrative weaknesses that could lead to corruption, and recommends corrective measures. Besides, the bureau conducts lectures and seminars to educate public sector officers on the consequences of corruption (Corrupt Practices Investigation Bureau 2009).

The strong political will and comprehensive actions to curb corruption help to ensure that Singapore does not face the problem seen in some countries, where corruption in the water sector adversely affects investments in water infrastructure and hampers efficiency and achievement in water management.

According to the Corruption Perceptions Index computed by Transparency International, Singapore was ranked as one of the countries with the lowest perceived level of public sector corruption in the world (Transparency International 2010).

Institutional Setting and Governance

Formed on 1 May 1963, PUB is Singapore's water authority.[146] It is owned by the government but operates as a statutory board that adopts a corporate approach in its operations. PUB is responsible for water supply, wastewater, and storm water management. It is a statutory board under the Ministry of the Environment and

[146] The predecessor of PUB was the city council of the State of Singapore.

Water Resources (MEWR), which is the parent ministry that oversees environmental and water-related affairs. MEWR was known as the Ministry of the Environment (ENV) before September 2004.

From May 1963 to September 1995, PUB was responsible for the production and supply of electricity, water, and piped gas. On 1 October 1995, its electricity and gas operations were corporatized and transferred to Singapore Power Pte Ltd, in a move toward privatizing the electricity and gas industries. PUB continued to be the water authority, and also took on a new role of regulating the electricity and piped gas industries (PUB Singapore 1996, 3 and 8–9). On 1 April 2001, the regulatory functions for electricity and gas were transferred to the Energy Market Authority, a new statutory board, while used water and drainage functions (which were under ENV then) were transferred to PUB (PUB Singapore 2002b, 3 and 43). The transfer enabled water supply, water catchment, and sewerage to be managed by a single agency, PUB, in an integrated and holistic manner. The Public Utilities Act (Chapter 261) stipulates the responsibilities of PUB. It has a high degree of autonomy and strong government support to carry out its role as the national water agency.

Efficient water management requires close and efficient interagency cooperation, and this is evident in Singapore. PUB works in close collaboration with the Urban Redevelopment Authority (URA). URA is Singapore's national land use planning authority. It prepares long-term strategic plans and detailed local area plans for physical development. It then coordinates and guides efforts among relevant public sector agencies (such as PUB) in implementing the plans. Given Singapore's small size, prudent land use planning is important to ensure that there is sufficient land for the various needs of the country, and to support economic growth and future development. Moreover, careful land use planning and zoning minimizes negative impact of economic development on the environment, and helps to ensure that water catchments are clean.

PUB also works in collaboration with the National Parks Board (NParks) to create green and blue spaces in Singapore for residents to enjoy in their daily lives. NParks is responsible for providing and enhancing the greenery of Singapore, and manages major parks, nature reserves, and roadside greenery.

Both supply management and demand management are key components of Singapore's water strategy. The country's approach to water management is integrated and holistic. It encompasses an effective legal and regulatory framework, supply management (which includes catchment management, and protection and expansion of water sources), demand management (including water pricing and public education programs on water conservation), wastewater management, storm water management, research and development, outsourcing, and public–private partnerships (PPPs).

Supply Management

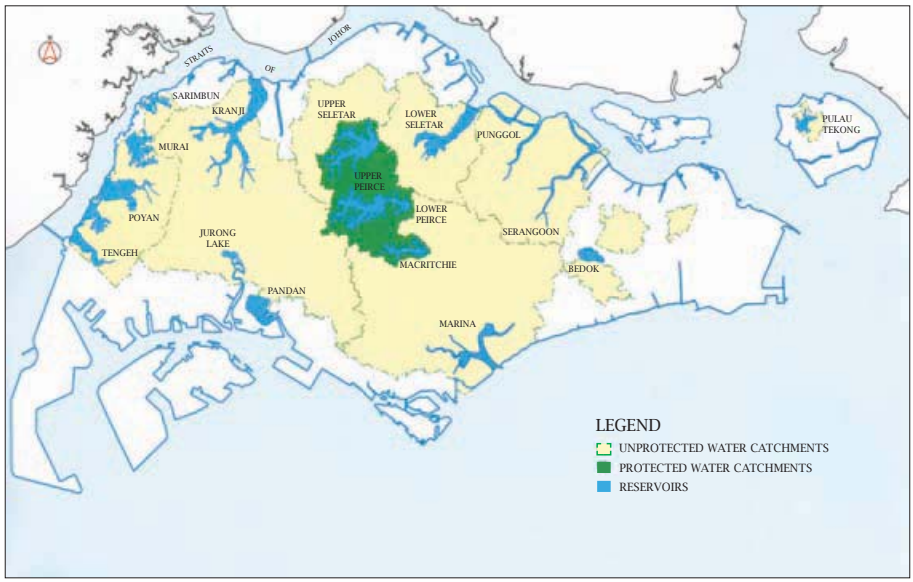
The Four National Taps

Before 2003, Singapore relied on rainwater collected in local catchments and water imported from its immediate neighbor—Malaysia—to meet its water needs. To ensure that Singapore has a sustainable supply of water, PUB has diversified the country's water sources in recent years and established a long-term water supply strategy known as the Four National Taps, which comprise water from local catchments, imported water, high-grade reclaimed water, and desalinated water.

Local Catchments

In Singapore, reservoirs were created by damming major rivers. Being a small city state, Singapore has limited land to serve competing needs. In 2007, 50% of Singapore's land area was already used as water catchments. This was increased to 67% with the completion of three new reservoirs: the Marina Reservoir (Singapore's 15th reservoir) which was ready to be used as a freshwater reservoir in 2010 (PUB Singapore 2010d), and the completion of the Punggol and Serangoon Reservoirs (its 16th and 17th reservoirs) in the northeast of Singapore in 2011 PUB Singapore 2010b, 5) (Figure 1).

Figure 1 Reservoirs and Water Catchments in Singapore



Note: Protected water catchments refer to catchments that are left in their natural states, in which development is prohibited. On the other hand, development is allowed in unprotected water catchments but is limited to residential estates and clean or light industries. For instance, warehouses located within unprotected catchments are not to be used for bulk storage of hazardous or pollutive substances.

Source: Map provided by PUB Singapore in 2010.

The remaining land comprises small catchments around the fringes of the island. Besides being too undersized to be converted to reservoirs, the small rivers and streams in the fringe catchments have daily incursions of seawater. PUB is studying the feasibility of using variable salinity plants to produce drinking water on a large scale. Using advanced membrane technology, variable salinity plants are two-in-one plants that can treat either freshwater or seawater into drinking water. This new technology, with a lower production cost than desalination, will enable PUB to reclaim water from surface runoff at fringe catchments around the island, and this could further increase Singapore's water catchments from 67% to 90% of its land area (Tan et al. 2009, 158–159). PUB's variable salinity plant was named the global winner in the Applied Research category of the International Water Association Project Innovation Awards 2010 (PUB Singapore 2010c).

To ensure that water in catchments would not be polluted, the government adopted careful land use planning. Pollutive industries were prohibited from locating within water catchments. The government resettled squatters, moved street hawkers, relocated farms away from water catchments, and subsequently phased-out pig farms throughout the country in 1984. It also enacted comprehensive regulations and strictly enforced penalties against polluters. Besides, gross pollutant traps are installed in various locations (such as drains and canals) across the island, to keep water resources clean by trapping debris and litter. Earth control measures, particularly for construction sites, were also put in place to improve the quality of storm runoff into waterways, thereby minimizing the presence of silt in reservoirs after storms.

Imported Water

Singapore purchases water from the Johor state of Malaysia. Water is imported from Johor through pipelines across the causeway that separates the two countries. Two bilateral agreements were signed in 1961 and 1962 on raw water purchase.[147] The 1961 agreement allowed Singapore to draw water from a designated land at Gunong Pulai, the Tebrau River, and the Scudai River for 50 years until 2011. Singapore paid an annual rent of S$5 per acre for the land and a charge of RM0.03 for every 1,000 gallons (3.79 cubic meters) of raw water.[148] The 1962 agreement enables Singapore to draw up to 250 million gallons of raw water per day from the Johor River until 2061, at the same price for raw water as the 1961 agreement.[149] When Singapore separated from Malaysia and became

[147] The 1961 agreement (Government of the State of Johor and City Council of the State of Singapore 1961) was called the Tebrau and Scudai Rivers Water Agreement, and the 1962 agreement (Government of the State of Johor and City Council of the State of Singapore 1962) was called the Johor River Water Agreement. The water agreements were signed between Singapore and the Johor state of Malaya. At that time, Singapore was a state of the British empire, while Malaya was an independent nation. Malaysia was formed in 1963, following a merger of Malaya, Sarawak, Singapore, and North Borneo (which became Sabah).

[148] Section 16(i) of the 1961 agreement.

[149] Section 13(1) of the 1962 agreement.

an independent country in 1965, the Malaysian Federal Government guaranteed these two water agreements in the Separation Agreement.

In 1990, Malaysia and Singapore signed a supplement to the 1962 water agreement. The supplement, which will also expire in 2061, allows Singapore to build a dam across the Johor River to facilitate the extraction of water from the river and to purchase treated water generated from the dam. This is over and above the original quota of 250 million gallons of raw water per day, which Singapore could draw from the Johor River under the 1962 agreement. The price of this additional supply that Singapore will pay is the weighted average of Johor's water tariffs plus a premium of 50% of the surplus from the sale of this water by PUB to its consumers after deducting Johor's water price and PUB's cost of distribution and administration of this water, or 115% of the weighted average of Johor's water tariffs, whichever is higher.[150]

Bilateral negotiations from 1998 to 2002 for the renewal of the first agreement upon its expiry were unsuccessful due to disagreement over the price of water that Singapore should pay, among other bilateral issues. Since the late 1990s, Singapore has been conscientiously developing other sources of water, in order to have sufficient water to meet its needs and increase water security after 2011. By leveraging on technology, the country succeeded in turning used water and seawater into safe drinking water, adding high-grade reclaimed water and desalinated water to its inventory of water sources in the 21st century and stepping up their production, thereby becoming more self-sufficient in water.

Singapore decided that due to these new water sources (including new reservoirs), it was not necessary for the country to renew the first water agreement with Malaysia upon its expiry in 2011.[151] Moreover, Singapore plans to further increase the production of reclaimed water and desalinated water, so that it can be self-sufficient in water if necessary when the second agreement expires in 2061 (PUB Singapore 2010b, 1).

Reclaimed Water

Since 1997, Singapore was fully sewered and using a modern sanitation system (Tan et al. 2009, 183). All used water is collected and treated. Singapore attempted to reclaim water from used water way back in the early 1970s. But the technology was not cost-effective then. When major improvements to membrane technology were made in the late 1990s, PUB and ENV formulated a study and found that the cost of water reclamation had declined substantially, making it economically

[150] Section 8(a) of the supplement to the 1962 agreement (Government of the State of Johor and Public Utilities Board of the Republic of Singapore 1990).

[151] Dr. Yaacob Ibrahim, Singapore's minister for the Environment and Water Resources from 2004–2011, in his oral reply to questions of a Nominated Member of Parliament, during a Singapore parliament sitting on 26 April 2010. See Parliament of Singapore (2010).

viable to produce reclaimed water on a large scale (Tan et al. 2009, 238–239). After successful trials using a demonstration plant and extensive testing of water quality, Singapore began to use advanced dual-membrane (microfiltration and reverse osmosis) and ultraviolet technologies to produce high-grade reclaimed water (branded as NEWater) on a large scale in 2003.

Used water is purified and treated to drinking standards to form NEWater. A small amount of NEWater is pumped into reservoirs for indirect potable use. That is, the NEWater is mixed with raw water in reservoirs to pick up essential minerals that the human body needs but it lacks due to its purity, before being further treated at the waterworks to become drinking water. The amount of NEWater introduced into raw water reservoirs constituted about 1% of Singapore's total daily water consumption in 2004, and this was progressively increased to about 2.5% of total daily water consumption by 2011 (Ministry of the Environment and PUB Singapore 2002; PUB Singapore 2004).

The bulk of NEWater produced is supplied via a separate distribution network to industrial and commercial customers for direct non-potable use (such as in wafer fabrication in the semiconductor sector, landscaping, fire sprinkler water tanks, and air-conditioning cooling towers). NEWater is purer than tap water, making it ideal for use in industrial manufacturing processes that need ultra-pure water.

To enhance the public's acceptance of NEWater, PUB placed strong emphasis on public education before launching NEWater in 2003. It embarked on an intensive, multilingual campaign that emphasized on the high quality of NEWater. Advertisements, exhibits, leaflets, pamphlets, and posters in Singapore's four official languages were used, explaining in simple terms what NEWater was and the technology used to produce it. A documentary on the technology and the experience of other countries in the use of reclaimed water was broadcasted on local television. Exhibitions on NEWater were held at community and school events. PUB also conducted briefings and seminars on NEWater for various groups such as the media, members of Parliament, community leaders, business communities, and other government agencies.

To further engage the media in helping shape positive perceptions of NEWater, media representatives were taken on an educational tour to parts of the United States and Europe to show them that water reuse had been successfully adopted for many years in those countries. Furthermore, PUB established a NEWater Visitor Center that was integrated with its first NEWater plant in Bedok, for the public to learn about NEWater, witness its production process, and understand its role in Singapore's water strategy, through guided tours, exhibits, video shows, virtual guide, and interactive games. PUB also gave out free samples of bottled NEWater to the public at the NEWater Visitor Center and during community and national events, so that people could try out NEWater, thereby helping them overcome the psychological barrier toward reclaimed water.

Kids enjoying NEWater, at the NEWater Visitor Center.
Photo courtesy of the Public Utilities Board.

Besides, Singapore's government leaders set good examples by drinking NEWater in public occasions. During a parade to celebrate the country's National Day in 2002, Goh Chok Tong, Singapore's Prime Minister at that time, other senior government leaders, and about 60,000 participants toasted to NEWater. Moreover, the government persuaded Singaporeans to drink recycled water by linking it to the country's survival, amidst the deadlock at that time, encountered in negotiations with Malaysia to extend the water agreements with Johor.

