Proceedings of International Workshop on **Drinking Water Loss Reduction:** *Developing Capacity for Applying Solutions*

UN Campus, Bonn
3-5 September 2008

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Proceedings No. 1
UNW-DPC Publication Series

UNITED NATIONS UNIVERSITY
UNW-DPC

UN WATER
UN-Water Decade Programme on Capacity Development

Acknowledgments

The International Workshop on Drinking Water Loss Reduction: Developing Capacities for Applying Solutions was held from 3 to 5 September 2008 at UN Campus in Bonn, Germany. The workshop was co-organized by UN-Water Decade Programme on Capacity Development (UNW-DPC) and the United Nations Human Settlements Programme (UN-HABITAT). The activity was coordinated by Dr Reza Ardakanian, Director of UNW-DPC and Dr Jose Luis Martin-Bordes, Programme Officer of UNW-DPC with the support of the UNW-DPC team. Copy editing of this publication was done with the support of Patricia Stadie.

Co-Editors	Reza Ardakanian
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Layout	Lou Smith
Corporate Design	Helmut Langer
Number printed	500
Print	Paffenholz, Bornheim, Germany
Photo rights	©UNW-DPC

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United Nations University
UN Campus
Hermann-Ehlers-Str. 10
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Bonn, Germany
January 2009

TABLE OF CONTENTS

Foreword by the Director of UNW-DPC

UNW-DPC is a joint capacity development programme of the UN Agencies and Programmes cooperating within the interagency mechanism known as UN-Water. It is hosted by the United Nations University in Bonn and is funded by the German Federal Government. The aim of the programme office is to support and strengthen the capacity development activities of the more than two dozen UN organizations and programmes within UN-Water.

The International Workshop on "Drinking Water Loss Reduction: Developing Capacity for Applying Solutions" was organized by UNW-DPC in collaboration with UN-HABITAT and marks the first workshop in a series aimed at developing knowledge and capacity worldwide in technical, administrative and political approaches to reducing drinking water losses within urban water supply systems.

More than 60 participants, including water managers and water decision-makers from various cities around the world, confronted with the problem of drinking water losses, met in Bonn to share their experiences regarding different solutions. Representatives came from Latin America (São Paulo-Brazil; Managua-Nicaragua; Lima-Peru; Mexico City-Mexico), Asia (Gwalior-India; Lalitpur-Nepal), Africa (Kampala-Uganda; Lusaka-Zambia) and the Middle East (Alexandria and Sharkia region-Egypt, Madaba and Amman-Jordan; Ramallah-Palestinian Authority; Abu Dhabi,-United Arab Emirates), and Europe (Leipzig and the Ruhrgebiet region-Germany; Sofia-Bulgaria; Budapest-Hungary). They discussed the most promising approaches, especially highlighting the need for institutional capacity development and the establishment of cooperation in order to apply the best available technical and managerial solutions.

It is because of the quality of the approaches described and the discussions held about them, that I would like to personally thank once again, all the participants and supporters of the workshop (including Prof. Dr F. Meyer-Krahmer, State Secretary of the German Federal Ministry of Education and Research (BMBF) and Dr M. Konukiewitz, Director for Global and Sectoral Policies of the German Federal Ministry for Economic Cooperation and Development (BMZ), as well as UN-HABITAT and the members of the Workshop Organizing and Scientific Committees, without whom the workshop could not have been the success it was.

As a significant outcome of this workshop, a number of recommendations were made and these included key issues and action-oriented tasks for policy makers and managers to take note of. In this publication of the workshop proceedings, you will find 29 papers describing in more detail the different state-of-the-art approaches to reducing drinking water loss adopted in different cities around the world, as well as an account of the vibrant discussions the participants had regarding these approaches and their conclusions as to the way forward in tackling this pandemic problem. We envisage this publication as serving the wider water sector community as a capacity development resource for use by international organizations, policy makers and water supply managers in their consideration of coherent and integrated strategies for reducing water losses within urban supply networks.

We hope that, having read these proceedings, you will look forward, as I do, to the results of the next workshop in the series of regional workshops related to Water Loss Reduction and Water Efficiency that UNW-DPC is jointly organizing with UN-Water members and other partners in the Arab countries and in South Eastern Europe in 2009. In addition, other regional workshops are considered to be organized in Latin America, Africa, and Central and Eastern Asia.

Dr Reza Ardakanian
Director, UNW-DPC
(co-organizer of the workshop)
Bonn, Germany

BACKGROUND

Water loss from distribution systems is a problem in almost all conurbations around the world, but can be a serious issue in areas where water is scarce. This problem deserves immediate attention and appropriate action to reduce avoidable stress on scarce and valuable water resources.

Several big cities have already started programmes geared towards the step-by-step reduction of the losses and it is well known that many institutions and water suppliers have developed and implemented strategies and technologies to control leakage and water loss. These strategies have proven highly efficient and received worldwide recognition.

To address the drinking water loss problem, UNW-DPC is organizing, in cooperation with UN-HABITAT, the workshop "Drinking Water Loss Reduction: Developing Capacities for Applying Solutions". With this workshop, UNW-DPC and UN-HABITAT hope to encourage follow-up projects and help to establish communication between the policy makers, water managers, researchers and providers of technical solutions.

This workshop is a joint contribution of UNW-DPC and UN-HABITAT towards the achievement of the Millennium Development Goals related to water and to the International Year of Sanitation 2008.

OBJECTIVES OF THE WORKSHOP

The workshop aims to encourage the exchange of experiences and information on successful examples within the different national programmes in improving water leakage control and reducing water losses in water supply systems. The workshop will concentrate on the most promising approaches, highlighting especially the need for institutional capacity development and the establishment of cooperation in order to apply the best available technical and managerial solutions. The focus lies on developing countries and countries with economies in transition, especially those under water stress.

PARTICIPANTS AND CONTRIBUTORS

The workshop is aimed at representatives from major cities around the world and, particularly, the decision-makers responsible for water supplies. In Bonn they will have the opportunity to meet their counterparts from Germany, neighbouring European countries and from around the world.

Providers of innovative technical solutions for detection and control of unaccounted flow, leakage control and water metering are invited to present their products and approaches in a Technical Exhibition that will be held during the workshop.

WORKSHOP PARTNERS

BMBF
Federal Ministry of Education and Research, Germany
www.bmbf.de/en/

BMZ
Federal Ministry for Cooperation and Development, Germany
www.bmz.de/en/

IBWS
Water Strategy Initiative Office, Germany
www.dlr.de

PTKA
Projekt Management Agency Forschungszentrum Karlsruhe
www.fzk.de/fzk/

GTZ
German Technical Cooperation
www.gtz.de

InWent
Capacity Building International, Germany
www.inwent.org

DWA
German Association for Water, Wastewater and Waste
www.dwa.de

DVGW
German Technical and Scientific Association for Gas and Water,
www.dvgw.de

Stein & Partner
Prof. Dr.-Ing. Stein & Partner GmbH
www.stein.de

German Water Partnership
www.germanwaterpartnership.com

Universität Karlsruhe (TH)
Karlsruhe Research University founded 1825
www.uni-karlsruhe.de

Opening Session Speeches

Welcoming Address by Dr. Reza Ardakanian, Director of the UN-Water Decade Programme on Capacity Development (UNW-DPC)

Bonn, 3 September 2008

State-Secretary Prof. Dr. Meyer-Krahmer,
Director Dr. Konukiewitz,
Ambassador Dr. Keferstein,
Vice-Rector of UN University in Europe Prof. Dr. Bogardi,
Distinguished guests,
Ladies and gentlemen,

It is my pleasure to welcome you to the first international workshop that UNW-DPC, the UN-Water Decade Programme on Capacity Development, is conducting in this wonderful location, the UN Campus in Bonn.

The theme of this workshop is clear. Of course within the whole water cycle there are many more areas of concern when it comes to the inefficient management of water:

Agricultural water use and abuse is a nightmare. By far the largest percentage of available fresh water is used, consumed and polluted by agriculture.

Non-existent or defunct appropriate sanitation systems, particularly in urban settings, are polluting valuable water resources for local consumption. Pollution directly reduces the volume of fresh water available, and increases the stress on the often already scarce resources.

Mismanaged allocation of permits for water resource abstraction and to release treated or untreated urban and industrial sewage water into local water courses or groundwater cause further large losses of valuable water.

Ladies and gentlemen,

Water always requires holistic thinking, in all its dimensions. Today we are starting with a workshop on urban drinking water loss reduction.

Developing capacities, especially of urban water managers and decision-makers and water supply utilities as

institutions from around the world, to learn from each other's approaches to tackle losses in distribution systems, is one step towards better water management. We hope this workshop will increase the understanding for applying solutions to the challenges in urban water management.

Reducing water losses in urban drinking water supply networks could make a substantial contribution to making progress in achieving directly one water-related MDG target:- reducing the number of people without sustainable access to clean water.

In some places up to 50% of the water prepared for distribution by the urban water utilities is not reaching the users due to leakages or other unaccounted-for water. Any cost calculation for water supplies needs to take into account these losses within the system; in the end these are also paid by the customers – or if the full costs are not yet passed on to the customers - are covered by the municipality or the state. In the end people are paying for water they never see.

Water losses in urban networks not only lead to economic costs for the utilities, but also reduce the number of people that the water can reach. Where urban water supplies are concerned, minimising losses from the system to the lowest technically feasible level is an urgent requirement.

Distinguished guests,

I am honoured to welcome here with us the representatives of the German Federal Ministry of

Education and Research (BMBF), State-Secretary Professor Meyer-Krahmer, the German Federal

Ministry for Economic Cooperation and Development (BMZ), Director Dr. Konukiewitz, and the German Foreign Office, Ambassador Dr. Keferstein.

We are very grateful for the contributions from the two German Federal Ministries BMBF and BMZ to UN-Water in support of the activities of the Decade Programme on Capacity Development, and to the City of Bonn, where we are located.

I am also very pleased about the cooperation on this activity with our UN-Water partner, UN-Habitat, and with the United Nations University, represented here by the Vice-Rector for Europe, Professor Dr. Janos Bogardi. Of course I am also extending my gratitude to UNU as our host organisation.

Ladies and Gentlemen,

We are honoured to host this first UNW-DPC workshop here at the UN Campus in Bonn. I wish you all very interesting discussions and join you in looking forward to useful outcomes for future improvements in urban water supply networks throughout the world.

Statement by Mr. Andre Dzikus, Chief WSS-II, WSIB, UN-HABITAT, Nairobi

Bonn, 3 September 2008

Dr R. Ardakanian, Director of UNW-DPC, Prof. Dr J. Bogardi, Vice-Rector of UNU in Europe, Hon'ble Mayors of various cities, other workshop participants, Ladies and Gentlemen

UN-HABITAT is most delighted to be associated with both UNW-DPC and UNU and would like to congratulate Dr. Ardakanian as well as Prof. Bogardi for organising this workshop on such an important subject in this beautiful city of Germany. UN-HABITAT feels privileged to be invited for the opening of this joint event. But due to unforeseen circumstances it has not been possible for the UN-HABITAT representative to be personally present and make this statement. Dr Anna Tibaijuka, Executive Director, UN-HABITAT values our special relationship with UNW and UNU and sends her cordial greetings on the occasion of the opening of this workshop. This workshop is most timely considering the big challenge which many cities in the developing world are facing due to huge water losses arising out of water leakages in the system.

As you are well aware, more than 50 per cent of the population is now living in urban areas. Urbanisation is a reality that we have to face and turn to our advantage. Cities no doubt are the centers of economic and social development. However, urbanization has also put enormous pressure on the world's natural resources, water in particular.

Water is essential to good health and economic progress, yet its provision to most urban residents in the developing world is still an unattainable goal. At this moment, almost 300 million urban residents are without safe water and about 600 million lack adequate sanitation facilities, at great risk to life, health and happiness.

A significant proportion of those living without proper water supply and sanitation are urban dwellers, mainly in the peri-urban areas. They are forced to draw on water sources that are unsafe, unreliable and often difficult to access. Virtually all urban dwellers with inadequate provision live in the low and middle-income nations of Africa, Asia and Latin America and the Caribbean. Inadequacies in the provision of water, sanitation and hygiene bring an enormous health burden: half the urban population in Africa, Asia and Latin America suffer one or more of the diseases associated with inadequate water and sanitation, and among the urban population of low-income countries, one child in six dies before the age of five.

Water needs to be provided for many different purposes. Domestic use accounts for only 5 per cent of a nation's water requirements whereas agriculture uses 85 per cent and industry 10 per cent. Cities have to try to balance these competing demands as water for household use is never enough. Urban areas generate over 50 per cent of the national product in many countries, an important reason why industries and the urban poor should have access to water.

To each of these competing users, water must be allocated equitably, which means distributed according to national economic, social and environmental priorities. Moreover, as water is a basic human necessity, it should be given fairly. A city or nation should not neglect the poorer groups who cannot pay much for their water supplies. Both make contributions to national development. Neglecting the needs of the poor means a further decrease in family and urban productivity affecting up to 40 per cent of the world's urban population. On the other hand, supplying too much to groups with the capacity to pay encourages wasteful use of water.

In the current millennium, the world's cities are not only facing the challenge of supplying adequate water and sanitation to their residents, but also have to ensure that the available water is not wasted or contaminated. Already, the level of "unaccounted-for" water in many cities

exceeds 50 per cent a wastage we can ill afford. Better maintenance and management of urban water systems is, therefore, a strategic investment that can bring this loss down considerably.

The scarcity of water is not due to the actual shortage but is a crisis of water governance. There is a need for active and passive leakage control, planned maintenance, education and public involvement, elimination of illegal use of water and capacity building for training the utility staff in the art of leak detection and repair of leaks as well as water meter management. An integrated approach to urban water management is essential for the social, economic and environmental sustainability of cities.

In 1999, UN-HABITAT launched the Water for African Cities Programme to address the urban water challenge facing the continent. In order to support the African Water Utilities, UN-HABITAT in association with Rand Water of South Africa produced a Manual titled Water Demand Management Cookbook, with the objective of providing guidance on how to manage the water losses in their potable water distribution systems.

Inspired by the success of the programme in Africa, UN-HABITAT in partnership with the Asian Development Bank and the governments of the countries in the region launched the Water for Asian Cities Programme in March 2003. This was the first comprehensive initiative to support Asian countries to effectively manage the growing urban water crisis. In December 2007, UN-HABITAT has now taken another initiative Water for Cities in Latin America and the Caribbean to assist countries in their efforts to increase sustainable access to water supply and sanitation. UN-HABITAT has facilitated the development of Water Demand Management Strategies in the four cities of India to meet the challenge of reducing non-revenue water from 60% to 15% in a period of five years. Our Water for Cities Programmes presently being implemented in all these regions invariably focus on water conservation and demand management so as to minimize losses due to leakages and reduce non-revenue water.

We are very pleased to join hands with UNW-DPC for organizing this international workshop on Drinking Water Loss Reduction. I am sure that the City Mayors and all other representatives from major cities around the world will immensely benefit from this workshop. I wish the workshop a grand success.

Thank you!

Address by Professor Frieder Meyer-Krahmer, State Secretary, German Federal Ministry of Education and Research (BMBF)

Bonn, 3 September 2008

Dear Professor Bogardi, dear Dr Ardakanian, dear Dr Konukiewitz and dear Excellencies, distinguished guests and ladies and gentlemen:

On behalf of my minister Dr Annette Schavan, I would like to welcome you all very warmly here to Bonn - this historical place here in Germany, as Professor Bogardi described it. It's a great honor that you are here, and it is also good to have the United Nations here and also to have this baby here, which we started one year ago. It's more or less exactly one year since we celebrated the opening of the offices of the UN-Water Decade Programme on Capacity Development, and I am very much impressed, Dr Ardakanian, by how this child has developed. Normally, it takes time for a baby to be born, and I'm very much impressed by how quickly you started, how much drive you have developed, and how visible you have already become. I'm also impressed by how closely you are linked meanwhile not only to the German community but also internationally. So, congratulations! This was really an excellent start, and I wish you for the coming years all the best, and hope you can keep on track and maintain the speed. I think the problem needs this kind of speed because it's really urgent.

Please let me mention some of the activities you have developed. In particular I would like to emphasize the capacity development workshop for water journalists in Tehran in November 2007, the co-organization of a learning center event on integrated water resources management in New York in May this year, and the United Nations University international course on environmental change at the UNU headquarters in Tokyo. I should also mention that you established multiple cooperations between UNW-DPC and some very important organizations, and of course partly with our cooperation, namely with the German Water Association, with the European Water Association, with the Regional Center on Urban Water Management in Tehran, and also with the Arab Water Council. Such cooperation is very important for your organization. Meanwhile we in Germany have established the so-called German Water Partnership, which is an association between the scientific community on the one hand and industry on the other hand, and I think it is not necessary to explain how important and how complicated that is. But I can tell you that in this specific activity we were able to bring together five different ministries, two of which being the Ministry for Economic Cooperation and Development, represented here by Dr Konukiewitz, and the Ministry of Environment, which Mr. Holzwarth is representing. The third is my own, the Ministry of Education and Research. But we also have on board the Ministry of Industry and also the Ministry of Foreign Affairs. Usually these ministries fight each other and have

a tendency to keep to themselves, and it took a lot of effort to convince all these actors to sit together and plan a common baby. So I am really proud and am also very grateful to you both, because you are one of the driving forces behind the development and establishment of this kind of link.

I'm underlining this not to tell you why the German government is so successful. This is normally my job, but I'm very critical, and I think governments have a lot of problems organizing themselves properly. No, what I wanted to say is we are facing many problems, which are in fact horizontal problems. The water issue is one of them, but we also have climate change, energy, health and so on. And governments have to find an answer to these horizontal problems. Governments are organized in a vertical way. These different ministries all have their separate allocated tasks, and this is ok. But they have to organize themselves to find a new form of governance and management for these problems - really to act horizontally. And in this specific case I can tell you we are proud that it is working - maybe not perfectly, but it is working and we are working on making it perfect. One of the reasons I mention this is because I understand that a key element of the things you are discussing today and during this workshop is how to bring together the relevant actors, and this is a typically horizontal thing - bringing together actors that are working in vertical structures, but need to be connected.

My manuscript now proposes that I should tell you something else, that water is a challenge, and I was supposed to tell you something else on the topics and the problems you are discussing. I will not do that. You are the community that has been really active for many years in this field, and I as a state secretary won't tell you things about your field because you know many things far better than I do. I just want to say that the German government, represented here now by BMZ, BMU and BMBF, supports the establishment and the work of the UN-Water Decade Programme based here in Bonn. We do that jointly. We are happy to see a UNW-DPC that is strongly involved in the analysis and the improvement of capacity development on water related issues worldwide. With this dedication to promoting education and research in the area of water resource management, my ministry welcomes and supports this workshop, bringing together water experts from 20 cities around the world to exchange their experiences. The range of the topics will cover innovation and technology aspects, but I also learned that it is important also to include other aspects, and I take away with me from here - as a lesson for myself - that there is a need to bring together scientific and technological aspects, that it is necessary to think about governance, that it is necessary to include consideration of finance and management issues. And in fact one thing I learned is that it is necessary to develop a holistic approach: a holistic approach means an intellectually holistic approach, but also bringing together the relevant actors as I mentioned before. This is a very important message to the policy makers because that's a challenge for us.

I was pleased to accept the invitation to be here today, I hope you will have a very intensive debate. One thing is clear: we are fully aware as a government of the relevance of the water issue in its many strategic, geographical, political, social and scientific dimensions. We are fully aware that on the topic of this workshop there is a clear need for feasible solutions. We need to understand best practices, not just one practice but that there are many practices, there is a need for exchange of experience and perspectives, and that is what you are doing. The challenge is huge and politics needs to facilitate convincing solutions, and for this task we need you. We also need your lessons and the messages you want to send us. And we will listen very carefully to and look closely at the results you will prepare. I wish you an interesting workshop, and good luck. And also we need the relevant results from you on which to act.

Thank you very much.

Address by Dr Manfred Konukiewitz, Director for Global and Sectoral Policies, German Federal Ministry for Economic Cooperation and Development (BMZ)

Bonn, 3 September 2008

Prof Mayer Kramer, Prof Bogardi, Dr. Ardakanian, honorable dignitaries, dear colleagues, I am very pleased to attend the UNW-DPC workshop on Drinking Water Loss Reduction and to convey the greetings from my minister who wishes you successful and fruitful discussions and exchange of experience.

Please allow me to give a brief introduction concerning the creation of this UN-Water Programme. Approximately one year ago we passed an important milestone with the opening of the DPC Center. This was the birth of the baby, but before birth there is conception and pregnancy, and therefore please allow me to go back a few more years. I would like to mention some important people that were behind the launch of the Decade Programme of UN Water. Some of them are here today like Dr. Holzwarth from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, and Prof Bogardi from UNU. James Bartram from WHO is not here, he played an important role as chair of UN-Water. We worked hard to make this happen, and to overcome the obstacles which popped up as we tried to move ahead. I was asked by several partners: "What is the agenda of the German government in supporting the creation of this programme? My answer was: "The German government does not pursue a separate agenda, The intention is to serve a joint purpose, to create a hub for capacity development that can serve as an entry point to the 25 UN agencies dealing with water. It is definitely not the idea to establish agency number 26." By addressing the important task of capacity development, the challenge is for UNW-DPC to bring a more coherent approach into the UN system. In brief this is the core mandate, and I am very pleased to see that this is translated into action with this workshop. Today's collaboration with UN-HABITAT is a good example of this approach.

The subject Dr. Ardakanian picked up for this workshop is a very important one, also in terms of development cooperation. Water and Sanitation is one of the most important priorities in German Development Cooperation. Germany is one of the three largest bilateral donors world-wide with an annual commitment of approximately 350 million euro for the water sector. And we are committed to increase this investment, in line with our contribution to achieving the MDG. According to the latest publication of WHO / UNICEF still 884 Million people have no access to improved drinking water resources. The most efficient and economic way to increase the supply

is to reduce leakage in supply systems. Roughly one third of the water provided to urban drinking water distribution systems is either lost through leaks, or not included in the revenue and financing system. In some developing countries drinking water losses can make up to 70 %. Political willingness and capacity development has to go hand in hand to improve the drinking water loss all over the world.

Drinking water loss reduction is not only a technical issue for engineers. Indeed, as we can see in Germany, the technology is available and is ready for use. It is the question of efficiency, management, financing, transparency and corruption in the water sector. This gives me the opportunity to mention another important milestone: the Bonn freshwater conference in 2001. My minister, Heidemarie Wieczorek–Zeul, said in the closing session a very important sentence: "Corruption is a bigger leak in the water sector than rotten pipes". And the conference outcome document took up the corruption issue for the very first time in the intergovernmental arena. This statement sent an important signal and made clear that corruption is one of the main obstacles for a sound development in the water sector.

However, while reducing loss of drinking water in water supply systems is important, we have to keep in mind that still up to 70 % of freshwater is lost in agriculture. A high percentage of this water has drinking water quality. Thus more efforts and a strong political commitment are needed in order to improve the efficiency of water usage. The water supply system of a city can be in perfect condition and on a technically sophisticated level, but if there is no water available due to overexploitation or wrong allocation even the best supply system will fall dry. This is why an integrated water management is so important.

I wish this conference very successful proceedings. Thank you very much.

Introduction of Chairpersons and Speakers

Chairpersons

CHAIRPERSON SESSION I: TECHNICAL SOLUTIONS AND CASE STUDIES

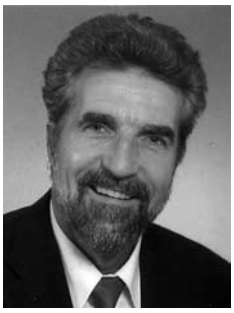
Prof. D. Fuhrmann, Deputy Head, Water Technology and Waste Management Division – Project Management Agency Forschungszentrum Karlsruhe, Germany

CHAIRPERSON SESSION II: POLITICAL AND ADMINISTRATIVE SOLUTIONS AND CASE STUDIES

Prof. Dr Dr K.U. Rudolph, Professor, Institute of Environmental Engineering and Management at the private University of Witten/Herdecke, Germany

CHAIRPERSON SESSION III: TOOLS FOR CAPACITY DEVELOPMENT AND CASE STUDIES

Mr Rudiger Heidebrecht, Head of Deparment Training and International Cooperation, DWA - German Association for Water, Wastewater and Waste



CHAIRPERSON SESSION IV: WORKSHOP REPORTING AND THE WAY AHEAD

Prof. Dr G. Klein, Head of Water Strategy Initiative Office, Aerospace Center, Germany.

Participants

UGANDA: CITY OF KAMPALA

Dr William T. Muhairwe has a Masters Degree and a PhD in Business Administration from the Ludwig Maximilian University in Munich, Germany. He has held a number of high profile positions including Deputy Executive Director of the Uganda Investment Authority. He is currently Managing Director of the National Water and Sewerage Corporation, Uganda.

ZAMBIA: CITY OF LUSAKA

Ian Nzali Banda has a Bachelor degree in Civil Engineering, and a Masters degree in Civil and Environmental Engineering. He is currently pursuing a PhD at the University of Cape Town, South Africa. He has been a Development and Training Consultant for various international organizations, and is currently CEO of a public water utility in Zambia, and Chairman of the Zambian Water and Sanitation Association.

ZAMBIA: CITY OF LUSAKA

Osward M. Chanda has a degree in Civil and Environmental Engineering, and gained a Master of Engineering Science in Environmental Engineering from Melbourne University. He was technical specialist and later manager of the water sector reforms in Zambia, and established seven of the ten Zambian water companies. He is currently CEO of NWASCO, the regulatory agency, and developed the regulatory regime and established a fund to support water access for the urban poor.

BRAZIL: CITY OF SAO PAULO

Francisco José Falcão Paracampos has two BSc degrees (Civil Engineering from the Rio de Janeiro State University in Brazil, Environmental Engineering from London University, UK), and an MSc in Environmental Engineering from Imperial College, London. He has more than 25 years' experience, including the management of large water and sewer networks. He heads the largest business unit at SABESP, responsible for daily business operations in all sectors.

MEXICO: MEXICO CITY

Oscar F. Martínez Villalba is a civil engineer. At the Mexico City Water System, he is manager of the North Sectionalizing Department and he is responsible for the water leak control project in the North area of Mexico City.

NICARAGUA: CITY OF MANAGUA

Francisco Reyes is a civil engineer. At the Nicaraguan Company for Water Supply and Sewerage ENACAL, he is Chief of the Management Control Team and supervisor of water loss reduction projects.

PERU: CITY OF LIMA

Humberto Enrique Reyes Rocha is an industrial engineering graduate, Master of Business Administration and has a Masters Degree in economics from the Pontificia Universidad Católica del Perú. At SEDEPAL he is responsible for evaluating the fulfillment of the company's goals, and is in charge of designing indicators for monitoring the operative management and increasing efficiency and productivity.

INDIA: CITY OF GWALIOR

Vivek Narayan Shejwalkar, by training a mechanical engineer, has held top executive positions in banking/financial institutions. He was also the President of Gwalior Development Authority. In 2004, he was elected Mayor of Gwalior, a city with a population of about 1 million. Since his election he has introduced many reforms, including a number of UN-Habitat-assisted urban water and sanitation projects being managed by the community.

IRAN: CITY OF TEHRAN

Azizolah Mobini has a BSc in Fluid Mechanical Engineering from Isfahan University of Technology and an MSc from the Energy, Power & Water Insitute of Technology, Tehran, Iran. He worked for the Kashan Water & Wastewater Company where he was expert on water loss reduction and then water supply manager. He has been with NWWEC since 1998, where he is currently manager of water losses reduction.

NEPAL: CITY OF LALITPUR

Krishna Prasad Devkota has a Masters Degree in Public Administration as well as an MBA, and is currently CEO of LSMC. He is responsible for coordinating and managing work in the fields of infrastructure development and management, urban water supply and sanitation, environmental management, cultural heritage management etc. He is a member of the Kathmandu Valley Drinking Water Management Board.

EGYPT: CITY OF ALEXANDRIA

Nadia Ahmed Abdou has a BSc in Chemical Engineering and an MSc in Health Engineering from the University of Alexandria. Her main areas of expertise are drinking water industry, construction, operation and management of water treatment plants, laboratories and research departments, and implementation of water projects.

EGYPT: SHARKIA GOVERNORATE

Salah El Din Mohamed Ali Bayoumi has a Masters Degree and a PhD in Environmental Engineering, and spent two years of his PhD programme at the University of Washington, in Seattle, USA. Following 25 years of experience in both government and private agencies, he is currently Chairman of the Sharkia Potable Water and Sanitation Company, serving approx. 6 million people.

JORDAN: CITY OF AMMAN

Marina Meuss has a geography degree from the University of Kiel, Germany and 12 years' experience as a water sector advisor for GTZ. She has spent considerable time abroad, including four years in Jordan. Her main areas of expertise are water sector reform, utility management and private sector participation. She is current planning officer/water sector advisor at GTZ Headquarters, working in Macedonia, Uganda, Namibia, Central Asia and Lebanon.

JORDAN: CITY OF AMMAN

Dr Stefan Gramel has a Bachelor Degree in Civil Engineering, a Masters Degree in Environmental Technology, a Bachelor in Business Administration and a PhD in Water Supply. He has worked for the KfW Development Bank and is currently managing various projects, including one on water loss reduction in Jordan and Palestine.

JORDAN: CITY OF MABADA

Tarek Zuriekat has a degree in Business and Accounting from the University of Edinburgh, Scotland and has been Business Manager of Engicon, a firm specialising among other things in water and wastewater, since 2002. As a result of the Madaba Micro PSP project the company founded a subsidiary to focus on service contracts for billing and collection, leak detection, repair and other operations and maintenance activities.

PALESTINIAN AUTHORITY: CITY OF RAMALLAH

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STEIN & PARTNER GMBH

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VAG ARMATUREN GMBH

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Workshop Papers

Keynote Presentations

Economic Aspects of Water Loss Reduction

By Prof. Dr. K.U. Rudolph, University of Witten/Herdecke, Germany

SUMMARY

R. Lienberger has given some figures (WATER21, June 2008, page 48) as to, what a reduction of water losses in lower and middle income countries to just half of the current level would deliver as benefits:

- *11 billion* m^3/a would be available to water customers;
- *130 million* people more could again access public water supply;
- water utilities would gain *US$ 4 billion* of self-generated cash flow.

These figures illustrate the economic importance of water loss (WL) and the need for water loss reduction programmes (WLR-P). For decision making and design of WLR-P, costs and benefits have to be analysed and evaluated, using a cost:benefit-analysis (CBA). This paper explains that:

- CBA must be appropriate to regional conditions (OPEX, CAPEX) and include surplus technical and administrative WL-damages;
- German guideline recommends WL below 20 m^3/h·km resp. below 7 %;
- design and implementation of WLR package solutions would support WL promotion, and local business should be developed rather through franchise than through subcontracting.

1. FIGURES ABOUT WATER LOSSES IN DIFFERENT REGIONS

Due to different calculation methods and not always reliable data basis, it is necessary to verify data about water losses case-wise. Data published for different countries reflect averages and cannot be taken as truth for selected cities or utilities. Figure 1 shows data published for developing European countries and developing countries. As one might expect, water losses in most developing countries are quite high (up to 90 %), due to poor operations and maintenance of existing facilities. The low rate of water losses in Germany (less than 8 %; some utilities are around 3 %) are resulting from the high financial budgets available for utilities, and the fact that the German tariff system allows full cost recovery for structural maintenance, without any significant problems of tariff collection. For sure, this is a strong economic incentive towards extensive WLR-P.

Water losses in %

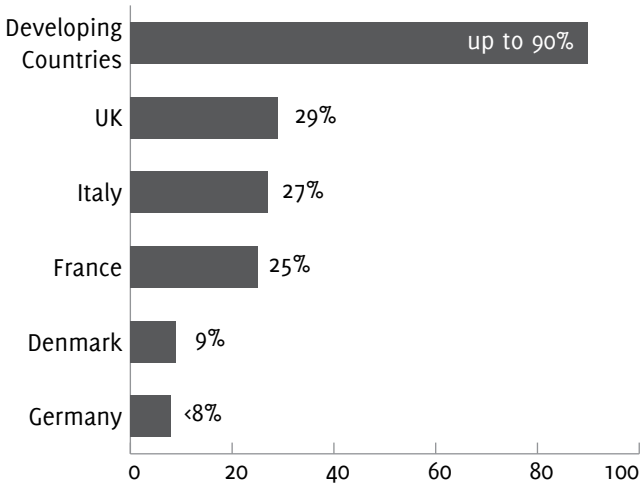

Figure 1: Water Loss Figures from Different Countries.

Source: BGW 2004 u.a.

Years ago, an expert team from the World Bank made a tour through Germany and criticised that German water utilities have realised "uneconomically low water losses". The discussion at that time was that ca. 15 % of water losses would seem economically feasible under the conditions of the region (where water is not scarce; the recommendation would probably have been lower for countries which need desalination to produce supply water).

The German utilities, being criticised to overstretch their WLR-P to non-economic low water loss rates, argued that low water losses are an indicator for good network

maintenance, and that well-maintained networks have a longer lifetime and less repair costs.

At any rate, even if 15 % might have been justified a decade ago, the present "assumed optimum" might well be 4 %, or so,

- because of increased costs for supplied water (production + distribution), especially power and regional water shortages,
- because of improved technologies for water loss reduction (WLR), e.g. for leak detection, trenchless rehabilitation, automated metering, asset management etc.

Figure 2 includes guide figures from German standards, for water losses in [m^3/h · km] which might serve as first orientation whenever no other economic considerations or data are available. These indicate that percentages below 7 % are reasonable.

German Standard DVGW W 392

Water loss category	Approximate sec. water losses qvr in m3/h-km		
	City	Town	Rural
Low water losses	<0.10	<0.07[2]	<0.05[1]
Medium water losses	0.10 – 0.20	0.07 – 0.15[3]	0.05 – 0.10
High water losses	>0.20[5]	>0.15[4]	>0.10

Figure 2: "Reasonable" Level of Leakage

Remarks:

1 Hardly Achievable

2 Very good maintenance, new systems

3 Achievable with technical/operational measures

4 Maintenance not efficiently performed

5 Maintanence or/and system in poor condition. If >.30

2. A STANDARD APPROACH OF COST:BENEFIT-ANALYSES

The CBA-method of "first choice" is usually a comparison of WLR-costs with WLR-benefits, measured as reduced costs for water production, according to reduced leakages. Figure 3 visualises the results of a CBA for a city, which could avoid water desalination, if the water losses were reduced below 30 %. From this level, the cheaper water from a river dam in the mountains would be sufficient to meet the demand.

Leakage Rate to costs for water loss reduction and substitution

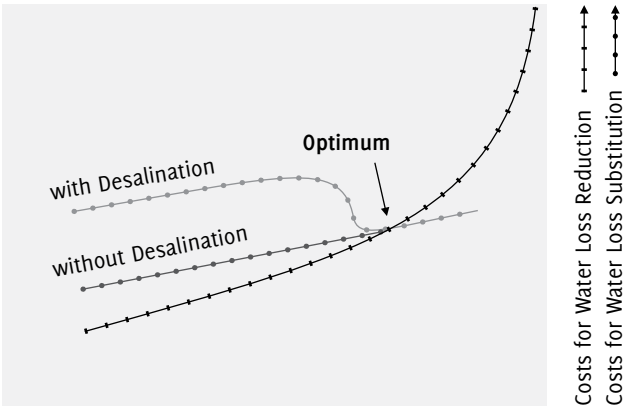

Figure 3: CBA (Cost:Benefit-Analysis) for WLR-P

Another CBA approach is to compare the specific supply costs for different levels of water loss reduction, which is usually going along with equal levels of technical failure. Figure 4 shows a calculation of specific supply costs in two different networks (a) current situation for a large Asian city and (b) a calculation for the technical stages equal to high quality equipment and maintenance, like often achieved by water companies and water utilities in Germany (like Gelsenwasser, Huber, Remondis, Siemens), Europe and other countries. It can well be understood that leakage and technical failure inflates the specific cost per water delivered enormously. Although higher costs for equipment might lead to a higher overall CAPEX of additional 15 % (note: civil constructions unchanged), the resulting costs per cubic meter are much lower (€/m^3 1.33 for high quality compared to €/m^3 4 for poor quality).

A) Theoretical CAPEX	=	1€/m² ≙ 1€/1000 l
Leakage rate 45%	≙	450 l lost
Technical failure 30%	≙	300 l lost
		750 l lost
Real CAPEX	=	1€/250 l
	≙	4€/m²
B) Theoretical CAPEX	=	1.15€/m² ≙ 1.15€/1000 l
Leakage rate 8%	≙	80 l lost
Technical failure 6%	≙	60 l lost
		140 l lost
Real CAPEX	=	1.15€/860 l
	≙	1.33€/m²

Figure 4: WL and Cheap Technologies cause Surplus Costs

For developing and transformation countries, especially ones that are dry and have scarce water resources, the definition of major cost components should reflect the specific situation onsite. This applies to labour costs (maybe near

to zero for low-skilled labour in national economies with high unemployment), on electric power (in various countries, power is still subsidised and does not reflect the real values, which should be considered in a CBA), on imports and foreign currency exchange rates (local products may be advantageous under certain national-economic conditions), on natural resources (like land used for plants to substitute water loss reduction) and on the calculation focus (any CBA should clearly indicate what is considered to be OPEX and CAPEX, especially regarding the difference between operational and structural maintenance, and whether the focus is on micro-economic or macro-economic issues).

Furthermore, a CBA should not be limited to public expenditures. Whenever water supply services are not reliable in continuity and pressure, the private customers are bearing significant surplus expenses e.g. for booster pumps, roof storage tanks etc. These surplus expenses (in one case: $/m³ 0.50 water sold) are often much higher than the expenses, which the (usually public) utility would have had to spend for appropriate water loss reduction programmes, structural maintenance and network rehabilitation.

3. SPECIFIC REQUIREMENTS FOR CBA IN DRY AND DEVELOPING COUNTRIES

Revising about two dozen cost: benefit-analyses (most of them donor-funded) in the frame of research projects funded by the World Bank, the EU and the German Federal Ministry of Education and Research, IEEM (the Institute of Environmental Engineering and Management headed by the author) found that 17 were not appropriate in economic and methodology and/or regarding the input data. This may have led to unfair decisions regarding

- wastewater pond systems versus activated sludge technology,
- decentralised versus centralised systems,
- water loss reduction versus desalination plants.

4. SURPLUS DAMAGES THROUGH TECHNICAL LOSSES

The following figure 5 shows that the costs of failures from leaking or even collapsing pipe network exceed the savings in expenses for structural maintenance and rehabilitation(s). And emergency repair *after* failures have happened will generate significant surplus costs, especially for accidents, through destabilisation or foundation, through road collapse, through wetting of buildings, electric appliances etc., through damage of trees and greenlands, by flooding, hygienic risks or even diseases, odour nuisance, for clean-up costs of flooded areas, for emergency surplus costs etc.

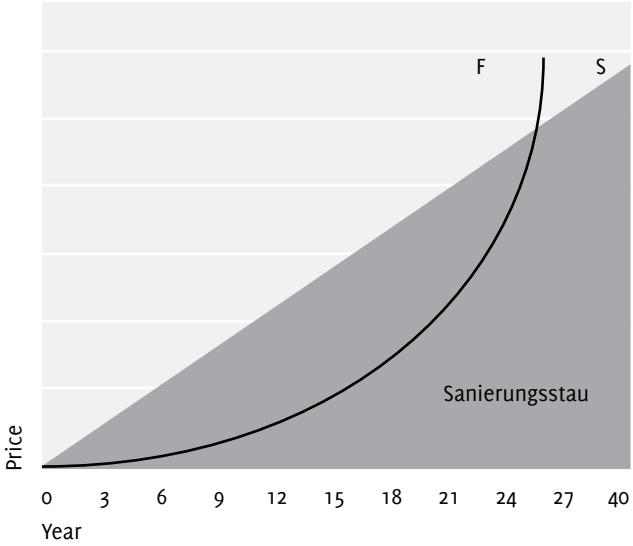

Figure 5: Damages through Technical Losses

5. SURPLUS DAMAGES THROUGH ADMINISTRATIVE LOSSES

The administrative losses, e.g. through water theft or non-payment of supplied water, according to the valid tariffs, is in no way limited to the loss of revenues on behalf of the water utility. The surplus effects are much more severe, like

- excessive consumption
  (Who does not have to pay, will not save water, and this will finally lead to water shortage, hitting usually the poor and sub-urban population)

- llegal water trafficking
  (In many cases, it was found that illegal water trafficking is likely to happen in those supply areas where administrative losses are not dealt with. If the water utility does not fight for proper payment through the water customers, somebody else will step in - leading to structures often described as "local water mafia".)

- unwillingness to pay/to charge
  (Wherever there is little revenue, the incentive on behalf of decision makers and managers to decide on appropriate water tariffs and search for appropriate billing and collection is hampered.)

- Finally, administrative water losses above a certain level will lead to financial destabilisation of the water utilities and prevent the development of sustainable water services.

This may result in a situation which can be called "the vicious circle in water & sanitation" (see Figure 6).

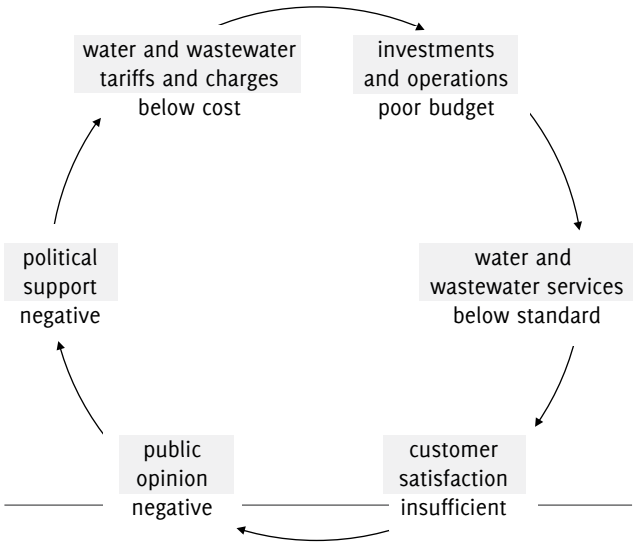

Figure 6: The Vicious Circle in Water & Sanitation

In many developing and transformation countries, water tariffs are below costs. The utilities have to work with insufficient budgets. But, with an insufficient budget, investments and operations are below needs, which leads to poor water services, bad customer satisfaction and a negative public opinion. As a result, the political support ("willingness to charge") to decide on cost-covering water tariffs, cannot be expected. This vicious circle could be broken if all water produced reached the paying customer.

In other words: A proper water loss reduction programme is an essential pre-condition to achieve sustainable water services.

6. PUBLIC RELATIONS AND WATER LOSS REDUCTION

There are several reasons why water loss reduction programmes are not attractive for public relations and decision makers depending on public votes:

- Water loss reduction *activities* are either invisible to the public, or disturbing.
- Today's politicians will be made responsible for costs and disturbances of water loss reduction programmes, whereas the benefits are for tomorrow.
- Serious "package *solutions*" are not yet on the market, for easy handling by the client (apart from some very new IT, GIS-based service products).
- *Lobbying powers* are focused rather on large investments (e.g. desalinations, dams), than on water loss reduction programmes as a business target.

75 % of total costs are usually for distribution, only 25 % for production of water. Operations and maintenance, especially water loss reduction programmes, are often neglected in budget making. Water loss reduction programmes usually receive only 10 % to 30 % of the calculated needs in budget expenditures (estimated average).

The question is, how to better promote water loss reduction programmes. Probably the following activities are necessary:

- Raise awareness, education, training;
- Eradicate intransparencies and populism;
- Promote financial benefits of water loss reduction;
- Create reliable "package solutions";
- Enable the local business.

The last issue is of outstanding importance. Franchise might be one option to change the acceptability. Of course, until now, only experienced international players would be able to deliver an overall, reliable success-oriented package for the water loss reduction in urban networks. Instead of hiring such international large com-

panies (who are not always favoured by local decision makers), it might seem better to hire local and smaller business, enabled through franchise contracts by the professional international players. This approach is different from the conventional scheme, to assign the international player, who would then sub-contract local SMEs to whatever condition and durability.

7. ACKNOWLEDGEMENTS

This paper includes results and findings from research projects and studies sponsored by :

German Federal Ministry of Education and Research, Project No. 02WT0354. German Federal Ministry of Education and Research, Project No. 0330734A. German Federal Ministry of Education and Research, Project No. VNM 07/004. The European Union, Project No. TH/Asia Pro Eco/04 (101301). The European Union, Project No. ASIE/2006/129-100. The World Bank, Project No. 1539

The author would like to thank these institutions for supporting the work on the important issue of water loss reduction.

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Solution oriented capacity development towards IUWM: focus on water loss reduction

By Prof. Dr. Günter Klein, Head of Water Strategy Initiative Office, Aerospace Center, Germany

ABSTRACT

Water supply at global scale is facing three major challenges:

- The Water and Agriculture Challenge
- The Water and Industry Challenge
- The Water and Urbanization Challenge

For each of these fields the prognosis seems to be daunting: How can we expect, or create stability, in the light of poverty, climate change and demographic change? However, on each of these areas, there are examples of excellent performance at high economic efficiency and good feasibility to be found and to be communicated.

For the 50 % world population, presently living in urban settings, water supply is crucial for life and health. Through individual and institutional capacity development many cities across the world enabled their citizens to cooperate effctively for achieving safe and reliable water supply.

However, roughly one third of the water provided to urban drinking water distribution systems is either lost through leaks, or not included in the revenue and financing system. This pattern can be changed. The workshop "Control of water loss in distribution systems" is about sharing experience and joining forces towards delivery of the common goal "water for all".

Five tasks have been identified:

1. Make the economic benefits of proper water systems maintenance visible to all stakeholders
2. Make the positive political power of adequate water supply for all visible
3. Make the better choice the easier choice
4. Find appropriate solutions to any economic, climatic or cultural context
5. Find a convincing approach to enhance human capacity towards valuation of water as the essential element for all life processes

1. INTRODUCTION

No wealth and no health without understanding the role of safe water!

One of the key-elements to success in all countries and societies in the world, and in history, was and is the proper handling of water. Experiences gained in many industrialized countries over the last centuries need to be made available at the earliest possible stage. Sustainability will only be achieved when the global society works together and avoids the repetition of mistakes, especially those, that harmed the natural resources irreversably. The ways, in the past, that many industrialized countries have chosen to solve water quality and availability problems, and the ways in which these solutions are presently implemented – or not implemented - under the new challenges like ageing societies and climate change, also pave the way for future learning approaches towards meeting the global challenge (Klein 2008).

Ongoing debates about a human right to water indicate that therer might be a new, and innovative approach: The essential needs of human beings cannot be put under legal, or economic criteria. Basic preconditions for life include safe and reliable water supply. This is not negotiable, neither between individuals, nor between countries.

It is, therefore, essential to handle water ressources everywhere in the world as part of the global inheritage for life. Living systems are open systems, with various entrypoints for ressources and energy. Where it is necessary, organisms and living structures organize the use of resources with highest efficiency. Living structures of human beings, like urban agglomerations have to organize their use of water resources in a similarly efficient way. Ensuring adequate water supply and control of water loss it as important for urban systems as it is for individual organisms. Without water supply we don't make it longer than 3 days, with unhealthy water humans don't survive much more than their first three months. With enough water of sufficient quality we can make it 100 years, and our urban systems can

survive many centuries, as long as water supply is not destroyed. Like the blood veines in our body, the water distribution system of any urban agglomeration has to be kept clean and without leaks. With such an understanding this workshop will lead us towards healthy and human urban water management approaches.

2. MEETING THE WATER AND SANITATION TARGET? THREE BIG CHALLENGES!

UN World Water Day 2007 stood under the heading: Dealing with water scarcity. While the "average" policy maker and journalist would associate this problematic challenge with illustrations of desertified landscapes, or with farmers looking sadly at their dying plants during drought periods, the focus of solution oriented professional work is more and more directed towards three major fields of action: Where has water scarcity been created?

- The Water and Agriculture Challenge
- The Water and Industry Challenge
- The Water and Urbanization Challenge

This approach takes the water issue away from problem analysis and description of catastrophies. It leads, instead, towards solution oriented work in a global partnership. And it will provide orientation to those institutions nad organizations, who teach the future constructors and managers of water systems, engineers, accounters, or plumbers.

Each of the three big challenges has to be taken in the understanding, that they are inevitably linked. No progress will be achieved in the long run on either of these fields without taking the other two seriously into consideration. It will be of crucial importance to develop a future oriented understanding of a constructive and productive relationship between land use, and industrial and agricultural use of water as part of the global, regional and local water cycles, in comparison to the perceived, or provoked, competition for water resources. It has been sufficiently and convincingly demonstrated, that conflicts, and even armed conflicts around water, have been, and will be artificial (Shuval et al., 2006).

Technical and economic excellency wanted!

However, at the same time, we need to recognize the needs to deal with each of these challenges individually, and case by case, in a technically and economically professional and adequate way.

No doubt, that huge regions are suffering most from wastage of water via inappropriate structures for agricultural irrigation. The technical and organisatorial solutions are available, but not widely implemented.

No doubt, that economic growth and industrial development needs water of adaquate quality and sufficient quantity. Technical solutions exist, and have been applied, for ensuring econmic growth and raising the water efficiency, and thus decoupling industrial expansion from water demand. Increasing production of steel, cars, paper or any other product does not need increasing amounts water: The majority of successful economies has increased the product output and at the same time reduced water consumption, in many cases by one or two orders of magnitude, in some cases down to almost zero.

Optimizing internal processes – for securing external support

In the former two fields, the link between productivity and provision of water in adequate qualtiy and quantity has been well described, or, vice versa, the lack of success due to failure of appropriate water management is obvious.

The understanding of the economic and ecologic value of efficient water use in urban systems seems to be less developed. The aim of this workshop is, to raise awareness, that

- Water stress in many agricultural settings has been created by water abstraction for urban agglomerations' water supply.
- Discharge of sewage from urban agglomerations has disrupted regional water cycles and has polluted water resources substantially.
- Construction for dwelling and transport has closed land surface, thus converting areas that had been water collecting or storing into areas of rapid water discharge.
- Water availability for urban agglomerations is strongly depending on undisturbed functions of aquatic systems in the surroundings.
- In the overall context of IWRM, integrated urban water management (IUWM) plays a major role - either by wise use of (their own) existing resources, or instead, by wasting them and exploiting other peoples resources for life.

Thus, by stabilizing these peri-urban functions, urban systems can avoid entering a self-damageing cycle, which needs to be, and can be interrupted. One major contribution towards this end is the efficient use of water within the urban system, and prevention of avoidable loss through an Integrated Urban Water Management approach. Distrubution systems can be maintained and managed in a way, that less than 10 % of water loss are economically and technically feasible. Higher losses are not only ecologically questionable and a violation of human rights and global targets like the MDGs, but they are at the same time economically insane and damaging. A global learning exercise is needed, to make the tools for solving the problems related to this challenge available for the management of any city – small towns as well as the big mega cities and urban-industrial agglomerations.

The only productive way of water related interaction is cooperation. Therefore, this article is directed towards progress in common sense, good governance and the necessity to cooperate – to the benefit of all. Adequate cooperation for water instead of competition has only winners, no one will loose. This approach needs the competence of all stakeholders, to act in such a way, and to fully understand their respective gains in the long run. Many ideas have been developed and publisheed in one or the other language and country, however, the vast majority of actors in needs do not yet have access to the most appropriate capacity development tools.

This chapter is about a new attempt of the world communitiy to enhance the capacity of all professionals involved, from the plumbers and farmers towards the water sytems managers and decision makers at local or national level, driven by the UN Water networks and the Global Water Partnership commitment under the MDG:

Goal 8 Develop a global partnership for development

- Environmental health interventions can make a valuable and sustainable contribution towards reducing the global disease burden and improving the well-being of people everywhere
- Many interventions can be cost-effective and have benefits beyond improving peoples's health, benefits such as helping to alleviate poverty and reducing gender inequalities

2.1. IUWM - Integrated urban water management – a feasible approach worldwide?

As described above, the water system management under the IWRM approachs needs to take all aspects into account. However, at each individual point of the global system, adequate and specific action is needed, and excellent performance at any point of action is necessary. We have, therefore, focussed this pesentaton on one of the three big challenges for the following reasons:

Solution oriented works needs ressources – not much, but well focussed

Many cities across the globe gather a magnitude of wealth and economic dynamics in their modernizing centres. Here, provision of sufficient water and sanitation seems not to be an issue, and it is not at all a question of economic feasibility. The cost for water supply in these centres is negligible in relation to the economic turnover characterizing business in these places. However, many of these urban centres suffer from bad maintenance of distribution systems, sometimes combined with bad compliance with financial regulations. In the majority of cases, a suitable system for water pricing has not even been established.

As can be shown by analysing many cities in industrialized countries, the most excellent systems of control and maintenance of urban do not consume more than some 2 – 3 % of the average income. A new economic analysis is needed: cheap is excellent, excellence is cheap!

