CHAIRE DE L'ÉDUCATION À L'ÉCO-CITOYENNETÉ ET AU DÉVELOPPEMENT DURABLE (CEEDD)

FONDATION DIANE

Université Saint-Joseph de Beyrouth (USJ)

WATER TRAINING CURRICULUM

Table of Contents

Acronym

CSO	Civil Society Organization
NRW	Non-Revenue Water
PSF	Practice Sharing Forum
THM	Town-Hall Meeting
WWM	WasteWater Management
WWTR	WasteWater Treatment and Reuse

I. Introduction

A curriculum's design and execution are guided by a set of beliefs, values, and principles known as a curriculum philosophy. It guides the selection of content, the methods of instruction, and the types of assessment used to evaluate learning outcomes. A knowledge of how learning happens and what it means to be educated is also reflected in the curriculum philosophy. It is informed by theories of learning, social and cultural contexts, and the needs and goals of learners.

The beliefs and experiences of those engaged in the creation and implementation of the curriculum can have an impact on the philosophy of the curriculum, whether it is explicit or implicit. A curriculum philosophy is an important aspect of curriculum design, as it shapes the overall approach to teaching and learning and provides a foundation for decision-making throughout the curriculum development process.

In addition, a curriculum is a central guide for trainers on which their practices should be based toward developing targeted skills and set of knowledge in a specific domain. It is structured and organized to enhance trainees' learning and to facilitate instructions.

This curriculum is specifically designed to train the staff of the Community Support Organizations (CSOs) in Lebanon by building their capacity to engage in water sanitation and conservation. It provides a framework for trainers to properly plan instructions for the trainees aiming at introducing them to the latest challenges and opportunities, as well as to the new practices related to this sector.

This curriculum includes a combination of goals, methods, instructional practices, learning experiences, and materials that are designed to evaluate the target learning outcomes of the Lebanese CSOs, to inspire them to become advocates for sustainable water management and positively impact their community.

II. Goals of the curriculum

Simply defined as the expectations for teaching and learning, the goals within a curriculum are explicitly the end towards which an effort is directed. The goals must also include the breadth and depth to which a trainee is expected to learn.

This curriculum aims at building the capacity of the CSOs staff, so they can become fully aware about the administration, finance, management, and implementation of sustainable development projects in the water sector.

The curriculum is designed over ten major goals:

1. Provide a thorough understanding of the technical aspects of water management, including the principles of water treatment and distribution, wastewater collection and treatment, and Non-Revenue Water (NRW) management.
2. Explore innovative technologies in Water and Wastewater Management (WWM), including water reuse, desalination, and smart irrigation systems, and their potential application in Lebanon.
3. Develop skills in the evaluation and management of water and wastewater treatment systems, including the design, operation, and maintenance of treatment plants and distribution systems.
4. Introduce the principles and practices of Wastewater Treatment and Reuse (WWTR) and their potential for addressing water scarcity and reducing water pollution in Lebanon.
5. Develop an understanding of the importance of NRW management and strategies for reducing water loss in distribution systems.
6. Discover the regulatory frameworks and policies related to WWM in Lebanon.
7. Equip CSOs with the knowledge and skills needed to design and implement sustainable WWM practices.
8. Promote awareness of the importance of water conservation and the need for sustainable water use practices in Lebanon.
9. Foster collaboration among CSOs, government agencies, and other stakeholders to address water-related challenges in Lebanon.
10. Contribute to the development of a more sustainable and resilient water system in Lebanon through the adoption of innovative and sustainable water management practices.

These goals are divided into 4 outcome areas:

<u>Water and Wastewater Management:</u> 12 hours

Overview of the water especially in Lebanon (2 hours)

- Introduction to water resources, water bodies and water cycle
- Overview about the consuming sectors and the water distribution system and storage
- Tips about water sustainability and future challenges

Wastewater testing parameters (2 hours)

- Examine the chemistry and microbiology of water (parameters)

- Guidance for water and wastewater quality assessment

Monitoring and sampling processes of water & wastewater (2 hours)

- Understand the water quality monitoring program
- Develop a water monitoring plan

Water Services (2 hours)

- Understand how urban water services are delivered and the relationship between users and resources
- Explain why we currently (and historically) don't have enough, safe, regular water at our tap in Lebanon

Policy (1 hour)

- Conceptualize the legal framework governing the water sector and its current state of development

Institutions (2 hours)

- Understand the roles and responsibilities of mandated authorities, such as the MoEW and WEs, as well as their challenges
- Identify relevant stakeholders and possible synergies with mandated authorities and the private sector

Economic Uses (1 hour)

- Compare the value of water across different value chains and differentiate its use value and exchange values

Wastewater Treatment & Reuse: **12 hours**

Wastewater collection technologies & Treatment technologies (3 hours)

- Identification of wastewater collection systems
- Understand the wastewater treatment processing
- Characterization of the main biological treatment processes
- Decision making factor about the method of treatment to be chosen

WWTR applications (3 hours)

- Identify different sector of treated water reusing
- Highlight new water treatment technologies
- Identify consideration to be taken while reusing water

Methods to increase Stakeholders' acceptance (2 hours)

- Understand concerned stakeholders and their perceptions
- Understand credibility of water reuse organizations and community trust.
- Understand the importance of establishing effective communication with water reuse organizations

Introduction to reuse/sanitation safety planning and governance system Module (1 hour)

- Describe historical background of the existing sanitation paradigm
- List characteristics of the new sanitation paradigm
- Describe the elements of the sanitation safety plan

Sanitation Safety Plan (2 hours)

- Understand priority areas, purpose, scope, boundaries, and leadership for sanitation safety plan.
- Create a multidisciplinary team representing the sanitation chain for development and implementation of the sanitation safety plan

Describe the existing sanitation system (1 hour)

- Understand how to map the system
- Define and characterize waste fractions
- Identify potential exposure groups
- Gather compliance and contextual information
- Validate system description

Identify hazards & assess existing control measures (1 hour)

- Identify hazards and hazardous events
- Refine exposure groups and exposure routes
- Identify and assess existing control measures
- Assess and prioritize the exposure risk

Monitor Control Measures (1 hour)

- Define and implement operational monitoring
- Verify system performance and monitoring plan
- Audit the system (Independent assessment)

<u>Non-Revenue Water:</u> 12 hours

Distribution Systems (1 hour)

- Visualize the components and bottlenecks of (urban) water distribution systems with an emphasis on Lebanon

Vicious Cycle (1 hour)

- Describe how the level of service and cost recovery are intertwined and the downward spiral that results from/in failure

Water Balance (2 hours)

- Estimate the NRW burden of a system and understand physical and commercial losses and benchmarks

Intermittent Supply (2 hours)

- Discuss the dialectic and quantify the impact of non-continuous water supply and NRW

Managing Water Flow (1 hour)

- Determine suitable approaches/technologies for flow measurement and management

Managing Water Pressure (1 hour)

- Determine suitable approaches/technologies for pressure measurement and management

Managing Water Losses (1 hour)

- Determine suitable approaches/technologies for leak, tapping, and unauthorized use detection and management

Beneath the Asphalt (3 hours)

- Reconcile theory and visualization with actual on-field realities of infrastructure and institutions

<u>Innovative Technologies in Irrigation:</u> 12 hours

Understand the importance of water saving in irrigation (4 hours)

- Define water saving
- Understand the importance of water saving based on French and United Kingdom current water crisis.
- Recognize the need for water efficient tools, focusing on tools used to save water
- Discuss the different examples of water saving in irrigation (e.g.: Drip irrigation versus flood irrigation).
- Discuss concept of deficit irrigation and Hydroponics

Recognize the different tools available for water saving in irrigation (2 hours)

- Discuss some innovative methodologies that help farmers on the field (e.g.: mobile applications, drones, sensors, hydrogel, etc.).

Build a functional water irrigation system (6 hours)

- Butt Welding Machine
- Electro Fusion Machine
- Preparing Detailed BOQ
- Drip system Drawing and sizing
- Demo system installation
- Different crops water requirement calculation

III. Methods

Methods are defined as the broader techniques used to help the trainees achieve learning outcomes. They relate to the general principles and management strategies used for instruction.

These choices support the facilitation of learning experiences to promote participant's ability understand and apply content and skills. Methods are differentiated to meet trainees' needs and interests, task demands, and learning environments. They are adjusted based on ongoing review of trainees' progress towards meeting the goals.

The pedagogical approach for this curriculum is a combination of different teaching methods, including interactive exercises, case studies, socio-cognitive debates, and problem tree analysis. The curriculum also includes theoretical and practical components to facilitate the learning process. There is a strong emphasis on active learning, where participants are encouraged to engage in problem-solving and critical thinking to identify representations and obstacles related to professional integration and water management. The curriculum also includes sessions that provide guidance and hands-on training in various aspects of water management, such as wastewater treatment and monitoring, distribution systems, and sanitation safety planning. The overall pedagogical approach aims to foster a deeper understanding of water and wastewater management concepts and their practical applications through an interactive and participatory learning process.

This curriculum is designed based on different learning theories described in the following paragraphs:

- The Cognitive learning theory that focuses on helping the participants to learn how to maximize their brain's potential can be applied via a socio-cognitive debate, problem tree analysis, brainstorming, etc. as it helps to connect new information with existing ideas hence deepening memory and retention capacity.

- The Behaviorism learning theory focuses on the idea that all behaviors are learned through interaction with the environment, role plays align with this theory by incorporating the participants in a new environment.
- The Constructivism theory focuses on the construction of knowledge by the trainees rather than just passively taking in information. As participants experience the world and reflect upon experiences via video analysis, problem situations, etc., they build their own representations and incorporate new information into their pre-existing knowledge.

- The Humanism learning theory claims that humans are not able to learn if their environment is not favorable or if they are in a bad psychological state. And finally, social learning theory suggests that social behavior is learned by observing and imitating the behavior of others, that's why throughout the training, the participants will learn by recalling the methods the trainers themselves use.

- The Connectivism theory emphasizes the role of technology and networks in learning. Connectivists believe that learning is a process of creating connections and that technology can enhance and support learning by facilitating connections between learners, resources, and ideas.

These theories are applied through the execution phases of the curriculum that are divided into five phases:

1. The first phase aims at identifying the representations and the obstacles of the participants related to their understanding and knowledge of water related issues in Lebanon. During this training session, interactive exercises, and the methodology of "problem tree analysis" approach as well as a socio-cognitive debate are used to diagnose the representations and obstacles of professional integration of the participants. The problem-situations and case studies discussed are derived from the Lebanese context taking into consideration all the complexity and the diversity of the Lebanese society.

2. The second phase provides Lebanese CSOs with a comprehensive understanding of water-related issues in the country. Through a series of modules, the curriculum covers various aspects of the water sector, including an overview of water resources, consuming sectors, and the water distribution system, with a focus on sustainability and future challenges. Participants will also learn about wastewater testing parameters and monitoring and sampling processes for water and wastewater, as well as gain an understanding of the roles and responsibilities of mandated authorities and relevant stakeholders in the water sector. Additionally, the curriculum covers policy and economic uses of water, enabling participants to develop a deeper understanding of the legal framework governing the water sector and the value of water across different value chains. Overall, this phase aims to equip CSOs with the necessary knowledge and skills to address water-related challenges and promote sustainable water management practices in Lebanon.

3. The third phase covers various aspects related to WWM and WWTR. The first part of this phase focuses on the identification of wastewater collection systems and understanding the wastewater treatment process. Participants will also learn about the decision-making factors for selecting the appropriate treatment method. The second part of this phase covers WWTR applications, highlighting different sectors of treated water reuse and considering important factors to be considered while reusing water. In the third part of this phase, participants will learn methods to increase stakeholders' acceptance of WWR, including understanding stakeholder perceptions and the importance of effective communication. The fourth part of this phase introduces the concept of sanitation safety planning and governance systems, including its historical background, characteristics of the new sanitation paradigm, and the elements of a sanitation safety plan. The fifth part covers the development and implementation of a sanitation safety plan, including understanding priority areas, creating a multidisciplinary team, and defining the existing sanitation system. The final part of this phase involves identifying hazards and assessing existing control measures, as well as monitoring and verifying system performance.

4. The fourth phase focuses on various aspects of water distribution systems. Firstly, participants will learn about the components and bottlenecks of urban water distribution systems, with a specific focus on Lebanon. The concept of the vicious cycle, which explains how the level of service and cost recovery are intertwined, will also be discussed. Participants will gain an understanding of the physical and commercial losses of water systems and how to estimate NRW burdens and benchmarks. The impact of non-continuous water supply and NRW will be quantified. Approaches and technologies for managing water flow, pressure, and losses will be explored. Finally, participants will reconcile theory and visualization with actual on-field realities of infrastructure and institutions through a module called "Beneath the Asphalt.

5. In the fifth phase, trainees will explore the importance of water saving in irrigation. They will start by defining what water saving is and understanding its significance in light of current water crises in France and the United Kingdom. They will also recognize the need for water-efficient tools, including the different examples of water-saving irrigation methods, such as drip irrigation and flood irrigation, and the concept of deficit irrigation and hydroponics. Additionally, trainees will identify different tools available for water saving in irrigation, such as innovative methodologies that help farmers on the field, including mobile applications, drones, sensors, and hydrogel, among others. Finally, in the last part of this, trainees will build a functional water irrigation system, which involves several steps, such as preparing a detailed Bill of Quantity (BOQ), drip system drawing and sizing, and demo system installation, among others. They will also learn how to calculate different crops' water requirement and use specific equipment such as the Butt-Welding Machine and Electro Fusion Machine.

IV. Materials

Materials are the tools selected to implement methods and achieve the goals of the curriculum. They are intentionally chosen to support a participant's learning and to reflect his interest, cultural diversity, world perspectives, and address all types of diverse learners.

Some potential tools that could be used to implement the methods and achieve the goals of the curriculum include interactive exercises, case studies, problem tree analysis approach, socio-cognitive debates, guidance documents, water quality monitoring equipment, flow and pressure measurement devices, leak detection technologies, as well as visualization tools such as diagrams and maps.

Additionally, relevant policies and legal frameworks may be referenced and analyzed as part of the curriculum. The selection of tools would be guided by the desired learning outcomes and the most effective ways to convey the information to the participants.

The table below resumes the themes developed and delivered by the trainers for **48** hours:

Module	Sessions	Expert	Time (hours)	Methods of Delivery
Water and Wastewater Management	Overview of the water Especially in Lebanon	Jules Hatem	2	Questions & Competition
				Video + Quiz + Discussion + Google Earth
	Wastewater testing parameters	Jules Hatem	2	Presentation Sticky notes + Mentimeter
				Presentation + Case study
	Monitoring and sampling processes of Water & wastewater	Jules Hatem	2	Discussion than a presentation
				Case study + Presentation
	Water Services	Jules Hatem	2	Brainstorming + Video + Discussion
				Problem tree analysis
	Policy	Jawad Taher	1	Flipped Pedagogy
	Institutions	Jawad Taher	2	Role play + Debate
	Economic Uses	Jawad Taher	1	Think Pair Share
	Wastewater collection technologies & Treatment technologies	Jules Hatem	2	Presentation, group work
	Wastewater reuse applications	Jules Hatem	3	Case study

Wastewater Treatment & Reuse	Methods to increase Stakeholders' acceptance	Jules Hatem	2	Case elaboration and presentation
	Introduction to reuse/sanitation safety planning and governance system	Jules Hatem	1	Video and Discussion
	Sanitation Safety Plan	Jules Hatem	2	Brainstorming + Group work
	Describe the existing sanitation system	Jules Hatem	1	Presentation + Examples
	Identify hazards & assess existing control measures	Jules Hatem	1	Documents sharing than summarizing
	Monitor Control Measures	Jules Hatem	1	Elaboration of a real monitoring plan and control measures
Non-Revenue Water	Distribution Systems	Jawad Taher	1	Conceptual Mapping
	Vicious Cycle	Jawad Taher	1	Future Wheel
	Water Balance	Jawad Taher	2	Functional Jigsaw
	Intermittent Supply	Jawad Taher	2	Pass the Bucket
	Managing Flow	Jawad Taher	1	Video + Discussion
	Managing Pressure	Jawad Taher	1	Video + Discussion
	Managing Losses	Jawad Taher	1	Game
	Beneath the Asphalt	Jawad Taher	3	Site Visit
Innovative technologies in irrigation	Understand the importance of water saving in irrigation	Wadih Skaff	4	Flipped pedagogy + Presentation + Videos + Debate
				Presentation + case study + practical exercice
	Recognize the different tools available for water saving in irrigation	Wadih Skaff	2	Presentation + discussion + live demo sensor installation
	Build a functional water irrigation system	Ziad Farhat	6	Direct Application
				Direct and practival application
				Practical exercises

V. Assessment

Assessment in a curriculum is an ongoing process of evaluating the knowledge, skills, and understanding that trainees have acquired through their learning experiences. It involves measuring learning outcomes and determining whether trainees have achieved the desired goals and objectives of the curriculum, which can be documented in various ways such as tests, exams, assignments, projects, presentations, and other forms of evaluation.

Feedback from assessments is used to make decisions about instructional approaches, teaching materials, and academic supports to enhance opportunities for trainees and guide future instruction.

The purpose of assessment is to provide feedback on the effectiveness of the teaching and learning process, identify areas for improvement, and help trainees identify their strengths and weaknesses. This allows for opportunities for remediation and further learning.

The curriculum and its implementation are evaluated as follows:

1. A satisfactory assessment for each training session via a questionnaire to assess the following:

a. The quality of the material delivered
b. Trainee's satisfaction on the trainers
c. The level to which the training was to their expectations
d. The level to which the training covered the learning outcomes

2. The acquired skills are evaluated via the practical simulations and monitoring during coaching provided for the preparation of training programs by the trainers (experts). – *Pre/post tests to be included after approval.*

3. A workshop on a new type of research called « participative research » will be implemented. This type of research enables trainees to build their own development and knowledge. The trainings by the means of research are one of the latest trends in terms of training design. Participatory research consists of focusing on reflection and action done by the participants. In other words, participants will be trained through an active and innovative method by guiding them to build their own knowledge through research. The trainees will be assigned to research on water legislations after this workshop. The results of this research will be shared in a practice sharing forum (PSF).

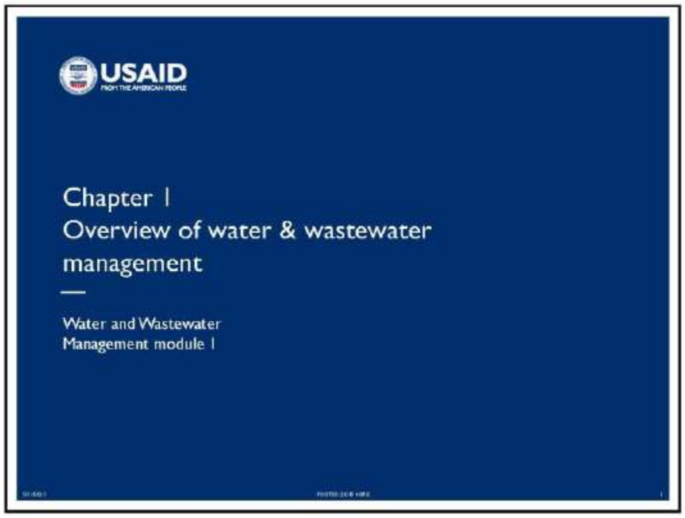
4. The PSF will allow trainees to share their findings in front of experts in the field of water. This will serve as a double purpose as it's a networking opportunity for the CSO and it's a chance to assess the trainees' acquired skills and how they can apply on ground what they have learned. During these forums, professionals in the fields of water resources as well as representatives from relevant entities related to water in the area will be invited to talk about their expertise and knowledge about the topic. These PSFs promote collaboration and knowledge-sharing among participants, providing a space to discuss topics related to the work they done, and exchange ideas to improve overall performance and outcomes in the field.

5. The trainees will elaborate the town hall meetings (THMs) with coaches. Their acquired knowledge and skills during the training program will be evaluated through the organization and the implementation of the THMs. Coaches will be available to ensure the successful implementation of the THMs. These meetings are usually open to the public and allow attendees to ask questions, voice their opinions, and receive updates on current and upcoming initiatives. Town hall meetings are often used as a means of promoting transparency and community engagement.

6. The trainees will then be assigned to write a full project proposal to remediate to issues related to water sanitation and conservation in their region

Annex 1 – Water and Wastewater Management

1.1 – Overview of Water and Wastewater Management



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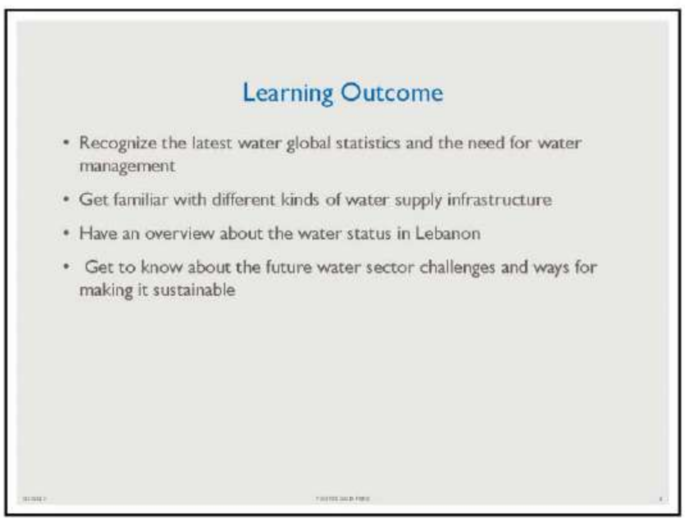


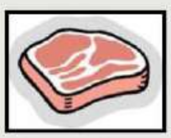
2

Outline

3

1-Introduction (1/3)

- Do you know how much we need to produce a/an ?



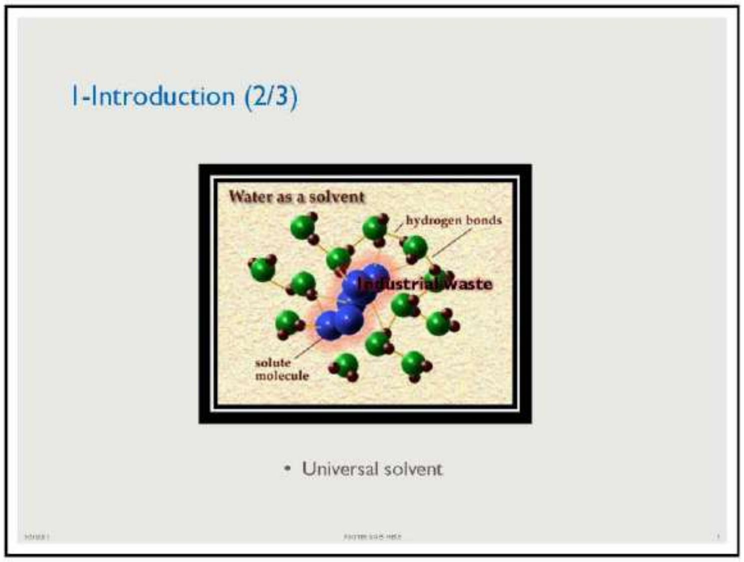
41,500 L for 1 kg of meat

500 L for 1 orange

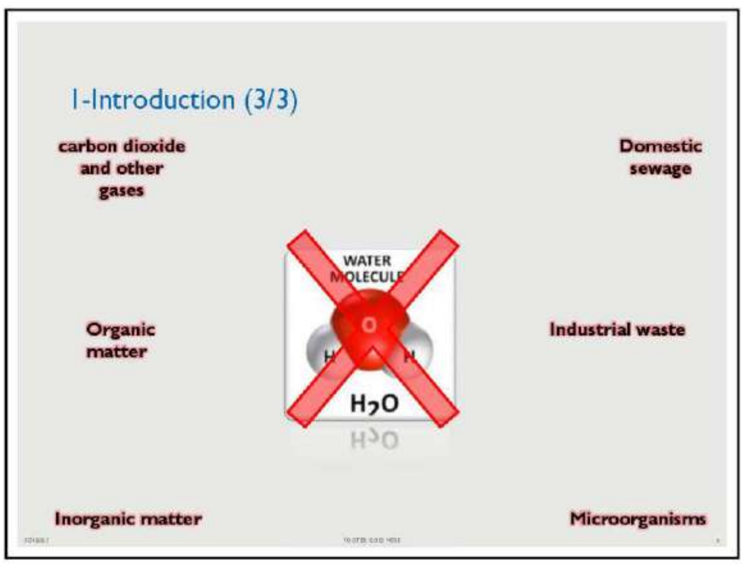
5000 L for 1 kg of rice

50 L for 1 newspaper

4


1-Introduction (2/3)
Water as a solvent
hydrogen bonds
Industrial waste
solute
molecule
• Universal solvent

5

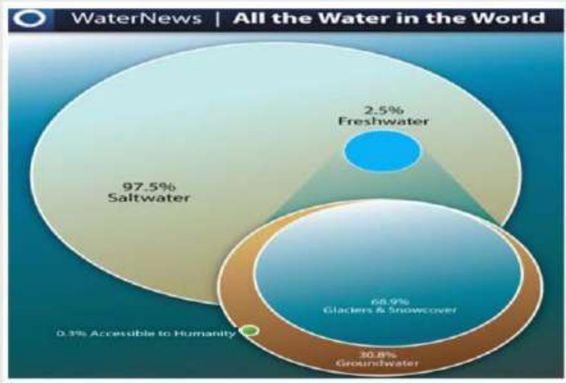

1-Introduction (3/3)
carbon dioxide
and other
gases
Domestic
sewage
WATER
MOLECULE
O
H
H
H₂O
Organic
matter
Industrial waste
Inorganic matter
Microorganisms

6

3

2-Numbers speak (statistics) (1/6)

JH45

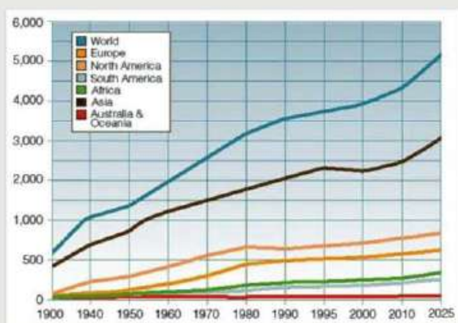


- Water distribution over water bodies

7

2-Numbers speak (statistics) (2/6)

JH45



- Global water consumption 1900-2025 (by region, in billions m3 per year)

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4

Slide 7

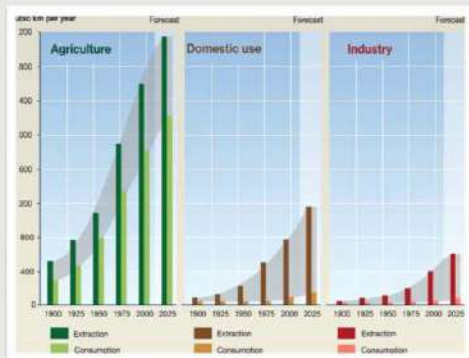
JH45 http://www.unwater.org/statistics.html
Jules Hatem, 3/13/2023

Slide 8

JH45 http://www.unwater.org/statistics.html
Jules Hatem, 3/13/2023

2-Numbers speak (statistics) (3/6)

JH45

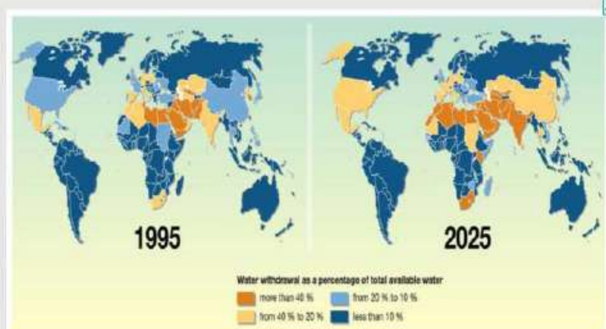


- Water consumption in different sectors

9

2-Numbers speak (statistics) (4/6)

JH45



- Water withdrawal as percentage of total available water

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Slide 9

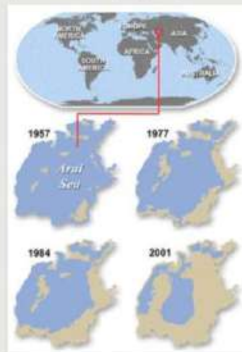
JH45 http://www.unwater.org/statistics.html
Jules Hatem, 3/13/2023

Slide 10

JH45 http://www.unwater.org/statistics.html
Jules Hatem, 3/13/2023

2-Numbers speak (statistics) (5/6)

JH45

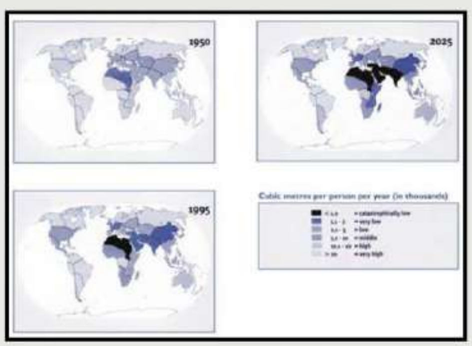


- Example of water withdrawal (Aral sea)

11

2-Numbers speak (statistics) (6/6)

JH45



- Global water availability

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Slide 11

JH45 http://www.unwater.org/statistics.html
Jules Hatem, 3/13/2023

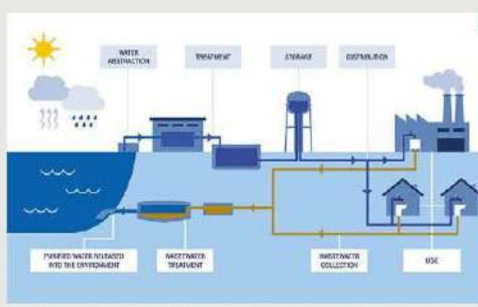
Slide 12

JH45 http://www.unwater.org/statistics.html
Jules Hatem, 3/13/2023

3-Water cycle

13

4-Water supply infrastructure



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Slide 13

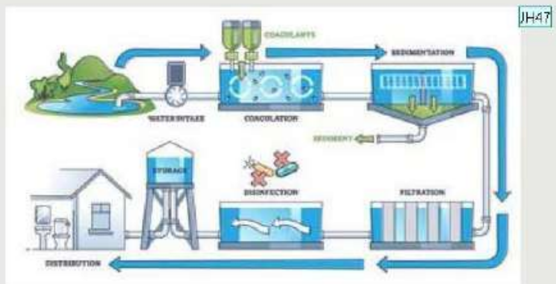
JH46 https://www.australianenvironmentaleducation.com.au/education-resources/the-natural-\
Jules Hatem, 3/13/2023

Slide 14

JH48 https://aquamain.com/why-is-water-infrastructure-so-important/
Jules Hatem, 3/13/2023

4-Water supply infrastructure

4.1-Water treatment plant



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4-Water supply infrastructure

4.2-Storage tanks

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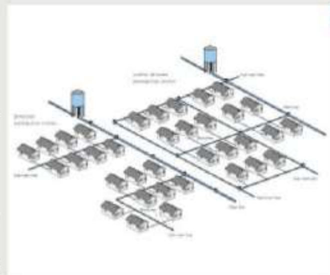
Slide 15

JH47 https://www.livestrong.com/article/128483-steps-water-purification/
Jules Hatem, 3/13/2023

4-Water supply infrastructure

4.3-Water distribution systems (1/4)

- Water can be distributed by following these methods:
  - -Gravity
  - -Pump
  - -Pump And reservoir
- General characteristics of water distribution system are:
  - -Able to supply clean water sufficiently
  - -Effective distribution system
  - -Piping system is able to supply water continuously with minimum maintenance
- Material Used in distribution pipe should be durable and do not give long term side effect to consumers
- Distribution system should be economical, in terms of its design, layout and construction



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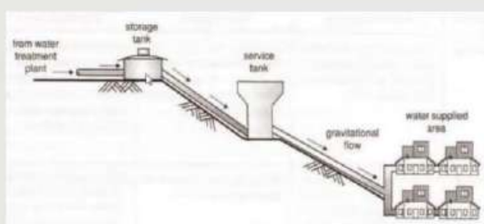
4-Water supply infrastructure

4.3-Water distribution systems – Gravity system (2/4)



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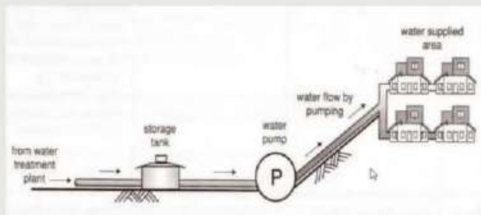
Slide 17

JH49 https://www.emergency-wash.org/water/en/technologies/technology/community-distribu
Jules Hatem, 3/13/2023

5/31/2023

4-Water supply infrastructure

4.3-Water distribution systems – Pump system (3/4)



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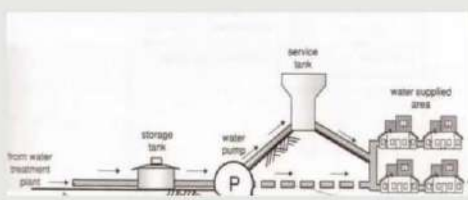
4-Water supply infrastructure

4.3-Water distribution systems – Pump and Reservoir (4/4)



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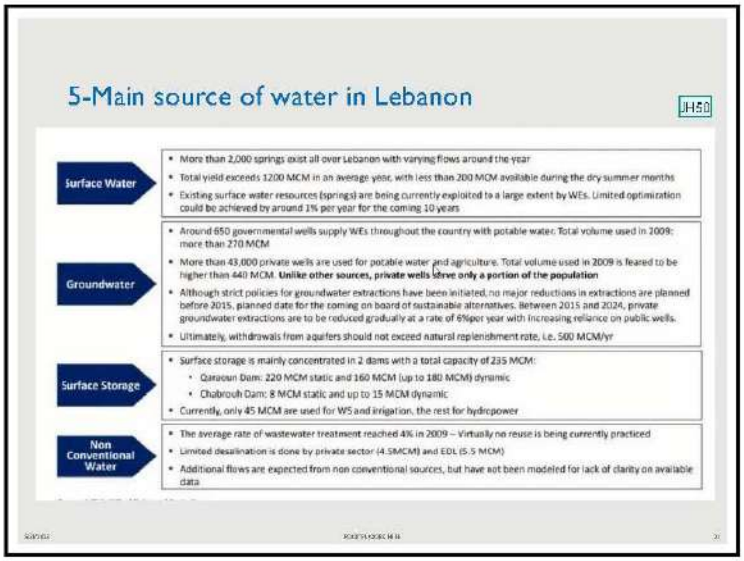

5-Main source of water in Lebanon
JH50
Surface Water
More than 2,000 springs exist all over Lebanon with varying flows around the year
Total yield exceeds 1200 MCM in an average year, with less than 200 MCM available during the dry summer months
Existing surface water resources (springs) are being currently exploited to a large extent by WEs. Limited optimization could be achieved by around 1% per year for the coming 10 years
Groundwater
Around 650 governmental wells supply WEs throughout the country with potable water. Total volume used in 2009: more than 270 MCM
More than 43,000 private wells are used for potable water and agriculture. Total volume used in 2009 is feared to be higher than 440 MCM. Unlike other sources, private wells serve only a portion of the population
Although strict policies for groundwater extractions have been initiated, no major reductions in extractions are planned before 2015, planned date for the coming on board of sustainable alternatives. Between 2015 and 2024, private groundwater extractions are to be reduced gradually at a rate of 6%per year with increasing reliance on public wells.
Ultimately, withdrawals from aquifers should not exceed natural replenishment rate, i.e. 500 MCM/yr
Surface Storage
Surface storage is mainly concentrated in 2 dams with a total capacity of 235 MCM:
Qaraoun Dam: 220 MCM static and 160 MCM (up to 180 MCM) dynamic
Chabrouh Dam: 8 MCM static and up to 15 MCM dynamic
Currently, only 45 MCM are used for WS and irrigation, the rest for hydropower
Non Conventional Water
The average rate of wastewater treatment reached 4% in 2009 – Virtually no reuse is being currently practiced
Limited desalination is done by private sector (4.5MCM) and EDL (5.5 MCM)
Additional flows are expected from non conventional sources, but have not been modeled for lack of clarity on available data

21


6-Sustainability of water sector in Lebanon
Capacity Building
Data Collection
Operation and maintenance
Fighting Climate change
Service coverage
Social responsibility & legal reform
Sustainability and Integrated management

22

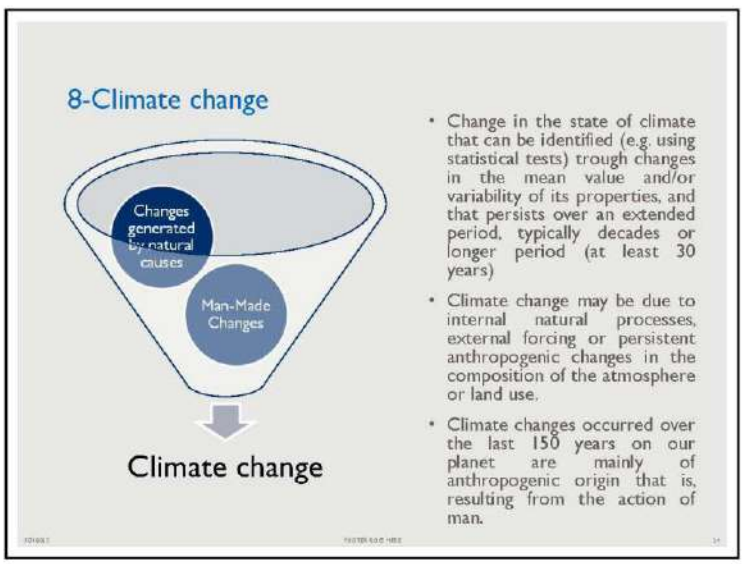
11

Slide 21

JH50 Source: MoEW, WEs, MoA
Jules Hatem, 3/13/2023


7-Future challenges in drinking water sector
Limited water resource
Sustainable water supply and treatment facilities
Other environmental changes
Public interests and participation
Climate challenge unknown

23


8-Climate change
Changes generated by natural causes
Man-Made Changes
Climate change
Change in the state of climate that can be identified (e.g. using statistical tests) trough changes in the mean value and/or variability of its properties, and that persists over an extended period, typically decades or longer period (at least 30 years)
Climate change may be due to internal natural processes, external forcing or persistent anthropogenic changes in the composition of the atmosphere or land use.
Climate changes occurred over the last 150 years on our planet are mainly of anthropogenic origin that is, resulting from the action of man.