A product such as NEWater could be potentially controversial due to its source. But through a well-timed and properly executed public education campaign that emphasized on NEWater's high quality and that reclaimed water had been used in other countries, Singapore effectively shaped positive perceptions on NEWater among its people and succeeded in convincing them to accept recycled water as a source of potable water.

To increase usage of NEWater in the years ahead, Singapore has expanded its production capacity of NEWater since its official launch in 2003. The first NEWater plants were opened in Bedok and Kranji in 2003, followed by Seletar in 2004, the Ulu Pandan plant in 2007, and a plant in Changi in 2010.[152]

[152] The Seletar Water Reclamation Plant and Seletar NEWater Plant were subsequently phased out in 2011 as used water collection was progressively migrated to the Deep Tunnel Sewerage System discussed in a later section. As of 2011, there were four NEWater plants.

The Changi plant is the country's largest NEWater plant with a full capacity of 50 million gallons (228,000 m^3) per day. With its completion, NEWater could meet 30% of Singapore's water needs in 2010 (PUB Singapore 2008a; PUB Singapore 2009f, 27; PUB Singapore 2010a). The Ulu Pandan and Changi plants are privately operated.

Singapore plans to further increase NEWater production by expanding the capacity of the Changi plant and building another plant at Tuas. NEWater is projected to meet 40% of Singapore's water demand by 2020, and 50% by 2060 (PUB Singapore 2010b, 3 and 35).

Desalinated Water

PUB also took advantage of advancements in technology and cheaper membrane prices to make desalinated water the fourth source of water supply for Singapore. In 2005, the city state began to use desalination to diversify its water sources, with the opening of the SingSpring Desalination Plant in Tuas.

The plant can produce 30 million gallons (136,000 cubic meters) of water per day, using the process of reverse osmosis. This is the same technology used in the production of NEWater. It is one of the region's largest seawater reverse-osmosis plants, and could meet up to 10% of Singapore's water demand in 2010 (PUB Singapore 2010b, 4). It is privately operated. The price that PUB paid to purchase desalinated water from the private operator (i.e., PUB's cost of desalinated water production) in its first year of operation was S$0.78 per m^3 (PUB Singapore 2003). After treatment, desalinated water is blended with treated water from the reservoir, before it is supplied to homes and industries in the western part of Singapore (PUB Singapore 2005).

In comparison, the price that PUB paid to the private operators of the Ulu Pandan and Changi NEWater plants, for the purchase of NEWater, was S$0.30 per m^3 in each plant's first year of operation (PUB Singapore 2004; PUB Singapore 2008a). This price was significantly lower than the cost of producing desalinated water.

Desalination is the most energy-intensive source of water and therefore the most expensive in terms of production costs, among Singapore's Four National Taps (PUB Singapore 2010b, 11). With existing technologies, it is less costly to produce NEWater than desalinated water. NEWater will increasingly become an important source of water in Singapore. However, desalinated water, as its newest source of water, has helped Singapore to diversify its water sources and increase water security. PUB has invested in research and development (R&D) to find ways to reduce the energy consumption so as to lower the cost of producing desalinated water. It plans to increase desalination capacity with a second plant by 2013. During the plant's first year of operation, the private operator will supply desalinated water to PUB at a price of S$0.45 per m^3 (PUB Singapore 2011a). Desalinated

water is projected to meet 25% of Singapore's water demand by 2020, and at least 30% by 2060 (PUB Singapore 2010b, 3 and 35).

Water Quality and Water Service Reliability

Users in Singapore enjoy a reliable, 24-hour supply of potable water daily, throughout the year. PUB's water network is designed in loops with alternative feeds to its customers. This ensures that should one feed source is unavailable, another source can be fed into the same network to meet customers' demand. The loop system, together with water storage tanks at the customers' end, help to ensure reliability of PUB's water supply network (Tay et al. 2008).

Before water is supplied to customers, raw water is conveyed by pipelines to PUB's waterworks where it is chemically treated, filtered, and disinfected to get rid of bacteria and viruses. The water is then pumped into the distribution system and service reservoirs, for consumption.

It is safe to drink Singapore's water straight from the tap. To ensure that the water supply is clean, water samples are regularly collected and analyzed for chemical and bacteria contents at PUB's Water Testing Laboratory. Samples of water at various stages of treatment at waterworks, raw water from all sources, and treated water from service reservoirs and selected points in the distribution network, are collected for daily or periodic analysis.

The quality of the country's tap water is well within international guidelines. Tests are conducted to ensure that the quality of treated water is within the Guidelines for Drinking Water Quality set by the World Health Organization (WHO). More than 80,000 tests are conducted monthly, based on more than 290 parameters, surpassing the 130 parameters specified by the United States Environmental Protection Agency (USEPA) and WHO. Independent checks are conducted by the National Environment Agency, which is another statutory board in Singapore. In addition, PUB's management of water quality is reviewed twice a year by an independent external audit panel comprising international and local experts (Chong 2009).

Using good quality materials for water pipes and replacing old pipes over time also help to keep the quality of potable water high. Corrosion-resistant materials, such as lined ductile iron and steel pipes with a life span of 50–70 years, are used for PUB's water supply network. PUB also requires building owners conducting works on pipes to engage licensed water service plumbers who must ensure that the water supply system is sterilized before being put back into service. Besides, town councils and management corporations of buildings are required to engage a licensed water service plumber at least once a year to inspect and, where necessary, clean and disinfect their water tanks and certify that the tanks are fit as drinking water storage. The plumber is required to submit his certification and water

sample test reports to PUB. Furthermore, PUB conducts spot checks and water sample testing to ensure that water tanks are properly maintained (Chong 2009).

These stringent measures that PUB has put in place, together with effective water treatment processes and continued investments in R&D, ensure that the quality of potable water in Singapore is high.

Similarly, PUB monitors the quality of NEWater closely. It established a comprehensive sampling and monitoring program for NEWater in 1999. Tests were conducted on water samples to detect 190 physical, chemical, and microbiological parameters at that time. The number of parameters monitored has since been gradually expanded to more than 290 (PUB Singapore 2009d).

In 2002, a 9-member panel of international and local experts, which supervised laboratory analyses conducted on NEWater over a 2-year period, endorsed NEWater as a safe source of water. The panel also supported the indirect potable use of NEWater in Singapore, in line with the practice in the United States (PUB Singapore 2002a).

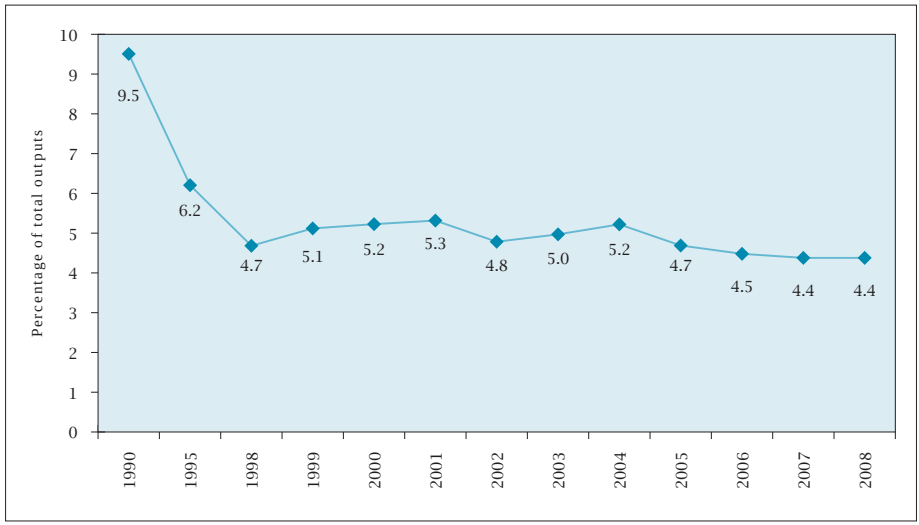
Although additional parameters are being monitored and lower levels of detection through more sensitive instruments are used over the years, NEWater still exceeds the requirement in all measures of quality. Since the monitoring program for NEWater began in 1999, NEWater had passed more than 65,000 tests that were audited regularly by the external audit panel of water experts. The quality of NEWater surpasses the Environmental Public Health (EPH) and USEPA drinking water standards, as well as the drinking water guidelines set by WHO (PUB Singapore 2009d).

Unaccounted-for-Water

Besides adding new sources to enlarge its water supply, Singapore also increased its water supply by cutting down unaccounted-for-water (UFW). UFW declined from 9.5% of total water production in 1990 to 4.4% in 2008 (Figure 2). Singapore's level of UFW is one of the lowest in the world.

In Singapore, the law prohibits illegal connections to the water supply system, and this is strictly enforced. This helps to keep UFW low. PUB also reduces UFW by minimizing the occurrence of leaks in the transmission and distribution network. To achieve this, PUB ensures that its new water supply networks are made of good quality materials and fittings. Unlined cast iron and galvanized iron pipes have been prohibited since 1980. PUB has introduced new and better-quality corrosion-resistant materials (such as copper, stainless steel, and steel and/or ductile iron) for new pipelines, and has tightened supervision of pipe-laying work to ensure high-quality workmanship and that newly laid pipelines are watertight. For existing

Figure 2 Decline in Unaccounted-for-Water, 1990–2008



Source: Data collected from PUB Singapore in 2009.

networks, PUB has implemented pipeline-replacement programs to upgrade and renew the existing network (Tay et al. 2008). Old pipes are systematically replaced. Besides, PUB has a comprehensive system of regular inspections that detect leaks, and this enables PUB to fix leaking pipes quickly.

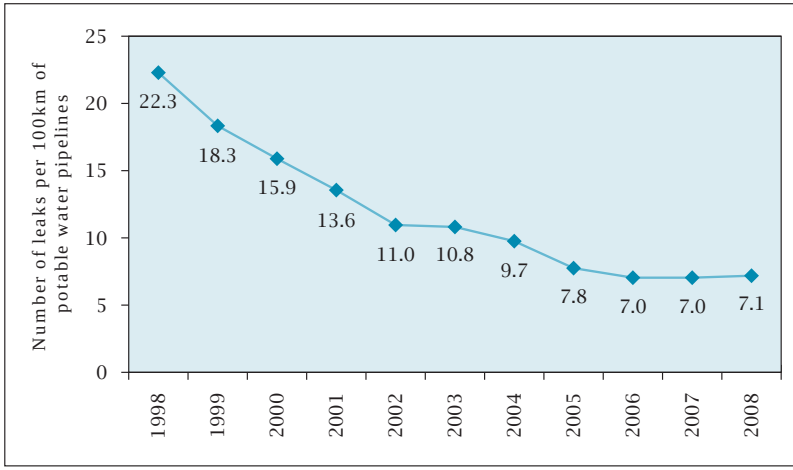
These measures have resulted in significant declines in the number of leaks in potable water pipelines over the years. In 2008, there were only 7.1 leaks per 100 km of potable water pipelines (Figure 3). Meters (which register water usage and are used for billing customers) are replaced to avoid meter inaccuracies arising from deterioration with age. As measures to control UFW reduce water wastage, they also help cut operating costs.

Demand Management

In 1965, Singapore's population was 1.9 million, and domestic demand for potable water was 142,000 m^3 per day (75 liters per capita per day) (Tan et al. 2009, 162). Over the years, population growth, industrialization, and economic development have led to increases in water demand. By 2008, the city state's population had increased by about 2.5 times to 4.8 million people, whereas domestic demand for potable water had increased by more than five times to 742,000 m^3 per day (156 liters per capita per day) (Department of Statistics 2009a, 9).

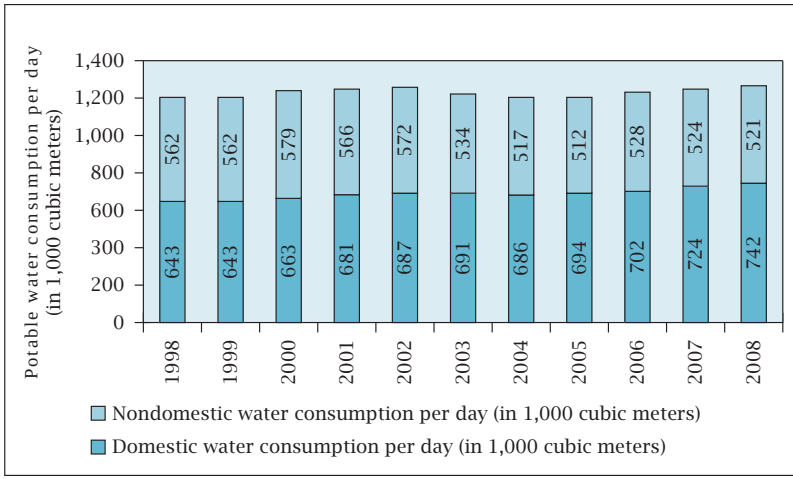
Figure 4 shows domestic consumption (i.e., consumption by households) and nondomestic consumption of potable water in 1998–2008. In 2008, domestic

Figure 3 Decline in Number of Leaks per 100 km of Potable Water Pipelines, 1998–2008



Sources: Adapted from PUB Singapore (2008g), p. 11; PUB Singapore (2009g), pp. 8–9.

Figure 4 Potable Water Consumption per Day, 1998–2008



Source: Data collected from PUB Singapore in 2009.

consumption constituted 59% of total daily consumption of potable water. There were 1,137,610 domestic customer accounts and 91,626 nondomestic customer accounts. Domestic consumption was about 0.65 m^3 per account per day, while nondomestic consumption was about 5.69 m^3 per account per day.

PUB recognizes the importance of managing water demand in the country's drive toward achieving water sustainability. Demand management has been an integral part of its water management strategy. To give demand management the needed focus, PUB established a Water Conservation Unit in 1981. The unit is responsible for managing water demand, and for promoting water conservation to domestic and nondomestic customers. PUB uses water pricing, mandatory requirements, and public education to manage water demand.

Water Pricing

Water pricing is an important mechanism to encourage users to conserve water. In Singapore, all water connections are metered. Meters at the customers' premises register water usage, and customers are billed for the water they consume. There is no free water.