However, why is reality so sobering? What is missing?

Lack of collaboration at the urban-rural interface

The loss due to leakages and the economic loss due to unaccounted water flow amounts to an order of magnitude between 25 and 50 % of the collected and distributed water. In many of the 100 mega cities with about 5 or more million inhabitants, some 250 to 500 million m^3/year of clean and safe water are either lost or not paid for. Saving just those losses caused by leakage, would be sufficient to provide another 10 - 20 million people with safe water services – in each of these cases.

While some big urban water suppliers e.g. in Germany manage to keep their losses below 5 %, there are far too many other places, where neither a system of continuous

maintenance, nor an effective system for leakage control has been established.

The opposite has "happened". Instead of implementing such a solution oriented approach additional problems have been created. Compensation for these losses has been taken from outside. The construction of new dams, abstraction of groundwater, and competition with local supplies and farmers in the peri-urban belts, puts additional stress on those people who form the human resources for the economic progress and success of the central urban areas. It should be noted, that these processes were not just "happening", but they were "actions" implemented on the basis of decisions against a more sustainable and future oriented approach. (Klein, 2008, in press)

Models of cooperation between the urban and the peri-urban and the surrounding communities, who provide the ecological basis for water and food supply, have been implemented. The successful ones have been based upon on a case-by-case analysis and cooparative decision making process. Case studies can be shown, having been implemented for many decades, and proven successful (e.g. Ruhr-Verband in Germany http://www.ruhrverband.de/ruhrverband_en/html/index.html). It is in the interest of the world community to look at the potential of theses study cases for averting the future projection of stress and competition at the urban-rural interface.

2.2. Capacity development – solution oriented towards effective control of water loss

The need to control the loss of water and to attach importance to sustainable maintenance of water supply all over the world, particularly in urban areas (with old and fragile pipes), is getting more and more well-defined in the domain of science and stakeholders. The example of cities like e.g. Teheran, where the unaccounted flow of water amounts to some 250 – 300 mio 3 out of the 1 billion m 3 provided, every year, or the Capital District of Mexico with impressive water losses of 12.8 m^3/s (roughly 360 Mio M^3 per year) applies to many other cities across the world. This magnitude between 30 and 50% of loss rate reflects the extent of the avoidable stress.

In the case of professionally operated plants the unavoidable operational and technical loss (dish water, pipe burst, accidents, etc.) amounts to around 5 to 12%, in the case of institutions under top management with implemented strategies and technologies it can decline below 5% (e.g. Gelsenwassser AG). Cities that suffer from bad maintenance of distribution systems (e.g. due to an insecure political situation) document losses from permanent fraction and leakages between 30 and 40%. Even countries with reliable water resources can be cornered in consequence of dry seasons (e.g. South-England 2007) or pressure fluctuation (Eastern Europe); additionally, illegal withdrawals amplify the problem.

The costs for distribution systems and employees for maintenance and care amount normally for more than 50% of the water pricing. Without this investment the adequated water supply would not be conceivable and the consequential charges would be incomparably higher (illnesses, downtime, loss of confidence).

The cost for reconstruction and maintenance of sustainable distribution systems amounts into the billions, which at first glance, looks tremendously high. However, regarding the social and financial burdon on households on one side, and the costing for adequate operation and maintenance of water supply systems well below 1% of the middle income all over the world on the other side, there is the need for transparency showing the true cost, regardless how the institutional arrangement of managing the system is structured. Privatisation of publically driven water supply services is not automatically a helpful strategy. This is especially true, where the urgently needed sustainment of water systems will be carried on by the municipality which may be financially weak and short in professional staff.

2.3. Linking technical progress with global networks for capacity development

Many cities across the world have developed long-term strategies towards the reduction in losses. In order to support the fulfillment of the Millennium Development Goals, control of leakage and water losses needs exchange of experience. This workshop will bring together providers of innovative technical tools, water supply companies, technical and organizational managers from around the world who are willing to engage in partnership for Capacity Development under following topics :

- Cost benefit analysis of maintenance, leakage control and detection of unaccounted flow

- Illustration of concepts for sanitation of distributions systems, case studies, benchmarking and indicators
- Declaration on International cooperation and work program for Capacity Development to control and minimize the water loss, target group-specific training programs (module), regional conferences
- Reports based on successful application (and failures) in sanitation and permanent operational reliability
- References to successful sanitation projects and application of modern technologies
- Concept development for group-specific training modules for application in e-learning and training workshops

Sharing experience and creating indicators for good performance will hopefully enhance the willingness of those in charge of building and maintaining of water distribution systems to improve their own local situation. In order to facilitate that on the basis of convincing knowledge, the focus of the UNW-workshop will be directed towards solution oriented capacity development on:

- Economic aspects of Drinking Water Loss reduction within Integrated Urban Water Management (IUWM)
- Technical and structural Interventions for long term Rehabilitation of Drinking Water Distribution Systems
- Political and administrative solutions
- Tools for capacity development

The future orientation will be directed towards

- Regional workshops
- Training Modules and e-learning curriculum
- Session on Drinking Water Loss reduction at WWF 3 in Istanbul 2009

3. ASSESSING THE NEEDS AND DESCRIBING TARGET ORIENTED TOOLS – FIVE (NEW?) TASKS

The preparatory process of the workshop has helped to distill the following tasks and areas of urgent action in capacity development :

Task Nr. 1: Make the economic benefits of proper water systems maintenance visible to all stakeholders:

- Consumers, who need and deserve reliable water supply 24 hours, every day
- Finance managers of cities or water supply companies, who are in charge of a reliable water supply
- Industry managers, whose success in business depends on a functioning infrastructure and a healthy workforce
- Regional managers in charge of infrastructure and physical planning
- Managers of financing institutions (including international development banks), who need to depart from non-sustainable and short sighted funding strategies.

This task still needs to be structured and delivered. The professional economic training and capacity development worldwide is still trapped in old-fashioned attitudes of "competition rather than action in partnership". And a new focus needs to be given to so-called "environmental economy". While a small group of "green" economists struggle to get their approach of analysing social and long-term cost of action, or rather in-action to the forefront of economic policy making, they are confronted with two traditional scools: those who try to handle the fall-out of misleading competition strategies by sharpening their own (and ineffective) tools, and those who build their thinking upon the motivation and optimization of hedge funds and interest management, thus making more money out of money, and as a (desired) side effect pushing for the drain of resources from public and state financing.

Task Nr. 2: Make the positive political power of adequate water supply visible to all

This needs new training approaches for policy makers at all levels. Sharing experience with those cites, either under long term stable conditions (e.g. Gelsenwasser in Germany) or unter political and economic transition (like Sachsenwasser in eastern Germany, former GDR, or Budapest, Hungary, during the transition from the cold war period into the accession to the European Union) can demonstrate the power of safe water supply as a tool for promoting social stability and social justice. And this has been demonstrated to be feasible within "human" time horizons: not centuries of hope, but a few years or a

decade of action. It is the strong wish of the public, and identically the strong wish of each individual and family, to build their lives and the health and wellbeing of their children upon a sustainable and reliable supply with safe water: 24 hours a day, 365 days every year. Based upon existing studies, the feasibility and the economic sustainability of safe and reliable water under all political and economic conditions can be communicated to managers and policy makers in charge. This message needs to be carried into the education schemes of many professions, from child care, through school and secondary education right the way into the learning programs of lawyers and engineers.

Task. Nr. 3: Make the better choice the easier choice

Technical means have been developed, to make the lives of technical and organisational staff easier. Remote sensing instead of digging, remote data collection via satellite, instead of touring through the country, in–line leakage detection and repair instead of boreholes and ditches for replacing old pipes. And of course: getting safe water from the tap all the time, instead of walking and waiting hours and hours - for unsafe water.

All these tools have been developed and applied in "wealthy" countries under financial stress. The managers of water works have been scrutinized to reduce their cost, and the way to do so is being more effective, avoiding mistakes (others had made before) and well known traps. Sharing experience and benefitting from the experience of others who went through similar challenges has created a solution oriented professional partnership. National and local networks had gathered and distributed experience and training materials, which have been made available to colleagues in partner countries, not the least through effective collaboration via networks such as the IWA networks.

Task Nr. 4: Find appropriate solutions in any economic, climatic or cultural context

We leave no doubt: physical laws are governing the behaviour of water like any other natural process. Human societies have no choice, and those have the best and most sustainable progress, that manage best to harmonize human activity with the universally valid rules of natural processes. Just as a reminder: human water use deals with some 0.2 % of the annual turnover (precipitation of rain and snow on land surface, feeding groundwater replenishment, flow through rivers and lakes), and this global cycle is moving not more than 0.3 % of the worldwide existing fresh water resources.

The true challenge lies with local and regional management of human water use within this tremendously rich and never ending flow of the water resource. Urbanization is one of the most dynamic human processes with a greatest potential to improve human living conditions, but only within the limits of the naturally given rules.

Task Nr. 5: Find a convincing approach to enhance human capacity towards valuation of water as the essential element for all life processes.

Water loss in man made water distribution systems is one of the easier avoidable violations of natural and physical rules, among the long list of examples of non-sustainable management of natural resources. Many individuals have learned their lessons; however, they did not find an easy approach to make happen what they felt necessary. Institutional capacity development will be one of the key processes towards more sustainable management of water distribution systems. All hands and brains and all professions are needed to deliver this, and they need to be well trained towards this end.

Academies, scools and institutions for vocational training and education have delivered a substantial collection of products. Only few of them take the essential element water into account – it seems to be taken for granted. Global networks for vocational training and education reach out to more than 150 countries worldwide. (e.g. through UNEVOC http://www.unevoc.unesco.org/snippet.php) However, following a very recent analysis of the areas of work, only one (!) country project was dealing with vocational training in the professional fields of water supply. This limited offer needs to be expanded, and then to be grasped by local and regional authorities, thus enabling them and their staff to do an even more effective job.

UN-Water has been invented under the leadership of then UN Secretary General Kofi Annan with the aim to make the many agencies join their forces, their knowledge and potentials. (http://www.unwater.org/flashindex.html) UNW-DPC has become one of the fruits of this integrating attempt, aiming at improved capacities world-wide for serving the MDGs, all of which are de-

pending on reliable supply with safe water (http://www.unwater.unu.edu).

Urban centres have been sources of knowledge and social power throughout human history. They have the potential to kick off a new understanding of responsibility for the water resources all over the world. Half of the world's population now living in urban agglomerations need a better and convincing approach for themselves, which will also be convincing for those living outside these agglomerations, and they should be released from carrying the burden of improper management of their resources.

4. CONCLUSION

Plugging the Leaks! Learning how to multiply efficiency at low (no) cost!

According to a report delivered at the WWF in Mexico by Transparency International, roughly 30 % of financial aid investment into water and sanitation has disappeaed through corruption channels. According to reports delivered by various national and international Institutions, many urban water supply systems lose between 20 and 50 % of the water in the distribution system, where it is mixed with leaking sewage.

Water and sanitation efficiency can be raised by closing the leaks where one third of the money and one third of the water are disappearing. Without additional funds, without additional raw water.

Plugging the leaks means: getting more and better life out of the given resources.

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Case Studies

Map of participating cities


Leipzig, Germany
Ruhrgebiet, Germany
Budapest, Hungary
Sofia, Bulgaria
Tehran, Iran
4/5
1
2
3
Lalitpur, Nepal
Gwalior, India
Abu Dhabi, UAE
Kampala, Uganda
Lusaka, Zambia
1 Alexandria, Egypt
2 Sharkia Governorate, Egypt
3 Rammalah, Palestinian Authority
4 Amman, Jordan
5 Mabada, Jordan

Uganda: City of Kampala

Incremental efforts to address the challenges of water loss reduction in water supply systems: The NWSC Uganda Experience

By Dr. William T Muhairwe, Managing Director, National Water and Sewerage Corporation and Mahmood Lutaaya

ABSTRACT

Water loss reduction in the water supply systems remains a daunting challenge for many utilities especially in developing countries. A number of initiatives have been undertaken in a drive to address this problem and the success rate varies from utility to utility. Overcoming this challenge requires careful attention and understanding of the different factors influencing the successful implementation of water loss reduction initiatives. National Water and Sewerage Corporation (NWSC) is government parastatal mandated to provide water and sewerage services in the large urban water centers in Uganda, on a commercially viable basis. Over the last ten years, the corporation has implemented a series of internal reform initiatives geared towards improved operational efficiency and service delivery. Water loss reduction within the water supply systems has been one of the key focus areas of the reforms.

This paper outlines some of the fundamental approaches undertaken by NWSC in addressing the challenges of water loss reduction. The incremental initiatives undertaken encompassing a combination of technical and institution strengthening solutions have registered positive results. The NWSC experience demonstrates the importance of cultural, stakeholder engagement, use of the right incentives and devolution of responsibility and decision making in fostering innovation, competition and in ensuring successful implementation of water loss initiatives.

1 INTRODUCTION

Many utilities especially in developing countries are faced with an enormous challenge of reducing water losses in the water supply systems. The need to address this challenge is of particular urgency due to the pressure exerted on the limited available water resources from the increasing population and the fears of the impact of climate change. A number of initiatives have been undertaken by different utilities in a drive to address this problem but the success rate varies from utility to utility.

National Water and Sewerage Corporation (NWSC) is a public utility company set up in 1972 with the mandate of providing water and sewerage services on a self-sustaining basis to the large urban centers of Uganda. The corporation currently operates in 22 large urban centers in Uganda, including the capital city Kampala, and has a total of over 200,000 water connections and service coverage of 72 percent.

Prior to 1998, the corporation with financial support from donor partners carried out significant investments and rehabilitation of the water supply system. However, these investments were not matched with the necessary efficient operation and management systems that were needed to ensure sustainable service delivery. The performance was inadequate with the corporation facing numerous challenges including high levels of water losses that compromised its ability to deliver effective and efficient services.

2 SITUATIONAL ANALYSIS

A critical analysis of the existing situation carried out in 1998 revealed three major causes of the poor performance and the high levels of water losses: poor management, cultural problems and technical problems.

Poor management

The corporation lacked effective and comprehensive institutional management systems to guide day to day

operations and future planning especially in respect to addressing the challenges facing the corporation. The implication of this was that the resources and assets of the corporation including the staff were not planned and managed in such a way as to timely and effectively react to and address the challenges including water losses in the system. The poor management was particularly reflected in the expensive and inefficient workforce that came at the expense of maintaining the facilities. The consequence of this was that the water systems were operated without adequate maintenance resulting in poor service provision.

Cultural problems

The work culture and mindset of the employee was characterized by an "I don't care" mentality, with most staff actions significantly at variance with the organization's goals and objectives. This debilitating corporate culture tended to undermine productivity and performance as well as organization harmony and cohesion. The top down approach used in designing most of the activities and taking decisions tended to harm ownership and hence the successful implementation of most initiatives. As a result there was a poor response rate to the few leakages that were reported. There was also uncontrollable and widespread vandalism of meters and other components of the water system which not only increased the level of water losses but also increased the cost of delivering the services. A big percentage of customers were consuming water illegally and there was no clear mechanism for tracking such culprits let alone measures to curb such practices.

Technical problems

The water supply network had suffered a period of neglect with little or almost no maintenance. This was attributed to the limited financial resources and poor management. The result of this was frequent leakages and bursts in the network which took almost two weeks before they were rectified. The distribution network did not have established hydraulic zones which made it a nightmare for network balancing and effective management of water losses in the system. Due to the high losses in the system and poor operational practices, most of the towns experienced intermitted services ranging from 15-21 hours. In addition, the system used for measuring water losses was unreliable with most of the bulk meters at the inlet and outlet of some of the plants and reservoirs were old and non-functional. The few existing customer meters were also defective and registering inaccurate readings due to the poor maintenance culture and lack of a clear meter replacement policy. The quality of materials used and the workmanship was poor leading to continuous breakdown of the network.

3 INITIATIVES UNDERTAKEN TO ADDRESS POOR PERFORMANCE AND REDUCE WATER LOSSES

Given the multifaceted challenges facing the corporation at that time, the strategic approach adopted was to use innovative approaches that included effective change management initiatives, operational initiatives to reduce water losses, stakeholder involvement and institutional strengthening approaches.

Change management

A series of short-term and action oriented change management programmes were introduced to address some of the technical as well as the institutional challenges including work methods and organization culture. The short term programmes included;

100-Days programme

focused on fixing all the visible leaks in the network as well as replacing old and faulty bulk meters at the treatment plants and reservoirs. These actions were considered as the cheapest and first steps to addressing water losses. The programme also impacted positively on enhancing the corporate image and caused a revolutionally thinking in the working culture and attitude of the staff.

Service and Revenue Enhancement Programme (SEREP)

SEREP was designed to consolidate the achievements of the 100-Days. In addition, SEREP recognized the centrality of all stakeholders especially the customers and the general public in fighting water losses. The programme therefore focused on sensitization and mobilization of public support to the efforts of the corporation especially addressing leaks as well as handling illegal connections.

Area Performance Contracts (APCs) and Internally Delegated Management Contracts (IDAMC)

Incentive based performance contracts were introduced in form of APCs and later IDAMCs to enhance account-

ability and clearly define the roles and responsibilities of the key players. The contracting arrangement promoted decentralization of decision making and increased autonomy to the operating units.

Cultural change

There is an underlying premise that without cultural change, it might not be possible to achieve significant improvements in performance. The corporation introduced the *Stretch-Out* concept to address the challenges of culture change. Stretch-Out inculcated a strong element of "worker involvement" in planning and decision making to enhance transparency and strategy ownership. During the workouts or brainstorming sessions, ideas were evaluated based on their merit, not on the individual who generated them. This enhanced self confidence and created a sense of appreciation. Stretch-out helped to create teamwork and promoted a bureaucracy free environment with minimum external interference. The stretch-out programme was later reinforced by the *One-Minute-Management* concept that focused on individual accountability within the group and each staff was required to have individual vision, mission and one minute goal.

In general the above short-term programmes encouraged ownership, collective decision making and a balanced bottom-up and top-down management approach.

Operational initiatives to water losses reduction

A substantial amount of the water losses in the system was attributed to illegal use but without well established hydraulic zones and demand management system, it was not possible to establish the percentage contribution of illegal use to the water losses. In an effort to curb down on the rampant illegal use in the system, dedicated and well facilitated illegal use management units were established in all operating areas with clear outputs that formed the basis for their remuneration. The units are responsible for identifying and taking proactive action on all illegal use cases in the respective areas. Regular spot checks are also conducted especially on large customers and construction sites.

The organization structure of the operating units was also streamlined to emphasize leakage control as a function and leakage management teams were established with clear areas of responsibility and expected outputs. The teams' activities are enhanced by fully fledged call centers that are the registration points of all reported leaks and bursts which are immediately routed to the responsible leak management teams. This approach has significantly reduced the response time to leaks to within two hours. The procedures to meter management and replacement were reviewed and a meter management policy established that clearly defined the maintenance procedures and ensured correct levels of maintenance for both customer and bulk meters with well defined life span for all meters in the system.

A policy for new water connections and service lines maintenance was established with the objective of increasing access, standardizing materials, ensuring good workmanship and promptly responding to leaks on service lines. This policy drastically increased the number of new water consumers due to the reduced access costs and there has also been registered reduction in the number of leaks on the service lines.

Stakeholder involvement

Utilities cannot win the fight against water losses on their own, there is always need for support from all stakeholders. The corporation therefore made efforts to link up and interact productively with the different stakeholders. This was done through a series of structured platforms such as the media and strategic alliance meetings to create awareness and sensitize the communities on their role and the corporation's efforts to improving service delivery. Amnesty programmes were also initiated in an effort to address illegal consumers. Incentives and reward schemes for individuals who reported illegal consumers *($32 for commercial illegal consumers reported, $20 for domestic illegal consumers reported & $3 for cases reported by staff)* and leakages *($1.5 -3 per case reported)* were also introduced. An individual found with an illegal connection is fined about USD 305 and billed for two years estimated consumption.

The private sector especially the legal firms were engaged to handle on behalf of the corporation cases of illegal connections or nonpayment that could not be amicably settled with the corporation. Strategic alliance with security agencies like the police and communities has played a vital role in addressing the challenges of meter vandalism in the system and the illegal connections.

Capacity building

The critical element for sustainable service delivery is the knowledge base and capacities of the employees of an organization. Adequate staff capacities help an organization to sufficiently and promptly respond to any challenge or problem. In recognition of the importance of capacity building, the corporation institutionalized policies aimed at promoting capacity enhancement in water loss reduction through:

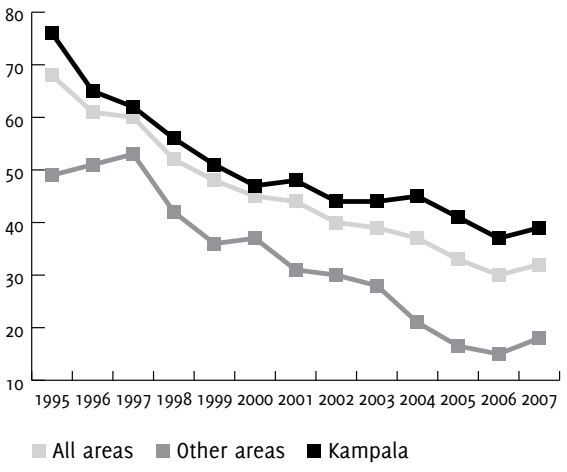
- Well structured in-house and external training on leak detection and repair
- Quality studies and analysis of water losses. For example the meter management study provided good insight into the causes of water losses and has been vital in focusing the water losses reduction strategies.
- Benchmarking with other utilities/partners especially in learning new and more effective technical approaches to managing water losses
- Extensive research collaboration with relevant institutions. Examples of collaborating institutions include Makerere University - Uganda, Public Utility Research Centre – Florida, USA, and Institute of Hydraulic Engineering – Delft, Netherlands.

4 ACHIEVEMENTS FROM THE INITIATIVES UNDERTAKEN

The implementation of the above management strategies has resulted in significant efficiency gains for the corporation. The level of NRW reduced significantly from 52% in 1998 to an average of 32.5% in 2007, with the small-medium towns registering NRW levels between 15-18%. Most importantly the change management initiatives lifted the spirits of all staff in the corporation and enhanced performance through increased accountability, increased customer focus, prompt decision making, increased autonomy and initiative taking. The programmes also allowed for wider stakeholder involvement and ownership in the activities addressing the challenges of the corporation. The capacity building programmes and benchmarking initiatives with sister utilities have strengthened staff capacity and promoted new ideas and approaches in water loss reduction.

The figures below gives a snapshot of the NRW performance improvement trends credited to the above initiatives implemented.

Figure 1 NRW performance trends for NWSC



5 SHARING THE NWSC EXPERIENCE WITH OTHER UTILITIES

NWSC has established an External Services wing with the main objective of sharing knowledge and its experience with sister institutions within the region. The services offered include both advisory and core utility services. The advisory services include organizational behavior change, contract design and incentive systems, monitoring and evaluation systems as well as initiatives to address water losses. A number of utilities within the region and beyond have already benefited from this noble cause and some these include Nairobi City Water and Sewerage Company, Lake Victoria Water Services Board, Nkana Water, Dar-es-salaam Water Services Company, Karachi Water and Sewerage Company, to mention but a few.

6 CONCLUSION

The NWSC experience clearly shows that the major causes of high levels of water losses reduction are poor management, cultural and technical problems. Therefore, any initiative to reduce water losses requires coherent efforts to address not only the technical and operations issues but also the institutional and administrative issues. The NWSC experience underscores the importance of using innovative and tailor-made initiatives, the right incentives, effective stakeholder involvement, capacity building and experience sharing with sister utilities in reducing water losses.

Zambia: City of Lusaka

Political and Administrative Solutions for Drinking Water Loss Control: The Zambian Experience

By Mr Ian Nzali Banda, Chair, Water and Sanitation Association WASAZA

Since the urban water supply and sanitation sector was reformed by the Government of Zambia in the mid to late 1990's, water loss reduction has and continues to rank very highly as one of the most critical performance improvement parameters for any of the newly established service providers (utility companies). From a service provider's perspective, there are two main arenas where drinking water is lost namely:

1. where the service provider has direct control and is able to prescribe and implement a solution without the involvement of external stakeholders such as along the transmission lines, at bulk storage facilities, and to some extent along the distribution mains
2. where the service provider has no complete direct control and needs the full participation of external stakeholders if a final solution is to be garnered. This is mainly in the tertiary distribution segment and at individual customer premises where there are no meters, high incidences of vandalism, and also highly defective plumbing fixtures.

This paper focuses on the arena where the service provider has no direct control. In Zambia, experience has taught us that these problems occur almost completely in the areas where the low income segment of the population reside which currently represents about 90% of the urban population. At face value, one can prescribe the technical solutions to reduce water loss such as meter installation, repair and general rehabilitation of the network infrastructure. However this approach has failed when implemented without a supplementing awareness campaign which is primarily aimed at changing the attitudes of the beneficiary communities so that they may appreciate and understand the adverse effects that say poor payment and vandalism bring to bear on the services they receive. Involvement of key stakeholders that can help facilitate this awareness campaign has proved extremely successful in Zambia. The first activity entails identification of the main umbrella community based organization who should be trusted and have had a positive influence on the community. Other stakeholders may include faith-based organizations, health service providers, local learning institutions, the police and the local political leadership. The key rationale behind this approach is mainly to enhance awareness on the many problematic aspects inherent in community water supply and also to develop a strong sense of ownership for all the existing and future interventions which the service provider intends to effect with the sole aim of improving upon the quality of service.

This paper will therefore show and highlight the aspect that a technical solution to water loss reduction in low income areas will only be tenable once a political and administrative strategy is formulated and implemented alongside the technical solution.

Key Words and Phrases: Service Provider, Drinking Water and Low Income Areas

INTRODUCTION

Urban water supply in Zambia has since the attaining of political independence in 1964, been the sole responsibility of local authorities, which draw their mandate from the Local Government Act, which defines the functions of local authorities, as, including the provision of water supply and sanitation services. This mode of service provision experienced a severe setback in the early 1970's when Zambia's economy began to rapidly decline due to the then sudden collapse of world copper prices. This

was further exacerbated by the rapid increase in oil prices attributable to the Arab-Israeli conflicts at the time. Both these events impacted negatively on the Zambian government's ability to adequately fund socio-economic activities such as investment in the water supply and sanitation sector. In the early 1990s the Zambian government acknowledged that the state and mode of water service provision required a major overhaul in order to make it more responsive to the population's needs (GRZ, 1994). In a bid to reinvigorate the water sector, a reform process was embarked upon by the Government. This involved a countrywide consultation of the various key stakeholders to review existing operational, policy, legal and regulatory frameworks.

One major output of the reform process was the passing of a new policy framework for the water sector called the National Water Policy (NWP) whose principal objective was:

> "to promote a sustainable water resources development with a view to facilitate an equitable provision of adequate quantity and quality of water for all competing groups of users at acceptable costs and ensuring security of supply under varying conditions. This entails establishing a well-defined institutional structure that will achieve the intended policy objectives" (GRZ, 1994).

The NWP also advocated for the "achievement of full cost recovery for the water supply and sanitation services (capital recovery, operation and maintenance) through user charges in the long run".

Other outputs of the reform process included the enactment of a new legislative instrument called the Water Supply and Sanitation (WSS) Act No 28 of 1997 which enabled local authorities to radically alter the existing mode of service provision to allow a range of new options including the establishment of commercial utilities.

THE INSTITUTIONAL FRAMEWORK FOR URBAN WATER SUPPLY IN ZAMBIA

Ten water supply and sanitation utilities have been established in Zambia as a direct outcome of the reform process. They have been formed in most cases as joint ventures between several local authorities within a province. The institutional framework for urban water provision is illustrated in Figure 1, which shows the relationship between the local authority (principal) and the established utility (agent).

The institutional framework for urban water provision is illustrated in Figure 1 below:

Institutional arrangements for urban water supply in Zambia

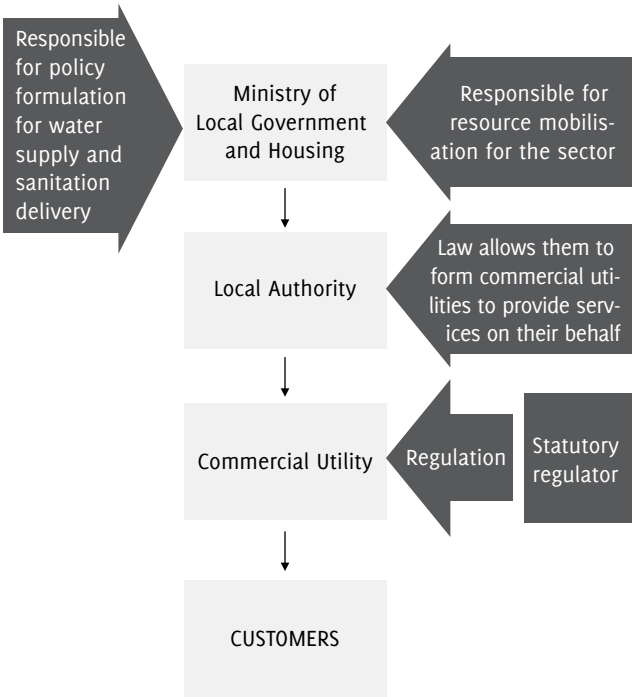


Figure 1: Institutional arrangements for urban water supply in Zambia

In this arrangement, the utility companies are expected to fully cover their operational costs from generated revenues as opposed to the previously unsustainable scenario in which local authorities were responsible for service provision whereby costs were not fully covered leading to deterioration of service standards.

WATER SUPPLY TO THE URBAN POOR

The national urban water supply regulatory authority, NWASCO, states that out of a total estimated population of 11 million persons in Zambia, 4.9 million or 45 percent reside in urban areas. The urban area population distribution by housing category is (NWASCO/DTF, 2005):

- 490 000 (or 10%) residing in High Cost Areas;
- 490 000 (or 10%) residing in Low Cost Areas; and
- 3 900 000 (or 80%) residing in Peri-urban Areas.

or as shown in Figure 2.

The vast majority of the low income urban population (sometimes referred to as the urban poor) reside in the peri-urban and low cost areas. According to NWASCO/DTF (2005), access levels to safe water supply in urban areas stands at 60% which translates to a population of about 2 million persons not having proper access.

Zambia's urban population by housing category

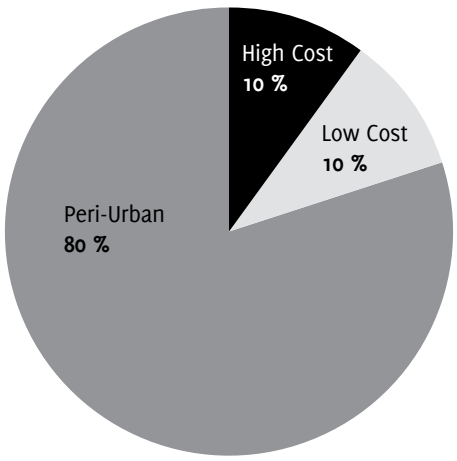


Figure 2: Zambia's urban population by housing category

THE PROBLEM IN PERSPECTIVE

The lack of access by 60% of the urban population imposes an urgent demand for redress by the utility companies. One of the key problematic areas is that of huge water loss after treatment has been affected. Results collated since the year 2000 by NWASCO, show that high treated water losses are due to:

- poor condition of the transmission and storage infrastructure;
- high wastage at customer premises due to defective plumbing fixtures; and
- high wastage at customer premises due to non-metering by the utility

Metering has emerged as one of the most critical interventions that utilities can employ so as to realize appreciable reductions in drinking water wastage as the customer is compelled to prudently use water supplied since the billing is based on the total volume consumed as opposed to a fixed metered tariff. Furthermore, metering of all customers will yield increased revenue levels whilst keeping the operational costs equal or less than the current levels. Utilities in Zambia have experienced soaring levels of revenue loss over the years due to high levels of treated water that does not yield revenue (non revenue water).

Purposive installation of meters in low income areas in Zambia is received with resentment since most customers have over the years been using excessive amounts of water as they have been on a fixed charge. It is common in these areas to find large vegetable gardens, car washing businesses, well watered lawns etc. all because their water supply is not metered. These customers also do not make it a priority to repair damaged plumbing fixtures in their homes. Furthermore, defaulting customers will in most cases not bother to settle amounts owing to the utility even after they are disconnected as they usually draw supplies from compliant neighbours on fixed tariffs. Figure 3 illustrates the levels of revenue loss due to loss of treated (drinking quality) water amongst Zambian utilities in the years 2003 to 2007. In the year 2006 to 2007 for example revenue worth approximately 53 million dollars was lost due to treated water loss. This amount would have been reduced by at least 30 million dollars if the metering ratio was equal or in excess of 95%.

UFW and Metering vs. Revenue Loss

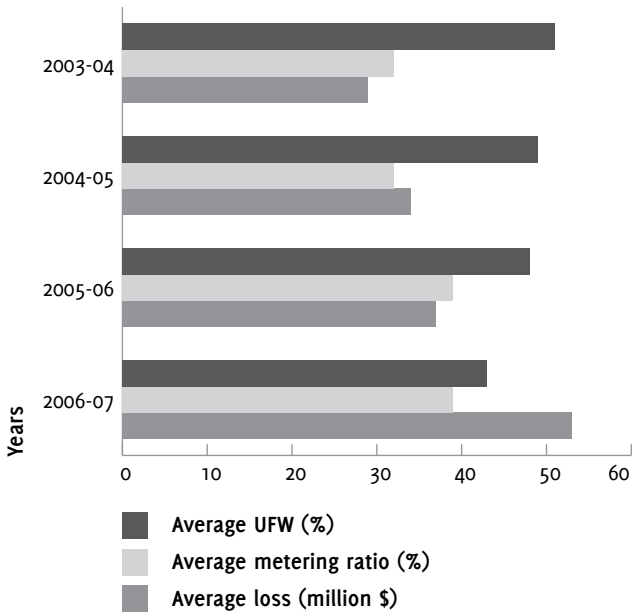


Figure 3: UFW and Metering versus Revenue Loss for Zambian water utilities compiled using data in NWASCO sector reports 2003 to 2007

It is therefore of absolute necessity for the utility to engage individuals or entities that can provide assistance to make this inevitable intervention be accepted by the community at the same time averting vandalism and or theft of the installed fixtures.

Two main methods namely political and administrative that have been used to augment the technical and commercial proposition of metering in Zambia are outlined hereunder.

POLITICAL SOLUTIONS

This has involved the garnering of support from the political establishment at national and local level.

National Level

It absolutely essential that the political establishment at national level demonstrates leadership by making pronouncements that do not contradict the ideals and objectives outlined in the various policy documents or at variance with a utility's operations. During election times for example politicians like to apply pressure on the utility to "waive" collections for services provided and not to enforce punitive measures such as disconnections for delinquent customers. Other actions include;

i. Non interference in tariff setting (this has been attained in Zambia through the establishment of an independent regulatory authority
ii. Public support of legal actions by service providers against defaulting customers
iii. Leading by example through prompt settlement of amounts due by government departments

Local Level

The role of the local political leadership such as elected councilors and MPs has more to do with direct interaction with the affected community. Experience has shown that this category of politicians have a more direct influence on the community as they in most instances even reside within the affected areas. Key issues amongst this group include;

i. They need to be made aware through facilitation by the utility on the benefits that metering would bring to bear on the service delivery process
ii. Their declaring public support for the intervention proposed by the utility
iii. Public condemnation of vandalism and pilferage of the utility's infrastructure

Care should be exercised however when engaging with this category of politicians to avert their temptation to take advantage of the situation to gain "political mileage" at the expense of the ultimate objective. Experience in Zambia's low income areas has shown that they may want to derive personal glory out of the proposed intervention or even frustrate it if they believe that the intervention will prove injurious to their political standing and ambitions.

ADMINISTRATIVE SOLUTIONS

This approach involves utilizing structures that are non-partisan or political but have a high level of influence on the affected community.

Community Based Organisations

These mainly consist of democratically elected entities that oversee developmental activities within a community. In Zambia there exists an area based organisation called the Residents' Development Committee (RDC) which the community members directly elect and also enjoys recognition by the local authority as a key stakeholder in overseeing developmental activities at community level such as security, health, education, trading, sanitation, water etc. Experience has shown that they are widely trusted by the community as their opinion and standpoint on developmental matters will be supported by the community without much opposition.

Prior to metering a low income area, the RDC has as an equal partner with the utility engaged in facilitating and awareness creation of the community on matters such as the benefits to be accrued, the adverse effects of vandalism and the general enhancement of social stability. Other specific activities that the RDC has engaged in include;

i. Public meetings
ii. Door to door campaigns
iii. Anti-vandalism campaigns and security surveillance in collaboration with the police

They can also be an agent for the utility by providing them with information on the general condition of the network.

Public Service Organisations

These include local schools, clinics and even the local police that can serve as vehicles through which facilitation and sensitization of the community on the proposed interventions and the expected benefits for the community. This approach enhances general acceptance and nurtures a sense of ownership which in turn stifles negative vices such as vandalism and pilferage.

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Zambia: City of Lusaka

Water Loss Reduction In Lusaka City - The Regulatory Influence

By Mr Osward M Chanda, Director, National Water Supply and Sanitation Council NWASCO

INTRODUCTION

The water sector in Zambia has been restructured focusing on decentralisation and commercialization of service delivery in order to foster efficiency and sustainability of quality service delivery (GRZ, 1994). The National Water Policy adopted in 1994 gave the political direction on what was to be expected in the sector and is summarized in the seven sector principles:

1. Separation of water resources functions from water supply and sanitation;
2. Separation of regulatory and executive functions within the water supply and sanitation sector;
3. Devolution of authority to local authorities and private enterprises;
4. Achievement of full cost recovery for the water supply and sanitation services (capital recovery, operation and maintenance) through user charges in the long run;
5. Human Resources development leading to more effective institutions;
6. Technology appropriate to local conditions and
7. Increased government spending priority and budget spending to the sector.

This gave the highest political commitment to improved service delivery requiring that certain minimum service quality standards are attained.

In order to achieve this quest, in 1997 the government through parliament enacted the Water Supply and Sanitation Act No. 28 with the aim *'..... to provide for the efficient and sustainable supply of water and sanitation services under the general regulation of the National Water Supply and Sanitation Council;...'* (GRZ, 1997). The Water Supply and Sanitation Act thus gave the required legal framework and administrative support for providing water and sanitation services, consequently establishing a professional and autonomous regulatory agency to set standards and monitor the service delivery of the water services providers.

The water policy emphasises the importance of reaching tariffs that are full cost covering, the need to provide incentives for efficiency, reliability and environmental standards in service provision. The politicians in Zambia have provided leadership at the highest level demonstrated in action and speech on the need to improve efficiency in service delivery which includes reduction in water losses. On a number of occasions the President, Cabinet Ministers and other senior government officials have made pronouncements against vandalism of public infrastructure including water and the importance of people and government institutions in particular paying for the services they use. The commercial approach in the provision of water and sanitation services was designed to make the running of water services a viable business with boards and managements that are inclined towards private sector. (GRZ1,1994)

The Lusaka Water and Sewerage Company (LWSC) which was established in 1988 but only started operations in 1990, serves about 1.1 million people of Lusaka City out of an estimated population of 1.5 million (CSO, 2007). LWSC was formed out of a municipal department for water within the provisions of the Local Government Act No.22 of 1991 as a private company to improve quality of service. It is wholly owned by the Lusaka City Council. All staff, assets and liabilities from the Lusaka City Council were transferred to Lusaka Water and Sewerage Company.

LUSAKA CITY WATER LOSS CHALLENGES

The problem of high water losses averaging 55% has plagued LWSC since its formation and consequently the

company has remained unviable and failed to deliver good quality service. LWSC did receive technical assistance in its formative stages from the German Technical Cooperation to help orient the organization to commercial management, but this was with limited success. After the establishment of the water services regulatory agency NWASCO in 2000, the challenge of high water loss in Lusaka City was confronted. Though the LWSC staff maintained that all they needed to address the problem was capital investment, the regulator realized more needed to be done. Only 32% of customers were metered and the staff had little experience on how to deal with the high water losses. While LWSC had many graduate engineers they did not have good practical water management skills, which contributed to the slow pace of improving services. (NWASCO, 2002)

Illegal Connections in Lusaka

EFFORTS TO REDUCE DWL

In 2001 UN Habitat Water for African Cities Project together with GTZ supported a water demand management pilot with drinking water loss reduction as one of the major outputs in Thornpark and Fairview areas of Lusaka City. NWASCO, the water regulator, provided oversight with the view of picking variable lessons to share with water utilities in the country.

Metering

The metering coverage in the selected areas at 52% at the start of the project in 2001 was raised to 100% in 2002 within the course of the project. Bulk meters were installed at the entry point to the areas. The initial average supply to the area was 22,748m3/month but reduced to 18,658m3/month at the end of the project in 2003.

Customer Database Cleanup

Despite LWSC having been in operation for over ten years, an exercise undertaken to register all the consumers in the area revealed that only 79% of the consumers were registered, thus significantly contributing to water loss.

Illegal bypass of meter

Billing and Collection

There were serious challenges with the billing of customers. Many customers had complaints regarding the billing. The problem was multiple faceted, ranging from inconsistent and wrong meter readings resulting in wrong billing; also the revenue collection system was poorly designed and remote from customers. The result was an initial reduction in the billing due to many adjustments posted which affected the collections.

Customer Relations

At a meeting to develop an action plan for customer relations, findings early in the project showed LWSC needed to change the strategy for sensitizing and educating of consumers on various water related issues and care for public infrastructure. Yet, little was done to follow through the recommendation. The effects of the little action manifested in the results. (Chinkuli, 2003)

PROJECT RESULTS AND CONCLUSIONS

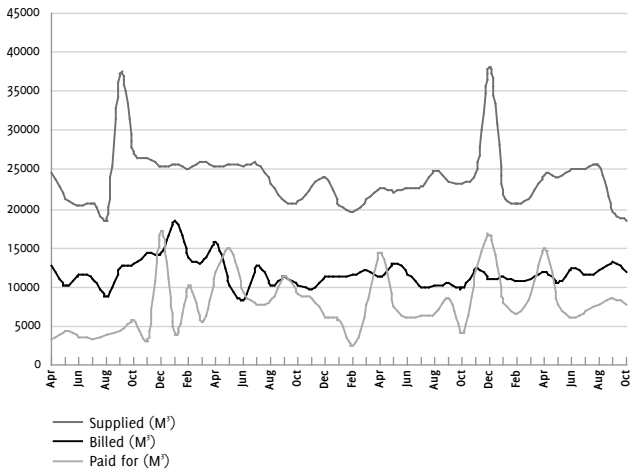
The immediate result of the project in the two areas was that the water supplied decreased by 18% indicating a real saving in pumping capacity but also in water available to

other people. This was coupled with increased pressure in the area network. (Chinkuli, 2003)

The revenue collections from the areas went up 30% overall comparing the start of the project and the end result. To maintain these good results it required continued sensitization of the customers and presence on the ground to monitor the network.

The water losses reduced from 52% at the start of the project in the area to 25%. With more capital investment replacing some old leaking pipes and valves the drinking water losses could be reduced further. (Chinkuli, 2003)

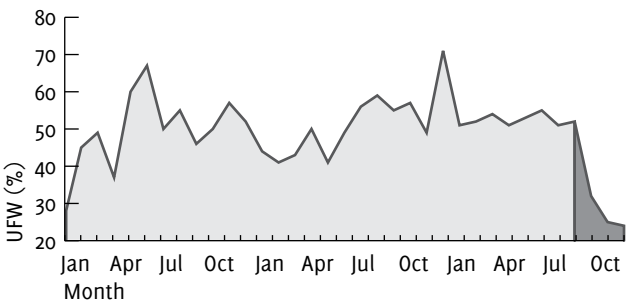
Qty of water supplied, billed and paid for (M³) - Thornpark



Source: Chinkuli, 2003

The project revealed that capital investment alone cannot resolve the problem of high water losses as 100% metering the areas did not result in an immediate reduction in water losses. It can control physical losses but not commercial losses. Engaging the consumers through awareness creation to take responsibility for the infrastructure and report any damage, illegal connections or leakages helps to minimize water losses. Continued effort in awareness creation among both management and operational staff is critical to garner the required urgency and support for managing water loss reduction. When management does not appreciate the need for interventions to reduce water losses it becomes difficult to effectively deal with the problem. Correct bulk and domestic meter installation that only allows meter operation under full bore at all times makes for accurate meter readings.

Progression of UfW - Thornpark



Source: Chinkuli, 2003

REGULATORY EFFORTS TO SUSTAIN DRINKING WATER LOSS REDUCTION

Despite the good project result, the overall LWSC water loss has remained high. The regulator has used a number of strategies aimed at forcing utilities to bring down their water losses and these are yielding results.

Ranking of Providers with Criteria Used

Commercial Utility	Performance Ranking		
	2006/07	2005/06	2004/05
Nkana WSC	1	4	1
North Western WSC	2	1	2
Chipata WSC	3	2	3
Southern WSC	4	3	7
Kafubu WSC	5	7	8
Lusaka WSC	6	7	9
Mulonga WSC	7	5	5
Western WSC	8	6	5
Lukanga WSC	9	N/A	N/A
Chambeshi WSC	10	9	10

	Indicator	Weighting
1	Water Quality	20 points
2	Collection efficiency	20 points
3	Metering ratio	15 points
4	Hours of supply	15 points
5	O+M cost coverage by collection	15 points
6	UfW	10 points
7	Staff per 1000 connections	10 points
8	Regulator's perception	10 points
9	Sanitation coverage	05 points
10	Water coverage	05 points

Source: NWASCO,2006

All service providers are issued with an operating license from the regulator. The operating license comes with conditions in terms of guidelines and standards as provided for in the Water Supply and Sanitation Act 1997. The service providers are made to sign three year service improvement agreements with the regulator on which basis the tariff is adjusted. Drinking water loss reduction has often been made a tariff adjustment conditionality in addition to demanding 100% metering of customers. The meter coverage now stands at 43% for LWSC. (LWSC, 2008) Beyond this, the performance of each company is annually published which highlights the progress made in each area including water loss reduction. The publication of the performance results and awarding of ranked providers at a function officiated by a Minister has been most effective as the providers make every effort to avoid bad publicity.

The regulator NWASCO undertakes regular inspection visits both planned and unannounced to the service providers to verify the progress reported and compliance to issued guidelines. Punitive measures are taken for non-compliance in any of the areas agreed upon.

CONCLUSION

The project took considerable time to achieve the desired results which was a result of weak customer awareness programmes and the wrong installation of the meters which is a human failure. It is very evident that adequately equipped personnel are the most critical in the reduction of water losses. Therefore skills and practical knowledge among both the operational and management staff are imperative to comprehensively deal with water loss reduction successfully. NWASCO has found this to be the most critical element in other providers in the country as well. In utilities with skilled personnel the problem of water loss is quickly addressed with availability of capital investments. The government at the time of reforms appreciated the significance of skilled personnel and included it as one of the seven sector principles for success of the reforms.

There is need for an external professional body (regulatory agency) to demand and monitor the improvement of water loss reduction among service providers, if significant results are to be recorded and sustained.

Reducing drinking water losses enhances the rate of attaining operation and maintenance cost coverage in a utility. The benefits of reduced water loss are real and therefore investing in measures to reduce water loss pays back and can help delay the expansion of the infrastructure.

The LWSC needs to invest in awareness campaign programmes and use strategies that are sure and proven.

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Brazil: City of Sao Paulo

Heading for an Efficient Water Loss Control: São Paulo Experience

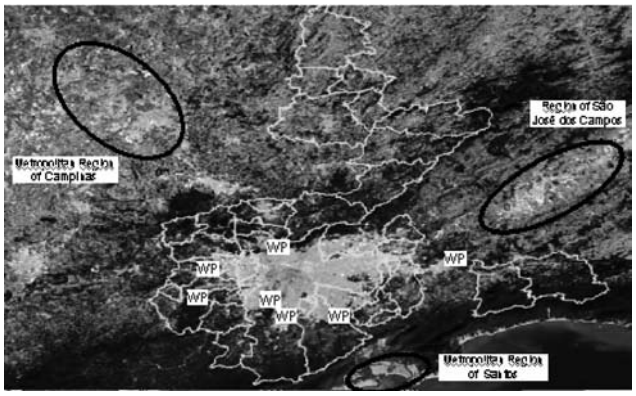
By Francisco Paracampos, Center Business Unit Superintendent, Companhia de Saneamento Básico do Estado de Sao Paulo SABESP

In 1995 SABESP - São Paulo Water & Wastewater Services - was forced to embark on a vigorous reorganization process in order to reach very hard financial and technical targets defined by the new board directory. A number of managing decisions were taken like five directories as executive board and to split into sixteen business units all the operations of water and wastewater systems of 360 municipalities, including the big ones. Also, it was reduced to 50.3% the position of the major shareholder, the São Paulo State.

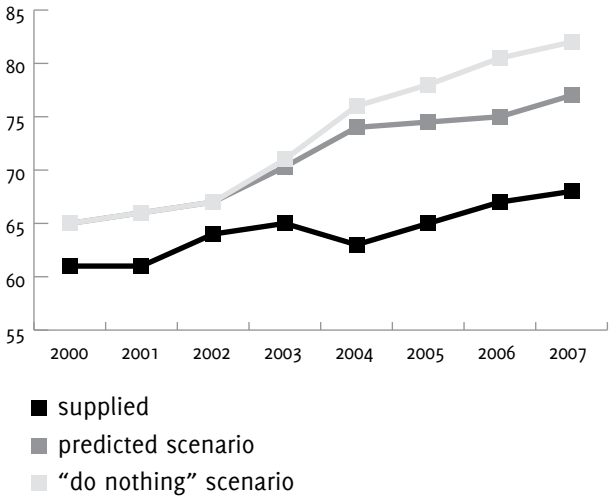
Apart from that, a number of future scenarios were analysed and consolidated strategies for the next five years, aiming to tackle with projected uncertainties and risks factories in a Master Plan. Surely, water loss was at the focus of the discussion, since growing demand for water services always accompanied with the expansion of the cities, plus the rising buying power of the population could lead to a possible supply risk some years ahead.

From a geographic viewpoint, São Paulo is settled in a plateau, 800 m above the sea level, with poor availability of surface waters; its historical development was viable only through import of water from neighbor catchments.

Metropolitan region of Sao Paulo and water resources dispute between neighbor regions



Overall Supply/Demand Balance in Metropolitan Region



Nowadays, these small villages have become prosperous cities around São Paulo Metropolitan Region and there is a typical dispute about a scarce natural resource.

Equilibrium had to be found among all the variables so, a series of plans were set up looking for efficient use of water: the water reuse program, the educational program for a rational use of water, the development of new tools for saving water in domestic duties and a robust water loss control program.

The results of these efforts were very positive since the production of water has increased in a mild trend and, for the last three years, has been stable (65.5 m^3/s) despite 100.000 new connections per year added to the water distribution network.

THE WATER LOSSES CONTROL PROGRAM

The São Paulo water supply system is fully metered, and so a reasonable water balance is regularly made as the

basis for future actions. Preparing a base line to use as a reference for the following developments was the very first step, and the IWA standard terminology (1) (2) was essential.

The key decision for initiating the diagnosis phase was to disaggregate the systems components for analyses prior to the implementation of costly field works. As a part of this planning phase, a number of field tests (3) were conducted for confirming critical information gathered from the water balance. Eventually, a subsequent disaggregation may be necessary to define the most suitable intervention strategy for each part of the distribution network.

The general plan is described below, and the combinations of actions for each intervention zone are properly tailored based on the diagnosis phase.

1. Disaggregation of System Components

São Paulo has 120 sectors - all of them were ranked based on the IWA water balance approach. Those which presented a poor performance were carefully analysed, considering real and apparent losses partition, with in-depth evaluation of water loss components and field test of N1 and Infrastructure Condition Factor (ICF) (4), looking for the best possible diagnosis.

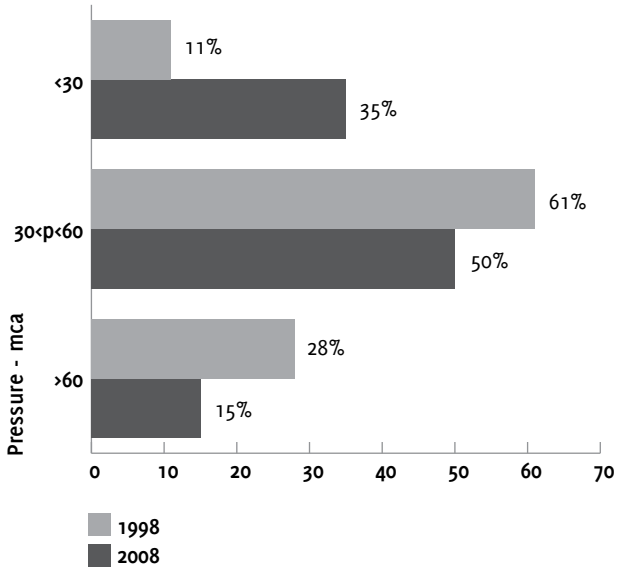
The prioritisation and the selection of the most appropriate intervention tools were based on the analysis and field tests mentioned above. Then a specific intervention strategy was developed for each area.