24

9-Impact of climate change on water resources

- Increased evaporation of surface water sources
- Reduced snow cover, earlier snowmelt seasonal water regimes
- Reduced river flows and increased strain on limited groundwater sources, limiting fresh water supply
- Salt water intrusion/salinization of coastal aquifers: destruction of coastal water infrastructure.

25

USAID
FROM THE AMERICAN PEOPLE

Thank you!

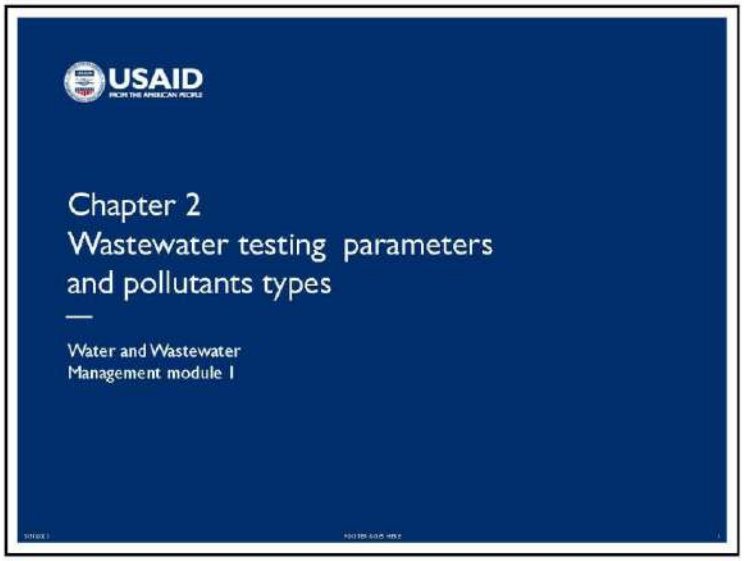
26

Slide 25

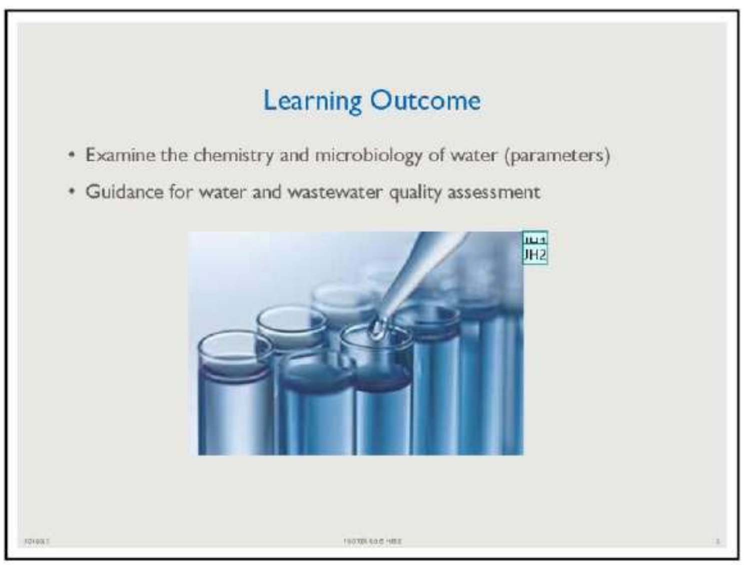
JH51 https://www.qgdigitalpublishing.com/publication/?i=578087&article_id=3346565&view=
Jules Hatem, 3/13/2023

1.2 – Wastewater Testing Parameters and Pollutants Types

5/31/2023



1



2

1

Slide 2

JH1 Three Counties Water. (No Year) Microbiological &
Chemistry Sampling. [Online] [Accssed on 11 March 2023]
Jules Hatem, 3/11/2023

JH2 https://threecountieswater.co.uk/services/microbiological-chemistry-sampling/
Jules Hatem, 3/11/2023

Outline

1. Introduction
2. Human Activity contaminating water
3. Water pollution
4. Categories of water pollution
5. Source of water contaminants
6. Effects of water pollution
7. Water quality
8. Water quality parameters
9. Water quality requirements

3

I- Introduction

- The human factor is most critical in aggrading this problem by wasting water, polluting water resources, and/or inappropriately managing water
- Total wastewater discharged globally in tens of millions of m3/day
- 80 -90% of all wastewater in developing countries is discharged directly into surface bodies

4

2

Slide 4

JH3 Shirin Ali. (2022). About half of US water 'too polluted' for swimming, fishing or drinking, report finds
Jules Hatem, 3/11/2023

JH4 https://thehill.com/changing-america/sustainability/environment/600070-about-half-of-u
Jules Hatem, 3/11/2023

2-Human Activity contaminating water

Water Use	Contaminating
Domestic use	Yes
Livestock watering	Yes
Irrigation	Yes
Aquaculture	Yes
Commercial fisheries	Yes
Food processing	Yes
Mining	Yes
Water transportation	Yes
Hydroelectric power generation	Yes
Nuclear power generation	Yes

5

3-Water Pollution

- Water pollution occurs when harmful substances contaminate a body of water, degrading water quality and rendering it toxic to humans or the environment

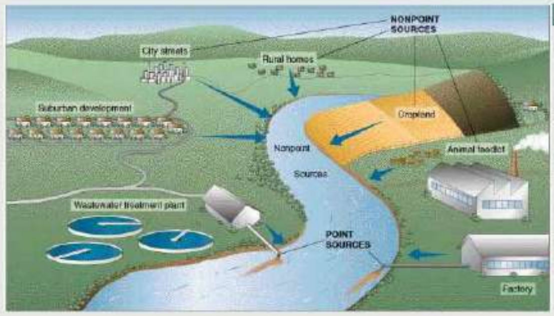
6

3

Slide 6

JH5 https://phys.org/news/2016-08-millions-pollution.html
Jules Hatem, 3/11/2023

4- Categories of water pollution (1/2)



JH7

7

4- Categories of water pollution (2/2)

JH6

POINT SOURCE POLLUTION
VERSUS
NONPOINT SOURCE POLLUTION

NONPOINT SOURCE POLLUTION	POINT SOURCE POLLUTION
Pollution that occurs from a single identifiable source	Pollution that occurs via many diffuse sources
Discharge of effluents occurs at one point	Caused by the discharge of effluents over a wide area
Effect is high	Effect is low
A treatment plant can be installed in the area of discharge	A treatment plant is less effective
Ex: faulty treatment plants, oil tank spills, combined sewer outfalls, etc.	Ex: farming fertilizers, road salt runoff, etc.

8

Slide 7

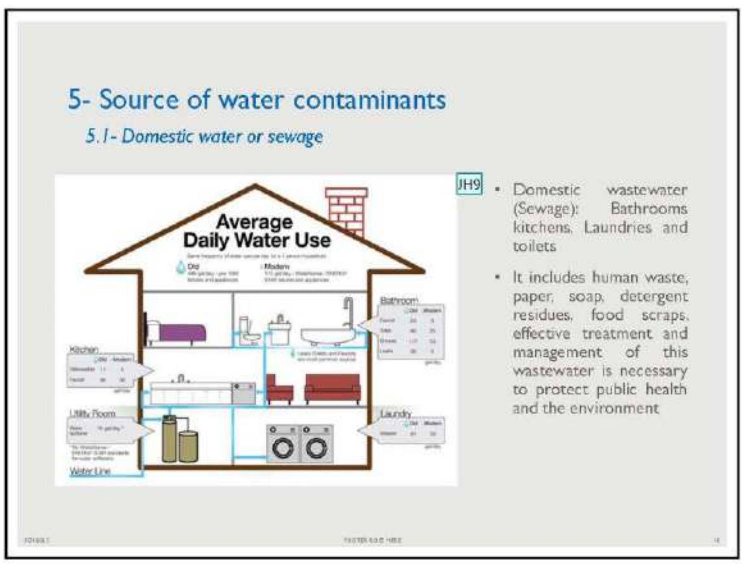
JH7 https://socratic.org/questions/what-is-the-difference-between-point-source-and-nonpoir
Jules Hatem, 3/11/2023

Slide 8

JH6 https://pediaa.com/difference-between-point-source-and-nonpoint-source-pollution/
Jules Hatem, 3/11/2023


5- Source of water contaminants
JH8
Mining
Agriculture Forestry
Industry
-textiles
-plastics
-chemicals
-ash
-nuclear waste
-and others
Household, commercial and government bodies
Construction Demolition
Wastewater treatment

9


5- Source of water contaminants
5.1- Domestic water or sewage
Average Daily Water Use
Kitchen
Bathroom
Utility Room
Laundry
Water Line
JH9
• Domestic wastewater (Sewage): Bathrooms kitchens, Laundries and toilets
• It includes human waste, paper, soap, detergent residues, food scraps, effective treatment and management of this wastewater is necessary to protect public health and the environment

10

Slide 9

JH8 https://sisu.ut.ee/waste/book/11-definition-and-classification-waste
Jules Hatem, 3/11/2023

Slide 10

JH9 https://droughtresources.unl.edu/household-water-use
Jules Hatem, 3/11/2023

5- Source of water contaminants

5.2- Industrial wastewater

- Industrial wastewater: These wastes my result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operation
- Industrial wastewater is the aqueous discard that results from substances having been dissolved or suspended in water

JH10

11

5- Source of water contaminants

5.3- Commercial wastewater

JH11

- Waste from premises used mainly for the general purposes of a business or trade or for the purpose of recreation, education, car washing, sport or entertainment

12

6

Slide 11

JH10 https://en.wikipedia.org/wiki/Industrial_wastewater_treatment
Jules Hatem, 3/11/2023

Slide 12

JH11 https://www.sulzer.com/en/shared/applications/commercial-wastewater-without-toilet-w
Jules Hatem, 3/11/2023

5- Source of water contaminants

5.4- Surface runoff water

- Rain and snow flow over streets, parking lots, and roofs collecting excess nutrients and pollutants before entering into a storm drain or water body

JH12

13

5- Source of water contaminants

5.5- Radio Active contaminants

JH13

- Radioactive substances: it's generated by uranium mining, nuclear power plants and the production and testing of military weapons
- Radioactive waste can persist in the environment for thousands of years making disposal a major challenge

14

Slide 13

JH12 https://www.facebook.com/SWCDINDIANAHancock/photos/a.755320454504294/345887!
Jules Hatem, 3/11/2023

Slide 14

JH13 https://www.youtube.com/watch?v=02BqQqguZYA
Jules Hatem, 3/11/2023

5- Source of water contaminants

5.6- Oil spills

- Oil and gasoline that drips from millions cars and truck every day.
- Land-Based sources such as factories, farms and cities
- Tanker spills accounts for about 10% of the oil in waters around the world
- Regular operations of the shipping industry contribute about 30%

JH14

15

5- Source of water contaminants

5.7- Agriculture

JH15

- Agriculture is the leading cause of water degradation
- Every time it rains, fertilizers, pesticides and animal waste from farms and livestock operations, wash nutrients and pathogens – such bacteria and viruses into waterways

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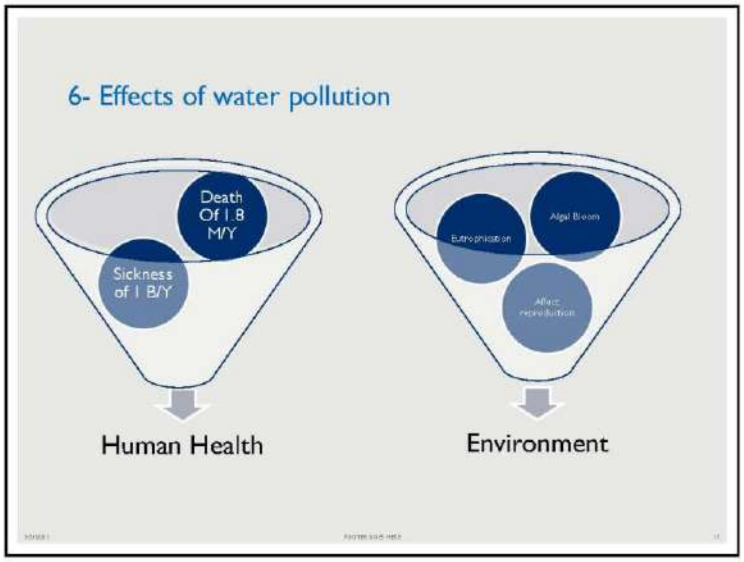
Slide 15

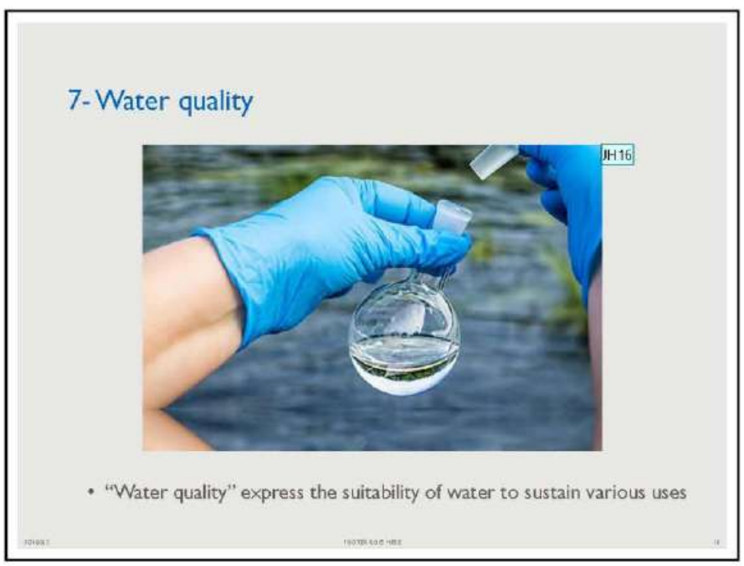
JH14 https://www.deccanherald.com/content/630253/impact-oil-spills-marine-life.html
Jules Hatem, 3/11/2023

Slide 16

JH15 https://flores.unu.edu/en/news/news/safe-use-of-wastewater-in-agriculture-in-practice.ht
Jules Hatem, 3/11/2023


6- Effects of water pollution
Death Of 1.8 M/Y
Sickness of 1 B/Y
Eutrophication
Algal Bloom
Affect reproduction
Human Health
Environment

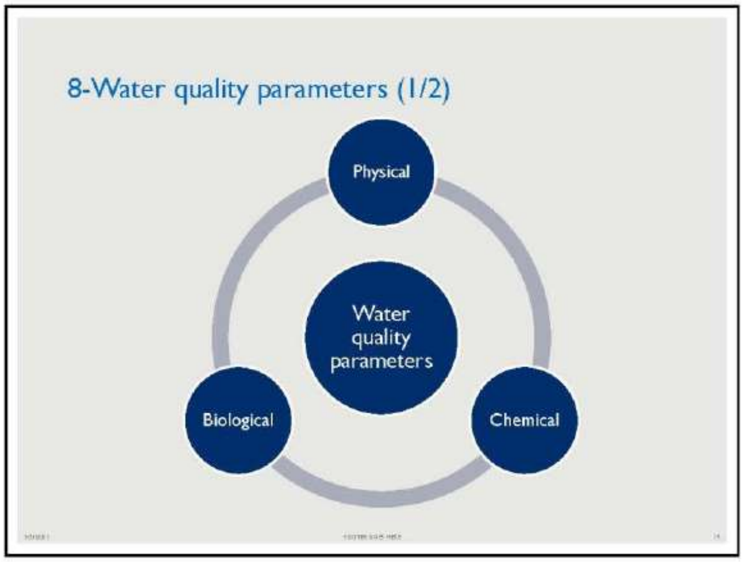
17


7- Water quality
JH16
• "Water quality" express the suitability of water to sustain various uses

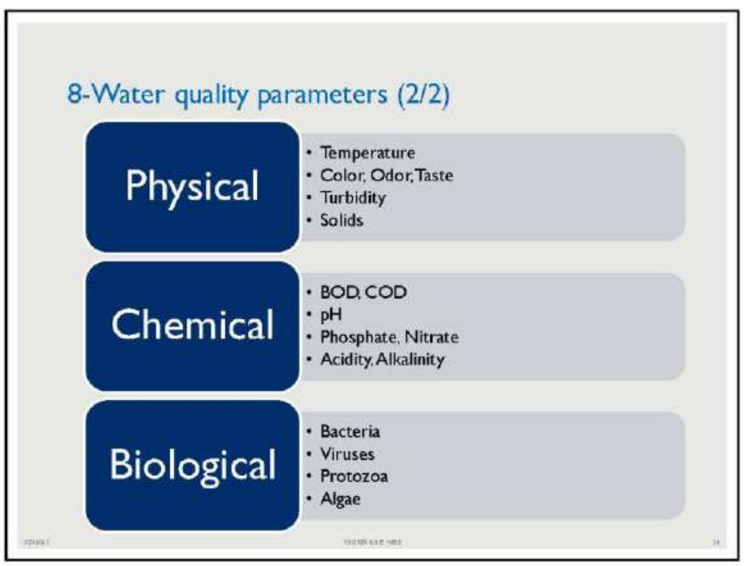
18

Slide 18

JH16 https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Quality
Jules Hatem, 3/11/2023


8-Water quality parameters (1/2)
Physical
Water quality parameters
Biological
Chemical

19


8-Water quality parameters (2/2)
Physical
• Temperature
• Color, Odor, Taste
• Turbidity
• Solids
Chemical
• BOD, COD
• pH
• Phosphate, Nitrate
• Acidity, Alkalinity
Biological
• Bacteria
• Viruses
• Protozoa
• Algae

20

8-Water quality parameters

8.1-Water physical characteristics

- The physical characteristics help in assessing the conditions of domestic wastewater whether fresh for septic and its earlier incarnations, for example ground water and/or industrial wastewaters mixed with domestic wastewater
- Temperature, turbidity, taste, color, solids, Odor

21

8-Water quality parameters

8.1-Water physical characteristics

8.1.1-Turbidity (NTU)

- Cloudiness of water, caused suspended material

Low turbidity water is clear, while high turbidity water is cloudy or murky

22

Slide 22

JH17 https://civilmint.com/turbidity-test-of-water/
Jules Hatem, 3/11/2023

8-Water quality parameters

8.1-Water physical characteristics

8.1.2-Temperature (°C)

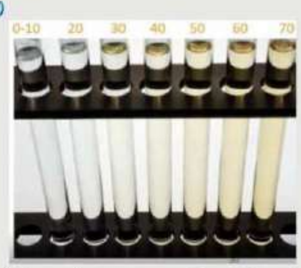
- Viscosity, solubility, odors and chemical reactions are influenced by temperature
- Chemical and biological reaction RATEs increase with increasing temperature
- Reaction rates usually assumed to double for an increase in temperature

23

8-Water quality parameters

8.1-Water physical characteristics

8.1.3- Color (PCU)



- Colored water indicate the presence of organic substances
- Color is graded on scale of 0 (clear) to 70 color units
- Pure water is colorless, which equivalent to 0 color unit

24

8-Water quality parameters

8.1-Water physical characteristics

8.1.4- Odor and Taste (TON or TTN)

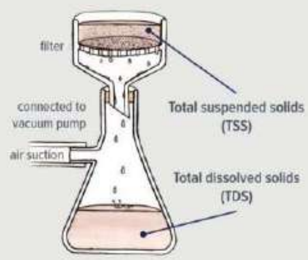
- Organic material discharged directly to water are sources of tastes and odor producing compounds released during biodegradation
- TON or TTN -= (A + B) / A (where TON is the threshold odor number and TTN is the thersold taste number

25

8-Water quality parameters

8.1-Water physical characteristics

8.1.5- Solids (mg/l or ppm)



- Residue remaining after evaporation of the water and drying the residue
- Total solid (TS) = Total dissolved solid (TDS) + Total suspended solid (TSS)
- How does TDS affect the quality of the water? When the amount of TDS is low the Water is fresh (attached a table of salinity) ….. high TDS so its saline or briny

26

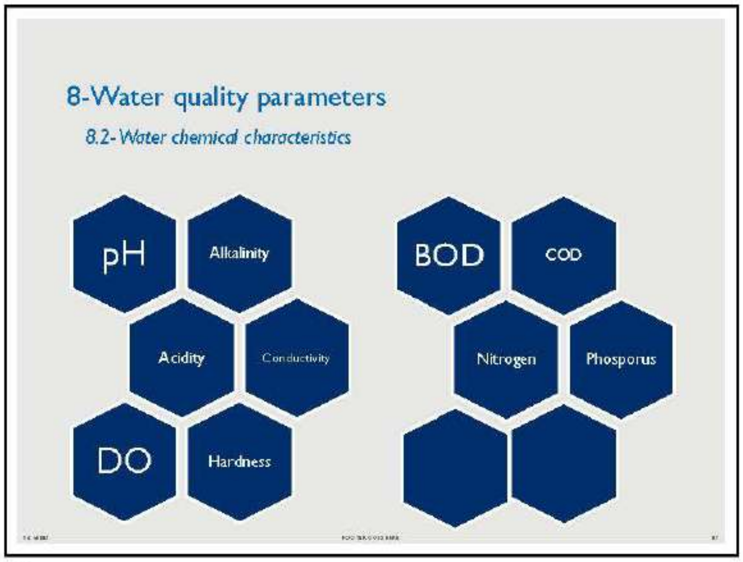
Slide 25

JH18 https://www.researchgate.net/figure/Taste-and-odor-wheel-for-the-drinking-water-indus
Jules Hatem, 3/11/2023

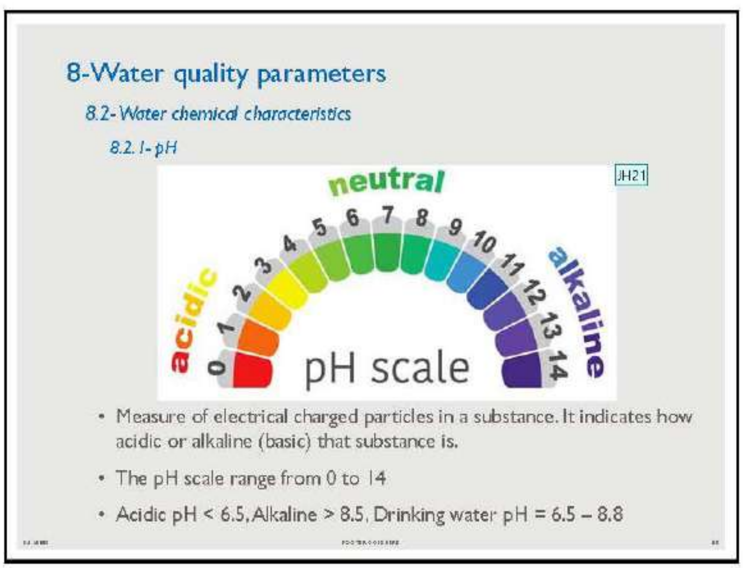
Slide 26

JH19 https://tappwater.mt/blogs/news/why-tds-fails-to-be-a-good-way-to-measure-water-qu
Jules Hatem, 3/11/2023

JH20 https://datastream.org/en/guide/total-suspended-solids-and-total-dissolved-solids
Jules Hatem, 3/11/2023


8-Water quality parameters
8.2- Water chemical characteristics
pH
Alkalinity
Acidity
Conductivity
DO
Hardness
BOD
COD
Nitrogen
Phosporus

27


8-Water quality parameters
8.2- Water chemical characteristics
8.2.1- pH
JH21
neutral
acidic
alkaline
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
pH scale
• Measure of electrical charged particles in a substance. It indicates how acidic or alkaline (basic) that substance is.
• The pH scale range from 0 to 14
• Acidic pH < 6.5, Alkaline > 8.5, Drinking water pH = 6.5 – 8.8

28

14

Slide 28

JH21 https://blog.havells.com/water-purifier/right-ph-level-in-drinking-water-how-essential/
Jules Hatem, 3/11/2023

8-Water quality parameters

8.2-Water chemical characteristics

8.2.2-Alkalinity

- Alkalinity (mg/L $CaCO_3$)
- Acid-neutralizing capacity compromised of total of all titribale bases.
- Alkalinity is caused by the presence of (OH^-), (HCO_3^-) and (CO_3^{2-}) or a mixture of two of these ions in the water
- $OH^- + HCO_3 \rightarrow CO_3^{2-} + H_2O$
- Alkalinity is determined by titration with a standard acid solution (H_2SO_4 of 0.02 N) using selective indicators (methyl orange or phenolphthalein)

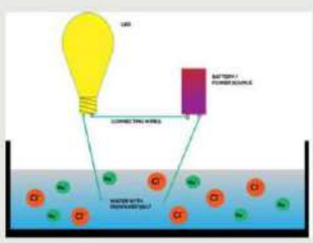
JH22

29

8-Water quality parameters

8.2-Water chemical characteristics

8.2.3-Conductivity (S/m)



- It is a measure of the ability of a solution to carry or conduct an electrical current

30

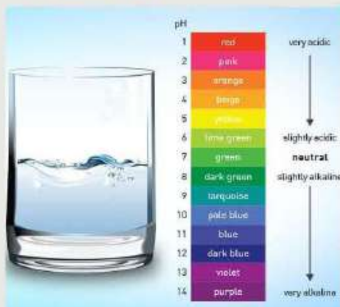
Slide 29

JH22 https://blog.orendatech.com/total-alkalinity-role-water-chemistry
Jules Hatem, 3/11/2023

8-Water quality parameters

8.2- Water chemical characteristics

8.2.4- Acidity (g/L)



JH23

- A measure of acids in a solution.
- Acids can influence many processes such as corrosion, chemical reaction and biological activities
- The level of acidity is determined y titration with standard sodium hydroxide (0.02 N) using phenolphthalein as indicator
- Acidity indicates the corrosiveness of acidic water on steel, concrete and other material

31

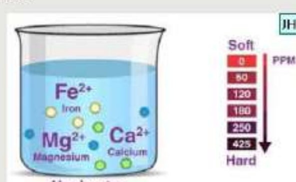
8-Water quality parameters

8.2- Water chemical characteristics

8.2.5- Hardness (ppm or mg/l) (1/2)

- Express the properties of highly mineralized waters, calcium (Ca^{2+}) and Magnesium (Mg^{2+})
- There are two types of hardness:
  - Temporary hardness which is due to carbonates and bicarbonate can be removed by boiling
  - Permanent hardness which is remaining after boiling is caused mainly by sulfates and chlorides

JH24



32

16

Slide 31

JH23 https://www.kent.co.in/blog/ph-level-in-drinking-water-why-do-you-need-to-concerned/
Jules Hatem, 3/11/2023

Slide 32

JH24 https://byjus.com/jee/hardness-of-water-types-and-removal/
Jules Hatem, 3/11/2023

8-Water quality parameters

8.2-Water chemical characteristics

8.2.5- Hardness (ppm or mg/l) (2/2)

- Without Lab. Equipment how can we tell the water is hard ?

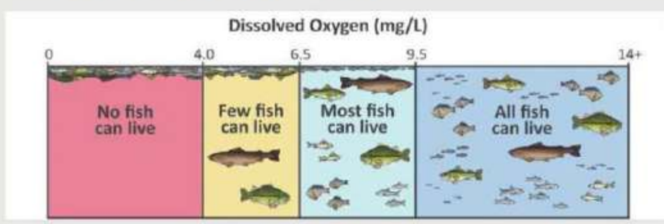
Water classification	Total hardness concentration as mg/L as $CaCO_3$
Soft water	<50 mg/L as $CaCO_3$
Moderately hard	50-150 mg/L as $CaCO_3$
Hard water	150-300 mg/L as $CaCO_3$
Very hard	>300 mg/L as $CaCO_3$

33

8-Water quality parameters

8.2-Water chemical characteristics

8.2.6- Dissolved Oxygen – DO (mg/l or ppm)



JH25

- Refers to the level of free, non-compound oxygen (O_2) dissolved in water or other liquids
- DO influence on the organisms living whiten a body of water. Each time the DO increases the water quality increases also

34

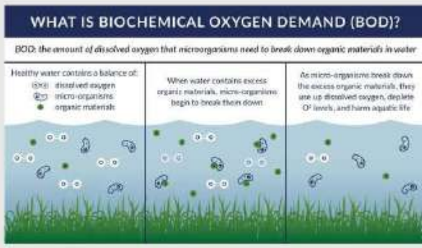
Slide 34

JH26 https://datastream.org/en/guide/dissolved-oxygen
Jules Hatem, 3/11/2023

8-Water quality parameters

8.2-Water chemical characteristics

8.2.7- Biochemical oxygen Demand – BOD (ppm or mg/l) (1/2)



JH27

- BOD is the measure of the quantity of oxygen used by aerobic in the oxidation of organic matter present in a given water sample of certain temperature over a specific time period.
- Indicator of the degree of organic pollution of water

35

8-Water quality parameters

8.2-Water chemical characteristics

8.2.7- Biochemical oxygen Demand – BOD (ppm or mg/l) (2/2)

- $BOD_5 = (D_0 - D_i)/D_f$
- if you take ample of water from a river and you dilute it 1/100, you test DO at sampling time to be equal to 8.7 mg/l and after 5 days of incubation it is 6.3 mg/l .... Calculate BOD_5 !

JH28

36

Slide 35

JH27 https://blog.iceslicer.com/how-do-deicers-affect-biochemical-oxygen-demand
Jules Hatem, 3/11/2023

Slide 36

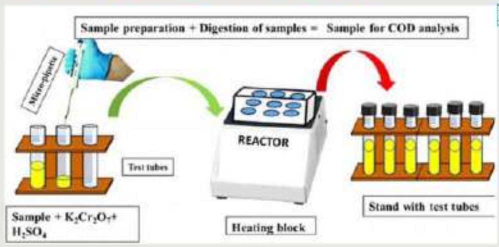
JH28 https://blog.iceslicer.com/how-do-deicers-affect-biochemical-oxygen-demand
Jules Hatem, 3/11/2023

8-Water quality parameters

8.2-Water chemical characteristics

8.2.8- Chemical oxygen demand – COD (ppm or mg/l)

JH29



- COD measures all the biodegradable and the non-biodegradable substances

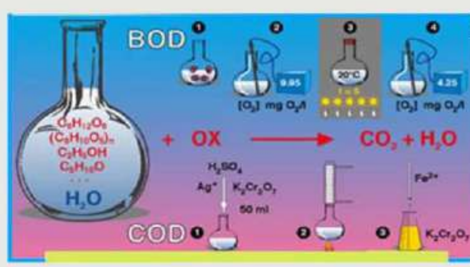
37

8-Water quality parameters

8.2-Water chemical characteristics

8.2.9- BOD v/s COD

JH30



38

19

Slide 37

JH29 http://www.enviroterm.com/2021/04/09/74160/
Jules Hatem, 3/11/2023

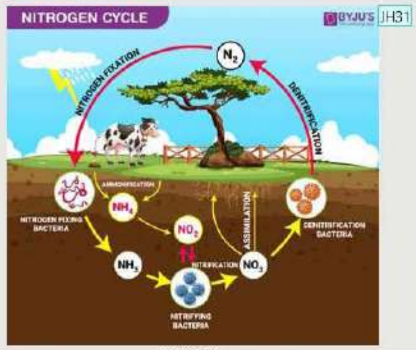
Slide 38

JH30 https://www.google.com/search?q=BOD+versus+COD&tbm=isch&ved=2ahUKEwjjmeek-
Jules Hatem, 3/11/2023

8-Water quality parameters

8.2- Water chemical characteristics

8.2.10- Nitrogen (ppm or mg/l)

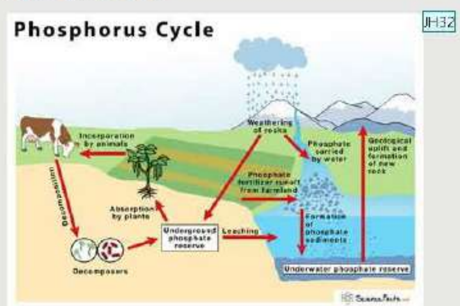


39

8-Water quality parameters

8.2- Water chemical characteristics

8.2.11- Phosphorus (ppm or mg/l)



40

Slide 39

JH31 https://byjus.com/biology/nitrogen-cycle/
Jules Hatem, 3/11/2023

Slide 40

JH32 https://www.sciencefacts.net/phosphorus-cycle.html
Jules Hatem, 3/11/2023

8-Water quality parameters

8.3-Water biological characteristics

JH33

- Some organisms can be used as an indication for the existence of pollutants based on their known tolerance for a specified pollutant.
- Microorganisms exists everywhere in nature
- Human bodies maintain a normal population of microbes in the intestinal tract, a big portion of which is made up of coliform bacteria.
- Although there are millions of microbes per milliliter in wastewater, most of them are harmless

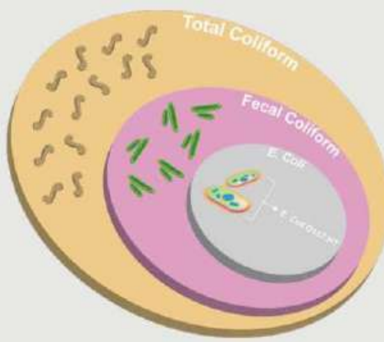
41

8-Water quality parameters

8.3-Water biological characteristics

8.3.1- Coliform

- The traditional indicator group for all microbial pathogens has been the coliform bacteria.
- Their ease of enumeration, crude relationship and disease occurrence, and the lack of better indicator led to the adoption of coliform counts international standards documents
- Exercise: Laboratory results show that the number of E coli is 15 counts, and the number of Fecal coliform is 20, calculate the total coliform count



JH34

42

21

Slide 41

JH33 https://rsscience.com/microscopic-organisms-pond-water/
Jules Hatem, 3/11/2023

Slide 42

JH34 https://albertawater.com/get-the-scoop-on-fecal-coliforms/
Jules Hatem, 3/11/2023

9-Water quality requirements (1/2)

- Based on the source and proposed usage of water, treatment processes and water quality requirements differ
- Water unsuitable for one use may be quite satisfactory for another and water may be considered acceptable for a particular use if water of better quality is not available
- Water quality requirements should be agreed with the water quality standards

43

9-Water quality requirements (2/2)

Microbiological Limits for Quality of Drinking Water Supplies (for Microbiological requirement and classification of non-chlorinated piped water supplies)

Class of Piped Water/Type of Test Count	Coliform count per 100 ml at 37°C	E. Coli (faecal Coliform) Count per 100 ml at 44°C
Excellent	0	0
Satisfactory	1 – 3	0
Suspicious	4 -10	0
Unsatisfactory	More than 1 0	1
		2 or more

44

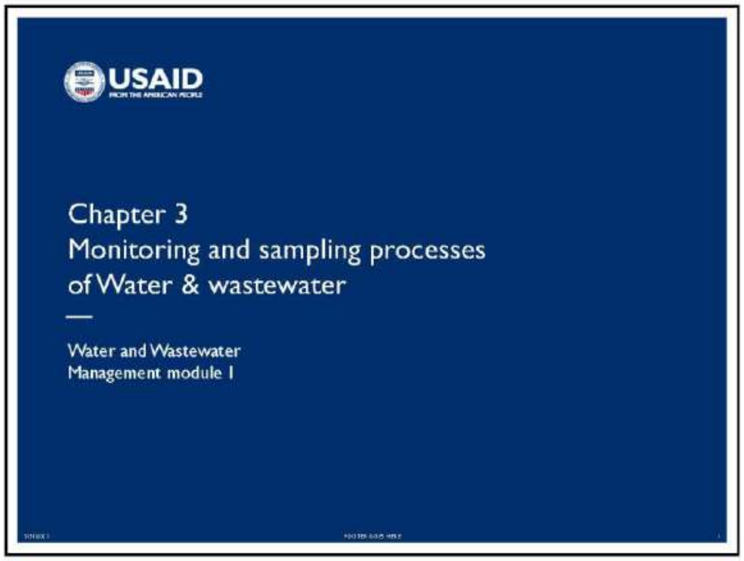
5/31/2023

45

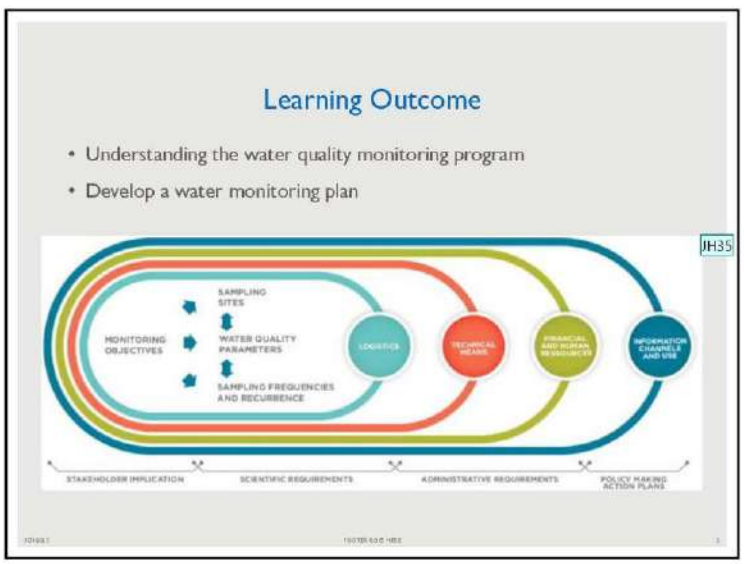
23

1.3 – Monitoring and Sampling Processes of Water and Wastewater

5/31/2023



1



2

1

Slide 2

JH35 https://www.sciencedirect.com/science/article/abs/pii/S0048969716314243
Jules Hatem, 3/11/2023

Outline

1. Introduction
2. The need for monitoring
3. Elements of water quality monitoring
4. Minimum requirements
5. Integrity of sampling
6. Steps of monitoring process
7. Summary
8. Quality Control

3

1-Introduction

- Having a good knowledge in water testing parameters is enough for the water quality monitoring
- The reliable assessment of water quality through water quality monitoring programs (WQMPs) is crucial in order for decision-makers to understand, interpret and use this information in information in support of their management activities aiming at protecting the resource.

