Water is Life..

Foreword

As the fourth most water-impoverished country in the world, Jordan has stood face to face with water shortages for more than two decades. The annual amount of water availability per capita is less than one-third of the international water-poverty line. Global climate change may lead to greater strain on already limited resources. This ongoing water shortage has caused drastic over pumping of groundwater aquifers that has resulted in a major decrease of available water. On the other hand, Jordan's stability, tourism attraction, and the quality of its business and health services make it a prime regional hub for investment. This challenging situation provides a great opportunity for Jordan to efficiently use each drop of its water.

The government of Jordan began taking steps since late 1980s to improve water management through policies, regulations, institutional reforms, and the use of new technologies. Water-use efficiency programs were launched afterwards to promote water conservation in the agricultural sector which uses more than 60 percent of the national water resources. In early 2000, the Kingdom embarked on a nationwide program to introduce urban water-use efficiency to the public and create a culture of water conservation for all parts of society. This was followed in 2007 by an institutional program that developed a water-demand management policy for the urban and agricultural sectors, and established the institutional model for urban water demand management at the Ministry of Water and Irrigation, the water utilities, and relevant public and private institutions. The program produced a set of water saving standards and a plumbing code for water-use efficiency. It also identified large consumer categories and conducted water audits and surveys to better help users understand their water use and pinpoint potential water-efficiency measures. A menu of best management practices was prepared for each water-use category to make efficient use of supplied water and benefit from water saving. The saved water will be accompanied by savings in energy and wastewater treatment and financial benefits, and will provide additional resources to reduce water shortage. The water efficiency best management practices are presented in six guides covering the residential, health, and tourism sectors, high rises and high-density developments, office buildings, and landscaping, as well as a guide for communication.

This water efficiency guide for high rise and high-density developments will help this sector benefit from the best management practices and technologies for water-use in both existing and new developments.

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Contents

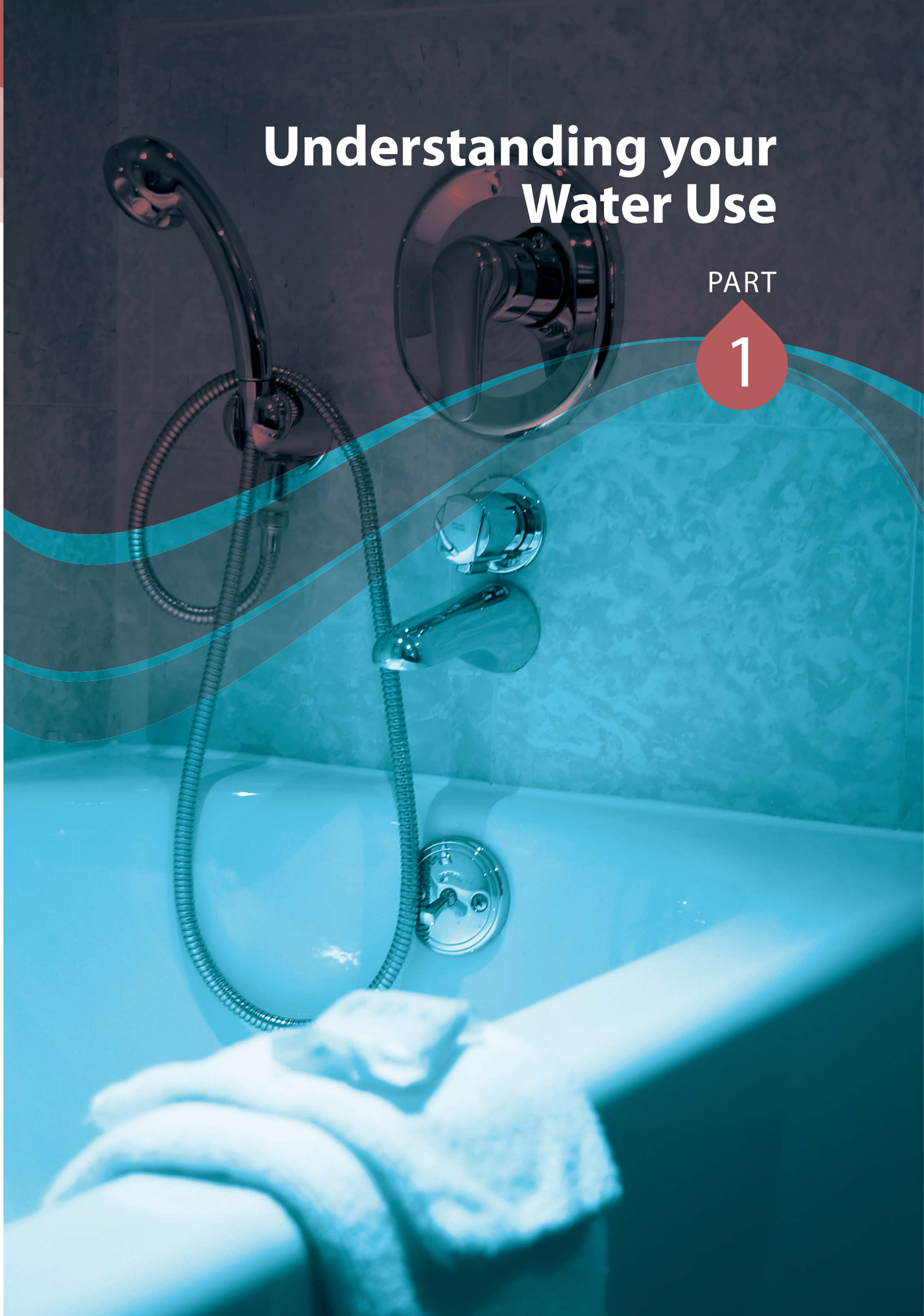
Introduction

High-rise buildings and master planned high-density developments are newly introduced to Jordan. As a result of the water issues related to the construction of the first high-rise building, Jordan Gate, and the launch of the Abdali master planned development, the Ministry of Water and Irrigation requested USAID to support a comprehensive study to investigate and make recommendations for the use of alternative water sources of supply and water use efficiency for high rise and high-density (HRHD) developments. This study was conducted in 2008-2009. It presented international and regional experience and recommendations for efficient water use and reuse in HRHD developments. Following these recommendations, studies and research were conducted in Jordan on residential, commercial, and institutional water use efficiency. This best management practices (BMPs) guide is developed for buildings and landscape in HRHD developments. Buildings include hotels, hospitals, offices, residential units, educational facilities, Mosques, fitness centers, supermarkets, and restaurants. The guide is based on lessons learned from the international practices and experience gained from the national studies and research. Considerable savings in water and money can be made by adopting best management practices for water-use efficiency and water reuse. This guide provides owners, managers, water utilities, developers, planners, designers, builders, and operators a set of best practices that apply to both existing and new HRHD developments.

The guide leads you through a step by step process that presents the reasons for saving water, where and how much water is currently used, and where and how to save water at each type of building within the high-rise and high-density development areas. A list of tips and technologies for best management practices are provided for indoor- and outdoor-water uses. The guide also helps you identify and fix leaks, manage water pressure, and accurately monitor water use. It offers you opportunities to benefit from potential alternative-water sources such as harvested rainwater, gray water, and treated wastewater.

To help you build a strong business case for adopting a water-use efficiency program, a cost-benefit analysis is presented for selected best management practices. This is illustrated by a case study that demonstrates investment cost, savings benefits, payback periods, and benefit-cost ratios for various water conservation interventions. A series of implementation tools are also illustrated, including the policy, code, and regulations that make water-use efficiency possible, the various public and private institutions that support water conservation, and a program for management of water distribution, treatment, and reuse[1].

[1]Since technology changes over time, the information in this guide needs to be updated periodically



Understanding your Water Use

PART

1

Why Save Water in HRHD Developments?

It Saves You Money

Saving water means reducing your water and wastewater bill. It also means reducing your energy bill due to saving in water pumping and heating. Water saving will lower treatment cost and capital cost as a result of scaling down pumps and water heaters. Being more water efficient means you can run your business and still have water available for tomorrow.

It Helps You Gain National And International Recognition

Saving water puts you in good position to compete for national awards such as the King Abdullah Center of Excellence Award where water efficiency is one of the key sub-criteria of this prestigious award. It also prepares you to certify for national and international green building certification. These awards and certification put you at the vanguard of the competition.

It is a Noble National Cause

Every drop of saved water will provide an opportunity for increased supply to other users who are in dear need of it, especially during water shortages and drought periods. Water saving contributes to sustainable water use, a national responsibility of all public and private sectors and all citizens.

HRHD Building Profiles

HRHD building types are profiled in following chapter. Each profile will address the unique water-use characteristics of the building type and introduce baseline and benchmark measures for the following key plumbing fixtures and processes: Private Lavatory Faucet, Public Lavatory Faucet, Showerhead, Toilet, Urinal, Kitchen Faucet, and RO Water Treatment.

While each building type's water use patterns are different, most use similar fixtures and processes. Accordingly, water use profiles, patterns, baselines and benchmarks will be profiled in Part 2; and Part 3 will follow with the best management recommendations for fixtures, appliances, processes, and operations that each building type has in common.

Water-use Baselines versus Water-use Benchmarks

The water-use baseline is the average water consumption for each water-use category, fixture, appliance, or process obtained from the audited facilities. A water-use benchmark is the targeted water use based on best management practices and standards recommended for each water-use category, fixture, appliance, or process in Jordanian facilities. Achieving the benchmark is the goal of a water-efficient facility.

Water Audit

This section is relevant to existing HRHD developments. A water audit[2] is essential for identifying where and how water is used at a given facility within the HRHD development and helps in establishing a business case for potential water use efficiency opportunities. These are the key objectives of a water-use efficiency audit:

- Understand the water supply and distribution systems.
- Identify water-use patterns.
- Identify deficiencies in the water network system, including leaks and wastage.
- Identify baseline and benchmark water use.
- Identify water conservation opportunities, including water reuse.

Performing a water audit requires the following steps:

1. Preparation and information gathering. A thorough preparation will maximize the efficiency of the audit. It includes a preliminary visit to the site that covers:
- Identification of decision maker (owner, business manager, etc.) and operation manager.
- Collection of information regarding address, contact information, physical size of the facility and its various buildings.
- Inspection of access to water supply and sanitation distribution systems.
- Gathering information on operating schedules, occupancy rate, and average number of clients (guests, patients, etc.), visitors, and employees.

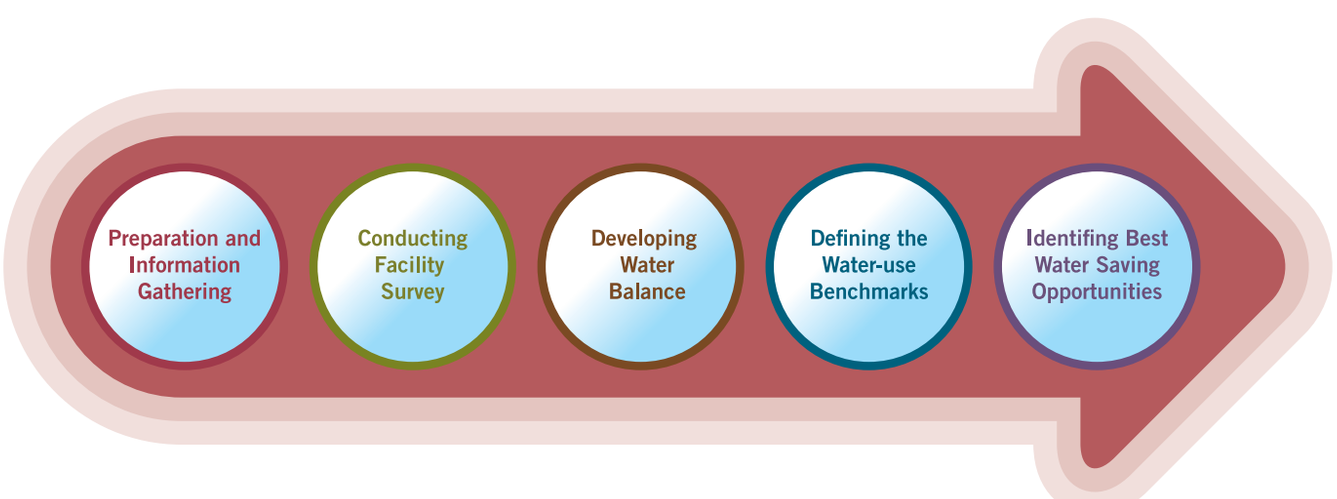
[2] Audits should be done on a recurring basis, preferably once every two years

- Identification of type of indoor and outdoor water usages, water supply sources (utility, private tankers, private well), and any water harvesting.
- Gathering of any previous water and energy audits, available records about water use metering and sub-metering, and water-energy billing. These records are used to create a preliminary estimate of water use to determine whether or not your facility is a high water-use facility.

2. Conducting facility survey to:
   - Walk through the facility with the people, who are familiar with the daily operations, particularly the manager of operations and maintenance, to understand how water is used in the various areas of the facility. Interview relevant staff and employees to confirm the information obtained in the preparation phase. Establish assumptions such as the frequency of use per day of the plumbing fixtures (faucets, toilets, urinals, showers, etc.).
   - Check water-using equipment such as boilers, coolers, water processing systems, laundry and kitchen appliances, and plumbing fixtures. It is also important at this time to discuss any recent water-efficiency improvements or changes.
   - Measure flow rates for each type of water-use fixture and the amount of water-use for each type of water-consuming equipment to establish a baseline of current water use. Direct flow-rate measurements can be done by using a bucket or plastic bag and a stopwatch. It can also be determined by using temporary strap-on meters on water pipes. Measurements of the volume of toilet flushes can be determined by special volumetric metering devices or estimated based on the toilet tank and observation of the actual flush. These measurements of plumbing fixtures and equipment flow rates and amount of water-use will help in identifying inefficient fixtures and equipment, leaks, and inappropriate water use. This step also includes recommendations for sub-metering of major water-uses such as laundry and heating.
   - Estimate outdoor water use, especially water used for landscape irrigation. Obtain data for irrigated areas, water requirement of all irrigated vegetation, and inventory of water delivery systems and devices (sprinklers, drippers, etc.) to determine irrigation volume.

   - Measure water quality to determine parameters such as pH, conductivity, total dissolved solids (TDS), and temperature. This will identify water-saving opportunities such as the increase of water-cooling and water-heating cycles based on TDS values, and rerouting of water from one process to another.

3. Developing a water balance for the water use baselines defined above, and make sure that the total indoor and outdoor water consumption including leakages, if any, match the total water-supply figures from the utility, private tankers, private wells, and other sources.
4. Defining the water-use benchmarks following the plumbing fixtures and appliances efficiency standards and best management practices shown in Chapter 2. These benchmarks are essential for identifying your water-savings target.
5. Identifying best water saving opportunities based on baseline and benchmark water uses, and prioritizing these opportunities according to the amount of water savings, cost of saving, and payback period.



HRHD - Water Use Profiles

PART

2

Hotels

Where and How Much Water is Used?

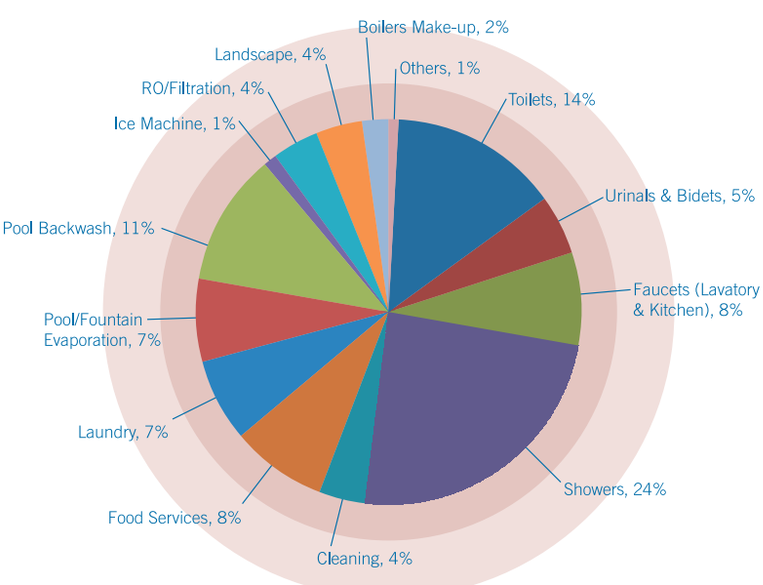
TThe tourism industry is among the major consumers of water in Jordan. Billing data from the Jordan Water Company (Miyahuna) show that this sector accounts for 10 percent of institutional and commercial water consumption in the capital.

To help users understand water consumption in Jordan's hotels, water audits and end-use analysis were conducted at nineteen hotels in 2008 and 2010. The five-star hotels water audits are reported in this section given that this hotel category[2] would most likely be representative of hotel facilities in HRHD developments.

Where and How to Save Water

The water-use at the audited hotels revealed that around 20 percent of the water used could be saved. The current and recommended water use specifications table shows the baseline average water-use, the benchmark water-use, and the potential percentage of water savings for key fixtures and processes at five-star hotels[3]. It should be noted that savings can also be accomplished as a result of good behavioral practices.

Water use profile for five-star hotels



[3]Readers who are interested in the audit results for the 2-3 star and 4 star hotels are referred to the Hotels Water Efficiency Guide.

Current and recommended flow rate specifications for plumbing fixtures and Processes in 5 star Hotels			
End Use	**Baseline Average Water Use for Fixtures and Processes[4]**	**Benchmarks Water Use for Fixtures and Processes[5]**	**Potential Percent Savings**
Private Lavatory Faucet	9.8 Liters/min	4.5 Liters/min	54%
Public Lavatory Metered Faucet	-	4.5 Liters /min or 1 Liter/ cycle[6]	-
Showerhead	12.1 Liters/min	7.6 Liters/min	37%
Toilet	7.3 Liters/flush	4.0 Liters/flush	45%
Urinal	1.8 Liters/flush	1.9 Liter/ flush	0%
Bidet	5.8 Liters/ flush	4.5 Liters/ flush	22%
Kitchen Faucet	13.1 Liters/min	8.3 Liters/min	37%
RO Water Treatment	3 Liters rejected water for 1 Liter produced	1 Liter rejected water for 1 Liters produced	50%

Indoor Water Use

Faucets and Showers

Lavatory and kitchen faucets average water-use in the audited five-star hotels is 8 percent of the total hotel water consumption. Shower water- use is much higher. It accounts for 24 percent of the total water-use. In some of the audited Jordanian hotels faucets and showers can flow up to 20 liters per minute. Faucet and shower flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology[7] for these fixtures. This will result in considerable savings for five-star hotels that can reach up to 54 percent of the total faucet water use and up to 37 percent of the total shower water use. This is why they are often considered the low hanging fruits of water saving programs.

Toilets

Toilet water-use in the audited five-star hotels averages around 14 percent of the total water consumption. The majority of toilets in Jordan's hotels are the gravity type. Toilets flushing rate exceeded 10 liters/flush in some hotels, with an average baseline of 7.3 liters per flush for five-star hotels. Standards for high efficient toilets have been set by the Jordanian Standards and Metrology Organization (JSMO) and were passed as technical regulation. Recommended flushing volumes are 6 liters per flush for single flush toilets and an equivalent of 4 liters per flush for dual flush toilets. The Royal Scientific Society (RSS) constructed a water efficiency laboratory in 2010 to test locally manufactured and imported plumbing fixtures and appliances for compliance with JSMO technical regulations. Replacing old toilets with an average of 7.3 liters/flush with 4.0 liters/flush dual flush toilets will result in a reduction of 45 percent of toilet water-use, with a payback period often exceeding 10 years. More cost-effective results can be achieved by replacing the existing toilet flushing system (trim) with a high efficiency system.

