

# OFFICE BUILDINGS

WATER EFFICIENCY  
GUIDE



*Water is Life..*



# Forward

As the fourth most water-impooverished 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 a 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 as 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, office buildings, and landscaping, as well as a guide for communication.

The introduction of this office buildings water efficiency guide to the governmental and private sectors will help them benefit from the best practices and technologies for water-use efficiency in both existing and new office buildings.

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# Contents

|  |           |
|--|-----------|
| Foreword   |           |
| Acknowledgements   |           |
| Introduction   |           |
| <b>Part 1: Understanding your water-use</b>              | <b>7</b>  |
| Why Save Water in Office Buildings?                      | 8         |
| It Saves you Money                                       | 8         |
| It Helps you Gain National and International Recognition | 8         |
| It is a Noble National Cause                             | 8         |
| A Snapshot of Office Buildings Water-use in Jordan       | 8         |
| Where and How Much Water is Used?                        | 8         |
| Water-use Baselines versus Water-use Benchmarks          | 9         |
| Where and How to Save Water?                             | 9         |
| Office Buildings Water Audit                             | 10        |
| <b>Part 2: Best Management Practices</b>                 | <b>12</b> |
| Defining Best Management Practices                       | 13        |
| Saving in Indoor Water-use                               | 13        |
| Faucets  | 13        |
| Toilets  | 13        |
| Trigger Sprays, Bidets, and Urinals                      | 14        |
| Food Services  | 14        |
| Cleaning Operations                                      | 15        |
| Saving in Outdoor Water-use                              | 15        |
| Landscape  | 15        |
| Water-wise Planning and Design                           | 15        |
| Soil Analysis and Improvements                           | 16        |
| Appropriate Plant Selection                              | 16        |
| Limiting Grass Areas                                     | 16        |
| Efficient Watering                                       | 16        |
| Use of Mulches   | 16        |
| Maintenance Practices                                    | 16        |
| Saving Water Through Monitoring and Operational Process  | 16        |
| Identifying and Fixing Leaks                             | 16        |
| Water Metering and Sub-metering                          | 17        |
| Pressure Management                                      | 17        |
| Other Procedures   | 18        |

|   |           |
|---|-----------|
| <b>Part 3: Cost-effectiveness Calculations</b>        | <b>19</b> |
| Cost-effectiveness for Selected BMPs                  | 20        |
| Identify the Investment Cost                          | 20        |
| Identify the Benefits                                 | 20        |
| Calculate the Payback Period and Benefit-Cost Ratio   | 20        |
| Case Study: A Jordanian Office Building               | 21        |
| Facility Information                                  | 21        |
| Current Water-use                                     | 21        |
| Investment Cost                                       | 21        |
| Benefits  | 21        |
| Payback Period and Benefit-Cost Ratio                 | 21        |
| <b>Part 4: Alternative Water Sources</b>              | <b>22</b> |
| Rainwater Harvesting                                  | 23        |
| How Much Rainwater Can you Capture?                   | 23        |
| What is The Quality of Harvested Rainwater?           | 23        |
| How do you Improve Harvested Rainwater's Quality?     | 23        |
| Where do you Use Harvested Rainwater?                 | 23        |
| Gray-water Reuse                                      | 24        |
| How Much you Can Generate?                            | 24        |
| How Much you Can Reuse?                               | 24        |
| Wastewater Reuse                                      | 24        |
| <b>Part 5: Enabling Tools</b>                         | <b>25</b> |
| How to Implement Office Building Water-use Efficiency |           |
| Best Management Practices                             | 26        |
| Policy, Codes, and Regulations                        | 26        |
| Institutional Support                                 | 26        |
| Steps For Successful Management of a                  | 27        |
| Water-use Efficiency Program                          |           |
| <b>Part 6: Water-saving Checklist</b>                 | <b>28</b> |

# Introduction

Government and commercial office buildings are among the large water consumers in Jordan. Water audits in twelve of these facilities show that significant water and money savings can be made by adopting best practices for water-use efficiency. This guide was developed to help government and commercial office buildings to be water efficient. It provides owners, managers, developers, planners, designers, builders, water providers, operators, and staff with water efficiency best practices that apply to both existing and new office buildings.

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. A list of tips and technologies for best management practices are provided for indoor and outdoor water uses including water use in common areas, offices, cafeterias and kitchens, heating, cleaning, and landscaping. 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 introduced, including the policy, code, and regulations that make water-use efficiency possible, the various public and private institutions that support water conservation, steps for successful management of a water-efficiency program, and a comprehensive water-saving checklist<sup>1</sup>.

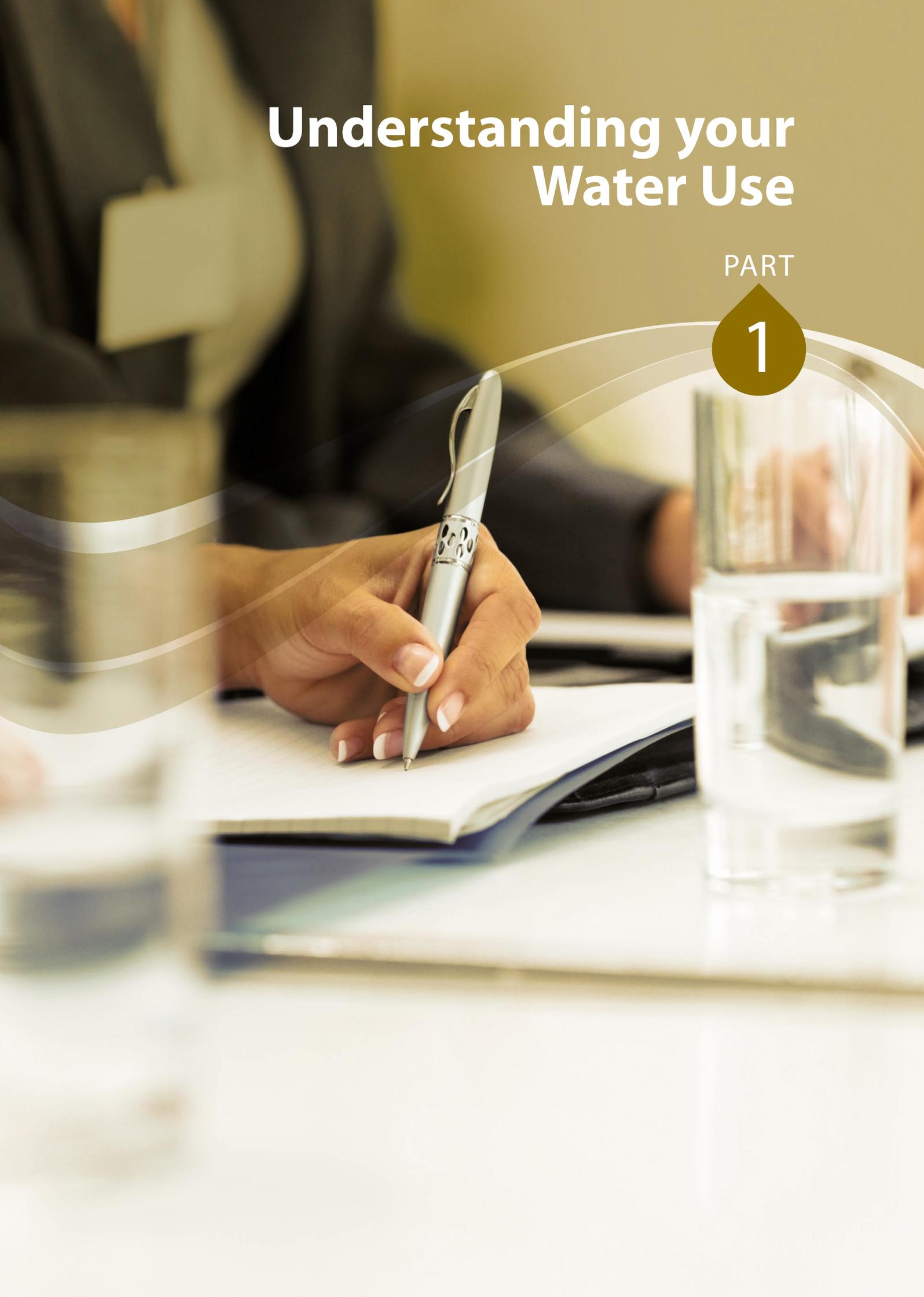
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<sup>1</sup>Since technology changes over time, the information in this guide needs to be updated periodically.