2. Optimization of Pressure Head in the Distribution Network

The water distribution network of São Paulo works on a gravity principle, and four thousand km of mains are made of pipes older than forty years. The city has experienced steady growth for decades, although a lower growth rate has recently been observed. There are parts of the system with nearly 100 m of pressure head and also, there were 40% of the distribution network with more than 60 m of pressure head. To face that, the initial target of the pressure control action was to reduce this extension affected by high pressures (5) since the impact of that on the performance (6) was absolutely relevant.

The following picture summarizes pressures behaviour in the system.

Pressure head in the distribution network



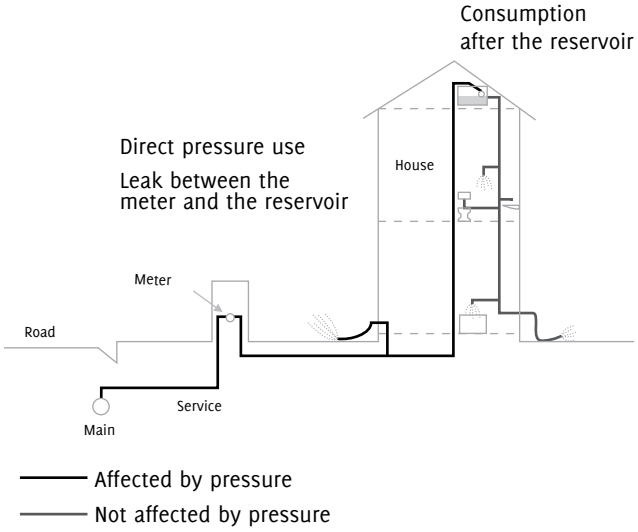
SABESP Central Business Unit

The distribution network usually has high velocity in old pipes, commonly undersized for the actual demand, and so significant headlosses occur during peak hours. Hence, an advanced pressure control strategy was compulsory to cope with such scenarios (7).

Another characteristic related to the São Paulo water supply system is the low overall distribution storage capacity (1,500.000 m^3), although there is a positive impact as the customers have domestic roof tanks.

The pressure reduction program was essentially done with pressure-reducing valves (PRVs) and rezoning works in some sectors. The main approach was to start the implementation of PRVs in large areas, regardless of the total head to be reduced in each area. SABESP has found that even a small amount of pressure reduction over a large area will provide excellent results (8), on both volume and frequency of new leaks reduction. Undoubtedly, such a view drove SABESP to obtain the most significant savings with the overall program. It is worth remembering that a traditional concept for the application of PRVs is to seek higher pressure reduction in a smaller area. This was also adopted in São Paulo when very critical points were addressed.

Typical residential supply situation in Brazil



A very skilled team is continuously checking the performance of the valves and regularly new operations rules are set.

The evaluated savings for the 974 installed PRVs is 3.3 m^3/s. The extension of pipes under PRV is 8.429 km.

3. Pro Active Leakage Control

Initially, considerable effort was made to reduce the time spent to fix leakages. It was necessary to reorganize the whole activity, and the response was relevant since the repair time decreased from 40 hrs to 14 hrs in three years. Afterwards, a leakage detection program was designed to survey the entire distribution network each year. Critical parts of the system are investigated twice or even three times per year, depending on the results achieved (0,3 leaks/km up to 1,6 leaks/km in the general figures). At present, all suspected points are registered, and just after close leaks have been fixed, a new investigation is conducted in the area. Special attention is done to trunk lines where the survey is slower due to traffic and difficulties to access the pipe.

The equipment varies from a simple listening bar to noise loggers, depending on what kind of investigation will be carried out. Such kind of short-term action brought good results in the first years, since it is not costly. The decision about survey frequency depends very much on the level of loss required for the sector, and the possible economic level of leakage (9) to be obtained.

A crucial point for the success is to have a well-trained team, and so only certified people work on this activity. There is a training camp and theoretical test is required for all participants involved, including contractors (10).

4. Renew the Infrastructure

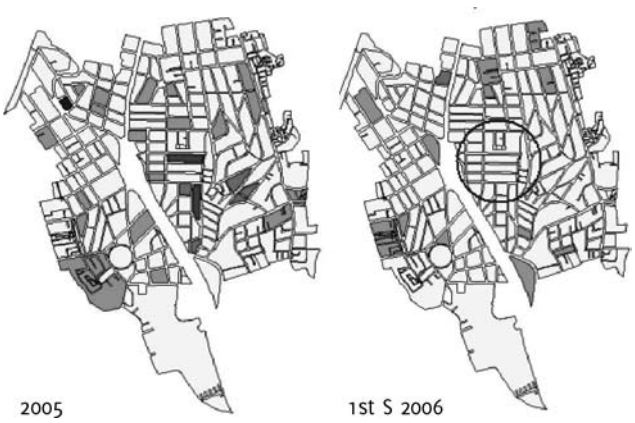
The weakest part of the São Paulo distribution network is the old service connections. In the ancient part of São Paulo 100,000 new connections have been changed each year, as well as rehabilitation works in another 1% of the total existing mains.

Results from this action using new materials (HDPE) are a very low frequency of failures in previously problematic areas.

Additionally, to reline critical mains (11) have recently been adopted and excellent results for optimising the pressure head came up. The positive aspect is a low traffic disruption and speed of execution and as negative point, is the short lifetime of such technology.

Systems with relative high ILI (12) like São Paulo will have to assume to renew the infrastructure as a costly but very effective and sustainable action in the longterm.

Sacoma district: reduction on water quality inquiries by customers



5. Metering Performance

It is a very effective way to reduce apparent losses to analyse in depth what is going on with meters throughout their lifetime, taking under consideration the registered volume and the expected performance (13).

These evaluations indicated a considerable volume under metered, and a strong investment was made in resizing and renewing meters. Also, manufactures were asked to provide better equipment, with more stable performance during the lifetime.

Aiming at good metering performance 450,000 meters have been renewed each year, which allowed 2.2 m^3/month recovery per residential meter. Larger meters are continuously resized, according to the change of customers' consumption patterns and a target of two years was defined as an average lifetime.

Several factors have induced customers to control their consumption and the main strategy when downsizing (7) is to keep the flow in the best accuracy range of the meter for as long as possible. It is important to have a database with typical pattern related to specific activities, for supporting decisions about the meter characteristics to be chosen.

Renewal of large meters was partially achieved through performance contracts, and was extremely successful (14).

6. Reinforce of Anti-Fraud Actions

Some strategies for gathering better data have proved successful like using a long historical commercial data (5 yrs), matched with standard parameters data for typical activities, and additional information collected from several sources. All this information is combined in order to define suspicious locations for further detailed inspections.

Also, an intensive training course for employees and contractors linked with the field training was done, beside the utilization of modern equipment like micro cameras and acoustic equipment. All that brought an overall recovered volume of 4,000.000 m^3 last year.

7. Reinforcement of the Commercial Data Base

Special attention was given to the commercial database (15) in the last three years. Relevant points are confirmed monthly, in addition to the volume consumed for billing purposes. For example, the number of inhabitants at the address, major usage of water (residential, commercial, kind of commercial activity, hours of use per day…), and eventually any anomalous situation at the meter set. Also, statistical evaluation of consumption is made on a routine basis.

8. Training

All employees involved with water operations receive around fifty hours of training course yearly. Similar action has recently been applied to contractors and there is an expectation that a better understanding about how and where small failures occur, will provide results in the long term.

9. Better Materials and Components

Higher quality control for materials is extremely important when one considers not only the cost of the material, but all the labour works involved in a enormous program like this. A reasonable amount of efforts were lost due to poor quality of key materials some time ago and the measure to overcome were:

- Certification of all manufactures for certain types of critical products.
- Certification process for all materials involved in the losses control program
- Check control for any material received by the warehouse of the company.

In short, actions are in progress in both directions, real and apparent losses. However, it will take longer to reach a level where the expectations about water efficient use could be considered by the society as enough.

FINAL REMARKS

Losses control is a kind of long-term program where eventually, good and fast results come up. However, the large majority of works are extremely expensive and a long time is needed for a complete task.

The strategy in São Paulo was to start with cheaper and faster short term actions, while the understanding and knowledge of the whole process grown up, and later on initiate the long term actions. Some savings were already achieved, both financially and physically. The challenge is still there, since the water resources limitations are present and the better understanding to support managing decision is the rational way to efficiency.

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Mexico: Mexico City

Sectoring Of Drinking Water Distribution Network Of Mexico City

By Mr Oscar Froylán Martínez Villalba, Manager of the North Sectionalizing Department, Mexico City Water System

INTRODUCTION

Mexico City is the largest city of Mexico, having more than 8.8 million inhabitants. It is also the capital of Mexico and has a special significance both from the economical and political aspects. Management of Mexico City Water Supply System is so complex due to its extent. This is the cause of problems like leakage, inequality and deficit in some areas of the city. Average consumption volume is over 32 m3/s, 45% of this volume is taken from external sources through Lerma and Cutzamala Systems which are situated up to 150 km from the city, therefore water has to be pumped to a height of more than 1000m, requiring 102 pumping stations, 17 tunnels and 8 km of canals, a very energy-expensive operation. Remainder volume is supplemented by ground water from internal wells.

Last decade the costs of supply, transfer, treatment, distribution and monitoring of water had become too much, likewise it will be difficult to have new sources without high economical environmental and social costs. Therefore the supplied water should not be wasted, and the reduction of water losses is an important issue. Mexico City Water System, the water authority, estimates that leakage is around 37% of supplied flow rate.

The current article describes the Sectoring project of the drinking water network, which has been implemented in Mexico City since 2001 in order to improve water leakage control and reducing water losses in the water supply system. Purpose of the project is the formation of blocks (sectors) within the network by the installation and close valves except at one or two inlet points for each sector. In 2001 Mexico City Water System started the design and planning stage of the Sectoring project based mainly on geographical/ topographical features and water consumption. At final of this stage Mexico City drinking water network was divided in 336 sectors.

From 2004 to 2007 Mexico City Water System has made heavy investments for the construction of 172 sectors and this year is working in order to put into operation 36 of built sectors. Put into operation stage has been harder than initially considered, however it is estimated that when 336 sectors are operating a reduction of 3 m3/s in water supply system will be achieved.

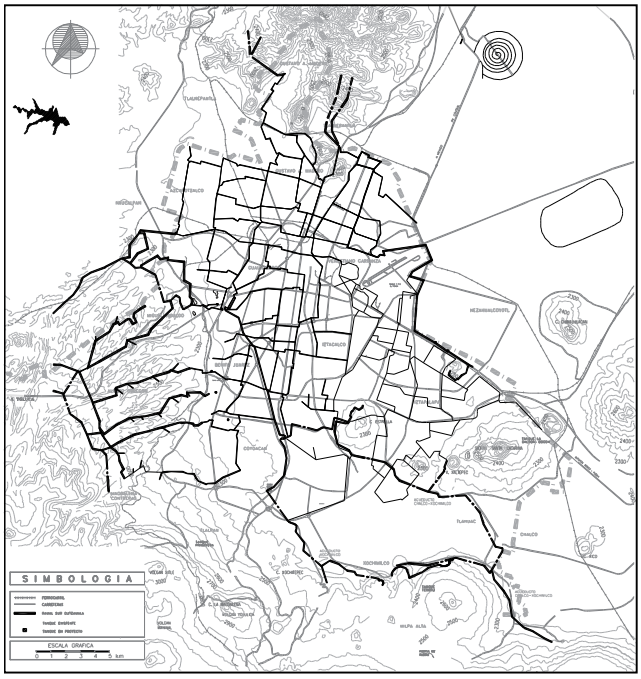
MEXICO CITY WATER SUPPLY SYSTEM

Mexico City, capital and largest city of Mexico, in the south central part of the country, in the Distrito Federal (Federal District). Situated in the Valley of Mexico, a highland basin, at an elevation of about 2350 m, the city is bounded by mountains on three sides. The rapid growth of Mexico City has created several problems, including serious air pollution, an increasingly complex water supply, and the sinking, by as much as 6 m, of parts of the downtown area into the soft lake deposits that underlie much of the city, damaging buildings and disrupting some water and sewerage lines. Supplemental water is now obtained from distant sources, Lerma and Cutzamala Systems, outside the valley, and modern multistoried buildings are built on huge steel and concrete drums to prevent their sinking.

Mexico City Water System, the water authority of Mexico City, supplies drinking water to 8.8 million people. Although the city has an area of 1.479 km2, its urban area of service is 632.42 km2. Average consumption volume is about 32 m3/s. Water is transported through 518 km of aqueducts and pipelines to 295 storage tanks, which have a joint capacity of 1,710 million m3. These tanks are used to regulate and distribute water to users, through 1,040 km of main pipelines and more than 12,000 km of secondary pipelines. 285 pumping plants, which have a joint capacity of 25.5 m3/s, are used to provide water to people who live in high places. 14 wells in continuous operation

are the main drinking water source of Mexico City. 54 pressure meter stations which are evenly distributed in drinking water distribution network allow knowing pressure data in real time. 98% of total population benefit from piped water, whereas 2% have no access to it and is served by means of cistern-carts. More than 25,000 visible leaks per year are repaired in secondary and service pipes. Finally water quality is constantly verified by means of permanent inspections and constant monitoring in water supply system.

External water sources of Mexico City



MAIN PROBLEMS OF MEXICO CITY WATER SUPPLY SYSTEM

In order to supply clean and safe water without interruption, complying with the water quality standards established in the Mexican regulation, is necessary to solve the following problems:

- Some components of the hydraulic system are so old and are located in instable soil and subsoil sink affects their performance, which increases complexity of operation system. Water extraction exceeds water infiltration to the Valley of Mexico's aquifer, the most important water supply source.
- As a consequence of urban zone expansion recharge area for aquifer has been reduced.
- There is irregular service water in the eastern zone of Mexico City because it is far from inlet points of external sources located in the western zone.
- Additional water volume is required from external sources to satisfy population consumption. 35 % of supplied flow rate is lost due to leaks in water network. Therefore it is necessary to improve programs of prevention for water supply leakage.

SECTORING PROJECT

In 2000 the Mexico City Government through Mexico City Water System decided to start the Sectoring Project of the drinking water network in order to improve water leakage control and reducing water losses in the water supply system.

OBJECTIVE

The purpose of the project is the formation of blocks (sectors) within the network by the installation and close valves except at one or two inlet points for each sector. It allows identifying and controlling, to some economic or rational level, losses in each sector.

Sectors must be supplied in inlet points from main pipes and wells inside must be connected to main pipes. In inlet points are installed an electromagnetic flow meter and an electronic control pressure valve. If it is required, hydraulic control pressure valves are installed inside sectors.

ADVANTAGES

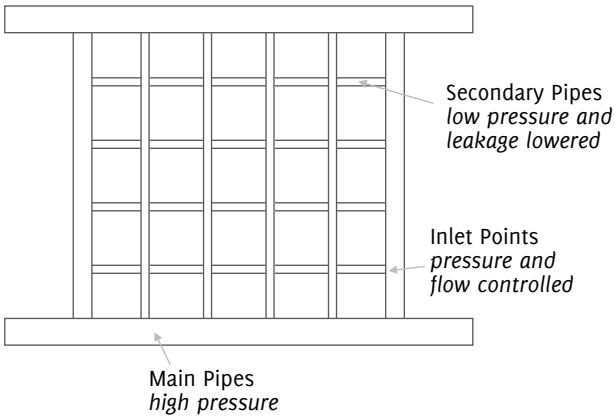
Once established, a functional sector can provide the information required to quickly identify unreported leaks and bursts as they occur. With proper metering, night flow patterns can be analyzed to reveal night time use, background, and active leakage. Bursts and flow rates can quickly be identified which allows for prioritization of leak detection personnel. During significant flow events, system performance can be observed providing necessary information for system enhancements. Reported bursts are difficult to ignore and typically trigger an immediate utility response, also:

- A system managed like this not only minimizes the area influenced by water suspension or rust-

colored water resulting from things like pipe breaks or leaks.

- Volumes recovered by reducing water losses can be used to solve water deficit zones.
- It also makes replacing pipes work efficient by facilitating sector-wise replacing pipes.
- Furthermore, because the inlet point into each block is distinct, simply by operating the inlet valve very precise water pressure and water flow control adjustments can be made, which can be in time of water shortage.
- Main pipes can operate with high pressure, and secondary pipes with low pressure, it allow transporting water to through the main pipes.

Objective - After Sectoring



Sector Operation Scheme

DESIGN STAGE

Before the sectoring project the drinking water network was divided just into five large zones to be operated. During the design stage of the sectoring project the network was divided in sectors based mainly on geographical/topographical features and water consumption.

The established size of sectors was around 5,000 connections, or 25,000 inhabitants. However it could vary from sector to sector. Sector boundaries were defined by natural limits (rivers, ravines, parks, etc), railroads, freeways and political limits.

Inlet points of each sector were identified. If it was required, hydraulic control pressure valves were considered inside sectors. It was also established that all sector cross connections should be closed or metered.

All boundary valves for all sectors were identified, serviced and marked. Boundary valves are defined as closed valves on cross boundary connections. It was established that if boundary valves did not seal properly, they should be replaced. The exact position of inlet points and all boundary valves were captured on a network AutoCAD file.

Design of sectors was assisted by EPANet. EPANet is software that models water distribution piping systems and was developed by EPA's Water Supply and Water Resources Division. It is a Windows program that performs extended-period simulation of the hydraulic and water quality behavior within pressurized pipe networks.

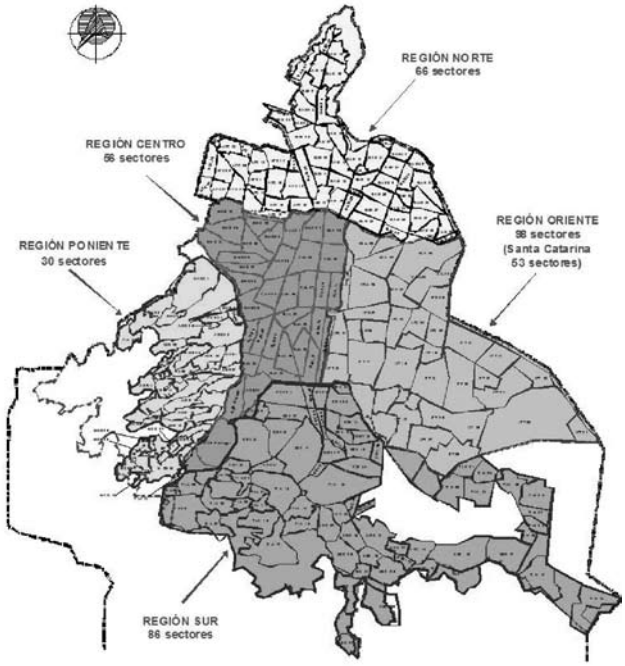
The following input data are required for calculations on a given network:

- Network configure teen (nodes, sections, pumps, valves, tanks)
- Data for each node: elevation, flow rate, time variation of flow in the node (when time simulation of network operation is performed)
- Data for each tank: initial water level in the tank, maximum allowed level, tank's diameter.
- Data for each section: number of nodes at the ends, section's diameter, section's material, material roughness.

During the simulation, EPANet application calculates the water flow rate per each section of the network and pressure in each node. Network model must be run until pressure and flow rated in proposed sector satisfy user needs.

At final of this design stage Mexico City drinking water network was divided in 336 sectors.

Division in Sectors of Mexico City drinking water network



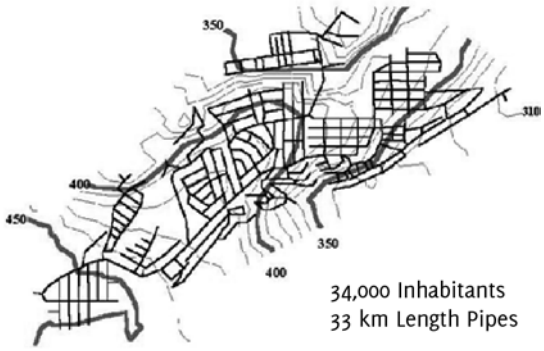
CONSTRUCTION STAGE

In 2002 the first sector, Santa Lucía 1, was built and put into operation. It is located in the western zone of Mexico City. This is a complex zone because water supply is 150 meters above lower users. During the day, the water pressure was sufficient due to the high demand. At night, with reduced customer demand, the pressure would increase substantially. And, because the main supply lines were manually closed, they would often leak or break.

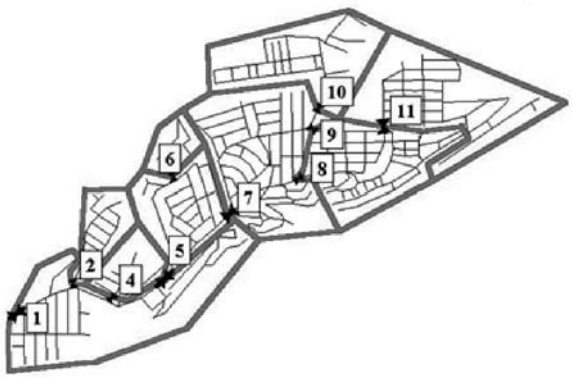
This was considered a pilot sector. Network design required establishing various pressure zones due to topography. Pressure control to the required minimal level lowering losses to the minimum, was achieved installing pressure reducing valves. That way, water losses were reduced from 35% to 23 % of flow rate supplied.

In 2004 start the process to build sectors in different zones of Mexico City. Heavy investments have been spent in the construction of 172 sectors, from 2004 to 2007. This year Mexico City Water System is working in order to put into operation 36 of built sectors. Put into operation stage has been harder than initially considered due to inaccuracies in network maps used during design stage, however it is estimated that when sectors are operating in 2013, it will be obtained 3 m3/s of reducing water losses in water supply system.

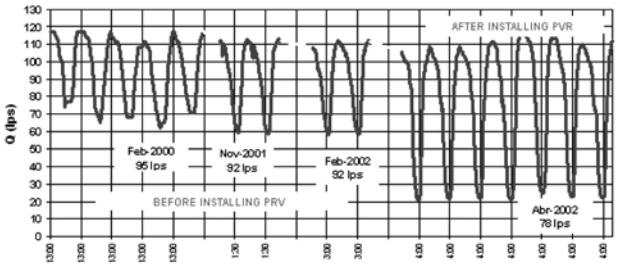
Scheme Network of Santa Lucia 1 Sector



Pressure Reduction Valves and Controlled Zones



Metered flow rate in Santa Lucia 1 Sector before and after pressure control



Nicaragua: City of Managua

By Mr F. Reyes, Project Supervisor, The Nicaraguan Company for Water Supply and Sewerage ENACAL

The Republic of Nicaragua is located in Central America, with a population in excess of 5.1 million.

The Company Nicaraguan Water Supply and Sewerage Health (ENACAL) is responsible for providing drinking water and collecting and treating sewage of the population.

To provide these services throughout the republic, Nicaragua has over 152 drinking water systems and about 30 sanitary sewer system. Following some 450000 users with household connections, of which only 44.4% have meters in good condition.

The target population is around 3.5 million, representing a coverage of 68.6%.

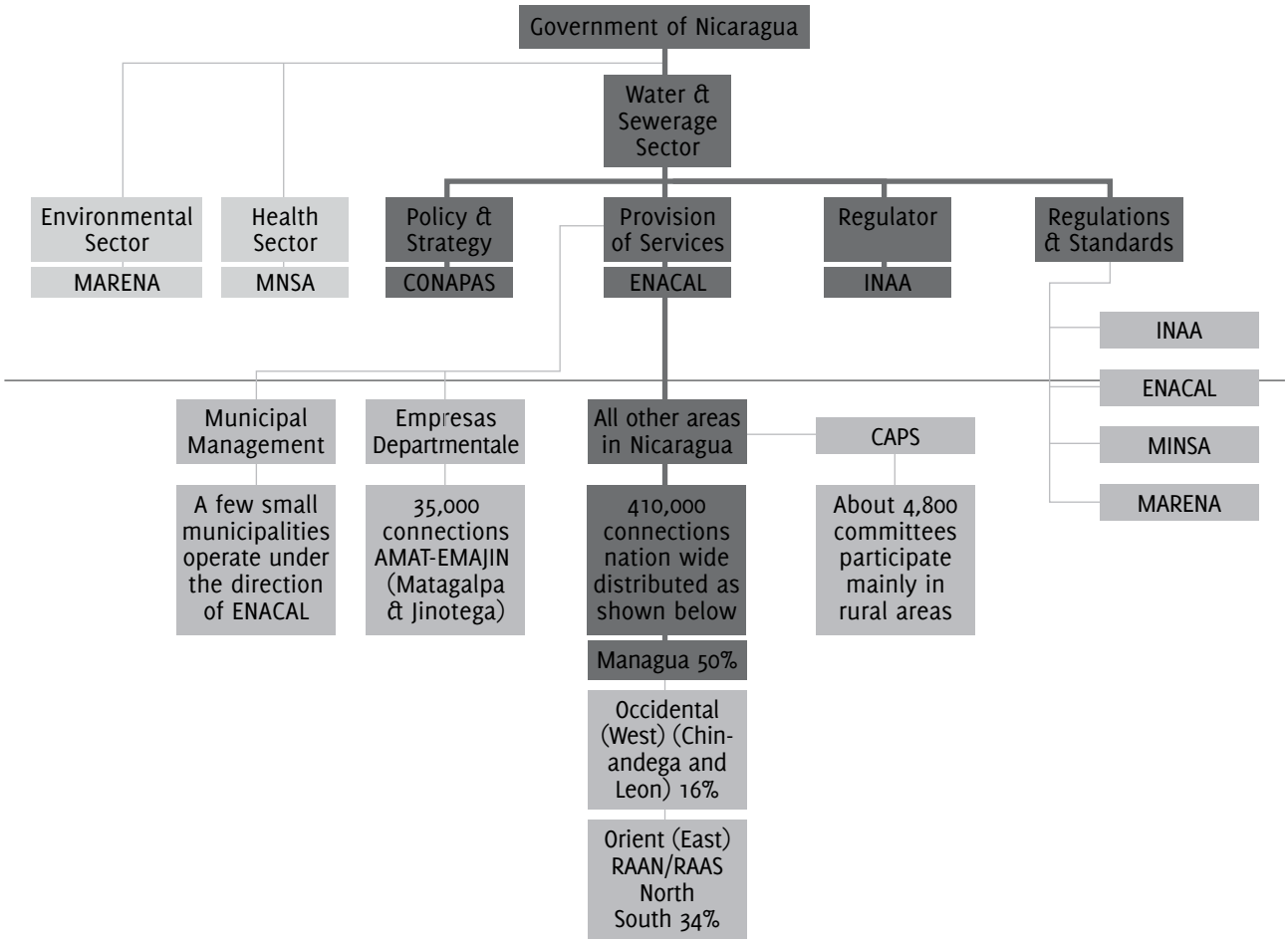
95% of water is produced from deep wells, bringing the energy consumption up greatly.

By the year 2007 water production was 2 million cubic meters and turnover was 1.5 billion cubic meters, which gives us a loss of 20% water, relatively large.

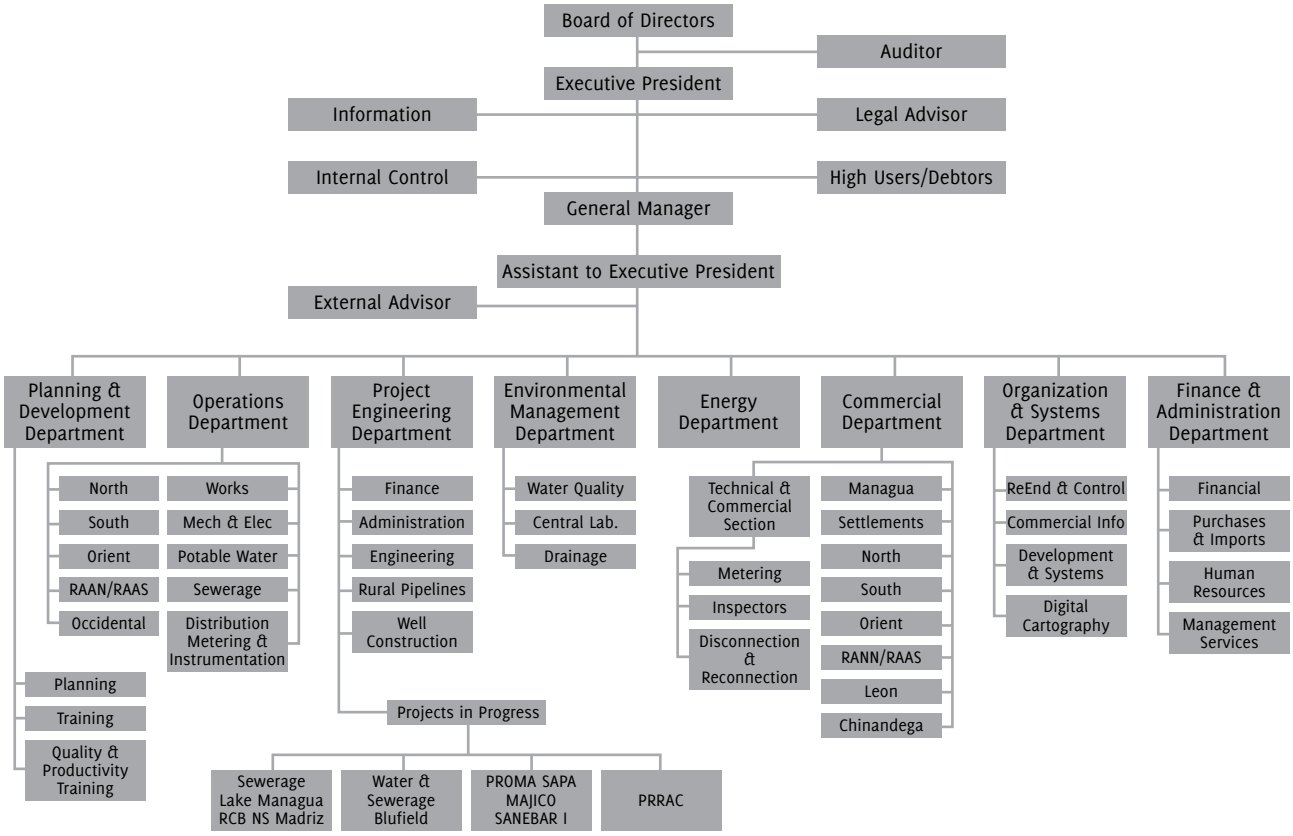
In the 1990 the company entered into a program to optimize the drinking water systems in major cities throughout the republic, with the goal of reducing water losses in the systems and reduce the cost of energy, accounting for over 50% of the costs of operation.

Thus, with help from the Canadian Agency for International Development (CIDA), began a project optimization in six cities across the country, these being: Leon, Chinandega, Esteli, Granada, Masaya and Diriamba. This

National institutional structure



ENECAL Organization



project brought very good results by reducing the losses in these cities from 52% to 12% and 15.

From this experience, ENACAL has been seeking funding to develop optimization projects in other cities, such as in the northern sector of the country, with help from the government of Luxembourg has developed a project of great importance for optimizing system operations Water in Esteli. Here we began to take the first steps leak de tection visible and not visible, creating macro and micro sectorization, among others, with satisfactory results.

It is important to note the efforts being made to optimize the capital Managua, where they have developed various programmes with the help of governments of Japan, Inter-American Development Bank (IDB) and now with the government of Spain. Among these projects, the projects closely interrelated to the present Study are considered to be IDB's Program to Modernize Management of Water and Sewerage Services and the Project by Spanish Government for Optimization of Water Supply System, Improvement of Macro and Micro Flow Measurements, Planning and Environment. The details of these projects and time schedules were discussed with the officials of these donor agencies as well as ENACAL officials concerned, and are described below.

IDB AND SPANISH GOVERNMENT PROJECTS

Main objectives of these two projects are similar, as they are related to enhancing the capacities of operation and management of ENACAL. One of the common issues addressed in the two projects is to reduce technical and commercial loss of water. Major approaches of the two projects are, however, different.

The approach of IDB's Program covers a broader area, and the project is composed of two subprograms. One is to enhancing the capacity of the commercial management covering the entire ENACAL' business areas, and the other is to augment the number of house connections for water supply as well as sewerage in the settlements (Asentamientos) in Managua.

The former subprogram includes the improvement of the commercial management dependent upon the input of the service contract with a consulting firm based on the performance basis. The fee for the consultant employed

in this contract will be determined based on the level of achievement. This subprogram also includes the introduction of computerized information system for modernizing commercial management and administration, and design and implementation of abatement program of Non Revenue Water (NRW). The consultant employed should develop the detailed plan of these programs together with the investment plans so that ENACAL implement the programs to achieve a certain level of improvement under the advice of the consultant.

In order to facilitate the new connections micro credit financing will be planned so that the households in Asentamientos could purchase necessary materials for sewerage connections and toilet facilities.

The Project of Spanish Government is mainly the study on the technical improvement of the water distribution control system of Managua. Total of 800 km of distribution pipeline is selected as the pilot project areas in Low Elevation Zone in Managua. District metering (establishment of Macro and Micro Sectors) is conducted the re together with analysis of leakage and other water losses. The computerized facilities and customer management using GIS is also introduced during the project.

FIELD INSPECTION OF EXISTING WATER SUPPLY FACILITIES

A field visit took place to the control centre of the Operation and Distribution Section, Asososca intake works, Managua I Wellfield, and two typical pumping stations (the only method of treatment is chlorination which takes place at the pumping station). The control centre is known as P3 and is located at the Asososca intake works. The operation of the whole of the Managua water supply system is controlled from this centre on a 24 hour basis with two controllers equipped with computers and radio communications and three mobile staff with radios.

OPERATION

Control of operation of the source works, pumping stations, reservoirs and the transmission and distribution system is managed on a routine basis from the P3 centre which also responds to any problems that may occur such as imbalance in the distribution system, power failures, etc. Instructions are issued via the radio system to those locations equipped with radio and to the three mobile units for the less important pumping stations. Generally the pumping stations are operated using two 12 hour shifts per day.

PERSONNEL AND TRAINING

All personnel are employees of ENACAL except for the security guards who are contracted from a private company. Not all locations have these security personnel.

Generally, operators are trained within ENACAL. Training is given on operation of the plant and equipment, including specific on the job training. ENACAL also operates short courses through the Human Resources section and most operators appear to have received training in Human Relations, and Plant Safety. Some specialist training has been given from outside sources, for example on computers and telemetry (N.B. the SCADA system is not operational).

METHODOLOGY OF LEAKAGE SURVEY

Selection of Model Districts for MNF Measurement

Ten model districts for Leakage Survey were selected consulting with Gerencia Comercial and Gerentia Operaciones of ENACAL. As EANCAL has already defined 265 micro sectors in the past similar NRW survey program carried out during 1990's, 15 micro sectors were selected as candidate s of the model districts from the list of micro sectors. Those candidate model districts were then examined in detail through the field confirmation work for hydraulic isolation from the surrounding area.

Locating boundary valves to isolate the model districts was not very easy as the distribution network drawings are not completely updated. The isolation of model districts were confirmed by locating all the boundary valves and closing these valves, and then the extent of the area affected by water supply suspension is carefully checked by confirming no flow from customers' faucets through house to house survey.

Finally 10 model districts were selected; four from Low Elevation Zone, three from Medium Elevation Zone and High Elevation Zone.

Map Preparation

CAD drawings of the micro sectors with distribution pipelines and registered customers' locations are available. However, interconnected pipelines recently installed have not been properly reflected on the drawings and they had to be located carefully during the field confirmation work. Through the field inspection the drawings were completely updated before the leakage survey.

Customer Registration List

The list of the customer registration number and water meter numbers was prepared for meter reading. Customer meters were read by three teams. Average consumption of the past 6 months was also entered in the list for reference.

Minimum Night Flow Measurement

Ultrasonic flow meters were installed on the inlet pipes into the model districts, continuous flow measurement to know Minimum Night Flow (MNF) and the total inflow during the period between the two time customer meter readings. Coordination with the police office was requested to ensure safety during the survey activities.

Customer Meter Reading With Listening Bars

One of the interests of this field survey was to know the conditions of existing water meters. Every customer connection was examined with the use of listening bars, and the customer meter conditions were also noted during the meter reading.

Water Pressure Measurement

Automatic water pressure recorders were installed at the inlet and extremity of the micro sectors to measure the 24 hour water pressure to obtain the average water pressure during 24 hours as well as the water pressure during the minimum night flow.

Leak Detection

The team carried out leak detection using leak detectors to pinpoint the leaking points in the micro sectors during the night in collaboration with the Commercial Department, Operation Department and Security personnel of ENACAL. The Team requested ENACAL to repair these leaks found out during the leak detection survey so as to know the degree of the leak reduction after the series of activities of this leakage survey.

Direct Connections or Illegal Connections:

- The direct connections are significant in number and the volume of water consumption through such connections is also considerable. As actual water flows were often observed in such houses during mid -night time indicating that lots of water is considered being wasted in such conditions.
- Approximately 13% of the total connections in the four micro sectors are regarded as illegal as the breakdown. There are several types of illegal connections as considered below:
    1. Water meters are removed but directly connected,
    2. Water meters are removed but connected with hoses specially during the night, and
    3. Water meters and pipes cannot be located but water is supplied probably from the neighbours or through substitute pipes laid by illegal users.

Water Consumption:

- Average water consumption per connection was analyzed by using the flow measurement data obtained from the leakage survey as the water flow and pressure conditions are always at satisfactory level and do not restrict the customer's water use in Low Elevation Zone.
- Average water consumption per connection excluding leakage is obtained from the balance of the total inflow into the micro sector and the Minimum Night Flow adjusted with the average water pressure during the measurement. Then, the consumption pe r connection was divided by 5.4 of the average number of family members of household to estimate the average water consumption per capita per day.
- The water consumption per capita per day in each micro sector ranges from 148 lpcd to 204 lpcd, and the average consumption is calculated as 180 lpcd.

Water Supply Condition

86% of consumers have water service every day. Only 67% of consumers have water service all day. 69% of consumers have water service with good pressure. Weak water supply services are in commercial zone 3, 6, 7 and 8.75% of consumers satisfied in water quality. About half of the consumers storage water, but this proportion is very low in Commercial Zone 1, 2 and 9.

MAJOR COMPONENTS OF NRW (PRELIMINARY DEFINITION OF NRW)

Apparent Losses

Unauthorized Consumption (Illegal Connections)

There is no statistical data on the illegal users. ENACAL estimates that approximately 10% of the total connections are illegal. (Gerencia Operaciones)

Suspended customers are defined to be those who do not settle their bills for a certain period of time, and ENACAL takes the following 3 step measures against such users until they start to pay the bills during 6 months:

1st Step: ENACAL closes the cock valves for supply lines.
2nd Step: ENACAL removes the water meters if the users continue to use water supply without payment.
3rd Step: ENACAL removes the supply lines if the users made direct connections.

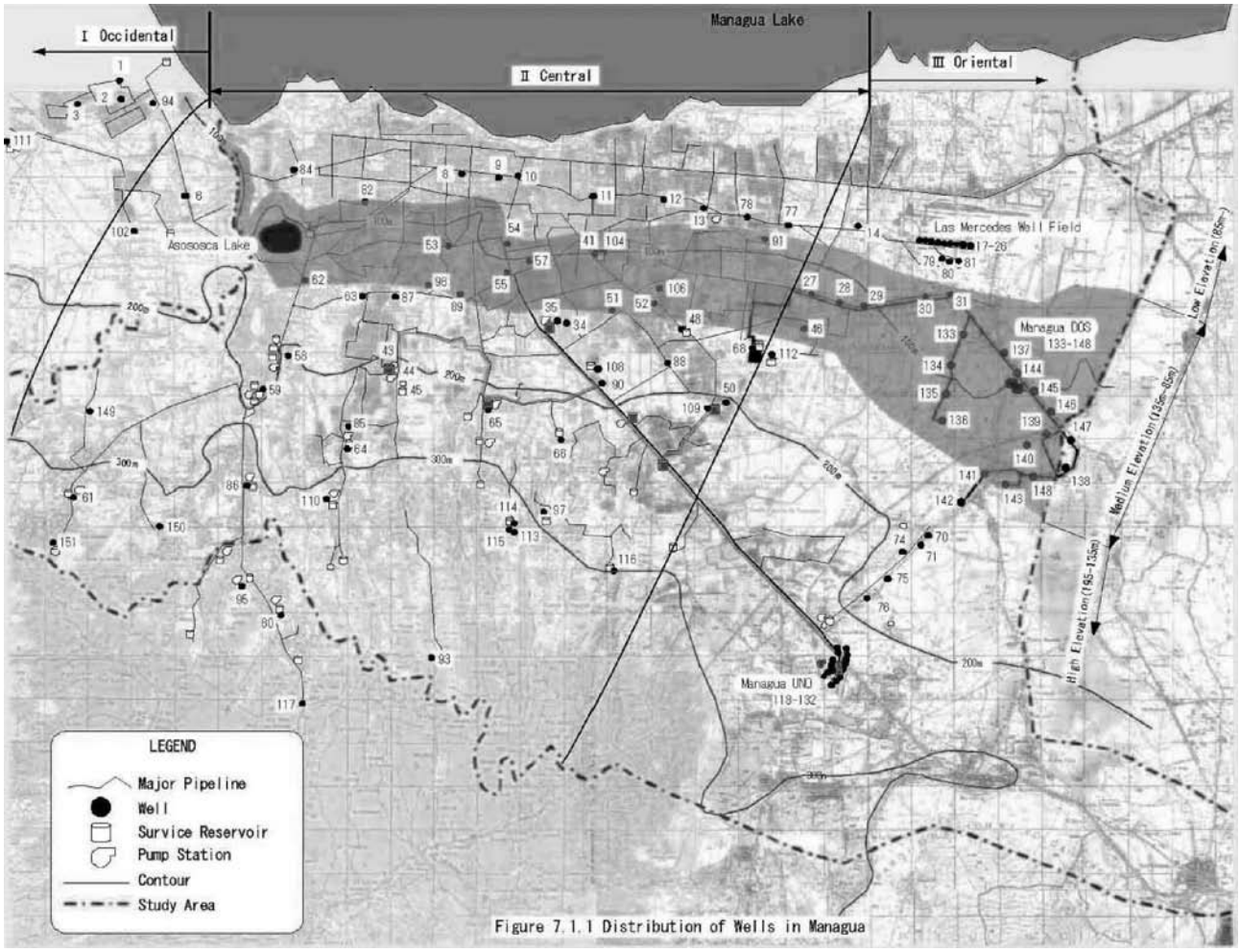


Figure 7.1.1 Distribution of Wells in Managua

After repeating such measures suspended customers are registered as "inactive" if they still do not pay or request t o terminate the water supply contract with ENACAL.

In most cases there are some conflicts between these users and ENACAL regarding water bills, meter reading, and the level of services. Even though ENACAL disconnects the supply lines as a measure for the penalty for such users and register them as inactive customers these users commit again illegal connections.

It is considered that the customers categorized in the suspended customers and inactive customers are potential illegal users. It is presumed that all these connections are illegal and their consumption per connection is similar to that in Asentamientos, the total consumption through illegal connections is estimated at 9,733,680 m3/year.

REAL LOSSES

Real losses are physical leakage occurring from al l the water supply facilities except the leakage downstream of the customers' water meters or the boundaries of customers' premises for direct connections.

As a preliminary assessment of leakage ratio, it is estimated as the balance between the production and the total volumes of the above items.

The following are our preliminary assessments of levels of leakage and NRW. NRW ratio, dividing the total amount of water not billed by that of production, is estimated at 56%.

System Leakage in 2003 (yearly volume)

Production:	145,057,938 M^3
Billed metered:	44,329,218 M^3
Billed unmetered:	18,327,504 M^3
Unbilled authorized:	758,000 M^3
Illegal:	9,733,680 M^3
Assentamientos Excess Water Use:	20,442,216 M^3
Total:	20,442,216 M^3
System leakage:	50,641,800 M^3 (35%)

Peru: City of Lima

SEDAPAL's experience in the reduction of water losses

By Mr H Reyes, Chief Management Control Team, Drinking Water and Sewerage Company of the city of Lima SEDAPAL

This work presents a summary of the the approaches implemented to reduce water losses in the water supply system.

Two projects were implemented in 1995: I)Micromeasurement and II) Control of Water Leakages, and the principal goals were defined : 1) Increase the level of micromeasurement 2) Update and keep the customers' cadaster 3) Implement the system of macromeasurement 4) Implement the Cadaster of Water Networks and Sewer 5) Detection, Repair and Control of Water Leakages 6) Implement the Sectorización of the Water Distribution 7) Detection of Clandestine Connections.

PROJECT I MICROMEASUREMENT

Increase the Level of Micromeasurement

SEDAPAL until 2008 has installed 1 886 000 micrometers in 43 districts of Lima and Callao, and increased the micromeasurement from 6.2% to 71%, and we could recovered an important volume of water that was estimated in 2.6 m3/s (see the Figure 1), it was possible because when the customers have the micrometer in their houses, they save approximately 9 m3 a month, the average per capita consumption water was reduced from 280 to 220 liter per person a day.

Figure 1

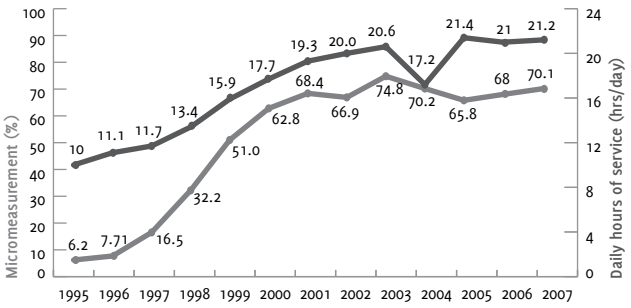
Sample		Projection to Total Customers		
Connections	Recovered Volume (M^3)	Connections	Recovered Volume (M^3)	Recovered Volume (M^3/S)
143,583	3,542,481	252,019	6,803,305	26

The water that was recovered was distributed to:

- Increase the hours of service, the average of hours of service was increased from 10 to 22 hours, now most of the 80% of the population have service 24 hours a day and (Figure 2).
- Increase the coverage of water service for new customers.

In 2006 the theft of the micrometers in Lima increased too much (we have registered 324 000 stolen micrometers until this year), because the price of the copper increase too, and it´s sold in the black market. The thefts caused that SEDAPAL reduced the level of micromeasurement.

Figure 2



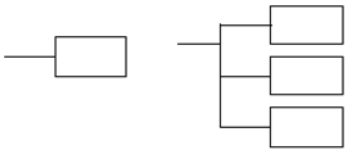
Update and keep the customer´s cadaster

We did the update of the customer´s cadaster in seven districts of Lima, that included 220 833 water connections (aproximately the 25% of total connectios), and we found 43 368 aditionals costumers that hadn´t been registered in the SEDAPAL´s comercial system (see Figure 3).

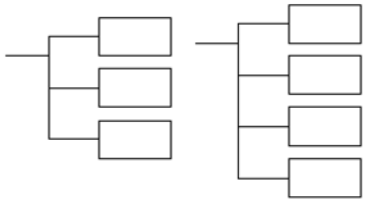
Figure 3 New Customers were detected

Distrito	Unidades Uso Antes Catastro	Unidades Uso Despues Catastro	Incremento
Carmen de la Legua	4,752	7,264	2512
La Perla	13,491	15,945	2,454
Bellavista	16,565	19,506	2,941
Callao	81,226	100,924	19,698
San Isidro	28,752	31,444	2,692
Miraflores	40,879	45,457	4,578
La Molina	35,168	43,661	8,493
Total	**220,833**	**264,201**	**43,368**

1. Individual customers who change to multirelative customers



2. Additional customers in the multirelative customers



Then we identified the number of the water connections without micrometer, and considering that the customer saves 9 m3 in a month (when he has a micrometer), and considering the average consumption in his district, we estimated the recovered volumes in a year: approximately 447 351 m3 in a year or 0.2 m3/s (see Figure 4).

Figure 4 Results of the Updates and keep the customer´s cadaster

District	Increase Customer	Customers without micrometer	9.1 M3 Volume saved per month with micrometer	Recovered volume m3/month	Average Consumption m3/month	New sold volume m3/month
Carmen de la Legua	2,512	2,314		21,053.3	21	48,584.6
La Perla	2,454	530		4,823.6	30	15,901.9
Bellavista	2,941	773		7,038.7	30	23,204.5
Callao	19,698	9,140		83,172.8	30	274,196.2
San Isidro	2,692	668		6,075.3	30	20,028.5
Miraflores	4,578	1,035		9,415.1	30	31,038.8
La Molina	8,493	1,147		10,433.7	30	34,396.7
Total	**43,368**	**15,606**		**142,012.5**		**447,351.1**

In 1999 we finished the implementation of the Commercial Management System, and we integrated with a Geographical System. Now is available in the internet a virtual commercial office, and all the SEDAPAL´s customers can look and check the information related to their water consumption.

Detection of clandestine connections

Every year we have campaigns of detection of clandestine connections and we found an important quantity of illegal connection and that had not been registered in the SEDAPAL commercial system, and considering that the customer saves 9 m3 in a month (when has a micrometer), and considering the average consumption in his district, we estimated the recovered volume in a year: approximately 30 804 m3 in a year or 0.02 m3/s (see Figure 5).

Figure 5 Results of the Detection of Clandestine Connections

District	Increase Customer	9.1 M3 Volume saved per month with micrometer	Recovered volume m3/month	Average Consumption m3/month	New sold volume m3/month
Carmen de la Legua	4		36.4	21	84
La Perla	46		418.6	30	1,380
Bellavista	58		527.8	30	1,740
Callao	613		5,578.3	30	18,390
San Isidro	47		427.7	30	1,410
Miraflores	55		500.5	30	1,650
La Molina	205		1,865.5	30	6,150
Total	**1,028**		**9,354.8**		**30,804**

PROJECT II CONTROL OF WATER LEAKAGES

Detection, repair and control of water leakages

The program began in 1997 and had checked 23 982 km of water networks until 2007, and has detected 66 499 water leakages, and we are estimating in 3.1 m3/s of water losses, the number of leakages by km is 2.8, and the average welth by leakage is 0.05 liter by second (see Figure 6).

Figure 6 Detected Leakages (6 Jan 1997 - 31 Dec 2007)

Km Checked	Number	Welth LPS
23,982	66,499	3,090.7

Leakages / Km	No	2.8
Average welth / leakage	LPS / leakage	0.05

Actually the total water networks is 10 683 km and we estimate that the detectable physical water losses are 1 376 liter by second or 43 418 m3 in a year, it means the approximately 6,7% of the total water production (see Figure 7).

Figure 7

Number of water leakages	2.8 leakages/km
Total network	10,683.0 km
Average Welth in leakages	0.05 lps/leakages
	1,376.80 lps
Total water losses	43,418,709 m3
Total production	650,800,000 m3
% water losses	6.7%

We also estimated the total recovered volume for detected and repaired not visible water leakages. In 1997 we estimated the number of water leakages by 5 leakages/km and that number was reduced to 2.8 in 2007, so we recovered 2.2 leakages/km and considering the total water network and the average welth by leakage, the volume recovered was estimated in 1 105 liters per second, it means that we can replace 37 wells (of 30 liter per second) and save underground water for cases of emergency (see Figure 8).

Figure 8

Number of water leakages		Reduced leakages
1995	2007	
5	2.8	2.2

Number of water leakages	2.2 leakages/km
Total network	10,683.0 km
Average Welth in leakages	0.05 lps/leakages
	1,105.82 lps
Wells (average welth lps)	30
Number of wells that can be replaced	37

Implement the cadaster of water and sewer networks

SEDAPAL has implemented the cadaster of water and sewer networks in the total area of responsibility. Currently we have 646 km primary pipelines (with diameter of 14 inch or more) and 10 036 km secondary pipelines. We identified that 36% of the primary pipelines and 68% of the secondary pipelines are 30 years old or more (see Figure 9).