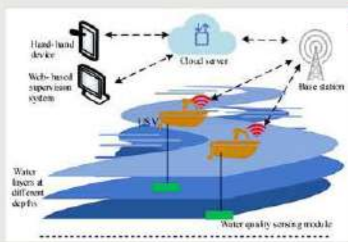
JH36

4

Slide 4

JH36 https://www.istockphoto.com/photos/water-quality-monitoring
Jules Hatem, 3/11/2023

2-The need for monitoring (1/2)

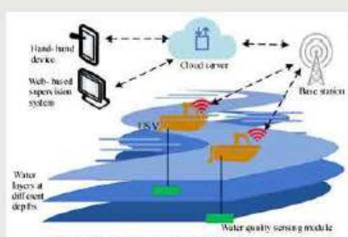


JH37

- Both sharing scientific knowledge and advanced technologies and building human and scientific/technical capacities are needed to improve water quality monitoring.
- Innovative technologies will produce reliable, accurate, continuous and systematic data on the quality of water resources
- Effort in raising awareness since every citizen can be part of the improvement of environment conditions, water quality management and decisions.

5

2-The need for monitoring (2/2)



JH37

- Monitoring are fundamentals tools in the management of freshwater resources
- Information characterizing the physical, chemical and/or biological status of water resources, determining trends and changes over time, and identifying emerging water quality issues
- Identify policies and measures to enhance water quality and wastewater, reduce and control water pollution from specific sources, evaluate the efficacy of pollution control and regulation policies and their implementation and deal with water quality emergencies

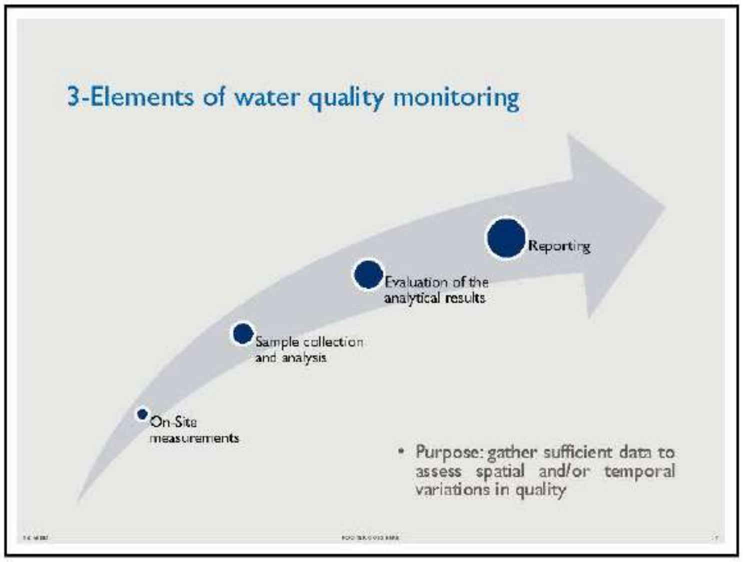
6

Slide 5

JH37 https://www.mdpi.com/2073-4441/12/3/681
Jules Hatem, 3/11/2023

Slide 6

JH37 https://www.mdpi.com/2073-4441/12/3/681
Jules Hatem, 3/11/2023


3-Elements of water quality monitoring
Reporting
Evaluation of the analytical results
Sample collection and analysis
On-Site measurements
• Purpose: gather sufficient data to assess spatial and/or temporal variations in quality

7


4-Minimum requirements
Required number of samples and tests on quality of wastewater effluents
Collect data, analyze and check compliance with set standards
Publication of test results

8

5-Integrity of sampling (1/2)

- Samples need to be representative of the body from which they were taken
- If the sample integrity is altered, the information gained from analysis could be misleading and ultimately results in mismanagement of water resources and/or polluting of the resource
- The main processes that have the potential to affect the integrity of a sample are: Contamination, Physical changes, Chemical changes and biological processes

9

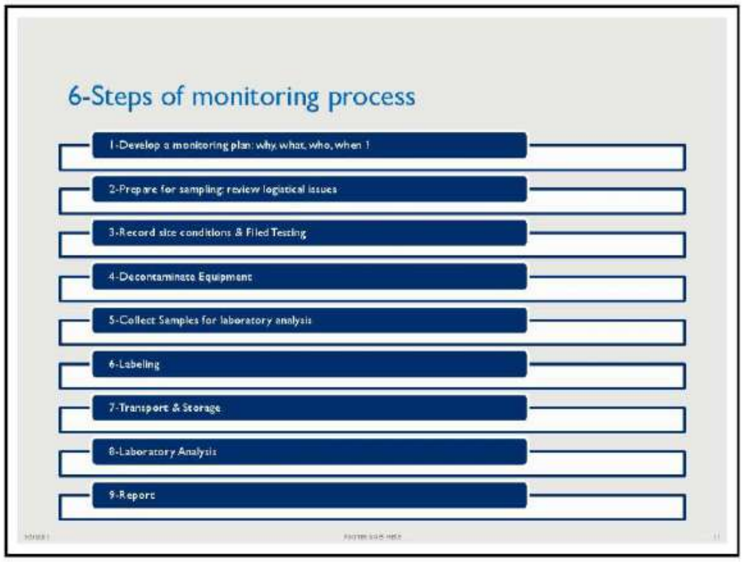
5-Integrity of sampling (2/2)

Contamination	Physical changes	Chemical changes	Biological process
• Foreign substances • Costly	• Temperature • Sorption • Degassing	• Precipitation • Oxidation	• Affect physical and chemical characteristics

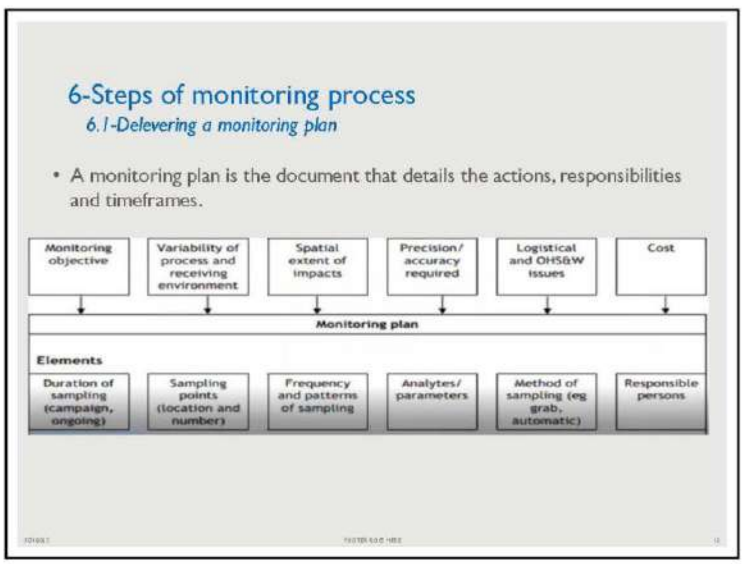
10

Slide 9

JH38 https://www.wastageproducts.com/services/other-services/
Jules Hatem, 3/11/2023


6-Steps of monitoring process
1-Develop a monitoring plan: why, what, who, when ?
2-Prepare for sampling: review logistical issues
3-Record site conditions & Filed Testing
4-Decontaminate Equipment
5-Collect Samples for laboratory analysis
6-Labeling
7-Transport & Storage
8-Laboratory Analysis
9-Report

11


6-Steps of monitoring process
6.1-Delevering a monitoring plan
• A monitoring plan is the document that details the actions, responsibilities and timeframes.
Monitoring objective
Variability of process and receiving environment
Spatial extent of impacts
Precision/ accuracy required
Logistical and OHS&W issues
Cost
Monitoring plan
Elements
Duration of sampling (campaign, ongoing)
Sampling points (location and number)
Frequency and patterns of sampling
Analytes/ parameters
Method of sampling (eg grab, automatic)
Responsible persons

12

6

6-Steps of monitoring process

6.1-Delevering a monitoring plan

6.1.1-Monitoring objective

- The first step in developing a monitoring plan is to clearly identify the objectives of the monitoring
- Water and wastewater monitoring can be undertaken to meet many objectives from gaining an understanding of an aquatic ecosystem

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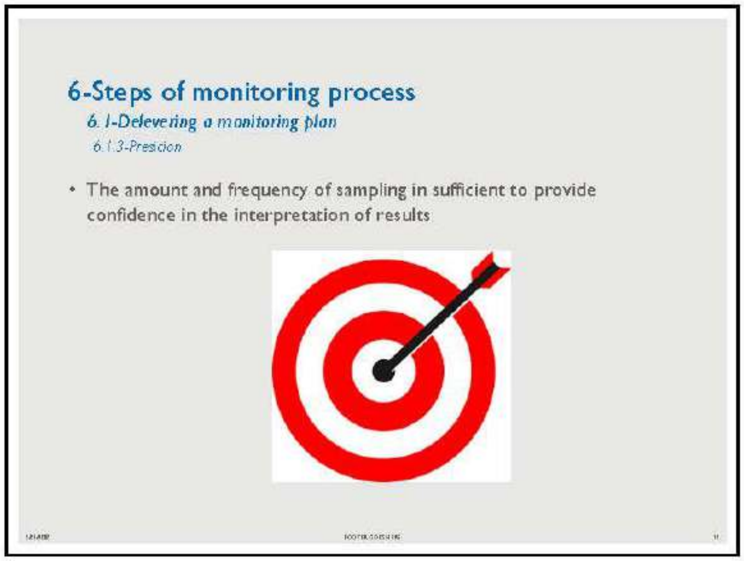
6-Steps of monitoring process

6.1-Delevering a monitoring plan

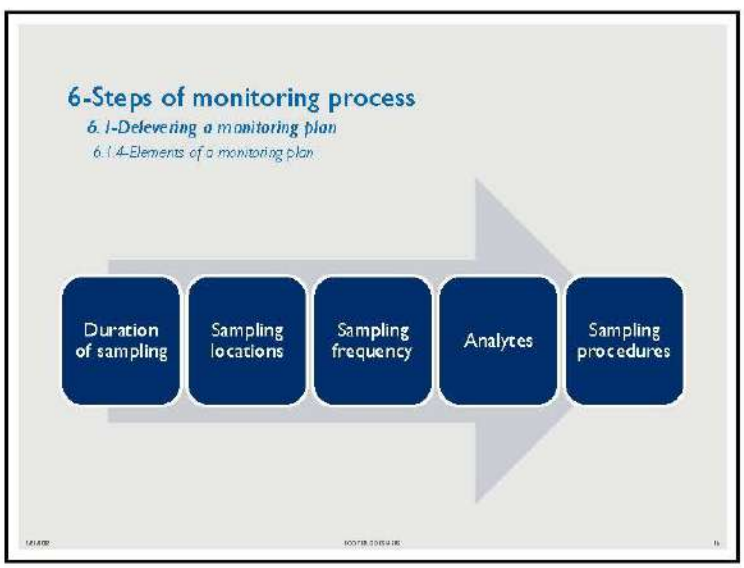
6.1.2-Variability Consideration

- Industrial process variability
  - Daily and weekly variation
  - Seasonal variation
  - Event Variation
- Environment variability
  - Diurnal variation
  - Depth variation
  - Tidal variation
  - Spatial variation

14


6-Steps of monitoring process
6.1-Delevering a monitoring plan
6.1.3-Presicion
• The amount and frequency of sampling in sufficient to provide confidence in the interpretation of results

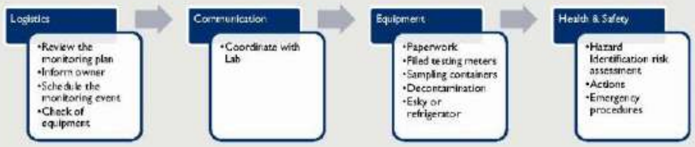
15


6-Steps of monitoring process
6.1-Delevering a monitoring plan
6.1.4-Elements of a monitoring plan
Duration of sampling
Sampling locations
Sampling frequency
Analytes
Sampling procedures

16

6-Steps of monitoring process

6.2-Prepare for sampling (1/3)



17

6-Steps of monitoring process

6.2-Prepare for sampling (2/3)

Analyte	Container type	Typical volume (mL)	Filling technique	Filtration and preservation	Holding time
physical and aggregate samples					
acidity and alkalinity	plastic or glass	500	fill container completely to exclude air	refrigerate	24 hours
colour—true	plastic or glass	500	fill container completely to exclude air	refrigerate and store in the dark	2 days
conductivity (at 25 °C)	plastic or glass	100	fill container completely to exclude air	none required	24 hours
oxygen, dissolved	glass			fix oxygen in the field and store in the dark (as per method of analysis used)	24 hours
pH	plastic or glass	100		refrigerate	6 hours
solids (dissolved or suspended)	plastic or glass	500	dissolved: fill container completely to exclude air	refrigerate	24 hours

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6-Steps of monitoring process

6.2-Prepare for sampling (3/3)

Equipment list	Check	Equipment list	Check
Documentation		**Quality control samples**	
Monitoring plan including site plan		Field blanks	
Appropriate area maps		Transport/equipment blanks	
Field notebook/record sheets		**Sample storage and transport**	
Chain of Custody		Eskies and ice	
Pens and textas		Packing material	
Sampling equipment		Ice packs/blocks	
Sampling rod		Packing tape	
Depth sampler		Address Labels	
Field meters		Courier information	
Disposable gloves		**Safety equipment**	
Sample containers (including containers for duplicates and blanks)		First-aid kit	
Labels for samples		Sunscreen/sunglasses	
Decontamination		Drinking water	
Clean work area, eg plastic groundsheet		Mobile phone/communication equipment	
		PPE– wide brimmed hat	

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6-Steps of monitoring process

6.3-Record site condition & Filed testing (1/2)

Filed Observation

- Weather: Temperature ,Wind and direction, Cloud cover/Rain
- Water: Tide / Depth
- Other: Surface film, algae, phytoplankton

Filed Measurement

- DO
- Temperature
- pH
- Conductivity
- Turbidity

20

10

6-Steps of monitoring process

6.3-Record site condition & Filed testing (2/2)

Analyte	Result/s		Instrument
Temperature			
Dissolved oxygen			
Turbidity			
Conductivity			
pH			
Chlorine			

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6-Steps of monitoring process

6.4-Decontamination

JH40

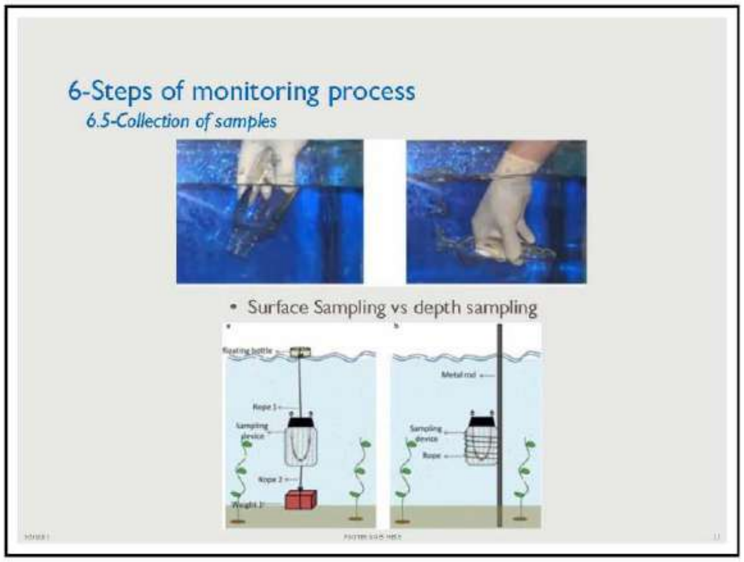
JH41

22

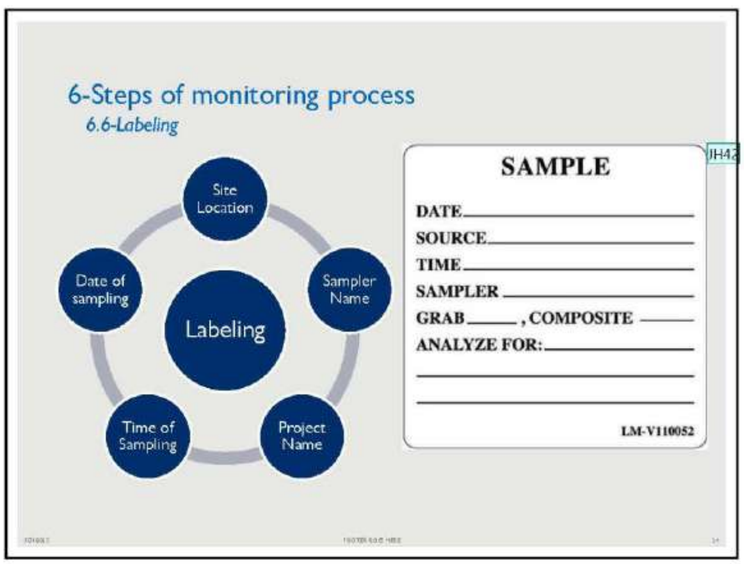
Slide 22

JH40 https://www.deltalab.es/en/producto/bottles-for-sterilization/
Jules Hatem, 3/11/2023

JH41 https://www.mesaustralia.com.au/blogs/news/can-you-autoclave-empty-glassware-and-p
Jules Hatem, 3/11/2023


6-Steps of monitoring process
6.5-Collection of samples
• Surface Sampling vs depth sampling
Floating bottle
Rope 1
Sampling device
Rope 2
Metal rod
Sampling device
Rope

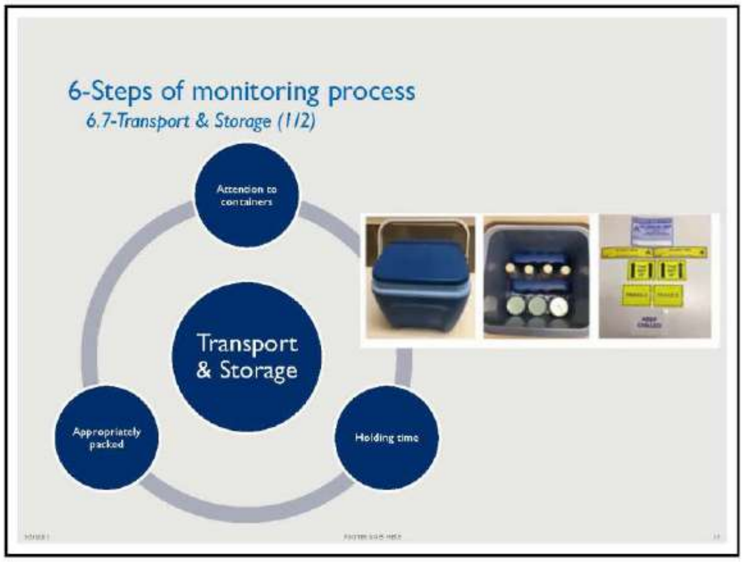
23


6-Steps of monitoring process
6.6-Labeling
Site Location
Sampler Name
Project Name
Time of Sampling
Date of sampling
Labeling
SAMPLE
DATE
SOURCE
TIME
SAMPLER
GRAB , COMPOSITE
ANALYZE FOR:
LM-V110052

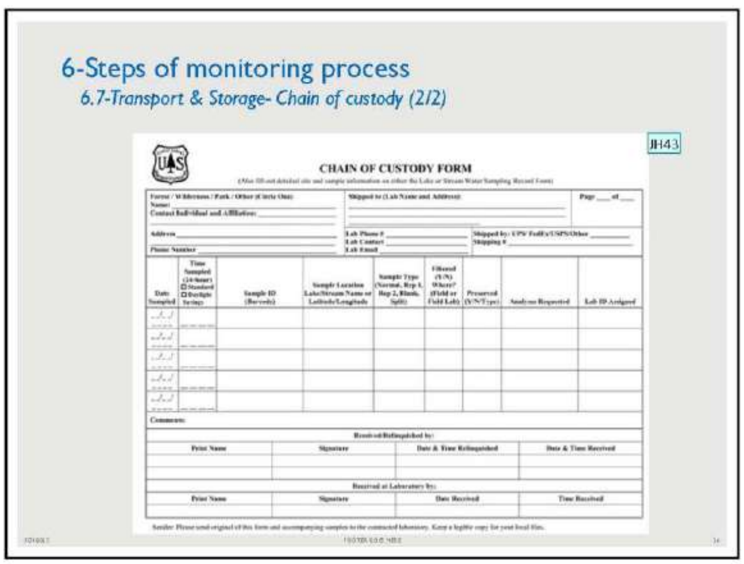
24

Slide 24

JH42 https://www.labelmaster.com/shop/sample-label-lm--v110052
Jules Hatem, 3/11/2023


6-Steps of monitoring process
6.7-Transport & Storage (1/2)
Attention to containers
Transport & Storage
Appropriately packed
Holding time

25


6-Steps of monitoring process
6.7-Transport & Storage- Chain of custody (2/2)
JH43
CHAIN OF CUSTODY FORM

26

13

Slide 26

JH43 https://studylib.net/doc/11091735/chain-of-custody-form
Jules Hatem, 3/11/2023

6-Steps of monitoring process

6.8-Laboratory Analysis

- The overall sample precision by using the Formula:

RPD: {(R1 – R2) / (R1 + R2)/2}*100

R1: result of Sample

R2: result of duplicate sample

27

6-Steps of monitoring process

6.9-Reporting (1/3)

- When submitting a monitoring report, the data must be reviewed and accompanied by appropriate supporting information

Report section	Requirements
Conclusions and proposed actions	• conclusions on meeting monitoring objective, compliance with assessment criteria and impact on environment • major assumptions or uncertainties • conclusions about effectiveness of the monitoring plan and overview of any proposed changes to monitoring plan (if required) • proposed actions to address non-compliance

28

6-Steps of monitoring process

6.9-Reporting (2/3)

Identity of Sample Location	Test parameter	Frequency (number of samples per year)	Total number of samples planned in a year	Number of tests conducted in a quarter of a year	Number of tests in compliance with Tanzanian standard limits	Cause of non-complianc e	Mitigation /corrective action taken (+ indicate time frame to completion)
	Ammonium						
	Biological Oxygen Demand (BOD)						
	Chemical Oxygen Demand (COD)						
	Color						
	Faecal Coliform						
	Nitrate						
	pH						
	Phosphorus						
	Total Coliform						
	Total Suspended						

29

6-Steps of monitoring process

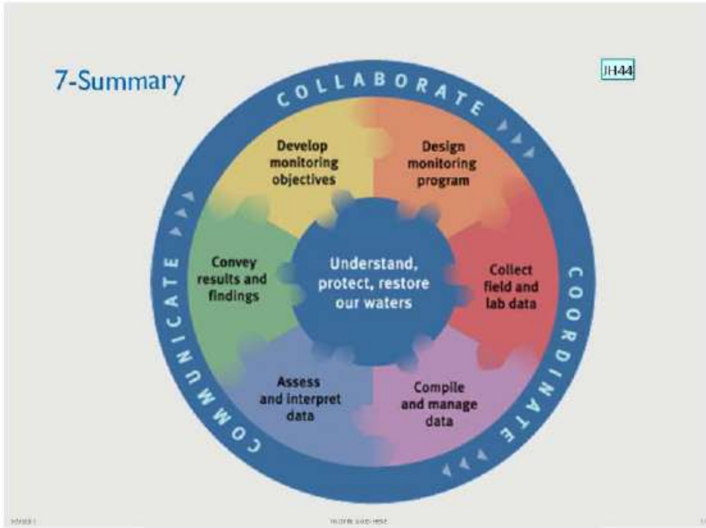
6.9-Reporting (3/3)

Parameter	Limit	Test Method
BOD_5 at 20 ^oC	30 mg/L	EMDC1 1173: Part 3 ± Five-day BOD Method
COD	60 mg/L	EMDC1 1173: Part 4 ± Dichromate Digestion Method
Color	300 TCU	ISO 7887: 1994, Water quality ± Examination and determination of color ± Section 3: Determination of true color using optical instruments
pH range	6.5-8.5	EMDC1 1173: Part 2 ± Electrometric Method
Temperature range	20-35 ^oC	See Annex A
Total Suspended Solids	100 mg/L	EMDC1 1173: Part 1 ± Gravimetric Method

30

15

5/31/2023



31

8-Quality Control

Monitoring Step	QC protocols	Purpose
Develop motoring plan	Various, including control sites, multiple sample locations, duplicate samples, sampling time	Ensure sample collected is representative
	Review of monitoring plan by EPA	To ensure that monitoring plan is in compliance with authorization and meets monitoring objective
Sample collection	Appropriate containers, filling and preservation	Minimize changes to sample (physical and chemical)
	Sample blanks—field, transport, equipment and container	Quantify contamination of samples during sampling process
	Decontamination of sampling equipment	Minimize contamination
Sample Filtrating	Filtration procedures	Minimise physical and chemical changes to sample
	Filtration blanks	Quantify physical changes and contamination in filtration
Field Test	Equipment calibration	Minimize and quantify bias and error in field equipment
Transport	Appropriate preservation techniques	Minimize changes to sample (physical and chemical)
Analysis	Duplicate samples	Check variability in lab analysis
Reporting	Peer review validation	Validate that sampling is undertaken as per monitoring plan and in accordance with sampling guidelines

32

16

Slide 31

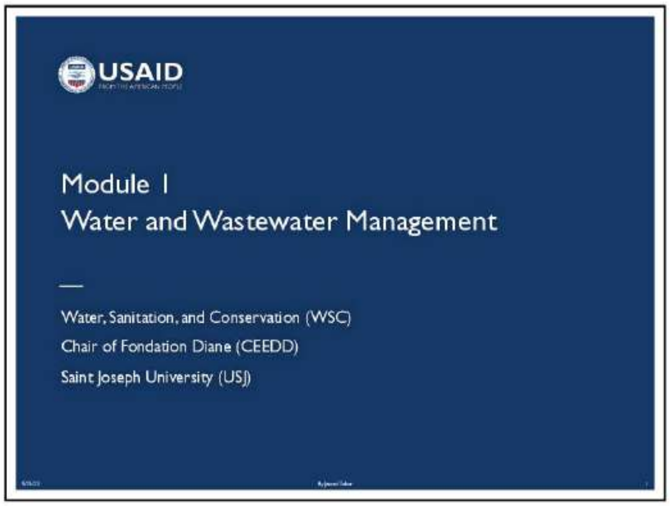
JH44 https://acwi.gov/monitoring/about_the_framework.html
Jules Hatem, 3/11/2023

33

17

1.4 – Water Services, Laws, Institutions, and Economic Uses

5/25/23



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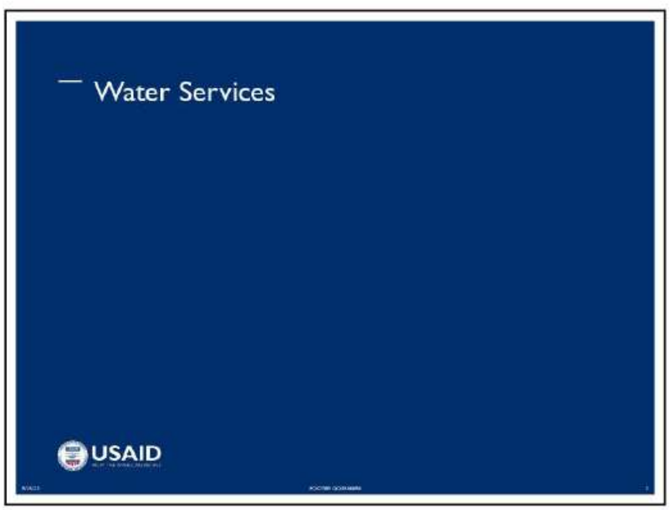

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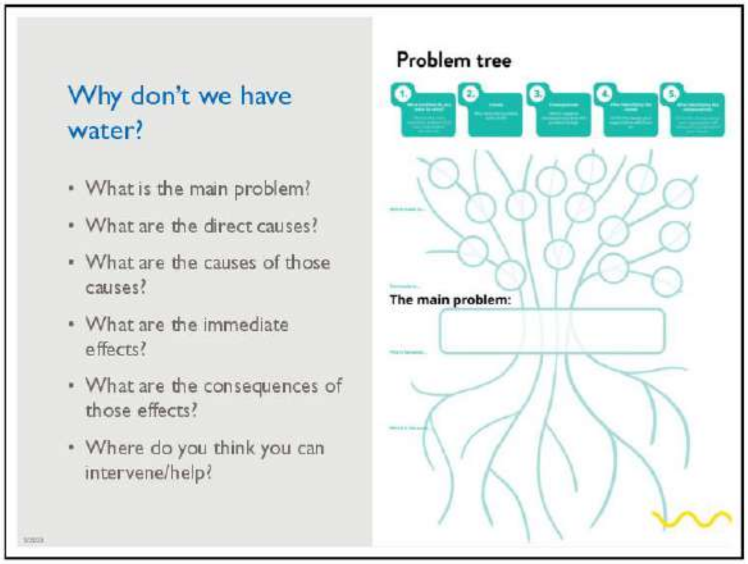
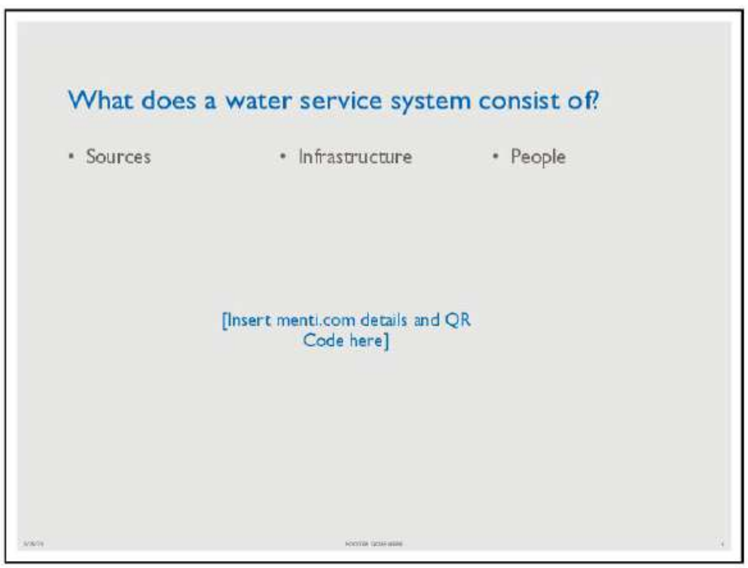
1


Why don't we have water?
• What is the main problem?
• What are the direct causes?
• What are the causes of those causes?
• What are the immediate effects?
• What are the consequences of those effects?
• Where do you think you can intervene/help?
Problem tree
The main problem:

3


What does a water service system consist of?
• Sources
• Infrastructure
• People
[Insert menti.com details and QR Code here]

4

Journey of a Water Droplet

5

Laws

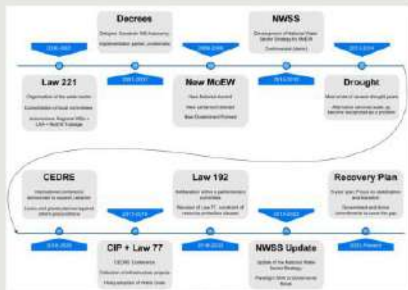
USAID

6

5/25/23

What does the legal framework look like?

- Different countries, different approaches (centralization, privatization)
- History: Traditional > Colonial > Modern > Contemporary
- State of transition; paradigm shift



7

Select excerpts from legislative and strategic texts

- Excerpt 1
Law 221:

- Excerpt 2
NWSS 2012:

- Excerpt 3
Water Law (192):

- Excerpt 4
Capital Investment Program:

- Excerpt 5
NWSS 2020:

- Excerpt 6
Recovery Plan:

8

4

Institutions

USAID

9

Development of a subregional masterplan

Resources:

- 1 Spring
- 1 Aquifer
- 5 Wells
- $10 million
- 1 week

Stakeholders:

- 3 Municipalities
- 1 Water Establishment
- 2 Farmer Associations
- Ministry of Energy & Water (Trainer)

Challenges:

- Competing demand
- Aquifer pollution
- Control of spring
- Information access
- Cost recovery

10

5/25/23

Integrated Water Resource Management

IWRM is a process which promotes the **coordinated development and management** of water, land and related resources in order to maximise economic and social **welfare** in an **equitable** manner without compromising the **sustainability** of vital ecosystems and the environment.

11

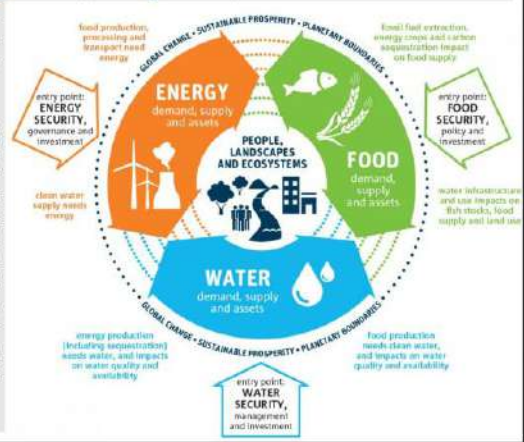
Integrated Water Resource Management

12

6

Water-Energy-Food(-Ecosystem?) Nexus

The water-energy-food nexus refers to the **interconnected** relationship between water, energy, and food systems. It recognizes that water, energy, and food are essential resources that are interconnected and **dependent** on each other for their **sustainable** management and provision.