Trigger Sprays, Bidets, and Urinals

Bidets and urinals water use accounts for 5 percent of five-star hotel total water consumption in Jordan.

Laundry

Laundries are a high water-use area in hotels. In Jordan laundry operations consume on the average 6 percent of five-star hotel total water-use.

Food Services

Food services water use represents on the average 8 percent of the five-star hotel total water consumption in Jordan. Kitchens are main areas of water use and are choice targets for water conservation.

Steam And Water-heating Boilers Operations

Around 2 percent of water-use in Jordanian five-star hotels is consumed by boilers for various purposes including hot-water supply, comfort heat for building spaces, and steam for kettles, diswashers, laundry, and sterilizers. Steam boilers offer many opportunities for water- and energy-savings.

[4] Based on the nine five-star audited hotels

[5] Based on Jordan Standards and Metrology Organization (JSMO) standards and technical regulations

[6] Based on 12 seconds per one use

[7] Flow regulators have been standardized by the Jordanian Standards and Metrology Organization (JSMO) as shown in the in the water-use specification table.

Comfort Cooling

A very limited number of hotels in Jordan use water cooling systems for air conditioning. Because of the Kingdom's water scarcity, hotels use split-unit air cooling systems or air-cooled chillers instead of evaporative cooling. The air cooling practice should be maintained for existing and new hotel facilties. It is enforced by the new water and sanitation plumbing code, which stipulates, "Cooling systems that evaporate potable water shall be prohibited for district cooling plants."

Cleaning Operations

Cleaning operations consume around 3 percent of five-star hotel water-use in Jordan. Most hotels have a variety of cleaning and rinsing applications that can consume large volumes of water.

Softeners/Reverse Osmosis

Softeners and reverse osmosis systems account for 4 percent of five-star hotel water-use. Improve the efficiency of water treatment systems in hotels by implementing the following key water efficiency recommendations.

- Select RO equipment that minimizes water rejection to a one-to-one ratio. Replacing existing one-to-three ratio water rejection RO systems with one-to-one ratio systems will result in 50 percent water savings.
- Capture RO reject for reuse in laundry operation, irrigation or other appropriate purposes.

Outdoor Water Use

Swimming Pools

Swimming pools can waste large amounts of water if not properly designed and equipped for efficient operation. In Jordan, swimming pools at five-star hotels use on the average approximately 18 percent of five-star hotel total water-use, with 7 percent of the water lost through evaporation and 11 percent used for pool backwashing.

Follow these key practices and considerations to ensure more efficient water use at swimming pools:

- Cover the pool outside of opening hours. Using a pool cover eliminates almost all evaporation.
- Use shrubs and fences as windbreaks reduce water loss due to wind evaporation.
- Keep a lower water level in the pool to help reduce water loss from extreme splashing

- Design pools to incorporate splash troughs along the edge to catch water that would normally be splashed out onto the deck. The troughs should drain back into the pool filter system.
- Install a meter on the pool's makeup line to monitor and reduce excessive backwashing and identify leaks.
- Choose a filtration system that will minimize water use while accommodating cost considerations.
- Reuse backwash water for irrigation where possible.
- Reduce the use of chlorine in the water and/or choose other treatment systems (ozone, electrolysis, salt, etc.). Proper water treatment will reduce the need to drain water from the pool.

Landscape

Landscape irrigation in five-star hotels accounts for roughly 4 percent of its total water-use.

Hospitals

Where and How Much Water is Used?

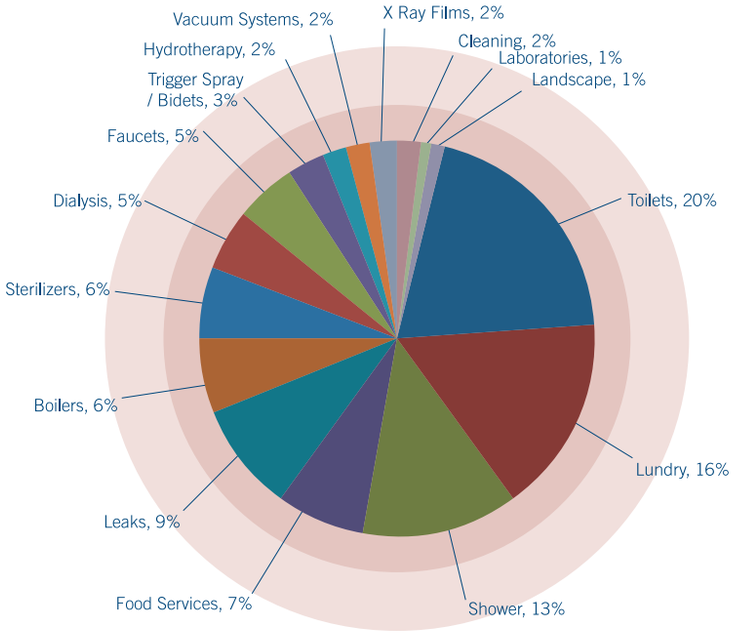
Hospitals and medical facilities are among the major consumers of water in Jordan. Billing data from Jordan Water Company (Miyahuna) show that health facilities account for 25 percent of institutional and commercial water consumption in the capital. To help users understand water consumption in Jordan's hospitals, water audits and end-use analysis were conducted at ten hospitals in 2008.

Hospitals water consumption was subdivided in domestic water-use, medical processes water-use, and water lost to leaks. Domestic includes faucets, showers, trigger sprays and bidets, toilets, food services, laundry, boilers, cleaning, and landscape. Medical processes cover sterilization, dialysis, hydrotherapy, X-ray films, vacuum systems, and laboratories. The profile shows that domestic water-use accounts for 73 percent of the total water consumption and medical processes for 18 percent. The remaining 9 percent are water leaks. In addition, the audits indicated that water-use baseline in Jordanian hospitals is 916 liters per occupied bed.

Where and How to Save Water?

The analysis of water use at the audited hospitals revealed that around 30 percent of the water used could be saved. The current and recommended water use specifications table shows the baseline average water-use, the benchmark water-use, and the potential percentage of water savings for key fixtures and processes. It should be noted that savings can also be accomplished as a result of good behavioral practices.

Water-use profile for hospitals



Current and recommended water use specifications for key plumbing fixtures and processes in Hospitals			
End Use	**Baseline average water use for fixtures and processes**	**Benchmark water use for fixtures and processes**	**Potential Percent Savings**
Private Lavatory Faucet	10 liters/min	4.5 liters/min	55%
Public Lavatory Faucet	10 liters/min	4.5 liters/min or 1.0 liter/cycle	55%
Showerhead	12 liters/min	7.6 liters/min	37%
Toilet	7.8 liters/flush	4 liters/flush	49%
Urinal	6 liters/ cycle	1.9 liter /cycle	68%
Kitchen faucet	20 liters/min	8.3 liters/min	59%
RO Water Treatment	3 liters rejected for 1 liter produced	1 liter rejected for 1 liter produced	50%
X-Ray film processing		Digital- no water	100%

Indoor Water Use

Faucets and Showers

Faucet and shower water-use is close to one fifth (18 percent) of hospital total water consumption. In some of the audited health facilities faucets have flow rates that reach up to 20 liters per minute and shower flow rates of 18 liters per minute or greater. Faucet and shower flow rates can be reduced without affecting the comfort of the water user by using appropriate flow regulator technology for these fixtures. This will result in savings of around 40 percent of the faucets and showers water-use.

Toilets

Toilets use around 20 percent of the total hospital water consumption in Jordan. The majority of toilets in Jordanian hospitals are gravity type, though there are also Turkish (squat) toilets. Based on the audited hospitals in Jordan, current toilets flushing varies from 2 liters/use for bucket type Turkish toilets to more than 10 liters/flush for gravity toilets, with an average baseline 7.8 liters per flush. Replacing old toilets with an average of 7.8 liters/flush with 4.0 liters/flush dual flush toilets will result in a reduction of nearly 50 percent of toilet water use with a payback period often exceeding 10 years. A more cost effective solution is achieved by replacing the existing toilet flushing system (trim) with a high efficient flushing system.

Trigger Sprays, Bidets, and Urinals

Trigger sprays, bidets, and urinals water-use account for 3 percent of hospital water-use in Jordan.

Laundry

Laundries are high water-use areas in hospitals. In Jordan, laundry operations consume 16 percent of hospital total water-use. There are excellent opportunities for saving water and energy in laundry operations.

Food Services

Water used in food services represents approximately 7 percent of Jordanian hospital total water consumption. Kitchens are main areas of water use and are choice targets for water and energy conservation.

Steam and Water-heating Boilers Operations

Around 6 percent of water-use in Jordanian hospitals is consumed by boilers for various purposes including hot-water supply, comfort heat for building spaces, and steam for kettles, diswashers, laundry, and sterilizers. Steam boilers offer many opportunities for water- and energy-savings.

Comfort Cooling

None of the audited hospitals in Jordan uses water cooling systems for air conditioning. Because of the Kingdom's water scarcity, they use split-unit air cooling systems or air-cooled chillers instead of evaporative cooling. This practice should be maintained for existing and new hospital facilties. It is enforced by the new water and sanitation plumbing code, which stipulates, "Cooling systems that evaporate potable water shall be prohibited for district cooling plants."

Cleaning Operations

Cleaning operations consume around 2 percent of hospital total water-use in Jordan. Most hospitals have a variety of cleaning and rinsing applications that can consume large volumes of water. The efficient cleaning practices can add up to significant water savings at a health facility.

Medical Processes Water Use

Medical processes use about 18 percent of hospital total water consumption in Jordan. This is more than the laundry service usage, and is about three times as much as the water needed for steam and water-heating boilers. Dialysis[7] uses 5 percent of this water, and sterlizers (6 percent) use nearly as much water as boilers and only slightly less than kitchens (7 percent). X-ray filming, hydroptherapy and vacuum systems use 2 percent each, and labortaries consume 1 percent of a hospital's water. Considerable water and energy savings can be accomplished by adoptintg the following water conservation practices.

Dialysis

- Select RO equipment that minimizes water rejection to a one-to-one ratio. Replacing existing one-to-three ratio water rejection RO systems with one-to-one ratio systems will result in 50 percent water savings.
- Capture RO reject for reuse in laundry operation, irrigation or other appropriate purposes.

Sterilizers

- Prohibit use of Venturi-type vacuum systems on steam sterilizers.
- Use dry sterilizers instead of Venturi systems.
- Where available, connect steam sterilizers to the hospital central vacuum system.
- Return condensate to the boiler instead of discharging it to the drain.
- Equip all stand-alone steam sterilizers with condensate-tempering systems. Recover this condensate water and reuse it in laundry operation, irrigation, or other appropriate purposes.

Vacuum Pumps

- For medical and dental vacuum pump systems, use dry vacuum systems to eliminate water use and save energy.
- Prohibit Venturi aspirator vacuum systems.
- Eliminate liquid-ring vacuum systems by using mechanical dry vacuum equipment.

X-ray Equipment

- Use digital X-ray imaging equipment instead of film X-ray equipment to eliminate water use.
- For existing non-digital X-ray equipment
  - » Install water-saver kits on the cooling water loops of the film developers to eliminate continuously flowing cooling water.
  - » Recycle rinse-bath water as make-up for the developer/fixer solution.
  - » Install a pressure-reducing device on equipment that doesn't require high pressure.

Hydrotherapy

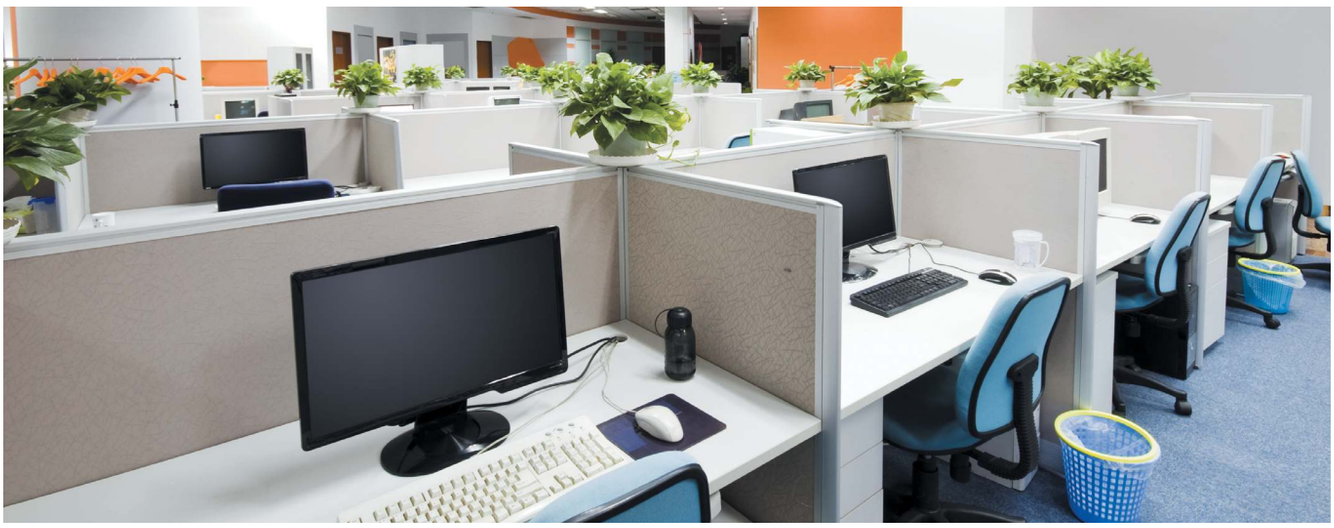
- Determine and use the exact volume of water required for each hydrotherapy tank. Record the use.
- Follow proper practices for cleaning and disinfection of vessels .
- Where large pools are used and the risk of cross infection is not a major issue, filtration and disinfection equipment should be installed to circulate and clean the water rather than dumping the water.

Outdoor Water Use

Landscape

Landscape irrigation in hospitals accounts for roughly 1 percent of its total water-use.

Office Buildings



Where and How Much Water is Used?

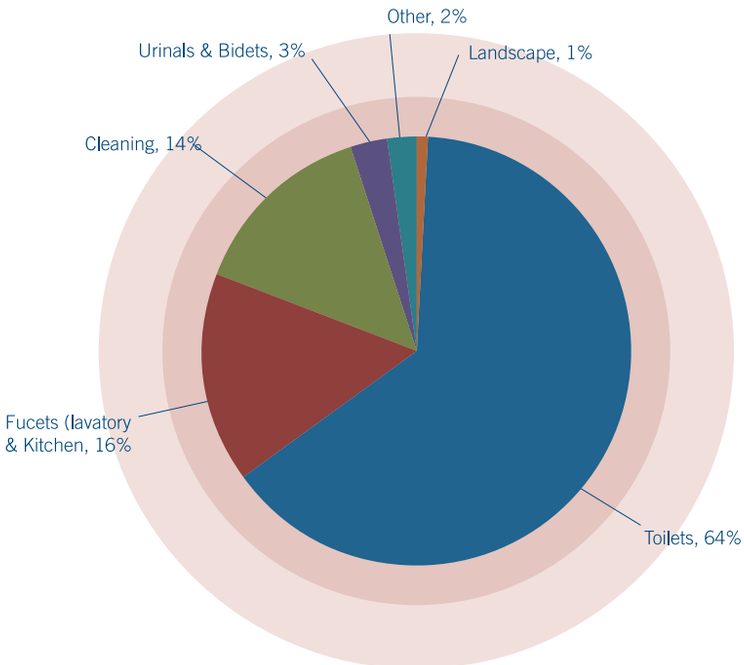
Government and commercial office buildings are among the major consumers of water in Jordan. Billing data from Jordan Water Company (Miyahuna) show that these buildings account for 38 percent of institutional and commercial water consumption in the capital.

To help users understand water consumption in Jordan's office buildings, water audits and end use analysis were conducted at twelve office facilities in 2008 and 2010.

The water use profile of the twelve buildings shows that almost all the water is utilized for indoor purposes. The most important indoor water users are toilets which use around 64 percent of the water, followed by lavatory and kitchen faucets (16 percent), cleaning services (14 percent), urinals and bidets (3 percent), and others (2 percent) including leaks. Outdoor water use is limited to landscape irrigation, which represents only around one percent of the total water consumption. The audits also indicate that the average amount of water used in office buildings is approximately 37 liters per employee per day.

Where and How to Save Water?

The analysis of water use at the audited office buildings revealed that around 30 percent of the water used could be saved. The current and recommended water use specifications table shows the baseline average water-use, the benchmark water-use, and the potential percentage of water savings for key fixtures. It should be noted that savings can also be accomplished as a result of good behavioral practices.



Water use profile for office buildings

Current and recommended water use specifications for key plumbing fixtures and processes in Office Buildings			
End Use	**Baseline average water use for fixtures and processes**	**Benchmark water use for fixtures and processes**	**Potential Percent Savings**
Restroom Lavatory Faucet	6.3 liters/min	4.5 liters/min	29%
Public Lavatory Faucet	6.3 liters/min	4.5 liters/min or 1.0 liter/cycle	29%
Toilet	6.2 liters/flush	4 liters/flush	35%
Urinal	2 liters/ cycle	1.9 liter /cycle	5%
Kitchen faucet	7 liters/min	8.3 liters/min	-
RO Water Treatment	3 liters rejected for 1 liter produced	1 liter rejected for 1 liter produced	50%

Indoor Water Use

Faucets

Lavatory and kitchen faucets average water use in the audited office buildings is approximately 16 percent of the total office buildings water consumption. In some of the audited offices faucets run around 9 liters per minute. Faucet flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology for these fixtures. This will result in impressive savings of around 30 percent of faucets total water-use. Flow regulators, especially the aerators are inexpensive, some cost around 2.5 JD a piece, and are easy to install and maintain.

Toilets

Toilets water use is around 64 percent of office buildings water consumption in Jordan. The majority of toilets in Jordanian office buildings are gravity type, though there are also Turkish (squat) toilets. Toilets flushing varies from 2 liters/use for bucket type Turkish toilets to more than 10 liters/flush for gravity type toilets, with an average baseline of 6.2 liters per flush as shown in the water use specifications table. Replacing old toilets running at an average of 6.2 liters/flush with 4.0 liters/flush dual flush toilets will result in a reduction of 35 percent of toilet water use with a payback period between 2 to 8 years depending on the toilet use per facility. More cost-effective results can be achieved by replacing the existing toilet flushing system with a high efficiency flushing system.

Trigger Sprays, Bidets, and Urinals

Bidets and urinals water use accounts for 3 percent of office buildings water-use in Jordan.

Food Services

Only a limited number of office buildings have food services, most of the offices have only coffee-tea services.

Cleaning Operations

Cleaning operations take up around 14 percent of office buildings water-use in Jordan. Most office buildings have a variety of cleaning and rinsing applications that can consume large volumes of water.

Outdoor Water Use

Landscape

In Jordan, Landscape irrigation averages approximately 1 percent of the office buildings water consumption.

Education Facilities

Where and How Much Water is Used?