Figure 9 Water Network

Centro de Servicios	Primarias	Secundarias	Total
Comas	91	2,376	2,466
Callao	129	1,196	1,324
Ate Vitarte	80	1,360	1,440
Breña	70	1,159	1,229
S. J. de Lurigancho	47	951	998
Surguillo	119	1,653	1,772
Villa el Salvador	111	1,341	1,452
Total Red	**646**	**10,036**	**10,683**

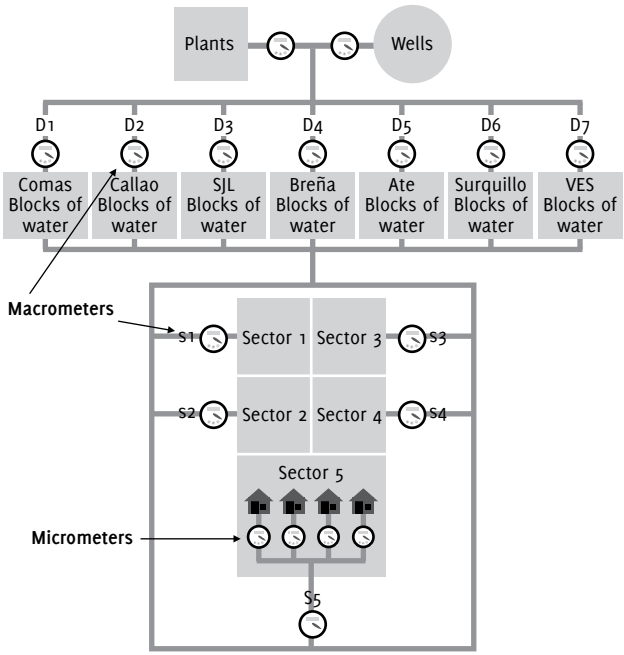
CODIGO	DESCRIPCION	KM	ANTIGUE DAD (años)
CR	Concreto Reforzado	17.8	50-65
AR	Acero Revestido	66.7	35
HRD	Hierro Fundido Ductil	210.4	2-25
FV	Fibra de Vidrio	19.1	10-15
AC	Asbesto Cemento	119.1	10-30

CP	Concreto Pretensado	60.9	15-30
FF	Fierro Fundido	19.4	50-65
PVC	Policloruro de Vinilo	7.8	7-12
Total		**521.2**	

Implement the macromeasurement system

The macromeasurement system was implemented to control the distribution of water to the seven centers of service or macrosectors in Lima. We have installed 51 macrometers for superficial water from the potable plants and there are another 330 macrometers for underground water from wells, in all of the district of Lima y Callao (see Figure 10).

Figure 10 Macromeasurement system



Production = P1+P2
Distribution = D1+D2+D3+D4+D5+D6+D7

Balanced of Micromeasurement
Bre ña = D4-(S1+S2+S3+S4+S5)

Implement the water distribution sectors

Lima was divided into 423 water distribution sectors, every sector considers a geographical area until 3 km2, and included 5 000 connections. It must have a point of water entry with a control camera and micrometer (see Figure 11).

Figure 11 Total Sectors in Lima

Estado / CS's	Ejecutado	En Ejecucion	Proyectado	Total General
Ate	12	11	61	84
Breña	33		0	33
Comas	22	22	45	89
Callao	18		54	72
Surq.	46		6	52
SJL	4	3	19	26
VES	28		39	67
Total	163	36	224	423

Conclusions

SEDAPAL reduced the water losses from 50% in 1995 to 37% in the 2007, the level of per capita consumption water was reduced from 280 to 220 liter per person a day, the micromeasurement increased from 6.2% to 71%, the average hours of service was increased from 10 to 22 hours a day and most of the 80% of the population have service

24 hours a day. These results were so great and help to the company to increase the coverage of the service for people from 75 % to 91 %, and we can reduce the extraction of the underground water from 8 m3/s to 3 m3/s.

India: City of Gwalior

Water loss reduction initiatives in Gwalior

Mr V.N. Shejwalkar, Mayor of Gwalior, Gwalior Municipal Corporation

ABSTRACT

Gwalior, the fourth largest city in the state of Madhya Pradesh, has a population of 0.95 Million. The water supply in the 177 km2 of the area of the city, managed by the Gwalior Municipal Corporation (GMC), is 140 million litres per day. However, a UN-Habitat-supported study revealed that a substantial quantity of the treated water does not reach the consumers due to transmission losses, resulting in water shortage and increase in the cost of supply. The reasons for such losses include leaking C.I.A.C. pipes, which have outlived their life span, leakage through air valves, sluice valves and service connection points, the large number of stand posts without controlling taps, lack of water meters to prevent wastage at the consumer end, lack of proper detection and repair of leakage, etc.

Therefore a water demand management strategy and action plan covering technical, financial and institutional reforms has been developed. This is under implementation and includes initiatives such as installation of bulk management meters and bulk revenue meters at strategic locations, implementation of district metered areas including leak detection and retrofitting, establishment of a leak detection team and capacity building of the technical staff of GMC.

Iran: City of Tehran

Water Losses Reduction Programme in Iran

Mr. Azizollah Mobini Bidgoli, Manager of Bureau for Supervision on Consumption Management & Reduction of Non Revenue Water, National Water & Waste Water Engineering Company (NWWEC), Ministry of Energy in Water and Wastewater Affairs Tehran, and Ali Akbar Ghazali

ABSTRACT

After the successful application of performance standards and indicators recommended by the International Water Association (IWA) by a number of countries, the National Water and Wastewater Engineering Company (NWWEC) decided to use the studies for the management and assessment of water losses in the networks under its control. Accordingly after review of the required information, the company prepared the strategic program (recommended by IWA) for reduction of water losses in the network, the first step of which consisted of preparing the water balance program. Accordingly, after the relevant training workshops and numerous meetings (over 80 in total) the water and wastewater companies (39 companies) were notified of the mentioned program in a very large scale. In addition to the IWA recommended indicators, new formats, software applications and indicators were also prepared and used for collection and verification of data and network comparison.

The article describes the process of water balancing implementation and presents some of the results obtained from 800 independent urban networks (all the towns and cities in Iran) and Tehran city during the years 2005, 2006 and 2007. The results include all the indicators recommended by IWA for grading cities according to the World Bank (WB) standards and some indicators defined by the NWWEC to take into account the regional conditions in Iran. After preparing a report on the existing status of networks in Iranian cities using the water balance, NWWEC is currently engaged in compiling a comprehensive program for accurate analysis of the non-revenue water components, their factors and finally the method to counter them and solutions to systemize the actions.

Keywords: Water Balance; Performance Indicators; Action Plan; Water Losses

1. INTRODUCTION

The National Water and Wastewater Engineering Company (NWWEC) is the entity responsible for service provision to the water and wastewater subscribers in the urban and rural areas. This company has 39 urban and 30 rural subsidiary companies. Since 2004 NWWEC has launched new programs to reduce water losses in the

Figure 1.1: The UFW ratio in the years 1996 to 2005 in Iran.

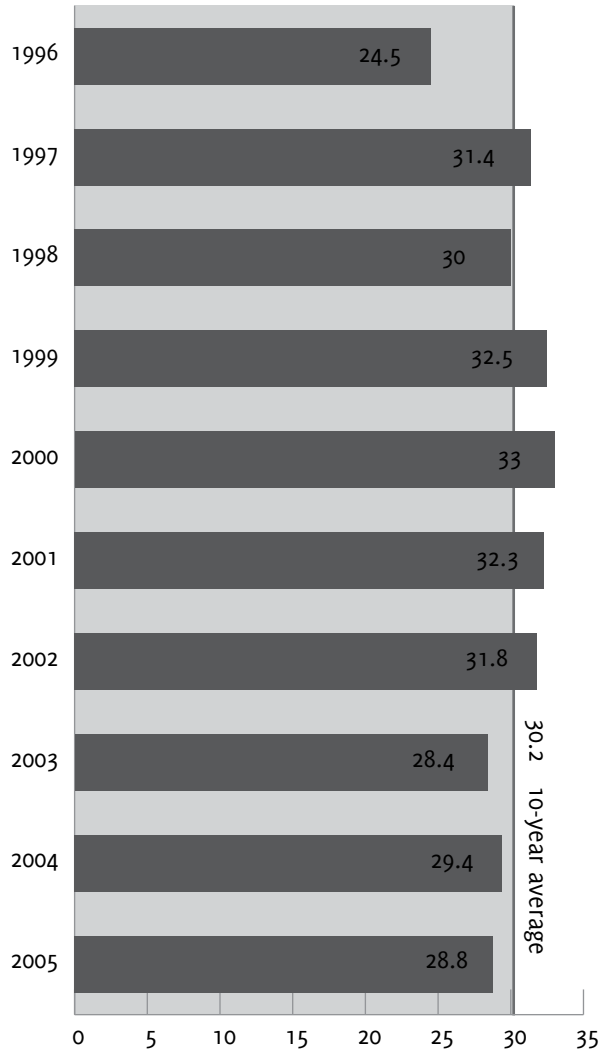


Figure 1.2: The IWA water balance form adapted to local conditions in Iran.

City	A	Inputs M³ per year	B	Total inputs M³ per year	C	Outputs M³ per year	D	Outputs M³ per year	E	Outputs M³ per year	F	Outputs M³ per year
		% of input		% of input		% of input		% of input		% of input		% of input
	Well		System input volume		Authorized consumptions		Authorized billed consumptions		Water delivered to other networks (bulk sale)		Revenue water	
									Billed metered consumptions			
	Qanat								Billed unmetered consumptions			
	Spring						Non-revenue authorized consumptions		Unbilled metered consumptions		Non-revenue water	
									Unbilled unmetered consumptions			
	Purchase of treated water				Water losses		Apparent losses		Unauthorized consumptions			
									Data management and system errors			
									Meter inaccuracies			
							Real losses		Leakage in distribution network			
	WTP input								Leakage in transmission lines			
									Overflows from storage tanks			
	Other sources								Leakage from tanks			
									Leakage on service connections			

distribution networks, using standards and indicators introduced by International Water Association (IWA) for better identification, measurement and control of water loss components. Some of the activities undertaken in this context are:

1. Institutional reorganization and human capacity building.
2. Introducing benchmarks for evaluating performance, progress and operations.
3. Introducing methods for identification of water loss components in the network.
4. Creating an integrated data bank to calculate the volume of water losses.
5. Training and educating efficient manpower in this field.

The Unaccounted for Water (UFW) studies in Iran began in the year 1996. Figure 1.1 shows the UFW ratio in the years 1996 to 2005. Given the unavailability of standards for monitoring, each company had its own definition for UFW and had taken special measures to reduce losses. Therefore, steps taken in the last 10 years to reduce losses were not quite successful and on average yielded only a 4% reduction.

Given the successful application of IWA standards in different countries, NWWEC decided in the year 2005 to use these standards for the management and evaluation of water losses in the subsidiary companies. In this context it decided to prepare the Non-Revenue Water (NRW) strategy, which initially consisted of preparing the water balancing program based on IWA guidelines

for assessing the water losses in all the (39) subsidiary urban companies.

To implement the water balance program in Iran, NWWEC prepared a standard water balance form based on IWA guidelines and the local conditions of Iran and distributed it among all the companies. Figure 1.2 shows the form in question.

As shown in figure 1.2 some minor changes have been made in the original form to take into account the water tariff regulations of Iran. For instance all consumptions below 7 m3 in Iran are free amounting to no income for the companies and constituting a major part of their Non-Revenue Water.

To verify the accuracy of the values of the components in the form, the real losses are calculated using three different methods. In case of any discrepancy, the values of all the components in the table are revised. These three methods are the top-to-bottom method (Balance), the bottom-to-top method (the application of Burst And Background Estimate (BABE) and Fixed And Variable Area Discharge (FAVAD) methods to estimate the components) and the Minimum Night Flow (MNF) in networks where such measurement is made possible.

2. ACTIONS TAKEN TOWARDS THE IMPLEMENTATION OF WATER BALANCE PROGRAM

As mentioned, NWWEC launched the water balance program in the year 2005, with the objective of assessing and managing the losses in networks of the subsidiary companies. Given the fact that companies had different definitions for UFW components prior to this action, there was an initial need for training the staff on the use of standard terms and for introducing the new indicators and methods for reduction of Non-Revenue Water. To this end the company undertook extensive activities to train the relevant staff, which included:

- Organization of 2 Specialized Training Workshops (700 man/hours)
- Organization of 2 training course (10000 man/hours)
- Holding explanatory meetings (640 man/hours)
- Organization of 36 local workshops in the companies for urban managers (5700 man/hours)
- Cooperation with the WBI for organization of a 2-day workshop targeted at all the Operational Deputies and staff in charge of Non-Revenue Water in the companies.

After these activities, NWWEC started to implement the program through measures described below:

2.1. Study, translation and compilation of various references

To make the most of studies in other countries, NWWEC referred to the results of studies undertaken by accredited international organizations and references such as the International Water Association (IWA), the American Water Works Association (AWWA) and the Water Research Commission (WRC), and adapted them to local conditions for application in Iran. The terms and definitions used by IWA were used to establish a uniform standard.

2.2. The compilation of Water Balance Manual

All the components of the water balance table (figure 1.2) were defined and examples of each component were presented in the form of a manual. Moreover the method for measuring these components was explained in detail. The manual was distributed to all the affiliated companies along with the water balance table.

2.3. Design of software in EXCEL

To facilitate the implementation of water balance program, NWWEC designed a software application in Microsoft EXCEL environment and presented it to all companies. By entering the needed data items, presented in a form, the network balance table as well as the entire company's balance table and the ration of components are calculated. In this software all the IWA recommended indicators such as Unavoidable Annual Real Losses (UARL), Current Annual Real Losses (CARL), Infrastructure Leakage Index (ILI), etc., in addition to other indicators defined by the NWWEC, are calculated resulting in a bar chart for each city and the possibility of comparing the networks. Also the pie chart of NRW ratio and its component is drawn for each city. The software is also able to calculate the incurred losses and provide an economical analysis for each city. This loss is related to the commercial components of NRW that can be eliminated (such as illegal consumption, apparent losses and real losses).

2.4. Collecting data from companies, analysis and generating reports

After distribution of guideline and water balance software to companies, all the required data were collected by the relevant companies on the basis of the guidelines and balance manual and submitted to the NWWEC. These data were reviewed in NWWEC and the Water Balance Report was produced as a separate booklet for each subsidiary company.

These reports include all information needed for balancing, the water balance table for each city, the performance indicators, charts and economical analysis and well as the companies' grades based on the table presented by the World Bank.

Moreover on the basis of results obtained from water balance table and indicators the reports propose separate solutions for reducing the Non Revenue in each company. Accordingly in the years 2005, 2006 and 2007 over 15,000 pages of reports were prepared, which include all the mentioned items particularly the water balance table for every city in Iran (over 800 cities). After the reports meetings were held with the relevant companies to discuss the results and to correct any eventual mistakes. This trend will continue in the coming years.

2.5. Defining indicators to control data accuracy and preparing the draft benchmarks for NRW components

For the purpose of conducting an economical analysis of losses incurred by NRW and to calculate the economi-

Figure 3.1: The water balance table for the year 2007 – Iran.

City	A	Inputs M³ per year	B	Total inputs M³ per year	C	Outputs M³ per year	D	Outputs M³ per year	E	Outputs M³ per year	F	Outputs M³ per year
		% of input		% of input		% of input		% of input		% of input		% of input
National Water and Wastewater Engineering Company (2007)	Well	2846439140 57.03	System input volume	4991494491 100.00	Authorized consumptions	3649742282 73.12	Authorized billed consumptions	3500312169 **70.13**	Water delivered to other networks (bulk sale)	77642040 1.56	Revenue water	3500312169 **70.13**
									Billed metered consumptions	3123484217 62.58		
	Qanat	19383471 0.39							Billed unmetered consumptions	299185912 5.99		
	Spring	172763284 3.46					Non-revenue authorized consumptions	149430114 **2.99**	Unbilled metered consumptions	92500955 1.85	Non-revenue water	1491182322 **29.87**
									Unbilled unmetered consumptions	56929158 1.14		
	Purchase of treated water	673002255 13.48			Water losses	1341752208 26.88	Apparent losses	493027875 **9.88**	Unauthorized consumptions	145584386 2.92		
									Data management and system errors	68249901 1.37		
									Meter inaccuracies	279193588 5.59		
	WTP input	1236217881 24.77					Real losses	Top-Down 848724333 **17** Down-Top 735825392 **14.74**	Leakage in distribution network	330656422 6.62		
									Leakage in transmission lines	54362190 1.09		
									Overflows from storage tanks	13153642 0.26		
	Other sources	43688460 0.88							Leakage from tanks	18774839 0.38		
									Leakage on service connections	318878299 6.39		

Figure 3.2: The water balance table for the year 2007 – Tehran.

City	A	Inputs M³ per year % of input	B	Total inputs M³ per year % of input	C	Outputs M³ per year % of input	D	Outputs M³ per year % of input	E	Outputs M³ per year % of input	F	Outputs M³ per year % of input
National Water and Wastewater Engineering Company (2007)	Well	268372205 27.45	System input volume	709266800 72.55	Authorized consumptions	768787021 78.64	Authorized billed consumptions	720716951 **73.72**	Water delivered to other networks (bulk sale)	0 0	Revenue water	720716951 **73.72**
									Billed metered consumptions	695828658 71.17		
	Qanat	0 0							Billed unmetered consumptions	24888293 2.55		
	Spring	0 0					Non-revenue authorized consumptions	48070070 **4.92**	Unbilled metered consumptions	48.49114 4.91	Non-revenue water	256922054 **26.28**
									Unbilled unmetered consumptions	20956 0.0		
	Purchase of treated water	0 0			Water losses	208851984 21.36	Apparent losses	112428485 **11.50**	Unauthorized consumptions	29329170 3.0		
									Data management and system errors	14664585 1.5		
									Meter inaccuracies	68434730 7.0		
	WTP input	709266800 72.55					Real losses	Top-Down 96423499 **9.86** Down-Top 96423499 **9.86**	Leakage in distribution network	7571906 0.77		
									Leakage in transmission lines	9776390 1.0		
									Overflows from storage tanks	4888195 0.5		
	Other sources	0 0							Leakage from tanks	4888195 0.5		
									Leakage on service connections	69298813 7.09		

cal value of preventable losses, NWWEC has compiled benchmarks for NRW components on the basis of international studies and those conducted by domestic consultants; and have mandated the relevant companies to reduce the NRW components down to the established standard level. For instance the established standard for Real Losses has been set as equivalent to four times the UARL value.

Moreover a number of indicators were defined to control the accuracy of information provided by companies, which is conducted by comparing the indicators with the submitted data.

2.6. Calculating the acceptable level of NRW (standard) in each city

Based on benchmarks defined and taking into account the condition of the network in each city, a standard level of NRW was calculated for each city and presented to each company. Accordingly the companies have been mandated to reduce their NRW down to the target level.

3. RESULTS OBTAINED FROM THE IMPLEMENTATION OF WATER BALANCE PROGRAM

The implementation of the Water Balance Program yielded a considerable amount of data on the situation of Non

Revenue Water in Iranian cities that was not previously available. This section presents some results of the project.

Figures 3.1 and 3.2 present the water balance table based on the NRW components and their ratio for the year 2007 in Iran and Tehran city.

As shown in figures 3.1 and 3.2 the Iran NRW ratio is 29.87% and the Tehran NRW ratio in the year 2007 is 26.28%. Figure 3.3 compares the NRW components in the years 2005, 2006 and 2007 in Iran.

Figure 3.3: Comparison of NRW components in the years 2005, 2006 and 2007.

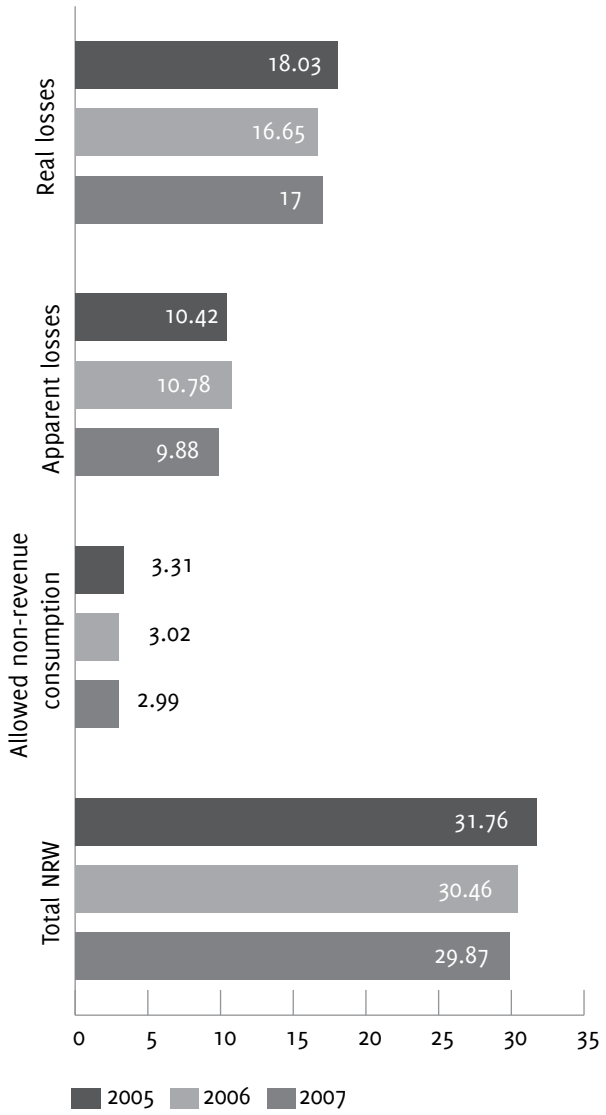
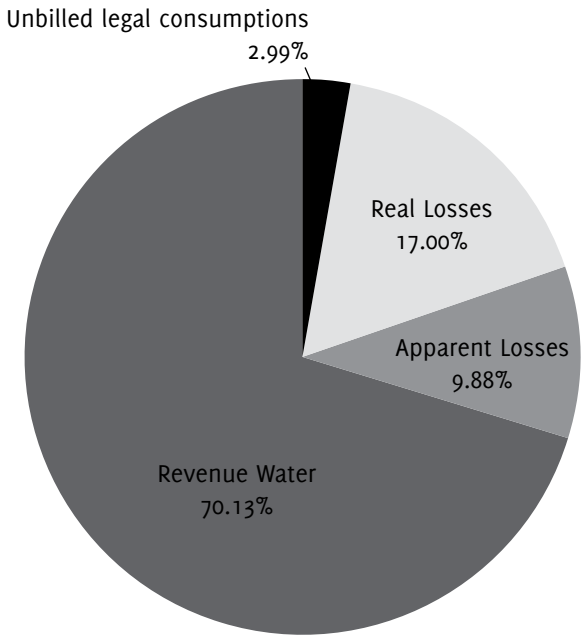


Figure 3.4 shows the ratio of NRW components to the total NRW in the year 2007.

Figure 3.4: The ratio of NRW components to the total NRW in the year 2007.



The ratios of real losses, the apparent losses and the unbilled legal consumptions in Iran are 17%, 9.8% and 3% respectively. Based on studies, the meter inaccuracies and the illegal connections take up 54% and 33% of the total apparent losses respectively while over 87% of the real losses are related to leakage from connections and distribution networks, and the rest is related to leakage from transmission lines and tanks and tank overflows.

Table 3.1 shows the ILI indicators in Iranian networks according to World Bank classification.

Table 3.1: ILI status of Iranian networks according to WB classification.

Network grade	2005		2006		2007	
	No. of cities	Ratio (%)	No. of cities	Ratio (%)	No. of cities	Ratio (%)
A	241	31.6	302	38.4	287	35.5
B	210	27.6	258	32.8	268	33.1
C	124	16.3	141	17.9	169	20.9
D	74	9.71	62	7.89	66	8.16
Cannot be reviewed	113	14.8	23	2.93	19	2.35
Total	762*	100	786*	100	809*	100

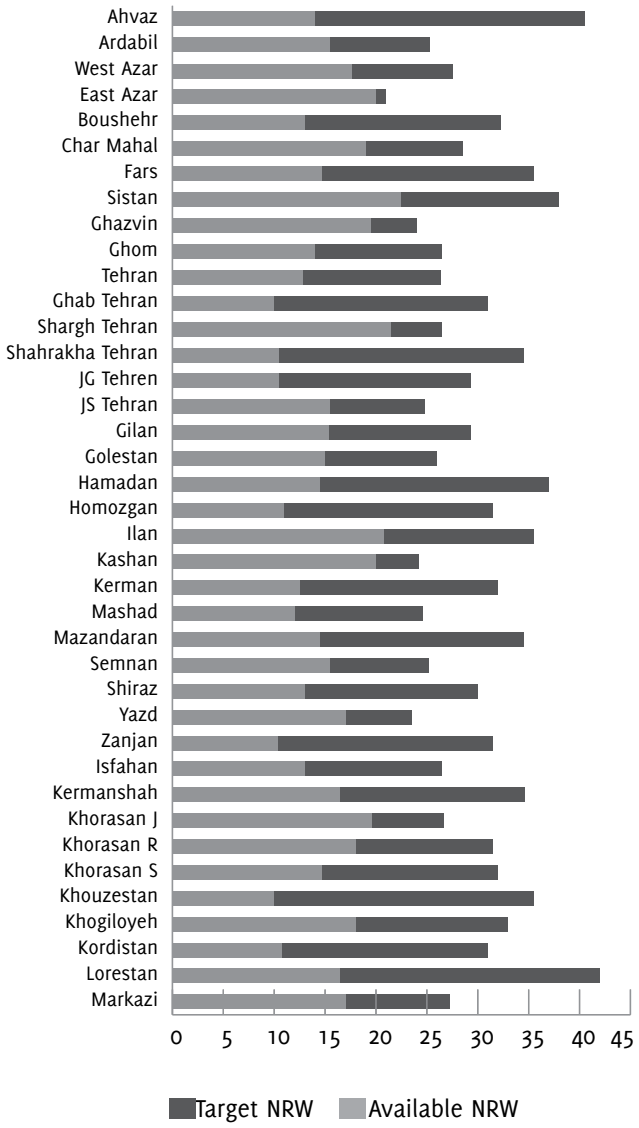
* In 2006 and 2007 new towns were added to NWWEC companies' coverage

A - (ILI<4) B - (4<ILI<8) C - (8<ILI<16) D - (ILI>16)

Figure 3.5 shows the available and target %NRW in NWWEC subsidiary companies and Tehran in the years 2007.

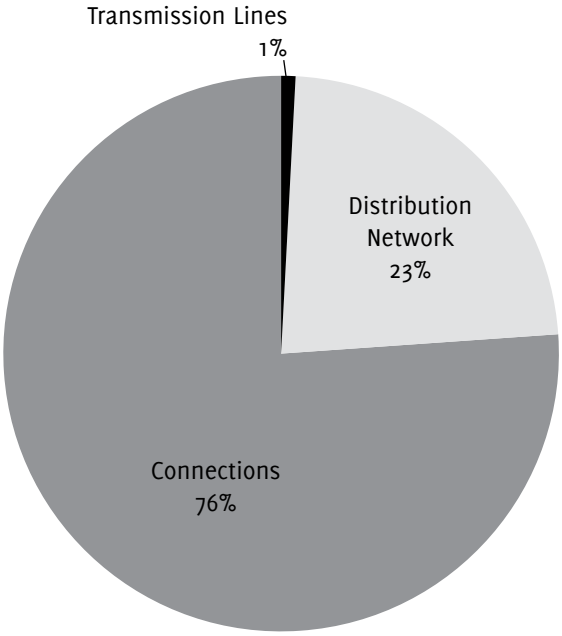
Figure 3.6 shows the number. of accidents occurring in the years 2007. As shown over 70% of the accidents occur at connections.

Figure 3.5: Length of Iranian Networks on age basis.



The information provided above is based on the Water Balance studies in the years 2005, 2006 and 2007. Before then this information could not be obtained in this form. Now the companies can prioritize their NRW Reduction projects based on the new data obtained from each city.

Figure 3.6: No. of accidents occurring in the years 2007.



4. CONTINUING THE STRATEGIC PROGRAM OF NRW REDUCTION

Considering the success of water balance program and based on results obtained from water balance table and performance indicators, NWWEC has considered the following executive procedures to continue the strategic program of NRW reduction:

- Defining District Metering Areas (DMA) in every city
- Network pressure management
- Preparing an Action Plan to reduce water losses in every city
- Developing the Water Loss Management Software
- Evaluating companies based on the new IWA standards
- Application of new technologies for data recording and measurements

The Action Plan on reducing water losses prepared by NWWEC and sent to all cities, addresses the three components of apparent losses, real losses and the unauthorized non-revenue consumptions. Each section of the plan consists of the following four strategies:

1. Real losses:
   - Pressure management
   - Active leakage control
   - Increasing the speed and quality of repairs

- Network and asset management

2. Apparent losses:
   - Consumer meter control
   - Checking the consumer data errors
   - Controlling unauthorized consumptions
   - Data review and analysis
3. Authorized unbilled consumptions
   - Control of sales and free consumptions
   - Process water management
   - Accurate measurement and logging
   - Controlling the administrative and system consumptions

Therefore 16 strategies have been compiled to reduce losses in the network, and each strategy in turn involves a number of projects. All projects are defined in the guideline on the Action Plans. Some projects are prerequisites for others and have priority over them. By sending the guideline to all subsidiary companies, NWWEC is currently preparing the Action Plan for water loss reduction in urban areas and estimating the relevant costs.

Moreover given the large volume to data and the considerable number of projects related to reducing losses, the company is preparing the comprehensive software on water losses, which is under its final stages.

In this software, which is a combination of nine different models, the impacts of activities undertaken to reduce losses are determined and analyzed. The software also analyzes the economic viability of each action. The nine models presented by the software are:

1. The accident management model
2. The leakage management model
3. The pressure management model
4. The minimum night flow model
5. The demand management model
6. The water balance model
7. The network rehabilitation model
8. The consumer data model
9. The economical analysis model

All models in the program are interlinked and the results of each model can be used by others. The software is currently under calibration and will be ready for application by all cities within a few months.

In addition to the above, NWWEC has planned five national pilot projects for accurate implementation of NRW reduction projects based on water balance results and assessment of their impacts. These pilots are under execution. An expected result of these pilots concerns the accurate control of defined coefficients and benchmarks in the Water Balance Program.

5. SUMMARY AND CONCLUSION

The IWA Water Balance Program has been implemented in all the national cities (800 in total) yielding acceptable outcomes on identifying the conditions of the networks from the aspects of real losses, apparent losses and non revenue water. Before the program this form of information was unavailable, while today it is available for every city. Currently all projects in the NWWEC affiliated companies are based on a target oriented strategy and are designed and defined accordingly. The results of the water balance program have illustrated the weaknesses of each network and through an economical analysis (made possible by the software distributed to each company) the priorities of each NRW reduction project are set. Moreover since successful implementation of Water Balance Program depends on accurate measurement of parameters of correct engineering estimation of some components, the companies are encouraged to upgrade the measuring equipment at their disposal.

Finally by defining and calculating the new performance indicators, it is now possible to make a correct comparison among different companies, which in turn motivates managers to increase the efficiency of their networks.

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Nepal: City of Lalitpur

Developing Capacity for water loss reduction in Lalitpur

LSMC's Initiatives in the field of Drinking Water Loss Reduction: (With a focus on Traditional Water Supply System)

Mr Krishna Prasad Devkota, Chief and Executive Officer, Lalitpur Sub Metropolitan City Office

1. DRINKING WATER SUPPLY IN LALITPUR

Laitpur Sub Metropolitan City has two different water supply systems:

- The modern piped water supply
- Traditional water supply system

The modern piped water supply in Lalitpur Sub Metropolitan City is managed by the Department of Water Supply Sewerage Co-operation, Lalitpur (DWSSC). According to it the piped network supplies 32 million liters of water in the wet season and 23 million liters in the dry season. In an effort to improve overall water supply and sanitation in a sustainable manner from February 2008 the newly established Kathmandu Upatyakako Khanepani Limited (KUKL) has taken the responsibility of drinking water management and its service within the Kathmandu Valley.

Kathmandu Upatyakako Khanepani Limited (KUKL) has been established under the "company Act" of the GON AS PPP approach. Kathmandu Upatyakako Khanepani Limited (KUKL) has representatives from the Ministry of Physical Planning and Works, Kakhmandu Metropolitan City, Lalitpur Sub Metropolitan City, Bhaktapur Municipality along with its seven board of directors, chairpersons and 1100 + active employees

However this case paper attempts to deal only with the traditional water supply system. The traditional water supply system has a long history as a past of massive Urban infrastructure of those times fulfilling the water needs of its people dating back to the Lichchhavi period (1st – 8th century A.D.)

The most remarkable thing is that many parts of this system are still functioning very well and contribute significantly to the day to day water demand of the city. It is assumed that about half of the city's total water demand can be fulfilled if all of these water spouts can be repaired and rehabilitated.

2. CONSERVATION AND REHABILITATION OF TRADITIONAL WATER SPOUTS

There are numerous traditional stone spouts scattered within the traditional city core of Lalitpur Sub-metropolitan City. Many of the spouts are still functioning and it is believed that about half of the city's water demand can be fulfilled if all the existing water spouts can be repaired and rehabilitated.

The stone spout is locally called as dhunge dhara and could easily be realized by its continuous extensive exploitation as a water resource for a long time. Beside the

Traditional stone spouts (Dhunge Dhara in Nepali) still functioning well

religious, cultural and medicinal use, the spouts are also valuable for their antiquity.

Among the 61 total stone spouts 42 are working properly in LSMC. All these spouts are working under natural sources. The people have great attachment with the spouts as these are 80% located within settlement areas. In some of words, there are higher numbers of spout distribution. The spouts are serving more than 27000 families, which is equivalent to 108000 population (in ratio 1 family= 4 people.) similarly, 70% of the spouts have drainage condition normal and the total discharge in the spouts is 3.98 MLD in monsoon and 1.44 MLD in dry season. It is also found 2.15 MLD water in monsoon and 0.78 MLD water in dry that is wasting in one night can be utilized.

3. HISTORY OF STONE SPOUTS OF LALITPUR CITY

During the ancient period in Nepal, people used to worship the source of water and manage them according to the situations and circumstances. The Lichchhavi (1st to 9th Century) inscriptions, mentioned water keeping in a 'Guthi' named "Paniya Gosthi". This 'Paniya Gosthi' used to manage the proper use of water in society and that would be well, pond, water spout etc. In course of managing water, people established water stone spouts in society choosing proper location of settlement.

Kathmandu valley is one of the main centers of development in the history of Nepal from ancient to modern period. Moreover, among the four judicial councils of the ancient period; "lanjgval "(water managing committee) would manage the difficulties of water division in villages. For instance, hitis of Lichchhavi period of Lalitpur Sub-Metropolitan city area, Nuga hiti (Sundhara – Sambat 34 of Amsuvarma in Patan Sundhara mentioned in inscription) of Sundhara tole and Chyasal hiti of Chyasal tole are some most significant and authentic facts which still now carries lot of archeological evidences.

Comparatively the medieval period was a fertile time in the use of water stone spouts in Kathmandu valley. In the case of Lalitpur district only innumerable hitis were established with demographic increase of people, village and then circumstances, other economic, religious cultural and political situations. Due to these causes the utility and importance of water conduits were one of the basic needs of families in societies.

In Shah Period (19th Century to Date), the Shah and Rana rulers had done some renovation works in the field of social and religious constructive works keeping the records in inscriptions. Actually, Shah period was guided from the neoclassical architecture which had given less importance to the ancient monument in the construction style. When Janga Bahadur came back from Europe, he and his successors adopted modern styles in religious and secular architectures. Gradually with the development of architectural styles ancient and medieval water stone spouts also regarded less useful than the private and personal water taps of houses. The community water stone spouts were neglected. Similarly, the new foundations while constructing huge buildings and other such construction works on the land surface blocked water sources and its traditional supply lines which led the ancient water stone spouts in very weak, poor and miserable conditions.

In summer season most of the water stone spouts provides water for three to four months regularly but water dries or the flow is decreased during other remaining months. Moreover, comparatively some water stone spouts give more water in summer season. Likewise wa-

ter stone spouts situated in Lalitpur Sub-Metropolitan City area are vanishing in fast pace and going to disappear in the womb of the earth. So it is necessary to preserve and conserve these sites like other historical and cultural monuments.

It was a special technique to bring water by finding water sources. Later, people converted those sources into temporary wooden spouts. Concentrating on the demand of local people, they installed more durable and permanent spouts as water stone spouts around the human settlement areas. In this way, to make the spouts clean, attractive and respective the then royal families, feudal high officials and the citizens made Crocodile, Ox, Tiger faced spouts using wood, stone and metal materials which are still scattered in different neighborhoods of Lalitpur Sub Metropolitan city areas.

4. LALITPUR SUB-METROPOLITAN CITY'S CONTRIBUTION IN THE FIELD OF WATER SUPPLY

Lalitpur Sub-Metropolitan City Office has been playing an important role in the conservation and rehabilitation of century old traditional water supply system. Every year there are numerous projects on the rehabilitation of traditional water supply system implemented by the municipality. The projects are either in the form of water source protection, effective and adequate handling and storage of drinking water or in the form of environmental improvement of the sunken water spouts. There have been numerous successful initiatives on storage of drinking water from the stone spouts. In such initiatives the community participation was very much appreciable.

Traditionally the water spouts are designed in such a way that there is no control valve system and water flows continuously for 24 hours a day. Usually during the day time the water is fetched and used by the local community and during the night time water is wasted. So the local community initiated the idea of storing the water during such off time. The wastage water management in Alko Hiti can be taken as an important initiative. The local community at Alko hiti is practicing a model job in this respect. The water is tapped into the reservoir from 6:00 pm. to 11:00 pm. and distributed to 180 house holds through pipe network system. They are collecting Rs.100 and Rs.125 per month from inside and out side locality customers respectively. The water management practices such as this if replicated in other spouts, this will definitely solve the water scarcity in Lalitpur city to a lager extent.

5. CONCLUSION

Lalitpur Sub-Metropolitan City office has been actively involved in the field of water source protection, effective and adequate handling and storage/use of drinking water (safe water from source to mouth) as illustrated above. If these traditional stone spouts are well managed, repaired and rehabilitated it will have an important contribution for the city's water demand and this will definitely solve the water scarcity in Lalitpur city to a lager extent.

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Egypt: City of Alexandria

The experience of the Alexandria Water Company in reducing water losses

By N. Abdou, Chair Alexandria Water Company

INTRODUCTION

Egypt boasts a 7,000 year old civilization developed on the banks of the Nile River. The current population of Egypt exceeds 70 million, 94% of whom live on 4% of the available land area. The Nile River supports the life of the population as it has for 7,000 years.

HISTORY OF THE ALEXANDRIA WATER COMPANY AND LOSS REDUCTION PROGRAMMES

In 1860, two companies were founded ,one was French and the other was an Egyptian multinational company. In 1879, it was transformed into an English company. In 1954, it became an Egyptian company. In 1961, the company was nationalized. In 1968, Alexandria Water Company became a general authority under the Ministry of Housing & utilities. In 2004, a presidential decree has been issued to transfer 14 companies to follow the Holding Company for Water and Waste Water.

Fig.1 The AWCO Service Area

Water loss control projects at AWCO started in 1992 thanks to a German grant and the area of Maamoura was chosen as (pilot area 1) for a loss reduction study. In 1995, the pilot area of Haddara was chosen as (pilot area 2) an example of an urban area, where losses were successfully reduced from 50% till approximately 36%. In 2005, the area of Toson –Abu kir was chosen thanks to a Dutch grant to study the commercial and physical leakages, with a successful loss reduction programme with percentages from 35% to 15%. In 2007, the area of Faisal – Mandara was chosen thanks to an Italian grant (Life Project) and the project is still in progress. Dividing Alexandria into DMAs is currently being prepared using GIS and hydraulic analysis administration, meter mapping and leak detection administration and distribution sector.

AWCO'S STRATEGIES TO REDUCE WATER LOSSES

The strategy of AWCO for reducing water losses consists in a series of structural and nonstructural measures and systematic control campaigns, such as:

- Continuous water pipelines maintenance and rehabilitation.
- Importing High-Tech leak detection devices
- Installing Ultrasonic Flow-meters to measure flow at the outlets of water treatment plants.
- Increase the response speed in cases of pipelines repairs. (hotline 125).
- Continuous training for the Company's engineers and technicians on the latest technologies to reduce water losses by the detection of invisible leaks to ensure high quality service and active leakage control.
- Implementing the SCADA system in water treatment plants and linking them with the main network information Center to supervise the performance (discharge and pressure) at the water plants.

WATER LOSSES REDUCTION STUDY AT TOSON AREA

The study carried out at the Toson Area can be summarized by the following methodology that was successfully implemented and achieved a reduction of water losses from 35% to 15%. The steps of the methodology are the following:

1. Prepare GIS map for the pilot area and correcting it by the Survey Team.
2. Repairing and replacing inefficient valves in the area.
3. On site field survey to locate the main distribution of the pipelines and house connections.
4. Implementing a zero- pressure test.
5. Field survey for the existing buildings and number of flats in each building (e.g. 16 building-1 school).
6. Registering data of sub & master meters in the area at the MMS sheets.
7. Data collection at GIS paper maps.
8. Building a concrete room for main inlet with changing a part of 6 meter length and 8" diameter of main pipeline.
9. Installing an ultrasonic flow meter as the main meter for the area.
10. Reading the ultrasonic flow meter weekly and all master meters to calculate the commercial loss.

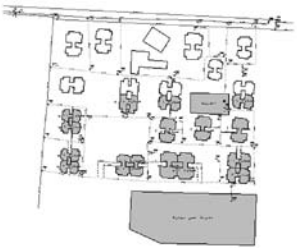
1st Step: Reducing Leaks From 35% to 21%

Week	Inlet meter flowmeter M³	Sum of master meters M³	Unaccounted for water %	Date
1	2400	1575	35%	9-16 June 07
2	2313	1561	33%	16-23 June 07
3	1057	846	21%	23-30 June 07

2nd Step: Reducing Leaks From 21% to 15%

Date	Unaccounted for water %	Sum of master meters M³	Inlet flowmeter M³	Week
17-24 May 08	21%	1359	1722	1
24-30 May 08	21%	1420	1798	2
30-11 June 08	15%	2464	2884	3
11-21 June 08	15%	2424	2864	4

Fig 2. Water Losses Reduction Study at the Toson Area



Abu Kir Leak Detection Pilot Area

Fig. 3 Pressure Loggers

Fig 4. Ultrasonic Meter

ig 5. Noise loggers distribution points.

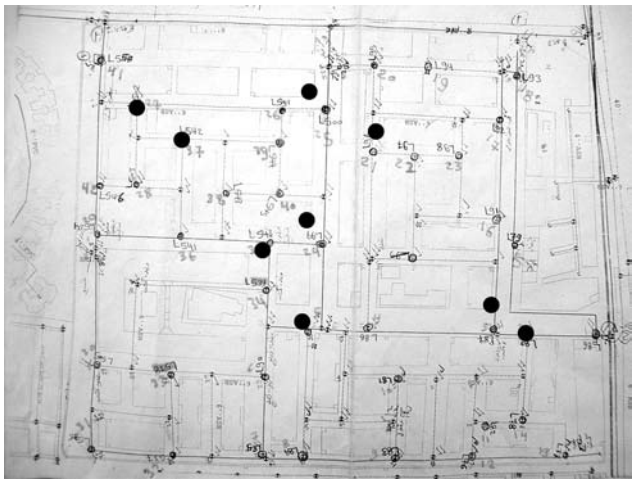
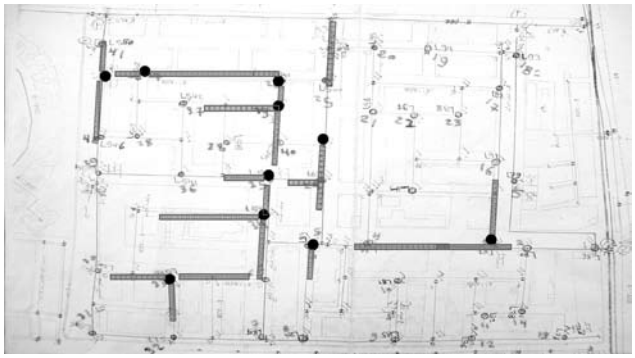


Fig 6. Possible Leak Positions from noise loggers results. Sections correlated.



METER BLOCK MAPPING ADMINISTRATION TARGETS MMS

The methodology for the meter block mapping and setting administration targets is presented below:

1. Analyze the cases of commercial leaks between the master meter and client meters.
2. Study the unaccounted-for water cases like water theft, which idecreases the Company revenue.
3. Determine the changes occurred in the meter structure at the building distribution batteries about which the company is not informed.
4. Determine the illegal connections and thefts.
5. Data correction for client activity and type of connection such as temporary or permanent.
6. Main clients meters following up.
7. Submit proposals for accumulative debts between clients and Company.
8. Adjusting meters with connection.
9. Supervising the addition of master meters on GIS programs regularly.

CONTINUOUS EFFORTS OF AWCO FOR WATER CONSERVATION

AWCO is committed to improve the efficiency of its service and to implement all necessary activities to increase water conservation and water loss reduction in its system. Some of the actions undertaken by AWCO to raise awareness about water conservation and the rational use of water are listed below:

- Awareness Campaigns in Primary School.
- Art Exhibition for School Students Drawings.
- Awareness Campaigns in Charity Associations .
- Awareness Campaigns in Media.
- Awareness Campaigns in Beaches and Hotels.
- Printing Posters.
- Establishment of a 125 Hotline.
- Developing Branches & WTP(s).
- Branches Automation.
- Call Centers.

Fig. 7 & 8. Awareness campaigns in schools

Egypt: Sharkia Governorate

Reducing UFW in Egypt: Case Study of Sharkia Potable Water and Sanitation Company (SHAP-WSCO)

By Prof. Dr. S. Bayoumi, Chairman, Sharkia Potable Water and Sanitation Company, A. Khalifa, Masahiro Takeuchi, and Alaa Talib

ABSTRACT

Without a doubt, water demand is globally growing while water resources are diminishing. For instance, water losses from distribution networks have long been a reality even in well-developed facilities and/or infrastructures that operated properly.

In the framework of technical cooperation between Egypt and Japan, a project for Improvement of Management Capacity of Operation and Maintenance of Sharkia Potable Water and Sanitation Company (SHAPWASCO) has been implemented at Sharkia Governorate since 2006 and it is planned to continue for three years. The project is focusing on three main fields, including decreasing the losses and unbilled water using modern techniques. As a result, water pipe fractures can be detected and repair work or replacement of the pipe may take place.

The project activities were implemented in pilot areas. In one of them the percentage of water leakage to the total water fed to this area was reduced from 26.5% to 9.3%. In other words, the saved volume of water reached 323 cubic meters per day. It is believed that if such activities are extended through the whole Governorate, it is possible to save water which is equivalent to the production of a whole water treatment facility.

In addition, human resource development on the basis of "capacity development (CD)" is too important to be included as part of this Project. At the early stage of the project capacity assessments (CA) of the organization and each level of the personnel of SHAPWASCO were conducted to identify the current conditions. At the same time, because of the necessity for training a fairly large number of staff members, workshops and seminars have been held simultaneously, and attention has been paid to the necessity of On Job Training (OJT) throughout the work procedures pertaining to the project activities.

Key words: unaccuounted-for-water, water distribution system

1. INTRODUCTION:

Water utilities in developing countries (particularly in Africa) face enormous challenges in meeting the water needs of the growing urban population. Many of these challenges are as a result of inappropriate utility management practices, including the lack of a commercial-oriented culture to drive performance improvements. Major players in the water sector are therefore implementing reforms and alternative approaches to improving utility management and performance(1). The reduction and control of water loss is becoming even more vital in this age of increasing demand and changing weather patterns that bring droughts to a considerable number of locations in the world. Many water utilities have been developing new strategies to reduce losses to an economic and acceptable level in order to preserve valuable water resources(2).

Also, reduction of water leakage and losses in municipal networks is primarily an economic problem. The two principal questions to be considered by both operational and financial managers are always: (1) how much can be invested?, and (2) how much will be saved by that investment?. In other words, if it can be shown that the return on investment is economically viable with a reasonable pay-back in months rather than years, leakage or more precisely unaccounted for water is tackled and the prob-

lem is dealt with. For instance, reducing leakage or reducing background consumption for example by installing water-conserving devices, will always result in added values. It is generally accepted that selective reduction in pressure across a pipe network will result in a reduced number of burst pipe occurrences and therefore reduced maintenance and repair costs as well as extending the operational life of the system. Similarly, reducing consumption by education, good housekeeping and the introduction of water saving products will extend the availability of the water resource and postpone the need to invest in the development of alternative water sources(3).

In an ideal world, every water supplier would like to eleminate leakage from water distribution systems as leakage adds to the cost of producing and distributing water and adds to the capacity requirement for storage systems, treatment works, and mains sizing. However, just as the world would like to eliminate world hunger, poverty and disease, it should be accepted, to be pragmatic, that it is an impossible task. For the vast majority of water distribution systems, leakage is something which cannot be eliminated completely. There will always be a level of leakage which has to be tolerated, and which has to be managed. In other words, when considering alternative ways of bridging the gap between the future need for water into an area, and the current availability of water, there are two principal methods: (i) supply augmentation this may mean adding reservoir or pumping capacity, increasing treatment capacity, bringing in water from an adjacent area, and (ii) reducing the future need for water by leakage reduction and demand management(4).

Although a number of options have been tried in an attempt to address the unaccounted-for-water problem, there is growing scepticism among policy makers and water sector professionals on how a diagnostic approach followed by the implementation of solutions which are practicable and achievable can be applied to any water company, anywhere in the world, to develop a water loss management strategy. In this regard, the case study of SHAPWASCO, Egypt shall be delineated.

2. PROJECT DELINEATION:

2.1 Background

In Sharkia Governorate, the second largest governorate in Egypt with approximately six million people, the public water supply and sewerage corporation (SHAPWASCO) took over the management of all the water supply and sewerage services in the governorate. SHAPWASCO, like other public corporations and firms, is suffering from low incomes arising from low are receipts; excessive labor cost due to overstaffing; high cost of inefficient operation of the facilities; high unaccounted-for water (UFW) ratio; low ratio of water charge collection; and insufficient management ability due to incapability of obtaining management information (concerning production, water supply management, and customers). Under such circumstances, in 2003, the Egyptian Government requested the Japanese government to implement a technical cooperation project to assist SHAPWASCO improve its operation and maintenance capacity.

Currently in the Governorate of Sharkia, a new water purification plant is being constructed under Japan's grant aid cooperation project, "the Project for Water Supply Development in Northwest Part of Sharqiya Governorate," so that this project is positioned as a collaborating project for the grant aid cooperation in progress. Following the request as stated above, JICA discussed the issue with the Egyptian side in May-June 2006, confirmed the relevance of the nature of the request; mutually signed minutes of meeting with the Egyptian side concerning the specific outline of the project; signed Records of Discussions on 20 September 2006; and the JICA expert team commenced their work in Egypt from 29 November 2006.

2.2 Project Objectives:

In the framework of technical cooperation between Egypt and Japan, a project for Improvement of Management Capacity of Operation and Maintenance of SHAPWASCO has been implemented at Sharkia Governorate since 2006 and it is planned to continue for three years. The overall goal of the project is to improve the management capacity of SHAPWASCO to operate and maintain water supply facilities in Sharkia Governorate, Egypt. On the other hand, the project purpose is to improve the management capacity of operation and maintenance of water supply facilities in the target areas which shall be mentioned below. However, the following outputs are expected to be gained from the Project: unaccounted-for-water (UFW) ratio is reduced in the pilot project areas and operation and maintenance capacity of water supply facilities is strengthened.

2.3 Project Scope Area:

For UFW reduction activity, two project areas are selected; namely: Project Area (1) includes Zagazig City and Zagazig Markaz and Project Area (2) includes Hihya Markaz, Diarb Nigm Markaz and Ibrahimiya Markaz. On the other hand, for SOP activity, a surface water treatment plant, a booster pumping station, an iron/manganese removal plant, and a groundwater well are selected from the water supply facilities (surface water treatment plants, pumping stations, iron/manganese removal plants, and groundwater wells) in the whole Governorate.

3. BASIC POLICIES OF UFW REDUCTION ACTIVITIES

Basic policies for UFW reduction activities were set up in the course of formulation of an "Action Plan" and implementation of the actions. The main features of these policies are delineated in the following subsections.

3.1 Criteria for Selecting Project Areas and Sites:

The basic parameters considered in the selection of the pilot project site are as follows:

1. The pilot project site should have control valves so that the district could be isolated from the network with just one inlet point. At this inlet point, a flow meter shall be installed to measure the minimum night flow rate. In rural areas in Markaz, we can identify some isolated regions with tree system of distribution networks.
2. Preferably, the used water billing method is computerized on a database.
3. The isolation valves should be in good working conditions.
4. Size and type of the area: the size should be limited to enable proper monitoring of the network and water connections.
5. Size and type of customers: the area should have a good mix of type of customers, i.e. sewer, non-sewer, private and governmental. The number of customers should be limited to manage the customer validation process.
6. The pilot project site shall have a high visible water leakage points and operating water pressure of 1-2 bars.
7. It is preferable to select an area with asbestos cement pipe. It is assumed that asbestos cement pipes have the oldest age.
8. The district shall be provided with water meters for each house connection. No unauthorized or un metered connections are allowed. If there are any connections without water meters, these shall be provided with new water meters by SHAPWASCO before the commencement of the pilot project.
9. All water meters shall be recorded and regularly read and documented in the billing database.
10. If fire hydrant exist in the pilot project sites, monitoring of fire fighting shall be taken into consideration to account the fire fighting water as legal losses during study period.
11. Preferably, no public taps exist in the pilot project site. If any exist, a water meter shall be installed at the public tap.
12. The area of the pilot project site shall be around 2 to 3 km2 or as per the conditions of the candidate site.
13. In order to minimize the cost for repair works, wide roads, roads with heavy traffic, paved road and so forth shall be avoided.
14. Appropriate network plans shall be available indicating the location of control valves and how to raise the pressure inside the area, if required.