# Understanding your Water Use

PART

1





## Why Save Water in Office Buildings?

### It Saves you Money

Saving water means reducing your water and wastewater bill. It also means reducing your energy bill because you will pump less water, heat less water, and have more water recycling for heating. Water savings will lower treatment costs and capital costs by 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 prestigious King Abdullah Center of Excellence Award, which includes water-efficiency as a key sub-criterion. It also prepares you to qualify for national and international green building certifications. These awards and certifications put you at the vanguard of the competition.

### It is a Noble National Cause

Every drop of saved water provides an opportunity for increased supply for 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 the public and private sectors and all citizens.

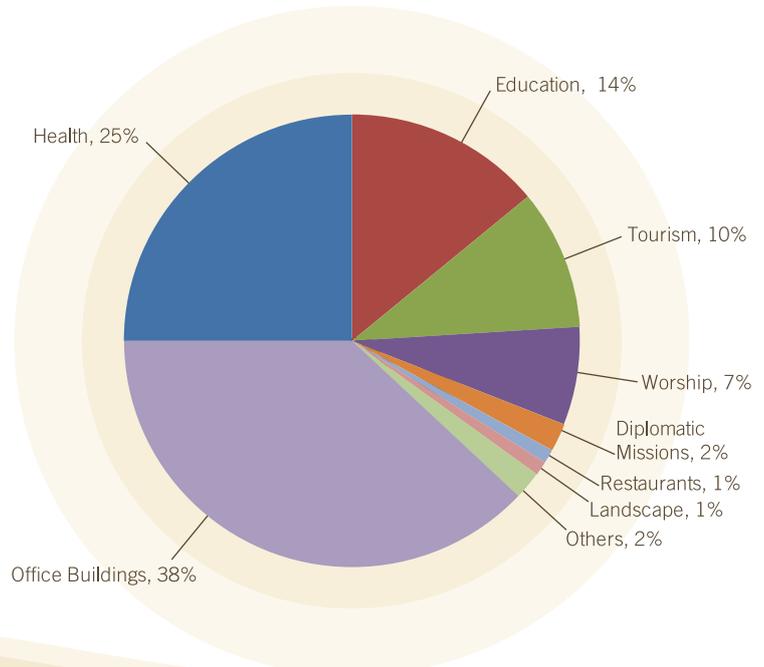
## A Snapshot of Office Building Water-use in Jordan

### Where and How Much Water is Used?

Government and commercial office buildings are major consumers of water in Jordan. Billing data from Amman National Company (Miyahuna) show that these buildings accounts 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.

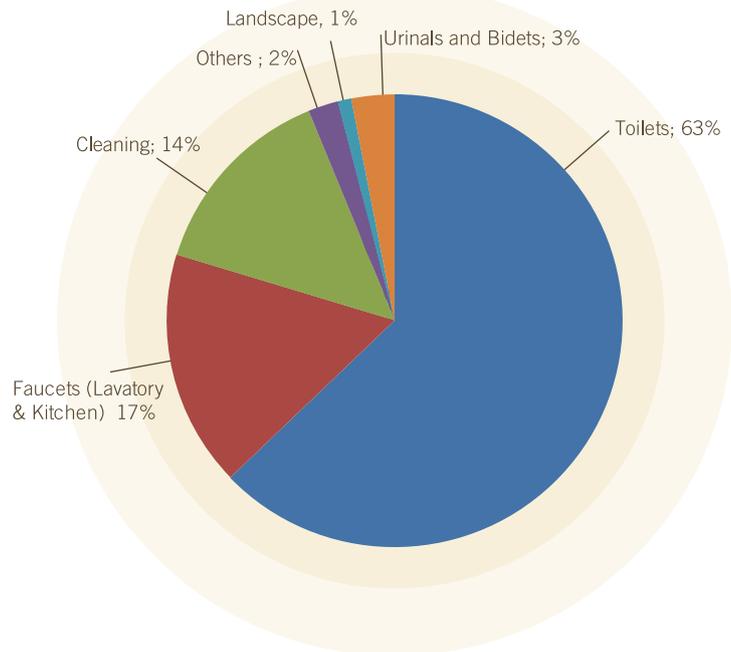
Water consumption for non-residential users in Miyahuna service area



## Where is your water going?



Water use profile for 12 Jordanian office buildings



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 consume around 63 percent of the water, followed by lavatory and kitchen faucets (17 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 32 liters per employee per day.

### Water-use Baselines versus Water-use Benchmarks

The water-use baseline is the average consumption for each water-use category, fixture, appliance, or process obtained from the twelve audited office buildings. 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 office buildings. Achieving the benchmark is the goal of a water-efficient facility.

### Where and How to Save Water?

The water savings is the difference between the baseline and the benchmark for water use. 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. Considerable savings can be achieved when you adopt the standards for plumbing fixtures.