Singapore's water tariff structure comprises a water tariff, water conservation tax (WCT), sanitary appliance fee, and waterborne fee. The government's policy is to price potable water to recover the full costs of producing and supplying it, as well as to reflect the scarcity of water in Singapore and the higher incremental cost of alternative sources like NEWater and desalinated water, which are more expensive than local catchment water as they are more energy-intensive. Hence, on top of the tariff, the government levies a WCT[153] to encourage water conservation (Government of Singapore 1997). The water tariff goes to PUB, while the WCT is channeled into a government-consolidated fund managed by the Ministry of Finance, which can then be used to fund national projects that would benefit the entire country. As the water tariffs reflect the true cost of water production, supply, and treatment, revenue could be ploughed back into R&D to identify more efficient ways of treating and distributing water, and to construct new water supply sources to meet future demand (Tan et al. 2009, 166).

In addition, a sanitary appliance fee and a waterborne fee are levied to offset the cost of treating used water and for the operation and maintenance of the public sewerage system. Singapore's progressive water tariff structure for domestic users and tariffs since 1 July 2000 are shown in Table 2. Tariffs have remained unchanged since then. Customers are charged for the actual volume of water they consume.

Prior to July 1997, domestic customers were charged much lower prices than nondomestic customers, for potable water (Table 3). In July 1997, the government began to progressively raise the tariffs of potable water and the WCT over 3 years, to reinforce upon domestic customers to treat water as a precious and strategic resource. Waterborne fees were also raised to recover the rising cost of

[153] The water conservation tax was first introduced in 1991.

Table 2 Tariffs of Potable Water (since 1 July 2000)

Tariff Category	Consumption Block (m^3 per month)	Potable Water Tariff (S$/$m^3$) (before GST)	Water Conservation Tax (% of tariff) (before GST)	Waterborne Fee (S$/$m^3$) (after GST)	Sanitary Appliance Fee (after GST)
Domestic	0–40	1.17	30	0.30	S$3 per chargeable fitting per month
	Above 40	1.40	45	0.30	
Nondomestic	All units	1.17	30	0.60	
Shipping	All units	1.92	30	–	–

S$/$m^3$ = in Singapore dollar per cubic meter, GST = goods and services tax.

Note: All prices are subject to the prevailing GST, which is 7% since July 2007.

Source: Adapted from PUB Singapore (2009a). http://www.pub.gov.sg/general/Pages/WaterTariff.aspx

wastewater treatment and the high cost of new sewerage facilities. The move was also meant to avoid indirectly subsidizing the usage of water. The sanitary appliance fee remains at S$3 per sanitary fitting per month. Only the volume-based waterborne fees were increased, to link the fee charged more closely with the volume of wastewater generated (Government of Singapore 1997).

From 1997 to 2000, the prices of potable water were raised in gradual steps to the 2000 level of S$1.17 per m^3 for water tariffs and 30% for the WCT, levied on the first 40 m^3 per month of domestic consumption for each household (Table 2). These new prices brought domestic water tariff and the WCT to the same level as those levied on nondomestic customers, removing any cross-subsidy between these two groups of customers. Moreover, the government abolished the previous practice of charging a substantially lower water tariff and no WCT for domestic consumption of up to 20 m^3 per month, to emphasize the preciousness of water in Singapore, right from the first drop. For domestic consumption of more than 40 m^3

Table 3 Tariffs of Potable Water (before 1 July 1997)

Tariff Category	Consumption Block (m^3 per month)	Potable Water Tariff (S$/$m^3$) (before GST)	Water Conservation Tax (% of tariff) (before GST)	Waterborne Fee (S$/$m^3$) (after GST)	Sanitary Appliance Fee (after GST)
Domestic	0–20	0.56	0	0.10	S$3 per chargeable fitting per month
	20–40	0.80	15	0.10	
	Above 40	1.17	15	0.10	
Nondomestic	All units	1.17	20	0.22	
Shipping	All units	2.07	20	–	–

S$/$m^3$ = in Singapore dollar per cubic meter, GST = goods and services tax.

Note: All prices were subject to the GST, which was 3% in 1997.

Sources: Adapted from Government of Singapore (1997) and data collected from PUB Singapore in 2009.

per month, the revised prices of S$1.40 per m^3 for water tariffs and 45% for the WCT are even higher than the prices paid by nondomestic customers, to further discourage overconsumption among households.

Despite increases in prices, the monthly water bill (inclusive of sanitation fees) of an average household of four was about S$42 in 2008 (Chan 2009). This constituted only 1.1% of the monthly household expenditure, or 0.6% of the monthly household income of an average 4-person household living in public housing.[154]

As shown in Table 2, nondomestic customers pay a waterborne fee of S$0.60 per cubic meter, which is twice the amount that domestic customers pay. This is presumably because it is more difficult and costly to treat wastewater discharged by nondomestic customers (Tortajada 2006).

Singapore does not artificially lower the price of water across the board as the means to subsidize the poor, so as not to also subsidize the rich who can afford to pay for their water consumption. Instead, the government provides direct and targeted financial assistance, in the form of Utilities Save (U-Save) rebates, to households living in public housing as these tend to be low-income and middle-income households. The rebate is credited to the household's utilities account with the bill collector, Singapore Power Services Ltd (SP Services). The household can use the amount to pay for its monthly utility bills (which include electricity, gas, and water). If the rebate is not used completely within 1 month, the household can still use it in subsequent months, giving it an incentive to conserve water and energy. The amount of rebate that a household receives depends on the type of public housing where it resides, with households living in smaller apartments receiving larger rebates as these households tend to be the poorest. The government also gives additional rebates during economic downturn. In 2009, S$125 million of U-Save rebates were given to households (Ministry of Finance 2009).

Moreover, low-income households receive help from PUB in other ways. For instance, PUB set aside S$600,000 to implement a nationwide program since April 2009 to install water-saving devices in needy households with above-average water consumption, to help these families reduce their water consumption and water bills (PUB Singapore 2008e).

PUB also supplies industrial water, which is low-grade reclaimed water, to industries. Industrial water is used in industrial processes as a substitute for potable water, thereby helping Singapore to moderate the increase in the demand for potable water. Industrial water is not fit for human consumption.

[154] Estimated based on the data of average monthly household expenditure and average monthly household income published in Department of Statistics (2009b), p. 234 and p. 241. In Singapore, public housing is commonly known as Housing and Development Board (HDB) flats.

PUB prices NEWater based on cost recovery. When PUB first began to supply NEWater to industrial and commercial customers for direct non-potable use in 2003, it charged a tariff of S$1.30 per m^3 (excluding GST). Outsourcing the design, construction, operation, and maintenance of the Ulu Pandan and Changi NEWater plants to the private sector had enabled PUB to reap economies of scale. With economies of scale, productivity gains, and more competitive membrane technologies, PUB was able to bring down the cost of NEWater production over the years. To transfer these cost savings to customers, PUB lowered the tariff of NEWater to S$1.15 per m^3 in January 2005 (PUB Singapore 2004), and further lowered the tariff to S$1.00 per m^3 in April 2007. Besides production costs, the tariff of NEWater also covers the cost of transmission and distribution (PUB Singapore 2007a). The tariff was increased to S$1.10 per m^3 in October 2010.

The waterborne fee for NEWater is S$0.60 per m^3, which is the same as the waterborne fee that nondomestic customers pay for potable water. But unlike potable water, PUB does not levy a water conservation tax on NEWater. Hence, to nondomestic customers, the cost of using NEWater is lower than the cost of using potable water, as the latter carries a water conservation tax. The lower cost and the purity of NEWater have attracted a steady increase in its take-up rate among industrial and commercial customers (Figure 5). These customers include wafer fabrication plants, petrochemical plants, power generation plants, and commercial and institutional buildings. As industrial and commercial usage of NEWater increases, more potable water becomes available for domestic use.

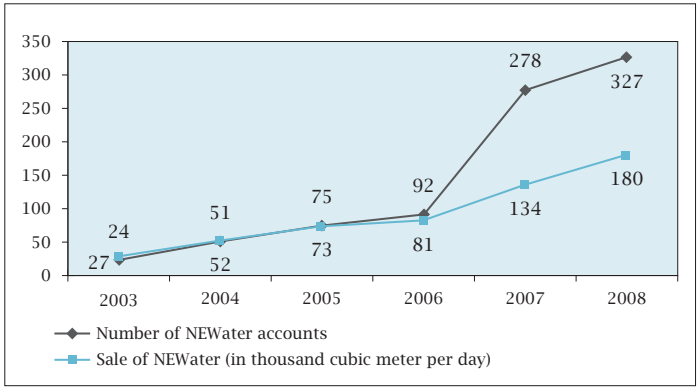
Mandatory Requirements

Besides using pricing to manage water demand, PUB has also imposed mandatory requirements to achieve the objective of water conservation. For instance, it is mandatory to install water-saving devices (such as constant flow regulators and self-closing delayed action taps) in nondomestic premises and common amenities areas of private, high-rise residential apartments and condominiums, since 1983. Besides, PUB limits the maximum allowable flow rates at water fittings. In 2003, the maximum allowable flow rates were reduced by 25%–33% to prevent water wastage. The requirement on limiting the maximum allowable flow rates at water fittings was also extended to all domestic premises (Tan et al. 2009, p.172).

Moreover, PUB has implemented a Mandatory Water Efficiency Labeling Scheme that involves labeling water devices sold in Singapore with up to 3 ticks to indicate how water efficient they are, so that consumers can make informed choices prior to purchase.[155] It was first introduced on a voluntary basis in 2006, as part of the 10-Liter Challenge discussed in the next section. Since July 2009, it is mandatory

[155] Products that use the least water are labeled with 3 ticks.

Figure 5 Increase in Number of NEWater Accounts and Sale of NEWater, 2003–2008



Sources: Adapted from PUB Singapore (2009g), pp. 8–9; Ministry of the Environment and Water Resources, *Key Environmental Statistics*, various issues.

for taps, mixers, dual-flush low capacity flushing cisterns, urinal flush valves, and waterless urinals sold to be labeled. Moreover, only those with at least a 1-tick water efficiency rating could be installed in new property developments and existing premises undergoing renovation.[156]

Public Education and Other Water Conservation Programs

Over the years, PUB has implemented various campaigns and programs to educate the public on the need to conserve water and to make it a daily, lifetime habit. The first nationwide campaign with the tagline "Water is Precious" was launched in 1971. Campaigns are ongoing since then.

Other water conservation initiatives that PUB has introduced in recent years include the following:

(i) **Water-Efficient Homes.** Launched in 2003, the Water-Efficient Homes program was designed by PUB but run by organizations at the community level. This community-driven program encourages residents to conserve water by installing water-saving devices (such as thimbles in taps) and adopting good water-conservation practices in their homes. PUB provides Do-It-Yourself (DIY)

[156] Mandatory labeling of water efficiency was extended to washing machines sold since October 2011. See PUB Singapore (2011b).

water-saving kits free-of-charge to households. It also sets up mobile exhibitions to demonstrate to residents how to install water-saving devices. Its employees also visit households to install the devices.

(ii) **10-Liter Challenge.** This program was introduced in 2006 to encourage households to reduce their daily water consumption by 10 liters. The public was offered useful tips on how to save water.

(iii) **Water Volunteer Groups.** Since 2006, PUB works with the People's Association, community development councils, schools, and grassroots organizations to form water volunteer groups.[157] These volunteers encourage households to take the 10-liter challenge. They also teach residents ways to conserve water.

(iv) **Friends of Water Program and Watermark Awards.** Implemented in 2006, the Friends of Water program aims to inculcate a greater sense of ownership among people to care for and cherish Singapore's water resources. PUB encourages individuals and organizations to join the program to contribute toward raising awareness about water and what it takes to sustain Singapore's water supply.

Watermark Awards, introduced in 2007, are given to Friends of Waters who make significant contributions in promoting water conservation, raising awareness about water issues, and keeping Singapore's waterways clean.

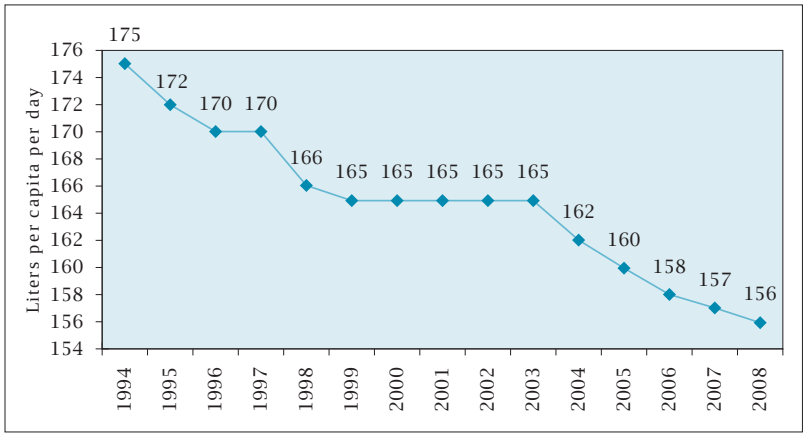
(v) **Water Efficiency Fund.** Launched in 2007, the Water Efficiency Fund encourages industries to try water-saving tactics (such as using NEWater or seawater as an alternative water source), and to promote water conservation in the community. Under the scheme, corporations that have creative and innovative ideas on how to reduce water consumption could apply for financial support to carry out those initiatives, which include conducting feasibility studies, doing trials with new water-saving technology, or implementing community-wide water conservation campaigns.

(vi) **10% Challenge.** The 10% Challenge was introduced in 2008 to challenge nondomestic customers to improve their water efficiency and reduce their monthly water consumption by at least 10%.

PUB's practices in managing water demand (including increases in prices of potable water implemented in 1997–2000) and efforts in promoting water conservation have yielded positive results. Per capita domestic water consumption declined steadily from its highest historical level of 175 liters per day registered in 1994, to 156 liters per day in 2008 (Figure 6).

[157] The People's Association is a statutory board that promotes racial harmony and social cohesion in Singapore.

Figure 6 Decline in Per Capita Domestic Water Consumption, 1994–2008



Source: Data collected from PUB Singapore in 2009.