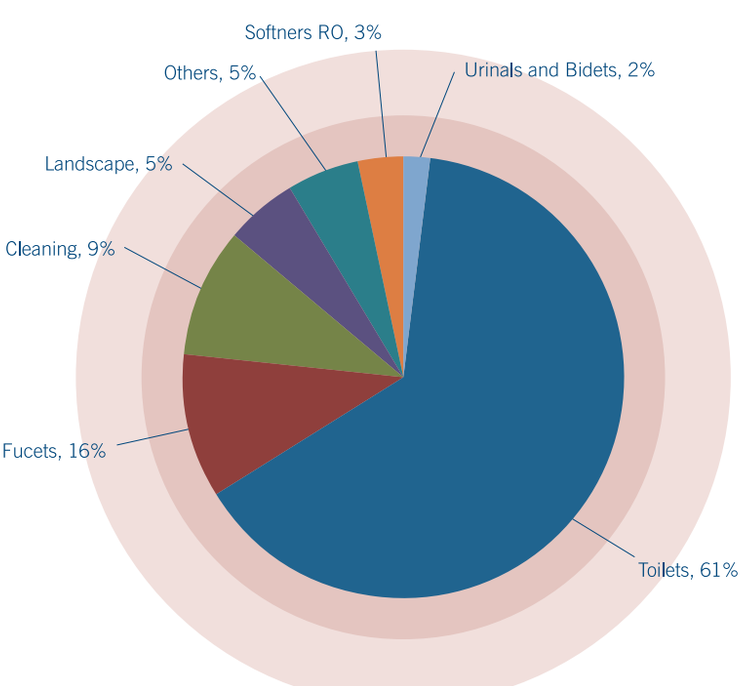
Educational facilities are among the major consumers of water in Jordan. Billing data from Jordan Water Company (Miyahuna) show that these facilities account for 14 percent of institutional and commercial water consumption in the capital.

To help users understand water consumption in Jordan's educational facilities, water audits[8] and end-use analysis were conducted at eight schools and six universities in 2008 and 2010.

The profiles show that for schools the highest water-use occurs at toilets (61 percent), followed by faucets (16 percent), cleaning (9 percent), landscape (5 percent), softeners (3 percent), and urinals and bidets (2 percent). For the universities the major water-use takes place also at toilets (36 percent), followed by cleaning (18 percent), faucets (15 percent), landscape (14 percent), showers (12 percent), and urinals and bidets (2 percent).

Where and How to Save Water?

Based on the audited educational facilities, around 15 percent and 25 percent of water savings can be achieved at schools and universities, respectively. The current and recommended water use specifications table shows the baseline average water-use, the benchmark water-use, and the potential percentage of water savings for key fixtures and processes. It should be noted that savings can also be accomplished as a result of good behavioral practices.



Water-use profile for Schools in Jordan

[8]End Use Analysis for Large Consumers – Schools and Universities Audit Report, USAID-IDARA, Jordan, 2011

Current and recommended water use specifications for plumbing fixtures and processes in Education Facilities			
End Use	**Baseline Average Water Use for Fixtures and Processes**	**Benchmark flow rates for fixtures and processes**	**Potential Percent Savings**
Lavatory Faucets	6.0 liters/min.	4.5 liters/min	25%
Lavatory Metered Faucet		1 liters/cycle	-
Showerhead	10.7	7.6	29%
Kitchen faucet	11.0 liters/min	8.3 liters/min	25%
Urinal	2 liters/ flush	1.9 liter/ flush	5%
Toilet	5.4 liters/flush	4.0 liters/flush	26%
RO Water Treatment	3 liters rejected water for 1 liter produced	1 liter rejected water for 1 liter produced	50%

Indoor Water Use

Faucets

The faucets flow rates exceeding the benchmark or standard can easily be reduced without affecting the comfort of the water user by adopting appropriate flow regulator technology for these fixtures. This will result in around 15 percent to 25 percent reduction of the faucet flows respectively for schools and universities.

Showers

Generally, elementary and secondary schools in Jordan do not have shower facilities. In universities, showers account for 12 percent of the total water-use. Shower flow rates in universities can reach up to 20 liters per minute. These flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology.

Toilets

Toilets water-use accounts for 61 percent and 32 percent of the total water consumption at schools and universities, respectively. Jordanian schools and universities have gravity type and Turkish (squat) toilets. Toilets flushing varies from 2 liters/use for bucket type Turkish toilets to around 8 liters/ flush for gravity type toilets, with an average baseline of 5.4 liters per flush as shown in the water use specifications table. Replacing old toilets running at an average of 5.4 liters/flush with 4.0 liters/flush dual flush toilets will result in a reduction of 26 percent of toilet water use with a payback period between 3 to 25 years depending on the toilet use per facility. More cost-effective results can be achieved by replacing the existing toilet flushing system with a high efficiency flushing system.

Trigger Sprays, Bidets, and Urinals

Bidets and urinals water use accounts for 2 percent of education facilities water use.

Cleaning Operations

Cleaning operations consume 9 percent and 18 percent of the total water-use at schools and universities, respectively.

Softeners/Reverse Osmosis

Softeners and reverse osmosis systems account for 3 percent of the schools water-use. Improve the efficiency of water treatment systems in hotels by implementing the following key water efficiency recommendations.

- Select RO equipment that minimizes water rejection to a one-to-one ratio. Replacing existing one-to-three ratio water rejection RO systems with one-to-one ratio systems will result in 50 percent water savings.
- Capture RO reject for reuse in irrigation or other appropriate purpose.

Outdoor Water Use

Landscape

Landscape irrigation in education facilities accounts for 5 percent and 14 percent of the total water use at schools and universities, respectively. A suitable landscape can be created using a series of water-conserving landscape practices. In the case of universities and schools with large landscape areas, it is recommended to use non-conventional water resources for irrigation, such as rainwater harvested from roof tops and treated waste water. High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.

Swimming Pools

Two of the audited schools and one university have swimming pools. Potential water saving can occur by implementing water efficiency practices.

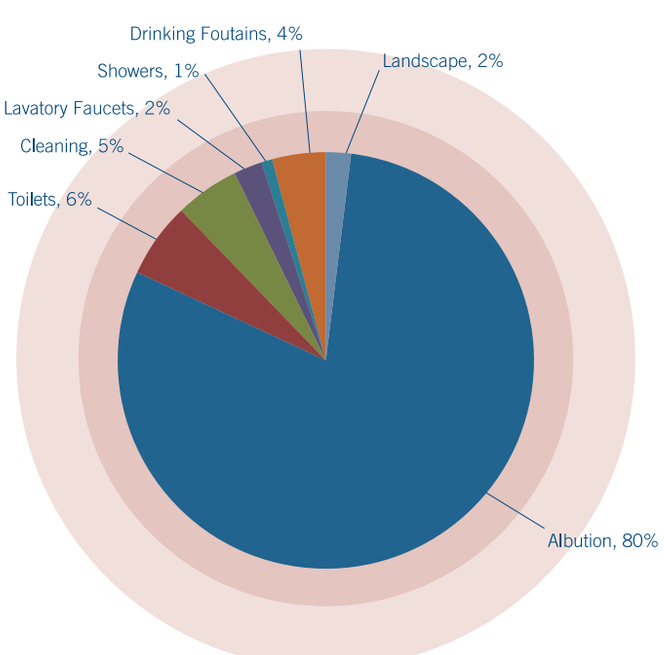
Mosques

Where and How Much Water is Used

Mosques are among the large water consumers in Jordan. To help users understand water consumption in Jordan's Mosques, water audits[9] and end-use analysis were conducted at five Mosques in 2008.

Based on the results of the audited Mosques, the water use profile shows that water ablution accounts for most of the water use in mosques (approximately 80 percent), followed by toilets (6 percent), cleaning (5 percent), drinking fountains (4 percent), lavatory faucets (2 percent), landscape (2 percent), and showers (1 percent) . Some water use is attributed to staff living at the mosque.

Water Use profile for Mosques in Jordan



Where and How to Save Water

Based on the audited Mosques, approximately 50 percent of the water used could be saved. The current and recommended water use specifications table shows the baseline average water- use, the benchmark water-use, and the potential percentage of water savings for key fixtures.

[9]End Use Analysis for Large Consumers – Mosques Audit Report, USAID-IDARA, Jordan, 2010

Current and Recommended Water Use Specifications for Plumbing Fixtures in Places of Worship			
End Use	**Baseline Average Water Use for Fixtures and Processes**	**Benchmark flow rates for fixtures and processes**	**Potential Percent Savings**
Ablution Faucet	11 liters/min	4.5 liters/min	50%
Lavatory Faucet	8.7 liters/min	4.5 liters/min	48%
Showerhead	9.6 liters/min	7.6 liters/min	21%
Toilets	2.6 liters/flush	4 liters/flush	-

Indoor Water Use

Faucets

Flows of ablution faucets and Lavatory faucets can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology. This could result in potential savings of 60 percent of the water-use for ablution and 40 percent for lavatory. Respect recommended flow rates for the various uses that are illustrated in the table.

Recommend flow rate for bidets and urinals	
Lavatory faucet, metered	1 liter/cycle
Lavatory faucet	≤ 4.5 liters/min
Ablution Faucet	≤ 4.5 liters/min

Showers

Shower water-use in Mosques is limited; it is attributed to staff living at the mosque.

Toilets

Toilet water use in mosques in Jordan is around 6 percent of the total water consumption. The majority of toilets in the mosques are the Turkish (squat) toilets with an occasional gravity toilet. The flushing volume of toilets on average in mosques is 2.6 liters per flush. It is recommended to retrofit the toilets with flushing volumes exceeding 6 liters/flush to 4 liters/flush.

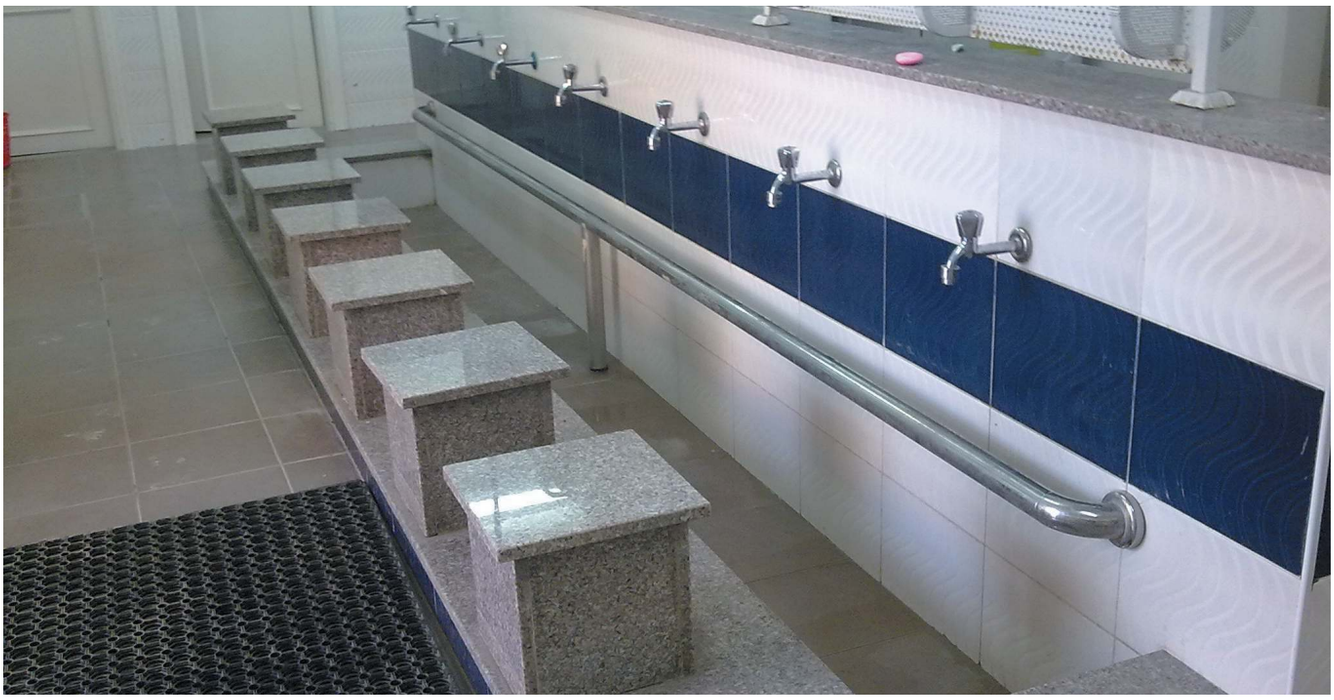
Cleaning Operations

Cleaning operations account for 4 percent of a mosque's total water-use. Most places of worship use water to clean the exterior grounds of the building.

Outdoor Water Use

Landscape

Landscape irrigation averages approximately 2 percent of the Mosques water consumption.



Cinemas, Theaters and Cultural Centers

Where and How Much Water is Used

Cinemas, theaters and cultural centers are places where large audiences assemble to attend recorded or live presentations. Examples include music, theater, sports, dance, lectures, cinema, opera, ballet, and public or private ceremonies. The United States water consumption profile for cinemas, theaters, and cultural centers in HRHD areas, shows that the water-use is primarily confined in restrooms and kitchens. This water use profile could be applicable to cinemas, theaters and cultural centers in HRHD developments in Jordan[10]. Toilet use accounts for around 80 percent of the total water consumption; followed by lavatory faucets (8 percent), and cleaning (3 percent). Other use includes water lost due to leaks. The capacity of the building and the operational hours are important factors in the water-use patterns

Showers

Showers are mainly used in performers dressing rooms.

Toilets

Given that toilets account for the majority of the water consumption in cinemas, theaters, and cultural centers; substantial savings can be achieved when JSMO standards for toilets are adopted.

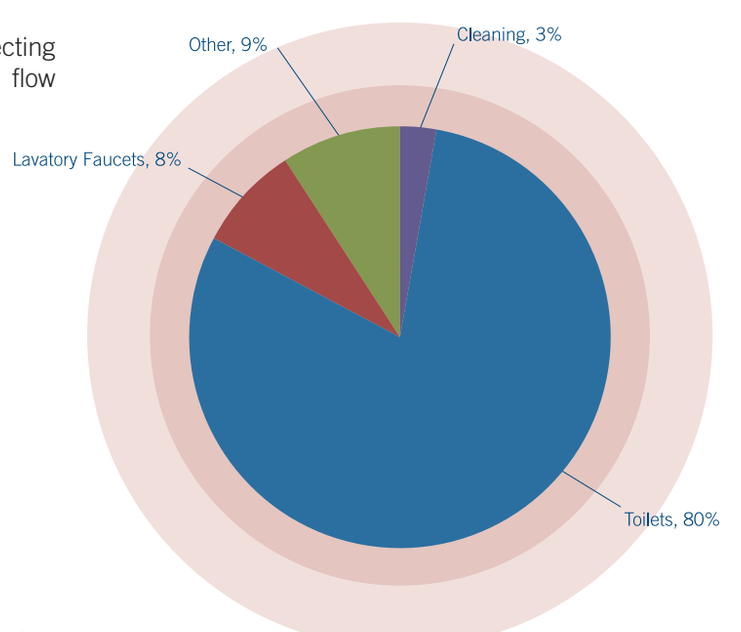
Cleaning Operations

Cleaning operations consume around 3 percent of cinemas, theaters, and cultural centers total water consumption.

Indoor Water Use

Faucets

Faucet flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology for these fixtures.



Water Use profile for Cinemas, Theaters and Cultural Centers In the US[11]

[10]USAID-IDARA recommends future water audits to confirm this data.
[11]American Water Works Association (AWWA)

Health, Fitness and Athletic Clubs

Where and How Much Water is Used

Health, fitness and athletic clubs are business locations where people exercise and receive treatments for greater fitness, improvement and overall health of their bodies. Based on U.S water-use profile for these facilities the largest water-use are Toilets (27 percent), followed by pools (25 percent), Lavatory faucets (20 percent), other including unaccounted (18 percent), showers (5 percent), cleaning (3 percent), and 1 percent each for kitchens and laundry. This water use profile could be applicable to health, fitness and athletic clubs in HRHD developments in Jordan[12].

Indoor Water Use

Faucets

Faucet flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology for these fixtures. This could result in significant water savings.

Showers

Showers water-use is significant (5%). It can be reduced by adopting JSMO standards for showerhead flow rate and good water efficiency behavioral practices.

Toilets

Given that toilets water-use represents a large portion of the water consumption in health, fitness and athletic clubs; considerable savings can be achieved when JSMO standards for toilets are adopted.

U.S Baseline water use at health, fitness & athletic clubs[13]

Laundry

There are excellent opportunities for saving water and energy in laundry operations.

Food Services

Some of the health, fitness, and athletic clubs provide food and beverage. Kitchens are main areas of water use and are choice targets for water saving.

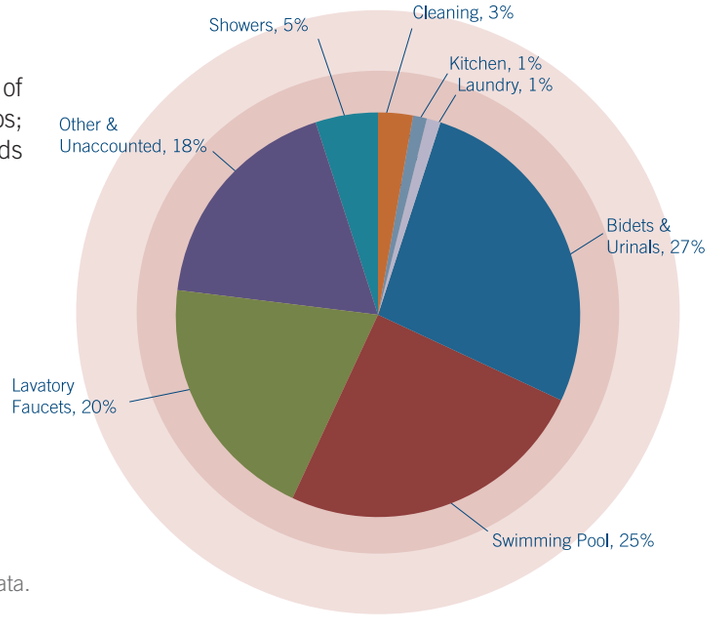
Cleaning Operations

Most of these facilities have a variety of cleaning and rinsing applications that can consume large volumes of water.

Outdoor Water Use

Swimming Pools

Swimming pools are the second largest water consumer in health, fitness, and athletic clubs. Swimming pools can waste large amounts of water if not properly designed and equipped for efficient operation.



[12] USAID-IDARA recommends future water audits to confirm this data.
[13] American Water Works Association (AWWA)

Large Grocery Stores and Supermarkets

Where and How Much Water is Used?

Large grocery stores and supermarkets provide retail sales of a variety of products mainly related to food and beverages. The United States (US) water consumption profile for supermarkets in HRHD areas shows that the majority of water-use is in food services (30 percent), toilets and lavatory faucets (30 percent), and cleaning (10 percent). This water use profile could be applicable to large grocery stores and supermarkets in HRHD developments in Jordan[14].

Indoor Water Use

Faucets

Faucet flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology for these fixtures. This could result in significant water savings.