Current and recommended water use specifications for key plumbing fixtures and processes in Office Buildings

| End Use Area             | Baseline average water use for fixtures <sup>2</sup> and processes | Benchmark water use for fixtures <sup>3</sup> 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 liters/cycle <sup>4</sup>             | 29%                       |
| Toilet                   | 6.2 liters/flush   | 4 liters/flush  | 35%                       |
| Urinal                   | 2 liters/ cycle  | 1.9 liter /cycle  | 0.5%                      |
| 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%                       |

<sup>2</sup> Based on the 12 audited office buildings

<sup>3</sup> Based on Jordan Standards and Metrology Organization (JSMO) standards and technical regulations

<sup>4</sup> Based on 12 seconds per one use

## Office Buildings Water Audit

A water audit<sup>5</sup> is essential for identifying where and how water is used in your office building and helps you establish a business case for identifying 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 at your office building requires the following steps:

1. Preparation and information gathering. A thorough preparation will maximize the efficiency of your 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 office building 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, visitors, and employees.
- 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 per employee water use to determine whether or not your office building is a high water-use facility.

2. Conducting facility survey to:

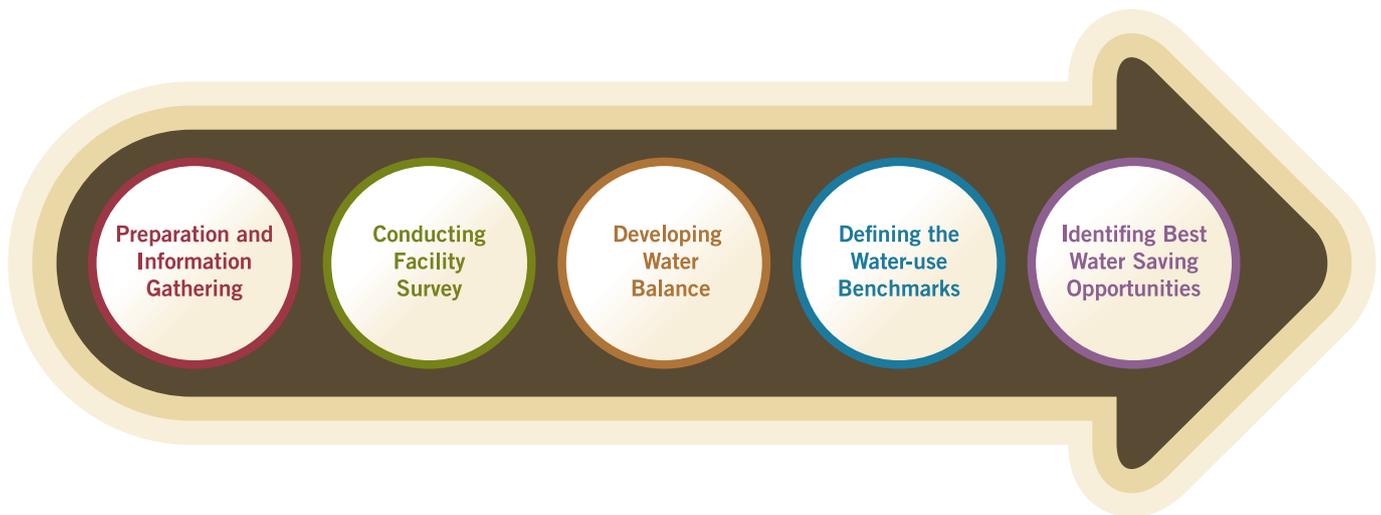
- Walk through the office building with the people, who are familiar with the daily operations, particularly the manager of operations and maintenance, to understand how water is used in the various areas of the facility. Interview relevant office building staff and employees to confirm the information obtained in the preparation phase. Establish assumptions such as the frequency of use per day of the plumbing fixtures (faucets, toilets, and urinals).

- Check water-using equipment, water treatment systems, 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. 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 fixture flow-rates and amounts of water use by the various equipments will help identifying inefficient fixtures and equipment, leaks, and inappropriate water use. This step also includes recommendations for sub-metering of major water-uses.
- 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.



<sup>5</sup>Audits should be done on a recurring basis, preferably once every two years.

3. Developing a water balance for the water use baselines defined above, and make sure that the office building total indoor and outdoor water consumption including leakages, if any, matches 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 Part 2. These benchmarks are essential for identifying your water-savings target.
5. Identifying best water-saving opportunities based on baseline and benchmarks water uses, and prioritizing these opportunities according to amount of water savings, cost of saving, and payback period.



# Best Management Practices

PART

2



## Defining Best Management Practices

Best management practices (BMPs) are a set of hands-on recommendations that help you identify opportunities and implement programs to save water in your office building. BMPs are developed for the various water-use categories in Jordanian office buildings and for monitoring and operational procedures. They are grouped according to indoor water use, outdoor water use, and monitoring and operational procedures. You can tailor your water-saving program by using part or all the BMPs depending on your budget and your environmental and regulation requirements. Tips and information are provided on water-saving amounts and cost recovery to help you prioritize your measures and make the most bang for your buck.

### Saving in Indoor Water Use

Office buildings indoor water use includes water used in faucets, toilets, bidets and urinals, and cleaning. According to the audited Jordanian office buildings, indoor use accounts on the average for around 97 percent of the total water use. These audits indicated great opportunities for water savings at affordable costs and with reasonable payback periods.

#### Faucets

Lavatory and kitchen faucets average water use in the audited office buildings is approximately 17 percent of the total office buildings water consumption. In some of the audited offices faucets run around 9 liters per minute. Faucets flows can easily be reduced without affecting the comfort of the water user by using appropriate flow

##### Recommend flow rate for different type of uses

|   |                                       |
|---|---------------------------------------|
| Public hand-washing faucet or self-closing faucet | ≤ 4.5 liters/min<br>≤ 1.0 liter/cycle |
| Restroom faucet                                   | ≤ 4.5 liters/min                      |
| Kitchen faucet                                    | ≤ 8.3 liters/min                      |

regulator technology<sup>6</sup> for these fixtures. This will result in impressive savings of around 30 percent of faucets water use. Flow regulators<sup>7</sup>, especially the aerators are inexpensive, some cost around 2.5 JD a piece, and are easy to install and maintain. This is why they are often considered as the low hanging fruits of water saving programs. Here are the recommended best management practices for achieving water savings for faucets at your office building.

- 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 table.
- Regularly inspect sensor units to ensure they work properly and cut off when required.
- Regularly clean faucets as sediments may accumulate and reduce the flow.



#### Toilets

Toilets water use is around 63 percent of office building water consumption. The majority of toilets in Jordan 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. 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 toilet. 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 having an average of 6.2 liters/flush with 4.0 liters/flush dual flush toilets will result to a reduction of 35 percent of toilet water use with a payback period exceeding 10 years. More cost-effective results can be achieved by replacing only the toilet trim system.