Singapore has targeted to further reduce per capita domestic water consumption to 147 liters per day by 2020 and 140 liters per day by 2030 (Inter-Ministerial Committee on Sustainable Development 2009, 35). To achieve these goals, the city state would further step up public education on water conservation, in line with its commitment to ensure that Singapore uses its energy, water and other resources efficiently.

Wastewater Management

Wastewater management is an integral part of Singapore's water policy and completes the water cycle. When the country obtained independence in 1965, only 45% of its population had access to proper sanitation. A Sewerage Master Plan was developed in the late 1960s to guide the development of used water facilities.

Over the years, Singapore invested substantially in wastewater infrastructure. By 1997, Singapore was fully served by a modern sanitation system (Tan et al. 2009, 183).

Used water is collected through a network of underground sewers that leads to sewage treatment plants, which, in Singapore, are known as Water Reclamation Plants (WRPs) to reflect that used water is a resource to be reclaimed. This used water network is separate from the storm water collection system, which comprises drains that collect and channel storm water and surface runoff to rivers and reservoirs. The separation of the systems prevents used water from polluting

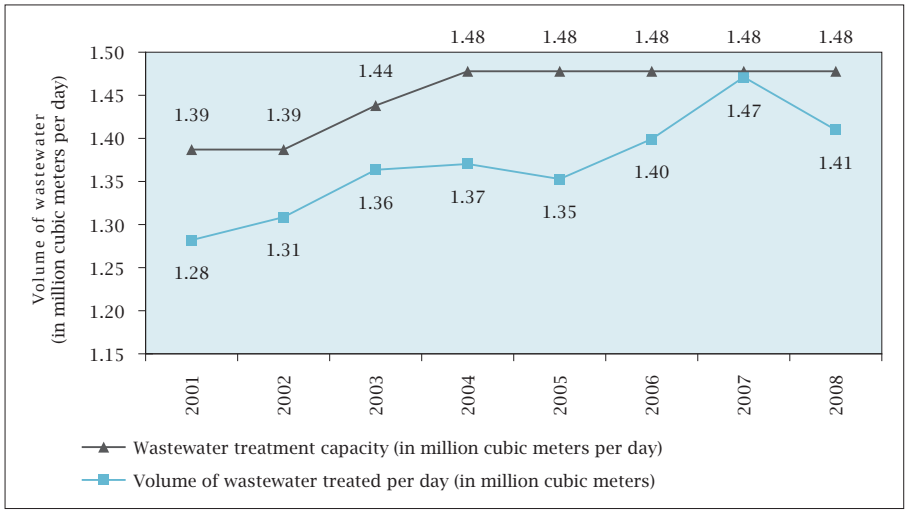
reservoirs and waterways, and stops storm water from entering the used water network and causing overflows.

Legislation and strict enforcement ensure that used water is properly managed and pollution is minimized. The Sewerage and Drainage Act (Chapter 294) governs the provision, operation, and maintenance of the sewerage system. The treatment and discharge of trade effluent into public sewers are regulated by this act and the Sewerage and Drainage (Trade Effluent) Regulations.

It is mandatory for all premises in Singapore to be connected to public sewers where these are available. Developers of housing and industrial estates have to incorporate a central used water facility to collect and convey used water into the public used water system. Proposals for development are scrutinized to ensure that they do not encroach on the public used water system, averting any potential damage to it (Tan et al. 2009, 180).

Used water received at the WRPs is first secondary-treated to international discharge standards. Much of the treated used water is then piped to the NEWater plants as feedwater for NEWater production. NEWater is produced by further purifying treated used water through a three-stage process of microfiltration, reverse osmosis and ultraviolet disinfection. Treated effluent that is not used to produce NEWater to meet demand is discharged into the sea (Tan et al. 2009, 158). In 2008, the total wastewater treatment capacity of the WRPs was 1.48 mcm per day, and the volume of wastewater treated was 1.41 mcm per day (Figure 7).

Figure 7 Wastewater Treatment Capacity and Volume of Wastewater Treated, 2001–2008

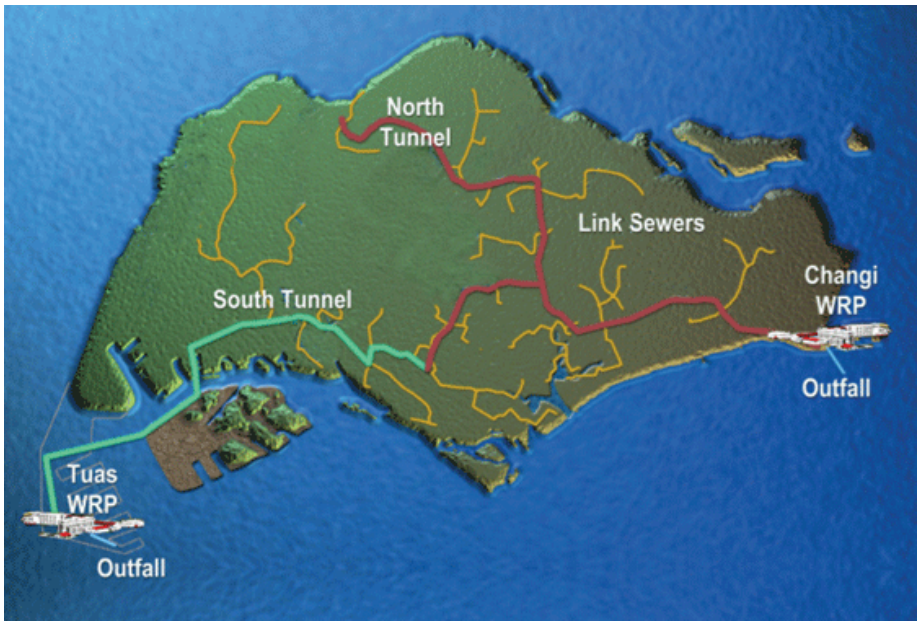


Source: Data collected from PUB Singapore in 2009.

Singapore imposes stringent limits on the physical and chemical characteristics of trade effluent that industries discharge into public sewers. Source control at the industries ensures that used water received at the WRPs, after being treated, provides consistent, good quality secondary-treated effluent for NEWater production. Site surveillance of targeted companies and on-site volatile organic carbon monitoring system at factories, sewer networks, and inlet of WRPs provide early detection of illegal discharge and, therefore, adequate response time for the affected used water to be diverted and treated separately for discharge to the sea instead of being used for NEWater production (Seah et al. 2008).

Although there was already island-wide modern sanitation in Singapore since 1997, the country continued to evaluate the efficiency and cost-effectiveness of its wastewater infrastructure. A Deep Tunnel Sewerage System (DTSS) was conceived as a long-term solution to meet Singapore's needs for used water collection, treatment, and disposal through the 21st century. The plan is to centralize used water treatment at two large WRPs—a new Changi WRP at the eastern end and a proposed Tuas WRP at the western end of the island—using the DTSS. Two large, deep tunnels crisscrossing the island would connect the two WRPs (Figure 8) (Tan et al. 2009, 188). With the DTSS, the other WRPs will be progressively phased out. This will allow the land where these WRPs and pumping stations are located to be freed up for other developments. The centralization of used water treatment at

Figure 8 The Deep Tunnel Sewerage System



Source: Map provided by PUB Singapore in 2010.

two WRPs will also allow for greater economies of scale and is more cost-effective in the long run.

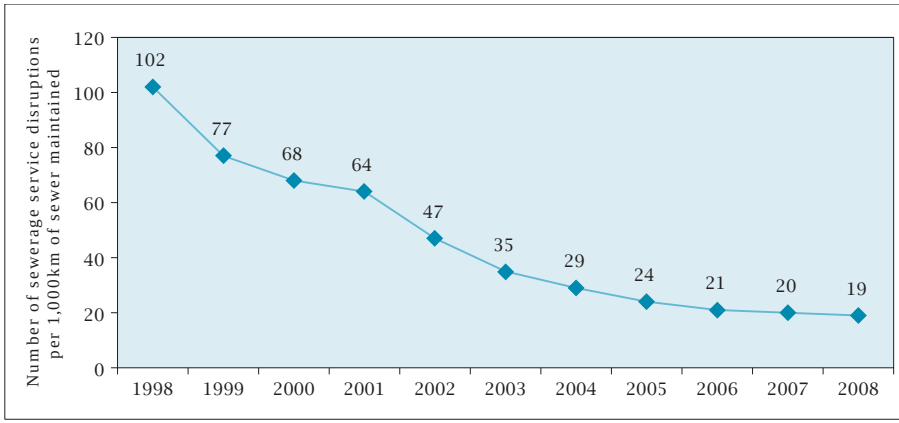
Phase 1 of the DTSS involved the construction of the Changi WRP, a 48 km long deep tunnel that runs from Kranji to Changi (North Tunnel), over 60 km of link sewers and a deep sea outfall, at a total cost of S$3.65 billion. This phase commenced in 2000 and was completed in 2008 (PUB Singapore 2008c; PUB Singapore 2009c). With this, the DTSS diverts used water from the eastern and northern parts of Singapore, by gravity, to the Changi WRP through the network of link sewers and the deep tunnel. Phase 2 is envisaged to be developed before 2030. It will involve the construction of the South Tunnel, a link sewer network, a new WRP at Tuas, and an outfall, located at the southwestern part of Singapore. When this phase is completed, a NEWater plant will be constructed at the Tuas WRP (Tan et al. 2009, 188; PUB Singapore 2010b, 35–36).

The Changi WRP is Singapore's largest water reclamation plant (Figure 9). It sits on only 32 hectares of land, one-third the size of a conventional WRP, and therefore saves land space. It is compact as its treatment tanks are stacked. It can treat 800,000 m^3 (176 million gallons) of used water per day, which is more than half of Singapore's used water (PUB Singapore 2009c). The main process facilities of the

Figure 9 The Changi Water Reclamation Plant

Source: PUB Singapore (2009c).
Photo courtesy of the Public Utilities Board.

Figure 10 Decline in Number of Sewerage Service Disruptions, 1998–2008



Sources: Adapted from PUB Singapore (2008g), p. 11; PUB Singapore (2009g), pp. 8–9.

Changi NEWater Plant were constructed on the rooftop of the Changi WRP, while its storage tanks were built on land. This "plant-on-plant" design saves land costs. It also saves on the cost of laying pipes, as treated used water from the Changi WRP is piped directly to the NEWater plant as feedwater (PUB Singapore 2008a).

PUB regularly rehabilitates aged and leaking public sewers island-wide. This minimizes incidences of leaks from the sewer network contaminating canals, waterways, and the reservoirs. It has also intensified sewer maintenance at choke-prone areas, over the years. The number of disruptions in the sewerage system due to sewer blockages and other sewerage-related issues declined steadily during 1998–2008, reflecting continual improvement in the reliability of Singapore's sewerage network (Figure 10).

Storm Water Management

In Singapore, rainfall is abundant and tends to be intense. This is especially so from mid- November to mid-January, which are the first 2 months of the north–east monsoon period that ends in March. Showers are frequent, heavy, and often coincide with high tides.

Floods were common in the 1950s–1970s, especially at low-lying areas. In 1951, a Joint Committee on Flood Alleviation was established under the Public Works Department, to improve the drainage system. In the 1970s, the Drainage Department in ENV was designated the drainage authority responsible for spearheading and implementing drainage planning and control strategies. In close consultation with the URA, Housing Development Board, Jurong Town Corporation, and other

development agencies, the Drainage Department drew up a comprehensive drainage master plan that guided the provision of drainage systems and set aside drainage reserves for future requirements (Tan et al. 2009, 205 and 209). In 2001, the Drainage Department became a part of the newly constituted PUB. Besides, flood alleviation projects targeted at flood-prone areas were planned. Over the years, careful planning and heavy investments in drainage infrastructure have put widespread flooding a thing of the past in Singapore.

More than S$2 billion were invested in drainage improvement works, over a period of 30 years till 2008 (PUB Singapore 2008d). Investment in drainage infrastructure and comprehensive flood management reduced flood-prone areas in Singapore from 3,178 hectares (ha) in 1970 to 79 ha in 2008. Flood-prone areas were further reduced to 56 ha (or 0.08% of the country's land area) by March 2011 (PUB Singapore 2011c, 61).

One of the most important flood alleviation projects implemented was the Bukit Timah Flood Alleviation Scheme. The Bukit Timah Catchment had a history of flooding, due to the undersized Bukit Timah Canal and Rochor Canal, which were the main outlets for the catchment. The flood alleviation scheme was carried out in two phases. Phase 1 (1966–1972) involved the construction of a new canal to divert storm water away from the Bukit Timah Catchment. During Phase 2 (1986–1991), the Bukit Timah Canal was deepened and widened, and a second diversion canal was built. Several subsidiary drains were also constructed to allow for more efficient drainage of storm water (Tan et al. 2009, 206–208).

A major flood alleviation project completed in the 21st century was the Marina Barrage. Completed in 2008, the Marina Barrage is a 350 meters-wide dam built across the southern end of the Marina Channel (Figure 11).

By damming the mouth of the Marina Channel, the Marina Barrage keeps seawater out and rainwater in, creating the Marina Reservoir—a freshwater reservoir that is Singapore's first reservoir in the city center and its biggest reservoir, with a catchment area of 10,000 ha that can meet about 10% of its water needs (PUB Singapore 2010d). This reservoir was made possible due to a 10-year project to clean up the Kallang Basin and Singapore River. The rivers and canals in the vicinity used to be highly polluted as a result of nearby farms, industries, markets, port activities, squatters, street hawkers, and a lack of sewage facilities. The clean-up was completed in 1987 (Tan et al. 2009, 67–75).

Not only is the Marina Barrage an urban solution to increase the country's water supply, it also serves two other functions. Aside from being a flood control mechanism, it also keeps the water level constant, providing a suitable venue for water-based activities. This three-in-one infrastructure is an excellent illustration of Singapore's integrated approach to water management.

Figure 11 The Marina Barrage

The Marina Bridge spans the Marina Channel and allows visitors to walk across both reservoir and sea all at once. The nine crest gates are housed under the Marina Bridge.

Aerial view of Marina Barrage.
Source: PUB Singapore.

As a flood control mechanism, the Marina Barrage acts as a tidal barrier, keeping seawater out during periods of high tide and alleviating flash floods in low-lying areas of the city. It has nine crest gates, which are lowered to release excess water from the reservoir into the sea when it rains heavily during low tide. If a storm coincides with high tide, seven drainage pumps are activated to flush excess storm water into the sea.