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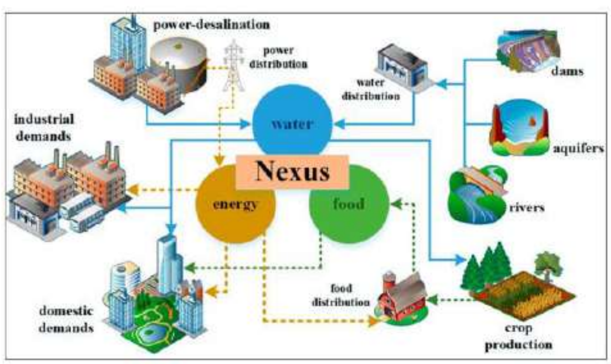
Water-Energy-Food(-Ecosystem?) Nexus



14

5/25/23

Debating Partnership Arrangements

- Public-Public Delegation Agreement (PPDA)
- One side for, one against
- Side for: Municipality
- Side against: Water Establishment
- Reference: Excerpt from NAHNOO Proposition (HawkaMaa)

- Public-Private Partnership (PPP)
- One side for, one against
- Side for: Private Water Company
- Side against: Civil Society Organization
- Reference: Excerpt from Civic Influence Hub Proposition (Blue Gold)

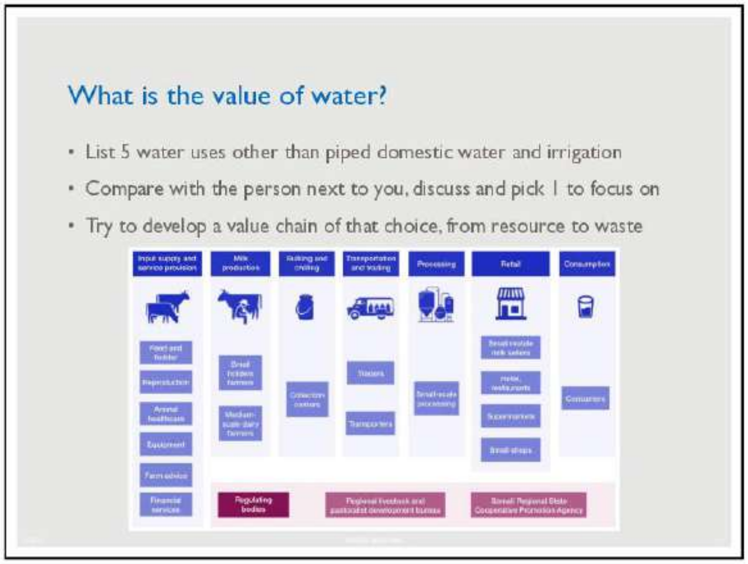
15

Economic Uses

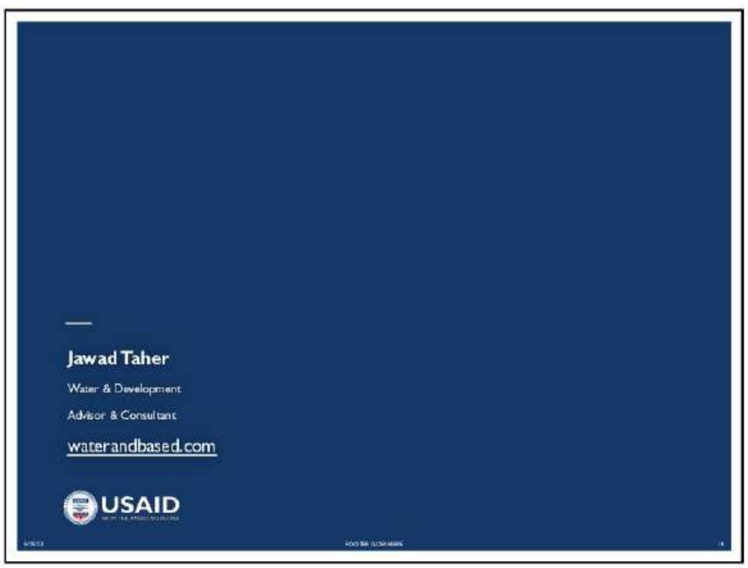
USAID

16

5/25/23


What is the value of water?
List 5 water uses other than piped domestic water and irrigation
Compare with the person next to you, discuss and pick 1 to focus on
Try to develop a value chain of that choice, from resource to waste
Input supply and service provision
Milk production
Transportation and trading
Processing
Retail
Consumption
Animal healthcare
Equipment
Farm advice
Financial services
Medium-scale dairy farmers
Transporters
Small-scale processing
Supermarkets
Small shops
Consumers
Regulating bodies

17


Jawad Taher
Water & Development
Advisor & Consultant
waterandbased.com
USAID

18

9

1.5 – WWM Recovery Plan

11/04/2023

WATER REFORM
long term technical assistance

Funded by the European Union

AFD Implemented by AFD

EU-AFD TECHNICAL ASSISTANCE PROGRAMME TO SUPPORT REFORMS IN THE WATER AND WASTEWATER SECTORS IN LEBANON

ROADMAP TO RECOVERY OF THE WATER SECTOR IN LEBANON

April 14th 2022

DISCLAIMER

This roadmap was prepared with the help of the EU-AFD Water Reform Programme upon request of the Ministry of Energy and Water.

1

WATER REFORM

Funded by the European Union

AFD Implemented by AFD

AGENDA

2

11/04/2023

WATER REFORM

Funded by the European Union

AFD Implemented by AFD

1. INTRODUCTION / OBJECTIVES

Objectives:

- Maintaining the continuity of water & wastewater services
- Working towards a better structured, more resilient and performing sector

This plan shall bridge the gap between the emergency actions needed to maintain the services & the longer term improvements in parallel with the reforms

3

WATER REFORM

Funded by the European Union

AFD Implemented by AFD

Covers ..

Water

Wastewater

Drafted upon

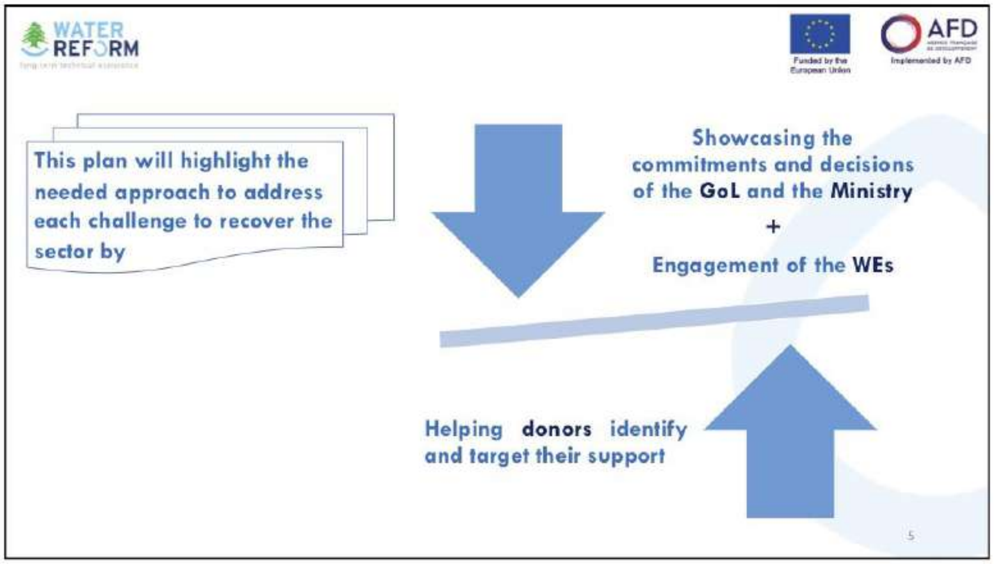
Data from the EU-AFD TA OPEX Cost Recovery Simulations

Discussions with MoEW & WEs

4

2

11/04/2023



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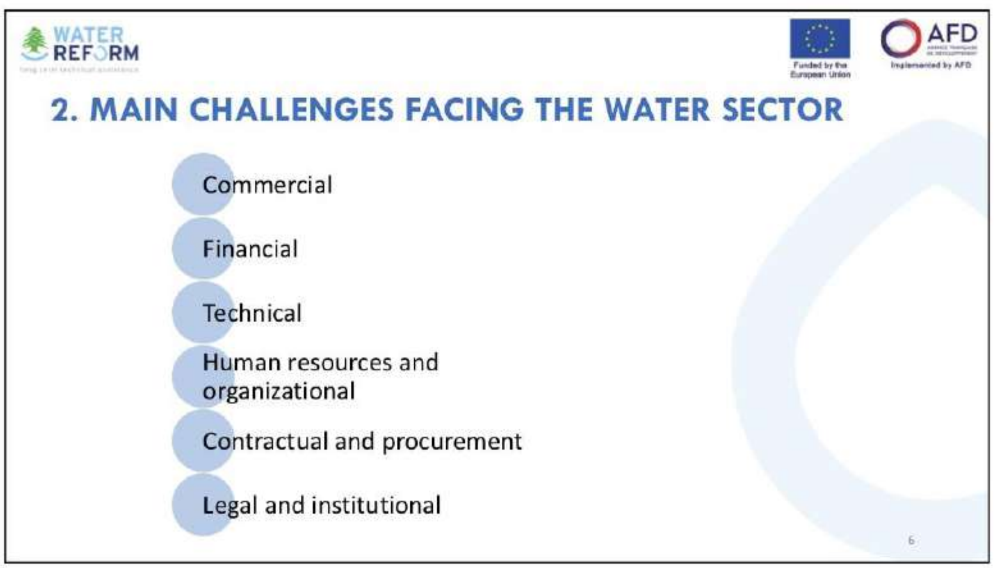

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3

11/04/2023

WATER REFORM

Funded by the European Union

AFD Implemented by AFD

2.1 COMMERCIAL CHALLENGES

2.1.1 Insufficient cost recovery leading to a negative financial balance

INPUT DATA ADOPTED (AS PER MoEW ASSUMPTIONS)

Indicator	Value in 2019	Simulation values
Exchange rate	1 500 LBP/$	20 000 LBP/$ (Sayrafa)
Diesel cost	850 LBP/liter	19 700 LBP/liter
Gasoline	25 000 LBP/20 liters	375 000 LBP/20 liters
Transportation fee	8 000 LBP/day	64 000 LBP/day
Salary multiplier	1	2
EDL tariff for 1 kWh*	170 LBP (0.113 USD)	4200 LBP (0.21 USD)
Consumer Price Index (CPI)	115	700
Including 11 WWTPs to be readily handed-over by the CDR to the WEs	No	Yes

Average tariff of 320,000 LBP/m3/yr (as was the case in 2021 and earlier years)

+

Operational Expenditures (OPEX) incurred on each water establishment

↓

The sector would still accumulate an ***additional total deficit of 120 Million USD in 2022***

7

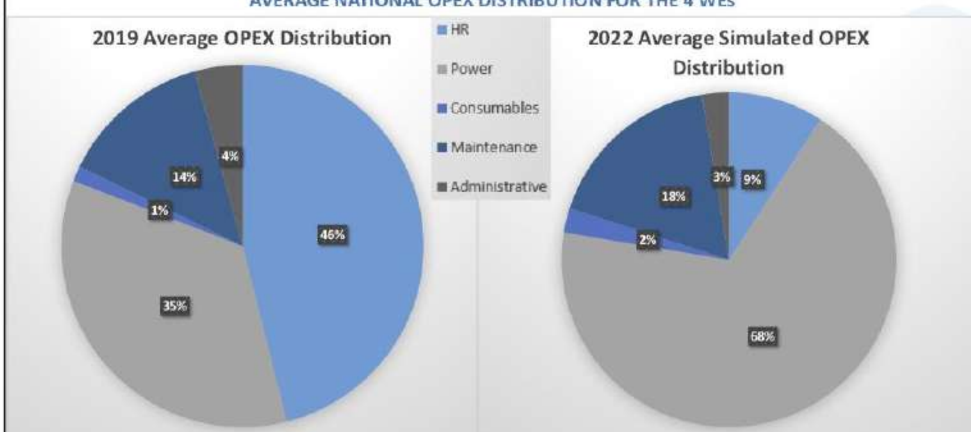
7

WATER REFORM

Funded by the European Union

AFD Implemented by AFD

AVERAGE NATIONAL OPEX DISTRIBUTION FOR THE 4 WEs



8

4

11/04/2023

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BASELINE FIGURES OF 2019 PROJECTED IN 2022 AT SAYRAFA RATE

	NLWE	BMLWE	SLWE	BWE	Total
Annual tariff (2019)	290 000 LBP	366 000 LBP	308 000 LBP	296 000 LBP	
Collection rate (2019)	51 %	69 %	54 %	46 %	
Revenue water (2019) (Billed / Produced Volume)	54 %	95 %	52 %	71 %	
Subscription rate (2019)	50%	60%	60%	37%	
Cash FLow (2019)	16 608 M LBP	100 261 M LBP	26 956 M LBP	10 200 M LBP	154 025 M LBP
OPEX (2019)	32 687 M LBP	89 425 M LBP	59 866 M LBP	23 150 M LBP	205 128 M LBP
OPEX Cost Recovery (2019)	51 %	112 %	45 %	44 %	
OPEX (2022)	362 494 M LBP	976 571 M LBP	877 836 MLBP	334 981 M LBP	2 551 882 M LBP
OPEX Cost Recovery in 2022 (unchanged 2019 tariff)	5 %	10 %	3 %	3 %	
Projected Balance in 2022 (unchanged 2019 tariff)	- 345 886 M LBP (- 17.3 M USD)	- 876 310 M LBP (- 43.8 M USD)	- 850 880 M LBP (- 42.5 M USD)	- 324 781 M LBP (- 16.2 M USD)	- 2 397 857 M LBP (- 119.89 M USD)
Breakeven tariff (2022)	6 090 000 LBP	3 400 000 LBP	9 480 000 LBP	8 080 000 LBP	

* *Considering no effort is made to improve subscription and collection rates as well as to reduce Non Revenue Water.*

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2.1.2 Insufficient collection & subscription rates

- **Low Collection rates** → Many users do not pay the annual tariff but are still having access to water.
- **The number of subscribers** to the water services with respect to the resident population **is low** in the four WEs, especially in the North and the Bekaa

	NLWE	BMLWE	SLWE	BWE
Collection rate (2019)	51 %	69 %	54 %	46 %
Subscription rate (2019)	50%	60%	60%	37%

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2.2 FINANCIAL CHALLENGES

- Arrears due to the operators of WWTPs and incapability to fund WW OPEX
- Lack of money for investments to improve the service

2.3 TECHNICAL CHALLENGES

- Inability to calculate the cost of delivered cubic meter
- High share of Non-Revenue Water and aging infrastructure

2.4 HUMAN RESOURCES & ORGANIZATIONAL CHALLENGES

- Lack of many key expertise and capacities, especially for wastewater management and supervision
- Demotivation / Loss of staff
- Inability to hire and fire staff despite autonomous status
- Outdated organigrams

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2.4 CONTRACTUAL & PROCUREMENT CHALLENGES

- Handing over the wastewater treatments plants to the water establishments
- Lack of adequate contractual modalities between the public and the private sector

2.5 LEGAL & INSTITUTIONAL CHALLENGES

- A non-operational water law
- Insufficient autonomy of WEs to assume the role of commercial utilities
- Absence of political support
- Ambiguity in the role of municipalities and the public-public partnership

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3. AXIS OF THE PROPOSED PLAN

The plan shall start first and foremost with credible decisions and commitments of the Government of Lebanon. Surely, many accompanying measures are crucial to enable commercial, technical, institutional and financial improvements with the help and support of the donors' community.

AXIS 1:	AXIS 2:	AXIS 3:
IMMEDIATE & PROGRESSIVE FINANCIAL MEASURES	PERFORMANCE OPTIMIZATION FOR COST RECOVERY	LEGAL & INSTITUTIONAL REFORM

AXIS 4: POLITICAL SUPPORT

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3.1. DETAILS OF AXIS 1: IMMEDIATE & PROGRESSIVE FINANCIAL MEASURES (1/2)

TARIFF INCREASE:

- **Increase in revenues of the WEs through a gradual yearly raise in tariff starting around 1 MLBP in 2022 up to 3 MLBP in 2026.**

These numbers shall be updated frequently and reported yearly to accommodate changes in the exchange rate and therefore adapt the annual tariff accordingly. This increase shall be accompanied with an improvement of the collection and subscription rates

ADJUSTMENT OF SALARIES OF PUBLIC SERVANTS

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3.1. DETAILS OF THE AXIS 1: IMMEDIATE & PROGRESSIVE FINANCIAL MEASURES (2/2)

SUBSIDIES:

- **The government of Lebanon commits to:**
  - cover part of the gap/deficit on selected expenses (such as power or a share of power) for a period of 5 years
  - engages the discussions with the donors to cover part of the remaining expenses (such as part of the maintenance including spare parts and also consumables)
  - paying the arrears to the private operators of the wastewater treatment plants as well as the fees covering the remaining of 2022.

- **The water establishments commit to cover other expenses (such as HR and part of the maintenance and a share of the power) during a period of 5 years**

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3.2. DETAILS OF THE AXIS 2: PERFORMANCE OPTIMIZATION FOR COST RECOVERY (1/3)

TECHNICAL IMPROVEMENTS THROUGH STRATEGIC KEY INVESTMENTS:

- **Optimization of operational expenditures by reducing power usage through:**
  - Increasing the power generated from solar PV by an overall of 20% over 2 years (2023 and 2024)
  - Favoring pumping from shallow underground sources and the use of surface water where feasible
  - Prioritizing rehabilitation of energy inefficient or low-efficiency systems over new investments (such as replacement of equipment)
  - Assessing hydropower potential of existing systems and implement where feasible
- **Reduction of NRW by 15 % in 2026 through:**
  - Prioritizing investments in reduction of leakages from networks and installation of district metering
  - Reducing illegal connections
- **Management of water production through:**
  - Prioritizing investments in installation of metering at water sources

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3.2. DETAILS OF THE AXIS 2: PERFORMANCE OPTIMIZATION FOR COST RECOVERY (2/3)

TECHNICAL IMPROVEMENTS THROUGH STRATEGIC KEY INVESTMENTS:

- Implementation of a data center at the MoEW where information are centralized, treated and made public
- Engagement and deployment of a national approach to sludge treatment and usage
- Ensuring continuous monitoring of water quality by prioritizing treatment through the financing of the consumables and rehabilitation works where necessary for the continuity of the operations
- Prioritizing the rehabilitation of existing infrastructure and the completion of small to medium unfinished systems with high impact on service continuity
- Engagement in modernization / digitalization of the WEs operations and management

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3.2. DETAILS OF THE AXIS 2: PERFORMANCE OPTIMIZATION FOR COST RECOVERY (3/3)

COMMERCIAL IMPROVEMENTS:

- **Increasing collection rate to reach 80% by 2026 (progressive yearly increase), with a series of measures:**
  - Communication campaigns with the help of donors
  - Political support to the water establishments to encourage payments
  - Engage with municipalities within a public-public partnership
- **Increasing subscription rate to reach 70% by 2026 (progressive yearly increase), with a series of measures:**
  - Communication campaigns
  - Political support for the removal of illegal connections

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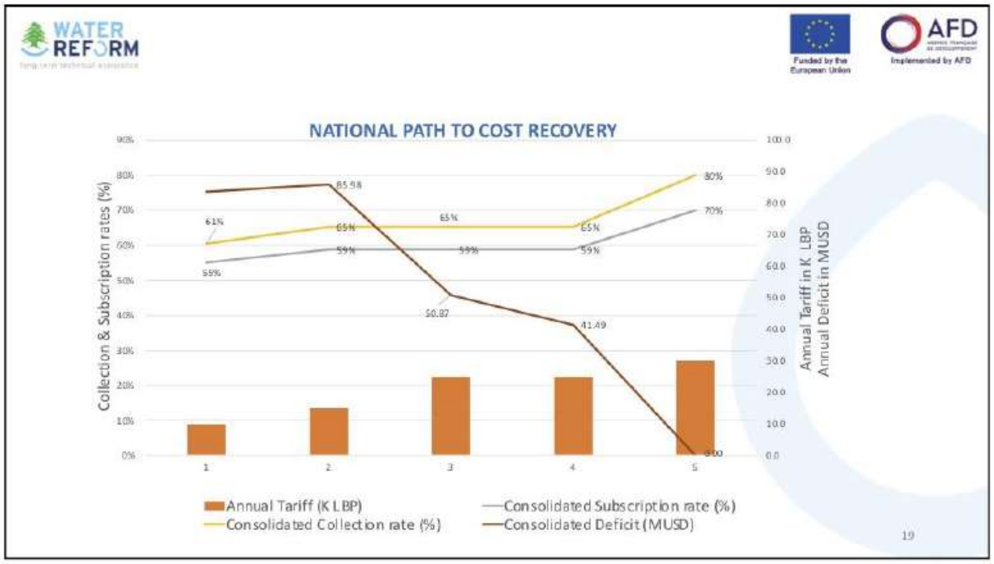

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WATER REFORM

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3.3. DETAILS OF THE AXIS 3: LEGAL & INSTITUTIONAL REFORM (1/3)

ORGANIZATIONAL STRUCTURE AT WEs:

- Assessment of the pertinence of the present organization charts and adopt new structure in light of today's challenges, WE strategy and the orientations of the new water law.
- Implementation of targeted capacity building for the administrative and technical staff
- Hiring of specialized technical staff at the WEs based on the needs identified in the newly adopted structure (such as wastewater management staff) while assessing the possibility of redeployment of public servants
- Elaboration of a transparent recruitment policy based on skills and qualifications.

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3.3. DETAILS OF THE AXIS 3: LEGAL & INSTITUTIONAL REFORM (2/3)

LEGAL & INSTITUTIONAL:

- Appointment of a monitoring committee for the follow up of drafting and approval of application decrees and bylaws
- Adoption of the application decrees and provisions of the new water law 192/2020
- Adoption of a public-public partnership model between municipalities and WEs customized on a case by case with clear distribution of roles and responsibilities on both water and wastewater systems at financial and technical levels
- Adoption of a public-private partnership model between the private sector and WEs based on clear performance obligations

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3.3. DETAILS OF THE AXIS 3: LEGAL & INSTITUTIONAL REFORM (2/3)

LEGAL & INSTITUTIONAL:

- Improvement of the management of the HR in the WE and separation from the public service council
- Renewal of the board of directors of the WEs based solely on skills and qualifications.
- Empowerment of the WEs to reach effective administrative and financial autonomy as per their legal mandate
- Improvement of the monitoring framework of the WEs at central level (performance monitoring of the WEs through KPIs, etc.)
- Establishment and adoption of regional strategies and business plans at WEs level in line with the national strategy and the recovery plan

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3.4. DETAILS OF THE AXIS 4: POLITICAL SUPPORT

No matter the attempts to reform the sector and empower its service providers, no achievement can be made without consistent, coherent and persistent political will. It is therefore crucial that the government of Lebanon and the political parties provide political support to this action plan and allow the water establishments to fulfill their full mandate to the satisfaction of users.

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4. SUCCESS FACTORS

Water Establishments should be committed to reach their performance targets within the proposed timeline;

Political empowerment, support and security support on the ground should be given by all political parties and the Council of Ministers to achieve the mandatory improvements;

Arrears and budget gaps should be paid by the **Government of Lebanon** in a timely manner;

Deficit should be covered over the upcoming 5 years to bridge the cost-revenue gap and ensure proper **service continuity**;

Specialized technical staff should imperatively be recruited at the WEs mainly for the wastewater sector;

Donors should be engaged in supporting clear financial measures and the optimization of performance to achieve cost recovery.

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1.6 – WWM Supporting Documents

3 WATER AND IRRIGATION

3.1 Introduction

In the 1970s, nearly 100% of the Lebanese population had access to public water services. This has changed drastically since the civil unrest period. The mobilized water resources and capacities of the networks were no more adequate to meet the demands. The Government of Lebanon launched since the 1990s a long-overdue rehabilitation and upgrading of the existing water infrastructure networks; reservoirs and pump stations have been rehabilitated, additional storage reservoirs have been constructed, transmission lines have been either replaced or rehabilitated, and networks have been extended or replaced in areas that were experiencing substantial losses. Yet, limited additional water resources were mobilized and increase in demand and shortages were growing at a faster rate than the rehabilitation and expansion works.

3.2 Background and Current Conditions

The rehabilitation programme implemented to date has not secured yet an adequate water resources management system. Water supply is still being rationed due to shortages of water resources, power failures and excessive power bills for the operation of the pump stations; adequate additional water resources have not been mobilized to date, and surface and ground water resources are heavily polluted due to current wastewater discharge practices. These conditions were intensified due to the additional resources required to meet the demands of and treat the wastewater generated by the 1.5 million displaced Syrians. The UNICEF – WHO, 2016 report revealed that only 36% of the total population are benefitting from safely managed drinking water services.

The Ministry of Energy and Water issued in 2010 the National Water Sector Strategy (NWSS), putting on track the surface water resources management plan, specifically the construction of the dams to meet water shortages, which entailes a concurrent scheme for the protection of the mobilized water resources from illegal and polluting wastewater discharge practices.

The NWSS of 2010 included assessment of the domestic, industrial, and irrigation water demands and projected the demands for 5 years intervals up to the year 2035. The 2010 demands were estimated at 1,473 MCM of which 505 MCM are domestic, 810 MCM are irrigation, 152 MCM are industrial, and 6 MCM are touristic demands. The available public resources provide only 60% of the total demand. The intention was, in addition to increasing the resources, to reduce the losses and un-accounted for water by 10-15% in the first 10 years. Since then old networks are being replaced but at a slower rate than planned; however no records are available to report the improvements and the Syrian crisis necessitated diverting the efforts towards meeting additional demands estimated at 61 MCM/year.

The four Water Establishments (WEs), North Lebanon, Beirut and Mount Lebanon, Bekaa, and South Lebanon, are responsible for the operation and maintenance of the water and wastewater systems. The development of the water resources, i.e, the dams for the mobilisation and development of surface water resources, is the responsibility of the Ministry of Energy and Water (MoEW). The WEs require capacity buildings to be able to properly manage, supervise and take over the upgraded and expanded networks as well as their operation and maintenance.

3.3 Impact of the Syrian Crisis on the Water and Irrigation Sector

The Syrian Crisis has resulted in the displacement of 1.5 million (LCRP 2015) Syrians into Lebanon, the Country whose population is estimated at about 4.5 million (NWSS 2010, number including displaced Syrians at the time). In other words, within a couple of years only, the population on the Lebanese territory increased by 25-30%, unevenly distributed over the various regions, with the highest concentrations in North of Lebanon and the Bekaa, close to the Lebanese-Syrian borders.

Such unanticipated multiplication of the population would have entailed significant impacts on countries with developed infrastructure and water sector; the impacts on Lebanon who is already suffering from a shortage in almost all its infrastructure sectors have evidently been much more severe, and specifically on the water/wastewater sectors. The water supply demands and the generated wastewater flows have been accentuated at the time the government did not have adequate resources to timely and adequately plan and implement considerable improvement on the relevant infrastructure.

Based on the official LCRP 2015 figures of the displaced Syrian population in Lebanon, and the water demand values adopted by the MoEW, the increase in domestic water demand due to the displaced Syrians in Lebanon is estimated at 61 MCM per year. This is accompanied with an increase in wastewater generation by about 50 MCM per year, leading to a total of untreated wastewater of 280 MCM per year at the national level. The Syrian crisis has as such double impact on the sector: it has significantly increased the shortage in supply, and at the same time aggravated the wastewater problem, which constitutes a major contamination problem to the surface and ground water resources used for potable, agriculture and industry.

3.4 Existing Programme and Strategies

The National Water Sector Strategy (NWSS) 2010 prepared by the Ministry of Energy and Water (MoEW), stresses among others, on two main goals:

1- Optimizing the exploitation of the surface water resources to become the main source for water supply and irrigation.
2- Institutional improvement to ensure a better management of the sector to maintain a balance between the demands and the available resources.

The exploitation of the available resources involves the following main components that need to be tackled to achieve the sector's goals:

- Production: the majority of the current water resources production relies on the groundwater which is being extensively extracted and leading to a continuous drop in the water table as the yearly consumption exceeds the recharge. The NWSS calls for a migration as much as possible to the mobilization of the surface water sources that are renewable; hoping to conserve the groundwater as a strategic reserve.
- Transmission and distribution networks should be maintained in good condition to prevent losses and assure continuous supply.
- Conservation and protection of water sources against pollution and specifically biological contamination resulting from shortage in wastewater networks and treatment plants that affects both the surface and ground water sources is essential. Industrial discharges should also be controlled to prevent chemical contamination.

To mobilize the surface water sources, the NWSS identified a list of 40 dams and hill lakes that can store significant volumes of water ranging between 0.3 and 120 MCM and achieving a total static volume of about 670MCM a year that can supply domestic and irrigation demands.

Few of the proposed dams have already been launched (Boqaata, Mseilha, Janneh, Kaysamani, Balaa, El Manzoul ,Yammouneh, Kouashra), Brissa's construction is completed except for lining its reservoir area, Bisri's funding is under preparation, others are considered priority projects but require funding, such as Bared, Qarqaf, Younine and Assi. It is also of utmost importance to initiate the necessary wastewater schemes for the protection of these resources.

Institutional capacity building is essentially required for setting an effective and sustainable management of the Sector, including operation, maintenance, management and conservation of the water resources and infrastructure assets, the reduction/limitation of the losses, and the continuity of the service.

The water sector, which was severely affected by the civil war and its consequences, has been subject to continuous rehabilitation, improvement and expansion. However, the efforts were always unable to cover the shortage in the water supply. The National Water Sector Strategy (NWSS) 2010, estimated the water supply deficit at about 40% of the total demands.

The efforts of the Ministry of Energy and Water in improving the water sector and reducing the shortage in supply are incessant.

Table 3-1 presents the budget spent by the ministry on upgrading and expansion of water networks during the last five years (2012-2016).

Table 3-1: Ministry's Expenditure on Water Networks

Region	Total MUSD
North Lebanon	70
Mount Lebanon	50
South Lebanon	24
Bekaa	18
Total	**162**

Table 3-2 lists the major on-going and recently completed projects divided into two categories A and B as follows:

A- Expansion and Improvement of Supply
B- Development of resources.

Table 3-2: List of Major on-Going Water Projects

Project	Budget (Musd)
A - Expansion and Improvement of Supply	
Greater Beirut:	
• Greater Beirut Water Supply Project (Awwaly conveyance project) - Phase 1 - Tunnel and Transmission lines.	197
• Upgrade of water systems in Greater Beirut to enable supply from Awwali project.	100
• Rehabilitation of water supply systems in Greater Beirut.	50
• Construction of Wardaniye Water Treatment Plant to serve Awwali project.	37
• Expansion of Dbaye Water Treatment Plant to increase supply.	5.1
• Rehabilitation works and construction of new works for Ain el Delbe including pump stations and networks	3
Jbeil: Improvement of water supply system in the caza of Jbeil and construction of waste water networks for the coastal area of Jbeil and associated treatment plant	38
Chouf: Rehabilitation and diversion of transmission line between Safa and Beiteddine, projects for increasing the water sources in Iqlim el Kharroub, and Isolation of Barouk spring	7.3
Akkar: Water supply projects in the villages of south Akkar from Hrar and Qabiit reservoirs (drilling and equipping of water wells, pumping stations, reservoirs, transmission lines and distribution lines) specifically in the villages of Meshmesh, Wata Meshmesh, Bazzal, Danbo, Beit Ayoub, Beit Younes, Qrayat, Bajaa, Shan, Houwaish, Qaiteea, and Continuation of the water supply project for the villages of Borghosh-Hrar region, Kaf et Tineh, and Qabiit and water supply systems consisting of groundwater wells, reservoirs and distribution networks that are under preparation. In addition to improvement of water systems in the villages of Fneideq, Tekrit, Beit Mlat, Bireh, Jouma, and Khirbet Daoud.	83.8
Minieh & Dannieh: Continuation of the water supply project for the villages of Minieh region - Part 1, and rehabilitation an continuation of water systems in Dannieh (Package 1 - Part 1)	17.9

Project	Budget (Musd)
Tripoli: Water supply projects in Qalamoun, Ras-masqa, Anfeh, and Koura regions.	6.3
Zgharta/Ehden: Water supply project in Ehden region and Maydan, and continuation of water networks in Fouwar within Northern Lebanon Water Establishment.	20.2
Bcharre: Rehabilitation of water supply networks in Bcharre region.	11
Koura & Batroun: Rehabilitation of water supply systems in Chekka, Anfeh, Koura coast, and Batroun and Equipping well and construction of potable water pump station for Chebtine village.	10.5
Baalbeck-Hermel: Water supply project for the villages of the caza of Hermel, and additional water supply works in the city of Baalbek and the next villages - 2nd package, additional water sources in Baalback-Hermel, rehabilitation of water treatment plant in Falawi to serve 18 villages from Yamoune spring, and Isolation of Daher el Aalwi spring in Ainata.	29.6
Zahle & West Bekaa: Rehabilitation of water supply systems in West Bekaa and the villages east of Zahle - packages 1, 2 and 3, rehabilitation/improvement of water supply systems in Qoblias, and construction of water supply systems for Dhour Zahle, Twayti, Maalaka, karak, Qaa el Rim, Hzarta and the industrial city.	51.2
Rachaiya & West Bekaa: Rehabilitation of water supply systems in the villages of Rachaiya - part 2 - package 3, transmission line from Arab reservoir to Aarayesh, and Various water supply works in Bkifa, Beit Lahya, Aaiha, El-Haoush.	15.8
Hasbaya: Water Supply Project for Jebel Amel Water Establishment-Phase 3 (construction of reservoirs, transmission and distribution lines from wazzani), Complementary works for the water supply systems of Hebbariye-Hasbaya, drilling and equipping of groundwater well and continuation of water supply network in Chebaa.	30
Marjaayoun & Bint Jbeil: Water Supply Project -Phase 3 (construction of reservoirs, transmission and distribution lines from Taybe treatment plant, wazzani water, and ground water wells in the region). Additional water works in Jebel Amel - caza of Bint Jbeil.	51.2
Nabatiye & Sour: Complementary Water Works project for Southern Lebanon water establishment (Kfaroua, mejdel selm, Debaal, Safad el Batikh, Touline, Chaqra, Borj rahal, Kfardounine, Qraye), and additional water works for Kfarremane/Nabatiye.	15.8
IRRIGATION - Marjaayoun & Bint-Jbeil: Litani conveyor 800 - main and secondary lines.	357.4
B - Development of Resources	
Batroun:	
• **Mseilha hill lake:** Construction of Mseilha dam and hill lake (12 MCM) for water supply and irrigation	59.4
• **Balaa hill lake:** Construction of Balaa dam and hill lake (2.2 MCM) for water supply	37.3
Greater Beirut and Mount Lebanon:	
• **Jbeil - Janneh Dam:** Construction of Janneh Dam (90 MCM) for water supply and irrigation.	340
• **Bisri Dam:** Greater Beirut Water Supply Project - Phase 2 - Construction of Bisri Dam (120MCM) including hyropower plant and waste water systems	580
• **Baabda - Kaysamani Dam:** Construction of Kaysamani Dam (1MCM) for water supply	25
• **Metn - Boqaata Dam:** Construction of Beqaata dam and hill lake (12 MCM) for water supply	63.1
• **Metn - Al Manzoul Hill lake:** Construction of dam and hill lake (0.4MCM) including water treatment plant and transmission line from the lake to reservoirs of Zaarour and Aintoura.	15.3
IRRIGATION - Baalbeck - Yamoune hill lake: Construction of Yamoune dam and hill lake (1.5 MCM) for irrigation	14.6
IRRIGATION - Akkar –	
• **Kouachra hill lake:** Construction of dam and hill lake (0.35 MCM) for irrigation	3.2

3.5 Development Vision

The target of the Ministry of Energy and Water and the Water Establishments includes mobilization of additional water resources to meet the current deficit as well as the initiation of an efficient and appropriately Development Plan to meet the projected future demands.

The Syrian crisis and its consequences call for the consideration of a fast/immediate programme within the Development Plan to attenuate on the short term, the severe impacts of the shortage in water supply on both the vulnerable Lebanese families and displaced Syrians (increased risk of waterborne diseases in addition to intensive contamination of the ground and surface water). This immediate phase will also contribute to meeting the expected increased water demands on the long term.

With the additional domestic water demand of 61 MCM resulting from the Syrian crisis (LCRP 2015 statistics/MoEW demands), the shortage in supply would increase to about 50%.

The climate change, reducing the total annual precipitations, the rainy season and rainfall days, is a major challenge to mobilize the necessary resources to meet the projected demands.