<sup>6</sup>Flow regulators have been standardized by the Jordanian Standards and Metrology Organization (JSMO) as shown in the water use specifications table.

<sup>7</sup>Aerators reduce the water coming through the faucets or showerheads by mixing it with air and maintaining a constant pressure (if the aerators are pressure compensating). This is why most people don't notice a difference in the amount of water coming out of an aerated faucet or showerhead.

## 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 don't impede waste removal or violate the manufacturer's recommendations.
- Test for leaks and make necessary repairs promptly.

| Recommend flow rate for different type of toilets |                                 |
|---|---------------------------------|
| Dual-flush toilets                                | ≤ 3/6 liters/flush <sup>8</sup> |
| Single flush                                      | ≤ 6 liters/flush                |

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.

## Trigger Sprays, Bidets, and Urinals

Bidets and urinals water use accounts for 3 percent of office buildings water use in Jordan. Current flow rates for trigger sprays, bidets and urinals in Jordan often exceed the new Jordanian water and sanitation plumbing code recommended standards. These standards shown in the table offer a good water-saving opportunity for owners and managers of office buildings. The new code also opens the door for the use of waterless urinals under specific design that respect hygiene and environmental considerations.

| Recommend flow rate for bidets and urinals |                   |
|--|-------------------|
| Urinal                                     | ≤ 1.9 liter/cycle |
| Bidet                                      | ≤ 4.5 liters/min  |
| Trigger Spray                              | ≤ 4.5 liters/min  |



<sup>8</sup>Equivalent to an average of 4.0 liters/flush

## Food Services

Only a limited number of office buildings have food services, most of the offices have only coffee-tea services. Here is a menu of best management practices for water saving for buildings that have food services operations.

### 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 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



## Cleaning Operations

Cleaning operations consume around 14 percent of office buildings' water in Jordan. Most office buildings have a variety of cleaning and rinsing applications that can consume large volumes of water. The cleaning practices presented here will help you achieve significant water savings in your office building.

- 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.

## Saving in Outdoor Water Use

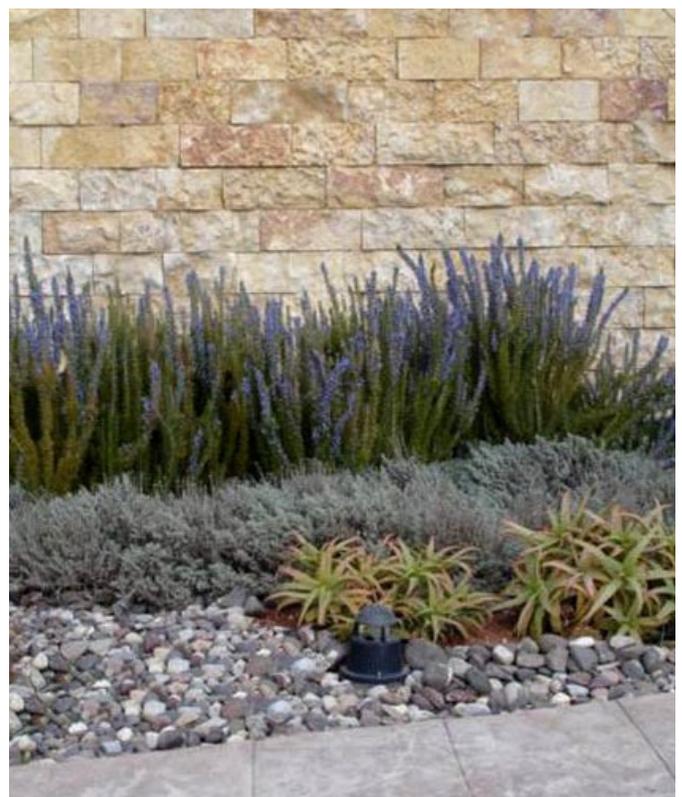
### Landscape

In Jordan, Landscape water use averages approximately 1 percent of the office buildings water consumption. A lively and colorful landscape can be created using a series of water-conserving 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 new and large office buildings 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 graywater and harvested rainwater. These alternatives are discussed thoroughly in Part 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 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. Fix that leaky pipe, toilet, faucet, or roof top tank and you will be amazed at how much money and water you can save. The establishment of a leak detection and repair program would be your most cost-effective way to save money and water in your office building. Here are best practices to assist you in 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 office building'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 office building's water use, it is essential to meter all your sources of water supply from the water utility and other sources such as private tankers, your own wells, and harvested rainwater.

- Coordinate with the water utility to ensure the utility's water meter is working properly.
- Install water meters to accurately measure each of your other sources of supply, if you have any. For water tankers, keep record of all supplied amounts.



- 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 basis.
- 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 office building. This includes any equipment or function 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.
- Food service areas.
- Both the feed and product water from a reverse osmosis or other water treatment system.
- Separately leased spaces in the building.
- 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 malfunction, 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. Many office buildings in Jordan receive their operating pressure from a roof tank system. This means that the top floor may have low pressure while the bottom floor has extremely high pressure. For office buildings with flush-valve systems, approximately two Bars pressure is needed, but for regular tank-type toilets, such as those found in most office buildings in Jordan, only one Bar is needed. This is appropriate for the second and third story below the roof top tanks and or for a floor no more than ten meters below the tank. Any floors lower than that would be candidates for a pressure control valve.



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 overflowing 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.

## **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 office building facility such as restrooms, kitchen, etc. Valves should be clearly marked stating which portions of the facility they serve and should be accessible to appropriate staff.

### ***Backflow Preventers***

Backflow preventers protect the water supply from contamination by sewer water and other sources of pollution. They prevent cross-contamination from

# 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 periods, and benefit-cost ratios. The following are key steps to help you complete your cost-benefit analysis to retrofit faucets and toilets. The retrofit consists of installing flow regulators for faucets and replacement of toilet trim (flushing system). An example of a case study for a selected office building is also shown.

### Step 1: Identify the Investment Cost

The investment cost for this example represents the retrofit costs that include the cost of the water-saving devices (WSDs) and their installation or replacement. The calculator below shows the approximate cost for the retrofit of each fixture, based on the Jordanian market. The installation cost is only considered for the replacement of the toilet rim by a professional plumber, assuming that the installation of the faucet regulators is done by your office building maintenance staff.

### Step 2: Identify the Benefits

Plumbing-fixture retrofit holds the most promise for water-saving and financial benefit. The financial benefits are roughly the savings in your water and energy bills as a result of savings in water consumption, wastewater, and hot water. Other financial savings such as the cutback on freshwater treatment cost and tanker water cost can also be considered.