Toilets

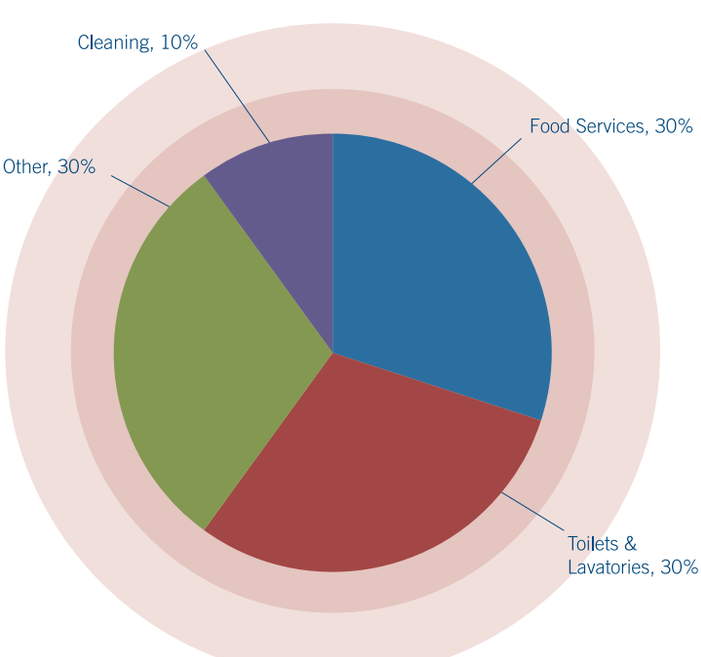
Given that toilets water-use represents a large portion of the water consumption in large grocery stores and supermarkets; considerable savings can be achieved when JSMO standards for toilets are adopted.

Food Services

They include food preparation along with vegetables and fruits cleaning operation, which are main areas of water consumption in large stores and supermarkets. Food services are choice targets for water saving.

Cleaning Operations

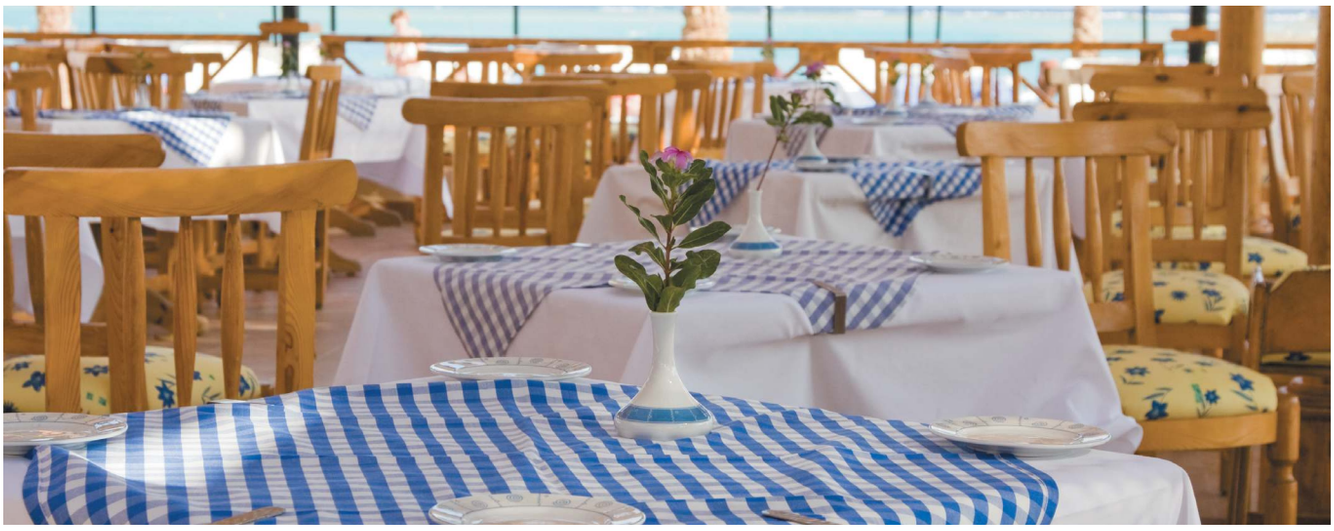
Large stores and Supermarkets have a variety of cleaning applications that can consume a significant amount of water.



U.S Baseline water use profile at Supermarkets[15]

[14] USAID-IDARA recommends future water audits to confirm this data.
[15] American Water Works Association (AWWA)

Restaurants



Where and How Much Water is Used?

The United States (US) water consumption profile for restaurants in HRHD areas shows that the majority of water-use is in kitchen (50 percent), followed by toilets and urinals (20 percent), lavatory faucets (12 percent) and cleaning (3 percent). This water use profile could be applicable to restaurants in HRHD developments in Jordan[16].

Indoor Water Use

Faucets

Lavatory and kitchen faucet flow rates can easily be reduced without affecting the comfort of the water user by using appropriate flow regulator technology for these fixtures. This could result in significant water savings.

Toilets

Given that toilets water-use represents a large portion of the water consumption in restaurants; considerable savings can be achieved when JSMO standards for toilets are adopted.

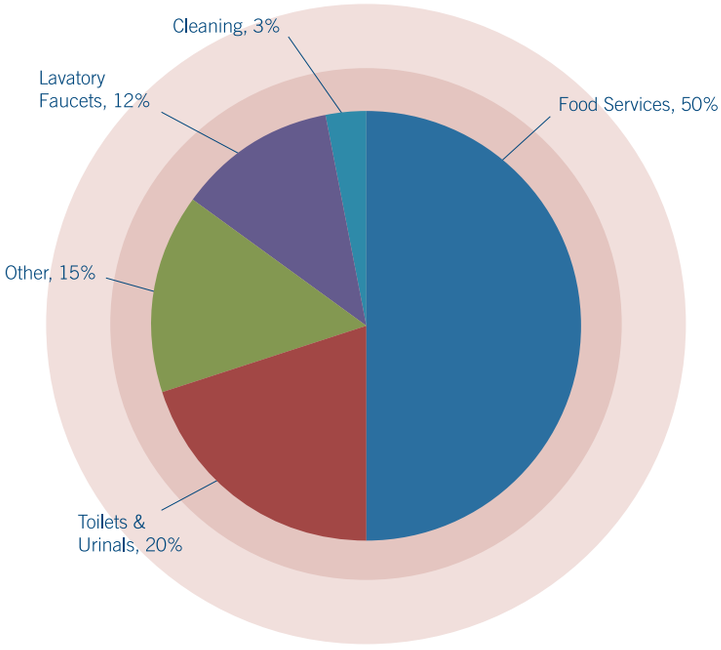
Food Services

Food services consume half of the total water-use in restaurants. Kitchens are main areas of water-use and are choice targets for water and energy conservation.

Cleaning Operations

Restaurants have a variety of cleaning applications that can consume a significant amount of water.

U.S Baseline water use profile at Restaurants[17]



[16] USAID-IDARA recommends future water audits to confirm this data.
[17] American Water Works Association

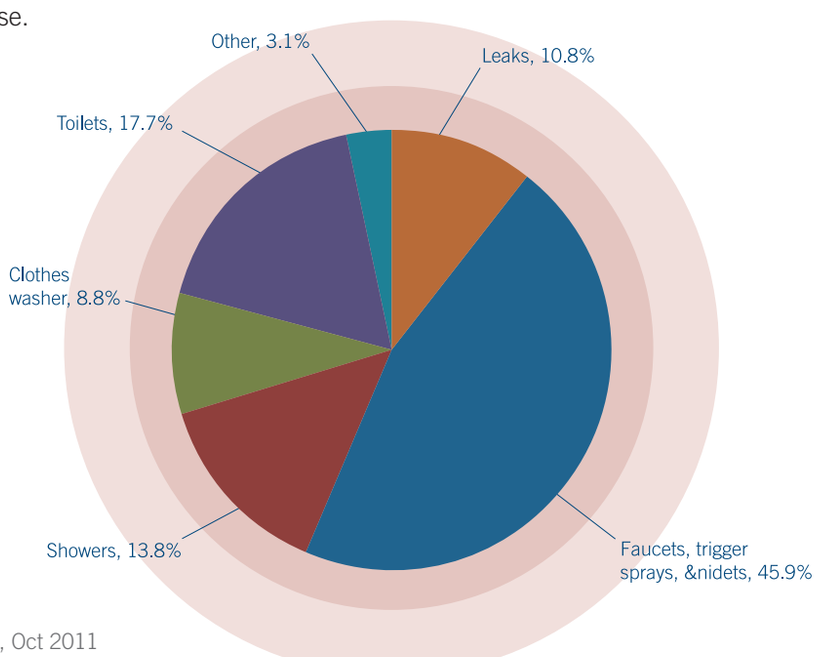
Residential

Where and How Much Water is Used

Non-Agricultural water-use represents approximately 35 percent of the total fresh water consumption in Jordan. Billing data show that the residential sector water-use accounts for approximately 87, 86 and 29 percent of the non-agricultural water consumption in the service areas of Miyahuna, Yarmouk Water Company, and Aqaba Water, respectively.

To help water users and the water utilities understand water consumption in Jordan's residential sector, an end use metering study was conducted at 95 residential units in 2008-2011 and water audits were carried in 2010 during a national baseline residential water-use survey[18] that covered 2,400 homes within the service areas of Miyahuna (1,400), Yarmouk Water Company (700), and Aqaba Water (300). The end use metering study consisted of recording indoor water consumption for 7 to 10 days via a data logger attached to a water meter installed at the outlet[19] of the roof-top tank that supplies water for indoor use. The data logger records all water-uses occurring inside the house.

The residential water-use profile indicates that the most important indoor water-use occurs via faucets, trigger sprays, and bidets which use around 45.9 percent of the water, followed by toilets (17.7 percent), showers (13.8 percent), clothes washer (8.8 percent), and leaks (10.8 percent). The main outdoor water-uses are landscape irrigation, cleaning, and car washing. The indoor water-use patterns obtained from the end use metering study are also confirmed by the baseline survey water audits. For more details about the end use metering and analysis the reader is referred to the residential end use metering final report .



Residential indoor water-use profile in Jordan[20]

[18]Baseline Residential Water-use Survey, USAID-IDARA, Oct 2011
[19]Houses are selected meeting the criteria that all the indoor water supply is delivered through the roof-top tank outlet pipe.
[20]Residential End Use Analysis for Jordan, USAID-IDARA, September 2011.

Where and How to Save Water

Significant savings can be achieved when adopting the standards for plumbing fixtures, especially for faucets and toilets. The current and recommended water-use specifications table shows the baseline average flow rates, the benchmark flow rates, and the potential percentage of water savings for fixtures with flow rates exceeding their respective standards. Note that the faucets flow measurements taken during the 2011 residential water audit were done when the faucets are turned at ¼ opening, a standard practice for water audits. However, the actual faucet flow rate varies based on the user's practice and the type of water use. For instance, users may use the kitchen faucets at flow rates higher than that of the ¼ faucet opening. On the other hand, faucet water use during ablution is often performed at less than ¼ faucet opening. This is confirmed by the 2008-2011 residential end use metering study that revealed that 30 to 35 percent of the recorded flows of faucets trigger sprays, and bidets are higher to their respective standards as opposed to the 95 percent found in the 2011 water audit of the 2,400 homes across Jordan. Therefore, the potential percentage of savings for both lavatory and kitchen faucets shown in the following table should only be considered as indicative values, an additional residential end use metering study is recommended to obtain realistic values of the expected savings based on the actual use of the lavatory and kitchen faucets. It should be noted that in addition to savings resulting from compliance with the Jordan Standards and Metrology Organization (JSMO) fixtures and appliances standards, savings can also be accomplished as a result of good behavioral practices.

Current and recommended water-use specifications for key plumbing fixtures and processes in Homes

End Use	Baseline average flow rates for fixtures and processes	Benchmark flow rates for fixtures and processes	Potential Percent Savings[21]
Lavatory Faucet	8.7 liters/min	4.5 liters/min	48%
Kitchen faucet	11.4 liters/min	8.3 liters/min	27%
Showerhead	9.6 liters/min	7.6 liters/min	21%
Toilet	6 liters/flush	4 liters/flush	33%
RO Water Treatment	3 liters rejected for 1 liter produced	1 liter rejected for 1 liter produced	50%

Indoor Water-Use

Faucets and Showers

The faucets and showers flow rates exceeding the benchmark or standard can easily be reduced without affecting the comfort of the water user by adopting appropriate flow regulator technology for these fixtures. This will result in 10 percent to 30 percent reduction of the flow rates of lavatory and kitchen faucets and showers. Here are the recommended best management practices for achieving water savings for faucets and showers in a household.

Faucets

- Use pressure compensating and tamper proof aerators.
- Respect recommended flow rates for the various uses that are illustrated in the table
- Regularly clean faucets as sediments may accumulate and reduce the flow.
- Do not let the water run needlessly when washing your hands, shaving, brushing your teeth, or performing ablution.

Showers

- Use shower-head aerator with a recommended flow rate of less than or equal to 7.6 liters per minute.
- Mixing-valves with water-temperature settings should be used in all showers to prevent scalding. Use appropriate circulation system to avoid cold water wastage.
- Take shorter showers, keeping showers for 5 to 8 minutes saves water.

Toilets

The majority of toilets in Jordan's homes that are located in the three utilities service areas are the gravity type, though there are also Turkish (squat) toilets. Toilets' flushing varies from 2 liters/use for bucket type Turkish toilets to more than 10 liters/flush[22] for gravity type toilets. The vast majority (96 percent) of the current residential gravity toilets in Jordan operate at flushing volumes exceeding JSMO standard. Replacement of these toilets with 3/6 liters dual flush toilets will result in a reduction of around 30 percent of toilet water-use with a payback period exceeding 5 years. However, replacing the existing toilet flushing system (trim) with a high efficiency flushing system can lead to the same saving with a payback of around one year.

[21] The potential percentage of savings is calculated for the fixtures with audited flow rates exceeding the benchmark or standard.

[22] The end use metering study carried by USAID-IDARA showed that the maximum toilet flushing volume in one of the 95 homes included in the analysis reached 10.6 liters/flush.

Don't Flush Your Money Down The Drain

- Follow recommended flush volumes for toilets as illustrated in the table.
- During adjustment or replacement of the flushing system (trim system), make sure you do not impede waste removal or violate the manufacturer's recommendations.
- Test toilets for leaks and make necessary repairs promptly. Dye-test all tank type toilets for "silent leaks" every six months by putting tablets or several drops of food coloring in the tank. Do not flush. Wait ten minutes. If the dye shows in the bowl, the toilet is leaking.
- Keep the toilet in working order by periodically inspecting and replacing flappers and other defective parts.

Recommended flush volumes for toilets	
Dual-flush toilets	≤ 3/6 liters/flush[23]
Single flush	≤ 6 liters/flush

Trigger Sprays and Bidets

Current flow rates for trigger sprays and bidets in Jordan often exceed JSMO standards. These standards shown in the table offer a good water-saving opportunity for residential customers.

Respect recommended flushing volumes for the various uses that are illustrated in the table

Laundry

Recommended flush volumes for bidets and urinals	
Bidet	≤ 4.5 liters/min
Trigger Spray	≤ 4.5 liters/min

Clothes washers' water-use varies from around 4 percent of the total indoor water use in Amman rural area to 11 percent in Aqaba. There are excellent opportunities for saving water and energy in laundry operation. This can be achieved by the following efficient practices.

Pre-washing

- Sort laundry by level of cleaning needed.
- Operate laundry equipment with full loads only.
- Set the number of cycles to accomplish the proper cleaning. Eliminate unnecessary cycles.
- Where possible, lower the level of water in a cycle.
- Select appropriate washing chemicals (detergents, softeners) that require fewer wash and rinse steps.

Appliances and Equipment

- Front-load washing machines are more efficient, they use much less water and detergent.

- Use water and energy-saving equipment following national standards and labeling programs, when available.
- Choose easily programmable equipment to use no more water than what is required for cleaning a load.
- Choose dryer equipment with dry lint collection systems.

Refrigeration

- Use adequate refrigerators to thaw frozen foods instead of thawing under running water. Thawing under flowing water is always wasteful and should be avoided whenever possible. If water thawing is required, use a low flow stream. Do not use running water to melt ice in bar-sink strainers.
- Eliminate all water-cooled equipment using once-through cooling and replace them with air cooled models that don't require any water for condenser cooling. This applies to icemakers, refrigeration equipment, and ice cream machines.

Dishwashing

- Do not let the water run needlessly when washing dishes.
- Dishwashing machine is more water efficient than hand washing, especially if you run full loads.
- Use dishwashers only with full load.
- Select water- and energy-saving kitchen appliances and equipment following local standards and labeling programs, if available

[23]Equivalent to an average of 4.0 liters/flush

Comfort Cooling

Some homes in Aqaba use water cooling systems for air conditioning. Because of the Kingdom's water scarcity, use air cooling systems instead of evaporative cooling. This is enforced by the new water and sanitation plumbing code, which stipulates, "Cooling systems that evaporate potable water shall be prohibited."

Cleaning Operations

Most homes use cleaning and rinsing applications that can consume large volumes of water. The cleaning practices presented here can add up to significant water savings.

- For outdoor areas such as sidewalks and parking lots, use brooms and dust-pans. Water should not be used to clean these areas.
- For indoor areas, follow these recommendations:
  - » Use a broom and dust-pan to clean solid wastes before mopping.
  - » Install a self-closing nozzle on the wash-down hose, so the water will not run when not needed.
  - » Install drains close to areas where liquid discharges are expected.
  - » Use a squeegee to push water to the floor drain.

Outdoor Water-Use

Car Washing

- Cars shall not be washed using water hoses.
- Bucket and cloth car-washing practice is water efficient.

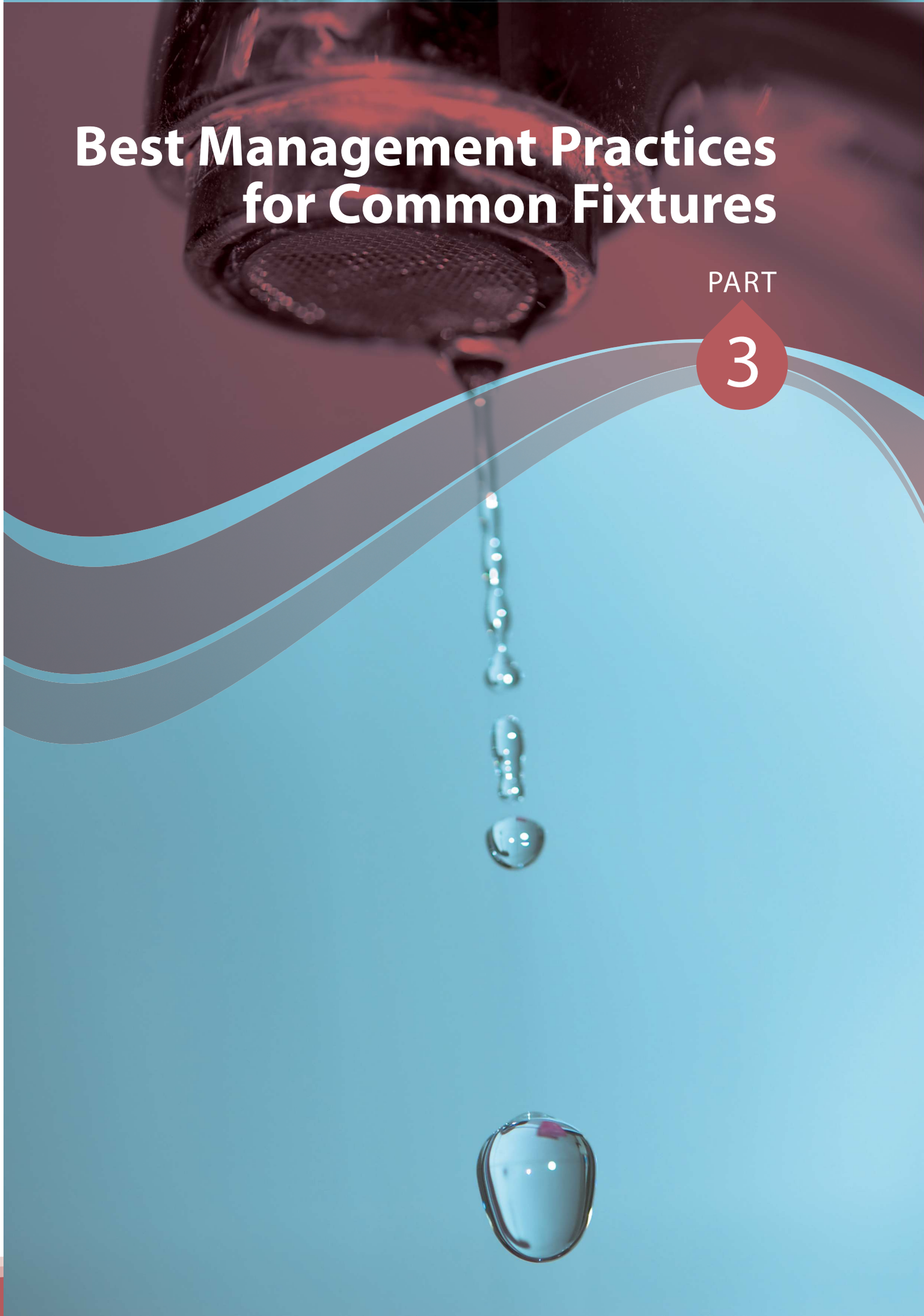
Swimming Pools

Some residences in Jordan have swimming pools. Swimming pools can waste large amount of water if not properly designed, maintained, and equipped for efficient operation. Follow these key practices and considerations to ensure more efficient water-use at pools:

- Cover the pool outside of opening hours. Using a pool cover eliminates almost all evaporation.
- Use shrubs and fences as windbreaks reduce water loss due to wind evaporation.
- Keep a lower water level in the pool to help reduce water loss from extreme splashing.
- Design pools to incorporate splash troughs along the edge to catch water that would normally be splashed out onto the deck. The troughs should drain back into the pool filter system.
- Choose a filtration system that will minimize water-use while accommodating cost considerations.
- Reuse backwash water for irrigation where possible.
- Reduce the use of chlorine in the water and /or choose other treatment systems (ozone, electrolysis, salt, etc.). Proper water treatment will reduce the need to drain water from the pool.