The Capital Investment Programme is divided into 2 categories:

- Category A: this category comprises the projects for extending the Supply through expansion and improvement of the existing systems to increase capacities and coverages to meet the increasing demands. This Category responds in its ultimate phase to the projected future demands but also contributes in its early phases to the short term demands.
- Category B: it consists in providing additional water sources relying mainly on renewable surface sources through construction of dams and hill lakes. This Category targets the projected future demands but will help as well alleviating the short-term demands through the early implementation of projects.

A separate Category includes the projects identified under Lebanese Crisis Response Plan (LCRP) which was launched a couple of years ago to mitigate to the exponential increase of demands induced by the displaced Syrians. It includes expansion of networks and mobilization of additional resources relying on ground water (on temporary basis) to attenuate the urgent additional shortage. However, since limited funds were secured, the projects were earmarked for funding.

The selection and prioritization of the water projects proposed to contribute in developing the sector have been done through the following criteria

- The scale of served population, giving priority to the projects serving larger population number in order to maximize the social and hygienic benefits of the investments
- The density of the displaced Syrians, in an effort to attenuate the impact of the massive increase in population and hence on water demands and hygienic conditions in the hosting areas
- Enhancing the benefit from the CAPEX already invested in the construction of headworks, treatment plants and collection networks.
- The readiness for construction and availability of studies (Feasibility, EIA, Tender Documents).

3.6 Lebanon Crisis Response Plan

Based on the above considerations, a Development Plan is proposed comprising two categories of projects to achieve the following:

Category A: Expansion and Improvement of the existing water supply system:

This Category can be divided into two parts:

- Part 1: this part includes the conveyance systems associated to ongoing or completed dams to enable the exploitation of these dams and hence are considered as complementary investments; they include among others, water treatment facilities, hydropower system, transmission lines, reservoirs and pumping stations.

  Four projects are selected for the first construction cycle to mobilize additional water resources in the North and Mount Lebanon serving directly a population of about 750,000, but affecting a larger population of about 1.5 million.

  One project for the distribution of irrigation water is also selected in this category as the main conveyor of the Litani irrigation Scheme is near completion. This project will irrigate an area of about 14,000 ha, provide large job opportunities, and improve food security, wellbeing and stability.

- Part 2: this part includes the expansion, upgrage and rehabilitation of distribution networks to enhance the water supply and provide access to water sevices to the growing population. Many of these projects fall within the goals of the LCRP, however funds from LCRP were not secured and hence they were reintegrated into the CIP plan. In the regions of North, Bekaa and South, elaborate water master plans are available and include proposals for massive improvement works in the water sector which are required to reach an acceptable level of service. The major part of these works is needed as a first priority, planned for the 2020 to 22 horizon. These projects are also within the LCRP goals; however their costs exceed the LCRP budgets.. Furthermore, as most of the LCRP funds were not secured, they have been listed as cycle 1 CIP projects, and grouped under the relevant Water Establishment.

The mentioned master plans include also continuations and expansions of the first priority projects proposed for later stages; these have been listed as cycles 2 and 3 projects.

Category B: Mobilizing additional water sources:

As previously mentioned, this category relates to the mobilization of additional surface water sources through the construction of dams and hill lakes.

In addition to El Bared Dam in Akkar, serving a population of about 590,000, two projects (Azounieh Dam, Maaser Chouf Dam) are prioritized for mobilizing additional water resources in Mount Lebanon to serve a population of about 300,000, 1 project in Baalback-Hermel which is the continuation of Assi Phase 1 dam, and 1 project in Bekaa/Zahle (Barhashah Dam) due to the significant shortage in the region.

Remaining expropriations for Chabrouh and Besri Dams are also listed in first priority since Chabrouh is completed and Besri about to be launched.

Two projects are selected for the 2nd cycle (Assi Phase 2 Dam, Ibl es Saqi Dam) and 12 others for the 3rd cycle until their construction documents are prepared.

Table 3-3 lists the proposed projects, their description, the estimated investment cost, their readiness for construction and their priorities.

Figure 3-1 shows the geographic distribution of the proposed dams as well as the ongoing or completed ones.

3.7 Municipalities and Governorates Requirements

The Lebanese Government has invited all the Mohafazat and Municipalities to raise their needs in the various sectors including the Water Sector in order to be taken into consideration in the Development Vision. Extensive lists have been received from the municipalities all over the Country including a wide range of requests extending from a minor water connection to the construction of dams. The received lists have been compiled and depending on the type, size, and necessity, the projects have been categorized as follows:

i. Proposed under CIP or covered by other projects proposed under CIP (additional water sources, transmission lines and new distribution networks, regional reservoirs, etc..)
ii. Short and medium term municipal needs (minor storage tanks, collection ponds, irrigation canals, cleaning of water courses, water quality monitoring, minor water connections and rehabilitations, pumps, generators, etc..). These local demands or small-scale projects are categorized as Category "C"; they will be allocated a budget of 200MUSD under proposed CIP project W55 (Short and Medium term municipal needs).

Most of the requests do not refer to a specific project but to the provision or increase of water supply in the regions; the extents and the components of the requested projects are not described and thus correlation has been made in such cases between the goals of the requests/projects and those of CIP projects. The lists include many requests for drilling and equipment of water wells, and others for construction or rehabilitation of local storage tanks. These also have been considered as covered by CIP projects since the latters include similar components and aim to ameliorate the whole water supply systems based on overall master plans.

It is worth noting also that some of the requests are specific for particular municipalities or villages, but others are general at the level of a caza or a union of municipalities. Some others fall within ongoing or under preparation projects as indicated in the tables.

Furthermore, only few projects include cost estimate.

Table 3-5 hereafter summarizes the proposed investments by Cycle and by Governorate. The investments related to Irrigation are given separately.

Annex 1
Excerpts from Policy Documents

Excerpt 1
Law 221:

تنظيم قطاع المياه - قانون رقم 221 تاريخ 29/ 05/ 2000
(قانون رقم 221 تاريخ 29/ 05/ 2000)
المرجع: ج.ر. عدد 25 تاريخ 08/ 06/ 2000 ص 1949

المادة 1:
تعتبر حماية المورد الطبيعي للمياه وتنميته، ضمن اطار المحافظة على البيئة وتوازنات الطبيعة، من صلب المنفعة العامة.

المادة 2: (كما تعدلت بموجب القانون رقم 377 تاريخ 14/ 12/ 2001):
وزارة الطاقة والمياه.
تتولى وزارة الطاقة والمياه في قطاع المياه، والصلاحيات والمهام الآتية:
1- رصد ومراقبة وكيل واحصاء ودرس الموارد المائية وتقدير الحاجات الى المياه ومجالات استعمالها في المناطق كافة.
2- مراقبة نوعية المياه السطحية والجوفية وتحديد معاييرها.
3- وضع مشروع التصميم العام لتخصيص وتوزيع الموارد المائية للشرب والري على نطاق الدولة ووضع مشروع المخطط التوجيهي العام للمياه والصرف الصحي وتحديثه باستمرار ورفعه بواسطة الوزير الى مجلس الوزراء.
4- تصميم ودرس وتنفيذ المنشآت المائية الكبرى كالسدود والبحيرات الجبلية والانفاق وتقويم مجاري الانهر وشبكات المياه وغيرها، ووضعها في الاستثمار.
5- اجراء التغذية الاصطناعية لخزانات المياه الجوفية عند الاقتضاء ومراقبة استثمار الكميات المستخرجة منها.
6- العمل على حماية الموارد المائية من الهدر والتلوث بوضع النصوص واتخاذ التدابير والاجراءات اللازمة لمنع تلوثها ولاعادتها الى نوعيتها الطبيعية.
7- منح الاجازات والتراخيص للتنقيب عن المياه واستعمال المياه العمومية والاملاك العامة النهرية واجراء كافة المعاملات المتعلقة بها ومنحها وفقا للقوانين والانظمة النافذة.
8- اجراء الدراسات والابحاث المائية والجيولوجية والهيدرولوجية وجمع المعطيات الفنية في حقل المياه ووضع الخرائط الفنية لها وتحديثها بانتظام.
9- ممارسة الرقابة والوصاية على المؤسسات العامة وعلى سائر الهيئات العاملة في حقل المياه وفقا لاحكام هذا القانون والنصوص والاحكام العائدة لكل منها.
10- تعزيز اداء المؤسسات العامة المائية الاستثمارية،ومراقبة هذا الاداء على اساس المؤشرات الواردة في برنامج الاعمال المصدقة حسب الاصول.
11- وضع المعايير الواجب اعتمادها في دراسات المؤسسات العامة الاستثمارية وتنفيذ أشغالها وشروط وأنظمة الاستثمار للمياه السطحية والجوفية ومياه الصرف الصحي والأنظمة القياسية لنوعية المياه ومراقبتها.
12- انجاز معاملات الاستملاك العائدة للوزارة وللمؤسسات العامة المائية الاستثمارية الخاضعة لوصايتها وفقا للقوانين والانظمة النافذة.
13- ابداء الرأي في تراخيص المناجم والمقالع من حيث تأثيرها على الموارد المائية.
14- تأمين العلاقات العامة مع المواطنين واعلامهم بكل ما يهمهم في شؤون المياه وترشيد استعمالها.

المادة 3: (كما تعدلت بموجب القانون رقم 377 تاريخ 14/ 12/ 2001):
المؤسسات العامة الاستثمارية للمياه والصرف الصحي:
تنشأ المؤسسات العامة الاستثمارية للمياه والصرف الصحي المبينة اسماؤها ومراكزها كما يلي:
- مؤسسة مياه بيروت وجبل لبنان ومركزها مدينة بيروت.
- مؤسسة مياه لبنان الشمالي ومركزها مدينة طرابلس.
- مؤسسة مياه البقاع ومركزها مدينة زحلة.
- مؤسسة مياه لبنان الجنوبي ومركزها مدينة صيدا.
تتمتع المؤسسات المذكورة بالشخصية المعنوية والاستقلال المالي والاداري، ويحدد نطاق استثمارها وفقا للخريطة المرفقة بهذا القانون.

المادة 4: (كما تعدلت بموجب القانون رقم 377 تاريخ 14/ 12/ 2001):
1- تتولى كل مؤسسة من مؤسسات المياه في نطاق استثمارها واختصاصها:
أ- درس وتنفيذ واستثمار مياه الشفة والري وجمع ومعالجة وتصريف المياه المبتذلة وفقا للمخطط التوجيهي العام للمياه والصرف الصحي أو لموافقة مسبقة من الوزارة على استعمال مصادر المياه العمومية أو على مواقع محطات تنقية المياه المبتذلة أو المصبات الجديدة لتصريف المياه المبتذلة.
ب- اقتراح تعرفات لخدمات مياه الشفة والري وتصريف المياه المبتذلة على أن تؤخذ بالاعتبار الأوضاع الاجتماعية والاقتصادية العامة.
ج- مراقبة نوعية مياه الشرب والري الموزعة ونوعية المياه المبتذلة عند المصبات ومخارج محطات التنقية.

2- تعمل مؤسسات المياه وفقا لانظمتها الخاصة.
يتوجب على المؤسسات المذكورة التعاقد مع شركة تدقيق للحسابات تحدد مهمتها بوضع تقرير حول البيانات المالية والحسابات الختامية ونظام الضبط الداخلي المعتمد في المؤسسة.

المادة 5: (كما تعدلت بموجب القانون رقم 377 تاريخ 14/ 12/ 2001):
يتولى ادارة المؤسسة مجلس ادارة مؤلف من رئيس وستة أعضاء يتم تعيينهم وتحديد تعويضاتهم بمرسوم يتخذ في مجلس الوزراء بناء على اقتراح وزير الطاقة والمياه، ويجب أن يكونوا من حملة الشهادات الجامعية المعترف بها في لبنان في اختصاصات الحقوق والمياه والبيئة والطب والهندسة والاقتصاد أو ادارة الأعمال.
- تحدد ولاية مجلس الادارة في مرسوم تعيينه وتنهي خدماته في اي وقت وفقا للاصول ذاتها.
- يقوم رئيس مجلس الادارة بمهام مدير عام المؤسسة، ويعاونه جهاز تنفيذي من المستخدمين يخضعون لسلطته.
- يضع مجلس ادارة المؤسسة جميع الانظمة العائدة لها ويجري اقرارها بمرسوم يتخذ في مجلس الوزراء بناء على اقتراح وزيري المالية والطاقة والمياه.

المادة 6: (كما تعدلت بموجب القانون رقم 377 تاريخ 14/ 12/ 2001):
تخضع المؤسسة العامة الاستثمارية للمياه والصرف الصحي لنقابة ديوان المحاسبة المؤخرة وفقا لنظام متفق عليه مع الديوان، ولقابة التفتيش المركزي، ولا تخضع لرقابة مجلس الخدمة المدنية.
- تنشأ لدى وزارة الطاقة والمياه لجنة لتقييم اداء المؤسسات العامة للمياه والصرف الصحي تؤلف بمرسوم يتخذ في مجلس الوزراء بناء على اقتراح وزيري المالية والطاقة والمياه من:
- وزير الطاقة والمياه، رئيسا.
- مدير عام وزارة المالية، عضوا.
- مدير عام الاستثمار في وزارة الطاقة والمياه، عضوا.
- مدير عام الموارد المائية والكهربائية في وزارة الطاقة والمياه، عضوا.
- مهندس في الشؤون المائية له خبرة ست سنوات على الاقل، عضوا.
- مجاز في الاقتصاد له خبرة ست سنوات على اقل، عضوا.
- مجاز في الحقوق له خبرة ست سنوات على الاقل، عضوا.
- مجاز في المحاسبة او ادارة الاعمال له خبرة ست سنوات على الاقل، عضوا.
- موظف من الفئة الثانية على الاقل في المديرية العامة للاستثمار، عضوا مقررا.
تحدد مهام واصول عمل هذه اللجنة بقرار مشترك يصدر عن وزيري المالية والطاقة والمياه، ولها ان تستعين بمن تراه من الخبراء للقيام باعمالها.

المادة 7:
استثناء من احكام المادة الاولى من هذا القانون، تستمر المصلحة الوطنية لنهر الليطاني المنشأة بموجب القانون الصادر بتاريخ 1954/8/14 بادارة واستثمار مياه الري في نطاق استثمارها (البقاع الجنوبي ولبنان الجنوبي) وتخضع هذه المصلحة للفقرة 2 من المادة الرابعة وللمادة السادسة من هذا القانون.

المادة 8:
تستمر المصالح المستقلة واللجان القائمة حاليا بادارة واستثمار مياه الشفة والري بممارسة اعمالها ريثما يتم دمجها في مؤسسات المياه المذكورة في المادة الثالثة من هذا القانون بصورة تدريجية على ان يتم ذلك في مهلة لا تتجاوز السنتين من تاريخ العمل بهذا القانون.

المادة 9: (كما تعدلت بموجب القانون رقم 377 تاريخ 14/ 12/ 2001):
تحدد دقائق تطبيق هذا القانون بمراسيم تتخذ في مجلس الوزراء بناء على اقتراح وزير الطاقة والمياه.

المادة 10:
لا تخضع المؤسسات العامة المائية لسائر النصوص التشريعية والتنظيمية المخالفة لاحكام هذا القانون او غير المتفقة مع مضمونه.

المادة 11:
يعمل بهذا القانون فور نشره في الجريدة الرسمية.

Excerpt 2
NWSS 2012:
[PDF External, Strategic Roadmap]

Excerpt 4
Capital Investment Program:
[PDF External, CIP]

Excerpt 5
NWSS 2020:
[PDF External, NWSS 2020]

Excerpt 6
Recovery Plan:
[PDF External, Recovery Plan]

Excerpt 3
Water Law (192):

الباب الخامس: - ادارة المرفق العام للمياه
الفصل الاول: - أحكام عامة
المادة 56
المؤسسات العامة الاستثمارية للمياه:
تقوم المؤسسات العامة الاستثمارية للمياه بادارة المرفق العام للمياه عملا باحكام القانون رقم 221 تاريخ 2000/5/29 وتعديلاته والانظمة الصادرة تطبيقا له، واحكام هذا القانون.
المادة 57
المرافق العامة للمياه:
1 - يتضمن المرفق العام لمياه الشفة خدمة جمع وانتاج ومعالجة ونقل وتخزين وتوزيع المياه. ويتم التوزيع على المنتفعين بشكل رئيسي بواسطة تفريعات من الشبكة. ولا يجوز تأمين المياه وبخلاف ما ذكر الا في حالات استثنائية ومؤقتة.
2 - يتضمن المرفق العام للصرف الصحي الجماعي، جمع ونقل ومعالجة المياه المبتذلة، والهدف من تكرير المياه المبتذلة القضاء على الملوثات لكي تتلاءم مع الاوساط المستقبلية، وتشمل عمليات التكرير معالجة وتنظيف جميع الملوثات والوحول في الشبكة ومحطات التكرير وصولا الى المصبات.
3 - ان المياه المبتذلة مصدرها الاساسي منزلي، ويجوز بموجب اتفاقيات عادية او خاصة تعقدها المؤسسات العامة الاستثمارية للمياه بهذا الصدد وصل المياه المبتذلة الناتجة عن الانشطة التجارية او الصناعية بشبكة الصرف الصحي العامة بشرط ان تتلاءم هذه المياه مع المعايير الفنية للشبكات ومحطات التكرير.
4 - يجوز للمؤسسات العامة الاستثمارية للمياه تزويد المياه لاغراض زراعية بواسطة شبكة الري او بواسطة مجموعة من المنشآت الهيدروليكية.
المادة 58
الاتفاقيات مع القطاع العام:
للوزارة والمؤسسات العامة الاستثمارية للمياه، ومع مراعاة اختصاص كل منهما وفق القوانين والانظمة المرعية الاجراء، عقد اتفاقيات مع اشخاص القانون العام من اجل تأمين ادارة مستدامة للمرفق العام للمياه وتطويره. ويمكن عقد هذه الاتفاقيات مع البلديات لتنظيم تطبيق احكام المادة الثامنة من قانون تنظيم قطاع المياه رقم 221 الصادر في 29 ايار سنة 2000 وبالنسبة للجان القائمة حاليا بادارة واستثمار مياه الشفة والري.
تراعي هذه الاتفاقيات عند تنفيذها احكام المخطط التوجيهي العام للمياه ومخططات الاحواض ولا يجوز ان تتناول ما يخالف موضوع استثمار المرفق العام للمياه.
المادة 59
مساهمة القطاع الخاص عبر المشاريع المشتركة:
تطبق احكام القانون رقم 48 تاريخ 2017/9/7 "قانون تنظيم الشراكة بين القطاعين العام والخاص" عند تلزيم عقد يعود ل"مشروع مشترك".
تراعي هذه العقود احكام المخطط التوجيهي العام للمياه ومخططات الاحواض ولا يجوز ان تتناول ما يخالف موضوع استثمار المرفق العام للمياه.
المادة 60
مساهمة القطاع الخاص عبر الاشكال الاخرى:
تبقى احكام الانظمة المرعية الاجراء لدى المؤسسات الاستثمارية العامة للمياه نافذة عند تلزيم عقود تعود لمشاريع تختلف فيها مساهمة القطاع الخاص عن الشكل المنصوص عليه في تعريف "المشروع المشترك". تراعي هذه العقود احكام المخطط التوجيهي العام للمياه ومخططات الاحواض ولا يجوز ان تتناول ما يخالف موضوع استثمار المرفق العام للمياه.
الفصل الثاني: - ادارة المرفق العام لمياه الشفة
المادة 61
نوعية المياه:
يجب ان تكون المياه الموزعة صالحة للشرب مهما كان شكل ادارة المرفق وعلى الادارات المختصة لا سيما الوزارة ووزارة الصحة العامة ان تسهر على تطبيق المعايير والمواصفات المعمول بها.
المادة 62
مبدأ حصرية المرفق:
ضمن نطاق الاستثمار، يتمتع المرفق العام لمياه الشفة بحصرية التوزيع وبالحق الحصري في صيانة جميع المنشآت وقنوات المياه الضرورية للمرفق.
تقوم كل مؤسسة عامة استثمارية للمياه باستلام جميع لجان ومشاريع مياه الشفة السابقة للقانون رقم 2000/221، والتي لم يتم استلامها بعد، وذلك ضمن مهلة سنة من تاريخ صدور هذا القانون ووفقا للاصول المرعية الاجراء.
المادة 63
واجب الوصل:
يلتزم كل مالك بناء بوصل بنائه وجميع الاقسام فيه بالشبكة العمومية لتوزيع مياه الشفة قبل إشغالها، ويتم الوصل وفقا للنظام الموضوع من قبل المؤسسة العامة الاستثمارية للمياه المعنية ووفقا للعقد الموقع بينها وبين المنتفع.
لا تسجل اي معاملة تتعلق بحق عيني على العقار المشترك بمياه الشفة في السجل العقاري، الا بعد إبراز صاحب العقار إفادة براءة ذمة صادرة عن المؤسسة تفيد بقيام المشترك بدفع جميع الرسوم والبدلات والغرامات المتوجبة عليه.
المادة 64
عقود الاشتراك الخاصة:
يجوز للمرفق العام لمياه الشفة ان يوزع المياه للمنتفعين لاغراض غير منزلية، ويتم تحديد إشتراكات خاصة في هذه الحالة.

المادة 65
اداء المرفق:
تطبيقا للنظام القانوني الذي يرعى اصول التفويض في المرفق العام للمياه او لما ينص عليه عقد الادارة المنظم مع الادارة المختصة، يلتزم المرفق العام لمياه الشفة بتلبية المقتضيات المتعلقة باستمرارية وبنوعية المياه المزودة وكذلك بمراعاة المهل المتعلقة بطلبات الاشتراكات او فسخها.
المادة 66
قياس استهلاك مياه الشفة:
يتم قياس استهلاك المشترك بواسطة عدادات مناسبة وفقا للعقد الذي يوقعه المنتفع. اما الوصلات غير المزودة بعدادات فعليها ان تلبي هذا الشرط خلال مهلة تحددها المؤسسة العامة الاستثمارية للمياه.
المادة 67
نظام المرفق العام لمياه الشفة:
تحدد في نظام المرفق العام لمياه الشفة العلاقات مع المنتفعين من المياه وخاصة الاصول التي ترعى الوصلات والاشتراكات الخاصة والاماكن المخصصة لوضع اجهزة قياس الاستهلاك بالاضافة الى اداء المرفق.
الفصل الثالث: - ادارة المرفق العام للصرف الصحي الجماعي
المادة 68
مبدأ حصرية المرفق:
ضمن نطاق الاستثمار المحدد في المخطط التوجيهي العام للمياه المنصوص عنه في المادة 16 من هذا القانون، يتمتع المرفق العام للصرف الصحي الجماعي حصريا بحق ادارة هذا القطاع وبالحق الحصري في صيانة جميع المنشآت والقنوات الضرورية لهذه المرفق.
المادة 69
واجب الوصل بشبكة الصرف الصحي العامة:
ضمن نطاق الصرف الصحي الجماعي، يتوجب على كل مالك لبناء ان يقوم بوصل البناء بالشبكة خلال فترة لا تتجاوز السنة من تاريخ التنفيذ الكامل لمنظومة الصرف الصحي.
اما الابنية او الاقسام غير المخصصة للسكن فيتوجب وصلها بشبكة الصرف الصحي خلال الفترة المذكورة، وذلك بالنسبة للفضلات ذات الطابع المنزلي.
كل شخص ملزم بالوصل بشبكة الصرف الصحي، وتحدد بدلات الصرف الصحي على اساس استهلاك المشترك على الشبكة العمومية لمياه الشفة. اما اذا استفاد بالكامل او جزئيا من مصدر مائي خاص، فعليه ان يصرح عن ذلك لدى المؤسسة التي تدير المرفق العام، ويتم تحديد بدلات الصرف الصحي المتوجبة عليه عن طريق قياس الاستهلاك الذي يتم من المصدر الخاص.
المادة 70
عقود الاشتراك الخاصة:
للمرفق العام للصرف الصحي ان يوافق على توصيل المياه المبتذلة غير المنزلية بموجب اتفاق وصل خاص شرط ان لا تؤدي طبيعة او حجم تلك الفضلات الى خلل في عمل منشآت الصرف الصحي، وان تحدد في الاتفاق المذكور اصول تقدير التلوث والاحجام المصرفة.
فيما يتعلق بالانشطة الموسمية، يجوز بصورة استثنائية ولمدة محددة، الموافقة على اتفاقات مؤقتة لتصريف الفضلات شرط عدم ترتيبها اي ضرر لمنشآت الجر او معالجة المياه المبتذلة او للوسط الذي تصب فيه.
المادة 71
اداء المرافق:
يلتزم المرفق العام للصرف الصحي الجماعي بضمان استمرارية وجودة جمع ومعالجة المياه المبتذلة.
المادة 72
نظام المرفق العام للصرف الصحي الجماعي:
تخضع العلاقات مع المنتفعين من شبكة الصرف الصحي الجماعي للانظمة التي تضعها المؤسسات العامة الاستثمارية المياه لادارة هذا المرفق، والمصادق عليها من قبل سلطة الوصاية.
المادة 73
مراقبة انشاءات الصرف الصحي غير الجماعي:
تحدد بمرسوم الاصول التي تعتمدها الادارة لمراقبة وادارة انشاءات الصرف الصحي غير الجماعي.
الفصل الرابع: - ادارة المرفق العام للري
المادة 74
احكام عامة:
1 - مع مراعاة الاحكام القانونية السارية المفعول، تتولى المؤسسات العامة الاستثمارية للمياه، كل ضمن نطاقها الاستثماري، ادارة واستثمار مياه الري ومن ضمنها صيانة انظمة جر المياه، وتخزينها ونقلها وتوزيعها والحفاظ على نوعيتها.
2 - تتضمن طلبات الاشتراك بمياه الري بنود تحدد نطاق التغذية، المساحة المروية، انواع المزروعات، رزنامة الري، الكميات المطلوبة وطريقة الري.
3 - ان كل تعديل في مندرجات البند اعلاه يحتاج الى طلب تعديل الاشتراك على ان يقدم هذا الطلب ضمن المهلة المحددة في انظمة الاستثمار العائدة لكل مؤسسة عامة استثمارية للمياه.
4 - تمسك المؤسسات المكلفة بالري سجلا يبين اسماء المستفيدين والمساحات المروية والزراعات المعتمدة والكميات المسحوبة، يجري تحديثه بشكل مستمر.
5 - لا تسجل اي معاملة تتعلق بحق عيني على العقار المشترك بمياه الري في السجل العقاري، الا بعد ابراز صاحب العقار افادة براءة ذمة صادرة عن المؤسسة تفيد بقيام المشترك بدفع جميع الرسوم والبدلات والغرامات المتوجبة عليه.

6 - يكون لأنظمة ادارة واستثمار مشاريع الري وتعديلاتها صفة الالزام في تنظيم العلاقة بين المستفيدين والمؤسسة العامة الاستثمارية للمياه.
7 - تقوم كل مؤسسة عامة استثمارية للمياه باستلام جميع لجان ومشاريع مياه الري السابقة للقانون رقم 2000/221، والتي لم يتم استلامها بعد، وذلك ضمن مهلة سنة من تاريخ صدور هذا القانون ووفقا للاصول المرعية الاجراء.

المادة 75

جمعيات مستخدمي مياه الري:

1 - ينشأ، عند الحاجة، وفقا لاحكام هذا القانون جمعيات لمستخدمي مياه الري، وذلك بمرسوم يتخذ في مجلس الوزراء بناء على اقتراح الوزير المستند الى طلب المؤسسة العامة الاستثمارية للمياه المعنية، على ان تضم هيئتها الادارية ممثل عن المؤسسة العامة الاستثمارية للمياه المعنية.
2 - يشترط في جمعيات مستخدمي مياه الري ان لا تبغي الربح، وان يكون منتسبا اليها 65% على الاقل من المستفيدين من مصدر مائي محدد، يمثلون على الاقل 51% من مساحة المنطقة الجغرافية المستفيدة.
3 - يتم تحديد المنطقة الجغرافية التي تعمل ضمنها جمعيات مستخدمي مياه الري والمصدر المائي الوارد ذكرهما في الفقرة السابقة في مرسوم انشاء الجمعية.
4 - يكون لكل جمعية من جمعيات مستخدمي مياه الري تسميتها الخاصة والفريدة والتي يمكن ان يكون اسم مقر عملها، او غير ذلك من الاسماء المميزة، التي يجب ان تبدأ بالعبارة التالية: "جمعية مستخدمي مياه الري" على ان ينحصر عملها ضمن النطاق الجغرافي او المصدر المائي المحدد لها، من دون ان يتداخل نطاق احدى هذه الجمعيات مع نطاق جمعية اخرى.
5 - تحدد دقائق تطبيق هذه المادة والانظمة الادارية والمالية التي تخضع لها جمعيات مستخدمي مياه الري وآلية تحويل اللجان القائمة الى جمعيات لمستخدمي مياه الري بمرسوم يتخذ في مجلس الوزراء بناء على اقتراح الوزير.

المادة 76

نشاطات جمعيات مستخدمي مياه الري:

تمارس جمعيات مستخدمي مياه الري النشاطات التالية:

1 - تشغيل وصيانة شبكة التوزيع الفرعية، بالاتفاق مع المؤسسة، والمحافظة عليها ضمن نطاقها.
2 - تنظيم عملية الاستفادة واستخدام مياه الري واستيفاء اشتراكات الانتساب الى الجمعية من الاعضاء، مقابل الخدمات التي يتم تأمينها لهم.
3 - اتخاذ التدابير المناسبة لمكافحة تأثر التربة ومكافحة الملوحة والتلوث والترويج لحماية البيئة.
4 - توفير معدات وآلات وادوات الري والتجهيزات، الضرورية لتشغيل شبكة توزيع المياه ذات الصلة ضمن نطاقها والمحافظة عليها، وكذلك تأمين استبدالها وتشغيلها وصيانتها.
5 - تدريب اعضائها على استخدام تقنيات الري الحديثة، وجوانب من الزراعة المروية، واساليب التوفير في استهلاك المياه، وترشيد استخدام الاسمدة والمبيدات الزراعية.
6 - المساهمة والمساعدة، بعد موافقة المؤسسة العامة الاستثمارية المعنية، في انشاء وتحسين وتأهيل وتشغيل وصيانة البنى التحتية المكملة لمشاريع الري، وخاصة اقنية البذل الرئيسية والثانوية ضمن نطاق الجمعية.
7 - السعي لحل النزاعات الناشئة بين اعضاء الجمعية او مع اطراف ثالثين.
8 - العمل على مراعاة واحترام وضمان مصالح اعضاء الجمعية.

المادة 77

المبادىء الاساسية:

على كل جمعية من جمعيات مستخدمي مياه الري ان تلتزم وتحترم في عملها المبادىء التالية:

1 - العدالة والانصاف، بما يؤمن احترام حقوق اعضائها، لا سيما في القرارات المتعلقة بتوزيع مياه الري على المستفيدين بصيغة تراعي التناسب والتوفيق بين الحاجات والامكانيات المتوفرة.
2 - ترشيد استخدام الموارد، عبر قيام الجمعية بادارة شبكة التوزيع الفرعية، داخل نطاقها، بطريقة عقلانية تمنع الافراط في استعمال المياه، وتأكل التربة، والملوحة والتلوث، فضلا عن تعزيز حماية البيئة.
3 - الشفافية والمشاركة، عبر العمل بطريقة علنية، واضحة، وشفافة، وتشجيع الاعضاء على المشاركة الفعالة في هيئاتها الادارية.

Annex 2
Stakeholder Profiles

Ras el Jabal Municipality

Ras el Jabal is a mountain village of 300 houses, and all its residents are from one family. Its economy is based on stone quarries, and some farmers have large apple orchards. The local spring is diverted to the orchards most of the year, and only allowed to run downstream to Kfar Roma and Wadi el Batata in Autumn and Winter. The spring used to supply all houses with water all year round, but in the last 5 years the flow has gone down to the point that residents need to buy water from apple farmers in the Summer. Sewage is disposed of in septic pits, and once a year desludged to a pond between the spring and Kfar Roma.

The municipality manages the spring water supply to houses and farms, but the farmers "own" the water through their property deeds. The municipality has tried several times to drill wells, but failed. An expert has told the municipality they do not have a suitable aquifer for a well, and they need to find another solution. The municipality is asking the MoEW to invest $10million in a wastewater treatment system that recycles sewage for irrigation to cover the gap. Ras el Jabal residents and farmers do not want to pay anything for water services, since they believe the spring has been theirs for 200 years.

Wadi el Batata Municipality

Wadi el Batata is a village in the valley below Ras el Jabal and next to Kfar Roma. Its 1,000 households are almost all farmers or agrofood producers, including 200 refugee families. Due to the water scarcity they face, they have drilled 10 wells to supply houses and farms with water all year round. However, due to electricity cuts, diesel generators have to be operated to pump water out, which is very expensive. The municipality built a hill lake above the village to collect water from the Ras el Jabal spring in the few months they are allowed to use it, but it ended up being heavily contaminated with sewage.

The municipality has allowed the West Lebanon Water Establishment to take over 3 wells and manage domestic water services since it cannot afford to pay for energy anymore. Households are happy to pay for water services, but constantly struggle to afford it since their businesses are failing. Businesses in the town are struggling due to the cost of water, which drives up the cost of their produce, as well as the reputation their farms now have since the sewage contamination poisoned 150 wedding attendees at Kfar Roma.

Kfar Roma Municipality

Kfar Roma is a village of just 100 permanent households and 700 houses, most of which are rented out seasonally (summer) to tourists. Tourists are attracted to the town's moderate, dry climate and panoramic view of Lebanon's largest wetland. The village's economy is entirely based on tourism, and there are two wedding venues and 7 restaurants that employ at least one member of each family. Since the poisoning incident, their tourism has suffered. An expert has also studied the wetland recently, and rumors are that the spring diversion and wells drilled in neighboring villages are slowly drying up the wetland earlier and earlier in the year.

The West Lebanon Water Establishment manages the town's only well, which is very productive and powered by a solar generator the local businesses paid for collectively. The municipality is panicking, and needs to find a way to secure the survival of the wetland. They are asking the Water Establishment to provide a diesel generator and fuel in order to pump water into the wetland in the summer. They hope this will slow down the drying up and save their village.

Batata Farmer's Cooperative

The Batata Farmer's Cooperative counts 100 farmers which produce potatoes almost all year round. They are desperate to secure enough water for their farms through the 7 wells they've drilled, but can no longer afford the diesel required to run the generators that power them. They had a lot of hope for a hill lake the municipality had built, but it was contaminated by sewage from Ras el Jabal. Last year, at a wedding ceremony in neighboring Kfar Roma, many attendees were poisoned. The wedding organizers accused the cooperative of supplying them with contaminated potato, and Kfar Roma businesses refuse to buy their produce anymore.

The cooperative is furious at the municipality for not taking action against Ras el Jabal. Farmers have threatened to attack Ras el Jabal and drive its residents away if sewage continues to reach their irrigation water. They are also demanding that the West Lebanon Water Establishment gives them back 3 wells they took control of recently to supply households, since these are the deepest, safest, and most productive wells in the village.

Jabal Apple Association

The Jabal Apple Association is an NGO created by a millionaire in Ras el Jabal. His nephews, who are apple farmers, are members and elect him as president of the association and mayor of the town every year. The president is the largest quarry operator, and uses the association to get funding from international donors for the rehabilitation of quarry sites he no longer needs. After the rehabilitation, farmers plant apple orchards on the sites and use spring water to irrigate them.

The association is the biggest donor to the municipality and has built the municipal office building, agricultural roads, and a garden. The association is trying to secure donor money to drill a well and install a solar generator to pump water to residents, since their study found that spring water is increasingly contaminated with dynamite residue from the quarries.

West Lebanon Water Establishment

The Water Establishment recently rehabilitated and equipped 3 wells in Wadi el Batata and serves its 1,000 households all year round. Although residents generally pay their tariffs, the cost of diesel has become so high that the establishment is starting to limit the supply hours through the generator. The municipality has told the establishment that, unless supply goes back up, residents might stop paying for the service and farmers will ask to take over the wells (which they had drilled years ago but could not afford to equip).

The Water Establishment also serves Kfar Roma's residents, although they are very few (100) except in summer, when thousands of tourists flock into the village. A local well with solar power supplies the town, and residents and businesses pay their tariffs most of the time. The municipality wants the water establishment to install a diesel generator and supply more water to meet the increasing demand.