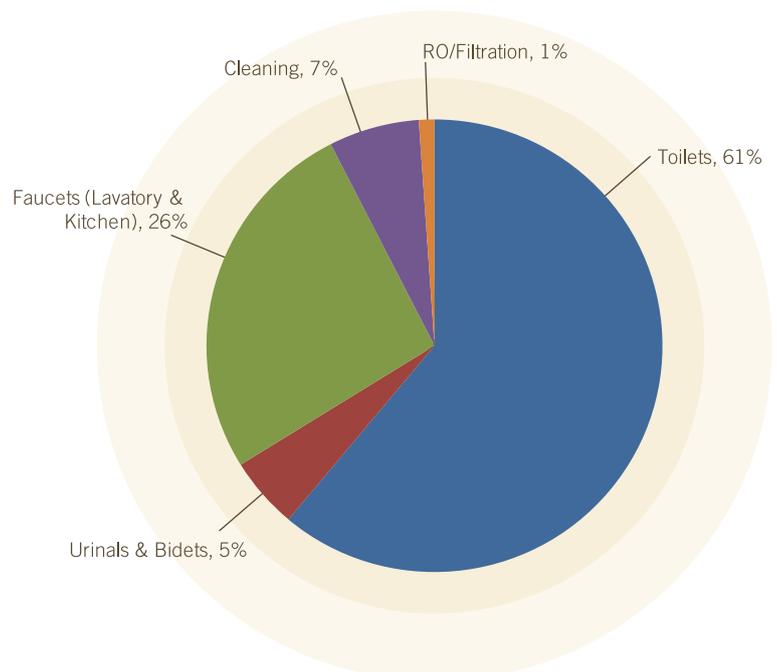


### Step 3: Calculate the Payback Period and Benefit-Cost Ratio

The payback period represents the amount of time required to recover the investment cost. It is simply the ratio of the investment cost over the annual financial benefit. For example, if the retrofit of all faucets and toilets in your office building costs you JD 5,000 with an expected saving (benefit) on your water and energy bills of JD 10,000 annually, the payback period will be 5,000/10,000 or half a year. You can also calculate your payback period separately for each of the retrofit measures as shown in the case study.

The benefit-cost ratio for a given fixture is equal to the present value of the benefit during the life of this fixture divided by the investment cost for its retrofit.

Water Use Profile at the Office Building



## Case Study: A Jordanian Office Building

### Facility Information

This 1,800 square meters office building was constructed in 1965, has 300 employees who work 8 hour shifts for 239 days a year, and receives 80 visitors per day. The building gets all its water supply, which is 1,116 cubic meters a year, from the water utility.

### Current Water Use

Based on the water audit, this office building has 34 faucets, and 10 toilets. The average flow rates are around 7.2 liters/min for the faucets and 9 liters /flush for the toilets. The water use profile illustrated in this section indicates that the water use for faucets and toilets represents around 87% of the total building's water consumption. These fixtures annual use is around 971 cubic meters per year with 290 cubic meters for faucets, and 681 cubic meters 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 and 4.0 liters per flush for the dual-flush toilets. The total investment cost is JD 335 including JD 85 for retrofitting 34 faucets and JD 250 for replacing trims for 10 toilets as shown in the calculator presented in this section.

### Benefits

The expected benefits include saving 491 cubic meters of water per year, which is equivalent to 44 percent reduction in water use. This would result in approximately JD 740 reduction in the water and wastewater bill, and around JD 80 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 and toilets is a highly profitable water use efficiency measure. You only need 3 months to pay back the money for retrofitting your faucets, and 5.2 months to get back your toilets retrofit cost. The benefit cost-ratios are approximately 11.9 for faucets, and 9.4 for toilets..

| Cost-Benefit Calculator |  |                  |                |   |
|-------------------------|--|------------------|----------------|---|
|                         |  | Toilets          | Faucets        | Formula   |
| a                       | Average flow rate of existing fixtures (baseline water use)      | 9 Liters/Flush   | 7.2 Liters/min |   |
| b                       | Percent of water use (%)   | 61               | 26             |   |
| c                       | Annual consumption (m <sup>3</sup> )                             | 681              | 290            | $c = b \times \text{annual consumption} = b \times 1,116 \text{ m}^3$ |
| d                       | Average flow rate of retrofitted fixtures (benchmark water use)  | 4.0 Liters/Flush | 4.5 Liters/min |   |
| e                       | Number of fixtures   | 10               | 34             |   |
| f                       | Cost of retrofit for each fixture (JD)                           | 25               | 2.5            |   |
| g                       | Total cost of retrofitting ( JD)                                 | 250              | 85             | $g = e \times f$  |
| h                       | Percent of saving per fixture                                    | 56               | 38             | $h = (a - d)/a$   |
| i                       | Average annual water savings (m <sup>3</sup> )                   | 381              | 110            | $i = h \times c$  |
| j                       | Average annual savings <sup>9</sup> in water and wastewater (JD) | 572              | 165            | $j = 1.5 \times i$  |
| k                       | Percent of water heated  | 0                | 30             |   |
| l                       | Annual energy savings <sup>10</sup> ( JD)                        | 0                | 83             | $l = k \times i \times 2.5$   |
| m                       | Total annual savings ( JD)                                       | 572              | 248            | $m = l + j$   |
| n                       | Discounted benefits over life time <sup>11</sup> of fixture (JD) | 2,345            | 1,016          |   |
| o                       | Benefit-cost ratio   | 9.4              | 11.9           | $O = n/g$   |
| p                       | Payback period   | 5.2 months       | 3 months       | $r = g/m$   |

<sup>9</sup> Water supply and wastewater tariff = JD1.5/m<sup>3</sup>

<sup>10</sup> Cost of energy (Diesel) per heated cubic meter of water = JD2.5/m<sup>3</sup>

<sup>11</sup> Life time of each fixture is 5 year, and 7% return rate

# Alternative Water Sources

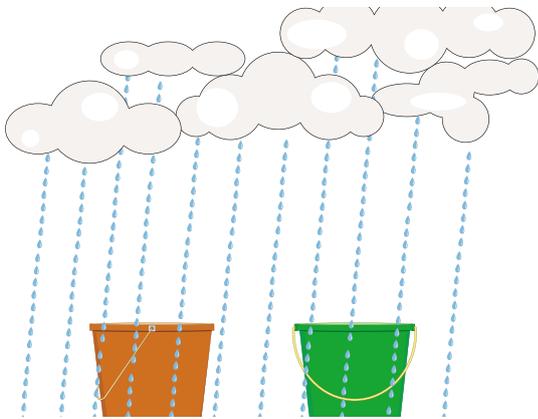
PART

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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 office buildings.