The Marina Barrage has won various awards, including the Grand Conceptor award—the grand prize—at the American Council of Engineering Companies of Massachusetts' 2009 Engineering Excellence Awards; and the Superior Achievement Award—the highest honor—at the American Academy of Environmental

Engineers (AAEE)'s Excellence in Environmental Engineering Competition in 2009 (PUB Singapore 2009b).

Although flood-prone areas have been reduced significantly in Singapore over the years, localized flash floods can still occur when rainfalls are extraordinarily intense and prolonged, as well as due to bottlenecks in the local drainage systems, inherent low-lying nature of certain areas, and obstructions in drainage outlets.

To further cut flood-prone areas, PUB continues to build and upgrade drainages in its ongoing drainage improvement program, while balancing with the need for Singapore to have enough land and resources for other development purposes. PUB has also made use of technology and other measures to provide additional flood protection and further alleviate and prevent flooding. These efforts include

(i) conducting regular site inspection and maintenance to ensure that drains are not choked,

(ii) reviewing rainfall patterns to assess the impact and action needed,

(iii) widening and deepening drainage networks (such as projects to widen and deepen the canals in the Bukit Timah area),

(iv) installing water level sensor systems along major drains and canals to provide early warning of potential flooding,

(v) working with other government agencies and private developers to provide sufficient drainage infrastructure for new developments,

(vi) putting in place a revised Code of Practice on Surface Water Drainage that stipulates stricter drainage requirements, including minimum platform and crest levels for buildings and entrances to underground facilities (such as basement carparks and underground mass rapid transit stations),

(vii) helping owners of older buildings to adopt flood protection measures (such as installing flood barriers and ramps at basements),

(viii) elevating road and building plinth levels (especially in low-lying areas) to enhance flood protection, and

(ix) adopting design features (such as rain gardens and bio-retention swales) that retain rainwater at where it falls to slow down the flow of rainwater.

PUB has also tapped the 24-hour closed-circuit television (CCTV) system of the Land Transport Authority (LTA) to keep track of potential flooding. The system consists of cameras installed at expressways, major road junctions and road tunnels in Singapore, and is used by LTA to monitor traffic flow. With PUB's initiative, over 560 locations island-wide with installed cameras are also being watched for floods. Flood alerts are sent out to motorists through the Expressway Monitoring and Advisory System (EMAS) (PUB Singapore 2008d).

The ABC Waters Program

Prior to 2004, access to water catchment areas in Singapore was restricted. Thereafter, PUB began to allow the public to use its reservoirs for water-related activities organized by selected associations. This was followed by the launch of PUB's Active, Beautiful, Clean Waters (ABC Waters) Program in 2006.

The 20-year program aims to transform Singapore's reservoirs and waterways beyond their functional uses—into beautiful and clean streams, rivers, and lakes—creating new community spaces for recreation and injecting vibrancy into the country's reservoirs and waterways. To encourage the public to have a closer relationship with water, PUB works with organizations such as the People's Association, Singapore Canoe Federation, Singapore Dragon Boat Association, Singapore Sailing Federation, schools, and community organizations to organize water-related activities at reservoirs. PUB hopes that when people interact with water, they can learn to appreciate, value, and conserve water, and learn to keep water catchments and waterways clean. The program is in line with Singapore's vision to be a city of gardens and water.

PUB's approach—engaging the community to achieve policy objectives—is reflected in its vision: *Water for All: Conserve, Value, Enjoy*. This strong emphasis on community engagement, making it an important component of integrated water management, is less common in other countries near Singapore.

Under the ABC Waters Program, projects have been completed at Kolam Ayer, Bedok Reservoir, MacRitchie Reservoir, Marina Barrage, and Bishan Park, transforming these areas into vibrant recreational venues for the community. Other projects have also commenced or will be carried out in phases (PUB Singapore 2009e).

Private Sector Participation

PUB encourages competitive involvement of the private sector in delivering its services. It adopts the "best sourcing" approach for procurement as part of its "Price-Minus" strategy to lower the cost of water supply through open competition. "Best sourcing" also helps PUB enhance production efficiency and improve service quality. In PUB, there is a Best Sourcing department, which undertakes the procurement task of the private sector's services for developing new and upgrading existing water, used water, and drainage infrastructure. The "Price-Minus" strategy, which PUB adopted since 2004, is not about cutting cost for the short term. It is about creating value and ensuring sustainability in Singapore's water resources in the most cost-effective manner.

For instance, PUB outsourced some of its large infrastructure projects through public–private partnerships (PPPs). The SingSpring Desalination Plant was PUB's first PPP project. Constructed at a cost of S$200 million, it was developed under a design-build-own-operate (DBOO) arrangement with a Singapore company, the SingSpring Pte Ltd. This company designed and constructed the plant, and will own and operate it to supply desalinated water to PUB for 20 years.

Similarly, the design, construction, operation, and maintenance of the Ulu Pandan and Changi NEWater plants were undertaken by the private sector, under DBOO agreements.[158] This was also the chosen approach for Singapore's second desalination plant targeted to be completed in 2013.[159] In these cases, local and international water companies were invited to submit bids in an open tender. The most competitive bid, which had to meet technical requirements and performance standards stipulated by PUB, was selected among the bids received. The DBOO arrangements enabled PUB to leverage on the expertise of the private sector to keep production capacity at the leading edge and at low cost. The arrangements also enabled PUB to purchase of NEWater and desalinated water from the plant's operator at a competitive price, making it possible for PUB to levy a lower-than-expected water tariff.

Customer Satisfaction

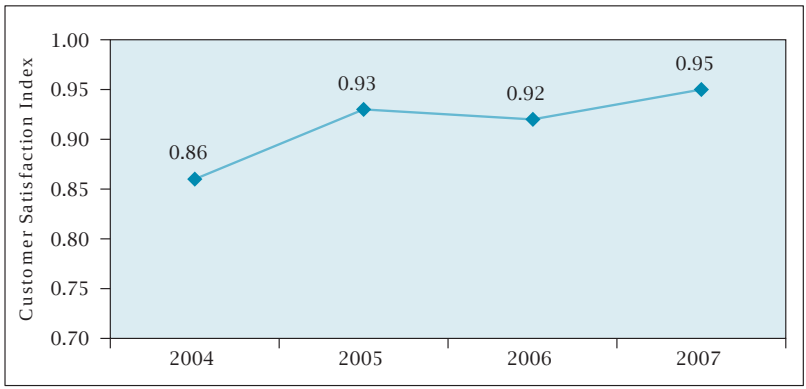
PUB places strong emphasis on delivering customer satisfaction. To measure the satisfaction of customers who have used PUB's services, its employees give out feedback forms, which customers can complete and post them back to PUB. In the form, customers are asked to rate PUB on the quality of its service, and to provide feedback and suggestions for improvement. A Customer Satisfaction Index is then computed based on the ratings. Data from 2004 to 2007 show an improvement in customer satisfaction, with an index of 0.95 achieved in 2007 (Figure 12).

Customers can also contact PUB directly to provide feedback. In August 2002, PUB implemented PUB-One, an initiative that brought together the handling of reports or feedback on water supply services, sewerage, and drainage at a single point of contact. The 24-hour contact center, which operates 7-days-a-week throughout the year, is manned by PUB staff. The initiative frees customers the trouble of having

[158] The Ulu Pandan and Changi NEWater plants were developed under DBOO arrangements with two Singapore water companies. The Keppel Seghers NEWater Development Company Pte Ltd. designed and constructed the Ulu Pandan plant and will own and operate it for 20 years. Sembcorp NEWater Pte Ltd. designed and constructed the Changi plant and will own and operate it for 25 years.

[159] The second desalination plant is developed by Hyflux Ltd. Through its wholly owned subsidiary, Tuaspring Pte Ltd., Hyflux will own and operate the plant, and will supply desalinated water to PUB for 25 years.

Figure 12 Customer Satisfaction Index, 2004–2007



Note: The Customer Satisfaction Index is on a scale of 0–1.
Source: Data collected from PUB Singapore in 2009.

Table 4 Key Service Standards for General Feedback

Channel	Service Standards
PUB hotline	90% of calls answered within 10 seconds
Emails	3 working days
Customer feedback forms, mails/faxes	5 working days

PUB = Public Utilities Board.
Source: Adapted from PUB Singapore (2008h), p. 21.

to call different hotlines to give feedback on different kinds of services and, therefore, enhances service quality and efficiency.

Through PUB-One, customers can contact PUB through six channels, namely a 24-hour toll-free telephone line, fax, email, short message service (SMS), web chat, and voice-over-Internet Protocol (VoIP). The multiple channels increase the contact center's accessibility. PUB also sets well-defined service standards for responding to feedback (Table 4).

Financial Resource Management

PUB has performed well in terms of managing its operating revenue and expenses. Its annual operating revenue increased during 1996–2008, reaching S$932.9 million in FY2008 (Table 5). Increases in the tariffs of potable water, implemented in 1997–2000, contributed to increases in operating revenue in those years. PUB has not raised potable water tariffs since the last revision in 2000.

Table 5 Financial Performance, FY1996–FY2008

In S$ million	1996	1997	1998	1999	2000	2001[a]	2002[b]	2003	2004	2005[c]	2006[d]	2007	2008
Operating revenue	403.9	435.6	462.0	490.8	540.3	547.1	548.2	542.4	549.2	703.5	1082.0	901.9	932.9
Operating expenses	(252.5)	(259.0)	(263.4)	(262.1)	(290.0)	(428.2)	(499.7)	(522.3)	(500.3)	(565.9)	(814.0)	(769.3)	(799.2)
Operating surplus[e]	151.4	176.6	198.6	228.7	250.3	119.0	48.5	20.1	48.9	137.6	268.1	132.6	133.7
Non-operating surplus	107.7	35.6	64.2	60.4	47.6	35.0	9.2	87.5	97.2	39.6	62.4	167.1	22.4
Operating grants[f]	0	0	0	0	0	120.3	176.1	172.6	167.5	119.9	99.8	90.2	180.4
Financing expenses	0	0	0	0	0	0	0	0	0	(3.5)	(55.6)	(74.6)	(85.4)
Surplus before contribution to GCF and tax[g]	259.1	212.3	262.8	289.2	297.9	274.2	233.7	280.2	313.7	293.5	374.6	315.4	251.1
Contribution to GCF and tax[g]	(51.8)	(42.5)	(52.6)	(57.8)	(59.6)	(67.2)	(52.4)	(61.6)	(62.7)	(58.9)	(74.8)	(56.2)	(45.0)
Surplus after contribution to GCF and tax[g]	207.3	169.8	210.2	231.3	238.3	207.0	181.3	218.6	251.0	234.6	299.7	259.2	206.1
Operating ratio[h]	0.63	0.59	0.57	0.53	0.54	0.78	0.91	0.96	0.91	0.80	0.75	0.85	0.86

( ) = negative, GCF = Government Consolidated Fund, PUB = Public Utilities Board.

Notes:

[a] On 1 April 2001, PUB's regulatory functions for the electricity and piped gas industries were transferred to the Energy Market Authority of Singapore, while the used water and drainage functions of ENV were transferred to PUB. The development and operating expenditure of the used water and drainage operations continue to be funded by the Government of Singapore.

[b] From 2002 onward, the accounts of PUB's wholly owned subsidiary, PUB Consultants Pte Ltd, are consolidated with PUB's accounts.

[c] On 1 July 2005, PUB took over the used water business from the government. Since then, used water revenue accrues to PUB to fund the used water operation. The government continued to fund the development expenditure for used water reticulation network, the Deep Tunnel Sewerage System, and certain operating expenses for used water operation.

[d] The financial year (until FY2005) started on 1 January and ended on 31 December. FY2006 was a 15-month financial period from 1 January 2006 to 31 March 2007. It was a transition period to effect the change of the financial year to begin on 1 April (previously 1 January). Subsequent financial years begin on 1 April and end on 31 March. This is to align with the government's financial period.

[e] Operating surplus refers to operating revenue minus operating expenses.

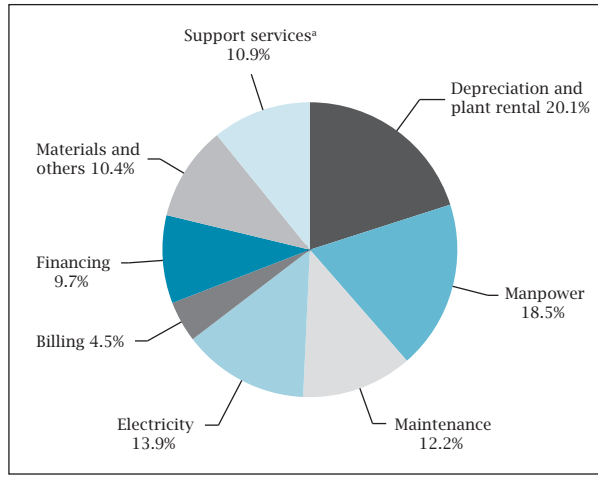
[f] Operating grants are grants received from the government for the maintenance and supervision of construction of government assets or projects approved by the government, such as drainage facilities.

[g] Contribution to Government Consolidated Fund ("GCF") and Corporate Tax ("Tax") were revised from 20% to 18% from FY2007 onward.

[h] Operating ratio refers to operating expenses expressed as a proportion of operating revenue.

Sources: Adapted from PUB Singapore (1998), p. 49; PUB Singapore (2007c), p. 43; PUB Singapore (2008g), p. 13; PUB Singapore (2009g), p. 2 and pp. 10–11.

Figure 13 Distribution of Expenses, FY2008



	S$ million	%
Depreciation and plant rental	177.4	20.1
Manpower	163.8	18.5
Maintenance	107.6	12.2
Electricity	122.8	13.9
Billing	39.8	4.5
Financing	85.4	9.7
Materials and others	91.8	10.4
Support services[a]	96.0	10.9
Total	884.6	100.0

[a] Costs for support services comprise manpower, depreciation, maintenance, administrative, and other expenses of service departments, such as Human Resources, Finance, Internal Audit, Best Sourcing, Policy and Planning, and Corporate Development departments.