The Water Establishment asked an expert from the Ministry of Energy and Water to study the three villages and propose solutions to the water problem. In Ras el Jabal, which the establishment does not serve, there is a bountiful spring that is diverted for agricultural use. However, the expert found that the spring is contaminated with dynamite residue from the quarry and is not suitable for potable water. She also determined that drilling wells in Ras el Jabal would not be successful due to geological formations.

Annex 3
PPDA Description

Public-public delegation agreements (PPDAs) refer to arrangements between water utilities and municipalities, where the former delegates the management of local water systems to the latter. This delegation allows municipalities to take responsibility for the management and delivery of water services in their jurisdiction, while the utility retains an oversight role.

PPDAs can have several benefits, such as improving the efficiency of water service delivery, promoting local accountability and decision-making, and fostering collaboration between the utility and the municipality. By delegating the management of local water systems, the utility can focus on its core functions, such as infrastructure development, strategic planning, and regulatory oversight, while the municipality can focus on the day-to-day management of water services.

PPDAs can also enhance the participation of local communities in decision-making processes, as municipalities are generally more responsive to the needs and concerns of their constituents. By delegating authority to the municipality, the utility can foster greater engagement and trust with local communities, leading to more sustainable and equitable water systems.

However, PPDAs can also present challenges, such as the potential for conflicts of interest or lack of capacity on the part of the municipality. To address these challenges, it is essential to ensure that the delegation process is transparent and that the responsibilities and accountabilities of both parties are clearly defined. It is also important to provide training and support to the municipality to build its capacity to manage water systems effectively.

Civil society representatives can play an important role in ensuring that PPDAs benefit all stakeholders. They can advocate for transparency and accountability in the delegation process, and provide feedback on the effectiveness and impact of the partnership. Civil society can also represent the interests of marginalized groups and ensure that their needs are taken into account in decision-making processes.

In conclusion, PPDAs can be an effective way to improve the management and delivery of local water services. By delegating authority to municipalities, utilities can foster greater collaboration and engagement with local communities, leading to more sustainable and equitable water systems. However, it is essential to address potential challenges and involve civil society representatives in the delegation process to ensure that the interests of all stakeholders are taken into account.

PPP Description

Public-Private Partnerships (PPPs) in the water sector refer to collaborations between public entities, such as governments or municipalities, and private companies in the provision of water and sanitation services. These partnerships aim to leverage the strengths of both sectors to improve access to safe and affordable water services for communities.

PPPs in the water sector can take different forms, depending on the specific context, but they generally involve the private sector investing in the construction, operation, or maintenance of water infrastructure, while the public sector provides regulatory oversight and ensures that the water services are accessible and affordable for all. The private sector may also bring technical expertise, innovation, and financial resources to the partnership, while the public sector provides the legitimacy and accountability needed to ensure that the services are delivered in the public interest.

One of the key benefits of PPPs in the water sector is that they can increase access to safe water and sanitation services for underserved communities. Private sector involvement can lead to increased investment in infrastructure and technology, which can improve the quality and reliability of water services. PPPs can also create new job opportunities and stimulate economic development in the region.

However, PPPs in the water sector are not without challenges. One concern is that private companies may prioritize profit over social and environmental goals, which can lead to the exclusion of low-income or marginalized communities. Another concern is that PPPs can lead to increased water tariffs, which may be unaffordable for some households.

To ensure that PPPs in the water sector benefit all stakeholders, it is essential to involve civil society representatives in the planning, implementation, and monitoring of these partnerships. Civil society organizations can represent the interests of marginalized groups and ensure that their needs are taken into account. They can also provide valuable feedback on the effectiveness and impact of the partnership, and hold both public and private partners accountable for their commitments.

In conclusion, PPPs in the water sector have the potential to improve access to safe and affordable water services for communities. However, to ensure that these partnerships benefit all stakeholders, it is essential to involve civil society representatives in the planning, implementation, and monitoring of these partnerships. By working together, public and private partners can create sustainable and equitable water systems that benefit everyone.

1.7 – WWM Strategic Roadmap

Infrastructure – Initiative Summary (2/6)

#	Initiative	Capacity (MCM) Static - Dynamic	Implementation time & CAPEX 11	12	13	14	15	16-20	Total CAPEX (MUSD)	Financing
1.3 Cont'd	▪ ***BML***	***166-233***							***859.0***	GOL Loans PSP
	– Qaysamani Lake	1.0	12.5	12.5					25.0	
	– Boqaata Dam	6-12	17.3	17.3	17.3	17.3			69.0	
	– Aazounieh Dam	4.1-5.0	16.3	16.3	16.3	16.3			65.0	
	– Maaser El Chouf Dam	2.2	13.3	13.3	13.3	13.3			53.0	
	– Janneh Dam	30-90		60.0	60.0	60.0	60.0	60.0	300.0	
	– Laklouk Lake	0.5			7.0	7.0			14.0	
	– El Manzoul Dam	0.4			4.0	4.0			8.0	
	– Bisri Dam	120.0						300.0	300.0	
	– Mokhada Lake	2.0			7.5	7.5			15.0	
	– Ratiba Lake	0.3			5.0	5.0			10.0	
	▪ ***North***	***80-151***							***488.0***	
	– Brissa Dam	0.8	3.0						3.0	
	– Kouachra Lake (Rehabilitation)	-	3.0						3.0	
	– El Bared Dam	37-90	28.8	28.8	28.8	28.8	28.8		144.0	
	– Qarkaf Dam	20-25		20.3	20.3	20.3	20.3		81.0	
	– Mseilha Dam	6-12	13.8	13.8	13.8	13.8			55.0	
	– Balaa Dam	1.2-2.2	8.7	8.7	8.7				26.0	
	– Rahwe Lake	2.2			12.5	12.5			25.0	
	– Iaal Dam	12-18						100.0	100.0	
	– Ouadi Chich - Arz Lake	1.0						30.0	30.0	
	– Atolbe Lake	0.7						12.0	12.0	
	– Hadath El Jebbeh Lake	0.4						9.0	9.0	
	▪ ***South*** – Ibl Es Saki Dam	***50***				50.0	50.0	200.0	***300.0***	
	▪ ***Bekaa***	***83***							***328.0***	
	– Assi Project Phase I	1.5	12.5	12.5	12.5	12.5			50.0	
	– Assi Project Phase II	63	28.2	28.2	28.2	28.2	28.2		141.0	
	– Younine	5.8	16.5	16.5	16.5	16.5			66.0	
	– Ouadi Sbat	0.6				7.5	7.5		15.0	
	– Barhacha Lake	2.0		5.0	5.0				10.0	
	– Massa Dam	2.5			8.3	8.3	8.3		25.0	
	– Rachaya - Ain Arab Lake	8.0				10.5	10.5		21.0	

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Infrastructure – Initiative Summary (3/6)

#	Initiative		Implementation time & CAPEX 11	12	13	14	15	16-20	Financing
1.4	▪ **Water Supply Transmission** – Replacement of existing over-aged transmission systems and associated equipment and bulk meters – Leakage detection/rehabilitation and partial replacement of damaged middle-aged systems and associated equipment – Expansion of transmission systems to meet growing demand including district metering – Rehabilitation/replacement of existing storage tanks including hydraulic equipment and flow meters – Construction of new storage tanks to meet growing demand and achieve 0,5 and 1 day retention time for BML and other WE's respectively including hydraulic equipment and flow meters – Construction of Awali – Beirut and Canal 800 (WS share only) conveyors and related transmission systems and equipment	2011-201: Full/partial replacement of 2,550 km of pipes and additional 156,000 m3 of storage in 465 tanks 2016-2020: Replacement of 250 km of pipes and additional 35,000 m3 of storage in 96 tanks	814 M$					121M$	GoL Loans/ Grants

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Infrastructure – Initiative Summary (4/6)

#	Initiative		Implementation time & CAPEX 11	12	13	14	15	16-20	Financing
I.5	**Water Supply Distribution** – Replacement of existing over-aged distribution networks including house connections – Rehabilitation and partial replacement of damaged middle-aged networks, supported by leakage detection campaigns – Expansion of distribution networks to cover new geographic areas and meet growing demand including house connections – Installation of customer water meters. Metering targets by 2015 in BML 95%, in North/South 85% and Bekaa 75%	2011-2015: Full/partial replacement of 6,900 km of pipes with house connections and installation of 640,000 meters 2016-2020: Full/partial replacement of 2,700 km of pipes with house connections and installation of 365,000 meters	580M$					274 M$	GoL Loans/ Grants

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Infrastructure – Initiative Summary (5/6)

#	Initiative	Area (ha)	Implementation time & CAPEX 11	12	13	14	15	16-20	Financing
I.6	**Irrigation** – Rehabilitation/replacement of existing over-aged irrigation systems and networks – Implementation of additional 15,000 ha of irrigation schemes until 2015 and 15,000 ha between 2016-2020	*As detailed below*	372 M$					205 M$	GOL Loans/ Grants
	North	***5,750***							
	• Noura El Tahta Scheme	5,000	4.0	4.0	9.0	9.0	9.0	29.0	
	• El Bared Scheme	750							
	Bekaa	***13,650***							
	• Assi Scheme	5,400							
	• Younine Scheme	1,550	15	15	36	36	36	119	
	• South Bekaa Phase 2 (Left Bank)	6,700							
	South	***14,700***							
	• South Lebanon Conveyor 800	14,700	20	28	48	56	47	56	

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Infrastructure – Initiative Summary (4/6)

#	Initiative		Implementation time & CAPEX 11	12	13	14	15	16-20	Financing
1.5	• **Water Supply Distribution** – Replacement of existing over-aged distribution networks including house connections – Rehabilitation and partial replacement of damaged middle-aged networks, supported by leakage detection campaigns – Expansion of distribution networks to cover new geographic areas and meet growing demand including house connections – Installation of customer water meters. Metering targets by 2015 in BML 95%, in North/South 85% and Bekaa 75%	2011-2015: Full/partial replacement of 6,900 km of pipes with house connections and installation of 640,000 meters 2016-2020: Full/partial replacement of 2,700 km of pipes with house connections and installation of 365,000 meters	580M$					274 M$	GoL Loans/ Grants

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Infrastructure – Initiative Summary (5/6)

#	Initiative	Area (ha)	Implementation time & CAPEX 11	12	13	14	15	16-20	Financing
1.6	• **Irrigation** – Rehabilitation/replacement of existing over-aged irrigation systems and networks – Implementation of additional 15,000 ha of irrigation schemes until 2015 and 15,000 ha between 2016-2020	*As detailed below*	372 M$					205 M$	GOL Loans/ Grants
	North	***5,750***							
	• Noura El Tahta Scheme	5,000	4.0	4.0	9.0	9.0	9.0	29.0	
	• El Bared Scheme	750							
	Bekaa	***13,650***							
	• Assi Scheme	5,400							
	• Younine Scheme	1,550	15	15	36	36	36	119	
	• South Bekaa Phase 2 (Left Bank)	6,700							
	South	***14,700***							
	• South Lebanon Conveyor 800	14,700	20	28	48	56	47	56	

92

Infrastructure – Initiative Summary (6/6)

#	Initiative	Implementation time & CAPEX						Financing
		11	12	13	14	15	16-20	
I.7	▪ **Wastewater** – Collection and treatment to at least preliminary level of 80% by 2010 and 95% by 2020 – Pre-treatment of all industrial wastewater by 2020 – Reuse of 20% of treated wastewater by 2015, and 50% by 2020 – Secondary treatment and reuse of all inland wastewater by 2020 and secondary treatment by 2020 of coastal wastewater where reuse is economically justified	1,895M$						GoL Loans/ Grants PSP
	1. Integrated and prioritized immediate investment:							
	a. Funded networks for the seven completed and two operational WWTPs along the coast	190						
	b. Completion of already funded projects	490						
	c. Networks for already completed projects (23 inland and 11 coastal plants)	880						
	2. Preparation of regional wastewater master plans	4						
	3. Integrated national investment program 2013-2020							
	a. Preparation and implementation				200			
	b. MEW responsibility for budget execution and project implementation with staff recruitment and capacity building	20						
	4. Economic reuse of treated wastewater and sludge (studies and investment)	31						
	5. Capacity building and pilots for wastewater sub-sector	80						
	▪ **Long term (wastewater)** – Continuation of the integrated national investment program – Updating pre-treatment plants to secondary and extension of Jbeil plant – Investments for reuse of treated wastewater for irrigation						1,213M$	

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Baseline

Demand/Supply Forecasts

Sector Enabling Environment

Investment Plan

Strategic Roadmap

I. Infrastructure Initiatives

II. Sector Management Initiatives

94

Management – Initiative Summary (1/9)

#	Initiative	Implementation time & Budget 11	12	13	14	15	16-20	Financing
II.1	**1.1. Perform all priority actions required to complete the restructuring of WEs and address potential limitations,** mainly: – Development of revised and improved organization structures for WEs based on roles and responsibilities – Drafting revised WE organization bylaws, supporting in the approval process and following up on their enactment – Implementation of the restructuring of WEs – Evaluate the potential for outsourcing of certain non-core functions – Providing needed support for WEs to gradually reach full administrative and financial autonomy **1.2. Improve on the operating model between WEs and MEW,** through: – Ensuring an integrated management of water resources – Ensuring the involvement of WEs in project planning and implementation for water supply, irrigation and wastewater – Improvement in coordination – Ensuring operational and financial empowerment of WEs together with proper mechanisms for performance management **1.3. Improve on the performance efficiency of WEs** to reflect: – More focus on irrigation and wastewater responsibilities, in addition to current water supply activities – Most suitable organization for technical functions – Improvements to support functions e.g., Strategic Planning and Business Planning, Water Demand Management, performance management, more focus on IT, Fixed Asset Management, Supply Chain Management, Customer Service, Control and Audit functions			14 M$				Technical Assistance Grants GOL

95

Management – Initiative Summary (2/9)

#	Initiative	Implementation time & Budget 11	12	13	14	15	16-20	Financing
II.1 Cont'd	**1.4. Restructure MEW's organization in line with the requirements of laws 221 and 247** to reflect more its water governance role, with main focus on policy making, planning and regulatory roles: – Development of revised organization structures for MEW – Drafting a revised organization law, supporting in the approval process and following up on its enactment – Implementation of the restructuring of MEW **1.5. Develop the process for the performance monitoring and evaluation of WEs,** including: – Monitoring body – Performance indicators – Tools and procedures		2 M$					Technical Assistance Grants GOL
	1.6. Provide the required manpower levels and capabilities to ensure an appropriate operation and maintenance of assets and the delivery of water at optimal service levels, through the: – Reduction of current vacancies (over 81% at MEW and 67% in WEs) to required manpower levels according to recommended organization structures – Continuous development of staff through proper training			4 M$				Technical Assistance Grants GOL

96

Management – Initiative Summary (3/9)

#	Initiative	Implementation time & Budget	Financing
		11 | 12 | 13 | 14 | 15 | 16-20	
II.1 Cont'd	**1.7. Enforce planning and capital spending responsibilities and coordination among various players in the water sector with a clear delineation of authorities,** where: – MEW is responsible for setting policies, strategies and national planning – CDR is in charge of planning and securing foreign financing of capital projects based on national plans – WEs, LRA and other national entities develop their specific business plans and master plans according to policies and guidelines of the national plan	11–15	-
	1.8. Involve stakeholder participation in the design and management of irrigation projects according to best practices, through: – Creation of formal Water Users Associations (WUAs) to replace the different organizations currently in charge of O&M of irrigation schemes – Definition of roles and responsibilities with respect to water management (including water quality) of the WUAs and other partners, in close cooperation with the intended beneficiaries – Providing well-focused training related to the establishment and management of WUAs to all involved parties	12–15: 8 M$	Technical Assistance Grants GOL

97

Management – Initiative Summary (4/9)

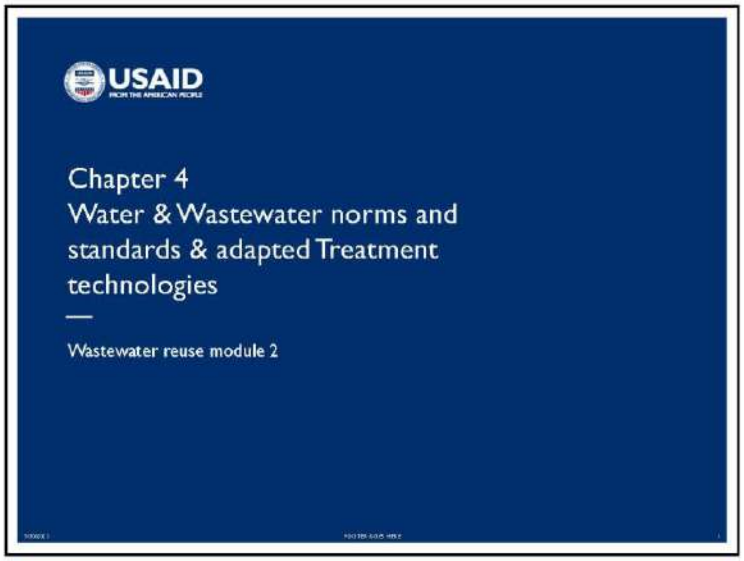
#	Initiative	Implementation time & Budget	Financing
		11 | 12 | 13 | 14 | 15 | 16-20	
II.1 Cont'd	**1.9. Improve irrigation water demand management and cost recovery, and sustainability of irrigation schemes,** through: – Adjustment of irrigation water tariffs to cover O&M costs at a first stage, and periodically review and adjust water tariffs to reflect actual costs – Basing water charges on volume of water used rather than area. Where metering is not feasible at this time, base water charges on a combination of a fixed charge to cover the basic services, and other charges which can be used as a proxy for the volume of water used, such as crop grown and/or hourly use of water – Carrying out periodic public awareness campaigns to inform policy makers and farmers of water shortages that could be faced in the next thirty years, and the need for water conservation for irrigation		
II.2	2.1. <u>Water Supply Tariff</u> ▪ **Implement a new consumption-based tariff which includes fixed and variable (volumetric) charges for connections equipped with customer water meters,** where: – Current lump-sum tariff should be temporarily maintained for unmetered customers – New tariff should be based on a proper cost analysis to cover, at a minimum, O&M cost as a first stage – No tariff increase would be introduced before concrete improvements are brought to the water sector	11–15: 3 M$	Technical Assistance Grants GOL

98

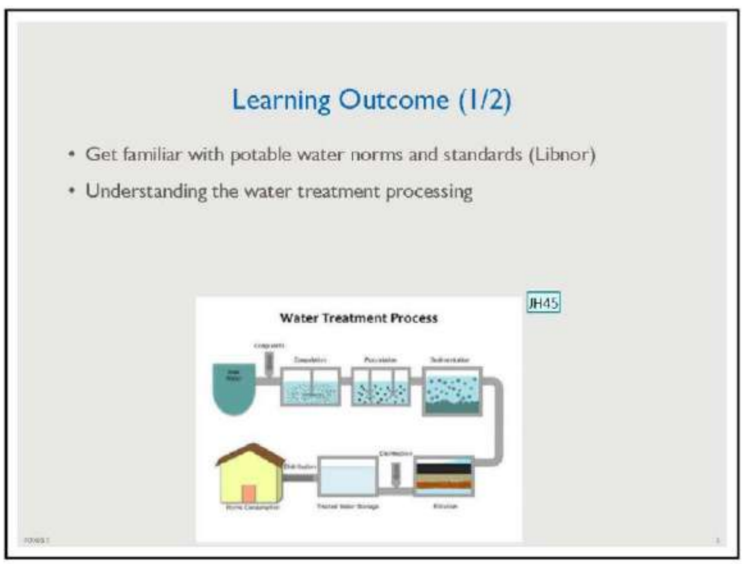
Annex 2 – Water and Wastewater Treatment & Reuse

2.1 – Water and Wastewater Norms and Standards & Adapted Treatment Technologies

5/30/2023



1



2

1

Slide 2

JH45 https://chem.libretexts.org/Courses/Furman_University/CHM101%3A_Chemistry_and_Glol
Jules Hatem, 3/11/2023

Learning Outcome (2/2)

- Identification of wastewater collection systems
- Understanding the wastewater treatment processing
- Characterization of the main biological treatment processes
- Decision making factor about the method of treatment to be chosen

JH45

3

Outline

1. Potable water norms & standards
2. Water treatment processing
3. The sewage management strategy approach
4. Sewage collection systems
5. Wastewater treatment
6. Quality of Entry Influent VS Effluent purpose of Use
7. Characteristics of wastewater
8. Norms and standards related to air, wastewater and wastewater treatment plants
9. Wastewater treatment flow scheme
10. Waste water treatment process
11. Wastewater treatment systems
12. Selecting unit operations and processes
13. Criteria and indicators used to assess the sustainability of treatment technologies

4

Slide 3

JH45 https://evreka.co/blog/how-to-handle-wastewater-treatment-and-disposal/
Jules Hatem, 3/11/2023

1-Potable water norms & standards (1/3)

Drinking water standard standards have been selected for analysis of physio-chemical and bacteriological indicators of pollution which will be used for describing the baseline status of water environment

5

1-Potable water norms & standards (2/3)

مؤسسة المقاييس والمواصفات اللبنانية
--------LIBNOR--------

Numéro de référence
Reference Number
NL 161 (A)
ICS: 13.060.20

مؤسسة المقاييس والمواصفات اللبنانية - ليبنور هي مؤسسة عامة ترتبط بوزارة الصناعة. أنشأت بموجب قانون صادر بتاريخ 23 تموز 1962 تتولى بموجبه "وحدها وضع المقاييس والمواصفات الوطنية ونشرها وتعديلها ومنح حق استعمال شارة المطابقة للمقاييس والمواصفات.

توضع المواصفات والمقاييس وتناقش وتصاغ في لجان فنية اختصاصية تؤلفها المؤسسة لهذا الغرض.

تتناول المقاييس والمواصفات الوطنية – على سبيل المثال لا الحصر – القياسات والمصطلحات والرموز وتحديد النوعية للمنتجات والسلع وطرق الفحص والتحليل والاختبار وأصول العمليات المهنية وقواعد الانشاءات الفنية".

"المقاييس والمواصفات اللبنانية التي تقرها المؤسسة اختيارية مبدئياً، ولكن لاعتبارات تتعلق بالسلامة العامة أو الصحة العامة أو المصلحة الوطنية، يمكن للحكومة أن تعطي لأي من المقاييس والمواصفات اللبنانية صفة الإلزام القانوني بموجب مرسوم يتخذ في مجلس الوزراء".

تشارك ليبنور في أعمال التقييس الدولية من خلال عضويتها وانتسابها إلى المنظمة الدولية للتقييس (**ISO**) واللجنة الأوروبية للتقييس (**CEN**) والمنظمة العربية للتنمية الصناعية والتعدين (**AIDMO**) ولجنة الدستور الغذائي (**CODEX Alimentarius**).

6

1-Potable water norms & standards (3/3)

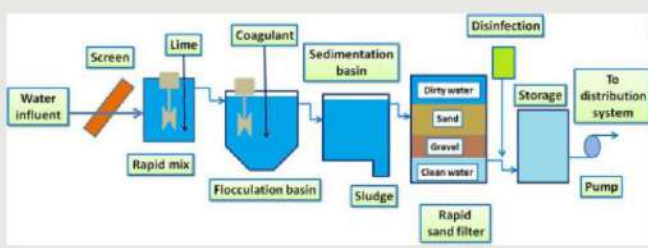
أعدت هذه المواصفة القياسية "مياه الشرب"، رقم 161:2016، وفقاً لإجراءات ليبنور الداخلية، وكانت لجنة "جودة المياه NL TC 147" في مؤسسة المقاييس والمواصفات اللبنانية هي المسؤولة عن إعدادها.
واعتمدت اللجنة الفنية في إعداد هذه المواصفة بشكل أساسي على الدراسة التي أعدتها منظمة الصحة العالمية والتي إستندت فيها على:

- Guidelines for Drinking-Water Quality – Fourth Edition – World Health Organization 2011.
- National Primary Drinking Water Regulations (NPDWRs) – Table of contaminants – US Environmental Protection Agency (EPA)

تلغي هذه المواصفة القياسية المواصفة القياسية اللبنانية التالية: NL 161:1999
وافقت اللجنة الفنية على هذه المواصفة في اجتماعها بتاريخ 2016/8/2.
أقر مجلس إدارة المؤسسة هذه المواصفة في اجتماعه بتاريخ 2016/10/28.
تجدر الإشارة الى أن الملحقات الإعلامية المرفقة بهذه المواصفة غير ملزمة.

7

2-Water treatment processing



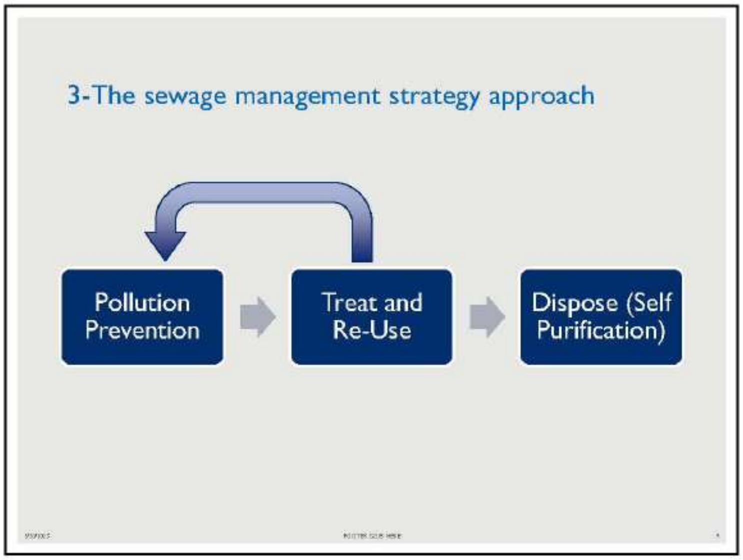
JH73

8

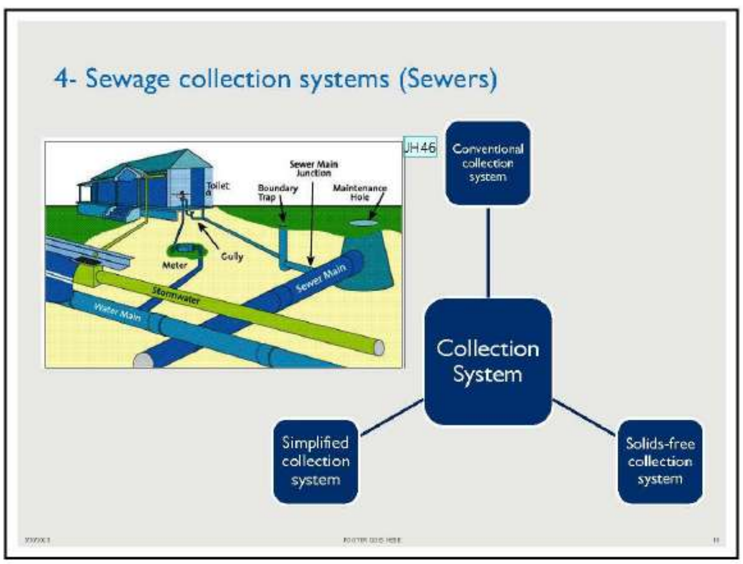
4

Slide 8

JH73 https://www.sciencedirect.com/topics/engineering/drinking-water-treatment
Jules Hatem, 5/27/2023


3-The sewage management strategy approach
Pollution Prevention
Treat and Re-Use
Dispose (Self Purification)

9


4- Sewage collection systems (Sewers)
Sewer Main Junction
Toilet
Boundary Trap
Maintenance Hole
Meter
Gully
Sewer Main
Stormwater
Water Main
JH46
Conventional collection system
Collection System
Simplified collection system
Solids-free collection system

10

Slide 10

JH46 https://www.thewatertreatments.com/wastewater-sewage-treatment/computer-applicatic
Jules Hatem, 3/11/2023

4- Sewage collection systems (Sewage)

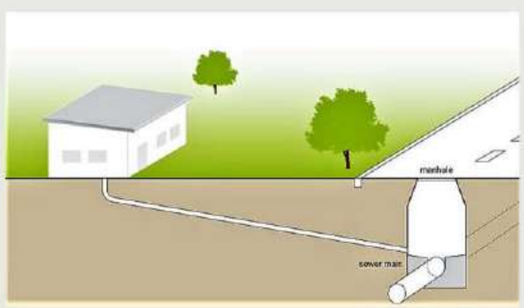
4.1- Conventional Collection System (1/2)

Advantages	Disadvantages
Convenient systems and no attention is needed by households or users	High investment costs
Abundant experience in such systems exist in the region	Minimum velocity is required to flush solids. Accordingly, minimum slope should be provided to maintain the minimum velocity
System is mostly in line with existing national codes and standards	Leakages may pose high risk for contamination as compared to other systems
Requires less maintenance as compared to other gravity systems	

11

4- Sewage collection systems (Sewage)

4.1- Conventional Collection System (2/2)



12

4- Sewage collection systems (Sewage)

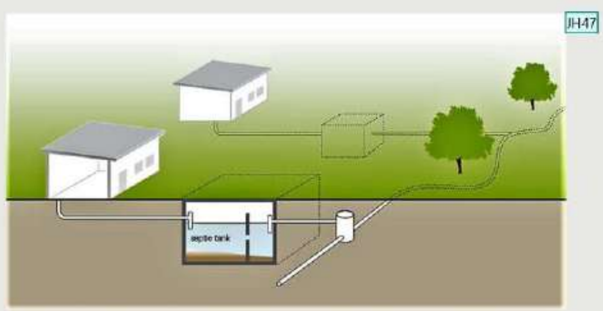
4.2- Solid-Free Collection System (1/2)

Advantages	Disadvantages
Cost savings might be 30 to 50% as compared to conventional sewer system	Space has to be provided for the interceptor tank at each household. Additionally, access to the interceptor must also be provided
No need for continuous downward slope and accordingly the pipes might be installed at shallow depths	Regular de-sludgingis crucial for the a well operated system
Inspection manholes are not required	Needs high public awareness as public are involved in the operation and maintenance of the system
Less environmental risks in case of leaks	In many cases in the region, codes and standards still need to be developed for such systems
Reduction on the treatment costs since solids are removed upstream	Lack of regional experience in such systems

13

4- Sewage collection systems (Sewage)

4.2- Solid-Free Collection System (2/2)



14

Slide 14

JH47 https://sswm.info/factsheet/solids-free-sewer
Jules Hatem, 3/12/2023

4- Sewage collection systems (Sewage)

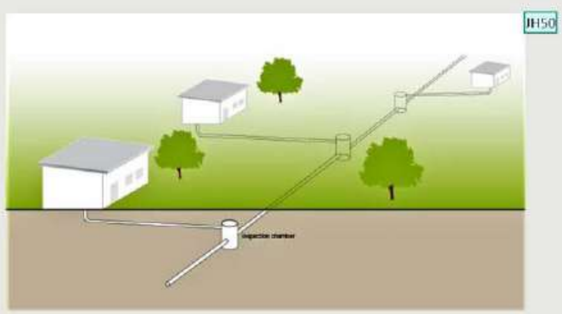
4.3- Simplified Collection System (1/2)

Advantages	Disadvantages
Shallow depth and flatter gradients as compared to conventional systems	Toilets need to be flushed with sufficient amount of water to provide flushing for the system
Pipes are smaller and cheaper as compared to conventional sewer system	Grease and grit traps need to be installed at each household and regularly maintained. Accordingly, community involvement is crucial
	Higher maintenance requirements as compared to conventional system
	No sufficient experience exists so far in the region regarding such systems

15

4- Sewage collection systems (Sewage)

4.3- Simplified Collection System (2/2)



16

8

Slide 16

JH50 https://sswm.info/taxonomy/term/3792/simplified-sewer
Jules Hatem, 3/12/2023

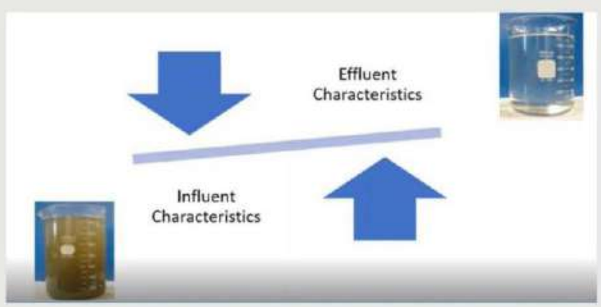
5-Waste Water treatment

- Water treatment is any process that makes water more suitable for a specific end use – in our case the process of converting wastewater into water that can be discharged back into the environment and/or reused

JH51

17

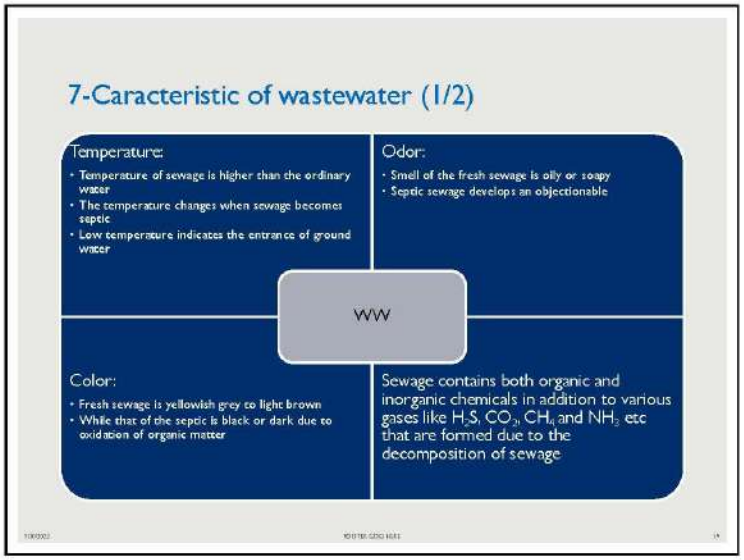
6-Quality of Entry Influent VS Effluent purpose of Use



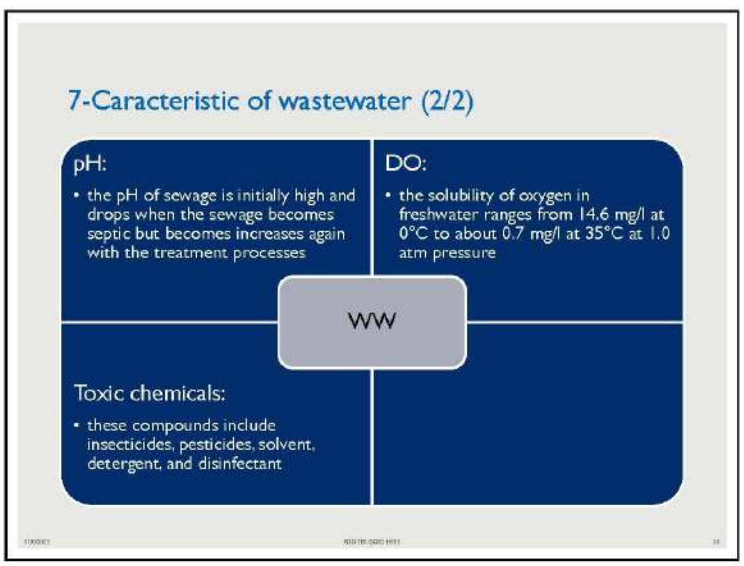
18

Slide 17

JH51 https://www.erg.com/project/evaluating-residuals-management-drinking-water-treatmer
Jules Hatem, 3/12/2023


7-Caracteristic of wastewater (1/2)
Temperature:
• Temperature of sewage is higher than the ordinary water
• The temperature changes when sewage becomes septic
• Low temperature indicates the entrance of ground water
Odor:
• Smell of the fresh sewage is oily or soapy
• Septic sewage develops an objectionable
WW
Color:
• Fresh sewage is yellowish grey to light brown
• While that of the septic is black or dark due to oxidation of organic matter
Sewage contains both organic and inorganic chemicals in addition to various gases like H_2S, CO_2, CH_4 and NH_3 etc that are formed due to the decomposition of sewage

19


7-Caracteristic of wastewater (2/2)
pH:
• the pH of sewage is initially high and drops when the sewage becomes septic but becomes increases again with the treatment processes
DO:
• the solubility of oxygen in freshwater ranges from 14.6 mg/l at 0°C to about 0.7 mg/l at 35°C at 1.0 atm pressure
WW
Toxic chemicals:
• these compounds include insecticides, pesticides, solvent, detergent, and disinfectant

20

8-Norms and standards related to air, wastewater and wastewater treatment plants - Decision nb. 8/1 - date 30.01.2001 – ELVs (1/2)

المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة ومحطات معالجة المياه المبتذلة

قرار رقم 8/1 – صادر في 30/1/2001

المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة

ان وزير البيئة،
بناء على القانون رقم 216 تاريخ 2/4/1993 (احداث وزارة البيئة) المعدل بالقانون رقم 667 تاريخ 29/12/1997،
بناء على المرسوم رقم 4336 تاريخ 26/10/2000 (تشكيل الحكومة)،
بناء على المرسوم رقم 4917 تاريخ 24/3/1994 (تعديل تصنيف المؤسسات الخطرة والمضرة بالصحة والمزعجة)،
بناء على المرسوم رقم 2678 تاريخ 21/3/2000 (قبول هبة من الاتحاد الاوروبي عبر برنامج الامم المتحدة الانمائي الى وزارة البيئة لتنفيذ مشروع تقوية نظام الترخيص والمراقبة في المصانع)،
بناء على اقتراح المدير العام،
يقرر ما يأتي:

21

8-Norms and standards related to air, wastewater and wastewater treatment plants - Decision nb. 8/1 - date 30.01.2001 (2/2)

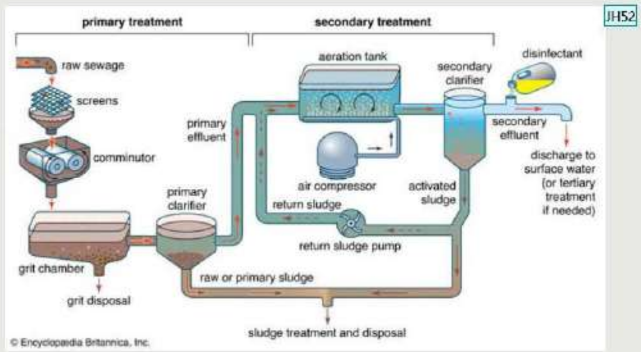
المادة 1- تعدل المادة الاولى من القرار رقم 52/1/96 المتعلق بتحديد المواصفات والنسب الخاصة للحد من تلوث الهواء والمياه والتربة بحيث تلغى الملاحق التالية:
ملحق رقم 1:«المواصفات المتعلقة بمياه الشرب»؛
ملحق رقم 2:«المتطلبات النوعية للمياه العذبة السطحية المستعملة او المعدة للاستعمال لانتاج المياه الصالحة للاستهلاك البشري»؛
ملحق رقم 6:« مستويات الحد الادنى لنوعية مياه الصرف المنزلية بعد المعالجة»؛
ملحق رقم 7:« المواصفات المسموح بها لتصريف او طمر نفايات سائلة او صلبة في المياه السطحية، الجوفية ومياه البحر داخل الحدود الدولية (نفايات لايعتد بضررها)»؛
ملحق رقم 8:« المواصفات لبعض المواد الضارة عند صرفها في البيئة البحرية داخل الحدود الدولية (نفايات سائلة غير منزلية)»؛
ملحق رقم 9:« الحدود القصوى لملوثات الهواء داخل اماكن العمل»؛
ملحق رقم 11:« الحدود القصوى المسموح بها لملوثات الهواء في الانبعاثات الناجمة عن حرق الزيوت المستعملة»؛
ملحق رقم 12:« الحدود القصوى المسموح بها لملوثات الهواء في الانبعاثات الناجمة عن حرق النفايات المنزلية»؛
ملحق رقم 13:« الحدود القصوى المسموح بها لملوثات الهواء من الانبعاثات في معامل الترابة».