### How Much Rainwater Can You Capture?

Office buildings usually offer more than rooftops for rainwater harvesting. To maximize water collection, other impervious (hard) areas 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 ( $m^3$ ) = Impervious area ( $m^2$ ) x annual rainfall (mm) x 0.80/1000

For instance, an office building facility in Amman that receives 350mm average annual rainfall and has 1,000 $m^2$  of impervious area, the potential rainwater that can be captured is approximately 280 $m^3$ . 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. Roofs of office buildings 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 your 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 office buildings for watering landscape, toilets flushing, and floor cleaning.

## Gray Water Reuse

Gray water<sup>12</sup> is untreated waste water that has not come into 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 office buildings.

### How Much You Can Generate?

Based on the average water-use profile of the twelve office buildings audited in Jordan, raw gray water from bathroom faucets is less than 17 percent of the office buildings' water consumption. To identify the optimum gray water potential in your office building, you need to conduct a water audit and also consider adjusting your gray water values in case you retrofit the water fixtures and appliances. For a new facility, your gray water potential is based on the estimated flows of the fixtures in your bathroom faucets.

### How Much You Can Reuse?

The gray water is by far less than the amount of water needed for toilet flushing. The latter is more than 3.5 times higher than the potential gray water that can be collected from faucet lavatories. Thus, on site gray water reuse for toilet flushing is not feasible in office buildings. Gray water reuse would be possible only for landscape irrigation. 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:

- Use gray water for your office buildings landscape irrigation under the following conditions:
  - » Use lavatory 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.

## Wastewater Reuse

More than 90 percent of all wastewater collected via the national sewage system in Jordan is currently treated and reused. The new water and sanitation plumbing code requires the establishment of satellite treatment plants within the premises of high-rise high-density (HRHD) developments for collection and reuse of wastewater. 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 office buildings located in HRHD areas that include water users from other sectors such residential and tourism:

- 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.
  - » Divert any treated wastewater that is not used for irrigation to the sewer system.
  - » Regularly monitor water quality and divert wastewater to sewer system in case of water contamination or malfunction of treatment process.
- For new offices within high-rise high-development areas use treated wastewater from satellite treatment plant for toilet flushing.

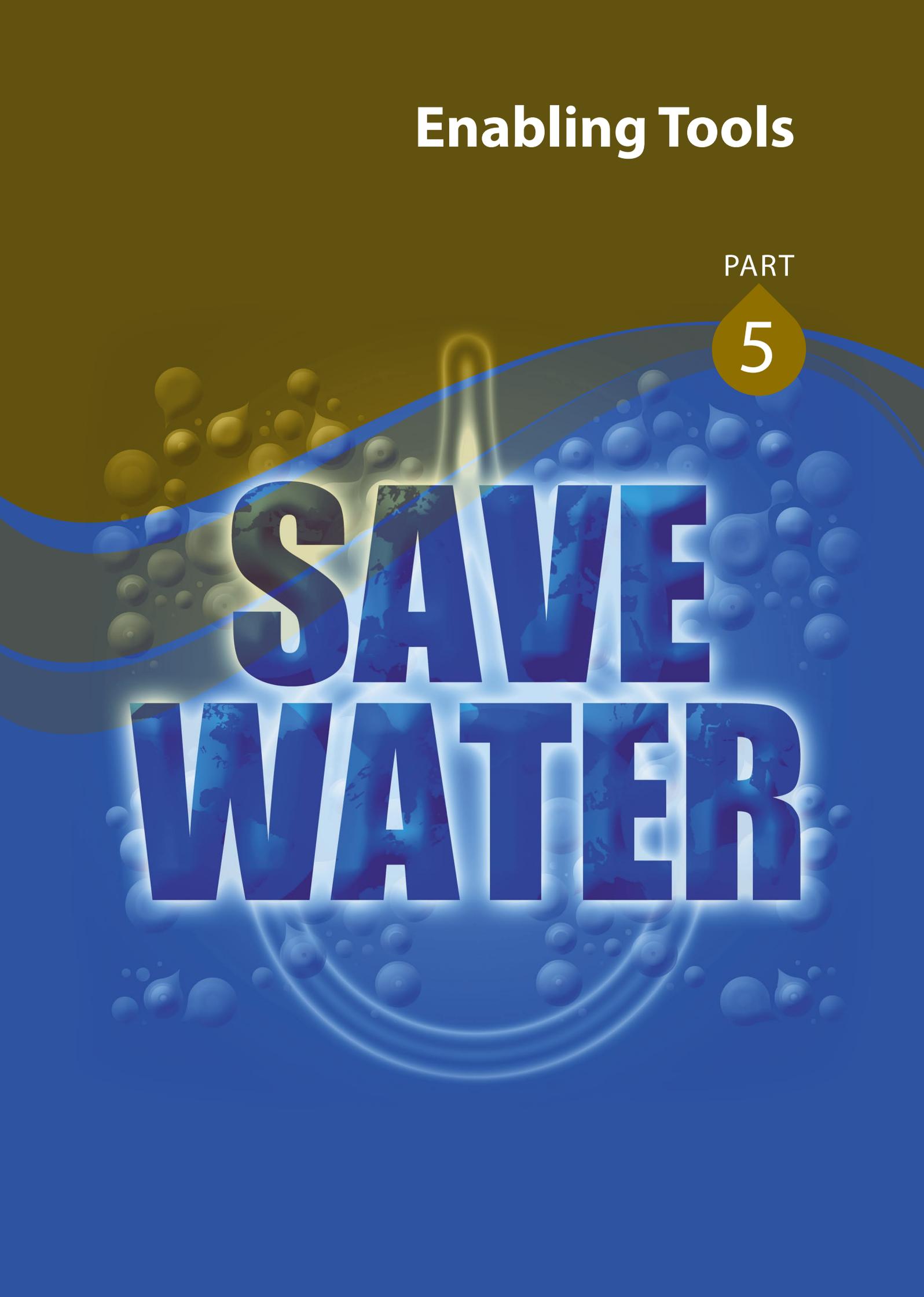


<sup>12</sup> Gray water defined according to the new water and sanitation plumbing code