Landscape

Based on the 2010 baseline residential water-use survey, residential gardens' water-use is around 3, 10, and 2 percent of the total residential water consumption in the service areas of Miyahuna, Yarmouk Water Company, and Aqaba Water, respectively.



Best Management Practices for Common Fixtures

PART

3

While each building type profiled in the previous section will begin from different baselines, and will be working towards specific benchmarks, all buildings will target reforms to the same water use fixtures, appliances, processes, and operations This section will profile the best management recommendations for these common areas. The reader should note that these best management recommendations do not apply to residential units. Best management practices for residential units are embedded in the Residential Unit Water Use Profile in the previous section.

Defining Best Management Practices

Best management practices (BMPs) are a set of hands-on recommendations that help in identifying opportunities and implementing programs for efficient water-use. BMPs are developed for the various water-uses in Jordan High Rise High Density (HRHD) developments. Tips and information are provided on water-saving amounts and cost recovery to help in prioritizing water-use efficiency measures and make the most bang for your buck.

Faucets and Showers

Here are the recommended best management practices for achieving water savings for faucets and showers.

Faucets

- Use pressure compensating and tamper proof aerators that can only be removed with a 'special' tool to reduce vandalism and theft.
- Use self-closing faucets in public lavatories.
- Respect recommended flow rates for the various uses that are illustrated in the tables below.
- Regularly clean faucets as sediments may accumulate and reduce the flow.
- Do not let the water run needlessly when washing your hands, shaving, brushing your teeth, or performing ablution.

Hotels	
Public hand-washing faucet Self-closing faucet	≤ 4.5 liters/min ≤ 1.0 liter/cycle
Guest room faucet	≤ 4.5 liters/min
Kitchen faucet	≤ 8.3 liters/min

Office Buildings	
Public hand-washing faucet Self-closing faucet	≤ 4.5 liters/min ≤ 1.0 liter/cycle
Restroom faucet	≤ 4.5 liters/min
Kitchen faucet	≤ 8.3 liters/min

Cinemas	
Lavatory faucet, metered	1 liter/cycle
Lavatory faucet	≤ 4.5 liters/min

Hospitals & Clinics	
Public hand-washing faucet Self-closing faucet	≤ 4.5 liters/min ≤ 1.0 liter/cycle
Patient room faucet	≤ 4.5 liters/min
Kitchen faucet	≤ 8.3 liters/min
Surgical scrub station faucet	≤ 8.3 liters/min

Showers

- Use shower-head aerator with a recommended flow rate of less than or equal to 7.6 liters per minute.
- Mixing-valves with water-temperature settings should be used in all guest showers to prevent scalding. Use appropriate circulation system to avoid cold water wastage.
- Take shorter showers, keeping showers for 5 to 8 minutes saves water.

Toilets

- During adjustment or replacement of the flushing system, make sure you don't impede waste removal or violate the manufacturer's recommendations.
- Keep the toilet in working order by periodically inspecting and replacing flappers and other defective parts.
- Test for leaks and make necessary repairs promptly. Dye-test all tank type toilets for "silent leaks" every six months by putting tablets or several drops of food coloring in the tank. Do not flush. Wait ten minutes. If the dye shows in the bowl, the toilet is leaking.

Recommended flush volumes for toilets	
Dual-flush toilets	≤ 3/6 liters/flush[24]
Single flush	≤ 6 liters/flush

Trigger Sprays, Bidets, and Urinals

Current flow rates for trigger sprays and bidets in Jordan often exceed the new Jordanian water and sanitation plumbing code recommended standards. The new code also opens the door for the use of waterless urinals under specific design that respect hygiene and environmental considerations.

Recommended flush volumes for bidets and urinals	
Urinal	≤ 1.9 liter/cycle
Bidet	≤ 4.5 liters/min
Trigger Spray	≤ 4.5 liters/min

Laundry

Excellent opportunities exist for saving water in laundry operations. This can be achieved by the following efficient practices.

Pre-washing

- Sort laundry by level of cleaning needed.
- Use laundry scales to weigh loads.
- Operate laundry equipment with full loads only.
- Set the number of cycles to accomplish the proper cleaning. Eliminate unnecessary cycles.
- Where possible, lower the level of water in a cycle.
- Select appropriate washing chemicals (detergents, softeners) that require fewer wash and rinse steps.

Appliances and Equipment

- For large laundry volumes, use tunnel washers that can reduce water use by 30 to 60 percent compared to washer-extractors.
- Use water- and energy-saving equipment following national standards and labeling programs, when available.
- Use water recycle or ozone equipment when feasible. This can reduce water use up to 50 percent.
- Choose easily programmable equipment to use no more water than what is required for cleaning a load.
- Choose dryer equipment with dry lint collection systems.

Kitchen and Food Services

The following recommendations will help save water in kitchens.

Refrigeration

- Use adequate refrigerators to thaw frozen foods instead of thawing under running water. Thawing under flowing water is always wasteful and should be avoided whenever possible. If water thawing is required, use a low flow stream. Do not use running water to melt ice in bar-sink strainers.
- Eliminate all water-cooled equipment using once-through cooling and replace them with air cooled models that don't require any water for condenser cooling. This applies to icemakers, refrigeration equipment, and ice cream machines. Air cooling with remote (outside) compressors that exhaust heat outside the building is recommended.

Cooking and Food-Service Equipment

- Use dry-steam tables that use no water to keep food hot while serving.
- Return and reuse condensate for all boiler-type kettles and properly size steam traps to operate efficiently and not inadvertently dump condensate. Insulate condensate return lines.
- Food steamers should be self-contained and connectionless because they don't need a water supply or a wastewater drain. Boiler-less steamers are also recommended.

Waste Disposal

Eliminate garbage disposals and sluice-trough systems in favor of garbage cans and strainer baskets. Strainer baskets also eliminate the need for a pulper system, thus eliminating water and energy use for disposal.

Dishwashing

- Use pre-rinse dishwashing spray valves with a water flow rate of 6 liters per minute or less. Spray valves should not be locked in the open position.
- Dishwashing equipment is more efficient than hand washing.
- Use dishwashers only with full load.
- Install steam doors on dishwashers to reduce evaporation loss of water.

Select water- and energy-saving kitchen appliances and equipment following local standards and labeling programs, if available.

[24] Equivalent to an average of 4.0 liters/flush

Steam And Water-heating Boilers Operations

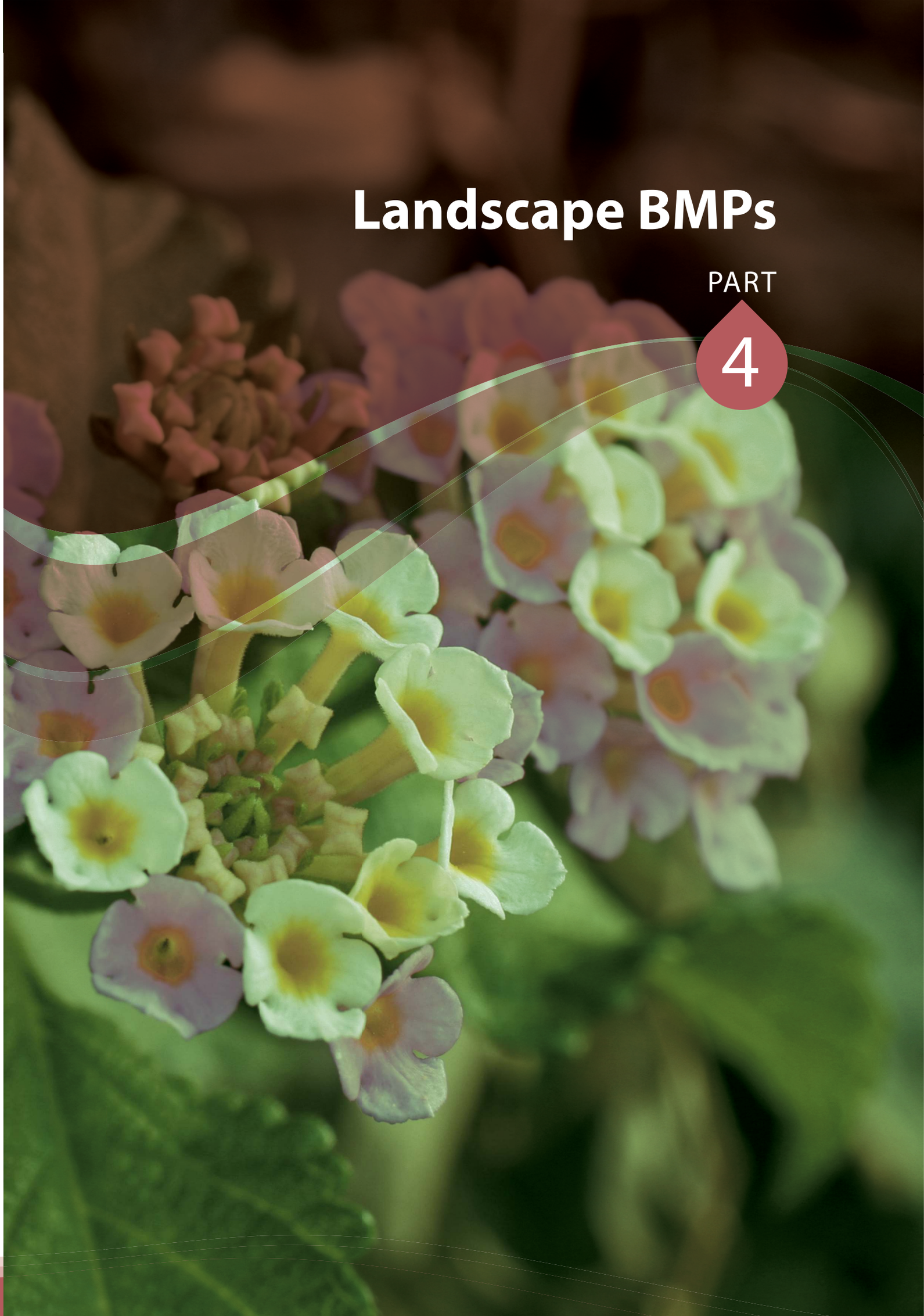
Around 2 percent of water-use in Jordanian five-star hotels and 6 percent of water-use in Jordanian hospitals is consumed by boilers for various purposes including hot-water supply, comfort heat for building spaces, and steam for kettles, diswashers, laundry, and sterilizers. Steam boilers offer many opportunities for water- and energy-savings. Here is a list of BMPs that help save water and energy.

- Don't use a central steam boiler. Instead:
  - » Use stand-alone steam boilers for sterilizers with condensate return where applicable.
  - » Use separate hot-water boilers for laundry, food service operations, faucets and showers, and comfort heating.
- Install make-up meters for cold feed-water lines on important steam-boiler operations.
- Install steam-condensate return to all steam boilers and meter condensate return when feasible.
- Use conductivity controllers for automatic blow-down of boilers which will better manage the treatment of boiler make-up water and maximize the cycles of concentration. For most hotels, steam boilers operate in the range of 15 to 40 cycles of concentration.
- For hot-water boilers, have boiler temperature and make-up meters clearly visible to the operator.
- Regularly check steam traps and lines for leaks and make repairs as soon as possible.
- Follow all the procedures related to heating in the Jordanian new water and sanitation plumbing code.

Cleaning Operations

The cleaning practices presented will help achieve significant water savings.

- For outdoor areas such as sidewalks and parking lots, use brooms and dust-pans. Water should not be used to clean these areas.
- For indoor areas, follow these recommendations:
  - » Use a broom and dust-pan to clean solid wastes before mopping.
  - » Install a self-closing nozzle on the wash-down hose, so the water will not run when not needed.
  - » Use new enzyme floor-cleaning products for areas that have a lot of grease residue such as kitchens. The new enzyme products help break down grease on the floor and do not require large volumes of water for cleaning.
  - » Install drains close to areas where liquid discharges are expected.
  - » Use a squeegee to push water to the floor drain prior to the final rinse.
  - » Use pressurized, air-assisted spray nozzles to provide more cleaning force with less water.
  - » Reuse-reject water or process water from other parts of the facility for mopping, provided this complies with health regulations.



Landscape BMPs

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Landscape BMPs

Landscaped spaces in a HRHD development usually cover a considerable percentage of the development area, and consume large amount of water. Water consumption can be significantly reduced by adopting water-wise landscape practices. The following principles are recommended to create water-wise landscaped areas:

Water Wise Planning and Design

Proper planning during the design phase of any landscape project can significantly reduce water use by:

- Conducting a comprehensive site analysis to maximize benefits from local-climates, sun/shade exposures, topography, and wind protection.
- Employing Proper zoning of functions according to water use is essential. A minimum amount of water should be allocated for areas with the least amount of use, while highly visible areas can be given more water.
- Hydro-zoning of plants by using plant grouping according to water need.
- Utilizing appropriate mixes of hard and soft areas to minimize both water consumption and maintenance cost.

Soil Analysis and Improvements

Soil textures in Jordan range from clay loam mixtures to sandy soils. To improve your landscape soil:

- Add organic matter to soils before planting to increase their water holding capacity, and improve plant growth and efficient use of water.
- Avoid soil compaction, as it reduces water and air circulation in the soil.

Plant Selection

A wide range of low water-use plants is available in the market. The following needs to be considered when selecting appropriate water-wise plants:

- Group plants with similar water needs together
- Utilize only drought tolerant, native plants ,trees and deep rooting shrubs
- Less emphasis should be placed on small shrubs, perennials and groundcovers

Limiting Grass Areas

Grass areas consume high quantity of water and need excessive maintenance. For this reason the following practices are recommended:

- Limit the size of the grass areas and use it only to provide functional benefits.
- Use only drought tolerant grasses such as Bermuda or Paspalum.
- Prohibit the use of grass to provide a green appearance when groundcovers or low shrubs offer an acceptable alternative.

Efficient Watering

The most efficient water use practices include:

- Use efficient drip irrigation system for large landscapes
- For HRHD developments landscape, consider automated system for large landscapes if proper supervision by qualified staff could be guaranteed
- Use sprinkler systems only for turf areas
- Prohibit hose watering and watering using the hose of transport tanker
- Water in the early morning or late evening to maximize absorption and minimize evaporation
- Adopt your frequent irrigation to changes with the season and the local weather variables such as temperature, humidity, wind and hours of sunlight
- Consider grading and directing surface run-off and rainfall gutters to landscapes
- Consider alternative water sources for irrigation, including reused gray water and harvested rainwater. These alternatives are discussed thoroughly in Chapter 4 of this guide.

Use of Mulches

Mulches (organic or inorganic) should be applied at the base of all plants to retain soil moisture and reduce the growth of weeds

Maintenance Practices

Appropriate maintenance practices are essential to sustain your water-wise landscape and achieve the desired water savings and appearance. These practices include:

- Use proper pruning, weeding, and fertilizing methods.
- Establish a regular maintenance program for irrigation systems and checking for leaks and damaged equipment.