3.2 Project Areas and Sites

Six project pilot areas in total were selected from Pilot Area 1 (Zagazig City and Zagazig Markaz) and Pilot Area 2 (Hihya, Diarb Nigm and Ibrahimiya Markaz), three sites each. Table 1 shows the list of the six project pilot areas where UFW reduction activities shall be carried out. After leakage survey (or minimum night flow measurement) of the fife project candidate sites in each project pilot area, the project pilot sites were selected. Moreover, the candidate areas were determined based on the study of the existing drawings and a field survey to be conducted in cooperation with the counterpart (C/P) team, considering the feasibility of measuring effects as a pilot project.

Table 1: Number of Pilot Project Sites in each Pilot Project Area

Pilot Area No.	Pilot Project Area	Number of Pilot Project Site	Size of Pilot Project Site (House Connection)
1	Zagazig City - East	1	500-1000
	Zagazig City - West	1	500-1000
	Zagazig Markaz	1	1000-3000
2	Hihya Markaz	1	1000-3000
	Diarb Nigm Markaz	1	1000-3000
	Ibrahimiva Markaz	1	1000-3000

Note: The number of house connection shown above is the preferable number. It is subject to change according to the situation of the area

3.3 Procedure of UFW Reduction Activities

UFW reduction activities have been carried out according to the flow chart below.

3.4 UFW Action plan

Actions

In order to achieve the target, the following fourteen actions were formulated in a form of UFW Action Plan in March 2007.

- **Action-U1:** Conducting training of C/P staff at Mostrod Training Center
- **Action-U2:** Conducting leakage (minimum night flow: MNF) survey for candidate areas
- **Action-U3:** Determining nine pilot project areas
- **Action-U4:** Preparing GIS drawings
- **Action-U5:** Learning experiences of Jordan UFW reduction project
- **Action-U6:** Making field survey of distribution network
- **Action-U7:** Surveying working conditions of water meters and conducting meter readings
- **Action-U8:** Measuring metering error for working meters and water wastage in the house
- **Action-U9:** Conducting MNF survey
- **Action-U10:** Making water balance analysis before repair works
- **Action-U11:** Conducting leakage detection survey
- **Action-U12:** Repairing leaking parts
- **Action-U13:** Conducting MNF survey (including meter readings) after repair works
- **Action-U14:** Making water balance analysis after repair works and its evaluation

Monitoring Items

Following that the actions to be taken were formulated in Action Plan, monitoring items and targets of the activities were set up as objectively verifiable indicators and approved in the Joint Coordinating Committee (JCC) meeting. Utilized Objectively verifiable indicators for UFW reduction activity are:

1. Water balance analysis can be conducted properly for the pilot project areas.
2. UFW ratio (initial) is reduced from xx% to xx% in the pilot project areas.
3. Leakage (real loss) ratio (initial) is reduced from xx% to xx% in the pilot project areas.
4. At least three members of each UFW team of Zagazig City and Hihya Markaz acquire leakage detection survey techniques.

5. At least one member of each UFW team of other Markazes related to the pilot project areas acquires leakage detection survey techniques.

4. PROJECT PROGRESS AND SAMPLE OF RESULTS

4.1 Progress of Developing Capacity (Actions U1 to U5)

Action U1 (Conducting training of C/P staff at Mostrod Training Center)

SHAPWASCO UFW team members received a training course on leakage survey technique at Mostrod Training Center in Cairo. The course was divided into the following: (i) Class room training: Engineers and supervisors of 16 UFW teams (total 31 participants) and (ii) Field training at Mostrod Training Center: UFW Head Quarter (UFW/HQ) team and UFW team members in the Project Pilot Areas (total 12 participants) attended. The target of the course was to shed light on the following issues: (a) How to calculate unaccounted-for water, (b) How to plan for leak detection, and (c) How to operate and use leak detection instruments. Issues related to the Flow meters (e.g. Types, characteristics of flow, outputs of flow meters, precautions during installation, etc.) are also had been addressed. Other topics that had been covered in the training regieme include:

- Basics for leak detection using instruments
- Factors affecting leak noise
- Tools and equipments for leak detection and its defects
- Preparing leak detection plan (target, period, etc.)
- Making annual plan for leak detection
- Data which have to be obtained in the network maps
- Pressure estimation curve in the network
- Action plan and data analysis
- How to make a leak detection project
- Explaining a basic experiment for determining leak

Action U2 (Conducting MNF survey for candidate areas)

The pilot project sites in each pilot area shall be determined by the results of leakage survey (or minimum night

Table 2: Results of MNF Survey for Candidate Areas for the Pilot Project

City/Markaz Name	Area		Number of House Connection	Date of Survey	Total flow in 24 hrs (L)	Leakage volume in 24 hrs (L)	MNF Ratio
Zagazig City - East	1	El Zend	501	18-19 Aug	1,706,504	983,704	57.64
	2	El Husienia	900	27-28 May	1,261,680	564,813	44.77
	3	Manshiat Husienia	1,200	17-18 Jun	1,801,177	915,791	50.84
	4	El Henawy	962	19-20 Jun	1,119,298	621,457	55.52
	5	Hai Mubarak	489	26-27 May	2,207,948	1,141,652	51.71
Zagazig City - West	1	Hai El Salam	365	4-5 Dec	1,160,427	659,468	56.83
	2	Abu Areiba	546	5-6 Dec	836,647	291,807	34.88
	3	El Zagazig El Buhari	600	22-23 May	738,584	360,461	48.80
	4	Hassan Saleh (1)	450				NA
	5	Hassan Saleh (2)	1,361	21-22 May	667,865	413,522	61.92
Zagazig Markez	1	Kafi El Hamam	2,012	3-4 Jun	2,279,650	886,284	38.88
	2	Bana Yous	2,410				NA
	3	El Messalania	1,000	2-3 Aug	562,950	193,982	34.46
	4	Shaiwida	900	4-5 Aug	782,111	457,146	58.45
	5	Tahlet Bordam	850	7-8 Jun	933,638	513,518	55.00
Hihiya Markaz	1	Southwestern area of Hihya City	3,560	4-5 Jun	4,249753	1,869,776	44.00
	2	Southeastern area of Hihya City	1,414	5-6 Jun	1,084,957	364,954	33.64
	3	El Shbraween	564	2-3 Jun	721,613	187,824	26.03
	4	El Mosalami	795				NA
	5	El Mahdiah	2,095	29-30 May	1,468,940	371,553	25.29
Ibrahimiya Markaz	1	Ibrihimiya City	1,025	18-19 Jun	1,333,366	483,871	36.29
	2	El Halawat	1,097	16-17 Jun	636,463	125,800	19.77
	3	El Seds	584	23-24 Jun	658,152	361,041	54.86
	4	Kafr Abo El Deeb	697				NA
	5	El Habsh	1,126	23-24 Jun	746,347	335,349	44.93
Diarb Nigm Markaz	1	Diarb Ngn City (El KOsailah El)	1,500	8-9 Aug	1,060,726	538,372	50.76
	2	Bahnya	1,800	11-12 Aug	1,847,791	750,256	40.60
	3	Taha El Marg	1,430	12-13 Aug	947,985	214,887	22.67
	4	Sahbarah	1,030	10-11 Aug	723,501	195,427	27.01
	5	El Sania	850	19-20 Aug	1,094,365	372,520	34.04
						Average	44.38

flow survey) for the candidate areas for pilot project sites. Results of MNF survey for the thirty (30) candidate areas are shown in Table 2 that shows an average MNF ratio of about 44%. It should be noted that this MNF ratio does not represent the leakage ratio because it was found after the MNF survey that leakage volume in 24 hours (considered as leakage during the survey) actually may include continuous consumption during the midnight hours in ordinary houses, public facilities, etc. Therefore, in the implementation stage of the Pilot Project, it is necessary to make a field survey of the consumption during the midnight hours.

Table 3: Results of Leakage Survey for Selected Pilot Project Sites

Pilot Project Area	Selected Site	Pilot Project Site	MNF*1 (L/s)	Leakage volume *2 (M³/day)	Water Volume Supplied into Site (M³/day)	Leakage Ratio (%)
Zagazig East	Area 1	El Zend	11.56	983.7	1,706.5	57.6
Zagazig West	Area 3	El Zagazig El Buhari	4.48	360.5	783.6	48.8
Zagazig Markaz	Area 1	Kafr Hamam	11.48	886.3	2,279.7	38.9
Hihya Markaz	Area 2	Southeastern area of Hihya City	3.98	365.0	1,085.0	33.6
Ibrahimiya Markaz	Area 1	Ibrihimiya City	5.24	483.9	1,333.4	36.3
Diarb Nigm Markaz	Area 1	Diarb Nigm City	6.38	538.4	1,060.7	50.8

Notes: 1. MNF (Minimum Night Flow) shows minimum flow at a certain time after midnight measured by flow meter and this MNF contains real water losses due to leakage, water wastage and water consumption during midnight in house. Accordingly, real losses due to leakage shall be calculated by deducting the water wastage and water consumption from MNF.

2. As for leakage volume, MNF in 24 hours is the result of accumulation of the calculated MNF in 1 hour adjusted taking into consideration of the pressure fluctuation (refer to equation mentioned below). Consequently, leakage volume in 24 hours is not equal to the volume calculated by the equation of MNF x 60 x 60 x 24 hour".

Action U3 (Determining 6 pilot project sites)

Evaluation and Determination of the Results of MNF Survey

The main criteria for selecting the Pilot project site to determine 6 pilot project sites are the following:

- The value of the MNF is very close to the average value in the all candidate areas.
- The area has a variety of water use as government sector (schools) and hospital.
- The number of water meter is near the required range 1000-1500 connections.
- The number of non working water meter is not large.
- The average pressure is at least 1.5 bars.

Results of Leakage Survey for Selected Pilot Project Sites

Based on the above mentioned criteria and the results of leakage survey, the selected Project Pilot sites in UFW reduction activity are shown in Table 3.

The equivalent leakage flow during the day could be determined by the following equation:

$$Q_1 = \sqrt{\frac{p_2}{p_1}}\ Q_2$$

Where:
Q1 = equivalent minimum night flow
P2 = Average pressure at minimum night flow time
P1 = Average pressure at the time of equivalent minimum night flow
Q2 = Minimum night flow at a certain pressure

Action U4 (Preparing GIS drawings)

Training of C/P Staff

GIS Unit has been established in SHAPWASCO HQ and GIS expert of JICA expert team has trained GIS staff for six (6) months from 1 May to 31 October, 2007 and then GIS staff has continued to provide GIS drawings by their effort from the beginning of November, 2007.

Information/Data incorporated in GIS Drawings

Relating to the activity for preparing GIS drawing, the following base maps, software and plotter have been provided by SHAPWASCO: GIS base maps prepared by using aerial photos, GIS software (ArcEditor and ArcView) with permanent licenses, and Plotter for printing large size drawings such as A0 size. The location of the existing valves, fire hydrants, tees and the information of the pipe such as diameter, material, length connecting with the existing water transmission and distribution pipelines more than 100mm in diameter have been incorporated in GIS drawings (the scale of 1 to 5,000). Also, SHAPWASCO has purchased GIS base maps (scale: 1 to 5000) covering whole Sharqiya Governorate.

GIS Network Drawings Prepared

Although GIS drawings are prepared for the selected six (6) pilot project sites in each City/Markaz according to the original plan, they will be prepared for all thirty (30) Nominated Candidate areas taking into consideration the possibility of the development of GIS activity for the whole Sharkia Governorate in future.

Action U5 (Learning experiences of Jordan UFW reduction project)

Participants

Participants in this Action are five members from SHAPWASCO and two members from JICA Expert Team.

Schedule

SHAPWASCO C/P Team (5 members) and JICA Expert Team (2 members) went to Jordan for exchanging experiences for UFW reduction activities in Egypt and Jordan. The teams stayed in Jordan from 11th June to 15th June 2007.

Results from this Action

Presentation by the Jordanian Side

C/P learned the current situation of UFW reduction activities done in Jordan through the presentation by the Jordanian side (WAJ and JICA Expert Team) about the Jordanian experience of Non Revenue Water (NRW) reduction and brief report about Capacity Development Project for NRW Reduction in Jordan (JICA technical cooperation).

Presentation by the Egyptian Side

- SHAPWASCO make a presentation briefly about the achievement of the project.
- Expert Team explained about the project components.

Information about the shortage of water resources in Jordan

- Jordan has a severe shortage of water resources, the available average for whole purposes (irrigation and water supply) / Capita is 160 cubic meter/ Year.
- The main resources of water in Jordan are wells. Jordan exceeded the safe limit of using well water
- and reached to 150% of the safe limit
- The average shortage of water in Jordan reaches to 350 Million cubic meter/ Year.
- 90% of Jordan population is served with water supply.
- Due to the shortage of water resources, the supply of water to citizens is once or twice a week for each zone to provide the service for the whole citizens.

Information about NRW in Jordan

- In 1999 the NRW percentage was 58%.
- NRW percentage was improved to 49% in 2006.
- The yearly target of WAJ is to reduce NRW by an amount of 3% every year and reach to 35% by the year 2011.
- Jordan is planning to reduce the NRW to 15% by the year 2019.
- WAJ staff acquired much experience in the field of NRW by the activities which have been done since 1997.
- WAJ is using the latest models of necessary equipment for leak detection and measuring flow and pressures, etc.
- WAJ is utilizing up-to-date international indicators for NRW and performance indicators.

What has been learnt through this Action

Through this Action, SHAPWASCO Counterpart Team has learnt as follows:

- Methodology applied in this project is not so different from the one applied in Jordan and it is effective for UFW reduction.
- Capacity of GIS unit should be improved.
- New department for NRW should be established in SHAPWASCO.

4.2 Project Sample Results (Pilot Project Site -1, Zagazig East)

4.2.1 Action U6 (Making field survey of distribution network)

The purpose of this action is to confirm the source of water to the area by isolating the valve at the entrance of the network and confirm that no water in the network after that. The survey also includes the confirmation of the minor valves, fire hydrants, and the governmental building in the distribution network. It was assumed that governmental building may have the largest amount of wastage during night hours after departure of employees.

Table 4: Network Survey Result in Zagazig East Area-1

Diameter of Asbestos pipe feeding the area	200 mm
Length of water distribution network pipes (material: Asbestos)	3,588 m
400 mm	10 m
200 mm	279 m
150 mm	698 m
100 mm	2,601 m
Number of Fire Hydrants in the area	6 pcs
Number of governmental buildings	0 pcs
Number of schools	2 pcs
Number of isolating valves	43 pcs
200 mm	5
150 mm	6
100 mm	32
Number of water meters	1,661 pcs

Source: GIS Unit at SHAPWASCO

Based on the GIS base maps, a draft of the water distribution network has been prepared by the UFW team. The GIS team drew the network for Zagazig East Area-1 and the pipe data was verified by the UFW team and the distribution network crew. The team made a site survey to verify all data indicated on the GIS map. All customer data was collected from the commercial department in SHAPWASCO. However, the network survey results in Zagazig East Area 1 are shown in Table 4.

4.2.2 Action U7 (Surveying Meters Working Conditions and conducting Meters Readings)

Working conditions of water meters were collected from the commercial department. Non-working meters were recorded by the meter reader of SHAAPWASCO and were verified by the UFW team. After confirming the status of the meters, a meter repairing team has repaired a part of the non working meters. Some of the non-working meters could not be repaired and they were replaced before the water meter reading was conducted. However, the status of the meters inside the site Zagazig East Area 1 is shown in Table 5.

4.2.3 Action U8 (Measuring metering error for working meters)

Meter error shall be one of the sources of the commercial UFW. A series of meter calibration for determining the accuracy of the meter has been conducted by the following method:

1. Select 20 to 30 working meters randomly in the pilot project site.
2. Close all the taps in the house.
3. Set the hands of the water meter at zero point.
4. Open one tap and close all other taps in the house. Measurement shall be done by the following three cases for the degree of tap opening:
   - Case 1 : Full opening
   - Case-2 : Half opening
   - Case-3 : Quarter opening
5. Keep running water into the measuring tank for one minute and close the tap.
6. Reopen the tap for one minute and close.
7. Repeat items 5 and 6 until water level shows 20L or other readings (10L and 15L which will be
8. determined taking into account the work progress at site and situation of the house).
9. Close the tap and read the meter.
10. Record the time of the measurement (from item 3 to 5)
11. Repeat the procedure from item 3 to 6 for all cases.

Table 5: Status of the Meters inside the areas

Meter Status	Number of Meters
Total number of meters as per commercial database	1,661 pcs
Meters outside the activity area[1]	238 pcs
Total number of meters inside pilot project area	1,423 pcs
Meters recorded closed by SHAPWASCO	124 pcs
Meters in closed houses[2]	126 pcs
Connection without meters (flat rate)	5 pcs
Meters lifted for maintenance by SHAPWASCO	5 pcs
Non working meters	364 pcs
Working Meters	799 pcs

1. Meters have a water supply outside the concerned network
2. Customer is outside the country and left his account open

The average meter error was recorded as 3.5% at an average flow of 0.253 L/s (15.2 L/min.). The positive sign of the meter error indicated that the water meter read more than the actual amount of water passing through it. The positive value also indicated that the amount of UFW should be decreased by this amount of error. This value shall be taken into account during the water balance analysis. The main source of wastage inside house is the leak in the faucet and toilets. This wastage can not be determined during day hours. To determine the leakage in house, the water usage pattern in the house should be recorded including the minimum night flow.

The method to determine the wastage in houses was based on installing a flow meter on the inlet pipeline feeding the house for complete 24 hours. The recorded minimum night flow is assumed to be the value of the wastage due to leakage from faucet and toilet. Table 5 represents the results of the flow meter records during this activity. All the surveyed building was medium houses except the fifth building which was a huge building consists of 15 floors and inside 130 flats. The main water connection to the building is 100 mm diameter and has one bulk water meter and was not working. The building has an elevated water tank at the roof floor level. The water is pumped from a pump at the ground level to feed the elevated tank. The pump is operated by a level control which means that when the level in the tank reach a minimum level, a signal from the level switch operates the pumps until the water level in the tank reach a certain maximum level at which the pump stops.

According to the measured results, it was concluded that the minimum night flow in the houses could represent the wastage in the faucets and toilets. The wastage in houses could be estimated as 12 L/hr. The calculated value was below the minimum start flow of the water meters. The installed water meters was class (B) which has -if calibrated or new- a minimum start flow of 30 L/hr. This value of wastage shall be taken into consideration when preparing the water balance analysis as starting flow and metering inaccuracies in apparent losses. This amount of water was measured as a part of minimum night flow value determined by the flow meter installed at the main pipeline to the study area.

Table 5 : Wastage in Houses during Night Hours

Building No.	No 1	No. 2	No. 3	No. 4	No. 5
Number of floors	5	5	5	4	15
Number of flats	11	10	10	8	130
Average number of persons per flat	4	4	4	4	4
Number of water closets	11	10	10	8	130
Number of automatic laundries	3	6	6	3	NA
Number of water meters	11	9	9	6	1
Total measured flow (L/d)	5,117	7,788	2,629	2,478	123,994
Average persons consumption (L/c/d)	116	195	66	77	238
Average MNF (L/s) from 1 to 6 AM	0.048	0.092	0.023	0.013	1.176
Minimum recorded flow at night	0.029	0.036	0.024	0.00	1.057
Calculated wastage per water meter (L/hr)	9.5	14.4	9.6	0	29.3

4.2.4 Action U9 (Conducting MNF survey)

A series of minimum night flow survey was conducted in this stage. It was assumed that the value of the minimum night flow (MNF) is an indication on the amount of leakage in the distribution network. This activity is summarized as follow:

1. A flow meter shall be installed on the water inlet(s) to record the amount of water entering the study area.
2. Two pressure recorders shall be installed as well; one of these recorders shall be installed at the inlet point and the other at the far end of the network for the same period of the flow meter recording to measure the average pressure in the network.
3. The flow meter shall be allowed to record the flow rate value for at least 24 hours.

4. The minimum recorded flow shall represent the amount of leakage in the network including the wastage in houses.
5. The equivalent leakage flow during the day could be determined by the equation:

$$Q_1 = \sqrt{\frac{p_2}{p_1}}\ Q_2$$

Where:
Q1 = equivalent minimum night flow
P2 = Average pressure at minimum night flow time
P1 = Average pressure at the time of equivalent minimum night flow
Q2 = Minimum night flow at a certain pressure

6. Determine the percent of MNF which represent a comparative basis for the UFW by dividing the equivalent minimum night flow by the total flow recorded by the flow meter (QMNF/QTOTAL).

A series of MNF runs was conducted before leakage detection or repair takes place. The summary of these results is represented in Table 6. This ratio of equivalent MNF was considered very high and its sources shall be analyzed after the leakage detection and repair works finish.

4.2.5 Action U10 (Making water balance analysis before repair works)

To establish a water balance analysis (Table 7) which is based on IWA methodology, the following procedure shall be followed:

Table 6: Summary of Result

Item	Unit	Value
Average flow	L/s	19.74
Minimum flow (MNF)	L/s	11.56
Maximum value of flow	L/s	27.92
Total flow rate (Q_{total})	M³/day	1,705
Equivalent MNF (Q_{MNF})	M³/day	984
Ratio	%	57.6

1. Determine the net amount of water entering the study pilot area.
2. Determine the authorized consumption equal the volume of metered and/or unmetered water taken by the recorded customers who are authorized to do so by SHAPWASCO. This also includes water exported across operational boundaries. Authorized consumption may include items such as fire fighting, training, flushing of mains and sewers, street cleaning, public fountains and gardens, etc, these may be billed, unbilled, metered or unmetered.
3. Determine the water loss which is the difference between system input volume and authorized consumption. Water losses can be considered as a total volume for the whole system, or for partial systems such as transmission or distribution schemes, or individual zones as in our case in Zagazig east Area 1. Water losses consist of real losses and apparent losses.
4. Determine apparent losses that include all types of inaccuracies associated with customer metering as well as data handling error (meter reading and billing), plus unauthorized consumption (theft or illegal use). The over recording of customer meters lead to underestimation of Real Losses and under-recording of customer meters leads to overestimation of real Losses.
5. Determine the Real Losses that indicate the physical water losses from the networks (i.e. leakage).

Table 7: Water Balance Analysis before Repair Works for Zagazig East Area-1 (unit:m³/day)

Water distribution volume 1,705 (100%)	**Authorized consumption 1,246**	Billed authorized consumption **1110**	Billed metered consumption **984**	**Water sold 1,110 (65.1%)**	Revenue Water (RW) **1,110 (65.1%)**
			Billed unmetered consumption **126**		
		Unbilled authorized consumption **136**	Unbilled metered consumption **0**	**Commercial losses 112 (6.6%)**	Unaccounted for water (UFW) **595 (34.9%)**
			Unbillled unmetered consumption 136		
	Water losses 459	Apparent losses **-24**	Unauthorized consumption **0**		
			Starting flow error and metering inaccuracies **24**		
		Real losses (leakage) **483**	Leakage on transmission and/or distribution mains	**Physical losses 483 (28.3%)**	
			Leakage and overflows at utility's storage tanks		
			Leakage on service connections up to point of customer metering		

This amount shall represent the water volume lost through all types of leaks, bursts, and overflows.

According to the status of water meters at this stage, it was difficult to determine accurately the volume of water consumed by the customers. It was assumed that the customer s consumption shall conform to the flat rate consumption (i.e. 25 m3/month/water meter). The second assumption was that meter inaccuracy is over registration of 2.5%.

4.2.6 Action U11 (Conducting leakage detection survey)

The leak detection started in early stages using the acoustic rod and the digital sound detector. When there was a point suspected to have a leak, the UFW team began to use a more advanced leak detection equipment such as the leak detector and/or the leak sound correlator to exactly locate the leak on the pipe. However, the following logicaal procedure in detecting leaks may be outlined as follow:

(1) Detection of leaking sound by Acoustic Rod or Digital Sound Detector

The first attempt to detect the leakage in the pipes and the house connection was done using the acoustic rod and the digital sound detector. When leakage occurs, leaking sound spreads through the pipe. At the point where valves are available, acoustic rod or digital sound detector was useful for detecting the sound. The method of leaking sound detection is shown on Opposite Figure. The UFW team has been trained on leak detection by the acoustic rod and the digital leak detector at Mostrod Training Center and OJT at site by assistance of JICA expert team during the activity.

(2) Detection of leaking points by Leak Detector

To detect the leakage on the distribution pipeline, the leak detector was used. The leak detection activity using the leak detector is shown in Opposite Figure. It was helpful to confirm the location of the leakage by night survey to isolate the background noise caused by traffic during daytime.

(3) Detection by Leak Sound Correlator

Leak Sound Correlator was applied to confirm the leaking point when leak sound is detected in two points. This equipment identifies the location of leaks by intercepting leak noise that is caught by a sensor at two valves or hydrants. It measures the difference in transmission time between two points, and processes the data by computer. Thus, it exactly shows the leaking point. The Opposite Figure shows the use of leak sound correlator in the activity area.

(4) Confirmation of Leak Point by Acoustic Rod

After detecting leak point, some holes were drilled at the detected leak points and acoustic rod was inserted in the hole to confirm the exact location of the leak point. This method is very useful especially in paved roads to make the decision of excavation in paved road worth. The Opposite Figure shows the confirmation of leaks when found by acoustic rod drilled in the ground.

(5) Pipe Locating Devices

In some locations, the buried electrical cables shall cause a big risk for labor to excavate beside. It was necessary to locate the position of the electrical cables before excavation. In other locations, when the buried pipes were not identified, devices shown in Opposite Figure were used to locate the electrical cables and/or the buried pipes.

- Pipe & Cable Locator
  This device was used for locating pipes and cables under the ground.

- Metal Locator
  A sensor of this device detects the location of hidden iron-made structures such as valve boxes and stop valves. In some locations, the asphalt paving covered the surface box of the valves and the cover of the valve chambers. The use of metal locator has led to the detection and relocation of these iron-made structures.

(6) Results of leak detection

The leak detection survey led to detect five (5) leaks in the area. All the detected leaks were on the house connections which were manufactured from lead. One of these leaks was on the connection to a public school. The reason for the leaks was due to wrong construction due to bending the lead pipe bending without using the proper facilities to bend such pipes. The following table and map indicate the summary and locations of the detected leaks.

Table 3-14 Summary of Detected Leaks Information
Leakage record sheet

No.	1	2	3	4	5
Date	21 August 07	22 August 07	23 August 07	24 August 07	25 August 07
Block Number	46	51	56	48	36
House number	335	2	39	13	School
Position	HC	HC	HC	HC	HC
Condition of leak	Crack	Packing	Unknown	Crack	Crack
Diameter of pipe	50	50	50	50	50
Material of leak pipe	Lead	Lead	Lead	Lead	Lead
Depth of pipe	70 cm	190 cm	100 cm	120 cm	70 cm
Ground conditions	Paved	Paved	Paved	Paved	Conc.
Cause of leak	Water pressure	Deterioration	Construction	Water pressure	Water pressure
Leakage size	Large	Medium	Medium	Medium	Large
Leakage quantity (measured)	3 L/s	NA	NA	NA	NA

4.2.7 Action U12 (Repairing leakage parts)

Following the leaks had been detected; the repair works takes place by SHAPWASCO equipment and facilities. All the lead pipes and house connection with detected leak has been replaced with PVC pipes with proper fittings.

4.2.8 Action U13 (Conducting MNF survey after repair works)

In order to confirm the effectiveness of the repairing work (or reduction percentage of leakage ratio), MNF survey was carried out after the repairing work of the leaking parts. In the mean time of the MNF survey, two rounds of meter reading were conducted in the same period (about 6 days). The purpose of collecting meter reading was to measure the billed authorized consumption to be used in the water balance analysis.

A flow meter has been installed at the main inlet pipeline and was allowed to record the flow rate for the whole 6 days. Two flow meters were used, one each two days to overcome the short lifetime of portable batteries that was used to operate the flow meter. The following table represents the main findings during the MNF survey after leak detection and repair.

Table 3-15 Status of Water Meters after Repair

Item	*unit*	*Status*
Duration of MNF survey	*day*	*6*
Total amount of water recorded by flow meter during measurement period	*M3*	*8,155 (1,359 M3/day)*
Number of read meters	*nos*	*1,163*
Number of locked meters	*nos*	*255*
Number of flat rate connection	*nos*	*5*

3.3.9 Action U14 (Making water balance analysis and its evaluation)

As described in item 3.3.5 of this report, the water balance analysis is a useful tool to evaluate the UFW ratio. The following data should be known or estimated before making the water balance analysis:

1. Quantity of water entering the study area network.
2. Quantity of water leaving the study area network and goes to another network at the boundary of it.
3. Quantity of billed authorized consumption.
4. Estimation of the unbilled authorized consumption.
5. Meter inaccuracy and error in start flow measurement (the minimum flow rate at which the water meter begin to record the flow amount).
6. In SHAPWASCO, there were no unbilled metered water. Previously, the governmental building did

Table 3-16 Water balance analysis for Zagazig East Area-1 after repair (m3/day)

Water distribution volume 1,359 (100%)	Authorized consumption 1,246	Billed authorized consumption **1110**	Billed metered consumption **984**	Water sold **1,110 (81.7%)**	Revenue Water (RW) **1,110 (81.7%)**
			Billed unmetered consumption **126**		
		Unbilled authorized consumption **136**	Unbilled metered consumption **0**	Commercial losses **117 (8.6%)**	Unaccounted for water (UFW) **249 (18.3%)**
			Unbillled unmetered consumption **136**		
	Water losses 113	Apparent losses **-19**	Unauthorized consumption **0**		
			Starting flow error and metering inaccuracies **-19**		
		Real losses (leakage) **132**	Leakage on transmission and/or distribution mains	Physical losses **132 (9.7%)**	
			Leakage and overflows at utility's storage tanks		
			Leakage on service connections up to point of customer metering		

not pay for the water. This case is not found in Zagazig East Area-1. All building has a meter except some 5 building which are billed on a flat rate of 25m3/month.

7. During UFW team survey for the distribution network and the status of the meters, the team did not find customers theft water (i.e. unauthorized consumption).

During the Action U8, it was found that the wastage in houses equal 12 L/hr/meter. It was assumed that this wastage shall be for a period of 8 hours (night hours). In the daytime, the use of the faucets and flush tanks in the toilet make the water meter run for a flow higher than the start flow. This shall make the meter record the total flow passing through it including the wastage flow.

The number of meters that could have a wastage including flat rate connections is 1,423 meters.

Total amount of wastage per day = 1,423meters x 12L/hr x 8hr/1000= 136 m3/day

The following table represents the water balance analysis after repair.

The value of 2 % of meter inaccuracy is adopted as over-registration taking into consideration of the replacement of non-working meters to new meters.

The common features of the detected leaks that all the leaks were on the lead pipe forming the house connection. Most of the leaks were due to cracks caused in the pipe by bending the lead pipe during construction period and then with water pressure and deterioration, the crack begins to spread. Due to asphalt pavement and the position of the crack on the side of the house connection, no water comes out the ground surface. All the leak water goes to the sewers in some case and to a ground aquifer in other cases. The results of leak detection survey are attached in Annex-7.

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Jordan: City of Amman

Water loss reduction in Jordan – Perspectives of KfW and GTZ

By Ms M. Meuss, Planning Officer, German Technical Cooperation, GTZ, Germany, and Dr S. Gramel, Technical Advisor, KfW Bankengruppe

1 SITUATION IN JORDAN

The situation of the Hashemite Kingdom of Jordan is precarious regarding the water related issues. Main elements, which characterize this situation, are:

- The water scarcity: the very small amount of water resources (appr. 150 m^3/a per capita, to be compared with 10,700 m^3/a as average of Europe or 1,400 m^3/a as average of the Middle East and North Africa) leads to overuse and dramatically falling levels of groundwater tables.
- The (administrative and physical) losses of the public water supply systems are still clearly too high: approximately 45 % in the whole country (between 35% and 75% in the various Governorates, for comparison: 7% in Germany).
- The cost coverage of approximately 135% of the O/M-cost and 70 % of the total cost (2006) makes it difficult for the water utilities to reduce the water losses considerably.

2 JORDANIAN-GERMAN STRATEGY ON WATER ISSUES

Based on the various problems and challenges of the water situation in Jordan, a joint Jordanian-German strategy was formulated and comprises the principles of the development co-operation between Jordan and Germany in the water sector. Important elements in relation to water loss reduction and institutional/capacity development are:

- "Jordanian-German development co-operation aims to help make a sustained improvement to water supply (for drinking and irrigation) and wastewater disposal. (…) The administrative and technical losses in the water supply sector must be reduced considerably. (…) In agriculture, greater use is to be made of treated wastewater and brackish water as a substitute for fresh water. (…)
- Jordanian-German development co-operation aims to help in the development of an appropriate institutional and legislative framework for water management in Jordan. The aim is to establish an effective system in which the institutions for controlling and operating water and wastewater systems operate within clearly delimited responsibilities. These institutions should include a regulatory body. When setting tariffs, the short-term aim is for operating costs to be covered and the future aim for all costs to be covered. They should apply to all types of water use and be dependent on the quality and quantity of water used.
- One aspect of particular importance in the restructuring of the sector is an efficient and sustainable management of the utilities. To this end, further efforts should be made to involve the private sector."

Therefore, this strategy focuses:

- Institutional development, so that water supply companies have a high level of own responsibility and independence from the national water authority,
- Framework conditions for the water supply companies which lead to incentives not to lose too much water in the system (e. g. through water prices that set such incentives).

Considering these elements together, it is intended that the institutional development and the organisational development of the water utilities will lead to the situation that the utilities have a high level of responsibility, capability and have clear incentives not to accept the situation of high water losses.

3 ACTIVITIES OF KFW DEVELOPMENT BANK IN JORDAN

3.1 Projects with the main focus on water loss reduction in combination with institutional and capacity development

According to the urgent need of a sustainable water resources management and water supply and in line with the Jordanian-German joint approach, water loss reduction plays a major role in the Jordanian-German development co-operation. The following list shows the current projects of water loss reduction implemented by KfW on behalf of the German Federal Ministry for Economic Co-operation and Development (BMZ). These projects are implemented in co-ordination with GTZ activities and comprise parts of the organisational development.

- Amman (target group: approx. 300,000 people, programme for tertiary system and house connections)
- Irbid, Jerash (approx. 1,400,000 people, investment programme, capacity development in co-ordination with the project "Northern Governorates")
- Northern Governorates (approx. 1,400,000 people, investment programme plus management consultant – as described in more detail below)
- Middle Governorates (approx. 200,000 people, project in co-operation with capacity development component of GTZ)
- Karak (200,000 people, investment programme plus component for operations management support (OMS))

3.2 Particular example: Northern Governorates

In the Northern Governorates, a model has been chosen which goes beyond the "typical" combination of an investment programme with a capacity development component. Therefore it is presented here in more detail.

An investment component of a large extent has been linked with the integration of an international water company, the so called "Managing Consultant". The model is very much oriented to a management contract (e.g. a part of the payment is linked to level of cost coverage as performance indicator). In contrast to a normal management contract, the international water company is part of the management of the Northern Governorates water utility (NGWA) – but is not representing the full management leadership. An expert of the international water utility and a Jordanian member of staff of the NGWA are always working together. The goals of capacity development and efficient use of the investment component are merged in this model. A main aim of this project is to improve the situation in a way that NGWA can be transformed to an independent public company.

At the beginning of 2008 the Midterm Review was carried out. A key result was to define further key performance indicators, as the target value for the cost coverage does not represent adequately the performance of the managing consultant because of external effects (such as tremendous price increases for energy).

3.3 Outlook: new projects

Bearing in mind the immense challenges of the Jordanian water sector and the current water crisis, the governments of the Hashemite Kingdom of Jordan and the Federal Republic of Germany are planning to increase the budget of the development co-operation considerably. It is envisaged to focus this programme on:

1. the reduction of water losses in the systems of public water supply,
2. Re-use of treated wastewater in the northern Jordan valley.

The water loss reduction measures are planned to focus on the existing hot spots in large parts of the country and will be combined with measures of capacity development mainly to improve also the operational capacity. The re-use project will tie in with some wastewater projects in the northern region of Jordan (wastewater treatment plants Wadi Shallala, Central Irbid, Wadi Arab, water amount of this – to the re-use system connected – treatment plants in 2020 estimated 20 million m^3/a).

4 ACTIVITIES OF GERMAN TECHNICAL CO-OPERATION (GTZ) IN JORDAN

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) the German Technical Cooperation (GTZ) GmbH has supported the Jordanian Ministry of Water and Irrigation (MWI) since 1994 by the provision of assistance through the Opera-

tions Management Support (OMS) Project in partnership with the German Development Bank (KfW) and the provision of Water Loss Reduction Programmes. Today the OMS assistance continues within the broad German-Jordanian Water Sector Programme.

The aim of the OMS component is to increase the efficiency of potable water supply and wastewater disposal services through business process reengineering, decentralisation and commercialisation of utilities and introduction of private sector participation. Change processes on the utility and sector level (Micro-Macro linkages) and especially the introduction of institutional changes in the water sector are closely linked to the implementation of OMS activities.

4.1 The Micro-Macro Linkages in Institutional Reform Processes

Reform processes can be differentiated according to the institutional level they address: reforms on utility level which focus on the improvement of the processes within a water utility and try to increase the performance of the targeted utility. Issues like customer services, human resource management, finance and accounting etc. are often key areas in this regard. Secondly reforms on the sector levels which address the institutional framework, i.e. the different institutional bodies of a water sector like political bodies (ministries), regulatory authorities and the operators. Main issues here are the allocation of responsibilities and competences between the sector institutions and the way they interact. Decentralisation, commercialisation or the introduction of Private Sector Participation (PSP) are some possibilities to change the institutional framework. A change process which induces improved performance on operational level, albeit often limited, is in many cases a first step and an eye opener for actors on operational level and political decision-makers about the possible achievements within a much less rigid institutional framework. This often leads to first small reforms in the institutional framework, allowing for more flexibility for the actors on the operational level by widening the scope to become further commercially oriented. So there is a clear link between changes on the micro or operational level and changes on the sector or macro level. This interdependence, here called „Micro-Macro-Linkage“, implies that sector reform efforts should be based on successful change processes on utility level. However, in systems with strong external and political influences, as is often the case in water sectors, the co-evolutionary dynamic needs to be supported. Therefore, co-ordinated activities on both levels are required, with success on one level leading to even more dynamics on the other level. This co-ordination can be achieved by various means. One possibility is technical assistance which puts a focus on the utility level first and gets also involved, directly or indirectly, in the institutional level. In Jordan, the OMS project was able to provide such coordinated activities and assistance on both levels.

4.2 The contents of the OMS project

Basically, as its name implies, the three topics „Operations“, „Management“ and „Support“ are the key contents of the OMS input, focussing on the support for the Water Authority of Jordan (WAJ) as the public party in charge of operation of water systems.

4.2.1 Operations

The first focus of OMS was and still is the analysis and - wherever required - the re-engineering of the relevant business processes in all operational activities related to the provision of efficient services for water supply and wastewater disposal. One of the most important and critical performance indicators of a water utility, especially in an extremely water scarce country like Jordan, is the percentage of non-revenue-water (NRW). All workflows related to water production, transmission and distribution, the meter reading, billing and revenue collection have a strong impact on this indicator and hence need to be analysed and re-engineered. This also implies comprehensive data collection and analysis. To introduce and maintain a high quality standard of workmanship and to enable the introduction of modern technologies, OMS supported WAJ in the establishment of a vocational training centre and the development of water sector related short term training courses. Further human resources development takes place in the form of on-the-job training, coaching and specialised training courses in information technology, GIS, organisational development and financial management.

4.2.2 Management

Managerial skills are usually underdeveloped in a public sector utility. This also was the case for WAJ at the beginning of the OMS project, since it had a very technical focus in operation at that time making engineers the leaders and directors. As a result the relevance of finance

and soft skills was neglected with substantial costs incurred and increasing deficits sustained. Long, inefficient bureaucratic processes and the lack of customer orientation prevailed. Therefore, and to create the basic preconditions for the initiation of good performance, output orientation and commercial business principles, OMS supported WAJ in the following: introduction of commercial, accrual accounting systems and financial management to develop information tools and documents required for an efficient and effective technical operation which is also sustainable in financial terms; development and application of decision making support tools using the integrated, GIS based Management Information Systems (MIS); re-organisation and decentralisation of WAJ business units in various areas.

4.2.3 Support

Obviously, special tools are required to assist in the achievement of operation and management improvements. For this, OMS activities were based on advanced information technology, like Oracle RDBMS, ESRI ArcGIS products and special expert, open source software. In addition, several tailor- made applications were developed and introduced in the regular business processes. The integration of the available information is provided by the Geographic Information System (GIS) and a modular application development approach is applied to enable WAJ in targeting the most pressing issues first. To enable and provide an even higher level of collaboration among the staff, OMS started the introduction of web based information technology like Internet map servers and MIS navigation tools. This should facilitate a wider use of the already developed applications across all business units, which in the Northern Governorates alone are geographically spread over more than 50 locations.

4.3 Outcomes of OMS on the Micro level

OMS has been, as indicated above, very active in direct support of various WAJ utilities in different governorates and regions. The following paragraphs provide an analysis of the outcomes of OMS with a particular focus on financial issues of these utilities.

Amman Governorate Water Administration (AGWA)

The financial performance of AGWA has considerably improved during the OMS implementation phase in Amman and prior to the effectiveness of the Management Contract. Revenues have increased by more than 15%, while the costs remained almost unchanged (OMS 1997, OMS 1999). This resulted in an increase in profits before interests and depreciation, compared to 1996, of JOD 1.9 million and JOD 2.6 million in 1997 and 1998 respectively. In total financial benefits of JOD 4.5 million were achieved between 1996 and 1998 (OMS 1997, OMS 1998a, OMS 1999). Since 1999 other factors for improvements came into play: a Management Contract was awarded, and rehabilitation of the networks has been achieved. Hence, the performance improvements since 1998 can not be attributed to the OMS project only; but assuming a sustained performance at the 1998 level, an annual saving of JOD 2.6 million would have been attributed to OMS activities. By 2006, the cumulative financial benefits, with 1996 as a reference base, would accumulate to more than JOD 20 million.

Aqaba Governorate Water Administration

Aqaba Governorate Water Administration had been the only regional subsidiary of WAJ which made a considerable profit before interest and depreciation even in the 1990s. However, scenarios for future developments in water demand and water production costs revealed the possibility of serious future cost increases. Therefore, performance improvements were seen as a key requirement to face the then future challenges. OMS contributed to the stabilisation of the profits on a high level. Profits increased by 32% mainly due to increasing revenues through improved customer management and business re-engineering. The total additional financial benefit between 1997 and 2000 accumulated to JOD 5.7 million (OMS 1998b, OMS 2001). Compared to 1997, additional benefits of JOD 1.6 million accrued in 2000 alone.

Northern Governorate Water Administration (NGWA)

The performance of NGWA improved more than that of the other utilities during the OMS implementation activities. Revenues increased by 35% between 2000 and 2004 (OMS 2005). This resulted in a reduction of losses from JOD 5.3 million in 2000 to JOD 4.0 million in 2004, or 25% in four years. Most importantly NGWA managed to sustain improvements until 2006 despite the reduction of OMS involvement by the end of 2003. This indicates that the staff and the management of NGWA have internalised the process of change and actively pursued improvements. A total financial benefit of JOD 3.9 million accrued in four years. Assuming a sustained performance at the 2004 level, total financial benefits would accumu-

late by 2006 to almost JOD 6.5 million compared to the year 2000.

Al Koura District (Regional Operation Unit/ Irbid Governorate)

Al Koura was the first pilot project for testing the Micro-PSP approach. However, unlike Madaba, the support for the billing and collection process was done by OMS, thereby simulating outsourcing to a private operator. Within one year, revenue in those areas improved by almost 30%, accounts receivable were reduced by 22% and the number of non-paying customers went down by almost 60%. The revenue increased by JOD 110,000 over the two years. Clear impacts on customer management improvements have also been achieved. Between 2001 and 2005 the number of complaints in Al Koura decreased by 70%, although the number of customers increased by 11% . Remarkably, these improvements were sustained even after OMS support was withdrawn, and the performance improved even more in 2004 and 2005. This is a clear sign that the improvement was sustainable and successfully implemented in Al Koura District.

Madaba Governorate Water Administration

OMS has been also active in the Madaba Governorate mainly to improve the base data, collect information and prepare the Micro-PSP contract. Consistent support to achieve actual improvements has not been provided. The Micro-PSP contract has since been awarded to the Jordanian engineering company Engicon and implemented sucessfully.

In total, considerable improvements have been achieved in all governorates and water administrations where OMS was involved. Revenues, in general, rose much more than costs, highlighting the effects of improved billing and collection systems, an improvement strongly linked to the Comprehensive Subscriber Surveys (CSS) which enhanced the capacity to identify customers and their preferences, and terminated the long standing monopoly of the tacit knowledge of the collectors and their presumptions. In addition more efficient processes, better customer management and management information systems supported the performance of the utility.

4.4 Conclusion

Within the last 10 years of OMS support to the Water Sector in Jordan major institutional changes were achieved. Today the central water authority relies to a large extent on decentralised and commercially run local water entities which are serving around 80% of the population. With the support of OMS a strong foundation of transparent and reliable information and success stories in transforming the utilities was achieved. Moreover, the successes on the utility level indicated the advantages of commercial-style operation and highlighted the shortcomings of the existing institutional structures in the public sector. Actions on operational levels within the existing frameworks also started to influence the structures at the institutional level. Facilitated by the analysis undertaken in the OMS project, the institutional bottlenecks to thorough and sustainable improvements on operational level became obvious: long and bureaucratic procedures e.g. for procurement, the lack of performance incentives for staff and management, the centralised technical and financial planning, the lack of customer orientation and long response times could not be changed just within the utility operations. Instead, the awareness started to rise at the decision making level that changes in the overall framework were required. And, in addition, OMS provided the tools which helped to facilitate change and was even involved in the change processes on institutional levels.

Of particular importance, especially in a highly sensitive and political issue like institutional reforms at the sector level, is the prevalence of trust between the consultants proposing the possible change processes and the government authorities in charge for the implementation. The co-evolution-based approach of OMS benefited from the successes at the utility level relatively early in the project. This enabled the development of a positive perception of the chances and benefits of increasing the flexibility of the existing rigid sector framework. In addition, the successes were also taken as signals for the competence of the OMS project, which paved the way for creating trust between OMS, MWI and WAJ.

Hence, in Jordan the co-evolutionary approach which was used for the introduction of change, i.e. the mutual support of activities on utility and institutional level for the overall change in the way the sector is run, proved successful and is an interesting example for other developing countries like Syria and Yemen.

Jordan: City of Mabada

The Case of the Mabada Micro Public-Private Partnership

By Mr T. Zuriekat, Business Manager, Engicon

1. BACKGROUND: JORDAN WATER SECTOR

Jordan is a country with a population of over 5 million people. It is currently one of the poorest countries in the world in terms of water resources. The per capita share of water is 150 cm/annum. Naturally, Jordan's largest challenge in the water sector is that demand exceeds supply. In 2004 Jordan's water demand was 1355 MCM meanwhile the actual supply was merely 866 MCM. The following table illustrates further the magnitude of this issue.

Year	2020	2015	2010	2005	2000	1995
Demand (MCM)	1746	1646	1539	1443	1297	1101
Supply (MCM)	1310	1270	1203	1110	830	728
Deficit (MCM)	436	376	336	333	467	373

This problem is further exacerbated by management problems and bottlenecks. The following points summarize the main challenges facing Jordan's water institutions:

- Water institutions are overstaffed
- Sector is heavily subsidized
- Tariff structures do not cover operations and maintenance costs
- Current levels of Non Revenue Water are high
- Depletion of groundwater aquifers through over-abstraction
- The state cannot afford to continue to support the sector as in the past and has to promote efficiency in investments
- Water bill collection is low is several governorates and as a result, the accounts receivable in several water authorities is continuously increasing.

Taking into account the above, the Ministry of Water in Jordan has worked towards improving the efficiency of its water operations through various PPP schemes. This paper examines the latest of such initiatives and arguably the most successful, namely the Madaba Micro PSP project.

2. THE ROAD TO MICRO PSP

2.1 Jordan Water Sector Experience With PPP

Jordan began the process of reform by separating the role of the Water Authority of Jordan (WAJ) as a bulk supplier and service provider. WAJ was then divided into 12 water administrations (utilities) throughout the kingdom. These utilities are now being commercialized through various PPP initiatives.

One of the most significant steps taken by the Jordanian Ministry of Water and Irrigation to involve the private sector was the Amman Water Authority Management Contract (400,000 subscribers). On 31 July 1999, the Ministry awarded the contract to the consortium of Lyonnaise des Eaux and Montgomery Watson Arabtech Jardaneh (LEMA). The contract was initially for four years and then was extended until the end of 2006. It was performance-based with two types of remuneration; fixed fee (US$ 8.8 million) and incentive payment (5% of improved cash flow). LEMA's responsibilities included the following:

- Water supply production
- Water distribution system
- Sewerage services system & WWTPs
- Rehabilitation projects
- Customer services

The contract objectives were as follows:

- Improve quality of service
- Compliance with Water Quality Standards

- Reduce water losses
- Improve billing revenues and collection of cash
- Improve staff skills
- Raise efficiency
- Transfer knowledge and technology.

At the end of the LEMA contract, Amman Water Authority was transformed into a publicly owned company, Miyahuna.

In 2006 the government awarded Severn Trent International a management consultancy for the Northern Governorates Water Authority (180,000 subscribers). A contract valued at EUR 5 Million. It is a three year contract, and while it is too soon to make a definite judgment on the success of this project, it is clear that the lack of authority granted to the operator as opposed to the LEMA model has negatively affected the performance.

2.2 Lessons Learnt

Following is a summary of what can be learnt from the previous PPP initiatives in Jordan's water sector:

1. In both the LEMA and NGWA contracts were of relatively large scale to justify the entry of international operators. For other smaller water authorities in Jordan it may not be feasible.
2. For the LEMA contract which was considered the more successful, it took at least four years for operator efforts to reap rewards in terms of cash flow and NRW (long payback period).
3. While LEMA were able to reduce NRW, it still stood relatively high at the end of their six and a half year operations, at 45%.
4. Both NGWA and LEMA contracts in their current formats, require the assistance of foreign donors. In this case these were the KfW and the World Bank respectively.

3. THE MADABA WATER AUTHORITY EXPERIENCE

3.1 Madaba Water Authority

Madaba is a governorate just south west of the capital city Amman. It has an area of 2000 km2 and a population of 150,000 inhabitants. The Madaba Water Authority (20,000 subscribers) has severe challenges summarized as follows:

- Incorrect billing due to estimations
- Loss of customers due to faulty application process
- Bills not distributed due to lack of information system
- High unaccounted for water ranging between 45 and 60 percent

3.2. Micro PSP Concept

During the GTZ (German Technical Assistance) program in the Middle Governorates, the Operations and Management Support (OMS), it was agreed by both the OMS advisors and WAJ that a different model of private sector participation was required for the small governorate of Madaba. The idea was to outsource a specific service for local operators on performance based contracts. This was termed Micro PSP. The official definition of Micro PSP is "is the Private Sector Participation of Jordanian Companies in Operation, Maintenance and Management of Selected Business Activities and Smaller Business Units of WAJ, to Support Commercialisation and Efficiency of Services Delivery to WAJ".

The advantages of this model of PPP are the following:

- Small scale approaches offer lower risk at lower costs
- Fast track – avoiding lengthy preparation
- Sustainable long term solution – resources within the country
- Support of local enterprises

- Maximum use of existing workforce
- Target oriented solution – revenue in short term
- Highly flexible approach

3.3. Project Objectives and Details

Customer service was seen as the most appropriate service to outsource in Madaba. The reasoning was obvious; Madaba had high administrative losses and also operating customer service required little investment. The objective of the Micro PSP was the following:

- Improve water and wastewater revenue
- Reduce customer outstanding amounts
- Improve customer management efficiency
- Installation of IT-based customer management system
- Technical and administrative development of Madaba customer management organization

The contract conditions are summarized as follows:

- Contract period: 3 years contract started in 2006
- Preparatory period: 9 months. During this period the operator is required to make the necessary equipment.
- Performance management period: 27 months
- WAJ staff seconded to the private contractor (42 people)
- WAJ receives all revenues collected
- Private operator works under supervision of WAJ
- Payment for contractor included fixed and performance based incentive fee

3.4. Tendering and Award

WAJ and GTZ had to work hard to inspire interest from the private sector. Companies that initially expressed interest were asked to take part in the preparation of the TOR. It was also emphasized that one of the main aims of the project was to build the capacity of the local private sector and that companies were not expected to show similar experience due to the lack of previous experience.

Companies were requested to submit technical and financial offers, the technical score was given according to the level of understanding of the project. The financial score was divided into fixed fee and performance fee which was a percentage of the increase in cash collection of a base year which in this case was 2005.