وتعرف الملاحق المتبقية وفقا للتالي:
ملحق رقم 3:« النوعية المطلوبة للمياه الصالحة للحياة المائية» يعرف بالملحق رقم 1؛
ملحق رقم 4:« مواصفات المياه الصالحة للسباحة: احواض، انهار، بحيرات وبحار» يعرف بالملحق رقم 2؛
ملحق رقم 5:« مواصفات المياه المبتذلة الحضرية» يعرف بالملحق رقم 3؛
ملحق رقم 10:«الحدود المسموحة لشدة الصوت ومدة التعرض الامن له» يعرف بالملحق رقم 4؛
ملحق رقم 14:« الحدود القصوى لملوثات الهواء الخارجي» يعرف بالملحق رقم 5.

22

11

9-Wastewater treatment flow scheme



23

10-Wastewater treatment process

10.1- Preliminary treatment – Screening

24

Slide 23

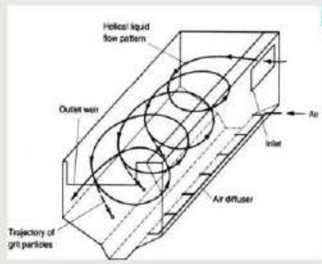
JH52 https://www.britannica.com/technology/wastewater-treatment/Primary-treatment
Jules Hatem, 3/12/2023

Slide 24

JH53 https://engineeringcivil.org/articles/environmental-engineering/wastewater-screening-cla
Jules Hatem, 3/12/2023

10-Wastewater treatment process

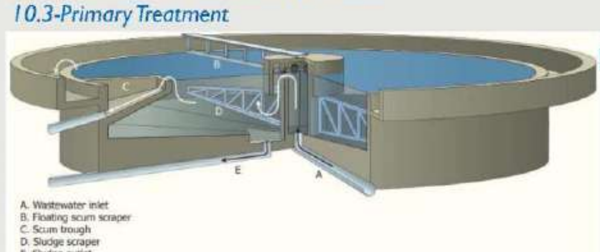
10.2- Preliminary treatment – Grit removal



25

10-Wastewater treatment process

10.3-Primary Treatment



- The purpose is to remove readily settleable solids and floating materials. Efficiently designed and operated primary sedimentation tank removes 50-70% of TSS and 24-40% of the BOD.
- The tank can be rectangular or circular and equipped with scrapers at the bottom to remove collect sludge at the sludge hopper. The clarifier is also equipped with scum removal mechanism.

26

Slide 25

JH54 https://www.kwsmfg.com/resources/problem-solvers/grit-removal-system-wwtp/
Jules Hatem, 3/12/2023

JH55 https://cgi.tu-harburg.de/~awwweb/wbt/emwater/lessons/lesson_c1/lm_pg_1436.html
Jules Hatem, 3/12/2023

Slide 26

JH56 https://missrifka.com/utility-system/waste-water-treatment-plant/primary-treatment-of-v
Jules Hatem, 3/12/2023

10-Wastewater treatment process

10.4- Secondary treatment – Aerobic Biological Processes

- Suspended growth
- Attached growth

27

11-Wastewater treatment systems

11.1- Activated sludge

28

Slide 27

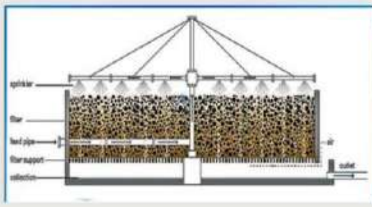
JH57 https://wateqcanada.com/municipal-wastewater/packaged-plants/fixed-bed-biofilm-reac
Jules Hatem, 3/12/2023

Slide 28

JH58 https://www.shutterstock.com/search/activated-sludge
Jules Hatem, 3/12/2023

11-Wastewater treatment systems

11.2-Tinkling filter



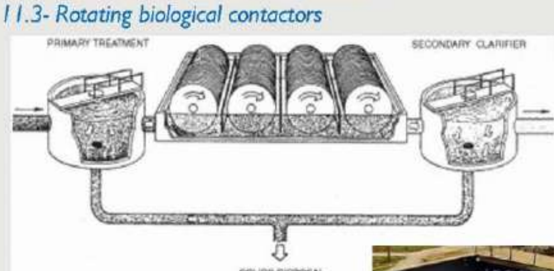
JH59

JH60

29

11-Wastewater treatment systems

11.3- Rotating biological contactors



JH61

JH62

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Slide 29

JH59 https://www.netsolwater.com/biological-trickling-filters-for-municipal-waste-water-treatn
Jules Hatem, 3/12/2023

JH60 https://civildigital.com/design-trickling-filters-common-operational-issues/
Jules Hatem, 3/12/2023

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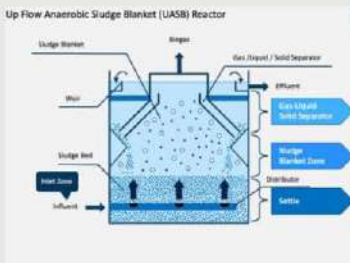
JH61 https://link.springer.com/chapter/10.1007/978-1-60327-156-1_10
Jules Hatem, 3/12/2023

JH62 https://sswm.info/water-nutrient-cycle/wastewater-treatment/hardwares/semi-centralisec
Jules Hatem, 3/12/2023

11-Wastewater treatment systems

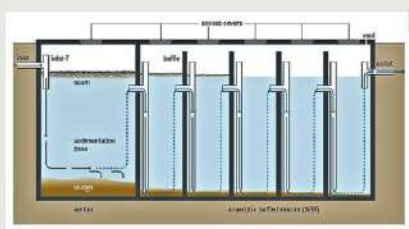
11.4- Anaerobic treatment – Up Flow anaerobic sludge blanket



31

11-Wastewater treatment systems

11.5- Anaerobic baffled reactor (ABR)



32

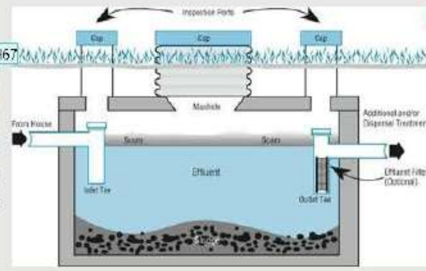
Slide 31

JH63 https://www.sketchbubble.com/en/presentation-up-flow-anaerobic-sludge-blanket-react
Jules Hatem, 3/12/2023

Slide 32

JH64 https://sswm.info/taxonomy/term/3931/anaerobic-baffled-reactor-%28abr%29
Jules Hatem, 3/12/2023

11-Wastewater treatment systems
11.6- Septic Tank



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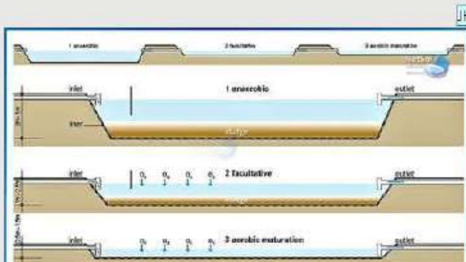
11-Wastewater treatment systems
11.7- Natural Systems – Waste Stabilization Ponds



Flow Chart for Mechanism of Purification in Stabilization Ponds

34

Slide 33

JH65 https://anaerobic-digestion.com/septic-tanks-anaerobic-digestors/
Jules Hatem, 3/12/2023

JH67 https://www.southportconcreteco.com/6-advantages-of-concrete-septic-tanks
Jules Hatem, 3/12/2023

Slide 34

JH68 https://www.netsolwater.com/flow-chart-for-mechanism-of-purification-in-stabilization-p
Jules Hatem, 3/12/2023

JH69 https://www.aboutcivil.org/types-of-wastewater-treatment-ponds.html
Jules Hatem, 3/12/2023

11-Wastewater treatment systems

11.8- Constructed Wetlands

JH70

JH71

JH72

35

12-Selecting unit operations and processes (1/3)

1. Process applicability	**Past experience, data from full scale plants, published data and from pilot plant studies. If new conditions are encountered, pilot plant studies are essential.**
2. Applicable flow range	Example: stabilization ponds are not suitable for extremely large flow rates in highly populated areas.
3. Influent wastewater characteristics	Affect the type of the process to be used. The presence of inhibiting constituents may limit the application of biological treatment systems.
4. Climatic conditions	Temperature affects the rate of reaction for most biological and chemical processes.

36

Slide 35

JH70 https://www.enviropro.co.uk/entry/136414/ARM-Ltd/Water-treatment-with-reed-bed-sys
Jules Hatem, 3/12/2023

JH71 https://armreedbeds.co.uk/projects/horizontal-flow/
Jules Hatem, 3/12/2023

JH72 https://armreedbeds.co.uk/
Jules Hatem, 3/12/2023

12-Selecting unit operations and processes (2/3)

5. Process sizing based on reaction kinetics or process loading criteria	Reactor sizing is based on the governing reaction kinetics and kinetic coefficients. Data on kinetics are obtained experimentally. Data on loading rates are based also on kinetics but can be obtained from pilot studies.
6. Performance	Needed effluent quality is important in determining the required treatment system.
7. Sludge production and processing	Are there constraints that would make sludge processing and disposal infeasible or expensive.
8. Environmental constraints	Environmental conditions such as prevailing wind direction and proximity to residential areas may restrict the application of some processes. Proximity to water bodies may require removal of some constituents such as nutrients.

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12-Selecting unit operations and processes (3/3)

9. Chemical requirements or any other resources requirements.	**What effects might the addition of chemicals have on the characteristics of sludge and what is the cost of the chemicals.**
10. Energy requirements	Energy requirements and future energy cost must be known for cost effective treatment systems.
11. Personnel requirements	How many do need for operating the systems and do they have the skills.
12. Flexibility	Can the unit operation be modified when needed to meet future requirements.

38

13-Criteria and indicators used to assess the sustainability of treatment technologies (1/2)

Criteria	Indicators	Short description
Technical aspects	Effectiveness Removal efficiency Reliability System manageability	Compliance with discharge standards Removal of pollutants (when not in standards, or beyond them Robustness, vulnerability and risks associated with errors, disasters Operation and maintenance, personnel requirements
Environmental aspects	Conservation External inputs Land use and impact Emissions Reduce, reuse, recycle	Protection of the ecosystem and conservation of biodiversity Need of materials, equipment, electricity, fossil fuels, self-sufficiency Footprint (area occupied), impact on the landscape Substances released into the environment, pollution prevention Sludge, biogas, treated water for irrigation, nutrients

39

13-Criteria and indicators used to assess the sustainability of treatment technologies (2/2)

Criteria	Indicators	Short description
Social aspects	Institutions and policies Management capacity Community participation and involvement Change of routines Social acceptability Scientific support Regulatory framework	Basic institutions, awareness of policy makers/pubic about sanitation Governmental and private proficiency to manage sanitation systems Changes by practitioners to adopt sanitation technologies, lobbies Cultural aspects, user's adaptation, poverty alleviation, minorities The role of universities and research centers (monitoring, innovation) Local legislation that promotes or hinders the use of different options
Economic aspects	Investment costs Running costs Life time externalities	Construction costs, equipment required, land cost Operation and maintenance, reparations, availability of spare parts Lifetime of construction items and electromechanical equipment Changes in natural capital, excavations, social disruptions

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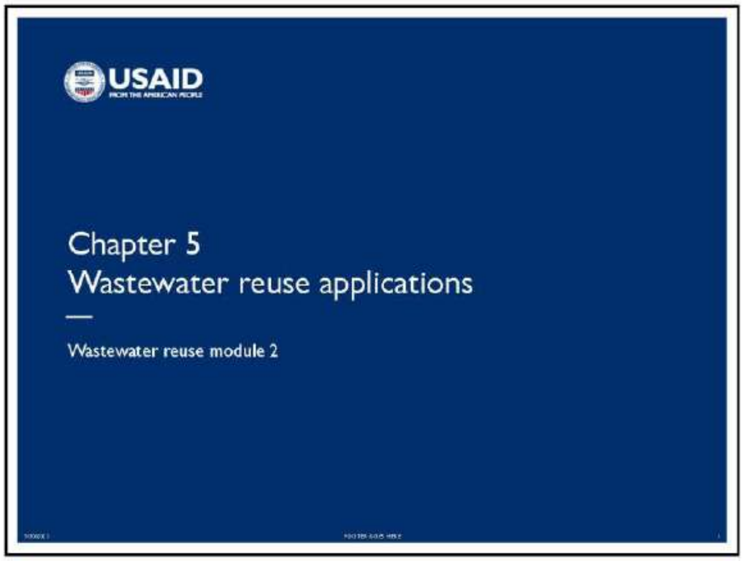
2.2 – Wastewater Reuse Applications

5/30/2023



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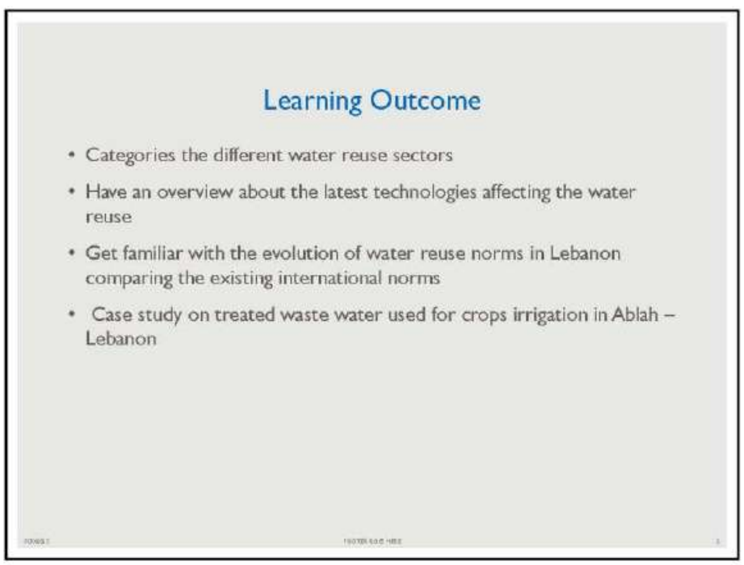


2

Outline

1. Identify the need for water reuse
2. Categories of wastewater reuse
3. Reusing considerations
4. Advanced technology
5. Water reuse standards at Lebanon
6. Case study Presentation: impact of irrigating vegetable crops from Ablah WWTP
7. Conclusion

3

I-Introduction

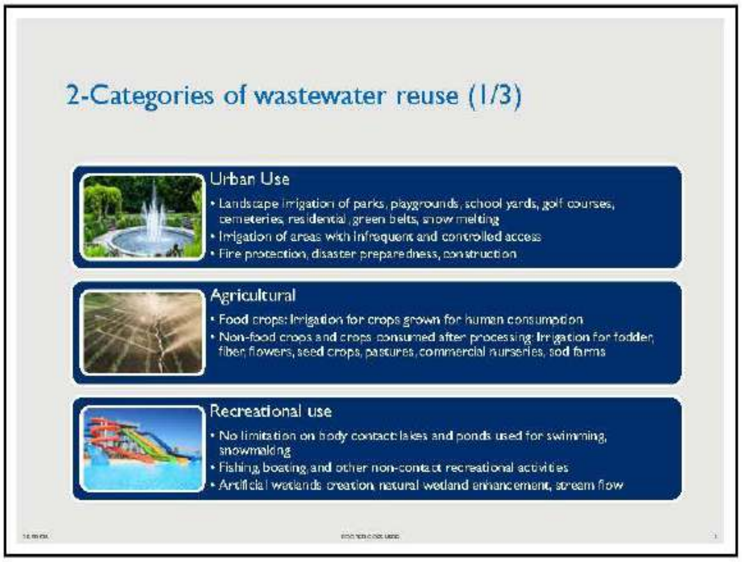
- Wastewater reuse can be adopted JH73 to meet the water demand in different fields and contribute to the conservation of freshwater resources.
- Practices of wastewater reuse vary among countries, as target applications and technology options differ significantly depending on socio-economic circumstances, industrial structure, climate, culture, religious preference, as well as policy readiness.

4

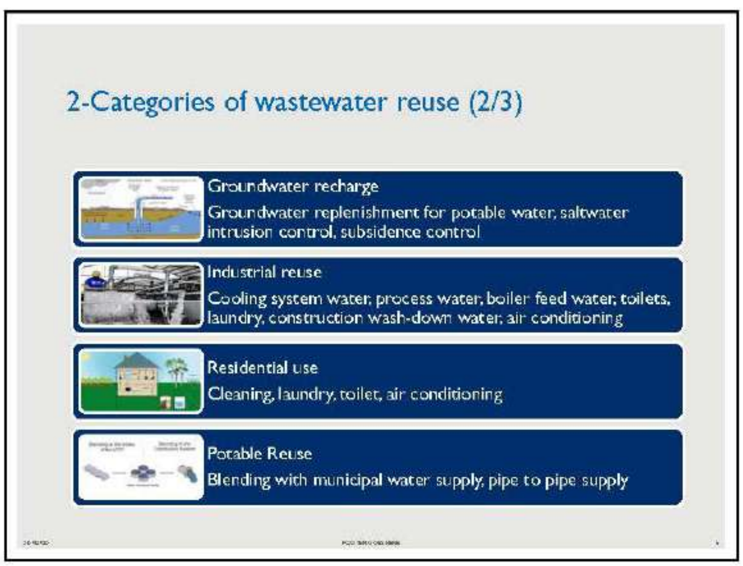
Slide 4

JH73 https://www.evoqua.com/en/markets/applications/industrial-water-recycle-reuse/
Jules Hatem, 3/12/2023

5/30/2023


2-Categories of wastewater reuse (1/3)
Urban Use
• Landscape irrigation of parks, playgrounds, school yards, golf courses, cemeteries, residential, green belts, snow melting
• Irrigation of areas with infrequent and controlled access
• Fire protection, disaster preparedness, construction
Agricultural
• Food crops: Irrigation for crops grown for human consumption
• Non-food crops and crops consumed after processing: Irrigation for fodder, fiber, flowers, seed crops, pastures, commercial nurseries, sod farms
Recreational use
• No limitation on body contact: lakes and ponds used for swimming, snowmaking
• Fishing, boating, and other non-contact recreational activities
• Artificial wetlands creation, natural wetland enhancement, stream flow

5


2-Categories of wastewater reuse (2/3)
Groundwater recharge
Groundwater replenishment for potable water, saltwater intrusion control, subsidence control
Industrial reuse
Cooling system water, process water, boiler feed water, toilets, laundry, construction wash-down water, air conditioning
Residential use
Cleaning, laundry, toilet, air conditioning
Potable Reuse
Blending with municipal water supply, pipe to pipe supply

6

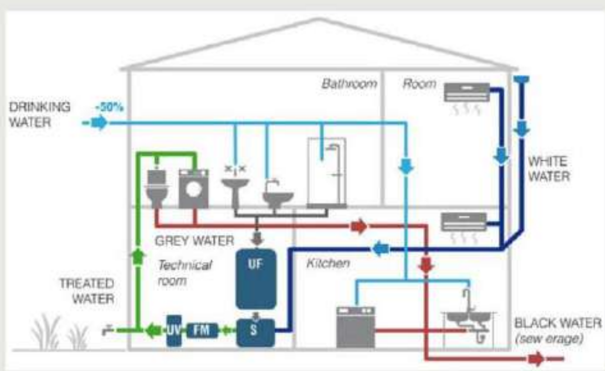
3

2-Categories of wastewater reuse (3/3)

- An important determinant of the potential applications and treatment requirements for water reuse is the quality of water resulting from various municipal uses.
- As the quality of treated water approaches that of unpolluted natural water, the practical benefits of water reclamation and reuse become evident. The levels of treatment and the resultant water quality endow the water with economic value as a water resource.

7

2-Grey Water V/S Black Water



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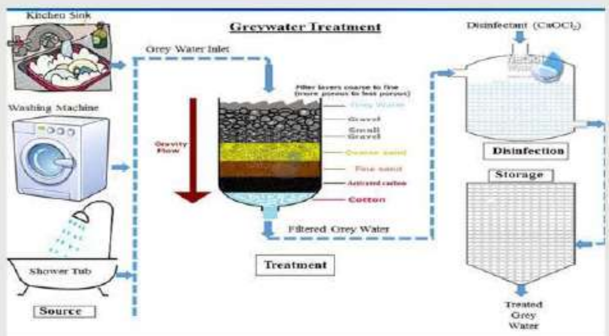
2-Grey Water treatment and reuse



9

3-Resusing considerations

Country/ Institution	BOD [mg L⁻¹]	TSS [mg L⁻¹]	Turbidity [NTU]	pH [-]	Chlorine residual [mg L⁻¹]	Micro-organisms [CFU 100 mL⁻¹]	Purpose
USA[1]	≤10	-	≤2	6-9	≥1	Fecal Coliforms non detectable	Unrestricted urban reuse
WHO[2]	≤10	≤10	-	-		Thermoresistant coliforms ≤10	Toilet flushing
Canada[3]	≤20	≤20	≤5	-	≥0.5	E.coli ≤200 Thermoresistant coliforms ≤200	Toilet and urinal flushing
Germany[4]	<5	-	-	-	-	Total Coliforms <100 Fecal coliforms <10 P. Aeruginosa <1	Service water
Japan[5]	≤20	-	not unpleasant	5.8 - 8.6	retained	Total Coliforms <1000	Toilet flushing
	≤20	-	not unpleasant	5.8 - 8.6	≥0.4	Total Coliforms <50	Landscape irrigation
Italy[6]	≤20	≤10	-	6.0 - 9.5	-	E.coli <10	General
S.Korea[7]	<10		<2	5.8 - 8.5	>0.2 mL L⁻¹	E.coli Not detectable	Toilet flushing
Israel[8]	<10	<10	-	-	-	Fecal Coliforms <1	General
China[9]	<10	-	<5	6-9	>1 (after 30 min), >0.2 (at point of use)	Fecal Coliforms <3	Toilet flushing
	<20	-	<20	6-9	>1 (after 30 min), >0.2 (at point of use)	Fecal Coliforms <3	Irrigation
	<8	-	<5	6-9	>1 (after 30 min), >0.2 (at point of use)	Fecal Coliforms <3	Washing

JH75 The question then is what level of treatment is necessary and satisfactory for a specific water reuse application?

- Reclaimed water quality requirements depend not only on the relevant regulations and guidelines, but also on specific applications for which reclaimed water is to be used.

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Slide 10

JH75 https://www.researchgate.net/figure/National-standards-and-international-guidelines-for
Jules Hatem, 3/12/2023

4-Advanced technology

- Today, technically proven water reclamation or water purification processes exist to provide water of almost any quality desired, including ultrapure water for precision industries and medical uses.
- With advancements in water reclamation technologies, it is technically possible to produce reclaimed water of virtually any quality.

11

4-Advanced technology

Membrane ultrafiltration (Membrane bioreactor MBR)	Reverse Osmosis	Carbon Adsorption	UV disinfection	Ozone disinfection

- **Technologies that follow secondary treatment which are suitable for most water reuse applications**

12

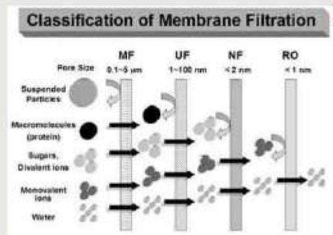
Slide 11

JH74 https://www.water-technology.net/projects/bundamba-treatment/
Jules Hatem, 3/12/2023

4-Advanced technology

4.1-Membranes Technologies

- Membranes represent the most significant development as several new products are now available for a number of water and wastewater treatment and water reuse applications.
- Treatment trains that incorporate membrane filtration are capable of producing several grades of product water that can serve a range of water reuse applications.
- Further, the cost of producing high-quality reclaimed water has decreased considerably, largely due to the development of low-pressure membranes and the entrance of a number of suppliers in the competitive marketplace.



JH76

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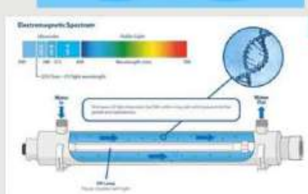
4-Advanced technology

4.2-Disinfection Technologies

JH77



JH78

- Chlorination remains as the most widely used disinfection technology and its effectiveness is vastly improved by improved reclaimed water quality.

Increased removal of particulate matter and the development of ultraviolet disinfection technology also improve the applicability of reclaimed water for many more applications.

14

Slide 13

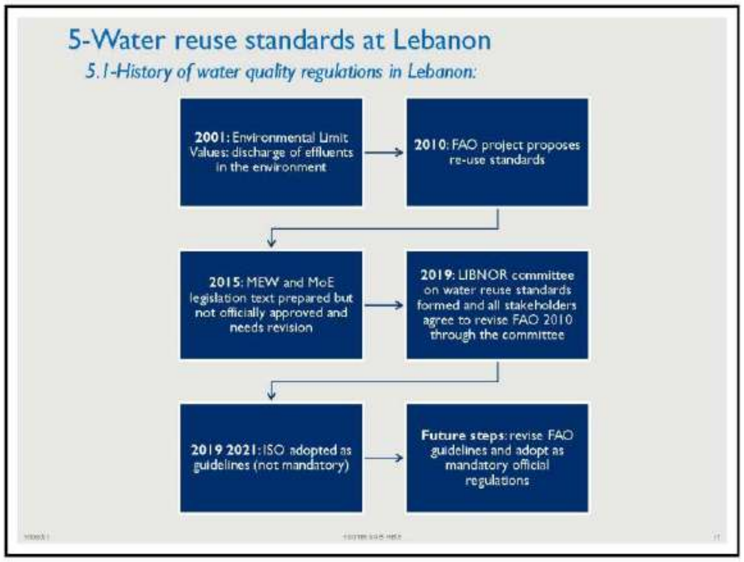
JH76 https://www.climate-policy-watcher.org/wastewater-treatment/membrane-processes-for-
Jules Hatem, 3/12/2023

Slide 14

JH77 https://www.techquintal.com/advantages-and-disadvantages-of-chlorination-of-water/
Jules Hatem, 3/12/2023

JH78 https://www.alfaauv.com/blog/all-about-uv-disinfection-systems-for-water-treatment/
Jules Hatem, 3/12/2023

5/30/2023



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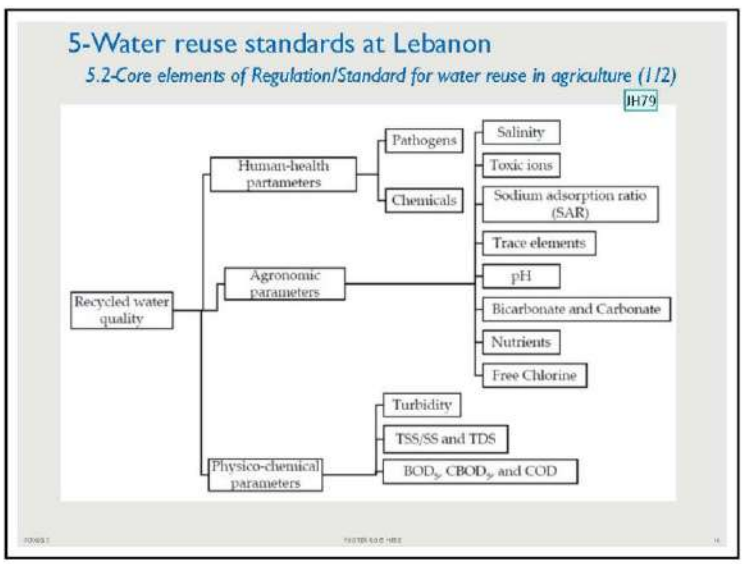

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Slide 16

JH79 Shoustarian et al. 2020
Jules Hatem, 5/28/2023

5-Water reuse standards at Lebanon

5.2-Core elements of Regulation/Standard for water reuse in agriculture (2/2)

1-List of parameters and threshold values
-Different categories of water with different target applications (categories of edible or non-edible plants (1-5 categories depending on countries) with recommendations of treatment technologies
-Complete restrictions on crops and use of irrigation systems

2-Monitoring protocol
-Frequency and performance of testing

3-Recommended best practices for safety
-On-farm management (safety measures for carrying irrigation agronomic practices to reduce risks and improve productivity)
-Handling of treatment technologies and reuse systems to increase safety

4-Governance framework
-Distribution of roles and responsibilities of each administration/stakeholder (if not stated in other regulations)

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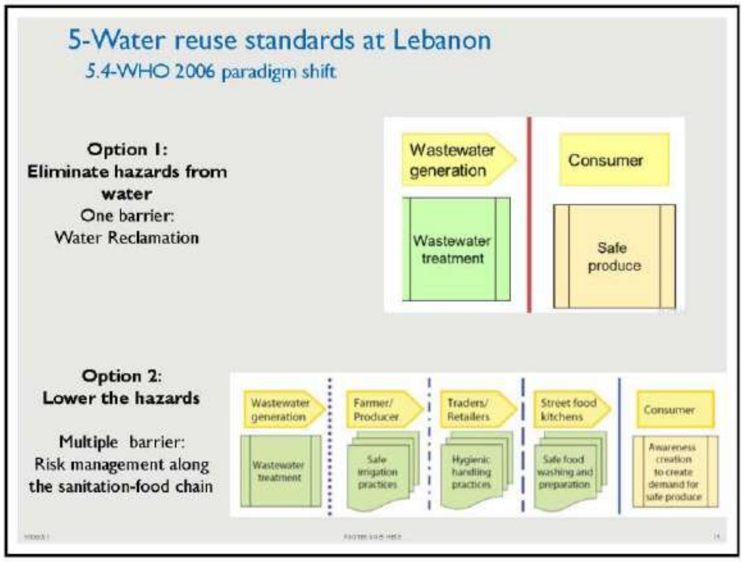
5-Water reuse standards at Lebanon

5.3-The main regulatory approaches and recent policy recommendations and trends

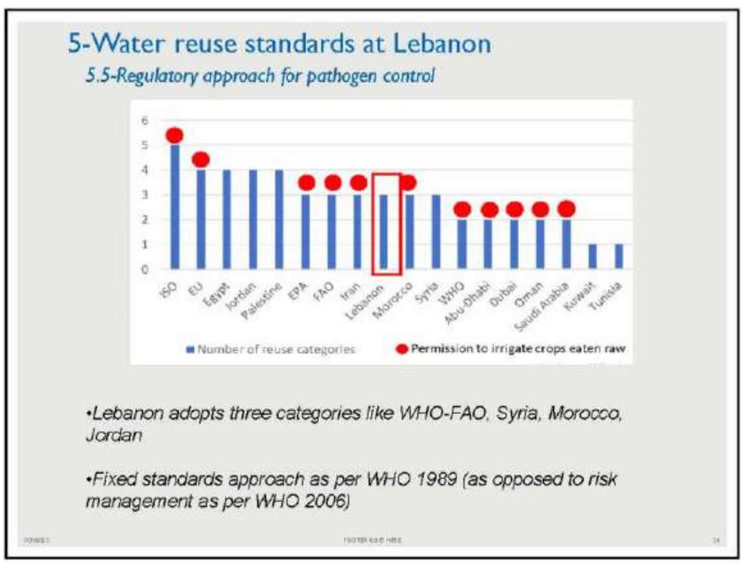
Californian Model	WHO (1989) and FAO (1992)	WHO 2006 risk management approach
• Zero risk, Best quality water (pathogens close to • Advanced, high cost treatment technologies • High number of parameters, lower limit values	• Level of stringency should be proportional to capacity of enforcement • Higher thresholds for pathogens • Less sophisticated and costly treatment technologies	• Paradigm shift from fixed standards related to water quality to health based standards achievable throughout the reuse chain

Standards need to be adapted to local contexts and take into consideration financial, technological and institutional capacities of the country

18


5-Water reuse standards at Lebanon
5.4-WHO 2006 paradigm shift
Option 1:
Eliminate hazards from water
One barrier:
Water Reclamation
Wastewater generation
Consumer
Wastewater treatment
Safe produce
Option 2:
Lower the hazards
Multiple barrier:
Risk management along the sanitation-food chain
Wastewater generation
Farmer/ Producer
Traders/ Retailers
Street food kitchens
Consumer
Wastewater treatment
Safe irrigation practices
Hygienic handling practices
Safe food washing and preparation
Awareness creation to create demand for safe produce

19


5-Water reuse standards at Lebanon
5.5-Regulatory approach for pathogen control
0
1
2
3
4
5
6
ISO
EU
Egypt
Jordan
Palestine
EPA
FAO
Iran
Lebanon
Morocco
Syria
WHO
Abu-Dhabi
Dubai
Oman
Saudi Arabia
Kuwait
Tunisia
Number of reuse categories
Permission to irrigate crops eaten raw
•Lebanon adopts three categories like WHO-FAO, Syria, Morocco, Jordan
•Fixed standards approach as per WHO 1989 (as opposed to risk management as per WHO 2006)

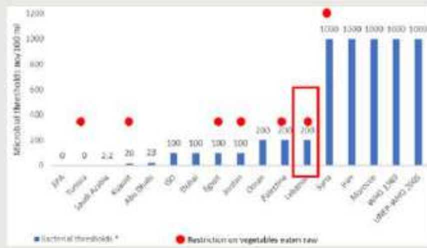
20

10

5-Water reuse standards at Lebanon

5.6-Pathogen threshold and restrictions on crops and irrigation systems

- *Bacterial thresholds for food crop irrigation lower than WHO 1989*
- *Lebanon does not allow crops to be eaten raw while most international guidelines do so. MENA countries are divided*
- *Lebanon completely forbids the use of sprinkler on food crops(except fruit trees) while WHO (1989) allows it.*
- *Restrictions on crops and irrigation systems will be hard to be enforced as all potential areas are planted with a mixture of crops including vegetables to be eaten raw, and use of sprinkler is widespread*