Saving Water Through Operational and Monitoring Processes

PART

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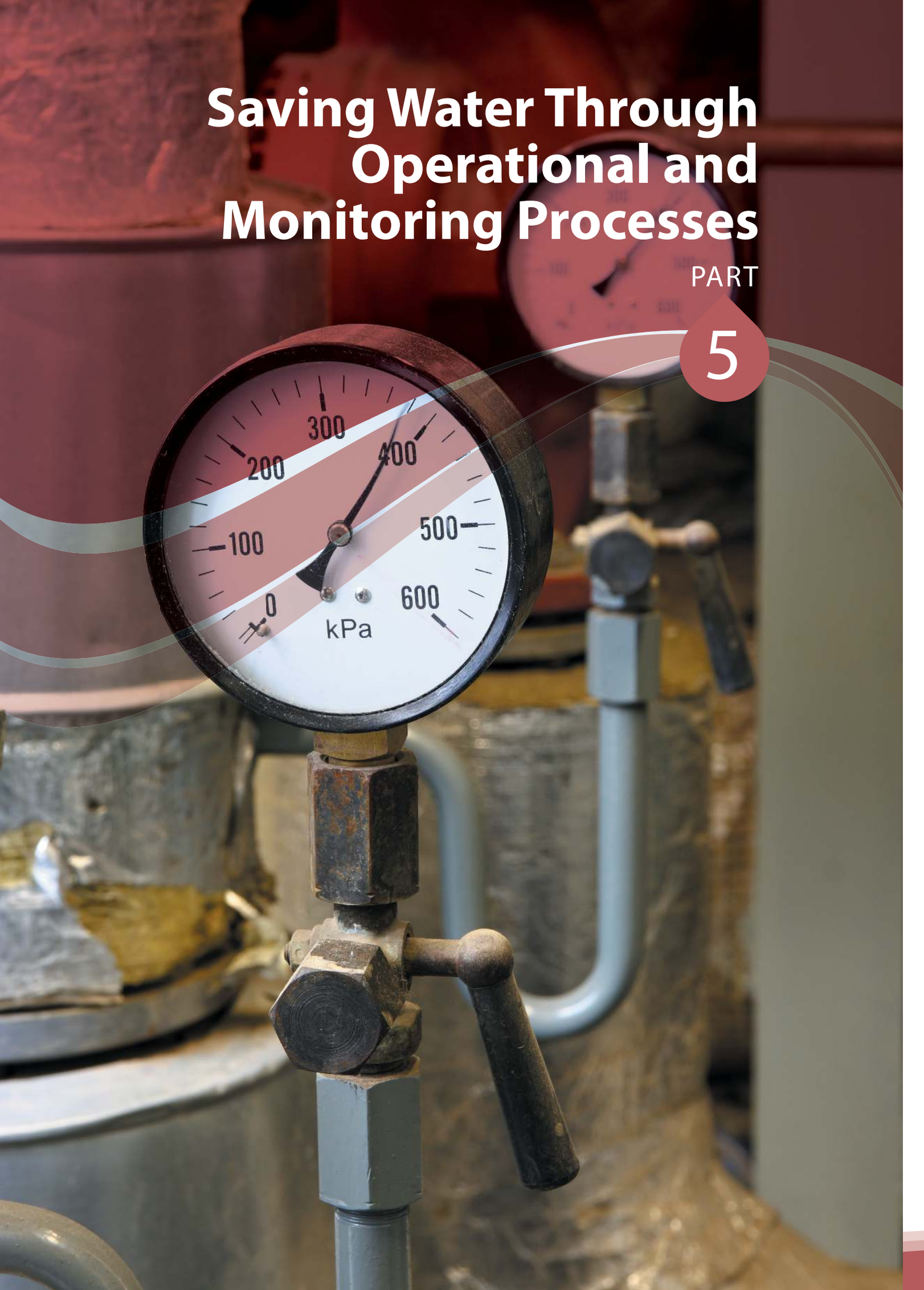

Saving Water Through Monitoring and Operational Procedures

Identifying and Fixing Leaks

Hidden water leaks can be wasting considerable water and energy without anyone being aware of it. Even what appears to be a small leak can amount to large volumes of water loss. Leaks become larger with time, and they can lead to other equipment failure. Fixing leaky pipe, toilet, faucet, or roof top tank will save you water and money. The establishment of a leak detection and repair program would be the most cost-effective way to save money and water in a facility. Here are best practices that are useful for establishing and benefitting from this program:

- Management is committed to providing the staff and resources needed to maintain plumbing fixtures and equipment on a regular basis and assuring prompt identification and repair of leaks.
- Repair staff is given the tools needed and is trained to make leak repair a priority activity.
- Staff is taught to report leaks and other water-using equipment malfunctions promptly.
- Staff is rewarded for success.
- Standard leak-repair equipment and parts are kept on hand so that repairs can be made without needing to wait for parts to arrive.
- Rooftop tank overflow or leakage water should flow to rainwater gutter system not to sewage system to allow detection of rooftop water loss.
- Records of the type, location, number, and repair of leaks are kept in a central location.

Water Metering and Sub-metering

Without accurate measurement tracking of your facility's water use, improving water efficiency is extremely difficult, if not impossible. Monitoring your water use allows you to know where and when water is being used and where your best opportunities for water savings exist.

Metering Water Supply

To accurately track your facilty's water use, it is essential to meter all your sources of water supply.

- Coordinate with the water utilty to ensure the utility's water meter is working properly.
- Install water meters to accurately measure each of your other sources of supply.
- Test all meters on a regular basis to ensure their accuracy.
- Keep track of and file electronically all your water supply records on a monthly basisis.
- Graph and analyze the data on a monthly basis to:
  - » Identify any abnormal increases due to leaks and any errors related to data reading and recording.
  - » Track water saving and evaluate your efficiency interventions.

Sub-metering Water Use

Track the volume of water used by sub-metering the major water-using equipment and processes within the facility. This includes any equipment or function (water treatment, kitchens, laundry, landscape, etc.) that uses a major portion of the facility's water and those that use more than ten cubic meters per day.

Specific water uses that should be sub-metered are:

- Water supplied to separate buildings.
- Hot and cold feedwater in laundry operations.
- Food service areas.
- Both the feed and product water from a reverse osmosis or other water treatment system.
- Steam boiler feed and condensate return.
- Hot-water boiler feed.
- Cooling tower makeup and blowdown, if any.
- Large evaporative cooling systems, if any.
- Separately leased spaces in the building.
- Swimming pools
- Landscape irrigation.

The following actions should be followed for data accuracy, recording, and analysis of the sub-metered water flows:

- Test all meters on a regular basis to ensure their accuracy.
- Keep track of and file electronically all the metered amounts on monthly basis.
- Graph and analyze the data on a weekly basis to:
  - » Quickly identify possible leaks, equipment malfuction, and any other data reading or recording errors.
  - » Track water saving and evaluate your efficiency interventions.

Pressure Management

Pressure management is an effective way to control the water pressure in buildings and reduce unnecessarily high flows, lessen leaks and pipe bursts, and improve the life of plumbing fixtures.

Other Procedures

The procedures and devices listed in this section are used to limit water losses during pipe ruptures, leaks, equipment failures, and other emergencies.

Emergency Shut-off Valve and Isolation Valves

These valves are extremely important. They are used to quickly shut off water flow when pipes rupture, connections leak, or equipment fails. This can help prevent major water damage. They also help isolate water use inside a building so the whole building does not have to be taken out of operation during repairs or replacement. These valves should be installed to isolate each critical water-use area in your facility such as restrooms, kitchen, laundry, swimming pool, etc. Valves should be clearly marked stating which portions of the facility they serve and should be accessible to appropriate staff.

Water-heater-temperature Pressure-relief Valves (TPRVs) and Relief Valves

TPRVs are found on the upper part of water heaters. They prevent the build-up of hazardous pressure by releasing water to an overflow pipe. Water-supply pressure should be within the range recommended by the manufacturer. The discharge from these valves should be clearly visible so leaks can be easily detected. These valves need to be inspected and tested every two months.

Backflow Preventers

Backflow preventers protect the water supply from contamination by sewer water and other sources of pollution. They prevent cross-contamination from cross-connections or when pressure is lost. Backflow preventers should be placed at clearly visible locations to facilitate leak detection, inspection, and testing by staff. They need to be inspected and tested on a regular basis.

Fire Protection System

The fire protection system includes on-site fire hoses and sprinkler systems. No flow should occur except in a fire emergency or testing. The system should have a method of recovering water used during periodic testing and flushing of the lines. It should be easy to inspect to ensure that any accidental connections to the water pipes have not been made. Fire system meters should be installed on all major fire-service connection lines.

Surge Tanks and Other Forms of Potable Water Storage

These tanks are important components of most building's water systems. They help store water for times when water service is not available and regulate pressure. They should have proper level controls to prevent overfilling or, in the case of pressure bladder surge tanks, over-pressurization. Overflows should be easily observed and some form of overflow indicator device should be used.

Alternative Water Sources

PART

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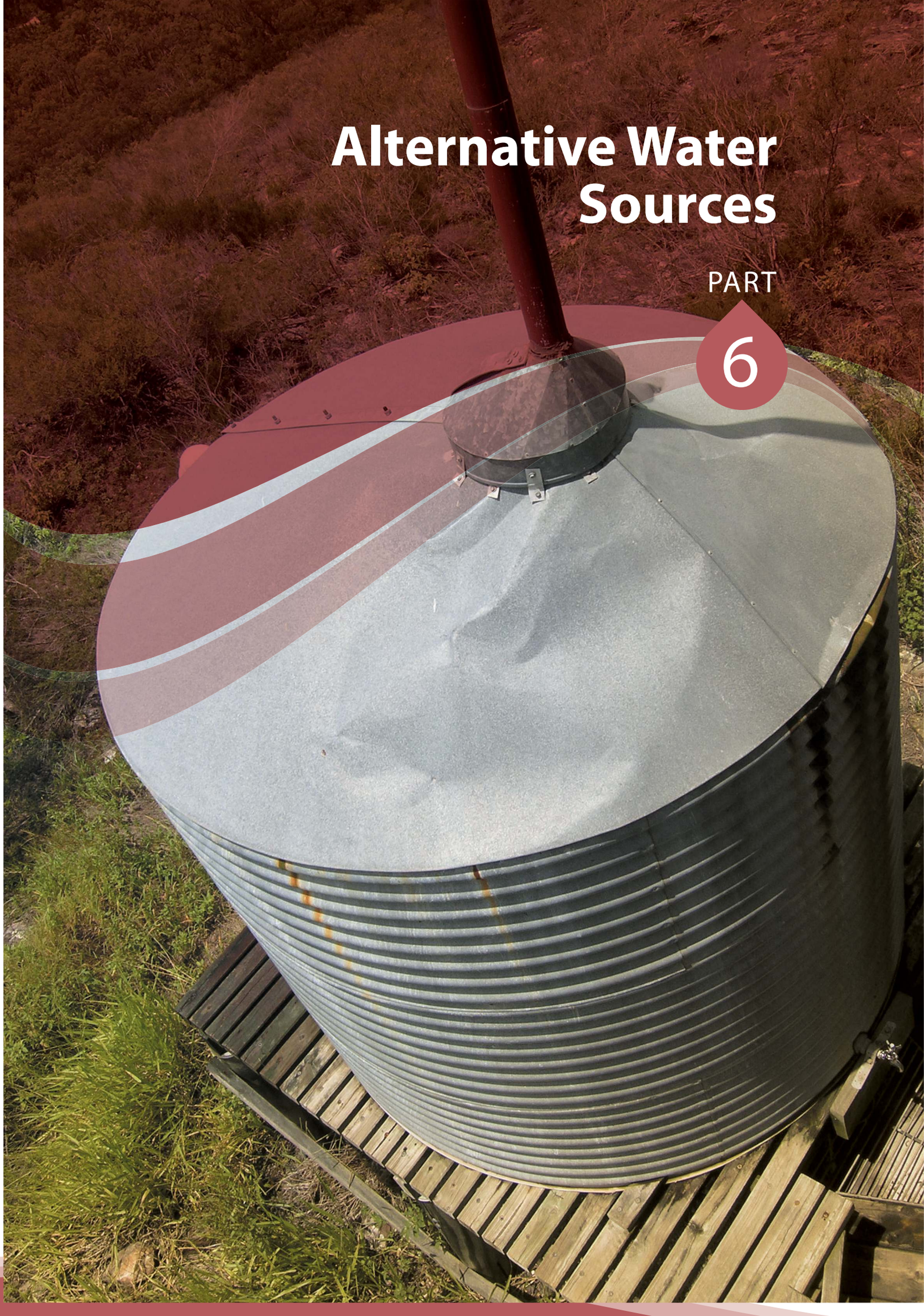


Rainwater Harvesting

Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, land surfaces, road surfaces, or rock catchments using simple systems such as pots, tanks, and cisterns. Rainwater harvesting has been used in Jordan since 850 BC. A number of distinctive historical examples that incorporate effective water-harvesting systems exist today in the country. These include the cut-stone reservoirs of the Nabatean city of Petra, as well as the underground cisterns found in the Umayyad desert palaces, Crusader-period castles, and traditional village houses. Most people neglected rainwater harvesting with the arrival of modern urban water supply. However, water scarcity and shortage during the past two decades revived interest in rainwater harvesting as an alternative water source and became part of the National Water Strategy. The Ministry of Public Works and Housing, in cooperation with the Ministry of Water and Irrigation, have recently included rainwater harvesting in the new water and sanitation plumbing code. This code illustrates where and how rainwater harvesting is feasible and cost effective. The reader is referred to this code for details related to feasibility of rainwater harvesting and design of rainwater collection systems. In what follows are guidelines specific to the use of the technology in building facilities.

How Much Rainwater Can You Capture?

High Rise and High-Density developments offer a great potential for rainwater harvesting at the level of the whole development or at level of a single facility. To maximize water collection, impervious (hard) areas other than rooftops such as paved or tiled open spaces, where feasible, can be considered for rainwater harvesting. The amount of harvested rainwater is directly related to the size of the impervious area and the average annual precipitation. Considering 80 percent rainwater collection efficiency, to account for losses due to evaporation, splash-out from gutters, and first flush diversion, the annual potential amount of harvested rainwater is calculated as follows:
Annual rainwater captured potential (m3) = Impervious area (m2) x annual rainfall (mm) x 0.80/1000

For instance, a HRHD development in Amman that receives 350 mm average annual rainfall and has 100,000 m2 of impervious area, the potential rainwater that can be captured is approximately 28,000 m3 per year. Potential rainwater harvesting in various Jordanian governorates, and for varying sizes of collection areas, are illustrated in the new water and sanitation plumbing code. The amount of rainwater storage that would be cost-effective to build is based on the monthly inflows of harvested rainwater, the monthly extracted water use, and the storage construction cost.

What is The Quality of Harvested Rainwater?

The quality of harvested rainwater is related to the rainfall area and the surface of the collecting area. Rainwater in an industrial area is more likely to collect airborne pollutants. Building roofs may collect contaminants like dust, leaves, bird feces, and even, occasionally, dead birds. Rainwater collected from paved areas contains significantly higher level of pollutants.
How do You Improve Your Harvested Rainwater's Quality?
Here are key recommendations to protect the quality of harvested rainwater:

- Install a "first-flush diverter device" between the roof downpipe and the rainwater storage tank to dispose of the first rainfall runoff collected by your roof.
- Install filtering screens and clean roofs on a regular basis to remove dust, leaves, bird feces, and other impurities to improve water quality and reduce the clogging of gutters and collecting systems.
- Clean tank water on a regular basis to reduce sediment deposits and water contamination.
- Add disinfecting agents such as chlorine to reduce biological contamination.
- Locate rainwater storage tanks far from contamination sources such as sewage networks.
- Regularly monitor storage-tank water quality to assess, especially, potential bacteriological contamination

Where Do You Use Harvested Rainwater?

If the above water quality protection recommendations are followed, harvested rainwater can be used in for watering landscape, laundry, toilets flushing, and floor cleaning.

Gray Water Reuse

Gray water[25] is untreated waste water that has not come onto contact with toilet waste, kitchen sink waste, dishwasher waste or similarly contaminated sources. Gray water includes waste water from bath-tubs, showers, bathrooms wash basins, clothes-washers and laundry tubs. The Ministry of Public Works and Housing, in cooperation with the Ministry of Water and Irrigation, have recently included gray water reuse in the new water and sanitation plumbing code. The reader is referred to this code which illustrates where and how gray water reuse is feasible. In what follows are some specifics related to gray water reuse in hotels.

How Much You Can Generate?

The amount of raw gray water varies with the type of building facility within the HRHD development. Based on the various audits conducted in Jordan, the percentage of gray water from the total water consumption is on the average around 83% for Mosques, 30% for homes, and 40% for hotels and 20% for hospitals. It drops to 30% for universities, 20% for schools and 17% for office buildings. To identify the optimum gray water potential in a building facility, a water audit needs to be conducted. Adjustments should be made to the gray water values in case of retrofit of the water fixtures and appliances. For a new facility, the gray water potential is based on the estimated flows of the fixtures in your showers, and bathroom faucets.

[25] Gray water defined according to the new water and sanitation plumbing code

How Much You Can Reuse?

The most common use of gray water is for toilet flushing and landscape irrigation. For HRHD developments, in building treatment and reuse is only possible in business activities such as Mosques, residential units, hotels, hospitals where there is enough gray water to meet the demands. Universities, schools, and office building do not generate enough gray water to meet their toilet flushing water needs, thus treated gray water in these facilities will only be limited to irrigation of landscape, if economically feasible. However, before deciding on the reuse options, you need to analyze the quality of the gray water and identify the contaminants it contains and determine the necessary treatment process, considering the health and environmental risks associated with gray water reuse.

The following precautions are recommended to prevent health and environmental risks, according to the gray water chapter of the new Jordanian water and sanitation plumbing Code:

- Exclude laundry water from soiled diapers or from any items soiled with feces or other excrements.
- Use treated gray water for landscape irrigation under the following conditions:

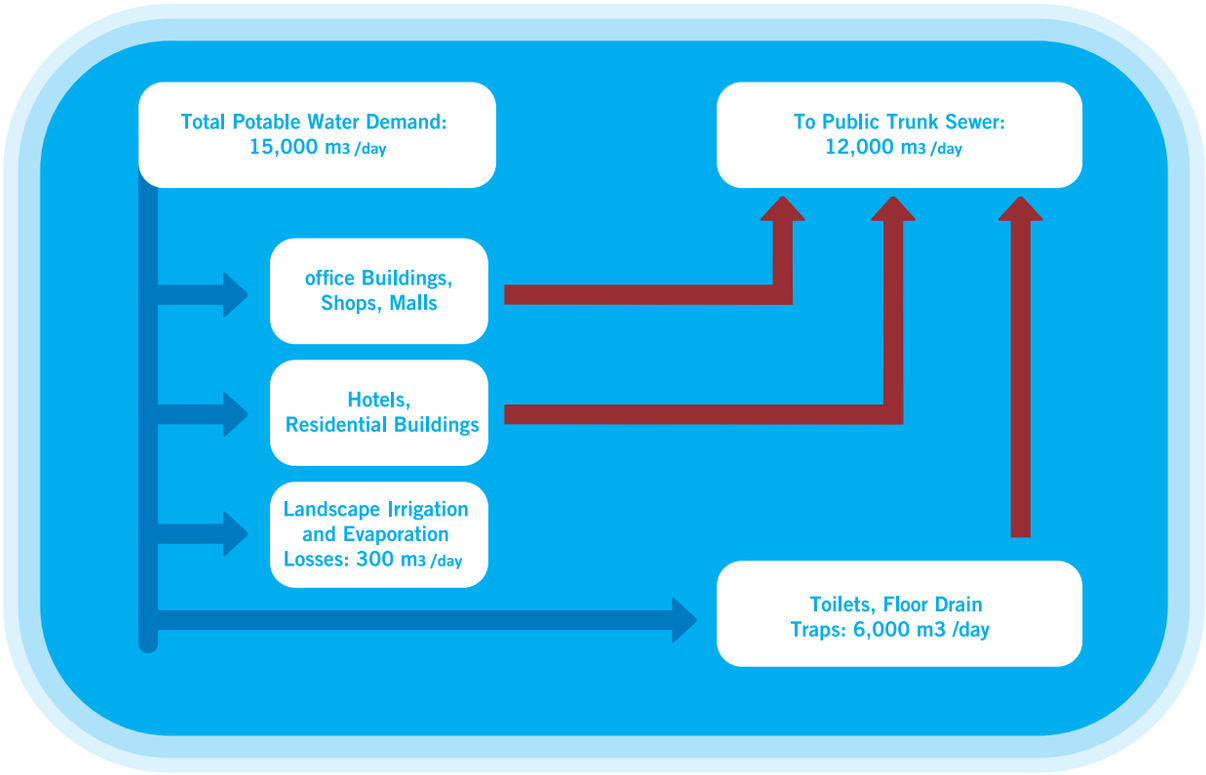
  - » Use showers and bathroom faucets gray water after on site primary treatment to remove hair and sediments, and disinfection to prevent risk of harmful bacteria
  - » Use subsurface irrigation, installed at least ten centimeters underground, to prevent human exposure to any potential pathogens.
  - » Avoid water logging your soil, do not irrigate after rain.
  - » Divert gray water that is not used for irrigation to the sewer system.
  - » Regularly monitor water quality and divert gray water to sewer system in case of water contamination or malfunction of treatment process.
- Do not use gray water for toilet flushing in health facilities to prevent infection risk due to pathogenic micro-organisms. Overload of pathogens may affect treatment process. Note that efforts are being made in Jordan to use advanced gray water treatment technology. This is currently done at the pilot level at the Dead Sea Spa Hotel. This exclusion may be reconsidered, if this scheme or any other future treatment technology compliant with the JSMO standards (Water-Reclaimed Greywater Reuse) is proven to prevent health risks.