Source: Adapted from PUB Singapore (2009g), pp. 4–5.

Annual operating expenses increased during 1996–2008, due to increases in the number and scope of activities and projects that PUB carried out. However, PUB has managed its expenses well. It posted a surplus after taxation and contributing to the Government Consolidated Fund in each of the years. Operating ratio has been in the area of 0.85 in recent years.

Costs of depreciation and plant rental accounted for the largest proportion (20.1%) of total expenses[160] in FY2008 (Figure 13). This was followed by manpower costs,

[160] Total expenses comprise operating and financing expenses.

which amounted to 18.5% of total expenses, as it was important for PUB to pay competitive remuneration packages to attract, motivate, and retain staff.[161] Electricity costs, which were influenced by world energy prices, constituted the third largest share of total expenses.

Water, NEWater, and used water are capital-intensive operations requiring significant capital outlay. Investments in assets belonging to the Government of Singapore are government-funded, and these assets comprise used water and drainage infrastructure. On the other hand, assets belonging to PUB basically pertain to water supply, and investments in these assets are largely financed by PUB's accumulated surplus. In FY2008, PUB invested S$809.7 million in plant and equipment (Table 6). Of this amount, S$510 million was for water, NEWater, and used water reclamation projects funded by and belonging to PUB. The remaining S$299.7 million was for used water reticulation network, drainage, and the Changi WRP projects. These assets were funded by and belonged to the government (PUB Singapore 2009g, 5–6).

PUB has also achieved high bill collection efficiency. SP Services is its billing agent. Revenue collection efficiency (expressed as a percentage of annual billings) has been close to 100% (Table 7). Monthly bill collection efficiency in terms of days of

Table 6 Capital Expenditure, FY1998–FY2008

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
PUB funded (in S$ million)	114.7	199.6	146.9	134.0	193.1	307.9	154.9	113.5	178.8	284.6	510.0
Government funded[a] (in S$ million)	0	0	0	352.7	666.4	815.5	883.2	777.5	773.5	370.2	299.7
Total (in S$ million)	114.7	199.6	146.9	486.7	859.5	1,123.4	1,038.1	891.0	952.3	654.8	809.7

[a] Government-funded capital expenditure is for assets belonging to the Government of Singapore.

Sources: Adapted from PUB Singapore (2008g), p. 11; PUB Singapore (2009g), pp. 8–9.

Table 7 Revenue Collection Efficiency, 1990–2008

	1990	1995	2000	2005	2008
Revenue collection efficiency (in %)	100.0	100.0	100.0	99.9	99.8

Note: Revenue collection efficiency refers to annual collections expressed as a percentage of annual billings for potable water consumption.

Source: Data collected from PUB Singapore in 2009.

[161] Manpower, depreciation, maintenance, administrative, and other expenses of service departments (Human Resources, Finance, Internal Audit, Best Sourcing, Policy and Planning, and Corporate Development) are accounted for in a separate category known as "Support Services," as shown in Figure 13.

Table 8 Monthly Bill Collection Efficiency, 2004–2008

	2004	2005	2006	2007	2008
Monthly bill collection efficiency (days of sales outstanding)	35	33	32	32	28

Note: Monthly bill collection efficiency (days of sales outstanding) refers to the time taken to collect bills.

Sources: Adapted from the Ministry of the Environment and Water Resources, *Key Environmental Statistics*, various issues.

sales outstanding has improved to only 28 days in 2008 (Table 8). This shows that bills are collected quickly and efficiently.

Human Resource Management

PUB has good human resource policies that enable it to attract, nurture, and retain talent so that it has capable staff to carry out its responsibilities efficiently.

Staff salaries at PUB are benchmarked against the salaries in the Singapore Civil Service, which are in turn benchmarked against the remuneration packages of the private sector. Competitive remuneration packages help PUB attract and retain capable employees and lower corruption possibilities. In 2004, PUB moved from a fixed salary scheme to a performance-based salary structure that rewards better performers with higher salary increments and bonuses. Moreover, promotions are based on work performance and potential, further motivating staff to perform.

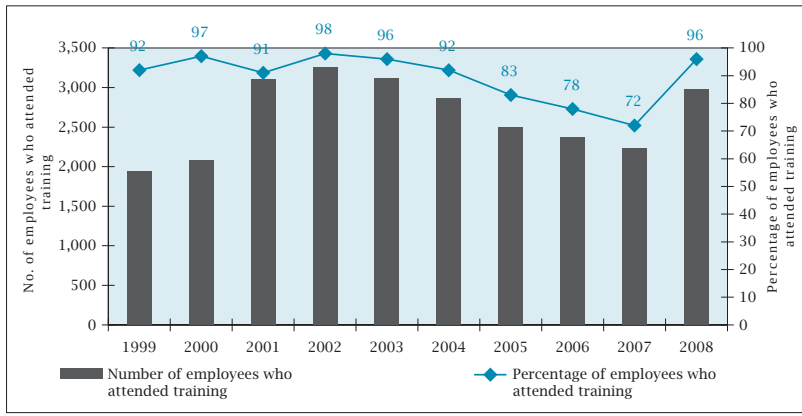
PUB has programs to identify and develop employees' talents. It sponsors its staff to further upgrade their skills, through postgraduate studies, leadership programs, and other courses. In 2008, 2,978 staff (96%) attended training (Figure 14). Of PUB's annual payroll, 3.1%–4% was spent on training in 1999–2008. Employees are also given exposure through challenging assignments such as overseas attachment and attachment to other organizations that allow them to develop their potential.

Due to its comprehensive human resource policies, PUB has been successful in attracting and retaining talent. Its resignation rate of 1.2% in 2007 was relatively low compared to the rates of other public sector organizations (mean of 7.2%–11.9% in 2007) in Singapore.[162]

To nurture the next generation of water leaders, PUB offers scholarships to students who have strong academic achievements and a passion for the environment, to pursue university studies in water-related and other relevant fields. In essence, good human resource policies enhance sustainability in human capital at PUB.

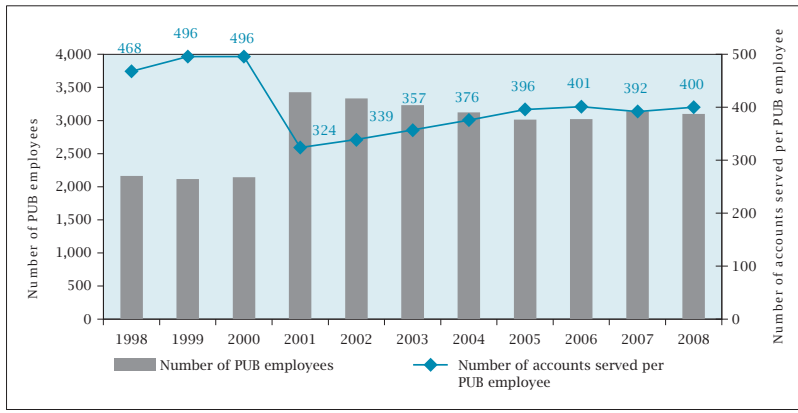
[162] Information was kindly provided by PUB's Human Resource Department.

Figure 14 Number and Percentage of Employees Who Attended Training, 1999–2008



Source: Data collected from PUB Singapore in 2009.

Figure 15 Number of Accounts Served Per Employee, FY1998–FY2008



PUB = Public Utilities Board.

Notes: Figures are as of end of each financial year. Number of accounts refers to the number of customer accounts for potable water and NEWater. In 2001, the Sewerage and Drainage Departments of the Ministry of the Environment were combined with the PUB Water Department to form the newly constituted PUB, resulting in a large decline in the number of accounts served per PUB employee. Thus, data before 2001 are not comparable.

Sources: Adapted from PUB Singapore (2008g), p. 11; PUB Singapore (2009g), pp. 8–9.

Staff productivity could be reflected by the number of accounts served per employee, which increased steadily during FY2001–FY2008 (Figure 15). In FY2008, each employee served 400 accounts, or there were 2.5 staff per 1,000 customer accounts.[163]

[163] The number of accounts served per PUB employee reached 414 in FY2010 (PUB Singapore 2011c, p. 61).

Lessons

In summary, the Singapore experience in urban water management offers several lessons for other cities, as follows:

(i) **Political and government commitment.** Strong political and government commitment is essential for a country or city to be sustainable in water. The Government of Singapore gave the water issue high priority—at the whole-of-government level. Without high commitment from its leaders to put water and sanitation high on the country's agenda, Singapore would not have been able to build infrastructures such as the Marina Barrage and DTSS, nor develop the NEWater, which required heavy investments. Only with high commitment will a country or city be able to invest in the infrastructure and technology needed to achieve sustainability in water supply.

(ii) **Integrated water management.** Singapore addresses both supply and demand aspects of water management. Its holistic approach to water management facilitates sound decisions and is an excellent success story in integrated water management.

(iii) **Public sector ownership of a utility can work.** PUB is an outstanding example of a successful public sector-owned utility that, with a high degree of autonomy, is efficient and has effectively tapped the expertise of the business sector. PPPs have enhanced production efficiency, and helped PUB lower cost and improve service quality. The Singapore example shows that a public sector-owned water utility, with a high degree of autonomy to carry out its role, can be as efficient as a private organization. At the same time, PPPs create business opportunities for the private sector and help the water industry to grow. PUB's experience shows that the utility, the users of its services, and its private sector partners can benefit from PPPs that are structured properly.

(iv) **Pricing water for efficiency and sustainability.** In many countries, water use is inefficient due to weak infrastructure and distorted incentives for water consumption. Singapore has overcome such inefficiency by making heavy investments in infrastructure, making its people pay for every drop of water consumed, and setting the price of water at a level that recovers costs. At the same time, it is important to make water affordable, as practiced in Singapore.

(v) **Making smart investment in technology and research and development.** PUB has applied advanced technology to increase water supply, improve water quality, and lower production and management costs. NEWater and desalinated water are the results of PUB's continued investments in water technologies and R&D. In particular, the success of NEWater, which clinched the *Environmental Contribution of the Year* award at the Global Water Awards 2008 organized by Global Water Intelligence (PUB Singapore 2008b), shows

that high-quality reclaimed water can be produced economically for human consumption and nondomestic use. Used water need not be wasted—it could be treated, reclaimed, and reused on an extensive scale to multiply water supply and enhance self-sufficiency in water. Singapore's water reuse technology could help solve the need for high-quality water for industrial uses in countries around the world.

(vi) **Attracting and retaining talent to manage utility.** Good human resource policies need to be put in place to attract, nurture, and retain talent so that the utility will have capable staff to carry out its role.

(vii) **Engaging the community.** The Singapore experience also shows that policy makers should actively engage the public to achieve policy objectives. Before PUB launched NEWater, it implemented an extensive, well-timed, and properly coordinated public education campaign, which emphasized on the high quality of NEWater and Singapore's survival. PUB's efforts shaped positive perceptions toward NEWater, and helped the government obtain the public's buy-in to drinking reclaimed water. This is an important lesson for other countries, which intend to introduce treated used water into their water supply.

Moreover, Singapore's approach of using reservoirs to serve as recreational and community spaces—for people to enjoy recreational activities—offers another lesson for other countries. By bringing the public closer to water, it creates a sense of ownership, and helps to educate people to conserve and value water as they enjoy water.

Although PUB is responsible for managing Singapore's water supply, water catchment, and sewerage, the active involvement of the people, private and public sectors (which PUB calls its 3P network or partners) creates greater awareness of the importance of conserving and valuing water, develops a sense of shared ownership of Singapore's water resources, and plays an essential part in the country's achievement in urban water management.

Challenges

Singapore expects its water demand to double by 2060 due to increases in population and commercial activities. About 70% of the demand was projected to come from the nondomestic sector, with domestic consumption making up the remaining 30% (PUB Singapore 2010b, 3). Used water and seawater are available to be transformed into NEWater and desalinated water, respectively, which could help meet Singapore's long-term water needs, giving the city state enhanced water security. Moreover, both sources are not subject to fluctuations based on the amount of rainfall, unlike local catchment water. The production of NEWater and desalinated water could be increased to supplement local water stocks during extended dry spells, thereby enhancing the reliability of Singapore's water supply.

However, they are more energy-intensive than conventional water sources—a challenge that Singapore faces. Energy efficiency needs to be improved going forward. If not, higher costs of water production could lead to higher water tariffs.

To improve energy efficiency, Singapore is exploring alternatives such as membrane distillation and a variable salinity plant, which can treat either freshwater or seawater into drinking water. It had awarded about $2.7 million worth of R&D funds to Siemens Water Technologies to do research and come up with innovations in desalinating seawater that are at least 50% more energy-efficient than current technologies, and test-bed the new desalination concept in Singapore. It had also piloted a study to look into the use of the Upflow Anaerobic Sludge Blanket (UASB) technology in wastewater treatment at its plants.[164] The UASB technology potentially uses 30%–40% less energy than conventional aerobic treatment systems (Ibrahim 2009).

Although Singapore's achievement in water management is outstanding, it is also seeking to further optimize its water management through lowering capital and operating costs; optimizing the use of labor, technology, and other resources; and further enhancing water quality. Moreover, PUB has adopted a four-pronged approach to meet the challenges of climate change, as follows:

(i) putting in place a robust water supply with two weather-resilient sources (NEWater and desalinated water), as earlier discussed;

(ii) working with other agencies to monitor the sea-level and rainfall trends to develop appropriate measures to deal with future flooding risks;

(iii) continuously investing in R&D to develop capabilities and innovative solutions; and

(iv) working closely with other governments and industry partners to help bring water solutions to Asia and the world (PUB Singapore 2010b, 18).

This proactive approach that Singapore adopts in dealing with challenges—in the past and into the future—is certainly an important factor in its success in water management.

[164] The UASB technology was pioneered by Prof. Gatze Lettinga, who became the second recipient of the Lee Kuan Yew Water Prize in 2009.