# Enabling Tools

PART

5



**SAVE  
WATER**

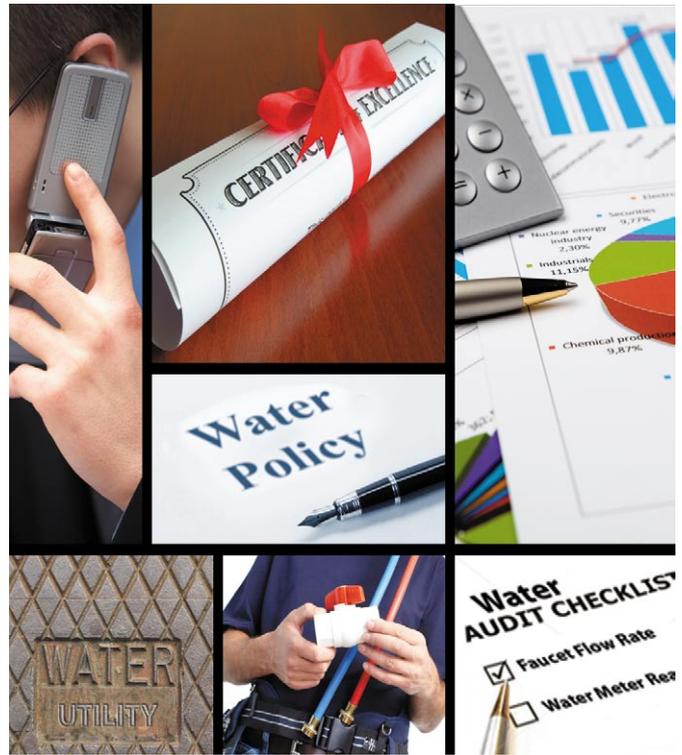
## How to Implement Office Buildings Water-use Best Management Practices

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 office buildings water-use management:

- Preparation of a new Water and Sanitation Plumbing Code that includes national technical regulations for the recommended water use specifications and sanitation for plumbing fixtures such as faucets, toilets, and showerheads as well as appliances. These specifications can be applied to your existing or new office building. The code also includes provisions for gray water reuse, rainwater harvesting, and managing water use and reuse for office facilities in high-rise and high-density buildings.
- 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 your existing or new facility according to the new 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

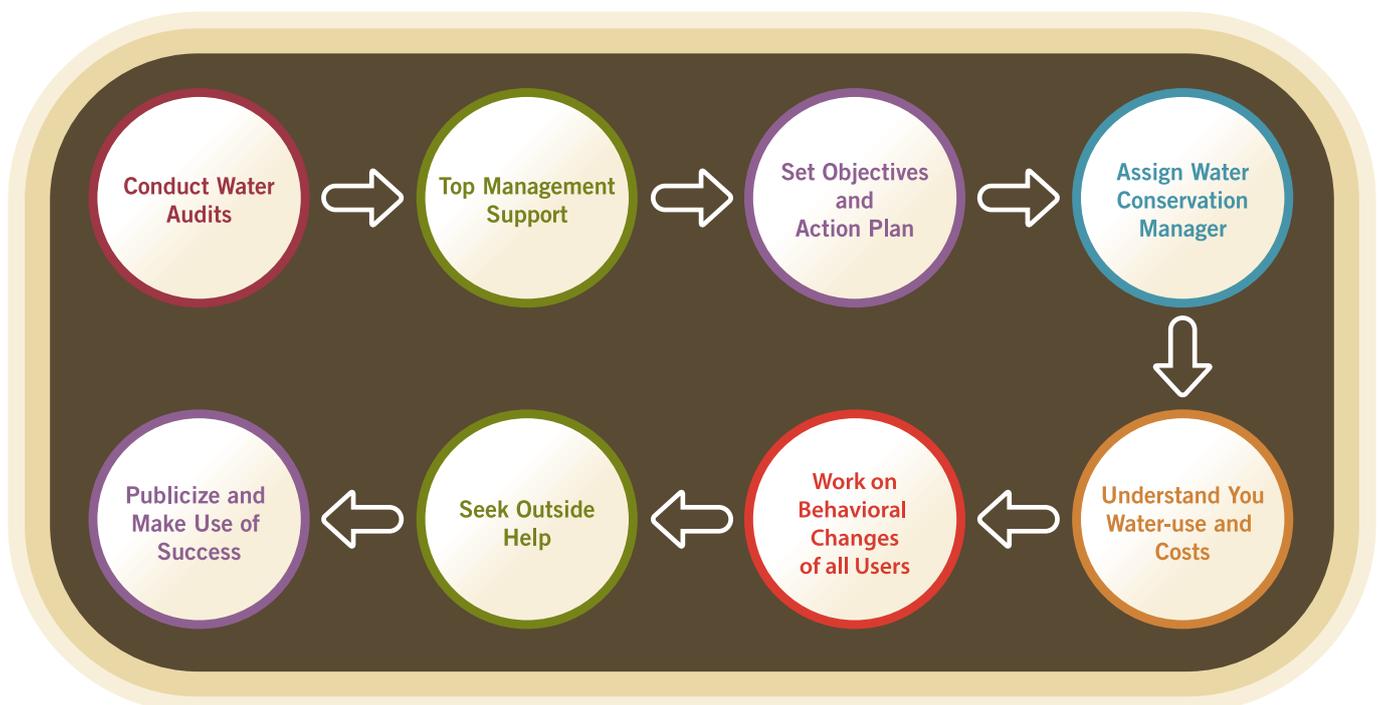
Water-use efficiency has been instituted at the national and water utility levels. Here are the key entities and program that can support you:

- 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 office buildings.
- 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 guide you in identifying and implementing water-efficiency measures in your office building. They have a state-of-the-art tracking tool that helps you assess 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 you with an incentive to save water, energy, money, and win the award, which will make you stand out from your competitors.

## Steps for Successful Management of a Water-use Efficiency Program

Without effective and structured management you cannot achieve your long-term sustainable saving objectives. Here are eight key steps to guide you in developing and managing a successful water-efficiency program at your office building:

1. Conduct a water audit to assess water uses and costs: A complete water audit is needed to identify water-use efficiency opportunities and give you firsthand estimates of expected savings in water, energy, and money.
2. Get commitment and leadership from top management: Office building owners and managers need to value and take the lead in water-efficiency programs. Showing them the utilities bills and sharing recommendations of water and energy audits would make them realize that valuable energy savings, wastewater, and water-treatment cost reductions can be achieved by water savings. This in turn would encourage them to accept and lead changes in processes and behavior to achieve all these savings.
3. Set realistic objectives and prepare an action plan: You need to set realistic annual water-savings targets based on your water audit results, and prepare an action plan listing and prioritizing all planned water-efficiency measures. Identify funds, schedules, and personnel needed for their implementation. And estimate savings, benefits, and payback period for each measure. The plan can also include other targets such as green building certification, the King Abdullah II Center for Excellence Award, etc.
4. Assign a water-conservation manager: Having a person dedicated to water conservation, although this does not need to be his/her sole task, will get you the most out of your efficiency program. The same person can also be responsible for energy conservation.
5. Understand your water-use systems and associated water-use costs: Sub-metering key water uses and conducting water audits help you tremendously in developing accurate monitoring of where, how, and when water is used. Developing a simple database to track your water-use, water-heating, and water-treatment costs will guide you in identifying and prioritizing water-saving measures and evaluating your water efficiency program.
6. Work on behavioral changes of employees and visitors: Establish an educational and awareness program at your facility to increase staff, clients, and visitor awareness on water conservation through signs, newsletters, and posters. Incorporate water conservation into employee training programs, and hold competitions to reward doers and achievers among your staff.
7. Get outside help: Consult the Chamber of Commerce, your local water utility, WDMU at MWI, the Ministry of Public Works and Housing, the Ministry of Environment, and other relevant institutions to make contacts for technical information and training, and look for opportunities for water conservation incentives.
8. Publicize and use success: Office buildings with successful water-conservation programs deserve to be recognized by the public. The public will certainly appreciate that your business is a socially and environmentally responsible partner in the community.