Wastewater Reuse

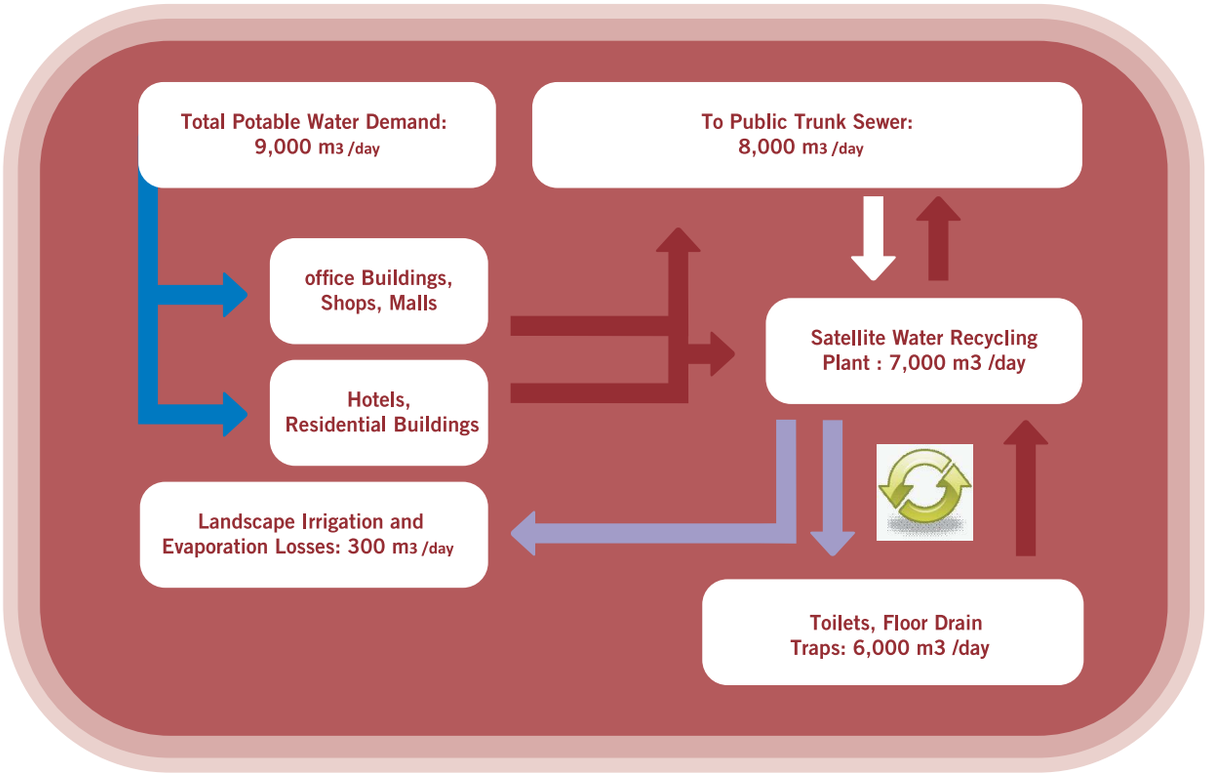
What treatment option?

Several wastewater reuse options were analyzed in the 2008-2009 study on water use and reuse efficiency in HRHD developments. The study used the Greater Amman Municipality (GAM) future HRHD development zone (Area C) as a pilot area. It recommended the construction of satellite treatment plants within the premises of HRHD developments. The satellite wastewater treatment and reuse was found to be the most cost-effective and environmentally superior water-demand reduction option. This recommendation has been adopted in the new water and sanitation plumbing code for Jordan. The satellite treatment option will result in 40% saving of water demand in Area C as illustrated in the following conceptual schematic diagrams showing water demand and water use without water recycling and with the satellite water treatment. A benefit-cost analysis of the satellite treatment case is presented in the cost effectiveness calculations section. For more details the reader is referred to the Area C report .

A conceptual schematic showing the flow of water under conventional and under water recycling systems is presented. Water demand volumes are based on the total water demand projected for Area C in the 2007 Amman Master Plan.



Schematic Diagram of Water Balance in Area C, without water recycling



Schematic Diagram of Water Balance in Area C with Satellite Water Recycling

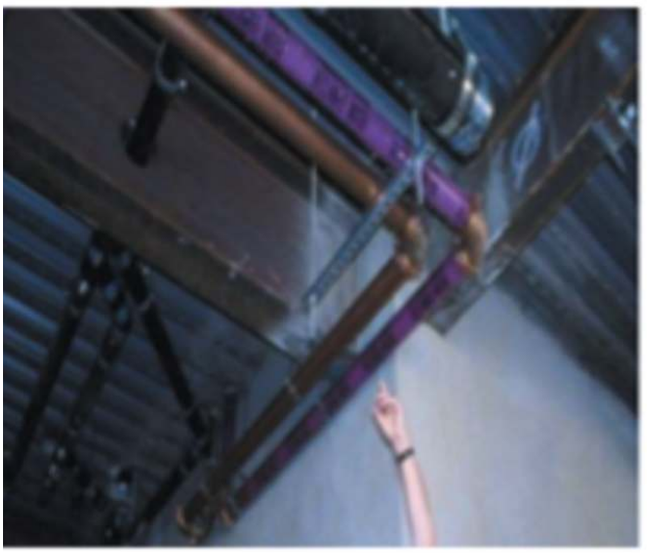
Reuse Recommendations

In addition to compliance with the Jordanian standards for wastewater reuse, it is recommended to take the following actions for reuse of treated wastewater in HRHD developments:

- Provide dual-plumbed infrastructure for water distribution for toilet flushing in newly proposed future developments. The infrastructure would be constructed with adequate horizontal and vertical separation from potable lines and from sewer lines. Color coding, markings, labeling, and signage should be provided. Inspections should be performed prior to covering the distribution system. Cross-connection control and backflow provisions should be instituted.

- Do not use treated wastewater for toilet flushing in health facilities to prevent infection risk due to pathogenic micro-organisms. Overload of pathogens may affect the treatment process. This exclusion may be reconsidered if tertiary wastewater treatment is proven to prevent health risks.

- Use treated wastewater for landscape irrigation under the following conditions:
  - » Use subsurface irrigation, installed at least ten centimeters underground, to prevent human exposure to any potential pathogens.
  - » Avoid water logging your soil, do not irrigate after rain.
- Regularly monitor water quality and divert wastewater to sewer system in case of water contamination or malfunction of treatment process.



Cost effectiveness Calculations

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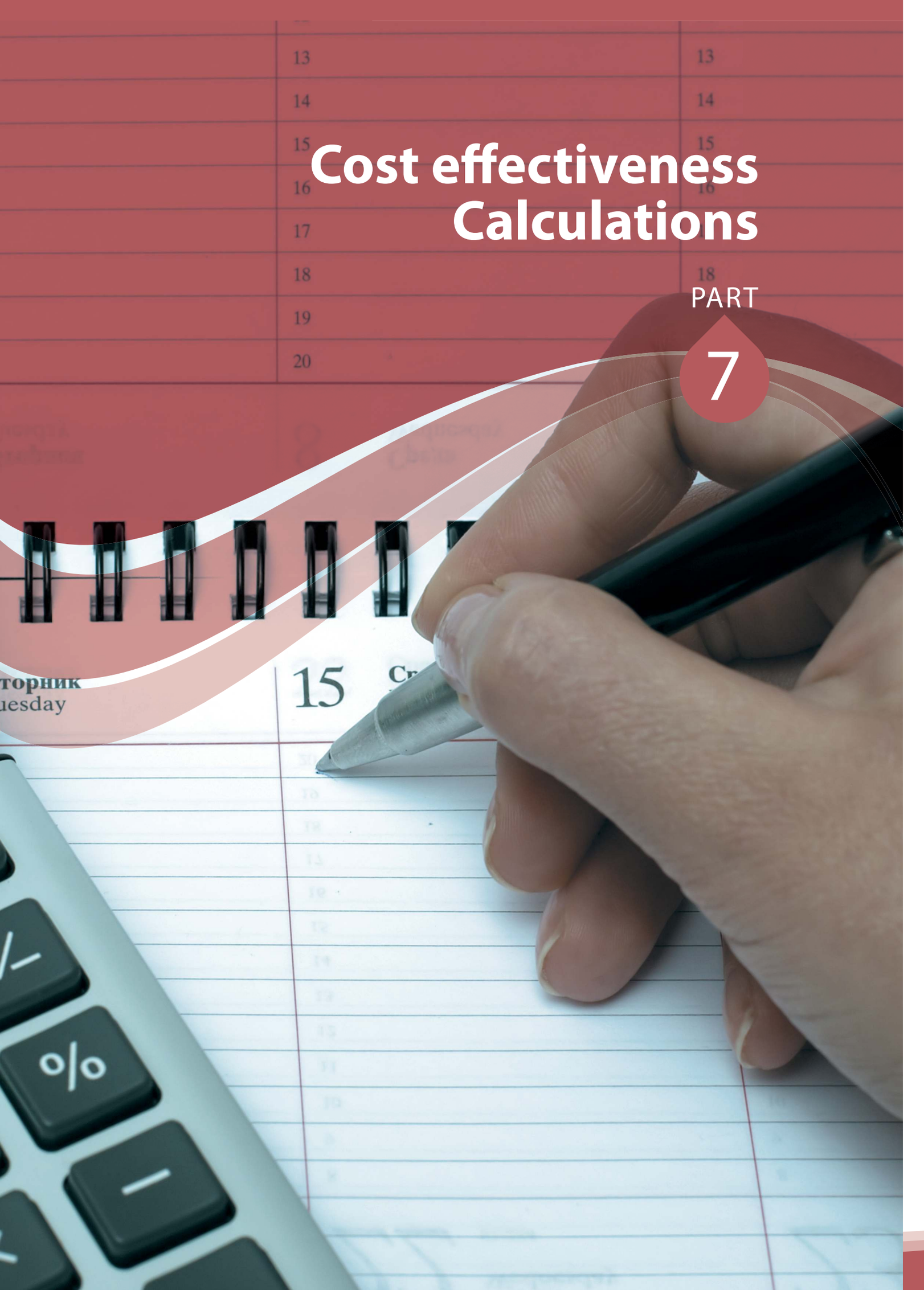

Cost-effectiveness for Selected BMPs

The way to build a strong business case for your water-use efficiency program is to carry out a cost-benefit analysis demonstrating investment cost, saving benefits, payback period, and cost benefit ratio. The following are examples of cost-effectiveness analysis for two BMPs, one for the satellite treatment plant BMP for a future HRHD development and one for a hotel plumbing fixture retrofit BMP in an old HRHD development.

Satellite Treatment Plant BMP

The satellite treatment plant will provide recycled water for toilet flushing, landscape irrigation, and other non-potable water uses in the future HRHD development in Area C. A preliminary[26] analysis of benefits and costs, using basic water and wastewater data from the 2007 Amman Master Plan, shows that the plant will reduce the fresh water demand for this future development by approximately 2.3 million cubic meters per year, as illustrated in the following table. This is equivalent to 3.6 million Jordanian Dinars (JD) savings in the water and wastewater bill. For details about the water and wastewater balance calculation and savings the reader is referred to the report on the Area C study[27].

Current and recommended water-use specifications for key plumbing fixtures and processes in Homes				
End Use	**Units**	**without Recycling**	**With Recycling**	**Savings (Benefit)**
Total Water Demand	m3/y	5,491,000	3,188,000	2,303,000
Cost of Water	JD/Y	5,491,000	3,188,000	2,303,000
Cost of Wastewater Treatment	JD/Y	3,361,000	2,057,000	1,304,000
Total Annual	JD/Y	8,852,000	5,245,000	3,607,000
Present Value of Savings Over 30 Years	JD			70,693,000

The estimated costs for the construction and operation of the satellite treatment plant and the treated wastewater distribution system are illustrated in the following table. The table indicates a very favorable benefit-cost ratio of 3.1 and a payback period of 6.4 years.

Size of Treatment Plant,m3/d	7,000
Cost of Treatment Plant, JD	12,825,000
Operation and Maintenance, JD/YR	192,375
Present Value, Treatment Plant O&M, JD	3,771,000
Cost of Distribution System, JD	5,000,000
O&M, Distribution System, JD	75,000
Present Value of Distribution O&M, JD	1,470,000
Total Cost of Water Recycling, JD	23,066,000
Benefit/Cost Ratio	3.1
Payback Period, Years	6.4

[26] The calculations are based on generalized assumptions and preliminary costs. They should be further refined before use as basis of design.
[27] Water Efficiency Recommendations for High Rise and High Density Developments including GAM area C

Jordanian Hotel Retrofit BMP

Facility Information

This hotel was constructed in the year 2000. It has 303 staff members and 268 rooms. The occupancy rate is estimated at 75% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The Hotel receives approximately 90 percent of its water and sewer service from the water utility and the remaining 10 percent is supplementary tanker water. The total water use is approximately 79,394 cubic meters per year.

Current Water Use

Based on the water audit, this hotel has 318 faucets, 268 showerheads, and 318 toilets. The average flow rates are around 7.7 liters/min for the faucets, 10 liters/min for the showerheads, and 8 liters /flush for the toilets. The water use profile illustrated in this section indicates that the water use for faucets, toilets, and showerheads represents around 57% of the total Hotel's water consumption. These fixtures annual use is around 45,254 cubic meters per year with 7,146 cubic meters for faucets, 23,818 cubic meters for showerheads, and 14,290 m3 for toilets.

Investment Cost

The retrofit program consists of an upgrade of the plumbing fixtures to meet the flow rates recommended in JSMO standards and the new water and sanitation plumbing code. These standards are, as mentioned in the best management section, 4.5 liters per minute for faucets, 7.6 liters per minute for showerheads and 4.0 liters per flush for the dual-flush toilets. The total investment cost is JD 9,415 including JD 795 for retrofitting 318 faucets, JD 670 for retrofitting 268 showerheads, and JD 7,950 for replacing flushing system (trim) for 318 toilets as shown in the calculator presented in this section.

Benefits

The expected benefits include saving of 15,860 cubic meters of water per year, which is equivalent to 20 percent reduction in water use. This would result in approximately JD 23,800 reduction in the water and wastewater bill, and JD 9,400 in energy saving. Details for water and financial savings are shown in the calculator.

Payback Period and Benefit-Cost Ratio

The payback period and benefit-cost ratio presented in the calculator show that the retrofit of faucets, showerheads, and toilets is a highly profitable water-use efficiency measure. You only need 15 days to recover your showerheads' retrofit cost, 1.4 month to pay back the money for retrofitting your faucets, and a maximum of 9 months to get back your toilets' retrofit cost. The benefit-cost ratios are 96 for showerheads, 34.8 for faucets, and 5.5 for toilets.

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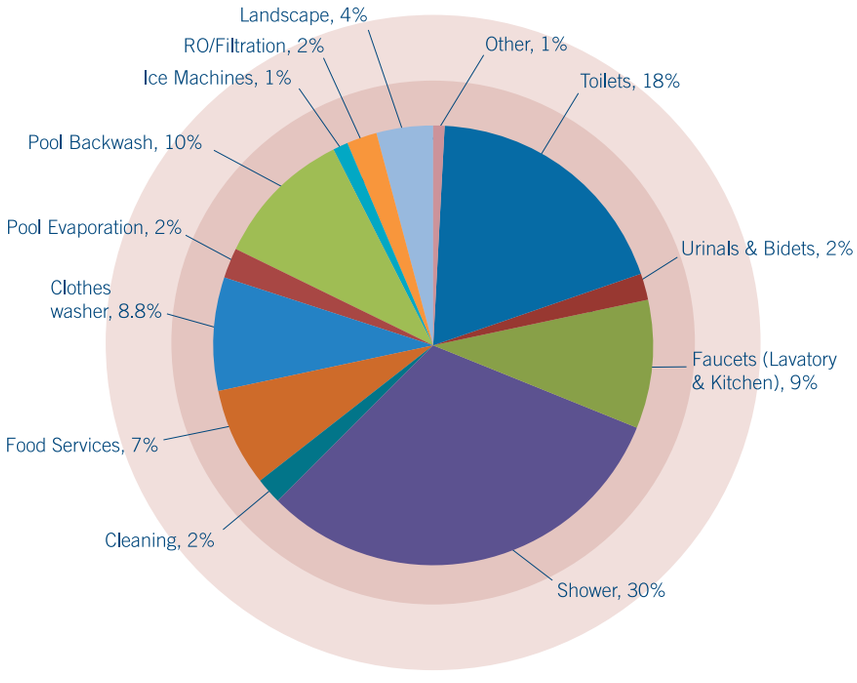


Water use profile for the Hotel

	Cost Effectiveness Calculator				
		Toilets	**Faucets**	**Showerheads**	**Formula**
a	Average flow rate of existing fixtures (baseline water use)	8 Liters/Flush	7.7 Liters/min	10 Liters/min	
b	Percent of water use (%)	18	9	30	
c	Annual consumption (m3)	14,291	7,145	23,818	c=b x annual consumption =b x 79,394 m3
d	Average flow rate of retrofitted fixtures (benchmark water use)	4.0 Liters/ Flush	4.5 Liters/min	7.6 Liters/min	
e	Number of fixtures	318	318	268	
f	Cost of retrofit for each fixture (JD)	25	2.5	2.5	
g	Total cost of retrofitting (JD)	7,950	795	670	g=e x f
h	Percent of saving per fixture	50	42	24	h= (a – d)/a
i	Average annual water savings (m3)	7,146	3,001	5,716	i= h x c
j	Average annual savings[28] in water and wastewater (JD)	10,719	4,502	8,574	j= 1.5 x i
k	Percent of water heated	0	30	50	
l	Annual energy savings[29] (JD)	0	2,251	7,145	l= k x l x 2.5
m	Total annual savings (JD)	10,719	6,753	15,719	m=l+j
n	Discounted benefits over life time[30] of fixture (JD)	43,950	27,688	64,451	
o	Benefit-cost ratio	5.5	34.8	96	O=n/g
p	Payback period	9 months	1.4 month	15 days	r=g/m

[28] Water supply and wastewater tariff = JD1.5/m^3
[29] Cost of energy (Diesel) per heated cubic meter of water = JD2.5/m^3
[30] Life time of each fixture is 5 year, and 7% return rate

International Experience

PART

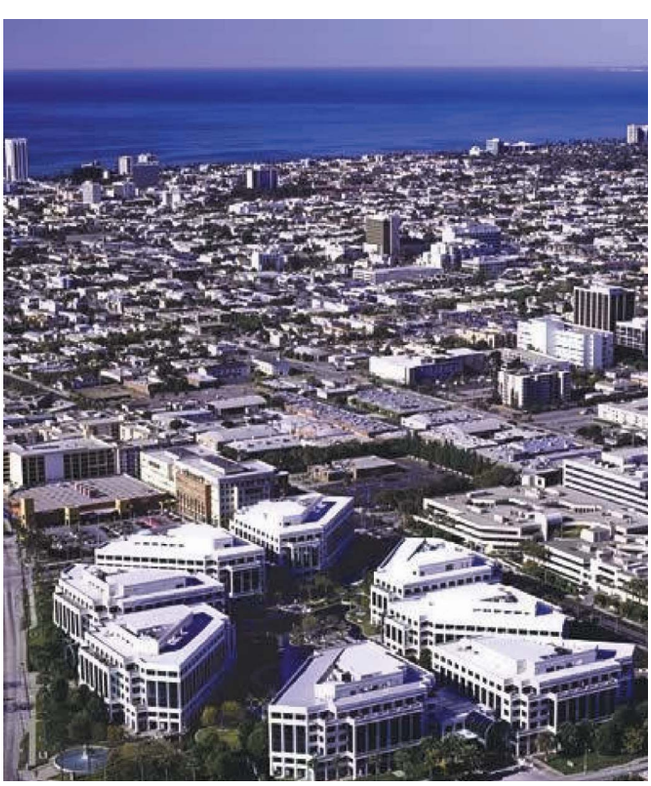
8

City of San Francisco

Park Merced high rise residential apartments were recently renovated and expanded. The building owner will reduce average per unit consumption of potable water from 273 liters per capita per day (lpcd) to 167 lpcd (39 percent) by installing 6 liters /flush toilets in addition to water efficient faucets, showers, and laundry machines in both new and existing units.