After a technical and financial evaluation, the contract was awarded to Engicon, a local engineering consulting firm specialized in infrastructure and architecture.

4 PROJECT RESULTS

4.1 Preparation Period Deliverables

During the first nine months of operation, Engicon accomplished the following:

1. Procured software and hardware to ensure that Madaba Water Authority is able to issue its own water bills. Whereas prior to contract commencement Madaba Water Authority relied on WAJ HQ in Amman to process and issue bills.
2. Office renovations were conducted to create a modern looking customer service facility.
3. Surveying and mapping of subscribers and digitalising all surveyed routes in the governorate were completed. This had an enormous effect on the accuracy of water meter reading. It reduced the meter reader monopoly and allowed Engicon to switch field employees from one area to the other.
4. Bonus scheme for seconded staff was developed and remuneration procedures made transparent
5. Training of staff (computer skills, customer care, data entries, appraisal course for management)
6. Sewerage database system installed

4.2. Performance in Two Years

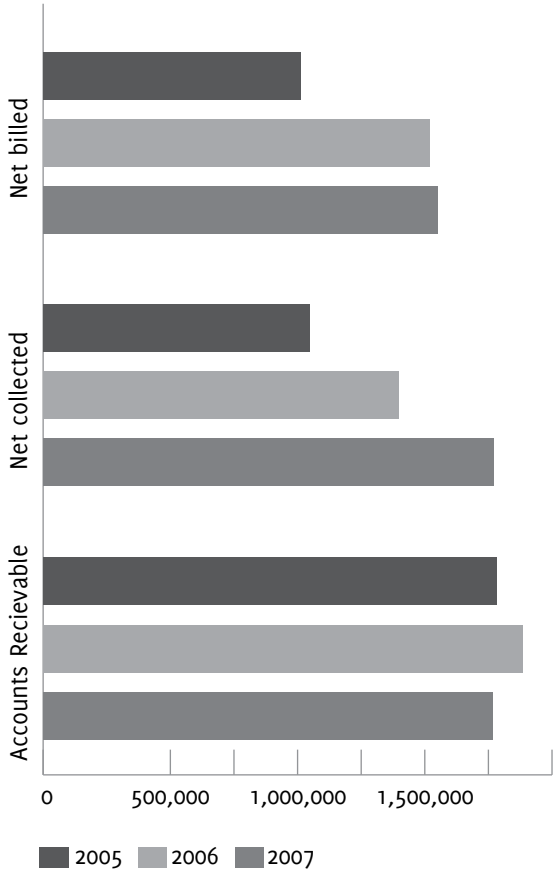
As a result of the above actions things improved dramatically and quickly. In fact the success of the project exceeded all expectation. The following summarize the results thus far:

- Net billed water increased 75% in first year of operation
- Net collections increased dramatically as follows: JOD 900,000 in 2005, JOD 1,300,000 in 2006 and JOD 1,900,000 in 2007. It is expected that in 2008 Madaba Water Authority will collect over JOD 2 million.

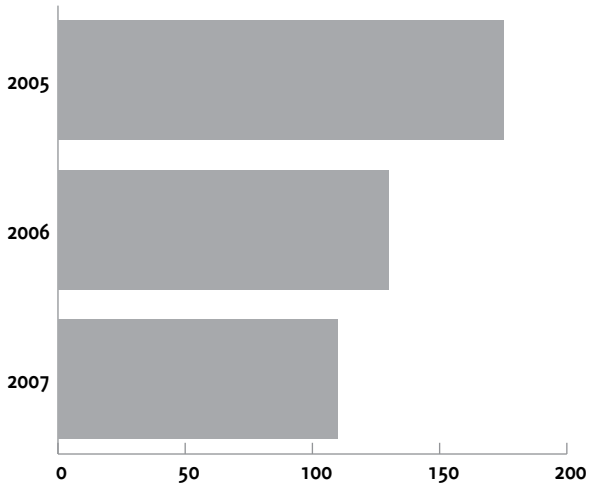
- NRW decreased from 45% to 34% at some point in year two.

The following graphs illustrate the results taking into account increase in water tariffs:

Key performance indicators



Accounts receivable as % of billings



4.3 Success Factors

The success of the Micro PSP model can be attributed to the following factors:

- Performance based pay guarantees win-win. It also reduced the need for variation orders. Wherever Engicon felt that an investment was required to improve cash flow, was possible if even if it was outside the scope of the contract, as it was in its best interest.
- Politically acceptable. The involvement of Engicon at that level is politically acceptable in Jordan as it did not involve the selling of any government assets and the company remuneration is tied to the government improved cash flow.
- Partnership with Government. The Ministry of Water and Irrigation proved to be a very positive partner in this venture. The project would not have succeeded if it had not been for the support of the Water Authority of Jordan.
- Sustainability. This model is now operational without any donor assistance. The government recovered its entire investment in this project in just under 18 months of operation.

5 CONCLUSIONS

5.1 Lessons Learnt

The Madaba Micro PSP contract was a big success by all standards, but the following needs to be noted for future duplications:

1. The project success depends on having a supporting government partner. While Engicon was fortunate to receive the support of the management of the Madaba Water Authority, in the future an incentive system to award the non-seconded staff for the success of the project might be needed.
2. While Engicon succeeded in doubling the cash collection, the situation with NRW is more complex. At the start of the performance based period, NRW began to be reduced rapidly going down as far as 34%, the lowest of any other water utility. This percentage has now risen again, due to increase in water pumping pressure to the governorate of Madaba. NRW now stands at 40%, which is an improvement over the previous figures, but does not match the success in revenue collection. Engicon has no control over anything outside billing and collection; if NRW is to be reduced consistently, the operator scope should be increased and performance based pay on NRW reduction should be included. Already both Miyahona and the Ministry are tendering out such contracts based on the Madaba experience.
3. The contract did not tackle overstaffing issues. Madaba Water authority is still overstaffed, and while Engicon has invested in training and installing a performance appraisal system, its most productive staff are still its own employees as opposed to seconded government staff.
4. Micro PSP is not an alternative for other PPP models; it can be a complement as well. Due to its structure, this model will add value to private and privately managed water utilities.

5.2 Future Outlook on Micro Psp

Stakeholders in the water sector have been looking at ways to duplicate the Madaba success story. Outsourcing water services is now the focus in most water utilities in Jordan. As mentioned earlier, Miyahona are now tendering a contract similar to Madaba with an added scope of operating and maintaining tertiary networks. A bonus will be paid as a percentage of increased cash flow and also as a percentage of the value of the reduction of NRW. It is the writer's view that this is an even better model than that of Madaba Micro PSP.

Micro PSP can be applied in other areas as well, such as operating water and wastewater treatment plants, pumping stations, and networks. Obviously drafting a performance based contract in these situations is more difficult than that of customer services, but with potential for improvement in output, energy efficiency etc. it can be done.

Palestinian Authority: City of Ramallah

Palestinian Water Authority: Capacity Development for Water Loss Reduction

Mr Ziyad Fuqaha, Training and Development General Director, Palestinian Water Authority

INTRODUCTION

Palestine is facing a very big problem due to the lack of water, water resources are scarce and declining through the last years due to the scarcity of rainfall. This will affect ground water aquifers in a negative way, ground water being the main source of water for the Palestinian territories beside the amount of water that is purchased directly from the Israeli side. Palestine can be largely categorized as an arid area.

Since the period 1967-1996 not enough efforts has been made in building new and suitable water distribution systems. This created a damaged water infrastructure including water distribution systems, water reservoirs and water meters and billing systems, and that requires very large investment in the field of rehabilitation of the water sector in Palestine. Also not enough efforts have been made during that period in the field of training and capacity development for the water institutions and water utilities.

The total population for the West Bank was around 2,141,000 people and the total water resource for 2007 was 84,481,000m3. The total of water consumed during that period was 56,650,000m3, and the remaining of 28,860,000m3, a rate of around 34.2%, were losses in the main pipe lines and in the internal water networks.

The Palestinian Water Authority is the main regulatory body in the water sector in Palestine which is responsible for the water resources and policy maker for this sector and since the establishment of PWA in 1996 has been working very hard to manage the limited water resource in the area and to provide the local communities with water connections. PWA took over a damaged water infrastructure with very old main pipe lines and internal water networks that causes very high leakage rates. Since 1996 PWA has started improving the water sector increasing the quantity of supplied water and negotiating with the donors for sufficient funds to rehabilitate the internal networks and replacing old water meters with more accurate ones. These actions reduce the drinking water loss reduction in Palestine.

With cooperation of international donors and neighboring countries, PWA started training programs in the field of non revenue water and based on training need assessment done in 2005 demand for water loss reduction techniques and meters is very high.

PALESTINIAN WATER AUTHORITY

Palestinian Water Authority (PWA) was founded in 1996 as a regulator of the water sector in Palestine; PWA is the policy maker and it follows up its adaptation by water utilities and water service providers. PWA is also responsible for restructuring of the water sector in Palestine and establishing the operational bodies such as the national water utilities and the regional water utilities that are responsible for water distribution in the main cities and the surrounding villages.

One of the main responsibilities of the PWA is monitoring the performance of the water service providers based on industry performance indicators, one of those indicators the water loss ratio. PWA is responsible for setting the training programs for the technical staff of the water service providers in order to improve their capacity in all water issues and that will enhance the water service given to the Palestinian citizens. Qualifying the training providers who are working in the water sector is also one of the main responsibilities of the PWA, thus only qualified training providers can give the training services to the water service provider employees, which will lead to a solid and professional training in the water sector.

PWA have the Water Law No.3 for the year 2002 and, in order to achieve all objectives intended by the law, PWA shall exercise the following responsibilities and tasks:

1. Execute the national water policy as approved by the national water council.
2. Ensure most efficient management of available water resources in Palestine.
3. Seek to achieve and develop water security through optimal planning and management of water resources and explore further resources to ensure balanced management between supply and demand.
4. Sets Standards and establish technical specifications to ensure quality control and quality assurance.
5. License the exploration of water resources including the construction of water projects.
6. Seek to achieve strong cooperation between PWA and other related stakeholders.

In order to achieve proper management of the water resources PWA established the following water management strategy elements:

1. Secure Palestinian water rights.
2. Strengthen national policies and regulations.
3. Build institutional capacity and develop human resources.
4. Improve information services and assessment of water resources.
5. Regulate and coordinate integrated water and wastewater investments and operations.
6. Enforce water pollution control and production of water resources.
7. Build public awareness and participation.
8. Promote regional and international cooperation.

WATER CONSUMPTION AND LOSSES

The total population of the West Bank of Palestine in 2007 is about 2,141,000, and the total water demand to cover the consumption needs is about 117.25 MCM while the total available water resources in 2007 were 84.48 MCM. That means that we have a deficit of around 33.98 MCM. Due to the water loses in the water networks and water meters and all other types and sources of losses, the total actual amount of water consumed for the year 2007 was only 56.65 MCM, which means that there is an actual deficit coming from lack of water resources and the water losses of around 61.46 MCM . The following table shows the water resources distribution and the water losses in the areas of Palestine:

Area	Population	Available Water Resources MCM	Water Consumption MCM	Water Losses MCM	Loses %
Jenin	256,212	5.3107	3.64	1.67	31.4
Tubas	48,771	0.82	0.55	0.27	32.5
Tulkarem	158,213	8.2676	4.62	3.65	44.1
Nablus	321,493	11.019	7.02	4.00	36.3
Qalqilia	91,046	6.302	4.49	1.81	28.7
Salfit	59,464	2	1.26	0.74	37.0
Jericho	41,724	4.516	3.14	1.38	30.5
Ramallah	278,018	13.695	10.15	3.55	25.9
Jerusalem	159,000	8.051	5.66	2.39	29.7
Bethlehem	176,515	8.664	5.30	3.36	38.8
Hebron	551,130	16.863	10.81	6.05	35.9
Total	2,141,590	84.481	56.65	28.86	34.2

RAMALLAH CITY WATER SITUATION AND LOSS REDUCTION

As the table shows, the Ramallah area is the city with drinking water loss , this was due to an intensive efforts by PWA and Jerusalem water undertaking for Ramallah district which is responsible for water distribution in the city, these efforts was focused in intensive plans for rehabilitation of water distribution systems including water networks , maintenance of water meters and changing old water meters into new ones more accurate and more efficient, intensive awareness campaigns for water usage and against illegal connections was made , while the water losses in the year 2000 was more than 45% it was reduced of around 50% and it reached 25.9% in the year 2007 , the table bellow shows the water demand of Ramallah city for the year 2007:

Water Demand MCM	*15.22*
Avaliable Resources MCM	*13.695*
Water Consumption MCM	*10.15*
Water Losses MCM	*3.55*
Actual Deficit MCM	*5.07*

This table shows that the total need of water for Ramallah city in 2007 was 15.22MCM while the total available resources are around 13.70 MCM, an amount of 3.55 MCM was lost due to different causes, then the consumed

amount did not exceed 10.15 MCM, which is 5.07 MCM less than the actual requirement.

WATER LOSSES – SOURCES AND TYPES

The water losses experienced in Ramallah city was from different sources, starting from the main pipe lines that connected the water source, (e.g. such as wells and pumping stations) with the internal water distribution network, and also these main pipe line were used to transfer the purchased water from Israeli side from the point that Israelis transfer the water to , into the main internal water network.

The internal water networks are also main source of water losses especially because these networks are very old and need a lot of rehabilitation; the other source of losses are the water meters and the house connections.

Water leakage is one of the main types of loss, due to the fact that the water networks and water meters are old and need too much rehabilitation and maintenance, illegal usage of water through illegal connections is very big problem that is facing Ramallah city, these illegal connections include theft of water from main pipe lines through making new connections without any permission and without water meters. Another type of illegal usage of water is through damaging the water meter, removing it or stopping it any one way or another. Inappropriate use of water through wasting the drinking water in many ways and consuming more than the actual needs is one of the types of the water losses.

There were some technical problems with the water meters especially velocity water meters, which did not count the true consumption especially when the flow of water is not with high pressure, which this is the normal case in Ramallah city.

SOLUTIONS USED TO REDUCE LOSSES

One of the main solutions in loss reduction is the training and capacity development, through restructuring of the water utility and adding a new department for Non Revenue Water, which includes professional staff with water loss reduction techniques. Training was controlled to be demand oriented and based on actual needs. In order to do so the PWA established a training coordination unit to control the training in the water sector in Palestine and they issue the first training needs assessment for water utilities in Palestine and they start coordination with different donors and organized many training courses in Palestine and in other neighbor countries like Jordan and Egypt and water sector in Palestine benefitted too much from other countries experience especially in the field of water loss reduction .

Rehabilitation of water networks either main pipelines or internal water networks is one of the main issues and solutions that reduces the water losses in the water supply networks. Many donors participated and granted PWA in order to rehabilitate the water networks at Ramallah city and in the neighborhoods ,and that was one of the most helpful support in water loss reduction.

Water meters need to be rehabilitated and maintained regularly, and during the last seven years Ramallah city changed and rehabilitated around 40% of the used water meters, and started using the volumetric water meters rather than the velocity water meters.

The new PA government started security efforts helping JWU and PWA employees to stop the illegal connections, and also public awareness campaigns were organized in order to make the public aware in the disadvantages of illegal connections and the inappropriate use of water.

RESTRICTIONS OF WATER LOSS REDUCTION

Palestine is a special case in the area due to the political, and security situation, there is a problem with law enforcement and a political well in water loss reduction, especially that water is a humanitarian need and can't be barred to any citizen. Implementation of water loss reduction programs or rehabilitation of water distribution networks or water meters and implementation of training programs needs big investments and funds.

Proper training programs should be implemented based on actual needs; transfer of knowledge and experience between countries is necessary, transfer of technology is also a very important factor in water loss reduction.

In Palestine control over the different areas is not directly the responsibility of the PA forces, and that leads to inability to reach many areas which are under Israeli control to make rehabilitation and stop illegal connections.

United Arab Emirates: City of Abu Dhabi

"Drinking Water Loss Reduction: Developing Capacity for Applying Solutions": Abu Dhabi Water Sector Experience in Water Losses Reduction

By Mr M.A. El Ramahi, Network Services Director, Abu Dhabi Distribution Co.

I INTRODUCTION

Abu Dhabi is the largest Emirate of United Arab Emirates which comprises almost 87% of UAE's geographical area. The following are some facts about Abu Dhabi Emirate.

Overall area is 77,000 Sq. Km.
Total Population is 3.5 Million.
Arid Climate Conditions
Limited natural water resources.

The water resources in the United Arab Emirates can be categorized to the following:

1. Underground water
2. Surface water
3. Desalinated water
4. Waste water treatment (Recycled water)

II ABU DHABI DISTRIBUTION COMPANY (ADDC)

Abu Dhabi Distribution Company is the only company licensed to distribute water and electricity within the jurisdiction of Abu Dhabi Municipal Area.

ADDC supplies power and potable water to the population of the Emirate of Abu Dhabi (excluding Al-Ain City), serving more than 1.4 million people (39% of the total population of UAE). Its jurisdiction covers 67,000 square kilometers (about 87% of the total area of UAE). It is an ISO 9001:2000 certified company, with manpower exceeding 2,700 employees and a fixed asset value of 6.7 Billion UAE Dirham (1.8 Billion US Dollars). ADDC and AADC are the only two companies among ADEWA group licensed to distribute and sell water and power to the public.

III SIGNIFICANCE OF REDUCTION OF WATER LOSS

Apart from the common reasons for the importance of water loss reduction, Abu Dhabi has more concern on the issue because of the following reasons.

1. Cost of Production

Abu Dhabi is mainly depending on Desalinated water. The cost of production of desalinated water is very high compared to other sources of water. It is assessed that it costs approximately Dhs. 40/- when the desalinated water reaches at the customer end.

2. Energy Conservation

For producing desalinated water a lot fuel has to spend and this is adversely affecting the energy conservation program of the country.

3. Fast Track Development

Abu Dhabi is in a path of fast track development. The demand is increasing sharply and the more production capacities are to be established. Construction of a desalination plant needs certain time but the anticipated development growth is much faster than the expected. Hence

savings from the water loss reduction process has to be counted for the future demand management.

4. Deferred Investment

Water loss reduction will result more water in the system for distribution and this will help to defer the capital investment in the water production field. Considering the huge capital investment for the construction of desalination plant, delaying the investment even for 1-2 years will count.

IV. WATER LOSS REDUCTION STRATEGIES AND ACTION PLAN

ADDC approaches the water loss issue from two 2 different perspectives.

Top-Down Approach &
Bottom-Up Approach

1. Top-Down Approach

In this method, the entered quantity of water through the interface points into the distribution system are being monitoring and the quantity of water which is leaving the distribution system to the customer end also being monitoring. The difference will indicate the unaccounted for water.

Unaccounted for Water = Quantity of water entered into th system – Metered Quanity of water at the customer end.

The target is to reduce the quantity of unaccounted for water.

Action Plan is to monitor the quantity of water at different control points in the network such as

Interface Location
District / Area Metering Location
Sector Measuring Point and
Customer Metering Location.

Accounting of water at these locations will give the actual quantity of water loss (unaccounted for water) at different pipelines such as

Feeder Lines, Pressure Ring Mains, Sector Mains & Distributors.

Projects are being executed to install meters with modern facilities at above mentioned control points.

2 Bottom – Up Approach

This approach is to verify the results of Top-Down approach by investigating physically at site. There are 2 activities are being followed by ADDC under this approach.

Water Balancing &
Network Scanning

A. Water Balancing

Water balancing is being carried out in selected sectors on priority basis adopting minimum night flow method. This gives the assessment of real water loss in the sector and verifies the results of unaccounted water.

B. Network Scanning

Precision Instruments are procured and Leak Detection Gang are scanning the pipeline physically at site. This will reveal the leakages on the pipeline. Subsequently these leaks are being repaired by the maintenance group. Network Scanning results to reduce the number of leaks and quantity of water loss.

V THE RESULTS OF THE EFFORTS IN THE FILED OF WATER LOSS REDUCTION.

The percentage of metered quantity of water compared to quantity of water entered in to the system is keep reducing for the past years.

ADDC completed more than 200 KM of network length scanned and the leaks on the pipeline repaired. Thus the assessed water loss percentage has gradually came down to 16.80% per volume of water entered into the system.

Water balancing is being carried out many sectors in various operational regions and identified many unauthorized customers in the network.

VI ACHIEVEMENTS:

Achievements include the assessment of Real Loss in the network and subsequent planning in Capital investment in the production as well as other operational areas like leak detection activities, procurement of leak detection equipments etc.

The following are some of the assessment about the results and achievements

As per the preliminary study report, the saving of 1% water quantity is 3.75 MIGD which is equivalent to 1,368 MIG per year costing Dhs. 54.75 Million (@ Dhs. 40/- per TIG).

The total water demand forecast table below shows that the above water saving will defer the investment required by two years.

From capital investment point of view, to increase system capacity by this quantity, (production and network), a total investment of 1.5 Billion Dirham is required

A projection of deferred Capital Investment is as below.

OTHER BENEFITS INCLUDE THE FOLLOWING

Prioritizing the area for Asset Replacement Scheme

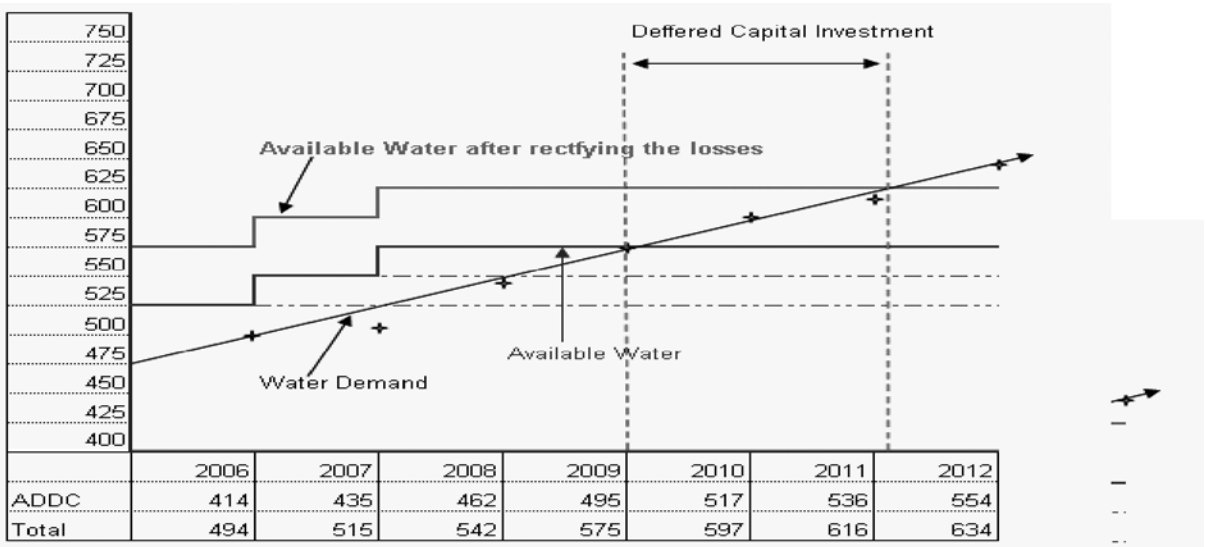
The results from Water Loss Studies help to prioritize the areas under the Asset Replacement Scheme. ADDC intention is to have an Asset Replacement Budget not less than 2% of the total CAPEX of each year.

Hydraulic Modeling & SCADA System demands the water loss assessment in the network for planning the future networks.

The results of the studies are essential for the establishment of a dynamic Hydraulic System which is under the process. SCADA system also require details of the water loss assessment of various areas within the distribution.

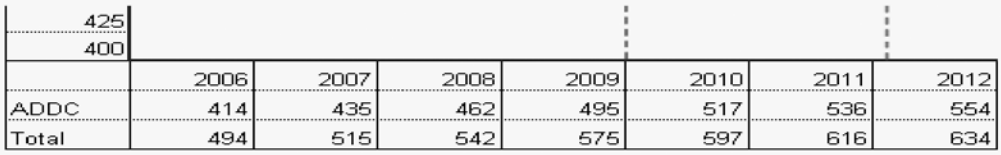
CONCLUSION

Hence the Reduction of Water Loss from the Distribution System is not only a commitment towards the society and future generations but significantly important in terms of financial investment also. Energy Conservation and Environmental Concerns also strongly demands the reduction of water loss from the potable water distribution system.



	2006	2007	2008	2009	2010	2011	2012
ADDC	414	435	462	495	517	536	554
Total	494	515	542	575	597	616	634

Note: 80 MIGD has been forwarding to Al Ain from ADDC Side. Total includes this quantity
Fujairah D.P. capacity not included in the calculation



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Bulgaria: City of Sofia

Some Political and Institutional Challenges For Water Loss Reduction in Bulgaria

Dr Atanas Paskalev, Managing Director, Aquapartner

1. BACKGROUND

Located on the Balkan Peninsula, Bulgaria has an area of 110 911 km2 and population a little less than 8 000 000. Average population density is 81 persons per km2 and about 65 % of them live in towns. Average annual precipitation fluctuates within the range of 500 mm up to 2 000 mm in the high mountains.

The water resources in Bulgaria are formed by the run-off of the internal rivers, underground waters and part of Danube river waters.

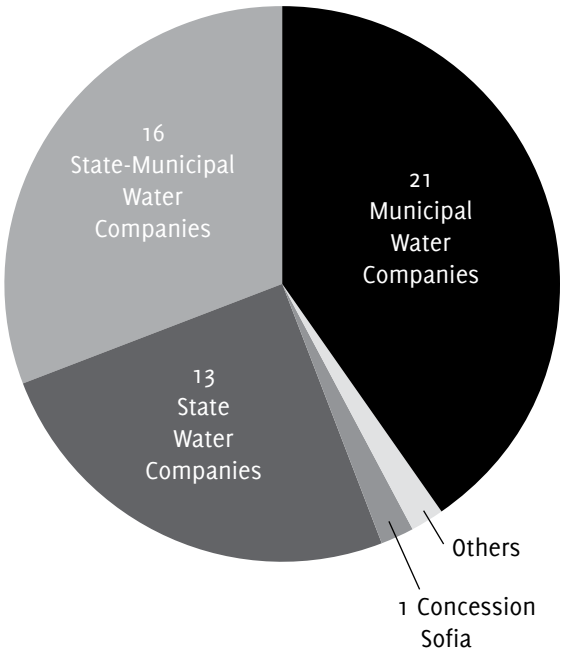
The drinking water generated makes up 7-8% from the average annual river run-off depending on the humidity during the year and is by average 840 000 m3 annually.

In Bulgaria, all 238 towns are water supplied, while villages – 89,9%. The length of the constructed water supply network is 44 874 km, and the transit water supply pipelines are in total 25 375 km but are depreciated with high level of water losses. Water is obtained from 10 water supply dams, 146 river catchments and 2 800 wells. Water is purified in 53 PWTPs and there are a total of 5 900 water supply reservoirs and 3850 pumping stations. This water supply infrastructure is managed by 13 companies with 100% state participation, 16 companies jointly - 51% state and 49% municipal participation, 21 municipal companies, 1 concession for the city of Sofia and some smaller-sized ones, as shown in Figure 1.

Major laws bearing on the water sector and its development are:

- Water Act, which is constantly being developed, the last amendments being related to its harmonization with Water Framework Directive–2000.
- Water Supply and Sewerage Services Regulation Act from 2004, which deals with price regulation, availability and quality of water supply and sewer services provided by operators.

Figure 1



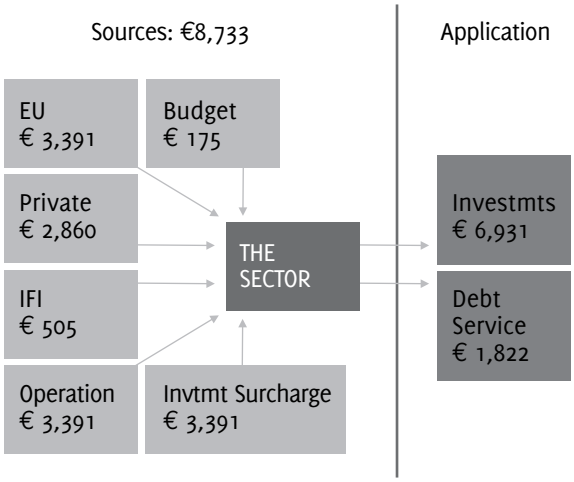
- Water Supply and Sewerage Services Act, which is now amid discussions before being adopted and which will settle the long standing problem with the ownership of this infrastructure and will, too, light up the introduction of the private sector.
- There are a number of other laws related to the water sector, but what deserves attention is the Strategy for development of the water sector formally adopted by the government in March 2004.

The major objectives of the strategy are:

- Creating conditions for efficient management of the sector
- Creating conditions for introduction of the private sector
- Improving the quality of the services

The investments needed for the water sector have been determined by experts of the World Bank and are provided in Fig. 2.

Figure 2: Sector Financing

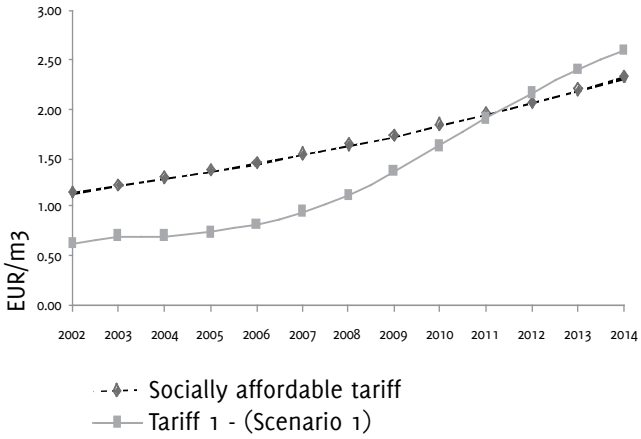


Indicative cash flow: 2004 to 2014 (in millions)

based on Bulgarian water strategy

As can be seen from the figure that the low standard and incomes would not allow a major portion of the investments to come through their inclusion in the price of the water, however optimistic, though, the affordability of the water price shown in Figure 3 may be.

Figure 3: Affordability

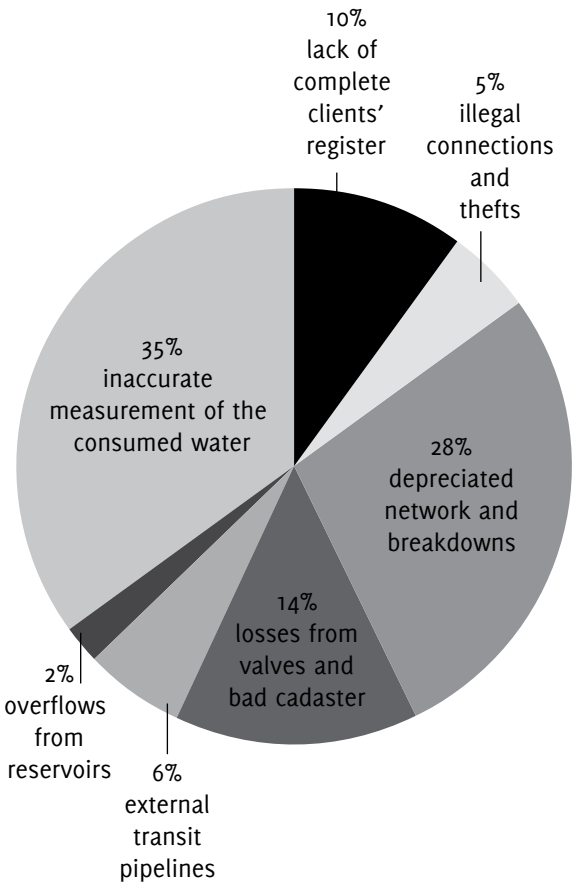


2. BRIEFLY ON THE WATER LOSSES STATUS

The first serious step in this respect was made during the so called „Water loan" from the World Bank (WB) 1996 – 2001. Under observation were 15 water supply and sewerage companies in terms of organizational, technical, financial and operational parameters.

The issue of water losses was the main focus of attention for the bank and a number of conclusions and proposals were made. Pilot zones were made and operating staff was taught. It was shown how water losses lead to less revenue from sales, bigger production costs and a necessity to raise the tariffs. A demonstration was made, too, of approximate figures in the distribution of the administrative and physical losses in case of assuming an optimal 50% of general losses, as is shown in Fig. 4 as an average picture.

Figure 4



The most serious step was made with the coming into force of the Regulation, in 2004, with Art. 7 Section 9 explicitly saying „encouraging the reduction of water losses...", and, furthermore, Art. 9, Para 2, Section 4 de-

manding target dates – „The general losses of water in the water supply systems and target dates for the reduction thereof", so that the water losses are the key parameter to monitor. Associated with the said law, a special Ordinance for the particularities was adopted. At first sight everything seems bound to happen, but by the date of July 2008 the average level of losses of water in Bulgaria remains approximately 60%.

3. THE APPROACH OF SOFIYSKA VODA AD FOR WATER LOSSES REDUCTION

As early as its first year of concession, Sofiyska Voda AD developed a Strategy for reduction of losses due to unaccounted-for water. To that end, the best world practice was used, adapted to the conditions of the water supply network of the city of Sofia.

Sofiyska Voda AD aims to achieve such a UFW level, which allows minimal capital and operational maintenance expenses but optimal effect in reduction of losses. Depending on the site conditions flow measuring devices using various type of measuring technologies were selected and installed.

The water supply network was subdivided into strategic water supply zones, into water demand management zones (DMZ) and 234 district metering areas (DMA), of which 34 were reservoir zones, 26 transit water supply pipelines zones and 174 distribution network zones.

A strategic model of the water supply network was developed and calibration was attempted with the use of sensitive and highly productive software SynerGEE, after which the next thing done was development of a detailed model. A Geographic Information System (GIS) and a system for control and data acquisition (SCADA) were introduced. Two major work groups of trained staff were formed, one working on the problem of apparent losses, the other on physical losses.

The first group, with the introduction of the new billing software „Affinity", started implementation of projects for replacement of water meters and a large-scale programme for measuring the water demand of all types of consumers, as well as searching for illicit connections.

The second group worked on the measures for reduction of physical losses due to overflows, break-downs and leaks using special equipment to listen for hidden leaks. The district of Obelya was set as a pilot zone for studying and reducing the losses of water, which should then cover the whole of the water supply network. Maps of the pressure in the water supply network were developed for monitoring purposes.

4. SOME CHALLENGES

The Sofiyska Voda AD's approach for reduction of the losses of water, as a concessionaire of the water supply network, leaves rather the expectations than achievements until now, as may be seen from the financial provisions in their Regulator-approved business plan.

First Regulatory Business Plan period 2006-2008

- Capital Investment related to UFW, BGN 29.6 million.
- KPI from Regulator 2006 UFW=62% , 2008 UFW=54%
- Actual 2008 UFW forecast to be 58%
- Second Regulatory Business Plan period 2009-2013
- Capital Investment related to UFW, BGN 63.7 million
- KPI from Regulator 2009 UFW=54%, 2013 UFW=44.8%

The Regulators UFW calculation is a simple one:

$$\frac{\text{Water into supply - Billed Water}}{\text{Water into supply}} \times 100$$

There are many reasons for the Bulgarian operators' performance being below expectations in terms of water losses reduction. Historically, following Bulgaria's emergence from a centralized economy over a long and painful transition period and population with low incomes, and the mentality that water is not a commodity, have led, in the process of switching to a market economy (and, respectively, a rise in prices) to low rate of collection of receivables and ongoing thefts. Lack of available capital investments, which, even if available, cannot be included in the price of water, leads to impossibility to carry out all tasks of the business plans, including water losses.

Here, however, is something particular to Bulgaria, which is purely political and has to do with investments. This is the choice of the right policy of depreciation. The assets

of our Bulgarian companies are kept low, approximately 10 times, to get a lower cost of water, but depreciations are the major resource for investment. Each party in office would not opt for a drastic rise in price, for elections concerns, and it is hard to find the balance this way.

It is also easy to notice that, throughout the years, the coming into power of another party leads to a change of the Directors of the larger state-owned companies, which also entails change of other employees in key positions without the necessary inheritance of the achievement results.

The institutionalization of the Regulator was done in a particularly abrupt way, from a political point of view: firstly, the regulation of the water services, which are specific, being performed jointly with the regulation of the electric power energy, heat energy and gas, and secondly, the appointment of mainly politically motivated staff.

To these political challenges, one should add the incessant amendments of laws and particularly the Water Act, the latest changes being related to Bulgaria's accession to the EU.

As for Sofiyska Voda AD in particular, non-achievement of expected levels of water losses has to do with a lot of other circumstances. At the time when Sofia concession was signed, Bulgaria had no know-how and skills for leading international negotiations. The conclusion of the contract was rather a display of political will for a change in the water industry and invitation of private sector than being a precise contract with flexibility for rapid changes in its clauses in response to the rapid changes in the country itself.

In addition, the contract was signed with the risk of the rapid changes in the respective laws, which 10 years later is in a phase of relative stability. It is unlikely that the private concessionaire would allow expenses beyond the agreed ones, unlike the other Water Companies which required endless disputes in Sofia City Council.

In addition to what has been said about Sofia, the political element is further complemented by the fact that pressure is exerted not only by the changing powers in the state, but also by changes in the local authorities bringing about further delay in the implementation of the contract including the reduction in water losses.

CONCLUSION

Still being a country in transition to market economy, Bulgaria has no sufficient sustainable political will for consistent institutional changes. The problem with water losses is not in the focus of the political class yet. There is no complete understanding and will for increasing the efficiency of the activities related to water supply and sewerage which consequently leads to the misunderstanding of the fact that the right management of the non-revenue water is actually saving investments which is a political responsibility.

In practice Sofiyska Voda even having the right strategic approach for reduction of the unaccounted for water and having the necessary knowledge and expertise for dealing with this problem turned out to be a typical example for the impossibility of its realization because of the labyrinth of political, institutional and legislative obstacles.

Finalization of the set of laws in this field gives some hopes but additional political and legislative efforts are required for improvement of the laws and their enforcement in practice as well as overcoming the chronic lack of institutional capacity.

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Germany: City of Leipzig

The Leipzig Model – success of a water and wastewater utility in transition with water loss reduction

By Mr J. Reik, Project Manager, Sachsen Wasser GmbH

THE TRANSFORMATION PROCESS OF KWL – KOMMUNALE WASSERWERKE LEIPZIG

In November 1989, the wall came down - the wall that separated the eastern German Democratic Republic (GDR) from the western Federal Republic of Germany (FRG).

Living in the eastern part of Germany, the people of Leipzig experienced a socialistic system that regulated not only the daily but also the cultural life as well as the economy.

Of course, this system also had its effects on the water sector. The drinking water supply and wastewater discharge within Leipzig has been done by a formally centrally structured water distribution agency, the "VEB Wasserversorgung und Abwasserbehandlung Leipzig" (state-owned enterprise for water distribution and wastewater treatment Leipzig). This agency had hierarchical structures, highly subsidised tariffs and high rates of non-revenue water.

Especially the Operation and Maintenance (O&M) of the water network was affected by the situation in the country. Although the knowledge how to do a proper O&M of the water network has been within the agency, the scarcity of capital and material made it not possible for the workers to run the network in a sustainable way. They acted reactive, only repairing the most urgent leakages. Because no proper O&M could be done, the number of leakages and damages in the network increased a lot during these years. These circumstances not only increased the wear of the network but also the costs of running the system year by year.

Then in 1989, the peaceful revolution in Germany took place, and suddenly the water agency woke up in a totally different social system. Basically from one day to the next, the ideology changed and together with the ideology also the way to run the water companies.

To meet the new situation in an appropriate way, a new company was founded, the "KWL - Kommunale Wasserwerke Leipzig" (Communal water and wastewater utility of Leipzig). This new company now had to take all new influencing factors into consideration of how to run their business:

Before 1990	After 1990
State-owned enterprise (VEB)	Market-based company (GmbH)
Water prices subsidised	Water prices cover costs
Failure to undertake necessary investments	High level of investment in water and wastewater systems
High political influence and centralised structures	Decisions based upon economic facts
Hierarchical structures	Process-orientated structures

Until now, a various number of actions took place to run the company more efficiently and to meet the market based environment in a competitive way.

Especially the in the O&M of the water network a lot of procedures and approaches changed. KWL invested over 1 billion € in the last 10 years to replace about ¼ of their water network. This investment has been urgently necessary, because in the long run, a proper O&M of the network is much cheaper than the costs for repairing big damages and the treatment of water wasted by leakages. It is scheduled to invest another 1 billion € into the network within the coming 10 years to have the system in an acceptable state.

But to reduce leakage within the water network, not only a considerably investment has been and will be made, but also a number of measures have been implemented.

To avoid leakages caused by pressure problems, the whole network has been hydraulically assessed. As a result, the network has been split into three pressure zones that are measured and controlled individually.

The whole organisation has been designed to be process-orientated, meaning that the O&M departments of KWL can more easily work hand-in-hand on the same problem. This also had as an effect that the communication between the departments increased and optimised solutions are developed quicker.

The improved communication is also reflected in a computerised network model, in which all departments are implementing their data (including GIS data and customer structure) and which is prioritising investment measures.

All procedures are completed by an intensive training programme for the utility staff, to work in an optimised manner on the O&M of the network, combined with the definition of clear targets that are controlled on a regular basis and bonuses that are given to the employees if these targets are fulfilled.

To identify which of these measures had which effect on the leakage reduction is impossible to say. It is the holistic approach throughout the whole utility and the consistent implementation of the measures that caused the reduction.

Starting with over 30% water losses before 1990, it has been possible to reduce these losses to 15%, a figure that will be reduced even more in the years to come.

It now can be stated that since 1990, KWL has successfully undergone transformation to a modern, market-based and customer-faced company with cost-covering prices and modern management tools.

Today, KWL is serving about 615,000 people with about 33 million m^3/a. Five waterworks and 21 wastewater treatment plants are in operation and 3,187 km of water and 2,561 km of sewer network are operated and maintained. KWL currently employs 538 highly skilled professionals to fulfil all obligations from the management contract that exists between the municipality of Leipzig and the company. The management contract comprises all aspects of the technical and commercial management of the water and wastewater system, including metering, billing, revenue collection and investment planning.

THE ROLE OF SACHSEN WASSER GMBH

Based on all the experience from the transformation process after 1990, KWL founded Sachsen Wasser GmbH, a 100% subsidiary of KWL, to offer nationwide und internationally its services to train, consult and advise other utilities on how to improve their performance, especially O&M.

Sachsen Wasser has access to all technical and commercial expertise assembled within the KWL group. Whereas Sachsen Wasser itself currently has 41 staff, the total staffing of the KWL Group amounts to approximately 750.

Sachsen Wasser GmbH itself operates another total of six water treatment works and nine wastewater treatment plants. It serves a total of 55,000 p.e. and 16,000 water meters. The length of the water distribution amounts to 360 km, the length of the sewerage system equals 227 km. Sachsen Wasser GmbH is responsible for all operation, maintenance and repair services related to these water supply and wastewater disposal systems.

Sachsen Wasser has always put great emphasis on elaborating tailor-made recommendations and capacity building measures that meet the Beneficiary's demand and has successfully participated in projects including management contracts in Germany and abroad. Besides Germany, consulting services have been carried out in a multitude of countries in Eastern Europe, the Middle East, Asia and Latin America.

THE APPLICATION OF THE WATER LOSS REDUCTION EXPERIENCE IN INTERNATIONAL PROJECTS

One of the running projects Sachsen Wasser has is located in the northern part of Bosnia and Herzegovina. In this project, Sachsen Wasser is working with three utilities, especially focused on water loss reduction, increasing the collection efficiency and implementing a cost covering tariff. Measures have been implemented and improvements have been made in the first utility, in the two other utilities, which joined the project at a later stage, the implementation of the measures is running at the moment.

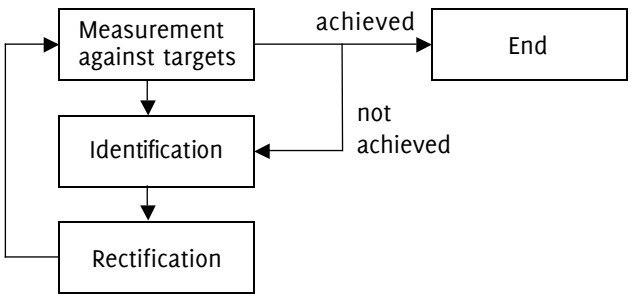
For the water loss reduction, number of actions have been taken place.

First of all, it was important to assist the utility with adopting a more proactive policy towards the reduction of unaccounted for water (UFW). This policy has the benefits that water losses are minimised, operating costs are reduced and the company image is enhanced.

After the utility has been ready to implement the measures and was convinced about the beneficial effect, an activity plan has been developed to set-up a certain number of District Metered Areas (DMA) to be able also to measure the success. This has been done with the following components:

- Strengthen the Concept and Establishment of DMA's within the Utility
- Set up Pilot Zones (DMA's) which will be evaluated on a technical and commercial basis (Physical Losses vs. Administration Losses)
- Develop Standard Operating Procedures for DMA management and policies designed to reduce UFW
- Provide training and assistance to the utility staff in accordance with needs.

To manage these DMAs, it is necessary to follow a specific procedure.



The key to manage DMAs is the measurement against targets.

It is necessary for the utility staff to take on responsibility for the measures and to base them on a sound physical database. With these preconditions, a good volumetric database has to be built up by source metering, a good DMA meter coverage and industrial cross-referencing within the area.

If the result of the measurement does not meet with the targets of the utility, is necessary to identify, where further actions should be taken:

- Priority Ranking from Measurement Process
- Improve Active Detection
- Measure Active Detection Activity
- DMA Drawings and Schematics

When it has been established in which areas it is possible to take further action, the rectification should take place. The rectification can be done in a number of ways:

- Supervision
- Re-correlation
- Site Identification
- Meter Changing
- Bursts on Private Supplies
- Site Rechecks

After the rectifications, the DMAs have to be measured once more against the targets. This process should be repeated until the targets set have been met.

This approach has been taken in Bosnia and Herzegovina and with these measures, including the strengthening of the concept and establishment of Pilot Zones within the utility, development of Standard Operating Procedures and providing Training and Assistance to the relevant staff, it has been possible to reduce the water losses in the selected DMAs by 13%-30%, even before investment measures.

Among the actions in these areas, not only the water losses have been reduced, but also the customer database and the length of the network have been checked:

		Before implementation	After implementation
DMA 1	# of customers	439	439
	Length of mains	3.785 m	3.785 m
	Assessed level of physical losses	79 %	50 %
DMA 2	# of customers	209	276
	Length of mains	3.669 m	4.242 m
	Assessed level of physical losses	65 %	45%

DMA 3	# of customers	634	631
	Length of mains	5.636 m	5.948 m
	Assessed level of physical losses	47 %	34 %
DMA 4	# of customers	272	220
	Length of mains	4.956 m	5.050 m
	Assessed level of physical losses	51 %	27 %

Summarising the activities in Bosnia and Herzegovina, the following statements can be made:

- The distribution network is extensive and DMA's reduce the size of the system into more manageable components.
- Operating targets and action limits can be set on both a commercial and technical basis.
- Trends and performance should be monitored and reported to the director and key staff on a regular basis.
- Effective DMA management will reduce costs, increase revenue and help to define future investment priorities.

On a more general basis, it can be said that:

- Leakage of water from the distribution system is wasteful and inevitable.
- It must be reduced to an economically viable minimum level.
- Its control is a reflection of the professional approach to the total management of the system.

Germany: Ruhrgebiet Region

Persevering Efforts to Reduce Water Losses

Mr C. Creutzburg, Director of Operational Unit, Gelsenwasser AG

1. BACKGROUND OF GELSENWASSER

Water is one of nature´s most precious resource; it must be preserved and protected for the future. On this basis Gelsenwasser delivers drinking water to some three million people every day or over 250 million cubic meters of drinking water each year.

When Gelsenwasser was founded in 1886 mining enterprises at the Ruhr committed their water supply to the charge of Gelsenwasser. Despite having no traditional supply area, Gelsenwasser soon gained municipal partners. We had to prove the ability in order for the franchise and supply agreements to be extended. We have held and improved our position over decades solely by virtue of our convincing performance, as we have been competing against customers´ in-company provision from the very beginning. This consistently forced us to come up with realistic and cost-effective solutions and at the same time guarantee safety, reliability, and the long-term dependability of supplies.

2. NETWORK MANAGEMENT AND „FRANCHISE MODEL“

Gelsenwasser is the owner of all assets and components and supplied on basis of numerous franchise contracts. The pipeline system of Gelsenwasser, approx. 6,000 km, contributes to approx. 75 % of the complete property value. In case of a completion of the franchise agreement, the mains will be assessed, sold and transfused to the municipality. We therefore assume that the actual condition of the mains will be taken into account at the time of the handing over.

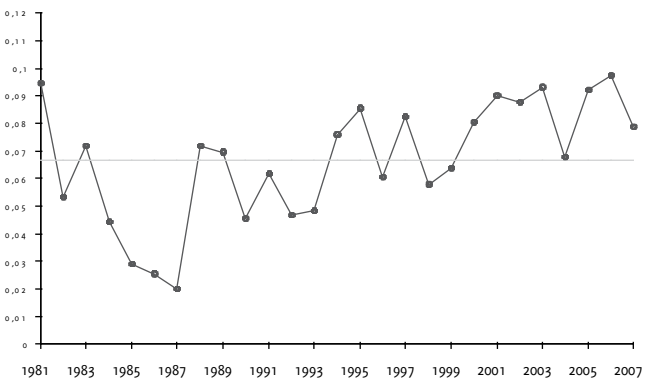
For the technical management of the mains an unlimited time horizon can be supposed theoretically. One of the most important influences, the strategically short-term justification, is thereby dropped.

In our opinion it is a quite decisive advantage in this concept that the asset-owner and the asset-user are one source. Particularly the correlation between investments and operating-costs can be optimized. Interfaces and different opinions of several contract partners are dropped. Gelsenwasser occupies the complete value-added chain from the water extraction to the customer. So therefore investments in the network or in water treatment capacities are a holistic approach. All investment decisions can always aim to the revenue water.

3. WATER LOSSES

Gelsenwasser has been dealing with this topic of water losses for a long time and must further deal with it in contrast to the water sector trend in order to keep the reached NRW on this technologically advanced level in future. The following chart shows the development of water losses of the mains from 1981 to 2007. The average in the given time period was 0.067 $m^3/h*km$.

Chart 1: Water Losses in the Gelsenwasser Network, [m^3/km*h]



The partially appearing differences from one year to the other can be explained with additions or dispositions of

sub-networks or changes in the supply structure. Inaccuracies and accrual accounting difficulties are also responsible to a minor part.

In the 1960s and 1970s systematic measurements were made at first to collect and then to reduce the water losses. The implemented measures finally led to the clear reduction of water losses in the 80s and 90s.

4. INTENSIFICATION OF THE NET MANAGEMENT

The objective of a good network management in this domain is to deliver the necessary amount of drinking water to the tap (at the required pressure in order to guarantee the level of service) whilst abstracting the minimum amount of water from the aquatic environment and without wasting money. Beside these economical and ecological aspects, water losses should be minimized for the safety of consumers.

Gelsenwasser water sales increased, particularly the supply to resellers, by approx. 25 % from 1960 to 1980. In parallel, water sales to industry (steel and coal) decreased. The changes in customer structure as well as in delivery locations in the network in the past necessitated a more conscious and more intensive activity.

Depending on the structure of a water utility provider the portion of the pipe network in the fixed assets represents between 60 and 80 %. Even as far as investments are concerned, the pipe network represents considerably more than 60 %. As a general rule the weight is comparable to the operating expense. As to the influence on operative costs, considerable parameters volunteer to the technical executive.

Without detailed knowledge of the actual and strand-related condition every strategic optimization remains too superficial, subjective and overall too generalized.

From 1960 the systematic, regular leak detection and the preventative network inspection was introduced at Gelsenwasser. Base data like network balance sheets (dimension, laying year, material) as well as detailed network plans are another prerequisite and since then have been improved systematically over the years. A GIS (geographic information system) with database function for the storage of all technical relevant data was introduced in 2000. In addition a systematic documentation and classification of the pipe damages had already been introduced in the sixties.

The evaluation of the information mentioned before, the age-related structure of the mains as well as the structural change, led to a rehabilitation programme for the first time at the end of the 1960s.

5. ORGANISATIONAL SETUP

Because of the importance of the network for Gelsenwasser, water distribution became a division which is reporting directly to the management. With the clear separation and recording of costs separated in profit centre structures a transparent performance evaluation became possible within the company.

The technical executive for the network can be aware of his task as asset owner to whom corresponding technical and economic action competences are transferred. The budget development with regard to the investment and operational expenditure must correspondingly be reflected in the technical indicators, among others in the network and service quality, particularly NRW. Efficiency and process improvements can be carried out internally and systematically. All subdivisions are controlled, among others by internal benchmarks and target-settings.