# Water Saving Checklist

PART

6



# Office Buildings Best Management Practices Checklist

| Understanding Your Water Use   | Yes/No | Recommended Practice  |
|--|--------|---|
| Do you know your office building water use?  | Yes No | If No, read and record utility's water meter information so you can identify changes in your facility water use, ensure utility's water meter is working properly.  |
| Have you conducted a water audit for your office building?                           | Yes No | If No, conduct water audits to find where, when, and how water is used in the facility and identify the best opportunities for water savings.   |
| Do you know how much water and all its associated charges are costing your business? | Yes No | If No, calculate your own water cost and associated charges as indicated in the cost-effectiveness section.   |
| Do you know where water is used in your office building?                             | Yes No | If No, install sub-meters in the facility to develop your own water balance. All major water-using equipment and processes in the office building should be sub-metered as indicated in the sub-metering section. |
| Do you have water conservation educational and awareness programs?                   | Yes No | If No, establish educational and awareness program at your facility to increase staff, clients, and visitor awareness of water conservation through signs, newsletters, and posters.                              |
| Have you assigned a water conservation manager?                                      | Yes No | If No, assign a conservation manager responsible for water and energy conservation.   |

| Monitoring and Operational Processes                                     | Yes/No | Recommended Practice  |
|--|--------|---|
| <b>Leak Detection</b>  |        |   |
| Do you regularly check for leaks?  | Yes No | If No, establish regular leak detection program to ensure that all plumbing fixtures and systems and all water-using equipment are checked routinely and repaired immediately.                |
| Do you record building leaks?  | Yes No | If No, keep records of the type of leaks, their location, and number in a central location.   |
| Do you read your water meters regularly?                                 | Yes No | If No, regularly read your meter. If there has been a sudden unexplained increase in your water bill, chances are you have a leak. Use your water meter to help you check for «silent leaks.» |
| Does the facility manager have standard-leak repair equipment and parts? | Yes No | If No, make sure staff has tools and parts to make timely repairs.  |

## Pressure Management

|  |     |    |   |
|--|-----|----|---|
| Have you checked pressure at your building floors? | Yes | No | If No, install pressure controls on building floors if pressure is over 3 bars. |
|--|-----|----|---|

## Treatment Processes

|  |     |    |  |
|--|-----|----|--|
| Have you checked the ratio of treated water to reject water for reverse osmosis equipment? | Yes | No | If No, 1to1 is the optimum ratio of treated water to reject water for reverse osmosis equipment. |
|--|-----|----|--|

## Indoor Water Use

Yes/No

Recommended Practice

### Faucet

|  |     |    |   |
|--|-----|----|---|
| Is your faucets flow rate less than or equal to 4.5 liters/minute? | Yes | No | If No, install faucets flow regulators (aerators) at flow rate less than or equal to 4.5 liters/minute. |
|--|-----|----|---|

|   |     |    |   |
|---|-----|----|---|
| Do you regularly check for faucets leaks? | Yes | No | If No, faucets should be checked routinely and maintained or replaced as necessary. |
|---|-----|----|---|

### Toilet

|   |     |    |  |
|---|-----|----|--|
| Does your building have dual flush toilets? | Yes | No | If No, replace inefficient single-flush toilets in high-use areas with 6/3 liters dual-flush types, or retrofit toilet trims (flushing systems) to less than or equal to 6 liters per flush. |
|---|-----|----|--|

|  |     |    |  |
|--|-----|----|--|
| Do you regularly check for toilet leaks? | Yes | No | If No, arrange for leak test to identify hidden leaks using dye or food coloring in the toilet tank. |
|--|-----|----|--|

### Urinal

|   |     |    |  |
|---|-----|----|--|
| Do urinals at your facility operate at less than or equal to 1.9 liter per cycle? | Yes | No | If no, replace them with efficient urinals that reduce flow rate to less than or equal to 1.9 liter per cycle. |
|---|-----|----|--|

|  |     |    |  |
|--|-----|----|--|
| Do you have automatic on-demand urinals? | Yes | No | If Yes, check urinals regularly to see that sensors are working properly and that worn or faulty parts are replaced. Adjust urinal flow rates to less than or equal to 1.9 liter per cycle |
|--|-----|----|--|

### Cleaning

|                              |     |    |   |
|------------------------------|-----|----|---|
| Do you use hose in cleaning? | Yes | No | If Yes, clean sidewalks and parking lots with brooms and dustpans. Using water for cleaning these areas is prohibited. Use mops or squeegees instead of hoses for indoor areas. |
|------------------------------|-----|----|---|

|  |            |           |  |
|--|------------|-----------|--|
| Do you use a hose for washing car?                         | <b>Yes</b> | <b>No</b> | If Yes, wash your cars using bucket.   |
| <b>Food Services</b>                                       |            |           |  |
| Are your refrigeration and ice making machines air-cooled? | <b>Yes</b> | <b>No</b> | If No, use air-cooled machines for both refrigeration and ice-making equipments.   |
| Do you use water to thaw food?                             | <b>Yes</b> | <b>No</b> | If Yes, use adequate refrigerators to thaw frozen food instead of thawing under water.   |
| Are your dish washers operated in full load?               | <b>Yes</b> | <b>No</b> | If No, operate the dishwasher only when full load.   |
| Do you use pre-rinse spray valves?                         | <b>Yes</b> | <b>No</b> | If No, use pre-rinse spray valves of less than or equal to 6 liters per minute flow rate to rinse dishes before going into the dishwasher. |

| <b>Outdoor Use</b>                       | <b>Yes/No</b> |           | <b>Recommended Practice</b>  |
|--|---------------|-----------|--|
| <b>Landscape and Irrigation</b>          |               |           |  |
| Do you have a water-efficient landscape? | <b>Yes</b>    | <b>No</b> | If No, Ensure a water efficient landscape by following appropriate soil preparation, plant selection and placement, and efficient irrigation system and practices. |
| Do you use fresh water for irrigation?   | <b>Yes</b>    | <b>No</b> | If No, use recycled water according to recommendations given in the alternative water sources section.   |

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