Santa Monica, California, USA

The Water Garden is a high-density suburban office complex situated on 7 hectares. The project is comprised of six 6-story glass towers and two 5-story glass towers totaling 127.000 m2 of office space with three levels of subterranean parking. The Water Garden, which offers landscaped private balconies adjacent to many tenant suites, was built in two phases. Phase I was built in 1990 and Phase II in 2000. All wastewater from this complex is treated at a membrane-based treatment plant built into the basement of one of the buildings. Recycled water from this plant is used for toilet flushing, fountains, pools, and landscape irrigation around the complex.



New York City, New York, USA

The Solaire Building is a 293 unit luxury-residential high rise located in Manhattan's Battery Park City. It is built to LEED platinum standards and stands out as the model for the decentralized water reuse concept. Among other sustainability features, this 27-floor building features complete water recycling system and rainwater catchment, treatment and reuse system built into the basement, with the recycled water piped to supply all toilets and other non-potable water-using fixtures. It has been operating successfully since 2004 and it demonstrates a 48% reduction in potable water consumption and a 60% reduction in waste discharge based on actual readings.

There are now three additional residential water reuse projects in Manhattan that followed suit and one commercial building, the LEED Platinum Bank of America building, which are all operational. Three additional systems are under construction or design presently bringing the total to eight decentralized water reuse systems in New York City by the end of 2009. It is clear that The Solaire set a new ceiling exemplifying the attributes of decentralized water reuse and more recent projects are raising that bar even higher by:

- Employing new non-potable water uses such as laundry supply in addition to cooling towers, irrigation and toilet flushing
- Adopting lower energy concepts that employ gravity distribution in segmented pressure zones throughout high rise buildings
- Incorporating storm water more effectively to lower treatment costs"

Tokyo, Japan

The Tokyo Metropolitan Government Center, located in the world-famous Shinjuku District of the City of Tokyo, is comprised of several high-rise buildings. All these buildings receive recycled water from a decentralized (satellite) treatment plant serving the Shinjuku District, for flushing toilets and urinals and for other non-potable uses in the buildings and surrounding areas. These systems have been operational for at least ten years, are extremely well maintained and have been a model for many other water recycling systems throughout Japan.

Some Japanese cities set a guideline to require building owners to install water recycling and dual distribution systems for newly proposed buildings of certain floor space and/or water demand:

- Building with floor space greater than 5,000 m2 or installed water supply pipe diameter of greater than 50 mm, and
- Building with floor space greater than 3,000 m2 or potential demand of reclaimed water greater than 100 m3/day.

Berlin, Germany

In October 1998, rainwater harvesting systems were introduced in Berlin as part of a large scale urban redevelopment, the DaimlerChrysler Potsdamer Platz, to control urban flooding, save city water and create a better micro climate. Rainwater falling on the rooftops (32,000 m2) of 19 buildings is collected and stored in a 3500 m3 rainwater basement tank. It is then used for toilet flushing, watering of green areas (including roofs with vegetative cover) and the replenishment of an artificial pond.

Burj Dubai, UAE

Burj Dubai, the tallest building on the face of the planet, is standing at least 160 stories high.

Housing a staggering 1,000 condos, an Armani hotel, 57 elevators, and a slew of other amenities, Burj is a symbol of luxury and excess. However, it has some notable green features such as an 11-hectare green oasis surrounding the foot of the tower which will be irrigated using an innovative condensate collection system. Condensation from the building's cooling equipment will be recovered providing approximately 57,000 m3 of water a year. This is certainly helpful when you are operating a gigantic tower in the desert.

1 Bligh Street, Sidney, Australia

1 Bligh Street is a new development in Sydney's legendary Darling Harbour that is taking the term 'wastewater' head on. 1 Bligh Street doesn't waste anything. The iconic new building in Sydney's skyline is setting a new standard for green buildings. Much of the zeal surrounding the property is related to the onsite black water treatment system that is meeting all the building's non-potable water needs by supplying water for toilets and cooling towers. In addition to the black water system that supplies 90% of the building's water demand, the building hosts a double skin façade that reduces electricity consumption up to 50%, and a tri-generation plant that produces 25% of the building's energy.

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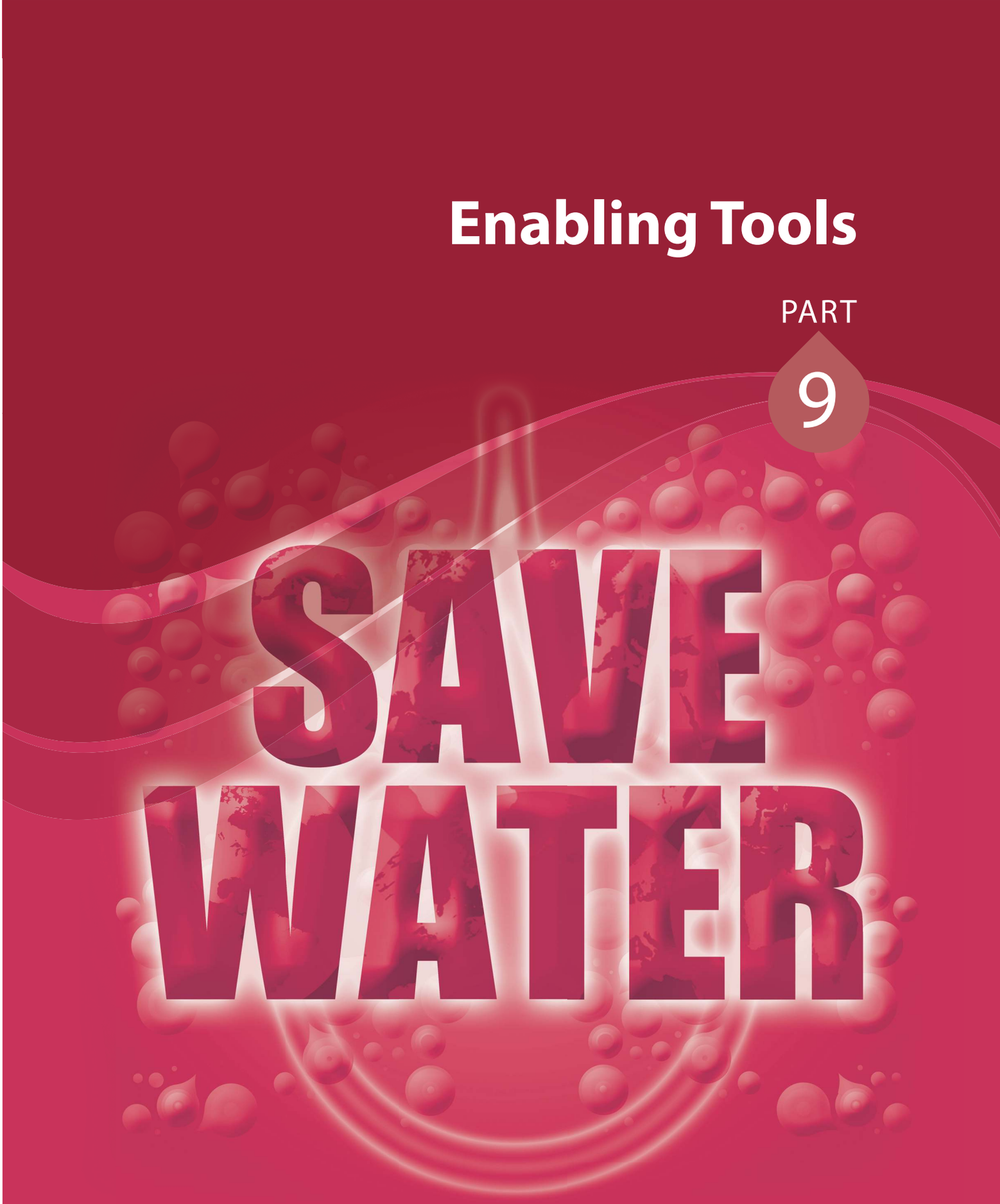
Enabling Tools

PART

9



How to Implement HRHD Best Management Practices

This section provides you with a comprehensive set of policy, institutional, management, and economic tools that will help you develop and implement water-saving measures and programs based on best management practices. These tools are based on more than a decade of Jordanian experience in water-demand management, including the Instituting Water Demand Management Program (USAID-IDARA) that received the Global Distinction Award from the Global Water Intelligence, as the largest and most comprehensive water efficiency initiative in the world in 2010.

Policy, Codes, and Regulations

Jordan is the first country in the region to develop a comprehensive water-demand management policy, which was prepared in 2008 by public and private stakeholders to promote efficient water use. This policy paved the way for the following developments, which are relevant to HRHD developments water-use management:

- Preparation of a new standards for sanitary fixtures and water using appliances by in JSMO
- Preparation of a new water and sanitation plumbing code that includes a separate chapter on plumbing code for HRHD developments. The chapter covers technical regulations for water efficient plumbing fixtures, appliances, devices, and processes in addition to provisions for managing water and wastewater within HRHD developments, including the establishment of satellite treatment plant.
- Establishment of a water-efficiency laboratory at the Royal Scientific Society to test the locally manufactured and imported water and sanitation plumbing fixtures and appliances for compliance with JSMO standards that save you water, energy, and money.
- Creation of Master Plumber certification and training program that provides plumbers with the qualification and capacity building for installation of water-efficient fixtures, appliances and equipment in existing or new buildings according to the new water and sanitation plumbing code instructions.
- Promotion of research and development in water-use efficiency to inform water users of new developments of technologies and best practices that promote water saving.

Institutional Support

Water-use efficiency has been instituted at the national and water utility levels. Here are the key entities and program that can support you:

- The Water-Demand Management Unit (WDMU) was established in 2002 at the Ministry of Water and Irrigation (MWI) as the entity that promotes water-use efficiency nationwide. The WDMU will assist you on any advancement in water conservation in the HRHD developments.
- Water Utilities: Miyahuna, Aqaba Water (AW), and Al Yarmouk Water (ex. NGWA) have developed Water-Use Efficiency Plans (WUE) to support implementation of water conservation programs in their respective service areas. They will be able to assist in the identification and implementation of water-efficiency measures in HRHD developments. They have a state-of-the-art tracking tool that helps in assessing potential water-saving opportunities with potential amount of water saving, associated energy saving, cost-benefit analysis, and recovery period for each one of your interventions such as installation of water-saving devices for faucets and showers, toilet replacement, implementation of water and sanitation code, etc.
- King Abdullah II Center for Excellence has included water- and energy- efficiency among its award criteria for all public and private institutions entering the competition. This provides institutions with an incentive to save water, energy, money, and win the award, which make them stand out from their competitors.

Management of water supply and water reuse

Management of water supply and reuse in HRHD developments is essential in achieving long-term sustainable saving objectives. The new water and sanitation plumbing code recommends the establishment of a management company to be in charge of the management of water supply, wastewater treatment and reuse in HRHD developments. The management company can be a public, private, or public-private new institution. The responsibilities assigned to the company would include:

- Potable Water Supply
- Wastewater Management
- Stormwater Management
- Production and Distribution of Recycled Water and/or Treated Gray Water
- Management of Excess Treated or Untreated Wastewater, Wastewater Solids, and Treatment Reject Waters
- Coordination and Management of Water Conservation Efforts
- Metering and Billing Consumption of Potable Water, Recycled Water, and Wastewater Discharges,
- Monitoring for Compliance with Safe Use of Recycled Water and Maintenance of Water Conserving Features
- Repair and Maintenance of Water-Related Structures
- Record Keeping and Reporting
- Public Relations and Outreach

For more details about specific tasks under each responsibility and scenarios for establishing the management company the reader is referred to the Area C report[31].

[31] Water Efficiency Recommendations for High Rise and High Density Developments including GAM Area C

Code Recommendations

PART 10

	Water Efficiency Measure	Criteria for Measures
1	Satellite Recycled Water System	Treat all of wastewater at an onsite central treatment plant and use disinfected tertiary recycled water as water source for toilet and urinal flushing, landscape irrigation and other non-potable uses.
2	In-Building Water Recycling	If a Satellite Recycled Water System is not feasible, install and use systems that collect, store and, where necessary treat, rainwater, gray water, condensate and wastewater for various non-potable purposes including toilet and urinal flushing.
3	Create Management Company for the HRHD Area	A management company would build, operate, and manage the satellite water recycling system, manage the potable water system including a central storage tank, monitor, inspect, and document each building regularly for compliance with codes, meter and bill customers, and assume other responsibilities.
4	Prohibition of Water Cooled-Air Conditioning	Cooling towers that evaporate water shall be prohibited for district cooling plants
5	Dual Plumbing	New buildings and facilities shall be dual plumbed for potable and recycled water systems. Recycled water from an external source would be used for non-potable demands.
٦	Automatic Vehicle Wash Facilities:	All source water shall be recycled water. In addition, recycle water from previous vehicle rinses in subsequent washes. The station shall be designed so no water runs off the site.
7	Landscaping Regulations	• A regulation will be adopted to require all landscapes to be designed and maintained in accordance with Water Wise Landscaping Principles. • Landscapes including parks and medians, gardens, and potted plants shall be irrigated with non-potable water • Ponds, fountains and decorative water features shall use recirculating water systems.
8	Prohibition of Potable Water Storage Systems Except for Tall Buildings	The Management Company will have a central storage facility and therefore, individual storage systems shall be prohibited to protect water quality and avoid water loss through leaking storage tanks, except in the case of tall buildings where the line pressure is not sufficient to move water to the top floor and a supplemental pump and storage system is required.
9	Tanker Water	Tanker water will be discouraged inside the development except in an emergency to protect water quality in the potable water system and ensure usage of recycled water from the satellite plant for non-potable purposes.
10	Meter Customer Water Consumption and Bill Each Customer for Water Use	• All buildings, apartments, villas shall be individually metered • If there is more than one customer within a commercial or residential building, meters or submeters shall be installed for each tenant within the building. • Bill each customer based on the metered volume of water consumed.
11	Install Submeters to Manage Water Use	Submeters shall be installed on major water using equipment for hotels and hospitals so water use for that area or process can be monitored and leaks and other malfunctions may be identified. Submeter locations will include: • laundry operations • swimming pools and spas • food service & kitchens • irrigation systems • separate water heating systems • makeup/feed water for blowdown water from cooling towers and boilers • condensate return lines to boilers • kidney dialysis water treatment systems • water treatment system and for the reject water • other types of water using equipment or process that consumes water Connect meters and submeters to a central data or computer system. Maintain record and monitor water use on a daily basis to identify any water waste that is taking place.

12	Control Maximum Pressure within Buildings	When static water pressure in a building exceeds 3.0 bars, an approved type of pressure regulator and pressure relief valve shall be installed and properly maintained by the customer so that the water pressure is reduced to 3 bars or less.
13	Water Waste Regulations	Regulations will need to be adopted requiring the following types of water efficient practices, with significant fines for violations. • All cars shall be washed (except at commercial carwash facilities) in areas where the runoff is captured and used for irrigation. • Hoses shall have shutoff devices installed • Sidewalks, streets and parking lots shall not be washed using hoses. • Shutoff valves shall be maintained in water storage tanks so that tanks do not overflow • Faucet, service line, or other type of leaks shall be fixed immediately • Irrigation systems water waste prevention: a. Prohibition of irrigation during daylight hours from June to September for all automatic irrigation systems b. Prohibition of runoff (caused by irrigation) into the street, driveway or sidewalk
14	Prohibition of Green Roofs	Green roofs shall be prohibited unless Water Wise landscaping principles are followed and all irrigation is with non-potable water.
15	Plumbing Fixtures	• Toilets shall be dual flush models with a maximum average flush volume of 6/3 liters per flush). • Pressure assist toilets shall have a maximum flush volume of 4.0 liters per flush. • Single flush toilets with a maximum flush volume of 6 liters per flush. • Urinals shall have a max. flow of 1.9 liters/flush, or shall be zero water consumption urinals. • Showerheads shall have a maximum rated flow of 7.6 liters per minute at 3 bars. • Self-closing faucets with preset flow times shall be installed on lavatories intended to serve the transient public and shall deliver not more than 1.0 liters of water per use. • Maximum flow rate and consumption of not-metered faucets for public lavatory shall not exceed 4.5 liters/min at 3 bars. • Faucets for homes and hotel guest rooms shall not exceed a flow of 4.5 liters/min at 3 bars. • Residential kitchen faucets shall not exceed a maximum rated flow of 8.3 liters/min at 3 bars.
16	Residential Appliances	• Clothes washers shall have a water factor not to exceed 8.75 liters per kilogram of wash load • Dishwashers shall use less than 24 liters per load (Standard) and 16.7 liters per load (Compact).

17	Food Service Equipment	• Commercial kitchen hand washing faucets shall not exceed 4.5 liters per minute • Ice making machines shall be air-cooled, Water-cooled ice machine are prohibited • Commercial refrigeration shall be air-cooled, or if water-cooled, shall have a closed looped system. No once-through, single-pass systems are permitted. • Combination ovens shall not consume more than 38 liters/min in the full operational mode. • Food Steamers shall be boiler-less or self–contained models where applicable. • Pre-rinse dishwashing spray valves shall have a maximum rated flow of 6.0 liters/minute or less. • Dipper wells shall have an in-line flow restrictor limiting flows to no more than 3 liters per minute. • Commercial dishwasher conveyor type: o high temperature sanitizing machines shall use not more than 2.6 liters per rack o chemical sanitizing machines shall use not more than 2.3 liters per rack • Commercial dishwasher door type: o high temperature sanitizing machines shall use not more than 3.6 liters per rack o chemical sanitizing machines shall use not more than 4.4 liters per rack • Commercial dishwasher under-counter type: o high temperature sanitizing machines shall use not more than 3.4 liters per rack o chemical sanitizing machines shall use not more than 3.7 liters per rack
18	Imported Medical and Laboratory Equipment 6	• Dry vacuum pumps shall be used, unless fire and safety codes for explosive, corrosive or oxidative gasses require a liquid ring pump. • The most water-efficient steam sterilizers available shall be used. • Digital imaging and radiography systems shall be used instead of water-consuming film development. • Where large-frame x-ray films of more than 150 mm in either length or width are required, use film processor water recycling units shall be used.
19	In-Building Potable Water Treatment Systems 6	• Use the most efficient water treatment systems available for all filtration processes. Pressure gauges shall be used to determine and display when to backwash or change cartridges. • For all ion exchange and softening processes, recharge cycles shall be set by volume of water treated or based upon conductivity or hardness. • Reverse osmosis (RO) equipment shall reject not more than one liter of water for every one liter of permeate produced for water softening. • Reject water from RO systems shall be reused, either with or without additional treatment as required, for appropriate uses such as laundry and landscape irrigation.

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