Budget plan requirements in the form of middle period planning help the respective organization units to maximize the output systematically with a given input. Corresponding efficiency comparisons at standardized tasks and operative activities help to achieve process improvements. The level of efficiency is an indicator describing how well a division is performing in generating the maximum desired output for given inputs with available and comparable technology.

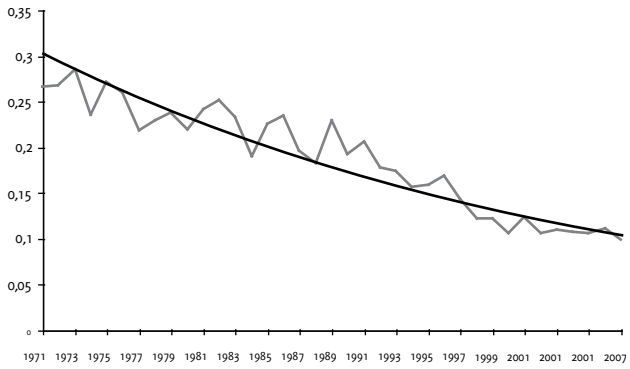
The success of the organisational unit regarding the reduction of water losses depends not least on the staff in the field – up-front funding. A specialized group has formed in the respective regional unit. This consciously selected group receives special training measures and has been equipped with corresponding technology. This group has a special position among the staff. All this led to a momentum at which permanent improvement and further development got recognizable.

6. PIPE BURSTS, REACTING MAINTENANCE

An apparent evidence for a bad net condition is an increased number of pipe damages. This reaches the public perception at the latest at this time. Arising service interruptions, obstructions of traffic and damages to third party property inevitably lead to discussions in point of cheapness. Increased damages internally lead to high staff costs, particularly in connection with nightly or overtime hours becoming relevant to eliminate the damage. A systematic and planned work organization is no longer possible (react instead of act).

Due to the implementation of regular leak detection it was possible to let leak repairs take place as planned and more systematically. In consequence the first step was taken on the way from failure orientated maintenance to condition orientated maintenance. The following chart shows the development of the pipe damages at Gelsenwasser.

Chart 2: Pipe Burst Ratio in the Gelsenwasser Network, [pcs/km]



In principle, since 1970 all pipe damages are classified among others according to the nature of damage and cause. The classification allows an intensive assessment with regard to the life expectancy of different pipe types under different influences. Leaks to sleeve connections are substantially more dramatic than pitting corrosion. An accumulation of brittle fractures of PVC-pipes can as well be an arbitrary indication for a forthcoming complete failure.

7. PERIODIC WORKFLOW, ACTING MAINTENANCE

The maintenance can be divided into determination and valuation of the current conditions, that means inspection, keeping the designed situation „servicing“ and restoring the designed situation „rehabilitation“. The regular leak detection is part of the measures used per default at Gelsenwasser. In the context of the long standing internal execution and optimization of the leak detection the following procedure has revealed itself as economically:

- Preventive network inspection, repair of leaks (incl. valves and fittings)
- Sound level measurement by noise data logger (cheap and fast sector scan), determination of further work steps in accordance with the following methods
- Electro-acoustic method (leak observation)
- Correlation measuring technique (localization)
- Repair of the leak
- Documentation of the damage characteristic

Gelsenwasser implemented flow measuring parallel to the above-mentioned at 45 sector points. The compliance with set limiting values gets monitored as well as the nightly one zero consumption measuring in real time. If it should come to any variation, measures must be worked off according to the order mentioned above in the area affected.

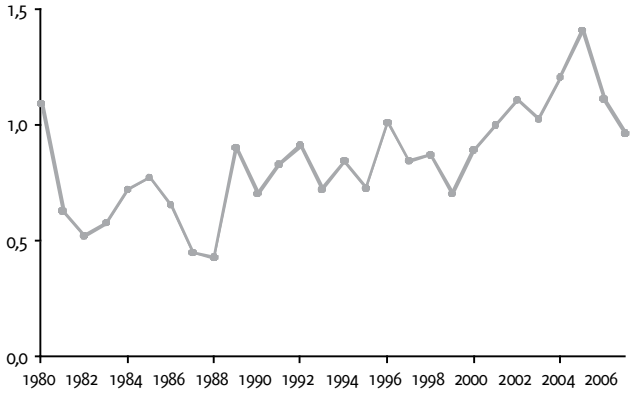
8. REHABILITATION

Rehabilitation is the most expensive part of maintenance. Nevertheless the applied rehabilitation strategy will influence main conditions and costs of maintenance sustainably. The objective is to solve frequently lasting and returning problems by means of:

- eliminating faulty points,
- improving safety and reliability of the distribution systems and
- reducing costs for maintenance.

Just repairing ruptures will only eliminate a local defect but never the faults in general. The rehabilitation strategy, the rehabilitation planning and the actual rehabilitation measure are deduced from all available data and are subdivided into the time and budget rows. The following chart shows the rehabilitation rate of the supply lines (dimension < 200 mm).

Chart 3: Rehabilitation Rate of Distribution Pipes [% p.a.]



The increase of the rehabilitation rate beginning in 2000 could be realized despite constant budgets by use of cost lowering measures in the pipeline engineering; being part of it: the systematic adjustment of metallic pipes to PE as well as slip-lining of PE-pipes in old cast iron pipes. In principle, Gelsenwasser uses only rehabilitation methods, if the new pipe also carries the static load. The relining brought about a cost reduction of approx. 30% in the average.

Gelsenwasser distinguishes the rehabilitation strategies into the areas: transmission and primary mains, local mains and service connection lines. Every component has its own specification and requires completely different approaches. For the underpinning of the right strategy, assumptions must be made concerning the life cycle of the different components.

In principle, for a better assessment at any works, in case the pipe gets "visible", a so-called "condition data sheet" must be filled out. The influences of different soil texture on the development of the corrosion are used with soil plans in addition.

A considerably better forecast based on research instead of preconceptions can therefore be taken particularly for the right time frame.

9. ADDITIONAL APPROACHES

From our experience and largely also our principles it is decisive to occupy processes about the complete value-added chain by internal resources/capacity. From this, a complete information chain is carried out with minimized interface problems. Coordinated staff development measures and systematic training concepts support the reproach of internal competence.

Moreover technical working groups and specified material catalogues in the Gelsenwasser group help to improve the quality of all technical processes or to accompany further technical developments. Many technical executives commit themselves moreover outside the company in technological committees and associations. The knowledge transfer is formed from the enterprise and to the enterprise on this platform.

10. OUTLOOK

Public water industry's obvious goal is to supply customers with potable water at any time in a sufficient quantity and pressure with an excellent quality. Target values for water losses in Germany are stated as a technical requirement in the DVGW- guideline W 392 and for damage rates of mains in DVGW W 400-3. Both guidelines are intended to give a framework for maintaining networks targeting low leakage und damage rates. Under the basic conditions set in Germany, we think we are on the right path in running our long-term systematic water loss management added to a sustainable rehabilitation strategy which will lead to an economic, ecological and also hygienic optimum in water supply.

We should bear in mind: continuity and solid work will pay in the long run.

Hungary: City of Budapest

Changing in water loss management and corporate culture at Budapest Waterworks

By Mr C. J. Csöre, Deputy Head of Network Operation Department, Waterworks of Budapest

THEME

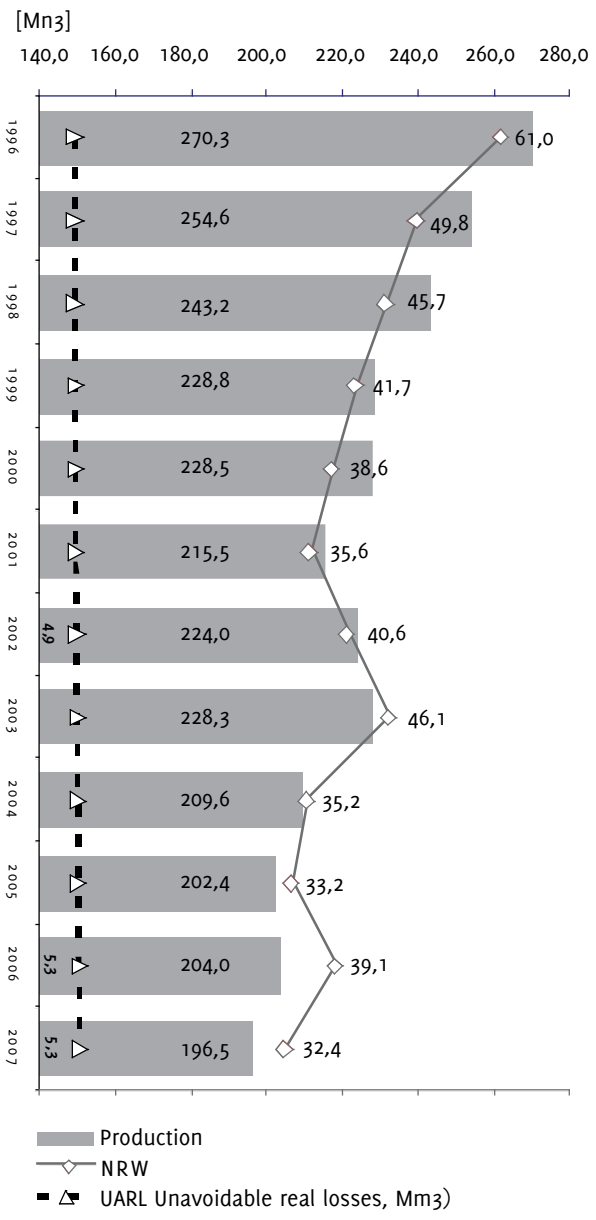
The area of non-revenue water is a little different than the other so called 'technical challenges'. In most cases, this field is not an equation we can put the figures (a certain action) into and the result will come automatically. The heart of getting an appropriate result is improving our management skills.

THE COMPANY STRUCTURE -PPP

Our service operation in the capital city celebrates its 140 year existence this year. During this long period, the owner of the company and the main decision maker was mostly the municipality, but in the year 1996 there was in international tender when the local government sold 25% plus 1 of the shares from the firm with the management rights for 25 years. There is a task sharing in the Shareholders' Agreement between the German RWE (finance and administration) and the French SUEZ (general management and operation).

In Hungary it is not a usual way, but in our operational area the service of water supply and the sewage collection and treatment are separated into two independent operators. Because of this traditional condition, we are only in charge of water production from our 750 wells with bank filtration along the Danube River, the maintenance and repairing of our 4800 km long distribution network, and serve our 1.9 million clients at the end of the 220,000 service connections whose aggregated average daily demand is 550,000 m3. The staff of employees is 1300.

Figure 1: Evaluation of production and NRW 1996-2007



MAIN DRIVERS AND GOAL OF THE LOSS REDUCTION

There are several players in this match with different interests. In Hungary there is no national regulation which deals with the expected level of NRW. It is usually written in direct contracts with the service providers. In our case, according to the expectation we need to reach the Effec-

tive Level of Leakage in short term. This settlement can support the aim of the municipality and the customers to keep the water fee low through the aim of the investors to develop and capitalize our knowledge.

FROM THE FIRST STEPS

In stock exchange parlance, there was a 'bear market' from the beginning of the contract to 2001. This early period of the contract was the place of optimization both in operational and financial side. But similarly than in the most optimization actions it slowed from year to year and in 2001 the 'market' has changed to 'bullish market'. After this time we recognized that our existing efforts would not be enough to maintain the improvement in the future.

In 2003, we started our Technical Development Program, and also changed the management of NRW. The technical development program contained the following main parts: Work Force Management, Operational Center establishment, Engineering activity restructuring, SCADA integration, Assets Management, Management Information System. From our NRW point of view, the WFM and the AM are the key from the six other main areas.

WORK FORCE MANAGEMENT

The burden of the project was to improve work management of network events (repair of leakages). The process included around 300 people from contact center to repair staff. Objectives were finding more efficient way of existing workflow and improving service level. We worked on three levels: process (renewal of event management process), technology (new IT tools -GIS based- & terminals -laptop, PDA-, and logistic (crew downsizing, equipment renewal/optimization).

Today the contact center can register the important technical data in a uniformed surface, dispatchers follow continuously updated works through digital worksheets and time stamps, workers on site have online GPRS connection and accessibility to the digital map.

Developments:

- Sophisticated work scheduling capability (maintenance, repair)
- Support on site (laptop, GIS, map)
- Work issue directly to the crews (digital worksheet)
- Data accuracy (time stamps)

Asset management optimization

Through the project we dealt with data management centralization, integration of databases and tools for analysis and decision support, monitoring of asset condition and performance, planning adequate infrastructure maintenance – to ensure a secure operation and investment prioritization based on assets condition assessment and risk models.

Developments:

- Underground assets condition assessment
- Risk model using 'Fuzzy logic'
- Long Term Development Plan

THE MANAGEMENT FORM OF NRW ACTIONS

In 2004, we defined the organizational structure with clear responsibility and scope of duties. The objectives became deeply detailed and the method of measuring results was identified.

Mobile IT tool in foreman's vehicle

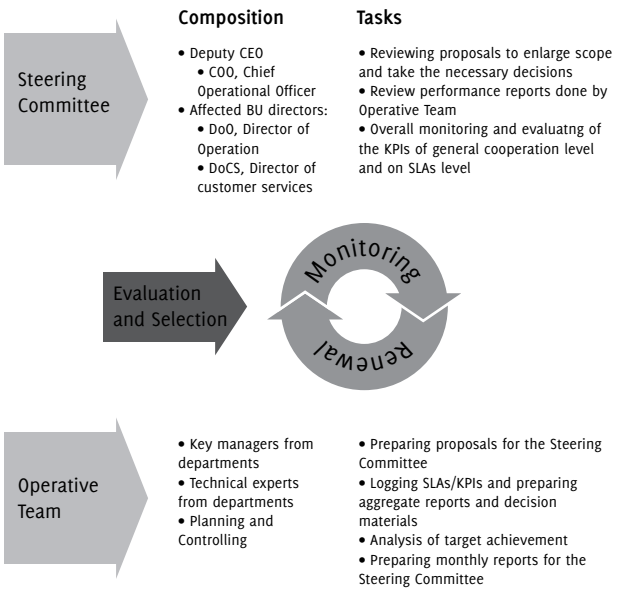
Figure 2: Principles

Key elements of gaining strategic goals	
1.	Focused scope (current and furute scope should be clearly defined
2.	Appointed permanent teams from both sides - on multiple levels (operative, manegerial levels)
3.	KPI System exists to monitor the cooperation and delivery of the targets
4.	Maximize total value generation to waterworks of Budapest
5.	Minimize total cost of ownership

6.	Gain and develop new valuable competences during the cooperation
7.	Pursue a common vision and consistent approaches
8.	Actively pursue new ways of doing business
9.	Develop those technologies/solutions of processes which can support rapidly and effectively the efficiency and the increase its business results
10.	Continuous effectiveness improvements should be ensured

A focused horizontal team was established which contained experts and managers from both the technical, engineering and commercial departments. This operative team was the basic organization for making the way of reaching the strategic goals, setting up the measuring system and establishing targets.

Figure 3: Management processes



The actions we established:

1. Physical losses

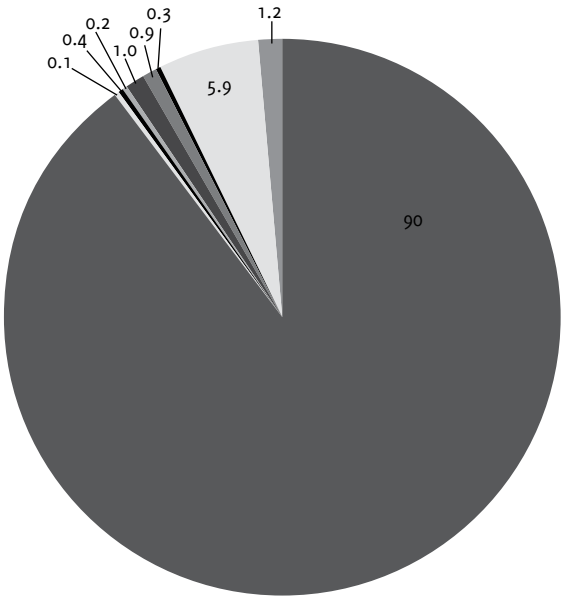
- Leakage detection (ALC)
  The staff (includes 13 people and 2 measuring cars) has been insourced and investigates 15% of the distribution network each year. They use night flow monitoring investigation and noise loggers. With this method we can find yearly 600 m3/h losses on invisible leakages.

- Water balance by zone
  The result of this comparison is used to help the allocation of limited resources of ALC team.

- Modeling – ELL (economic level of leakage), Water Balance
  In 2003 with the assistance of the SUEZ group we calculated the Economic Level of Leakage. Based on our existing technical (leakage detection) and financial (marginal cost of water) figures the target rate was 15,1%. In long term it is a moving target, because of the variable parts of the equation. The technical method of investigation, increasing energy prices, human costs or the condition of the network can slowly change in the time which requires new calculations.

Hence, with the breakdown of Water Balance we could appoint the main key areas for intervention.

Figure 4: The water balance in terms of money in 2007 (Euro)



1.2% Bulk water of exported volumes sold
90% Total volume billed
0.1% Volume of operational service water
0.0% Volume of authorised unmetered consumption
0.0% Metered volume delivered for free
0.4% Unavoidable annual real losses (UARL)
0.2% Volume of visible leaks
1.0% Volume of invisible leaks
0.0% Volume of semi visible leaks
0.9% Volume of invitable under-metering
0.3% Volume of under-metering due to obsolete meters
5.9% Customer of other losses

2. Commercial losses

If we look at the water balance breakdown in terms of money, we can recognize that, one of our mayor areas is the customer losses. Among the ongoing actions we can find active on site investigations (dedicated team), introduction of supplementary tariff, strengthening the internal (Water hunter) and external communication, mobile meters for fire hydrants, mitigation of unmeasured water consumption (hydrants, public fountains, etc), customer segmentation, consumption meter downsizing-, accuracy improving and production meter reconstruction.

- Customer inventory
  We launched the customer inventory project in 2005. The methodology was the comparison of our GIS data with the SAP-IS-U billing system. The objective is dual, first is identification of customers who are not in the billing list and secondly, cleaning of our database (Map and IS-U). After the running of the software we found 8342 connections without consumer, or in other terms 'possible consumers' and 73149 properties without any connection or consumer.

Figure 5: Picture shows the result of inventory

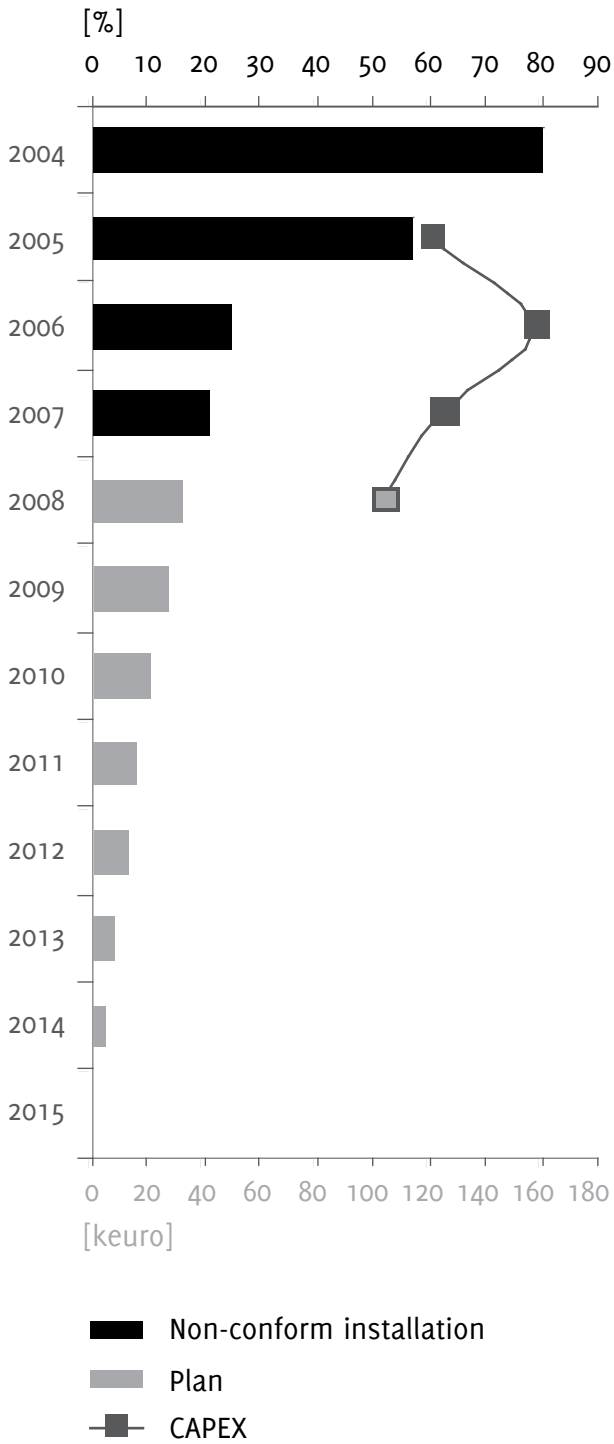
(green: connection without consumer , yellow: neither connection nor consumer)

With these actions on the customer losses side we found and bill 800,000 m3/ year which represent 0,5% of our sold water volume.

- Production meter reconstruction
  The complete survey of the condition of the production meters situated within the operational area of the Waterworks of Budapest took place in March 2004. As the result of the survey determined that the condition of the induction meters did not conform to the expected technical requirements in all cases, and it implied a number of tasks to the company, which will be carried out within the implementation of the action program by 2015.

We have achieved significant results during the implementation of the first three years of the program. The amount of inaccurately measured water was reduced to its proportion from the 2004 levels (non-conform installations: 81% to 21%; meters older than 10 years: 66% to 34%).

Figure 6: Production meter non conformity



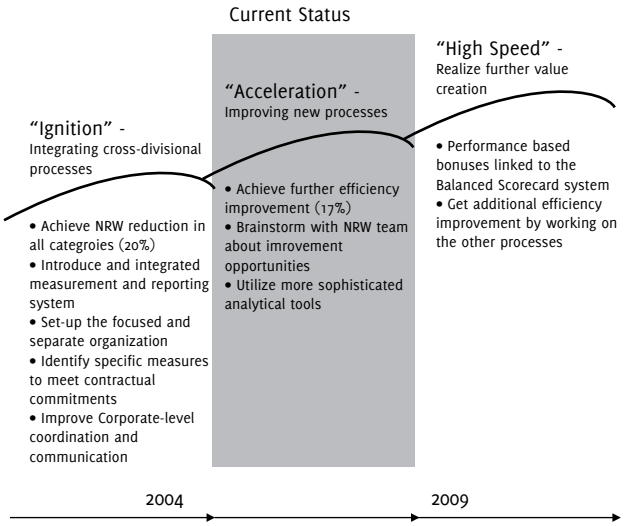
(% of total produced water)

WHERE WE ARE

Today, the actions mentioned above have become part of the daily routine. But we are not allowed to forget that the water loss management is not a project which usually has a lifecycle, and has an end. It is rather similar to a rock which is rolling down on the slope of a hill. We needed to slow and stop the wrong-direction-rolling with hard work, and start moving it in the right direction, but left to itself, the situation would deteriorate rapidly.

Follow-up of our existing performance indicators and correction of actions are among our tasks nowadays. Furthermore, we needed to find out, how we can insert these goals in to the managers' incentives, how we can show all of them their additional value and contribution to reach strategic goals. The way we chose is Balanced Scorecard. With this sophisticated tool we can breakdown the mission and strategic tasks into detailed objectives and tasks and we can show very simply the matches between them. The BSC system and targets are defined, but until this time the insertion of them to the management incentive system is only partially introduced.

Figure 7: Three hills



THE FUTURE

Our last figure of NRW level is at 16,5 % (at the end of 2007). It is close to our strategic target, but we have not finished starting investigation of new possibilities such as pressure management, "C" class meters usage in smaller diameters, district metering and remote meter reading. All of these projects are at the pilot stage and after getting preliminary results, based on the financial conditions (total cost of ownership) we will make decisions about the expansions.

Experts and Institutions

The Work of the International Water Association (IWA) Water Loss Task Force (WLTF) and the Factors Involved in Setting Targets and Strategies for Water Loss Reduction

By Mr Stuart Trow, Initiative Leader, IWA Task Force on Water Loss Reduction

ABSTRACT

The paper has two parts. Firstly, it describes the work of the Water Loss Task Force from its inception in 1997 to the current day. The structure and management of the task force is explained. The major achievement so far has been the development of international best practice for the measurement of water loss and for comparative performance measures. The paper outlines these methodologies and includes details of where they have been applied. Several working initiatives have been established to develop guidance notes on a series of related topics such as pressure management, district metering, leak location, apparent losses, acoustic noise principles, training, and asset management.

The author co-leads a further initiative on Target Setting and Strategy for water loss management. The second part of the paper describes the work of this initiative and the issues to be considered when establishing an appropriate plan of action for measuring, monitoring, controlling and reducing water loss. The paper sets out the reasons for setting targets, the factors affecting targets, the economic balance, the appropriate measures for monitoring progress, and the principal water loss reduction measures.

THE WORK OF THE IWA WATER LOSS TASK FORCE (WLTF)

The Water Loss Task Force is a group of people who continuously take on new challenges, extending the limits of current knowledge and freely share information for the benefit of all concerned. The group was formed by a small number of experts in 1997 to investigate water loss performance indicators, and became established as a permanent IWA Task Force in 2002. Over the past five years the Water Loss Task Force network has grown at a tremendous rate generating interest worldwide and has developed and promoted international best practices in water loss management. This includes the initiation of, and participation in, research projects to keep at the forefront of new developments as well as the organisation of specialised conferences and workshops around the world. The biggest and most successful event so far was "Water Loss 2007", a specialised conference that took place in Bucharest, Romania in September 2007, where over 275 delegates from 45 countries attended. Water Loss 2007 focused on a wide array of water loss control activities developed through the IWA Water Loss Task Force. There were 99 technical presentations over the three days covering the full scope of water system and loss analysis, water loss control programs, equipment, strategies and performance measurement assessments and results. All papers have been published in a comprehensive publication comprising three detailed and well edited volumes and also in an electronic format.

It is evident that water is a limited resource in many parts of the world, a situation that has highlighted, among other things, the need to reduce leakage from urban water distribution systems to levels that are considered economically acceptable. The thrust of the Task Force is spearheaded with this in mind, building and expanding on current and new activities and initiatives, in particular the following:

- Maintaining a leadership role in water loss management.
- Consolidating current knowledge and practices.
- Developing and disseminating "best practice" Guidance Notes.
- Encouraging and supporting research in new areas.
- Promoting awareness through seminars, workshops and conferences.

- Enhancing communication and strengthening membership.
- Collaborating with other Task Forces within the Specialist Group of IWA.

More specifically the WLTF has been able to accomplish the following:

Publications

- The practices promoted by the WLTF are well documented in articles, conference proceedings, guidance notes, software, manuals and text books. It is worth mentioning that the World Bank Institute has used the work of the WLTF as a basis to produce a series of training manuals which are currently being used for capacity building in developing countries.
- The WLTF publishes in every issue of Water 21, the Magazine of the International Water Association, articles relating to water loss management, updating progress on current initiatives and reporting on new developments and research findings.

Website

The Water Loss Task Force has its own website www.iwaom.org/wltf, which is continuously updated with news, articles, documents and information. The access to the website is open to any visitor and all downloadable material is available free of charge. It is worthwhile mentioning that judging from the number of downloads of the various articles, guidance notes and other information, the website has been extensively used and has proved a useful tool in promoting the work of the WLTF.

International Standards

The WLTF has become a focus for practitioners of water loss management, and the methods established by the group are being employed across the world. In order to ensure a consistency of approach the WLTF has pioneered two major achievements which have allowed for realistic comparisons between distribution systems which can have very different characteristics:

- Firstly, the IWA Water Balance (Fig 1) has become a best practice standard for the components of system input and for the terminology used internationally.

Figure 1: IWA Best Practice Standard Water Balance

<table>
<tr><td rowspan="9">Own sources</td><td rowspan="9">System input (allow for known errors)</td><td rowspan="2">Water exported</td><td rowspan="7">Authorised consumption</td><td rowspan="3">Billed authorised consumption</td><td rowspan="3">Revenue water</td><td>Billed water exported</td></tr>
<tr><td>Billed metered consumption</td></tr>
<tr><td rowspan="7">Water supplied</td><td>Billed unmetered consumption</td></tr>
<tr><td rowspan="2">Unbilled authorised consumption</td><td rowspan="6">Non-revenue water</td><td>Unbilled metered consumption</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="4">Water imported</td><td rowspan="4">Water losses</td><td rowspan="2">Apparent losses</td><td>Unauthorised consumption</td></tr>
<tr><td>Customer metering inaccuracies</td></tr>
<tr><td rowspan="2">Real losses</td><td>Leakage on mains</td></tr>
<tr><td>Leakage and overflows at storages</td></tr>
<tr><td colspan="2">Leakage on service connections up to the point of customer metering</td></tr>
</table>

Source: IWA Water 21 August 2003. Hirner and Lambert; 2000. Alegre et al; 2000.

Case studies are available from Europe (UK, Finland, Germany, Italy, Greece, Cyprus, Malta, Croatia), North America (USA and Canada), South America (Brazil), the Caribbean Islands, Australia, New Zealand, the Pacific Islands, South Africa and South East Asia.

- Secondly, the Infrastructure Leakage Index (ILI) has been used widely to provide a realistic comparison of performance on leakage management between countries. Numerous sets of data have been collected.

Guidance Notes

Within the above context the WLTF has so far developed two sets of Guidance Notes with simple, practical and easy to follow step by step methodologies of useful information for leakage professionals:

- The DMA Guidance Notes which cover the technique of District Meter Area management, which has been practised around the world for many

years with excellent results in minimising and controlling leakage.

- The Leak Location and Repair Guidance Notes is a comprehensive document which is intended as an introduction for leakage practitioners to the process of identification, location and repair of leaks.

Initiatives

New initiatives have been launched in areas where it was felt that further knowledge is required:

- Repair or Replace Dilemma for Services and Mains: This initiative aims to identify when infrastructure renewal should be carried out as the most effective approach for controlling leakage, as part of an integrated asset management plan.
- Acoustic Noise Principles and Applications: This initiative investigates the methods of leakage detection using acoustic noise and reviews current and new techniques applied across all pipe materials and diameters.
- Training People: Great importance is placed on the issue of sustainability which involves people, and has to do with their degree of dedication and knowledge. It is therefore, important to properly train people and to provide them with the right incentives in order to build the corporate knowledge needed for long-term sustainability.
- Apparent Losses Principles and Application: The area of research includes (but is not limited to) unbilled authorised consumption (such as corporate service consumption), which forms part of non-revenue water but is not considered as being either real or apparent loss, and the boundary conditions between real losses and apparent losses in certain controversial cases.
- Target Setting: This initiative considers issues such as understanding the mechanics and components of water loss, the cost comparisons of alternative water loss reduction measures, the role of comparative performance measures such as ILI in target setting, and alternative and novel approaches to target setting.

Water Loss 2009

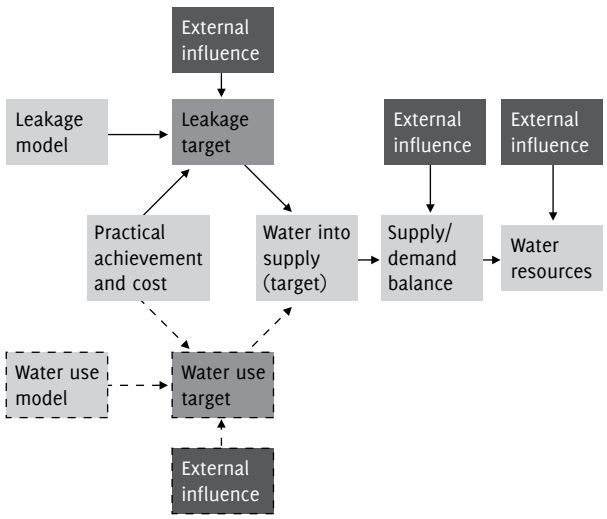
The next major event of the Water Loss Task Force is the specialised conference "Water Loss 2009" which will be held in Cape Town, South Africa, in April 2009. "Water Loss 2009" will be the fourth event in a series of IWA Water Loss Task Force specialised conferences. The conference will present and discuss the latest developments, strategies, techniques and applications of international best practices in water loss assessment, management, leakage reduction and control and improvement of customer metering. The technical sessions will provide a platform for specialists from around the world to present latest thinking and research as well as interesting case studies dealing with water loss related topics. There will be a specialised exhibition which will provide an ideal opportunity for companies to promote their services and products relating to all aspects of water loss management.

TARGET SETTING AND STRATEGY

It is generally agreed that it is both impracticable and uneconomic to eliminate water loss completely. Conversely, excessive water loss resulting from inadequate controls is also inefficient, and could lead to water shortages as well as high operational costs. Between these two extremes there is an optimum level of water loss which can be tolerated.

However, the debate over how to set and achieve an optimum target level of water loss has continued for many years and there is ongoing discussion over how best to achieve a compromise between several often competing factors as shown in the diagram below:

Figure 2 – Leakage Targets in Context of the Water Supply/ Demand Balance



Setting targets for water losses is not just about calculating an Economic Level of Leakage (ELL). Whilst ELL is a key element of any approach to target setting, there are a number of other issues which have to be considered. Water loss includes leakage from water mains and service connections, and also other losses e.g. overflow from service reservoirs. Targets should be set for all elements of non-revenue water.

Reasons for Setting Targets

There are many reasons why a water supply organisation would wish to set a target for water losses from its water distribution system. These may relate to external factors, internal operational factors, or economic reasons, and include the following:

- To ensure efficient operations
- To safeguard future water supplies
- For technical comparisons between water supply organisations, nationally and internationally, and between supply zones
- To demonstrate continual improvements to customers, in order to improve public perception
- To take account of political considerations
- To meet regulatory requirements

Factors Affecting Targets

The ideal target should take account of a number of issues, and will effectively be a compromise between a numbers of competing factors. The ideal target should be:

- Based on economic principles
- Practical - in terms of data needs and implementation
- Sustainable in the long term and flexible in the short term
- Consistent with the water resources plan
- Understandable, transparent, simple and consistent
- Founded on a sound understanding of leakage and water loss mechanics
- Sensitive to political considerations
- Able to allow for comparisons between organisations

It is likely that one or two factors will predominate. This is the case where regulation of the water industry leads to mandatory targets set by Governmental organisations. It is unlikely that any one target will meet all of the above requirements, and a number of measures will be needed.

Measuring Progress

All targets require some unit of measure, and these will differ depending on the purpose of the target, the way in which it has been established and the processes to be adopted to monitor progress against the target. The alternative measures include:

- Volume Rate: The most reliable target setting value is the absolute volume rate measured in Ml/day. This is best used for monitoring changes within an organisation over time, but it is of no use as a performance measure.
- Scaled measures: Targets may be set in term of the volume of water loss per unit length of distribution system (m3/km/day) or per connected property (litres/ property /day).
- Percentages (%): Water losses are often expressed as a percentage of the water into supply, or the water into the distribution system (DI). It is generally accepted that %'s are not a good technical measure because they are affected by other factors such as customer demand, and so they can vary seasonally even though the absolute volume of water loss remains the same. However it seems inevitable that the general public and the media will continue to use percentages. Targets may be set as a % year on year reduction.
- Infrastructure Leakage Index (ILI): ILI was introduced as a performance measure to allow reasonable comparisons between water suppliers and between zones within the same supply organisation. It has been considered for use as a target setting measure, and while this has some merit, certain issues should be taken into account. ILI is the ratio of current annual real losses (CARL) to unavoidable annual real losses (UARL), and whilst the assumptions used to calculate these parameters are not universally accepted, they have been tested and adapted in many different situations. ILI can be part of a target setting approach but should not be used in isolation to set targets.
- Economic Leakage Index (ELI). A recent derivation of ILI has been to introduce economic principles into the equation to derive an ELI to take account of the costs of Active Leakage Control

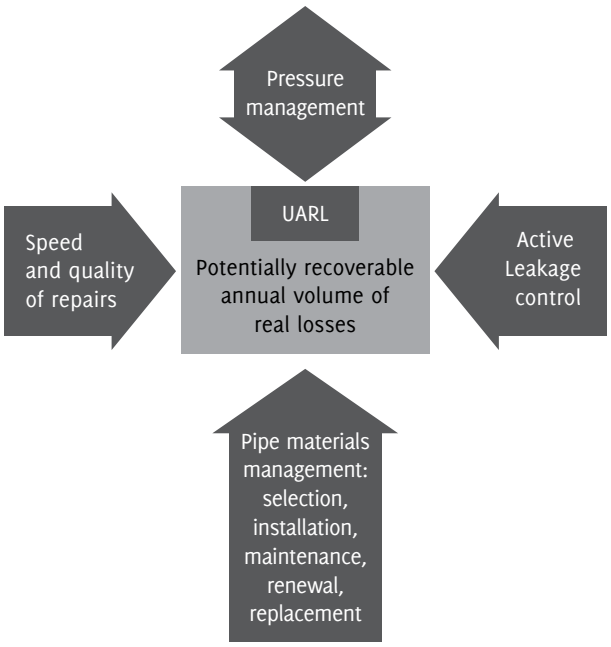
(ALC) and the value of the savings. ELI calculates an economic intervention frequency, and an economic level of real losses (ELRL). ELI is the ratio of CARL to ELRL

A Matrix of which measure should be used for which target would be of benefit and this is being developed by the WLTF initiative.

The Principal Leakage Reduction Measures

Figure 3 shows the four principle methods of leakage reduction. The IWA Water Loss Task Force promotes a methodology called "Squeezing the Box" which refers to the control of the shaded area of potentially recoverable real losses. In this method, each technique is employed to the optimum level, and the level of losses which results is deemed to be the optimum level of losses.

Figure 3 – The Four Principal Methods of Water Leakage Reduction



Diminishing Returns

A fundamental fact about leakage control is that every possible leakage control measure follows a law of diminishing returns. As more money is spent, the return in terms of water saved due to lower losses becomes progressively less. Some level of each activity will form part of an economic strategy. In order to set an optimum target for water losses, it is necessary to decide the appropriate level of each activity. Techniques have been developed to allow individual leakage management schemes to be prioritised.

Time Factor

It is important when setting targets to recognise that there is a time factor which must be taken into account. Targets will vary depending on:

- The status of the water loss strategy: At the beginning of a water loss reduction initiative, targets will tend to be based on default values, general data and assumptions. Strategy will be based on experiences elsewhere which may not be directly relevant. As the programme progresses, data specific to the particular organisation will be collected which will allow targets to be reviewed, and for the strategy to be refined to suit the particular operating environment.
- The availability of water: The availability of raw water will vary due to climatic changes, and the capacity of reservoirs and abstraction processes. Treatment works capacity will also be a limiting factor. Targets will change over time as the 'headroom' between water demand and available supply capacity increases and decreases. The timescales required to implement water loss reduction initiatives, fall into three general categories:
  - Short term measures: Leak detection and repair (Find and Fix)
  - Medium term measures: Pressure Management and District metering
  - Long term measures: Mains and service renewal

To establish an economic approach to setting and achieving targets, the following steps are recommended:

1. Clear the backlog of unreported bursts which has accumulated in the network from under investment in previous years by a period of intensive find and fix operations.
2. Vary Active Leakage Control (ALC) and optimise against the variable cost of Water (CV). This is short run ELL. Recent studies have shown that a short run economic intervention policy is governed by only three factors:

- the marginal value of water saved
- the cost of undertaking the intervention exercise
- the natural rate of rise of leakage (NRR)

3. Consider capital investment in leakage management options (Pressure control, rehabilitation, sectorisation etc.). Hypothesise interventions to work out discounted cost, benefit and derive Average Incremental Cost (AIC). Rank these and implement them in order. Reassess the benefits of each scheme after implementation of other schemes. This is long run ELL

From experience of implementing water loss reduction strategies it has been found that for any system, the Economic Level of Leakage comprises 3 Principal Components:

1. A level of "background" losses which results from an optimised entry and exit policy for DMA management, or exit policies for regular survey
2. A level of leakage from reported bursts with optimised repair time policy
3. A level of leakage from unreported (hidden) bursts resulting from an economic intervention policy for leak detection and repair

Achieving ELL

For any system, achievement of the ELL comprises 4 inter-related activities:

1. An optimised overall Pressure Management policy:
2. An optimised Repair Time policy for all bursts:
3. An economic Intervention Policy for awareness, location and repair of unreported (hidden) bursts. This will be influenced by the level of investment in leakage management infrastructure i.e. Telemetry/SCADA, DMAs, and advanced pressure management. The policy minimum level of leakage or exit level (background and other leaks remaining after interventions) will also influence the policy.
4. An economic level of Investment in mains and services renewals which takes account of all other factors

IWA promotes a 'Twin Track' approach to reducing leakage by a combination of pressure management and active leakage control. Furthermore, it is important to understand and control apparent losses so that time and expense is not wasted looking for leaks which do not exist

UK Review

A review has recently been undertaken for the industry regulators in the UK to consider how leakage targets should be set. This builds on the Tripartite Review of March 2002 which developed a report entitled 'Future Approaches to Leakage Target Setting in the UK'. The parties involved were a government department (DEFRA), the Office of Water Services (OFWAT), the Environment Agency (EA), the Consumer Council for Water, and the trade body Water UK. The report recommended a best practice approach to ELL, and several alternatives based on ELL.

The review considered in detail 24 target setting approaches and recommended four preferred alternatives. Three of these were modifications of the established ELL methodology. The fourth is based on a 'Frontier' approach comprising relative leakage efficiency targets. In all cases the need to take a long term view was emphasised.

Water Loss Task Force (WLTF) Target Setting Initiative

In July 2007, the WLTF established an initiative to consider the issues involved in setting targets which will include:

- Economic level of leakage (ELL) methodologies
- Water Loss as part of the Water Supply Demand Balance
- Cost comparisons of alternative water loss reduction measures
- The role of comparative performance measures such as ILI in target setting
- Alternative and novel approaches to target setting
- Political considerations
- Regulatory Issues
- Funding requirements
- Understanding the mechanics and components of water loss
- The impact of topography and pressure management on setting and achieving water loss targets

The initiative is co-chaired by Stuart Trow (StuartTrow@aol.com) and David Pearson (Daivid.dpc@btinternet.com).

A consultation paper is to be issued to WLTF members to seek their views. The aim is then to hold a meeting in Vienna in September to discuss the approach to be taken.

- The outputs from the initiative are expected to be as follows:
- The consultation paper
- A summary of the current approach to ELL
- A summary of possible alternative target setting options
- A Target Setting Methodology which is consistent with other WLTF initiatives
- Case studies from WLTF members

The expected duration of the initiative is 18 months reporting in early 2009.

ACKNOWLEDGEMENTS

The author wishes to thank the following for their help in compiling this paper:
Bambos Charalambous, the Chair of the Water Loss Task Force
David Pearson, Co-leader of the Target Setting and Strategy Initiative
Author
Author
Stuart Trow, Independent Consultant, (stuarttrow@hotmail.co.uk)

Knowledge shapes tight networks: E-Learning shapes Knowledge

By Prof. Dr.-Ing. Robert Stein, Chief and Executive Officer, Stein & Partner GmbH

"The Future is in the Underground" is one of our main principles. The underground infrastructure for supply and disposal are lifelines which decide on the quality of life and sustainability not only within the great cities. The significance, complexity and the immense financial value of these networks make a sustainable operation, maintenance as well as structural extensions and rehabilitation mandatory. As this technical knowledge is neither imparted by universities nor colleges to a sufficient level, e-learning based infrastructures provide the only access for decision-makers, engineers and technicians to enable them to decide about million investments in a responsible way in order to achieve for example watertight networks.

A leading e-learning concept is UNITRACC. This name stands for 'Underground Infrastructures Training and Competence Center'. The term 'Underground Infrastructures' refers to urban, underground supply and discharge infrastructures. For their planning, construction, maintenance, operation and rehabilitation UNITRACC provides the necessary technical knowledge by means of web-based communication, information, learning and working environments.

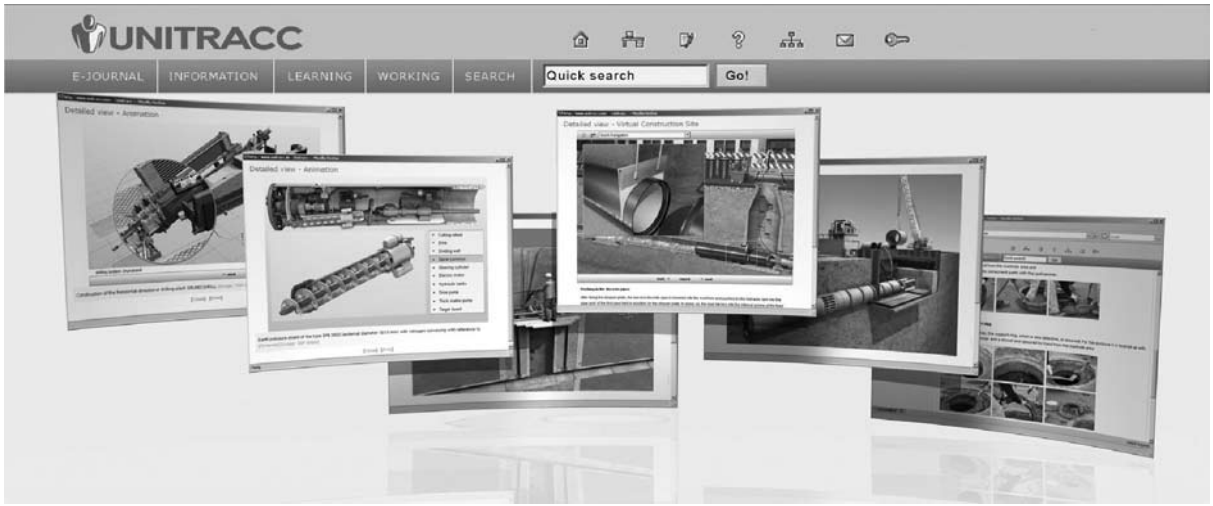
Already today UNITRACC can be considered the leading teaching-, learning and working platform for the construction sector as regards contents, didactics and technology. This is confirmed by the following awards UNITRACC has won: European E-Learning Award "eureleA 2004", the finalist place in the "Medida Prix 2004", the "No-Dig Award 2000 and 2005" as well as the award as "Selected Landmark 2007" in the competition "Germany -Land of Ideas" under the patronage of Germany's Federal President Dr. Horst Köhler.

The concept is based on the preparation of a service platform independent of time and locality, that provides target group and problem sensitive "all in one hand" solutions for supporting work and learning processes.

Target groups sensitive because contents and applications are adapted individually to the learning and qualifying level of the user.

Problem sensitive because applications can be combined and generated individually for tasks.

Fig. 1: UNITRACC -Underground Training and Competence Center



"All in one hand" because UNITRACC combines learning and working and thus interconnects the following aims:

- Creation of competence by the preparation of international, state-of-the-technology subject information and technical and economic data.
- Harmonizing basic and advanced training by the preparation of training material for trade schools, training centers and universities.
- Coordination and development of construction and research projects as well as preparation of software tools for engineering services.

1 ARCHITECTURE

In order to ensure a topical, operational competence development, that takes account of the qualification requirements and the necessity for continuous advanced training, as well as the problems and solutions required by the economy, ecology and state of the technology, the platform comprises three service areas (see Fig. 2):

Fig. 2: Platform areas – Information – Teaching and Learning –Working

1.1 "Information"

The Service Area "Information" has the character of a comprehensive, constantly growing and updated digital reference work. It covers general as well as very specific technical information and up- to- date overviews of standards. Users who want to go into detail are given model job-site documentations as well as compact, practical instructions on specific tasks. Internationally acknowledged standard works of technical literature provide extensive technical knowledge in a multimedia processed form. A continuously updated E-Journal keeps users posted about international developments and projects in the industrial sector.

1.2 "Teaching and Learning"

With the unique data pool that is made available on UNITRACC the Service Area "Teaching and Learning" designs qualification and training offers that are arranged in correspondence with individual needs. "Teaching and Learning" is the ideal starting point for personal vocational training and further qualification and in addition equips teaching staff as well as institutions offering courses and academic and vocational training with a pool of up-to-date and high-quality learning materials and examination documents. The modular structure of available material allows all users individual custom-made training. As a ground-breaking example of "electronic learning" UNITRACC has been awarded with renowned prizes.

1.3 "Working"

The Service Area "Working" offers essential tools for the practical work in the field of underground infrastructures and is directed at everyone involved in the sector, from the certified construction worker to the engineers and employees in charge of calculation and planning. Besides extensive collections of charts, "Working" offers users a range of very useful tools that are available online.

2 THE SERVICE AREA "INFORMATION"

All kinds of important basic and background information on underground infrastructures at a glance, presented in a form that makes even complicated facts and contexts quickly and intuitively comprehensible.

3 THE SERVICE AREA "LEARNING AND TEACHING"

The UNITRACC concept for vocational training and qualification imparts state-of-the-art technical knowledge by didactically assured teaching methods and based

on modern media. So facts and interrelations become experiencable and can be learned in an ideal way.

3.1 UNITRACC "Teaching and Learning" is directed at:

3.2 How to learn with UNITRACC?

"Electronic learning" with UNITRACC is learning with a high level of freedom as regards time and location. Wherever the users can access the internet, they get the chance to learn online at any time.

Learning with UNITRACC is anything else but anonymous: every learner gets a qualified personal tutor, who is available for all professional and organizational questions.

3.3 UNITRACC teaching material

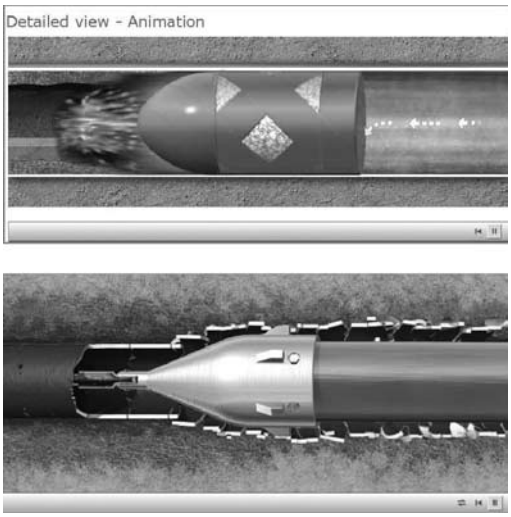
Complete courses on key topics of underground infrastructure (like water networks) form the foundation of UNITRACC's teaching offer. Depending on the requirements they take the learner several days or weeks to complete the course from the point of activation and can conclude with an exam. If they are passed successfully, the participants receive a certificate, which can be added to their personal CV as a certificate of further training.

The courses are primarily based on Papers and Presentation Slides.

Papers provide necessary background knowledge about the course's topic in written form.

Presentation Slides impart know-how through videos, animations and simulations and, where required, supplemented by audio comments in order to contribute to in-depth comprehension.

Fig. 3: Examples Animations



Virtual Construction Sites illustrate processes and procedures at job sites in 3D animations "from A to Z". They visualize processes and interrelations, which on-site normally drop from sight. Complicated and abstract processes become experiencable and intuitively learnable (see Fig. 4).

Fig. 4: Example "Virtual Construction Site"

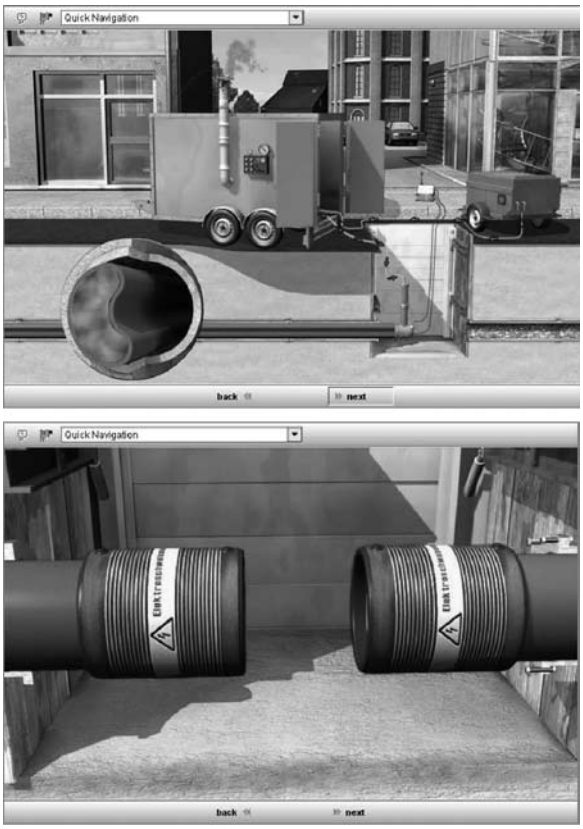


Photo Documentations of specific construction sites describe the realization of real construction projects including preparatory and finishing works without missing a detail.

Interactive Construction Sites go one step further in terms of didactics. Here the user get the chance to actively take a hand in the construction processes and to experience the consequences of his or her decision.