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CHAPTER X

Gearing for the Future: A Framework for Success

Kallidaikurichi Seetharam, Anand Chiplunkar, Cheon Kheong Tan, and Anand Madhavan[165]

A Cross-Utility Comparison

The cities studied in this research initiative were selected from wide-ranging contexts—Jamshedpur and Colombo from South Asia; Shenzhen from East Asia; and Bangkok, Kuala Lumpur, Manila, Phnom Penh, and Singapore from Southeast Asia. The objective was to reflect the striking socioeconomic diversity across Asian cities. The cities were selected to offer insights on utilities functioning under different governance systems—public or private—and from cities whose experiences would serve as useful lessons for developing Asian cities. The utilities in four of the cities selected (namely, Bangkok, Colombo, Phnom Penh, and Singapore) are government-owned, while those in the other four cities (Jamshedpur, Kuala Lumpur, Manila, and Shenzhen) are private entities or joint ventures between the government and the private sector.

Table 1 of Chapter I provides highlights of the key indicators in water management in the eight cities and nine water utilities analyzed in this book. In this chapter, we first compare the performance of the utilities covered. We then attempt to develop a framework to define a set of good practices for wider adoption and replication across Asia and in areas of similar contexts worldwide.

Coverage

The utilities continue to pursue the goal of providing a safe piped water supply to every individual in their areas of responsibility. Several of the utilities achieved a high level of coverage despite significant increases in areas to be managed and in population served.

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- During 2001–2008, the Phnom Penh Water Supply Authority (PPWSA) expanded its services to new areas, including the suburbs of Phnom Penh, and the number of connections grew by 138% during this period.
- During 1998–2008, the Manila Water Company Inc. (MWCI) more than doubled the number of household connections—from 311,000 to 641,000. This was accomplished as part of a growth strategy to expand into more densely populated new areas and aggressively connect households to generate more revenue.
- During 1998–2008, the National Water Supply and Drainage Board (NWSDB) in Colombo improved its population coverage from 77% to 92%, and increased its water connections by 120%, even as its service area grew by 144 km^2 and the population in the area doubled from 1.6 million to 3.2 million.
- From 1998 to 2008, the service area covered by the Metropolitan Waterworks Authority (MWA) in Bangkok increased from 35% to 70% of its area of responsibility comprising Bangkok, Nonthaburi, and Samut Prakan. With a corresponding 23% increase in population coverage from 6.4 million to 7.8 million, MWA increased its population coverage to 99% of its area of responsibility.

These examples show that expanding safe and reliable water access to 100% of the population and piped water supply access to over 90% of the area of responsibility are achievable goals.

Availability

There also appears to be a unanimous preference toward providing pressurized, continuous water supply as the default mode of service delivery. Several of these utilities have achieved this transformation in the last decade only, but this still shows that 24-hour, 7-days-a-week water supply is achievable by utilities in developing countries.

Besides being efficient and reliable, most utilities recognize the positive impacts of water quality (such as good health) that can be provided by continuous water supply. Even in Jamshedpur, where water supply was available only for about 7 hours daily in FY2009, nearly 25% of its population already had continuous supply, and there are plans to provide the entire city with continuous water supply in the next few years.

Providing pressurized, 24-hour, 7-days-a-week water supply is clearly achievable by utilities in developing countries, but it needs to be backed by tariff reform and comprehensive metering to be sustainable.

Metering

Almost all utilities covered in the study have achieved or are moving toward universal metering.

- Phnom Penh moved from 12.6% metered connections in 1993 to 100% metered connections in 2001.
- In Jamshedpur, the Jamshedpur Utilities and Services Company Limited (JUSCO) increased its metered connections from 1.8% in FY2007 to 26.4% in FY2009.
- Singapore's efforts at adopting 100% metering and demand management measures (including tariffs) have led to a decline in per capita domestic water consumption from 175 liters per capita per day (lpcd) in 1994 to 156 lpcd in 2008. Singapore has targeted to further reduce per capita domestic consumption to 140 lpcd by 2030.

Universal metering appears to go hand-in-hand with pressurized, continuous water supply and facilitates demand management.

Management of Unaccounted-for-Water and Nonrevenue Water

Phnom Penh's success in managing unaccounted-for-water (UFW), with just about 6% water losses in 2008, is comparable with that of Singapore and demolishes the myth that good practices of reducing UFW levels are impossible to achieve in developing countries. JUSCO has also achieved a remarkable reduction in nonrevenue water (NRW)—from 36% to less than 10%—over a very short period of 4 years. However, there are significant variations in the levels of loss reduction, with loss levels still hovering in the range of 30% or more in Bangkok, Colombo, Kuala Lumpur, and the West concession zone of Manila.

This is an important area for improvement for most water utilities in developing countries in Asia (including several of the utilities covered in this study). As Singapore has demonstrated, this is an area that requires continuous improvement and monitoring to achieve better results. Reducing UFW should be a continuous target and is an area for improvement among Asian utilities. An UFW level of less than 20% is a realizable goal.

Cost Recovery

Financial sustainability and sustained service delivery go hand-in-hand. Thus, it is vital for utilities to have healthy revenue streams and to diligently manage their costs.

The operating ratios of all the nine utilities studied are between 0.4 and 1.0. An operating ratio of less than 1.0 indicates that the utility can at least cover its operation and maintenance costs. It is vital that a utility keep its operating ratio low to ensure its financial viability in the long run.

Utilities can implement various measures to generate revenue to cover operation and maintenance costs, with excess for capital expenditure. These include (i) reducing UFW so that the bulk of the water produced is not lost and can be sold, (ii) setting water tariffs at a level sufficient to recover costs but keeping tariffs affordable, (iii) keeping an updated database of all customers so that bills can be generated and delivered promptly to all customers and subsidies could be targeted at needy households, and (iv) improving revenue collection efficiency with incentives for timely bill payments and penalties for late payments.

The success of many of the utilities studied indicates that it is critical for tariff reforms to move forward. However, the inability to implement user charge reforms continues to inhibit the expansion and provision of full water access in large parts of Asia, particularly in South Asia.

Experiences in Jamshedpur, Manila, and Phnom Penh provide useful pointers to overcome this challenge. Phnom Penh managed to push through tariff reform along with improved services, while JUSCO used an innovative shared investment program (a people–private partnership) to provide access to the erstwhile unconnected, poorer households in Jamshedpur. A number of mechanisms, including connection fee subsidies in Phnom Penh, direct household-level subsidies in Singapore, and output-based aid for connections by the MWCI can be adopted by water utilities to balance financial sustainability and the need to address the requirements of the urban poor in a targeted manner.

These instances reinforce that (i) the poor are often more willing to pay for better water and sanitation services than what political leaders are willing to charge, and (ii) the poor suffer more than the rich when public utilities are unable to fund expansion programs as their coping costs are substantially higher.

Financial sustainability need not necessarily conflict with addressing the needs of the urban poor. There are innovative mechanisms to address both of these goals, as illustrated in this book.

Revenue Collection Efficiency

Seven of the nine utilities have a revenue collection efficiency of at least 96%. This is a result of their efforts to collect water bills through incentives and penalties.

For instance in Bangkok, MWA imposes stringent penalties for late payments and offers several, convenient payment channels, such as payment at numerous post

offices and through bank account deductions (including via the internet, telephone, and mobile phone). These measures have helped improve collection efficiency.

Staff Productivity

Some utilities have improved staff productivity over time. Below are some examples:

- In Bangkok, the number of MWA staff per 1,000 connections declined from 4.0 in 1998 to 2.2 in 2008.
- In Colombo, the number of NWSDB staff per 1,000 connections decreased from 4.5 in 1998 to 3.9 in 2008.
- In Phnom Penh, PPWSA lowered its staff per 1,000 connections significantly from 22.2 in 1993 to 3.3 in 2008.

PPWSA does not outsource activities to the private sector. On the other hand, the utilities in some cities (e.g., Bangkok, Colombo, Jamshedpur, Manila, and Singapore) have outsourced activities to the private sector to enhance operational efficiency. Outsourcing has enabled these utilities to tap the expertise of the private sector, service more connections using fewer employees than when all activities are in-house, and reduce staff costs (as compared with no outsourcing) thereby contributing to their financial performance.

Sanitation

Although the Asian utilities covered have made remarkable strides in the provision of access to safe drinking water, many of them still have a long way to go to address sanitation issues comprehensively.

Singapore's approach to integrated water management is instructive. Its water authority, the Public Utilities Board (PUB), manages water supply, water catchment, and sewerage in an integrated and holistic manner, which also extends to institutional coordination and cooperation with the Urban Redevelopment Authority (URA) and the National Parks Board (NParks). Several other utilities recognize the need for integrated water management and have begun to take steps toward "closing the loop," but there is some way for them to catch up. There is a growing recognition among these Asian utilities of the need to bridge sanitation gaps. This recognition should be translated into visible action on priority.

Demand for water and wastewater services will continue to increase in urban centers in Asia that are developing rapidly. If services in these cities do not keep pace with economic development, the cities will face a number of difficult issues, such as deteriorating environmental conditions due to pollution and increased extraction of groundwater.

Conceptually, there is no reason why urban centers cannot make rapid progress in improving water and wastewater services. Knowledge, experience, and technology have been available for years, so the availability of these (or lack thereof) is not the core issue. Unavailability of funds is also not an insurmountable issue, as the private sector, along with donors, can provide the necessary financing to utilities that are committed to improving services. The constraints are mostly institutional and governance-related issues, including regular political interference in the work of water utilities (Biswas and Tortajada 2009). This can be corrected if there is political will to do so.

Decoding Good Practices: A Success Framework for Replication

No one single model of urban water management will be suitable for all urban areas. Cities are not homogenous and are at different stages of economic, social, legal, and institutional development. In addition, climate conditions may vary from one city to another, even within a single medium-to-large country, and the availability of water infrastructure is seldom similar. Under these conditions, there is no question that one size does not fit all, and a solution-in-search-of-a-problem approach will mostly fail (Biswas and Tortajada 2009).

Rather, this book has focused on a few crosscutting good practice themes culled from insights provided by the eight highlighted case studies. Figure 1 presents the success framework as a way to conceptualize seven universal themes for possible replication by water utilities in Asia and in the developing world.

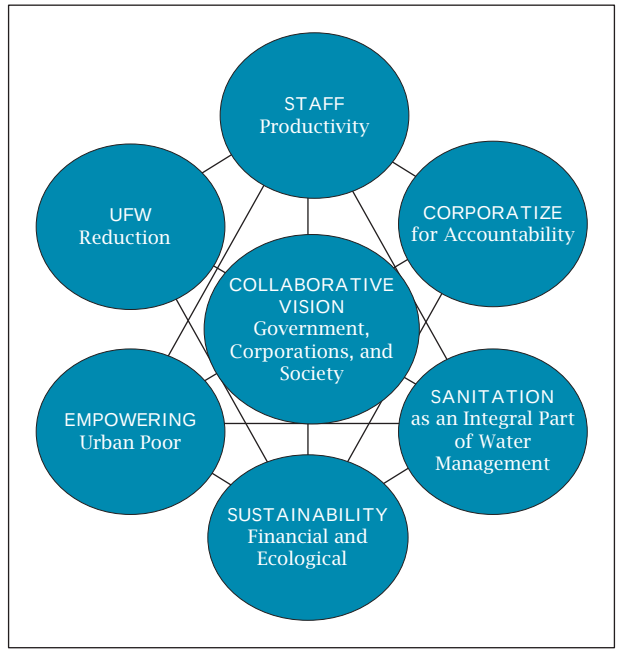
The seven themes are distinct yet interrelated. For instance, the likelihood of staff empowerment improves when a utility has a ring-fenced corporatized structure that drives accountability.

Staff Productivity

Leadership and commitment at the highest political levels are often explained as the critical ingredient for successful utility reform. However, sustained performance over a period of time will require leveraging this commitment at the highest level to create an empowered and highly motivated staff across various levels of the utility.

The vision and leadership provided by Lee Kuan Yew in Singapore and Ek Sonn Chan in Phnom Penh are often cited as key factors in mobilizing commitment and maintaining a steadfast focus toward improving the performance of water utilities in these cities. In both cases, this vision was backed by decisive efforts to build a

Figure 1 Good Practices: The Success Framework



UFW = unaccounted-for-water.
Source: Authors.

motivated and capable workforce that was fully empowered to translate the vision at the operating level.

Initiating results in the early stages of reform often requires a political commitment and a champion to drive the vision, but sustaining performance over a longer term will require an effective organization and empowered staff. The Ramos government in the Philippines provided the political commitment. MWCI transformed 80% of its workforce—who were former MWSS staff, had little incentive to be productive, and whose poor performance was tolerated earlier—into quality staff by introducing not only compensation packages competitive with other similar organizations in the private sector, but also implemented innovative schemes of giving incentives and rewards, career progression, and training opportunities based on merit. The flat structure with opportunities for growth empowers and motivates the staff and is a recipe for creating future business managers.

Unaccounted-for-Water Reduction

Low UFW is a common factor among all high-performing water utilities and is critical for efficient service delivery. Particularly in the Asian context, where ability to

pay for services is limited, water wasted through losses in the system signifies lost revenue and a lost opportunity to service users better and at lower cost. Water saved from reducing UFW could be redistributed to areas not receiving sufficient water supplies, thereby improving water access and revenue.

While Singapore and Phnom Penh stand out with respect to this dimension of good practice, there is clearly a lot to learn from other utilities like MWCI and JUSCO, which have also achieved rapid progress on this count. The solutions to achieve UFW reduction require a combination of technical interventions (Bangkok, Jamshedpur, Phnom Penh, and Singapore provide insights here) and involvement of the community (as Jamshedpur, MWCI, and Phnom Penh cases have demonstrated).

Corporatize for Better Accountability

Better accountability and empowerment of staff members are achieved when water utilities function autonomously. Thus, regulation is required to place water agencies at arm's length from governments and make them accountable to the public. Such autonomy for utilities, whether they are under public control or operated through public–private partnerships (PPPs), is a critical trigger for scaling up company vision and service delivery.

With such autonomy, utilities must view and structure water supply and sanitation as a long-term, sustainable business proposition. This approach, termed "corporatization," is critical to balance the powers and duties of a water utility and to drive greater accountability. While reforming water utilities, getting this balance right is among the crucial first steps.

All nine water utilities studied as part of this research have a corporatized structure that has supported their relatively autonomous functioning. The case of Jamshedpur is especially noteworthy; upon corporatization, the performance of JUSCO dramatically improved in a very short span of time.