Exercises prepare the user for the final examination tasks in the best possible way.

3.4 Learning by communication

Learning with UNITRACC is intensive, interpersonal communication: not only with your personal tutor, but also with other course participants, with whom you can get in touch and discuss course issues if you like.

4 THE SERVICE AREA "WORKING"

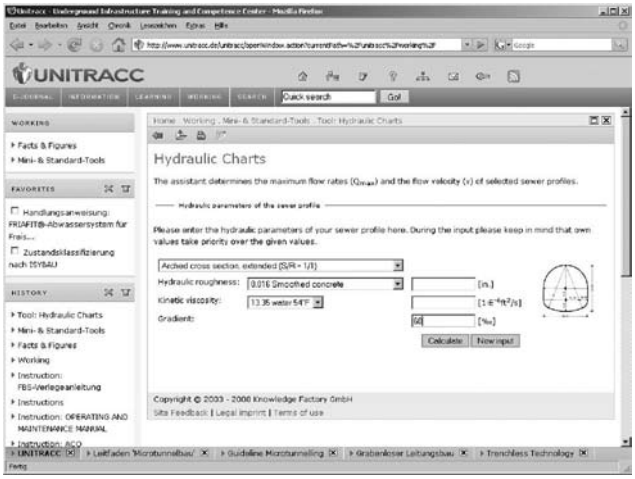
As UNITRACC presents state-of-the-art expert knowledge on the topic of underground infrastructure, it suggests itself not only to use contents for information purposes and teaching, but also for daily construction routine.

In the area "Working" UNITRACC provides a wide range of powerful tools for engineers who are in charge of planning as well as project managers and on-site supervisors.

Facts & Figures provide anything the practitioner requires for his work: from technical charts and tables to construction and rehabilitation techniques, and from compilations of material properties to test codes and legal basics.

Mini- and Standard- Tools provide practical daily help especially for engineers in charge of planning by means of task-related calculation programmes. This comprehensive area offers various tools ranging from the calculation of construction technical values, the application of hydraulic calculation models (see Fig. 5), the automatic conversion of condition texts to computer-based fee calculations according to the Fee Structure for Architects and Engineers.

Fig. 5: Example – working tool for hydraulic calculations



Many tools of the area "Working" on UNITRACC compensate for costly investment in software. From an economic point of view, this makes the use of UNITRACC even more interesting also for tasks that do not occur regularly or only once.

Active Leakage Control – Low cost technique for high efficiency results

By Dr T Petermann, Senior Project and Theme Manager, InWent - Capacity Building International

ABSTRACT

Nowadays the need for leakage monitoring is obvious. The prevention of economic damage, the risk of uncontrolled water flow in urban surroundings and the conservation of the precious resource wa-ter are the ambitious targets for the future. Automatic monitoring of water consumption is therefore a prerequisite for sustainable water loss reduction.

Active leakage control is based on automatic monitoring of the water supply system. This helps to reduce the running costs and increase the safety of supply due to fast and reliable leak detection, leading to appropriate action for repair and maintenance. Besides reducing running costs it also re-duces the incalculable risk of follow-up costs for emergency repair work and possible compensation claims.

In order to implement monitoring, the pipeline system has to be divided into separate metered ar-eas. The water in- and output data of each zone are continuously and automatically monitored.

The collection and analysis of flow data is done by small battery-powered data loggers. Every 24 hours the data are transferred via a GSM mobile device to a web server. Should the pre-set limits be exceeded, an alert message and the flow data actually recorded are transmitted to the server.

The flow data are stored, visualized and validated in a sql-database, which runs on the web server. This system allows browser-independent online access for both the customer and the system opera-tor. Visualization and comparison with previously monitored data ensures that losses and other ir-regularities are detected immediately.

Skills Development in the Water and Sanitation Sector: The Role of UNESCO-UNEVOC

By Ms N.Y. Mar, International Centre for Technical and Vocational Education and Training UNESCO-UNEVOC

ABSTRACT

Technical and Vocational Education and Training (TVET) plays an important role in the water supply and sanitation sector, providing skills for a wide range of activities, from plumbing to other forms of freshwater distribution, desalination, drinking water treatments, quality analysis and sewage treat-ment. The promotion of best practices and guidelines is needed to advance high-quality water-related TVET and to adapt to changes in social and economical infrastructure and pressures from climate and demographic trends. Overall, there is a need to establish effective collaboration between those engaged in the TVET sector and those working in all fields related to water supply and sanita-tion, in order to best apply available technical and managerial solutions for skills development and employability in the water supply and sanitation sector.

In connection with the UNESCO-UNEVOC activities within the framework of the UN Decade of Educa-tion for Sustainable Development, the presentation examines UNEVOC's initiative in the water supply and sanitation sector in Vietnam, recommendations and guidelines with regard to TVET teacher edu-cation, and discusses and evaluates such practices and guidelines from a global perspective. It also seeks to strengthen synergies between policy makers, researchers and practitioners with regard to promoting water-related TVET in developing countries and countries in transition, especially in those countries where there is stress and strain in the water and sanitation sector.

Active Leakage Control – Low cost technique for high efficiency results

By Dr H. Jansen, Chief Technical Officer, pmb-net Berlin AG

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From valve to automated solution

By Mr A. Rienmüller, Senior Manager, VAG Armaturen GmbH

ABSTRACT

Specifications

An innovative concept enables it to make an important contribution to the reduction of water loss. The systematic reduction of pressure in the main water supply system enables large amounts of drinking water to be saved.

Method

A plunger valve and a pressure sensor and flowmeter are installed at the supply area's feed point. A programmable logic controller (PLC) records, processes and archives the measured sensor data that are needed to control the plunger valve. Reducing the supply pressure reduces the amount of water lost. Positive side-effect: reducing the supply pressure reduces the risk of new leaks occurring in the supply system.

The feeding volume and supply pressure are constantly monitored and available for your review and analysis. Secure GPRS technology is used to transfer the data to a PC that is connected to the internet. An additional software programme enables the valve's operation to be monitored online. All the important operating information can be viewed on a text display. Control parameters can be viewed and changed on site.

System

At the heart of the system is a plunger valve. Based on the type of local power supply in the water system, the valve is powered by a DC, AC, or three-phase actuator. A flow meter continuously records the actual volume of water that is supplied to the distribution area

Workshop reports

Technical Sessions Report

The International Workshop on Drinking Water Loss Reduction, Developing Capacity for Applying Solutions, organized by UN-Water Decade Programme on Capacity Development (UNW-DPC) and UN-Habitat, held at the UN Campus in Bonn, Germany, on 03 – 05 September 2008, gathered more than 60 participants representing 18 cities from 4 continents, presenting cases of successful control of water losses in drinking water distribution systems under various conditions.

GLOBAL COMMITMENT, LOCAL AND REGIONAL ACTION

The opening session set the stage with presentations by Prof. J. Bogardi, Vice-Rector in Europe on behalf of the United Nations University (UNU), Dr. R. Ardakanian representing UNW-DPC, and opening addresses by the two German Federal Ministries BMBF (Federal Ministry of Education and Research) and BMZ (Federal Ministry for Economic Cooperation and Development) supporting UNW-DPC at the UN-Campus in Bonn. Reference was made to global commitments and programs, such as the fulfilment of Millennium Development goals (MDGs), resolutions from other global conferences, and the comprehensive tasks of UN-Water in gathering the knowledge of UN Agencies and Member States towards improving the situation of water and sanitation services worldwide.

Dr. Ardakanian placed water loss reduction in urban systems in a wider context of a sanitation, sewage and water quality perspective, and referred to the objectives of the workshop as follows:

- Exchange of experiences and information on successful examples
- Advocating the need for institutional capacity development and cooperation
- Bringing the focus to developing countries (esp. those under water stress)
- Raising awareness

UN-Habitat pointed out that the scarcity of water is not due to actual shortage but rather a question of water governance. An integrated urban water management approach would be essential for the social, economic and environmental sustainability of cities, where more than 50 % of the world population are living.

Prof. Meyer-Krahmer (BMBF) emphasized the need for relevant results and coordinated activities between the federal departments as well as the willingness of his ministry to facilitate international projects.

URBAN WATER MANAGEMENT DEMONSTRATES SOLUTION ORIENTED CAPACITY DEVELOPMENT

Two key note speeches oriented the workshop towards the need to develop capacities for delivering better, more reliable and economically sound services for all customers in urban settings. The specific role of urban agglomerations was highlighted with regard to the potential to guide economic and social development towards more sustainable solutions. Integrated Urban Water Management was described as a challenge to create a new understanding of how the valuation of water could be placed in the overall context of the economic potential of cities, where at the same time cultural and scientific diversity finds exceptional conditions for becoming an asset, or vice versa, becoming destructive. The workshop was seen as a challenge to show the positive potential, the creativity under various conditions, and case studies that will encourage others to join in a process directed towards more sustainable water resources management as a whole. A global process needs to be kicked off, showing that solutions are there, but without enhanced institutional and individual capacity appropriate solutions will not be applied to the extent necessary – or possible.

Prof. Rudolph (University of Witten/Herdecke, Germany) emphasized that cost benefit analysis should be appropriate to regional conditions and should also consider technical and administrative water loss damages. He came to the conclusion that it would be in any way economically reasonable to arrive at water losses below 7 % (optimum 4 %) as in the German case. He also called attention to the vicious circle in water and sanitation, which could arise when tariffs did not cover the costs. He pointed to the importance of raising awareness, eradicating intransparencies and developing local business.

Prof. Klein (IBWS, Germany) placed the drinking water loss issue in the centre of three major challenges being faced by water supply on a global scale:

- The Water and Agriculture Challenge
- The Water and Industry Challenge
- The Water and Urbanisation Challenge

He proposed solution oriented capacity development towards five main tasks:

1. Make the economic benefits of proper water systems maintenance visible to all stakeholders through training and capacity development
2. Find a convincing approach to enhance human capacity towards valuation of water as the essential element for all life processes
3. Find a convincing approach to enhance human capacity towards valuation of water as the essential element for all life processes
4. Make the better choice the easier choice
5. Make the positive political power of adequate water supply for all visible

TECHNICAL SOLUTIONS ARE AVAILABLE

Session I combined a group of case studies of urban water systems management (Alexandria, Egypt; Budapest, Hungary; Lima, Peru; Mexico City, Mexico) with presentations and discussions about available and effective technical tools. The reports from these cities indicated that within a time frame of a few years up to one or two decades substantial improvements in the control of water loss can be achieved. Conditions of political transition or under upcoming stress due to climate change hinder effective WLR. However, a reduction below a level of 30 – 20 % requires effective mechanisms for financial and technical management, which were not available or implemented in the majority of the cases presented and discussed here.

Demonstration of new and low-cost techniques for leak detection, or strategies for continuous remote control in monitoring and metering by some cases studies and companies present at the exhibition made it clear: there is a wide gap between the availability of technologies and management tools and their application in far too many cases. This issue was extensively taken up in the following workshop session.

Ms Abdou reported about several successful strategies introduced in Alexandria such as water pipeline maintenance, high tech leak detection devices, ultra-sonic flow meters at outlets, decrease of response time to repairs, surveying and GIS, training of technicians, awareness campaigns at schools etc., but emphasized that the most difficult issue would be the elimination of illegal connections. High penalties were imposed and three commissars were in charge of detection of illegal use.

In the case of Budapest great success was achieved within a very short time span. New methods were introduced concerning e.g. pressure measurement and meter reading. This was accompanied by a rise in the cost of water and a reduction in consumption. It was estimated that it took about 15 years until the investments became profitable.

The cases and technologies presented by Mr Villalba from Mexico City and two German companies showed the benefit that could be achieved by flow metering and adequate pressure measurement (reduction of costs, risk prevention, water saving, longer lifetime, water quality control).

In the discussion the questions were raised as to how effectiveness could be calculated, how politicians could be convinced and how customers could be taken into account. Ms Abdou reported that – not taking into account investments - after the introduction of the water loss program costs were covered and small profits could be made. VAG and pmb-net referred to return of investment after 6-8 months.

Dr. Ardakanian asked whether we needed more innovative ideas for technical solutions or if it was just a question of focussed investment of money and how to convince the politicians. The participants agreed that the problem was first of all a lack of public awareness. From the technical side in a second step we would need solution packages. Follow-up workshops might be an instrument to increase public awareness. The outcome of the workshop should find its way to the politicians, who should know more about the risks. The decisions makers need training.

POLITICAL AND ADMINISTRATIVE SOLUTIONS

Session II covered the broadest range of case studies of urban water systems management. Ten cases from four continents covered a wide range of experiences (Sao Paulo, Brazil; Madaba, Jordan; Leipzig, Germany; Kampala, Uganda).

Sao Paulo has introduced an Infrastructure Leakage Index which enables comparison of the grade of losses between cities and appraisal of the magnitude of loss within a city. In Jordan, which is facing greatest problems concerning water loss, a Micro PSP concept could successfully be implemented. This is based on a sustainable PPP-model involving the local sector and including outsourcing elements. A private company is in charge of the billing and revenue collection process and the payment of the contractors includes a fixed and performance based incentive fee. The initiation of this process did neither need big start up funds nor a long preparatory process, although the motivation came from international donors.

In the city of Leipzig process oriented structures with clear targets were introduced resulting in a reduction of water loss of about 30 % within a decade and cost covering tariffs at 3-4 Euros per m^3.

In the city of Kampala, Uganda in the mid 1990s water losses as high as 75 % could be attributed to poor management and cultural problems (illegal connections, vandalism, corruption, unwillingness to pay, collusion of staff with customers). This was accompanied by technical problems like old pipes and missing maintenance. But within one decade of great efforts Kampala achieved a reduction of the losses to 39 % in 2007. This success resulted from a change in management. First of all the priorities were set like fixing visible leaks, sensitising and mobilising public support to fight illegal connections and incentive based contracts with clear NRW targets (including incentives /penalties for staff). Secondly the staffs´ attitude had to be changed towards more involvement, transparency and individual accountability. In a further step operational initiatives were undertaken as e.g. raising the community awareness and also establishing incentives, rewards ("Water loss trophy") and penalties. On the question of how this political process started Mr Muhairwe answered that the Legislation gave free hand and the politicians did not interfere in the process, which is commercially oriented, with any directive. Mr Muhairwe saw the biggest problem in the attitude of the staff, who themselves were involved in illegal connections, and are only interested in progress if they profit personally.

In the case of Lusaka, Zambia it was considered important to bring in the local community through leaders whom people trust (councillors, health workers, educators, police). The process should be started on a political level followed by technical measures to reach sustain-

ability. The precondition to success would be skilled personnel. Then capital had to be invested, but could not be a solution by itself. To enforce compliance a regulatory authority would be needed. The awareness of customers and staff to water loss reduction measures had to be raised. Investment in WLR finally reduces the need for immediate expansion.

Bulgaria was the only case who reported about stagnation on a rather high level of around 60 % since 1999. The losses are composed to about one third of inaccurate measurements of the consumed water and to another third of depreciated networks and breakdowns. 14 % losses occurred from valves and bad cadastre and 10 % were attributed to lack of complete clients´ register. Another 13 % were said to result from illegal connections and thefts, external transit pipeline and overflows from reservoirs. The obstacles to progress were seen in a malfunctioning monitoring system and instable political conditions.

During the discussion the importance of private sector participation and commercialisation was emphasized. The question whether the regulator should be independent was positively answered by some participants. In their opinion the regulator should directly report to the government and get a defined percentage of all water billed. If not successful it should be possible to impose sanctions. But the politicians should not interfere in the every day business.

The question was raised whether money, technology or political changes should come first. In the cases of Jordan and Uganda, which received funds from German donors, it was emphasized that money was not the problem, but rather the attitude and the willingness to change.

In Germany it could be observed that more and more politicians were moving to utilities, which was not welcomed by everybody. Benchmarking became a more and more important issue. But the politicians would have to be guided.

The participants came to the conclusion that the sector had to advise the policy makers. It was also agreed upon between the panel, that incentives would be needed; water services are not "zero-business" but also a commercial issue.

Last but not least it was asserted that capacities would be needed and technical solutions would be nothing without capacity development for appropriate application and implementation.

Complete reports can be taken from the proceedings, including the instructive power point presentations. Despite the variety of cases and applied administrative or financial instruments the message from this session can be focussed as follows:

Awareness about the problems of water stress in urban settings does not automatically lead to a change in the culture of water management. A shift from a "culture of taking personal advantage" towards a "culture of collaboration and partnership" will be essential in order to strengthen the efforts to control corruption and to build up confidence in the water management. People must know the flow of their efforts and money.

Developing ownership and corporate identity at the top management of water authorities or water supply companies needs to be supported with ideas, how problems can be solved (or convincing demonstration of case studies, how others have solved similar problems) and needs to be backed up by a similar level of ownership within the staff of water companies, and among the consumers.

The role of business must not be restricted to delivering mechanical products, but the overall management of water systems needs to follow an "efficient economic approach". This may include public as well as private components, especially when it comes to liability, public or governmental responsibility and supervision. Private-public-partnership projects were presented as effective case studies, which deserve wider application.

Reluctance within governing bodies (at all levels) needs to be and can be resolved by reliable information, in combination with support from outside. This will, of course, require financial support via international aid and cooperation programmes, but also increasing pressure or expression of demand from international fora (e.g. UN mechanisms like UN-Water, technical networks like IWA or educational networks like TVET (Technical and Vocational Education and Training, UNESCO-UNEVOC network)).

It deserves to be noted that one city delivered the commitment to the MDG (reduction of un-served part of the population by 50%) well before 2015, simply by reducing drinking water loss, without the connection to newly developed water resources.

The valuation of water, in the wider sense as expressed in the key-note speech, needs to find the way into the daily experience of customers. They have to recognize their own benefit from a service that provides water for all, at any time throughout the year offered at an affordable price. Understanding that drinking water loss reduction is economically sound, cheap and guarantees a reliable service can be easy and logical, as some case studies have shown. The willingness to pay for good and reliable services is high.

How does this translate into capacity development programmes, into vocational training and education as well as into school or university curricula?

TOOLS FOR CAPACITY DEVELOPMENT

Some of the five cases and three programs (Abu Dhabi, United Arab Emirates; Palestinian Authority; Lalitpur, Nepal; Gwalior, India; Gelsenwasser-Ruhrgebiet, Germany) presented in Session III expressed the potential of and success with capacity development at all levels of professions and actors related to water management. It was shown that these activities must not be reduced to teaching and training facts and figures, since handling of water is determined by powerful traditional and cultural aspects. A big challenge stems from the fact that global pressure on natural resources goes hand in hand with the spread of "modern" technologies, trade rules and information technologies. As much as the potential of new technologies for training and education could be to the benefit of all people, it is also pushing processes and activities, without giving time for cultural and educational adaptation.

In some countries a tradition of making knowledge available and acting at a level of highest competence and liability ensures participation and reliable services – at very low cost. It was noted that customers in some EU countries receive safe water every day for less than 1% of their income, while poor people in many countries spend almost one third of their income for fulfilling just their basic water needs. Well designed training modules developed e.g. in Germany are one answer to the wish of water providers and customers not to worry about water supply. A silently ongoing process of research and innovation supported and developed services and demand continuously. Thus, increasing effectiveness in technology and services, and increasing awareness with the customer lead to a balanced supply-and-demand situation, which has been maintained for many decades. The awareness of the "right to express the demand" is spreading worldwide but delivery is lagging behind, due to lack of adequate competence development and infrastructure. Modern learning technologies (like e-learning) could help to reach out to so far untouched audiences, especially the younger generations in countries in transition. Balancing demand and supply also needs to be accompanied by strong efforts in demand management and more efficient use of water also at household level.

Vocational training of professionals at water service institutions has been supported by many international programmes, professional associations and educational networks. It seems to be difficult to reach out to those "non-water-professions" which have a strong impact on water management, like economists and accountants, architects and physical planners, lawyers, the jurisdiction, public administrators and journalists. Success in sustainable urban water resources management can be enhanced globally by increasing the effectiveness and re-directing the focus of new capacity development programs, that reach out to these groups of society.

Bi-lateral collaboration at national level and support through twinning programmes of cities or water companies have reached partners in many cities around the

world. However, many of these programmes usually have a society or culture oriented focus – without recognizing the essential value of water services. The enormous potential of twin-city-cooperation was highlighted as an instrument for sharing experience and developing awareness of challenges and solutions in the control of drinking water loss.

An exceptional case study was presented by the United Arab Emirates where arid climate conditions and limited natural water resources meet the highest per capita water consumption in the world. Water is free for private customers here and also subsidised for commercial enterprises. A reform of the water sector has been carried out including the adoption of the latest international standards and codes of practices, the implementation of highly advanced technologies and a consistent and gradual pattern to privatize the sector. As costs for desalination projects are high a top down-bottom up approach referring to water loss assessment and control has been introduced. Capacity development plays an essential role. Large investments were also done and all meters replaced by state-of-the-art technology. The UAE are interested in attracting foreign capital to privatise water supply and distribution, which might be interesting for companies like Veolia or Siemens. Mr Ramahi emphasized the willingness and interest of his country to cooperate with other countries, share knowledge and give support (e.g. co-financing of ACWUA).

In the impressive report of Mr Creutzburg showing the implemented tools and basic approach of the Gelsenwasser AG supplier, the importance of long term strategies was emphasized which led to one of the lowest water losses worldwide

The lectures of Mr Petermann and Ms Mar were followed by a discussion about the problem of dissemination of information especially in developing countries. In Mr Petermann´s view the developing countries should develop platforms, and build up organisations in order to build standards and share information. A regional process has to be initiated with competent focal points, since the update and amount of information increasingly becomes a problem.

TECHNICAL VISITS

In addition to the main programme of the workshop, two side events, combined with technical presentations, were

organized by German partner institutions. The participants visited the premises of the German Technical and Scientific Association for Gas and Water (DVGW) and the Wahnbach Reservoir, which supplies drinking water to Bonn and the surrounding area.

The Way Forward Report and Workshop Recommendations

Session IV was directed towards summarizing results and discussing future action.

A presentation about the International Water Association - Water Loss Task Force (IWA-WLTF), led to a comprehensive discussion of needs and gaps which could be taken as a challenge to globally active professional associations like IWA, as well as to the UN-Water mechanism e.g. through the specific mandate of UNW-DPC. The workshop participants, and the chairpersons with reflections on their respective sessions, were asked to address the key questions for future orientation, to express their perception and their proposals for further action both in a questionnaire and during the closing debate.

A comparative analysis has been carried out based on questionnaires submitted by the 19 cities participating in the workshop. It was meant to help identifying priority issues and gaps, collecting evidence, as well as presenting pitfalls and deficits. The results provide proof of the fact that half the cities have to cope with losses around and above one third of the abstracted water and that the widely communicated figure of one third of water being lost is more or less correct.

Three groups can be identified:

1. Cities with a stable situation of substantial progress in water loss reduction towards figures below 20 %.
2. Cases with dynamic reduction at high levels of loss (from beyond 50 % to around 30 %)
3. Stagnation at high level of loss (30-50 %) (often accompanied by low percentage of connections with water meters).

In all the "successful" cities stable socioeconomic conditions facilitate the appropriate measures to ensure the provision of reliable public services. In the case with the most reliable and sustainable water supply a long-term strategy of IWRM, maintenance, metering and capacity development delivered reduced water losses as a "side effect". Less successful stories combine a lack of performance in technical equipment (lie water meter installation) with obviously weak action on fields where the rules and mechanisms have been installed. Depending on the specific conditions, needs vary from case to case. However, the highest quotes of needs for short- or long-term improvement cover financial funds (for maintenance systems, reduction programs and appropriate technologies) and capacity building action. Public awareness is also considered to be of high importance.

Conclusions derived from Sessions I – III were presented and discussed as:

Future orientation in solution oriented capacity development

FIVE FUTURE AND ACTION ORIENTED TASKS IN THE AREA OF DRINKING WATER LOSS REDUCTION

The workshop recommended an action plan, addressing five future and action oriented tasks in the area of Drinking Water Loss Reduction:

Task No. 1: Make the economic benefits of reducing water loss as a contribution to proper water system maintenance visible to all stakeholders through training and capacity development for:

- Consumers who need and deserve reliable water supply 24 hours, every day.
- Finance managers of cities or water supply companies, who are in charge of a reliable water supply
- Industry managers, whose success in business is dependent on a functioning infrastructure and a healthy workforce, which both depend on clean and reliable water supplies
- Regional managers, mayors and local decision makers in charge of infrastructure and physical planning
- Managers of financing institutions (including international development agencies and banks) who

need to progress towards more sustainable funding strategies
- This task still needs to be structured and delivered. Professional economic education and capacity development world wide is still trapped in attitudes of "competition rather than action in partnership". A new focus needs to be given to "environmental economy".

Task No. 2: Find a convincing approach to enhance human and institutional capacity towards valuation of water as the essential element for all life processes.

- Institutional capacity development will be one of the key processes towards more sustainable management of water distribution systems
- Academies, schools and institutions for vocational training and education have delivered a substantial collection of products. Few of them take the essential element water into account – it seems to be taken for granted.
- Make better use of existing excellent networks: Global networks for Vocational Training and Education reach out to more than 160 countries worldwide. (e.g. through UNEVOC)
- WHO-Collaborating Centres

Urban centres have been sources of knowledge and social power throughout human history. Half the world's population currently living in urban agglomerations have the potential to kick off a new understanding of responsibility for the water resources all over the world.

Task No. 3: Find appropriate solutions to water loss problems in any economic, climatic or cultural context

- Social context, political and civil society, language and culture need to be understood
- Training material to be made available in local languages
- A culture of partnership and ownership has to be developed

Human water use deals with some 0.2 % of the annual turnover (precipitation of rain and snow on land surface, feeding groundwater replenishment, flow through rivers and lakes), and this global cycle is moving not more than 0.3 % of the worldwide existing fresh water resources. The true challenge lies with local and regional management of human water use within this tremendously rich and never ending flow of the water resource. Urbanization is one of the most dynamic human processes with the greatest potential to improve human living conditions, but only within the limits of the laws of Nature.

Task No. 4: Make the better choice the easier choice for water loss reduction in urban areas

Train technical and organizational staff on technical means, which make their lives easier:

- remote sensing - instead of direct excavations to search for water leakages,
- remote data collection via satellite - instead of touring through the city,
- in–line leakage detection and repair - instead of new boreholes and ditches to replace old pipes.

And of course:

- Getting safe water from the tap all the time - instead of walking and waiting hours and hours for unsafe water.

All these tools have been developed and applied in "wealthy countries" under financial stress. The managers of water works are constantly challenged to optimize their cost-benefit-relation and the way to do so is being more effective, avoiding mistakes (others had made before) and well known traps. Sharing experience and benefiting from the experience of others who went through similar challenges has created solution oriented professional partnerships.

Task No. 5: Make visible the positive impact of water loss reduction for ensuring adequate water supply for all: Avoidable drinking water loss is unacceptable.

- This message needs to be carried into the education schemes of many professions, from child care, through school and secondary education right into the learning programs of lawyers and engineers.
- Feasibility and economic sustainability of safe and reliable water under all political and economic

conditions can be communicated to managers and policy makers in charge.
- Achieve support by decision makers, through transparency about political benefits

This needs new training approaches for policy makers at all levels. Sharing experience with those cites, either under long term stable conditions (e.g. like Gelsenwasser in Germany) or under political and economic transition (like Sachsenwasser in Eastern Germany, former GDR, or Budapest, Hungary, during the transition from the cold war period to its accession to the European Union) can demonstrate the power of a safe water supply as a tool for promoting social stability and social justice. And this has been demonstrated to be feasible within "human" time horizons: not centuries of hope, but a few years or a decade of action.

And finally,

The Workshop recommends the following tasks for immediate action on solution oriented Capacity Development:

- Regional workshops, to reach out to all continents hosted by participant cities, beginning in early 2009
- A session on Drinking Water Loss Reduction at each World Water Forum (WWF), beginning 2009 in Istanbul, to reach out to the audience of water specialists
- Training Modules and e-learning curricula – to be developed to the highest standards and provided in local languages, to reach out to all stakeholders.

Country Analysis Report

Dr. Dagmar Bley & Dr. Günter Klein,

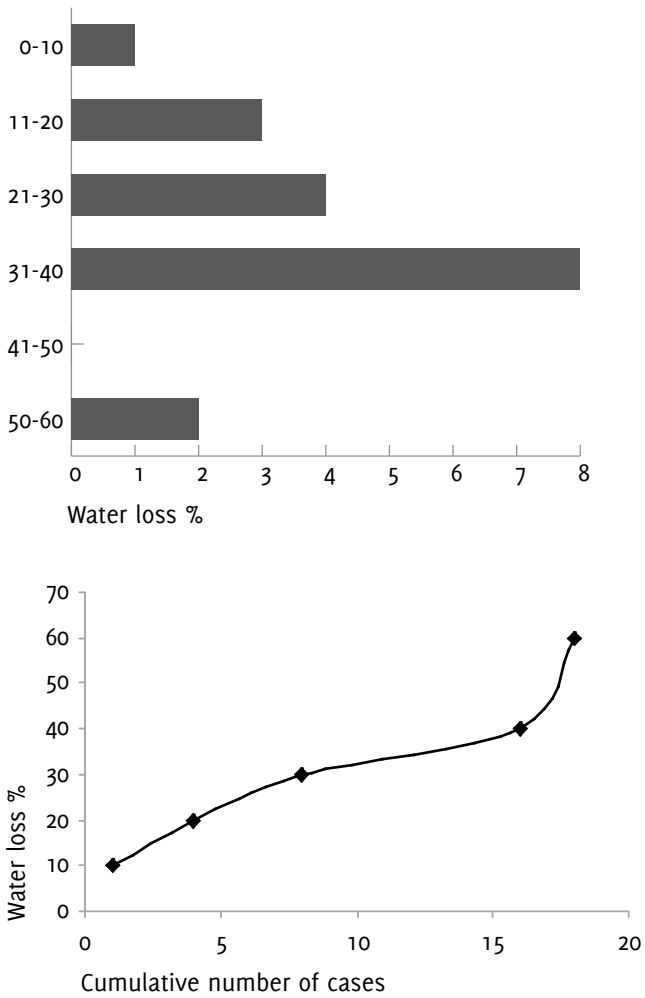
1. BACKGROUND

Drinking water loss in far too many cities is going beyond acceptability, in economic, ecologic, in hygienic and in reliability terms of water supply management. Beyond confirmation of this fact, it is important to go into details of individual cases, in order to identify the pitfalls, potentials and useful approaches for solving the problem in each single case. Many cities across the world have developed long-term strategies towards the reduction in losses.

With this background a comparative analysis has been carried out based on questionaires (in a grid of about 25 questions) provided to the 19 cities (20 cases) presented at the workshop. The aim was not to interpret the results as a global overview, but rather as an entry point towards developing a more detailed questionnaire of existing activities at the regional level, and a capacity development needs assessment, related to water loss reduction. The information collected was also ment to help identifying priority issues and gaps, collecting evidence, as well as presenting pitfalls and deficits.

The results are presented in a generalized form taking into account potential concerns about publicly spread data. In the comparative analysis you find the case studies numbered.

Fig. 1: Number of cases reporting percentage of water loss in 2007 (a: in classes; b: cumulative)



2. REPRESENTATIVITY

The first analysis of the sample with 18 reports out of 20 cases is demonstrating the willingness of the particitpants to be open and transparent. It also shows, that with a rather small, but well selected group of case studies, the full dimension of the problem, and the most promising elements for developing and applying solution can be described.

Not all the questionnaires were filled out completely. It was, as expected, difficult to develop such a short questionnaire, covering the most appropriate set of indicators for all the cases. However, it is possible on this basis to derive results.The overview in fig. 1 shows the wide range of documented water losses. The widely communicated figures of 1/3 of water loss meet the average in this distribution. However, it also provides proof for the fact that half of the cities has to cope with losses around and beyond one third of the abstracted water.

3. ANALYSIS IN DETAIL

3.1. Success stories

A number of cases are providing proof for the applicability of solutions. Four out of 18 cases have reported a stable situation of substantial progress towards figures far below 20 % of water loss. It shuld be noted, that three cass have achieved this progress within roughly one decade.

Table 1: Four most successful cases

Cases No.	Progress achieved	Actual loss 2007 (%)
17	Values around 2 %, increase from 0.9 % (1990) to 2.4 % (2007)	2.4
16	Substantial reduction form 27 % (1995) to 15 % (2007)	15
18		16.5
14		16.8

3.2 Highest losses

Cases with extremely high losses can be found across the world in many cities. In this table, the cases with highest losses are related to the installation of water meters and cover the range from about 35 % up to beyond 50 %.

Table 2: Cases with highest losses related to installation grade of water meteres

Cases No.	Water Loss 2007 (%)	Service connections with water meters [%]
5	54.3	44.4
3	51	43
2	40	25
12	40	
6	37	71
10	36.8	

3.3 Progress under difficult conditions

Greatest progress in reduction has been demonstrated by the "success stories", however, remarkable effect has also been achieved with some of the very problematic cases. It shoud be noted repeatedly, that this progress has been achieved within a time scale ranging from of a few years up to 1-2 decades.

Table 3: Greatest efforts in water loss reduction

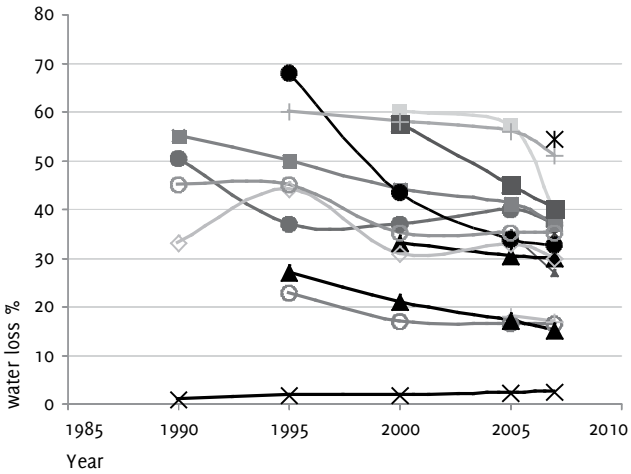
Cases No.	Water Loss 2007 [%]	Reduction [%], Time span
1	32.5	35.3 (since 1995)
2	40	20 (since 2000)
12	40	17.5 (since 2000)
4	29.8	14.2 (since 1995)

3.4 Development of water loss 1990-2007

Figure 2 illustrates a summarizing overview. Even in this anonymous form, it ist well suited to show the "Three phases" of water loss reduction development:

1. Stagnation at high level of loss (30-50 %)
2. Dynamic reduction at high levels of loss (from far beyond 50 % to around 30 %)
3. Substantial progress in water loss reduction (below 20 %)

Fig.2: Development of water loss [%] 1990-2007



4. REASONS FOR SUCCESS AND OBSTACLES

4.1 Success stories

Success stories are to be found among the cities, where almost all points inquired, like strategies, tools, measures of capacity development and financing instrument have received a positive answer. It should be noted that all these cases represent in one or the other way a transition period of several decades, either from one political scheme to another, mainly affected by a combination of structural and productivity changes (demography, industrial development, modernization).

Case 17, demonstrates the liability of water supply, managed in the best sustainable manner. A long term strategy of IWRM and maintenance delivered reduced water losses as a "side effect" of measures, such as:

- since 1886: system flow meters installed

- since 1960: network maintenance, inspection and detection programs implemented
- since 1970: meter reading and billing
- since 1980s: capacity development

Working as stock corporation without national, international or private organizational or financial support, appropriate pricing and billing ensured an economic optimum. This structural setup is also behind the cases 14, 16 and 18, which were facilitated by political and economic re-organization.

What do these cities have in common?

- Support from national or international institutions seems to play a minor role in these countries.
- Stable socioeconomic conditions facilitate the appropriate measures to ensure the provision of reliable public services.

What do these cities consider essential?

- All in common these 4 cities consider "funds for rehabilitation and water losses reduction programs" important.
- "Quality improvement in pipeline construction to prevent future water losses" as an important measure of their institution.
- Changes in the organization to optimise maintenance and increase of communication between relevant departments.
- Purchase of additional and appropriate equipment.

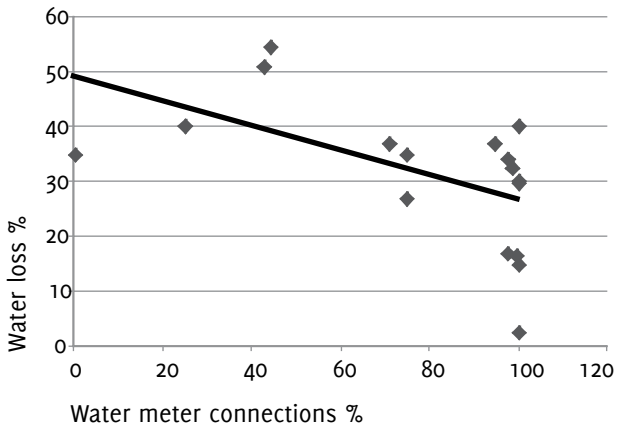
4.2 Less successful cases

Less successful stories combine lack of performance in technical equipment (like water meter installation) with obviously weak action on fields, where the rules and mechanisms have been installed in principle e.g.

- **pricing system** suffering from lack of complete water meter installation
- **water meter installation** suffering from lack of inspection, incomplete coverage
- **national program** suffering from lack of institutional capacity
- **awareness campaigns** suffering from lack of external financial support for implementation

Figure 3 illustrates, that without complete water meter installation water loss control is not achievable. But even with complete meter installation, additional efforts are necessary to achieve progress.

Fig. 3: Relation between water meter connections and water losses



4.3 Appropriate and necessary action

Cities with good progress in water loss reduction report a list of appropriate and necessary action:

- Inst. strengthening,
- Knowledge sharing,
- Reduction initiatives,
- Incentive schemes targeting reduction efforts,
- Decentralization of responsibilities,
- Periodic meter calibration
- Transmission mains leak repair
- Metering of all customers
- Ration supply to un-metered customers who have defective fixtures
- Surveying and drafting of all meter reader routes
- Applying a new incentive scheme to the employees
- Focused teams on illegal use identification and correction

5. STRATEGIES, TOOLS AND CAPACITY DEVELOPMENT IMPLEMENTED

No relationship between existence of national water policy and current amount of water loss can be identified. (All 6 cities with the highest water losses have a national water policy at reducing water losses in their countries.)

Concerning the 4 cities with the lowest losses, 3 out of 4 have a national water policy. Partially differing indication in same country occurs.

Benchmarks for reducing water losses are fixed and followed in almost all of the investigated countries (15 out of 18). The provider with the lowest losses considers publishable water sector benchmark figures as an important means to further reduce water losses.

System flow meters to measure the input are installed in almost all cities (15).

Frequency of meter reading and billing seems not to be important. Almost all providers perform meter reading and billing, in most cases with a monthly frequency. Only one institution (it is even the one with the lowest losses) does it on a yearly schedule, showing that the frequency is not a useful stand-alone-indicator for financial compliance. Awareness campaigns and measures to achieve a high customer satisfaction deserve more attention in this respect.

Most of the cities name to have preventive network inspections, leak detection programs and fighting of illegal connections. A network maintenance /rehabilitation program is implemented in all of the participating cities. The effectiveness in detail needs more attention.

Most cities already use IT-Systems, Computerized tools and information systems, except for real time measurement and supervision systems (6 cities do not have it). Further studies should be carried out to optimize and adapt IT-tools to local and national conditions, an obvious need in most of the cases.

6. NEEDS ASSESSMENT

Depending on the specific conditions, needs vary from case to case. However, the highest quotes of needs for short- or long - term improvement cover financial and capacity building action.

- 72 % of the regarded cities consider “Structuring and financing of maintenance systems” to be among the four most relevant issues for further progress in water loss reduction
- On the second position follow “personnel capacities and training” and “funds for rehabilitation and water loss reduction programs” each considered by 2/3 of the cities to be important,
- More than half of the 18 cities (10) consider institutional capacity needs to be relevant.
- Personnel awareness and political awareness seem to be considered less important, while public awareness is considered by almost 40 % of the cities to be relevant.
- Funds for rehabilitation and programs and appropriate technologies are considered to be the most important issues by 4 cities each. Additionally funds are also considered to be the second most important issue by 5 more cities followed by personell training (4 cities).

The Needs Assessment summarized in the following table has been compiled using the origin of their description.

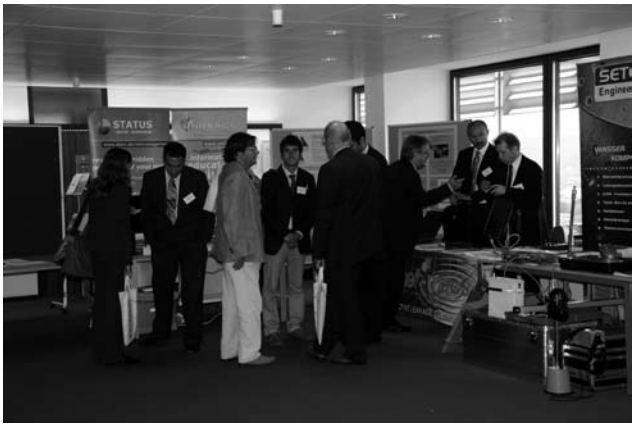
Table 4: Needs Assessment (four most important issues)

No	Cooperation/ Funding	Technology/ Metering	Maintenance/ Technology	Capacity Development	Others
10	Cooperation with international organ.	High tech flow meters	High quality equipment		
2	Financial resources	Meter all customers	Refurbish infrastructure		
11	Replacement of defected meters	Replacement of defected house connections			
17					Publishable benchmark water feature
9	Financial support			Strengthening inst. capacities	Support from top management, ministry
8	Financial support		Technologies		
16				Training of staff, awareness building	Time
6		Micrometers for all customers			
5	Financing		Equipment	Personell	
7	Upfront costs for implementing measures		Leak detection and maintenance tools	Capacity Building	
2					Exposure to best practice utilities
1	Asset management	Real time measurement	network hydraulic modelling		Benchmark initiatives

Ranking: 1. financial support; 2. technological equipment / flow meters; 3. maintenance of infrastructure; 4. capacity building / training

Technical Exhibition

Workshop Technical Exhibition – List of exhibitors



ACQUE S.P.A.

FRAUNHOFER INSTITUT FÜR SILIZIUMTECHNOLOGY

GERMAN TECHNICAL AND SCIENTIFIC ASSOCIATION FOR GAS AND WATER (DVGW)

GERMAN WATER PARTNERSHIP

GERMAN ASSOCIATION FOR WATER, WASTEWATER AND WASTE (DWA)

INTERNATIONAL POSTGRADUATE STUDIES IN WATER TECHNOLOGIES

INWENT – CAPACITY BUILDING INTERNATIONAL

PMB-NET AG

RBS WAVE GMBH

SEBA KMT

SETEC ENGINEERING

SIEMENS WATER TECHNOLOGIES

STEIN & PARTNER GMBH

VAG-ARMATUREN GMBH

Providers of innovative technical solutions for detection and control of unaccounted flow, leakage control and water metering presented their products and approaches in a technical exhibition that was held during the workshop. Representatives from German, Austrian and Italian companies exchanged technological advances with the participants of the workshop.

Annexes

WORKSHOP OVERVIEW

WEDNESDAY, 3 SEPTEMBER 2008

9:00	Arrival and registration
9:30	
10:00	Opening plenary
10:30	
11:00	Coffee break and visit to exhibition
11:30	
12:00	Keynote speeches
12:30	
13:00	Lunch break
13:30	
14:00	Introductory remarks
14:30	Session I “Technical solutions and case studies”
15:00	
15:30	
16:00	Coffee break and visit to Exhibition
16:30	Session I “Technical solutions and case studies” (cont.)
17:00	
17:30	
18:00	Break
18:30	
19:00	Reception and technical presentation (boat trip on the river Rhine)
19:30	
20:00	
20:30	
21:00	
21:30	
22:00	
22:30	

THURSDAY, 4 SEPTEMBER 2008

Session II "Political and administrative solutions and case studies”

Coffee break and visit to Exhibition

Session II “Political and administrative solutions and case studies” cntd.

Lunch break

Session III “Tools for capacity development and case studies”

Coffee break and visit to exhibition

Session III “Tools for capacity development and case studies” cntd.

Break and group photograph

Reception and technical presentation organized by the German Technical and Scientific Association for Gas and Water (DVGW)

Free Time

FRIDAY, 5 SEPTEMBER 2008

Session IV “Workshop reporting and the way ahead”

Coffee break and visit to Exhibition

Session IV “Workshop reporting and the way ahead” cntd.

Closing session

Lunch break

Field trip to the Wahnbach Reservoir near Bonn - Technical presentation and reception

Free Time

WORKSHOP PROGRAMME

Wednesday 3 September

9:00 Arrival and Registration

10:00 Opening Plenary

Welcoming Addresses:

- Dr R. Ardakanian, Director of UNW-DPC
- Statement from UN-HABITAT
- Prof. Dr J. Bogardi, Vice-Rector of UNU in Europe

Opening Addresses:

- Prof. Dr F. Meyer-Krahmer, State Secretary, German Federal Ministry of Education and Research
- Dr M. Konukiewitz, Director for Global and Sectoral Policies, representative of the German Federal Ministry for Economic Co-operation and Development

11:00 Visiting Technical Exhibition

Coffee break

12:00 Keynote (1)

"Economic Aspects of Drinking Water Loss Reduction within Integrated Urban Water Management (IUWM) ", Prof. Dr Dr K.U. Rudolph, University of Witten/Herdecke, Germany

12:30 Keynote (2)

"Solution oriented capacity development towards IUWM: focus on water loss reduction", Prof. Dr G. Klein, Head of Water Strategy Initiative Office, Aerospace Center, Germany

13:00 Lunch break

14:00 Introductory remarks, Dr R. Ardakanian Director of UNW-DPC

- Scope and purpose of the workshop, structure of sessions
- Distribution of tasks
- Introduction of chairpersons and rapporteur

14:30 – 18:00 Session I: Technical solutions and case studies

Invited presentations (15 minutes each):

- "The experience of the Alexandria Water Company in reducing water losses", Alexandria, Egypt, Ms N. Abdou, Chair, Alexandria Water Company
- "Changes in water loss management and corporate culture at Budapest Waterworks", Budapest, Hungary, Mr C.J. Csöre, Deputy Head of network operation department, Waterworks of Budapest

- "SEDAPALs experience in the reduction of water losses", Lima, Peru, Mr H. Reyes, Chief Management Control Team, Drinking Water and Sewerage Company SEDAPAL

Discussion with the members of the Panel

16:00 – 16:30 Coffee Break at the Technical Exhibition

Other invited interventions (7 minutes each):

- "The experience of Mexico City in water loss reduction", Mexico City, Mexico, Mr O. F. Martinez Villalba, Manager of the North Sectionalizing Department, Mexico City Water System
- "From valve to automated solution", Mr A. Rienmüller, Senior Manager, VAG-Armaturen GmbH, Mannheim, Germany
- "Active Leakage Control – low cost technique for higher efficiency results", Dr H. Jansen, Chief Technical Officer, pmb-net AG, Berlin, Germany

Discussion with the members of the Panel (cont. Session I)

19:00 Reception (boat trip on the river Rhine)

Thursday 4 September

9:00 – 12:30 Session II: Political and administrative solutions and case studies

Invited presentations (15 minutes each):

- "Heading for an efficient water loss control – São Paulo experience", São Paulo, Brazil, Mr F. Paracampos, Center Business Unit Superitendent, Companhia de Saneamento Básico do Estado de São Paulo – SABESP
- "The Case of the Madaba Micro Public-Private Partnership", Madaba, Jordan, Business Manager, Mr T. Zuriekat, Engicon Jordan
- "The Leipzig Model – success of a water and wastewater utility in transition with water loss reduction", Leipzig, Germany, Mr J. Reik, Project Manager, Sachsen Wasser GmbH
- "Incremental efforts to address the challenges of water loss reduction in water supply systems. The NWSC Uganda Experience", Kampala, Uganda, Dr W.T. Muhairwe, Managing Director, National Water and Sewerage Corportation

Discussion with the members of the Panel

10:30 – 11:00 Coffee break at the Technical Exhibition

Other invited interventions (7 minutes each):

- "Political and Administrative Solutions for Drinking Water Loss Control: The Zambian Experience", Lusaka, Zambia, Mr I.N. Banda, Chair, Water and Sanitation Association WASAZA
- "Water Loss Reduction in Lusaka City – The Regulatory Influence", Lusaka, Zambia, Mr I.N. Banda on behalf of Mr O. Chanda, Director, National Water Supply and Sanitation Council NWASCO

- "Reducing water losses in Egypt: Sharkia Potable Water and Sanitation Company Experiment", Sharkia Governorate, Egypt, Prof. Dr S. Bayoumi, Chairman, Sharkia Potable Water and Sanitation Company
- "Political and institutional challenges for water loss reduction in Bulgaria", Sofia, Bulgaria, Dr A. Paskalev, Managing Director, Aquapartner
- "The programme for water loss reduction in Nicaragua", Managua, Nicaragua, Mr F. Reyes, Project Supervisor, The Nicaraguan Company for Water Supply and Sewerage ENACAL
- "Operation Management Support (OMS) – steps towards efficient utility management in Jordan", Amman, Jordan, Ms M. Meuss, Planning Officer, German Technical Cooperation, GTZ

Discussion with the members of the Panel (cont. Session II)

12:30 – 13:30 Lunch Break

13:30 – 17:30 Session III: Tools for capacity development and case studies

Invited presentations (15 minutes each):

- "Abu Dhabi Water Sector Experience in Water Loss Reduction", Abu Dhabi, United Arab Emirates, Mr M. A. El Ramahi, Network Services Director, Abu Dhabi Distribution Co.
- "Capacity development for Water Loss Reduction in the Palestinian Water Authority", Palestinian Authority, Mr Z. F. Fuqaha, Training and Development General Director - Palestinian Water Authority
- "Developing capacity for water loss reduction in Lalitpur", Lalitpur, Nepal, Mr K. P. Devkota, Chief and Executive Officer, Lalitpur Sub Metropolitan City Office
- "Water loss reduction initiatives in Gwalior", Gwalior, India, Mr N. V. Shejwalkar, Mayor, Gwalior Municipal Corporation

Discussion with the members of the Panel

15:00 – 15:30 Coffee Break at the Technical Exhibition

Other invited interventions (7 min each):

- "Knowledge shapes tight networks – e-learning shapes knowledge", Dr R. Stein, Chief and Executive Officer, Stein & Partner GmbH, Bochum, Germany
- "Persevering Efforts to Reduce Water Loss", Mr C. Creutzburg, Director of Operational Unit, Gelsenwasser AG, Gelsenkirchen, Germany
- "WAVE – Capacity building to improve the performance of water service providers in Africa", Dr Th. Petermann, Senior Project and Theme Manager, InWEnt – Capacity Building International GmbH, Rackwitz (Leipzig-Zschortau), Germany
- "Skills Development for Water and Sanitation Sector: The Role of UNESCO-UNEVOC", Ms N.Y. Mar, International Centre for Technical and Vocational Education and Training, UNESCO-UNEVOC , Bonn, Germany

Discussion with the members of the Panel (cont. Session III)

17:00 – 17:30 Presentation of the knowledge management and training tool UNITRACC on Underground Infrastructure, Dr Stein, Stein & Partner GmbH

17:30 – 18:30 Break and group photograph

18:30 Reception organized by the German Technical and Scientific Association for Gas and Water (DVGW)

Friday 5 September

9:00 – 12:30 Session IV: Workshop reporting and the way ahead

Presentation of the workshop results and draft summary report
Discussion

10:15 – 10:30 "The work of the International Water Association (IWA) Water Loss Task Force (WLTF) and the factors involved in setting targets and strategies for water loss reduction" Mr S. Trow, Initiative Leader, IWA Task Force on Water Loss Reduction

10:30 – 11:00 Coffee Break at Technical Exhibition

11:00 The way ahead

Presentation and discussion of follow up project proposals:

- Regional workshops
- Draft project for training modules and e-learning curriculum
- Contribution of the Workshop on Drinking Water Loss Reduction to the 5th World Water Forum in Istanbul, March 2009

12:30 Closing Session

Closing remarks: Dr R. Ardakanian, Director of UNW-DPC

13:00 Lunch break

15:00 Field trip to the Wahnbach Reservoir, which supplies drinking water to Bonn and the surrounding area followed by a reception.

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The UN-Water Decade Programme on Capacity Development (UNW-DPC) is a joint programme of UN Agencies and Programmes cooperating within the framework of UN-Water.

Adding Value in Water-Related Capacity Development

UN-Water Decade Programme on Capacity Development (UNW-DPC) celebrated its opening in August 2007 at the UN Campus in Bonn, Germany. UNW-DPC is hosted by the United Nations University and supported by the Federal Government of Germany. The broad mission of UNW-DPC is to enhance the coherence and integrated effectiveness of the capacity development activities of the more than two-dozen UN organisations and programmes already cooperating within the inter-agency mechanism known as UN-Water and thereby to support them in their efforts to achieve the Millennium Development Goals (MDGs) related to water and sanitation.

UN-Water Decade Programme on
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