Collaborative Engagement among Government, Corporations, and Society

Clearly, there is no one answer that emerges when it comes to whether the solution for rapid performance improvement is a public sector-owned or private utility. Both PPWSA (a public sector-owned utility) and MWCI (a privatized water utility) have achieved success on different dimensions of water supply, including addressing the needs of the urban poor.[166]

[166] In 2012, the PPWSA became the first company to be listed in the Cambodia Securities Exchange.

Singapore's PUB, while managing all end-user services as a public utility, has successfully used PPPs in its water reuse program and other large-scale expansion initiatives. The JUSCO and MWCI cases demonstrate the importance of engaging the community to achieve wider service delivery goals.

There is clearly a need for a new paradigm to address integrated water management, namely engaging the government, corporations, and society in a three-way collaborative effort toward defining and driving service delivery. As many have pointed out, the PPP approach requires strengthening by adding a fourth "P"—people. Greater involvement of the community is clearly a critical requirement for successful utility performance.

Empowering the Urban Poor

Ensuring that water connections reach low-income communities is not only a social obligation; it is also important from the viewpoint of protecting the network. A water connection is a sign of ownership. With ownership comes a vested stake in the network that should translate indirectly into protection of the system.

However, the up-front fee for installation and connection is an expensive one-time cost for low-income communities. Programs for the poor often require a utility to understand the unique circumstances of the poor and then design a flexible program for them. Most, if not all, programs for the poor involve some kind of subsidy for obtaining a water connection and, in deserving cases, for the use of water as well. The small-piped water network program supported by ADB using a revolving fund approach allowed both MWCI and Maynilad Water Services Inc. (MWSI) to connect the households in urban poor communities. To meet the concession performance requirements, MWSI introduced a community self-help program with discount on monthly charges to speed up the connections to the urban poor communities.

Several of the utilities studied had interesting approaches to deal with water access for the urban poor. While MWCI managed to obtain external aid for subsidizing connection fees for the poor, JUSCO's intervention to involve the poor through funding the tail-end network through a connection fee is even more creative. There is also Singapore's direct household-level subsidy model. Several utilities also have a telescopic tariff, with tariffs for a lifeline supply kept at subsidized levels.

Overall, Asian water utilities need to show innovation with respect to a more inclusive approach, while at the same time ensuring sustainable access. The models discussed here demonstrate that sustainable provision of water supply to the urban poor is definitely within the realm of possibility.

Sustainability: Economic and Ecological

Operational autonomy needs to be backed by an ability of the utility to be financially independent with clear and well-defined revenue streams. For a long time, user charges in the Asian context have received a mixed response. Often, a sudden and drastic shift in user charge principles has evoked a strong backlash.

However, the merits of user charges are becoming more apparent, particularly in the context of their role in demand management. User charges are becoming a mainstream practice among water utilities, as there are now successful models of universal metering and differential tariffs based on volume of consumption and on the ability to bear cross-subsidies for the poor. Also, a gradual yet consistent shift in policy toward consumption-based user charges, along with a progressive increase in service levels, appears to be the most logical way forward. Singapore's experience outlines how the government gradually raised water tariffs for domestic consumers over a 3-year period to encourage water conservation and to reinforce its policy of having a progressive, full cost recovery tariff structure. Waterborne fees were also increased to recover the cost of wastewater treatment. By levying an additional water conservation tax, the government also provided incentives for reducing water demand. In the People's Republic of China (PRC), Shenzhen leads in the market-oriented, integrated water management reforms among cities. Tariffs were increased over the years to attain full cost recovery for water supply and wastewater treatment.

As issues relating to climate change become more prominent, city-level water utilities will also need to plan a healthy water balance to preserve ecological and environmental sustainability. The next good practice relating to sanitation and integrated water management is critical in this regard.

Sanitation

Effectively managing water resources requires an integrated and holistic approach. This includes both supply management (e.g., protection and expansion of water sources and the distribution system) and demand management (e.g., water pricing and public education programs on water conservation). Integrated components must also include wastewater management, storm water management, research and development, and where applicable, PPPs. It must also encompass an effective legal, regulatory, and institutional framework, including close and efficient interagency cooperation. By concurrently focusing on all these issues, some cities have managed to achieve their visions, which many urban centers of the developing world have found difficult to achieve.

Singapore probably has moved the farthest in this direction. It has a holistic vision for water, including recycling and preservation, backed by an integrated

organization (PUB handles both water and wastewater planning and execution) for water management. Shenzhen also has an apex-level organization that has complete accountability for integrated water management. Jamshedpur has outlined a "river-to-river" philosophy to capture the essence of integrated water management.

In many developing cities, expanding the wastewater network coverage from the existing low levels should be given immediate priority, and integrated planning should be carried out in implementing wastewater management projects. The "river-to-river" approach from water supply to wastewater disposal could be adopted to minimize groundwater pollution and comply with pollution control standards.

Utilities could impose a wastewater tariff to address the costs that often constrain wastewater treatment projects. The tariff would help to cover operation and maintenance costs and provide funds to extend the coverage of the sewerage network. It could be in the form of outright sewerage charges (such as the water-borne and sanitary appliance fees in Singapore), or by incorporating sewerage service costs into overall water usage charges (as practiced in Jamshedpur).

Operationalizing the Success Framework

To operationalize the success framework, some cities will undoubtedly face greater difficulties than others in translating political will into immediate change down to the utility level. This might be especially true in larger countries and/or in countries where the market structure for water service provision is decentralized and dispersed, as is commonly the case in Asia and the Pacific.

Countries with a high level of bureaucracy may also struggle to allow utilities enough flexibility to be successful. For example, in India, the heads of utilities in major cities are officers belonging to the Indian Administrative Service, who serve only 2–3-year terms. Unless competent utility managers can be selected based on merit and given adequate time to show results, cities cannot hope to fully solve their water problems in the foreseeable future (Biswas and Tortajada 2009). The 2005–2006 data on 20 water utilities in India confirms this. While average water supply coverage among these utilities was 81%, average UFW was high at 32%, with 14 of the utilities having less than 10% of the water connections that they provided being metered, and only one-third having recovered operation and maintenance costs in full (ADB and Ministry of Urban Development, Government of India 2007).

At the city level, each utility will also face its own unique circumstances that may slow its progress. For instance, many utilities may be stuck with old, dilapidated water supply networks, making reducing NRW and improving water quality more

difficult. While these problems might be a result of poor management and neglect by previous utility managers, utilities facing this challenge must push forward with solutions to ensure their financial success.

In this effort, many cities in the developing world make the mistake of letting capital expenditure —rather than improvements, efficiency gains, and savings—drive the implementation of water projects. This supply-oriented approach yields hardware improvements, which are vital to keeping up with expanding demands in urban centers and generating more revenue.

However, two problems often emerge from focusing too intently on investing in new systems. First, expenditures for operation and maintenance are not adequately considered. Second, service delivery does not improve, because of lack of attention to improving management and technical capacity, and inadequate finances to fund operation and maintenance.

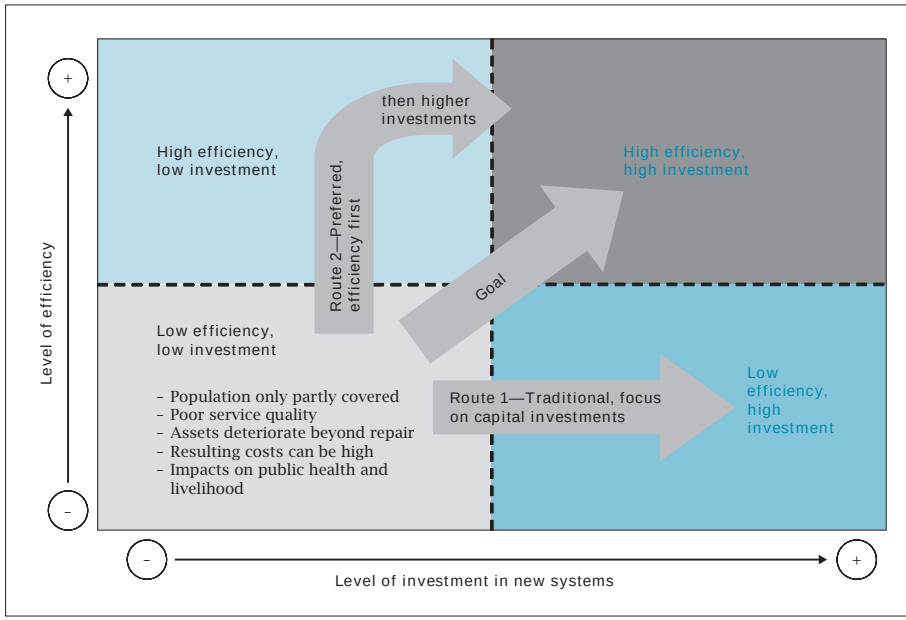
Poor service makes it much more difficult to convince customers to pay more for their water, which is a hard sell to begin with due to the persistent belief in many places that water should be heavily subsidized, if not provided for free. With low willingness to pay by customers, there is often little political will to raise tariffs, even to cover operation and maintenance expenses. Even in situations where customers are prepared to pay more for better service, unsustainable supply-oriented approaches sometimes persist (ADB 1996).

Consequently, water systems cease to function effectively due to financial shortfalls. Utilities struggle to maintain their level of service, and infrastructure deteriorates much faster than it should. The solution to these nonfunctioning systems is often the infusion of more capital investment for presumably better services—but at very little or no incremental charge to the customers. Since the core problems remain unsolved, such inefficient investment can sometimes make problems worse, with negative impacts on public health and the environment. As shown in Figure 2, cities that take this route (“Route 1”) have a harder time reaching their goal.

Rather than pursue this pathway, cities in the developing world should look to make their water systems more efficient and effective by reducing water losses, gradually increasing water tariffs, improving revenue collection, increasing staff productivity, and securing safe and reliable water supplies. This pathway is shown by “Route 2” in Figure 2, whereby a city reaches a limit of efficiency improvement by improving institutional systems and putting in place good practices. When efficiency gains are ensured, further visible improvement is possible only by enhanced investments.

It is essential that the success of the utilities highlighted in this book be equaled in other urban areas of Asia and the Pacific. The economic and social costs to cities not receiving clean, drinkable water supplies are quite high and growing.

Figure 2 Balancing Investment and Efficiency in Water Supply Systems



Source: Authors.

Emerging Challenges of Climate Change and Flooding to Integrated Water Resources Management

In closing, we would like to draw the attention to emerging challenges posed to the operations of city-level water utilities in the short term during specific events, and planning for sustainability in the long term. Increased urbanization and climate change have been accompanied by increased flooding of cities, for example, in Mumbai (2005), Pakistan (2010), the frequent flooding in the Philippines due to typhoons, and the floods in Southeast Asia (Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam) in 2011. A global trend of increased flooding is discussed in a publication by the World Bank (Jha 2012).

Increased urbanization has resulted in increased surface runoff requiring planning for the drainage of greater quantities of water. In a study on the effect of land use and land cover change in the Shenzhen region, for example, the authors noted that due to urbanization in the past 20-year period, runoff coefficient increased by 13.4% while flood peak discharge was intensified by 12.9% on average (Shi et. al. 2007). Numerous studies have indicated the evidence of climate change in Asia. Overall temperatures have risen by 1°C to 3°C over the last 100 years, precipitation patterns have changed, the number of extreme weather events is

increasing, and sea levels are rising. A rise in sea level is expected to increase salt-water intrusion impacting freshwater resources such as coastal reservoirs and groundwater.

A World Wide Fund for Nature (WWF) report (World Wide Fund for Nature 2009) examined the vulnerability of 11 coastal cities in Asia (five of which are covered in this book) to climate change, taking their environmental exposure, socioeconomic sensitivity, and adaptive capacity into consideration. The findings indicate that Dhaka (Bangladesh) is most vulnerable to climate change impacts. This city sits just meters above current sea levels, is regularly impacted by tropical cyclones and flooding, and has very limited adaptive capacity. Jakarta (Indonesia) and Manila (Philippines) are also highly vulnerable cities and tied for the second rank, largely because of the size of the cities, degree of exposure (both experience frequent flooding), and relatively low adaptive capacity. Kolkata (India) and Phnom Penh (Cambodia) are tied for the third most vulnerable cities, largely because Kolkata is prone to salt-water intrusion and sea-level rise effects, while Phnom Penh has very low adaptive capacity. Ho Chi Minh City (Viet Nam) and Shanghai (PRC) are tied for the fourth most vulnerable cities, because both are very susceptible to sea-level rise, although Viet Nam and the PRC may have slightly higher adaptive capacity compared to some of the other cities. Bangkok is the fifth most vulnerable city, mostly because it has a relatively high socioeconomic sensitivity to impacts (i.e., it has a large population and contributes a large proportion toward Thailand's gross domestic product [GDP]). Hong Kong, China; Kuala Lumpur (Malaysia); and Singapore are all tied for the sixth most vulnerable cities, mostly because all three have slightly more adaptive capacity than the other cities, although the climate impacts are still significant (World Wide Fund for Nature 2009, 4).

The utilities, therefore, need to consider adaptation and mitigation strategies to address these impacts. The WWF report has mentioned that costs of avoiding the worst impacts of climate change can be limited to around 1% of global GDP/year, whereas the costs of inaction range from 5% to 20% of global GDP/year (World Wide Fund for Nature 2009, 6). Translating the global impacts into country actions has indeed been a challenge. Singapore leads the way in planning and implementing adaptive strategies. To avoid seawater intrusion into its reservoirs, most of its reservoir dams are much higher than the projected sea-level rise, and if need be, the gate structures for the dams can be raised. By introducing NEWater and desalination, which are not rainfall dependent, Singapore has diversified and increased the resilience of its water supply, even during prolonged dry spells (Ministry of the Environment and Water Resources 2008, 9). Choices have to be analyzed separately for each city to strike a balance between mitigation and adaptation measures as mentioned in the World Bank publication. Climate-proofing the investments is now an inescapable necessity.

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ISBN 978-92-9092-740-2

Printed on recycled paper.

Printed in the Philippines