21

5-Water reuse standards at Lebanon

5.7-General number of parameters and threshold values

	BOD₅ (mg. L⁻¹)	COD (mg. L⁻¹)	DO (Dissolved oxygen)	TSS (mg. L⁻¹)	Turbidity (NTU)	Bacteria (no./100 mL)	Intestinal nematodes (eggs. L⁻¹)	N-NO3	Ph
Lebanon	25	125	✖	60	✖	≤ 200 (Fecal coliforms)	<1	<5	6.5_8
FAO								<5	6.5_8
ISO	10	✖	✖	10	5	100 (95%ile ≤ 10) (Thermo-tolerant coliforms)	None	✖	✖
WHO						1000 (E. coli root crops); 10000 (leaf crops); 1000 (low growing drip irrigated crops); 100000 (high growing drip irrigated crops)			
Egypt	15	✖		≤ 15	≤ 5	20 (E. coli)	<1	Not available	Not available?
Jordan	30	100	More than 2	50	10	100 (E coli)	≤1	<5	6_9
Morrocco	✖	✖	✖	100 (sprinkler irrigation); 200 (gravity irrigation)	✖	< 1000 (Fecal coliforms)	0	30	6.5_8.4
Syria	30	75	✖	50	✖	<1000 (fecal)	<1	20	6_9

22

5-Water reuse standards at Lebanon

5.8-Governance framework (1/2)

Role	CDR	MoEW	MoF	MoE	MoA (irrigation)	MoPH (drinking water)	Municipalities	WE	WB	Donors	NGOs	Research	Media	Water Users
Funding	X		X					Cost recovery?	X	X				
Policy & Strategy	X Master Plan	X National		X	X	X		X Regional	X	X		X		
Planning	X	X			X			X	X	X		X		
Contracting/ Constructing	X	X			X		X	X	X	X	X			
Development & Implementation	X	X					X	X		X	X			
Operation & Maintenance	X						X	X		X				
Tariff/ Tax Collection			X				X	X Propose tariffs						X
Legislation, rules and regulation		X		X	X	X					X Lobby	X		
Services & interactions with water users		X		X	X		X			X	X		X	X
Monitoring & Evaluation		X		X	X	X		X		X	X	X		

23

5-Water reuse standards at Lebanon

5.8-Governance framework (2/2)

- *The responsibilities of each administration are not stated in the standard*
- *More largely, a governance framework on reuse systems is missing in Lebanon : who does the operation of water reuse system? Who decides where water should be distributed?*
- *In the existing regulations, responsibilities overlap or conflict : no monitoring agency Jordan distinguishes between testing by operator and testing by monitoring agency*

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5-Water reuse standards at Lebanon

5.9-Lack of mention of direct/indirect Reuse

- *Some regulations allow for indirect water reuse, i.e., mixing the treated effluents with freshwater in rivers to supply existing irrigation infrastructure (Egypt Nile drainage system; Jordan dams and reservoirs).*
- *In Lebanon, regulating indirect needs to be considered because water is needed in existing reuse schemes Zahleh , Aitanit , Chouf at many locations)*

25

5-Water reuse standards at Lebanon

5.10-Recommendation

- *The FAO proposed guidelines for Lebanon in 2010 are generally strict relatively to other international guidelines and MENA countries , especially with regards to pathogen threshold and crop restrictiveness*
- *Crop and irrigation systems restriction are expected to be hard to be enforced in practice*
- *Enforcing the standards require establishing a clear governance framework for management and monitoring of reuse systems . This could be added to the Standards under revision or be designed an independent regulation*
- *The approach for pathogen control follows the ' fixed standards' approach. We recommend adopting aspects of the WHO risk management approach which can decrease the cost of investment on treatment technologies and address the informal reuse (outside of WWTPs) WWTPs), but this require strong institutional coordination and should be accompanied by an integrated plan for the wastewater management*

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6-Case study Presentation: impact of irrigating vegetable crops from Ablah WWTP (1/2)

From ReWater MENA project: MENA: More and safer water reuse in the Middle East and North Africa

Background

	E. Coli or Faecal Coli /100ml	Nematode eggs/l	Total Suspended Solids TSS mg/lit	Crops eaten uncooked is allowed	Code of practice
WHO	1000	<1	-	Yes	Yes
LEBANON	<200	<1	60	No	No

Proposition for wastewater reuse guidelines in Lebanon

Parameter	Category		
	I	II	III
BOD_5 (mg/l)	25	100	100
COD (mg/l)	125	250	250
TSS (mg/l)	60	200	200
pH	6 – 9	6 – 9	6 – 9
Cl_2 residual (mg/l)	0.5 -2	0.5 -2	0.5 -2
F. Coliforms (in 100ml)	<200	<1000	None required
Helminth ova (in 1 lit)	<1	<1	<1

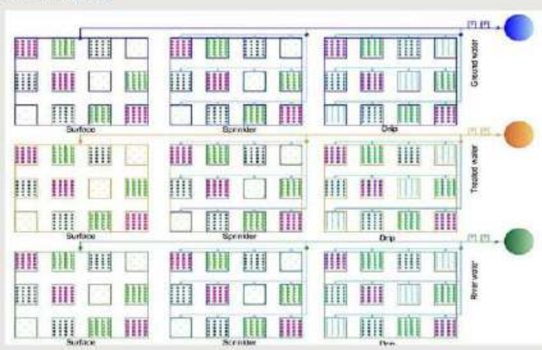
Vegetables eaten raw cannot be grown

Proposed by FAO within a local project year 2010/2011

27

6-Case study Presentation: impact of irrigating vegetable crops from Ablah WWTP (2/2)

From ReWater MENA project: MENA: More and safer water reuse in the Middle East and North Africa



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7-Conclusion

- As a result of the developments and improvements in treatment technology, many of the economic and environmental barriers to water reuse have been reduced significantly and several new opportunities for water reuse applications are possible.
- Health and environmental concerns associated with the use of treated wastewater effluent can be mitigated significantly, thus improving the acceptability (public acceptance) of reclaimed water for defined uses such as landscape irrigation and groundwater recharge.

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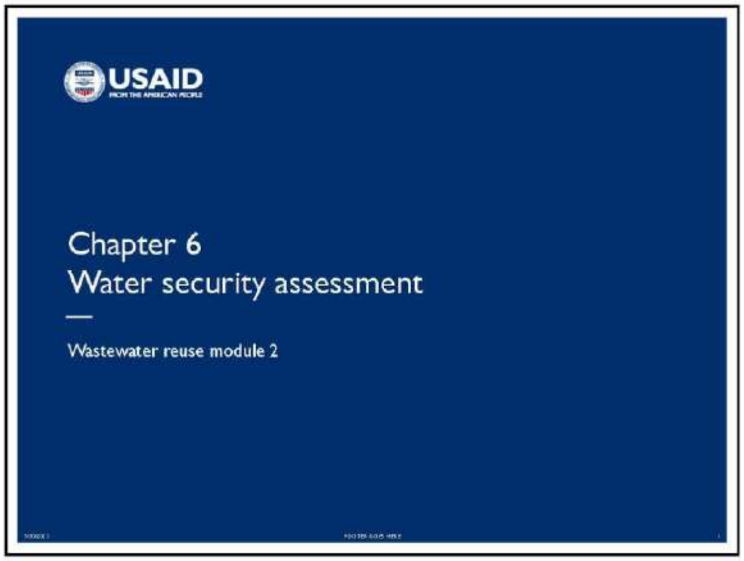
Thank you!

30

3.3 – Water Security Assessment



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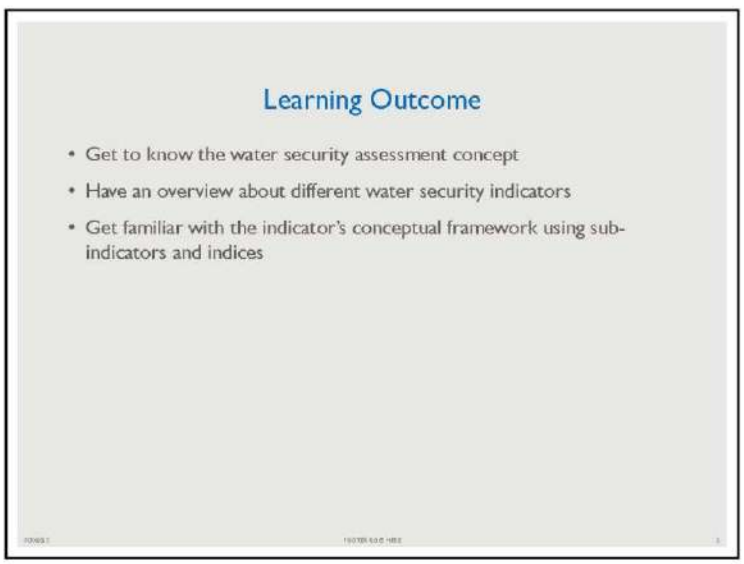


2

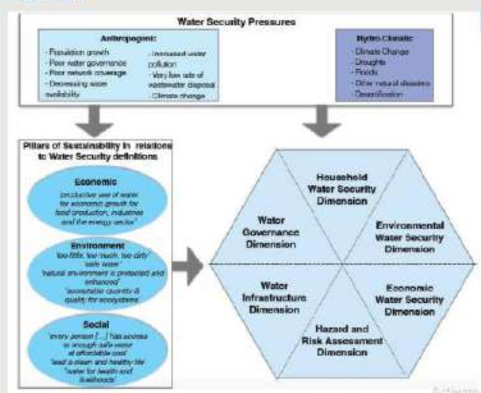
Outline

1. Introduction
2. Water security indices, sub-indicators & indicators

3

I-Introduction

JH52



- The water security assessment (WSA) in this study adopts an inter-sectoral and integrative approach to water security, founded upon the three pillars of sustainability: economic, social, and environmental. Indeed, the framework aims to harness the productive potential of water, minimize its damaging impacts while ensuring social equity through a holistic view of water management challenges

4

Slide 4

JH52 Conceptual Framework of the Water Security Assessment
Jules Hatem, 5/28/2023

2-Water security indices, sub-indicators & indicators

2.1-Household Water Security Indicator

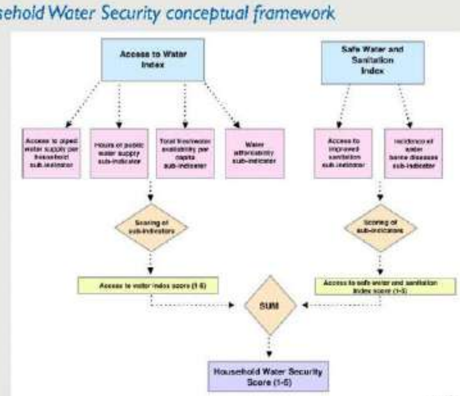
- This dimension aims to evaluate the access to water , in terms of water availability, affordability and level of access in households. It also tackles the sanitation and safety aspect of water, by evaluating the community's access to sanitation, as well as the incidence of water borne diseases in the region, which stem from the exposure to contaminated water resources. Indeed, an optimal state of water security means that every individual has access to safe drinking water and improved sanitation, at an affordable cost, while being protected from water-related diseases.

5

2-Water security indices, sub-indicators & indicators

2.2-Household Water Security conceptual framework

- .



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2-Water security indices, sub-indicators & indicators

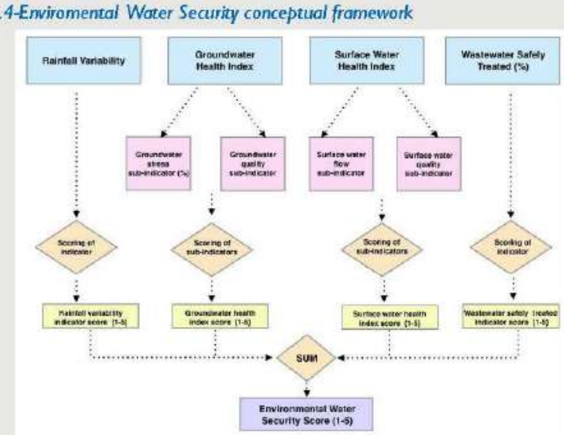
2.3-Environmental Water Security Indicator

- This dimension seeks to assess the status of and risks to water-related ecosystems, in terms of quality and quantity, focusing primarily on major rivers, peripheral springs, as well as public wells. This dimension also evaluates hydro-climatic and anthropogenic factors, which affect water availability and quality, primarily rainfall variability and pollution caused by untreated wastewater. The rationale for this dimension is that in a water secure world, the intrinsic value of water and water-related ecosystems is respected, and environmental protection is enhanced.

7

2-Water security indices, sub-indicators & indicators

2.4-Enviromental Water Security conceptual framework



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4

2-Water security indices, sub-indicators & indicators

2.5-Economic Water Security Indicator

- This dimension assesses the productive use of water resources to sustain economic growth in the agricultural, industrial and energy sector. The rationale is that water security is achieved in part by contributing to food and energy security in a cost-effective and cost-efficient fashion. In turn, the enhanced efficiency and productivity of water use in these respective sectors will ensure that the economic potentials of these sectors are achieved with minimal pressure on water resources.

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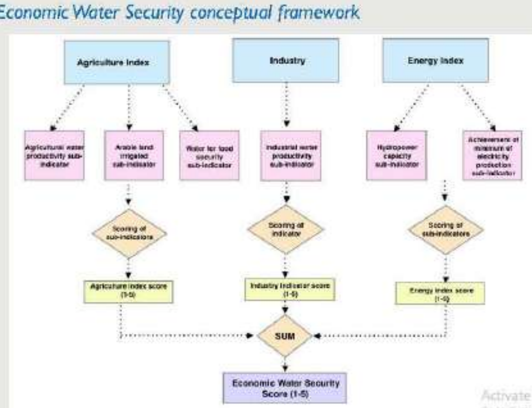
2-Water security indices, sub-indicators & indicators

2.6-Economic Water Security conceptual framework



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2-Water security indices, sub-indicators & indicators

2.7-Hazard and risk assessment Indicator

- This dimension evaluates prominent risks emanating from droughts and floods, and the impacts they might have, the economic sectors, and the community. This dimension accordingly assesses these risks by evaluating hazards, vulnerabilities, and coping capacities. Indeed, water security means that every individual is protected from water-related disasters, including but not limited to the ones mentioned..

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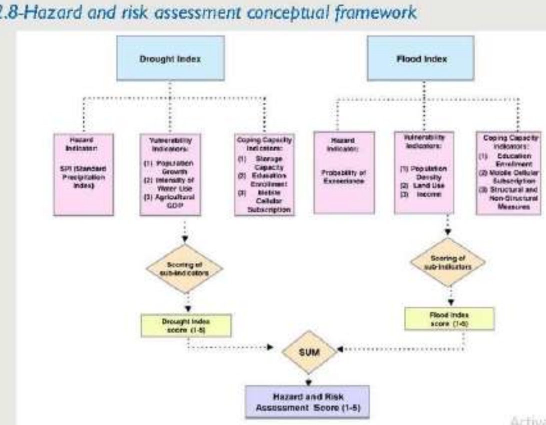
2-Water security indices, sub-indicators & indicators

2.8-Hazard and risk assessment conceptual framework



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6

2-Water security indices, sub-indicators & indicators

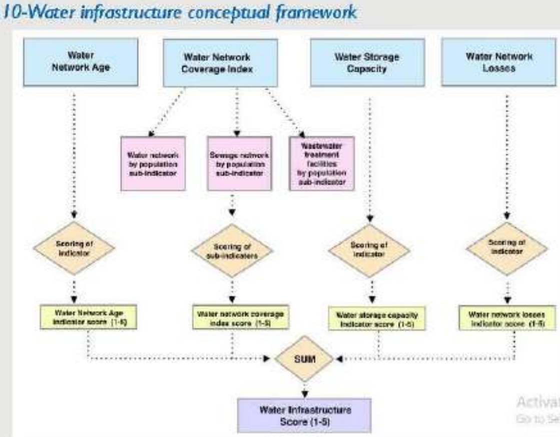
2.9-Water infrastructure Indicator

- This dimension seeks to assess the current status of water-related infrastructure in terms of network coverage, storage capacity, and network conditions, in terms of aging and losses. A well-designed and functioning water system ensures a complete and efficient coverage of water-services, warranting equal access to water and sanitation and enabling the water establishment to have an appropriate infrastructure to meet all water-related needs, thus enhancing overall water security..

13

2-Water security indices, sub-indicators & indicators

2.10-Water infrastructure conceptual framework



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7

2-Water security indices, sub-indicators & indicators

2.11-Water governance Indicator

- The ability of a government or institution to properly manage its interaction with water resources can be a defining factor in achieving water security. From over extraction to equitable access, the governance of water resources has a direct effect on the ecosystem and society. A country rich in water resources may still be far from water security, it is the quality of water governance that will determine the level in which communities can utilize as well as protect this valuable resource. This dimension also includes the financial sustainability of water supply services given the importance of this aspect in making available water resources to the above-mentioned productive sectors.

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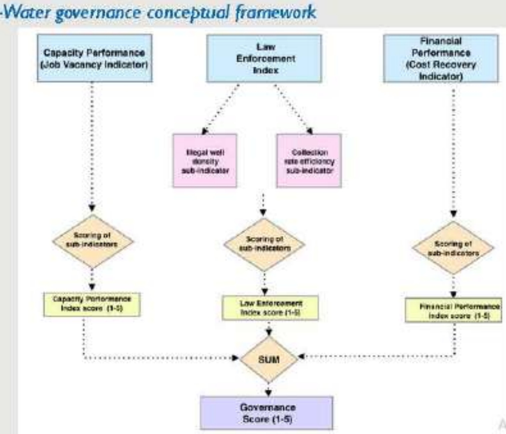
2-Water security indices, sub-indicators & indicators

2.12-Water governance conceptual framework



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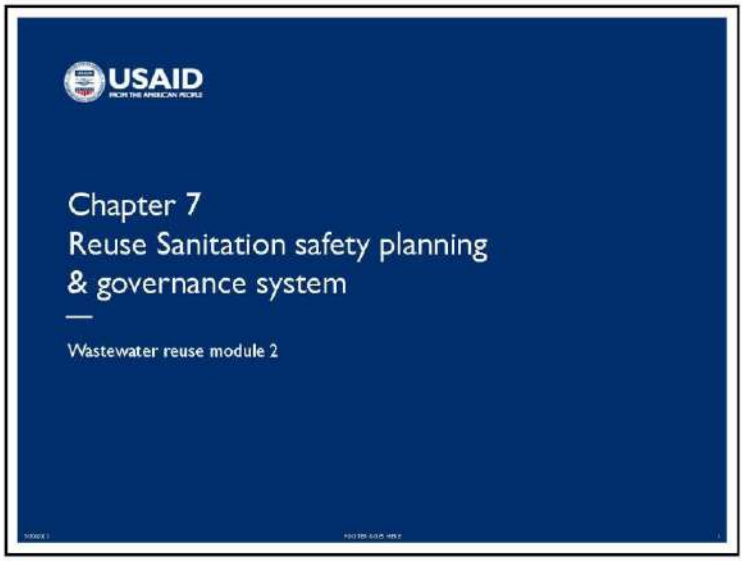
2.4 – Reuse Sanitation Safety Planning & Governance System



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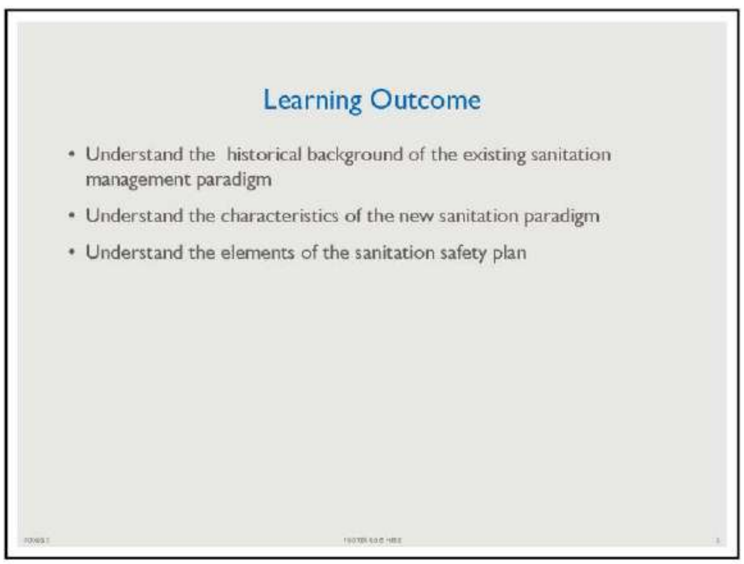


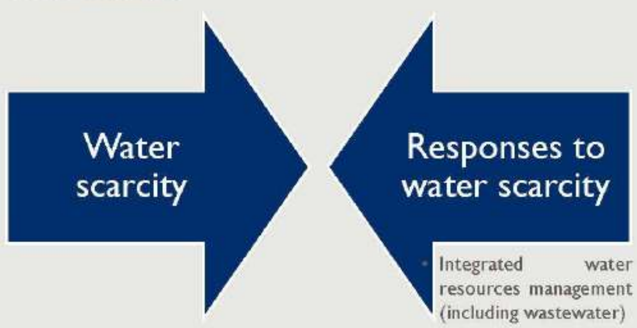
2

Outline

1. Introduction
2. The Conventional paradigm
3. Background
4. Characteristics of the conventional system
5. Motivation for change
6. Sanitation paradigm shift
7. Old Paradigm VS New Paradigm
8. Water chain
9. Elements of sanitation safety plan SSP
10. Steps for the SSP implementation
11. Chain of the wastewater

3

1-Introduction



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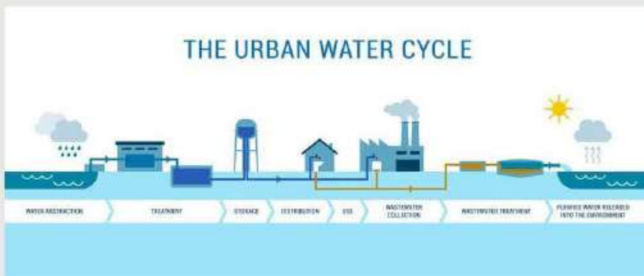
5/30/2023

2-The conventional paradigm

JH81



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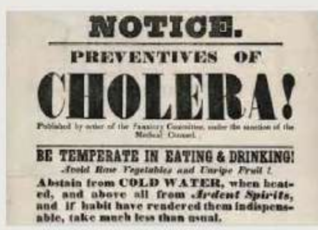
2-Background

JH83



- Cholera, influenza, and other outbreaks were responsible for 10s of thousands mortalities in very short period of time.
- "All smell is disease" and miasma is the main cause of death (Edwin Chadwick, commissioner of the Board of Health created in 1849).

6

3

Slide 5

JH81 https://stock.adobe.com/bg/images/the-urban-water-cycle/443479679
Jules Hatem, 3/13/2023

Slide 6

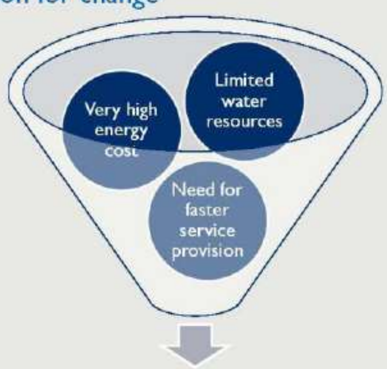
JH83 https://www.nytimes.com/2008/04/15/science/15chol.html
Jules Hatem, 3/13/2023

3-Characteristics of the conventional system

- Established when very little was know about water biochemistry, chemistry and physics and is not the zenith of scientific achievement
- Uses fresh water to flush excreta!
- Operated by the public sector
- Comfortable and invisible (practically resulting in less than 10% of sewage collected worldwide)
- Slow implementation and high networks investments (40% global coverage)

7

4-Motivation for change



Sustainable sanitation
(resource recovery)

8

Slide 7

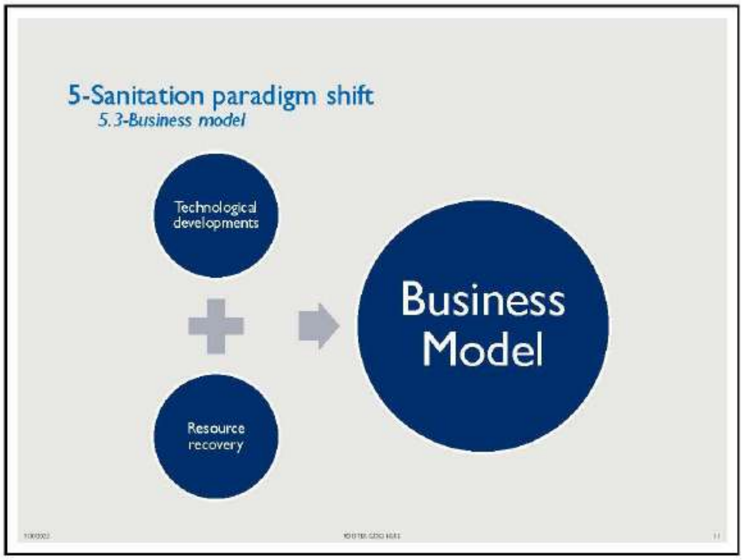
JH82 https://www.google.com/search?q=old+sewage+networks+&tbm=isch&ved=2ahUKEwj(
Jules Hatem, 3/13/2023


5-Sanitation paradigm shift
5.1-Laws and regulations, institutions
STANDARDS
Existing technical standards
Policies
Planning
Management
Codes

9


5-Sanitation paradigm shift
5.2-Technological advances
Dual Flush vs. Low Flow Toilet
Gallons Per Flush
1.3
0.8
1.3
Fresh water to transport excreta minimized
New technologies

10



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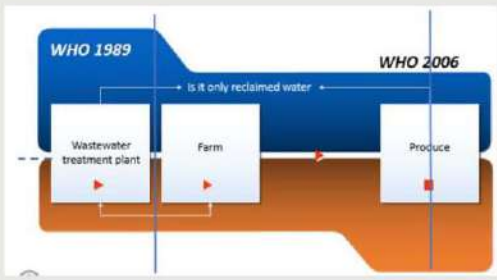
6-Old Paradigm VS New Paradigm

Old paradigm	New paradigm
Slow implementation	Rapid implementation
Prescriptive technologies	Adaptive solutions
One water quality type fits all	Provision of water quality based on use
Low priority on energy efficiency	High priority for energy efficiency
"Siloed" health, economic, engineering	Integrated systems appraoch
Financing via taxes, subsidies, tariffs	Innovative financing and business models
Less priority on resources conservation	High priority on resource conservation

12

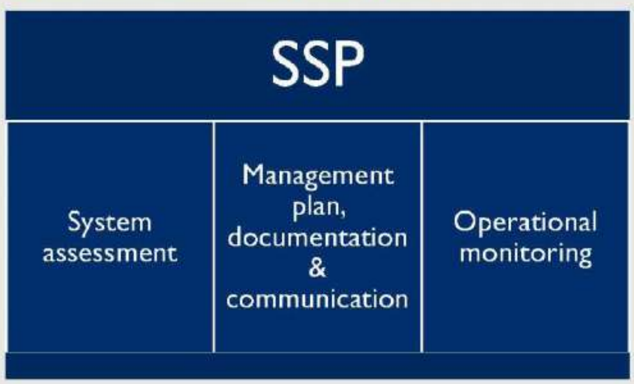
7-Water Chain



- Water is ingested while reclaimed water is not. The idea is the quality of produce that is ingested

13

8-Elements of sanitation safety plan SSP



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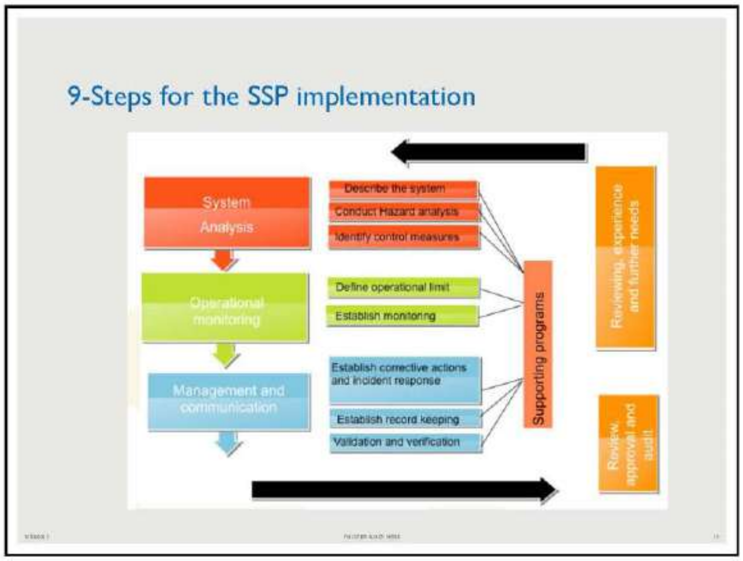
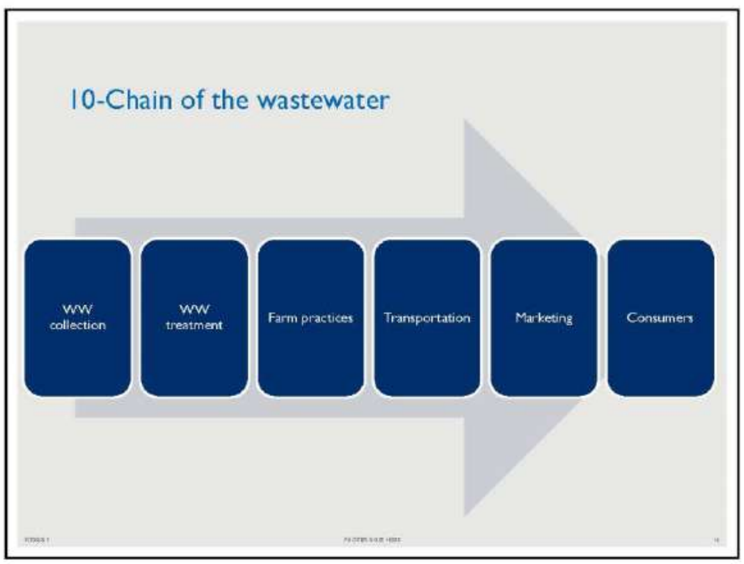

9-Steps for the SSP implementation
System Analysis
Describe the system
Conduct Hazard analysis
Identify control measures
Operational monitoring
Define operational limit
Establish monitoring
Management and communication
Establish corrective actions and incident response
Establish record keeping
Validation and verification
Supporting programs
Reviewing, experience and further needs
Review, approval and audit

15


10-Chain of the wastewater
WW collection
WW treatment
Farm practices
Transportation
Marketing
Consumers

16

8

17

9

2.5 – Sanitation Safety Plan

5/30/2023

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FROM THE AMERICAN PEOPLE

Chapter 8
Sanitation Safety Plan

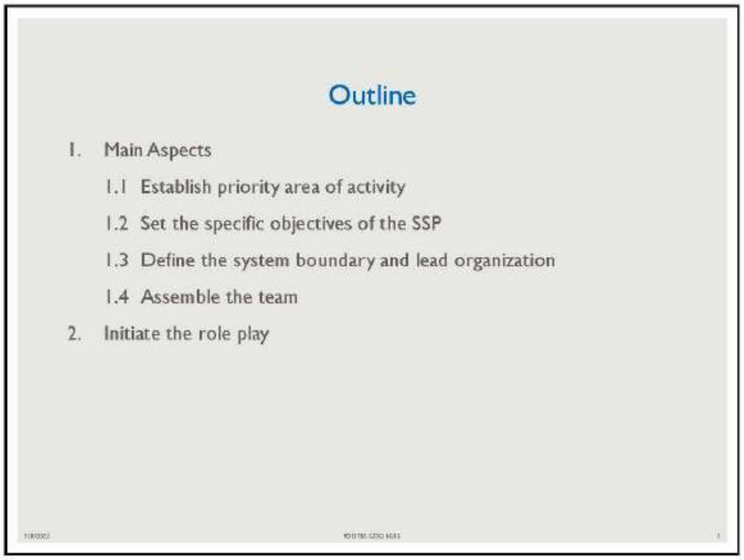
Wastewater reuse module 2

1

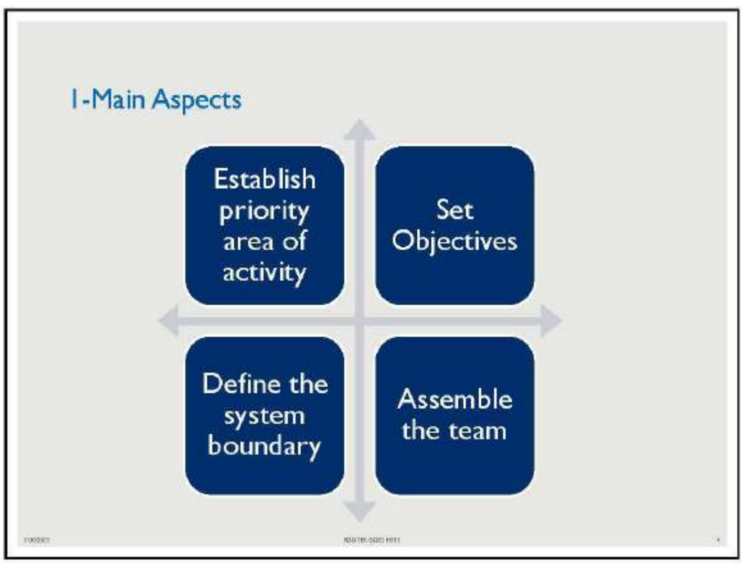
Learning Outcome

- Understand priority areas, purpose, scope, boundaries and leadership for SSP
- Create a multidisciplinary team representing the sanitation chain for development and implementation of the SSP

2


Outline
1. Main Aspects
1.1 Establish priority area of activity
1.2 Set the specific objectives of the SSP
1.3 Define the system boundary and lead organization
1.4 Assemble the team
2. Initiate the role play

3


1-Main Aspects
Establish priority area of activity
Set Objectives
Define the system boundary
Assemble the team

4

I-Main Aspects

1.1-Establish priority area of activity (1/2)

- Identify a certain geographic area (e.g. catchment area) through a steering committee
- You may decide to focus SSP on a certain activity that might pose a major health risk (e.g. fecal sludge management, post harvest activities, etc.)

JH79

5

I-Main Aspects

1.1-Establish priority area of activity (2/2)

Agree on priority area(s) of SSP	Agree on the lead agency and get its commitment
Secure resources including financial and human	Initiate policy discourse to create the demanded enabling environment

Take the lead in SSP and oversight the whole process

6

Slide 5

JH79 https://www.youtube.com/watch?v=eAf3VjQTV44
Jules Hatem, 3/12/2023

1-Main Aspects

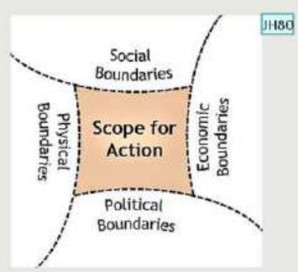
1.2-Set the specific objectives of the SSP

7

1-Main Aspects

1.3-Define the system boundary and lead organization

- Boundary should reflect the specific objective chosen earlier.
- Most relevant authorities shall be assigned to lead the development of SSP



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Slide 8

JH80 https://sswm.info/ar/planning-and-programming/exploring-tools/definition-boundaries/

Jules Hatem, 3/12/2023

5/30/2023

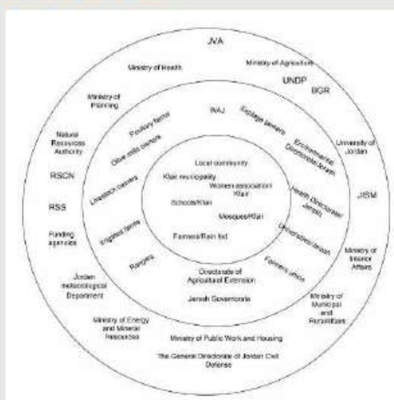
1-Main Aspects

1.4-Assemble the team

- Select the team based on the stakeholder analysis:
- A mix of health and technical skills should be included
- Assign a team leader
- Define roles and responsibilities for each team member
- Ensure management of financial and other resources.

9

2-Initiate the role play (1/2)



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2-Initiate the role play (2/2)

Primary stakeholders	Interests/Roles

Secondary stakeholders	Interests/Roles

11

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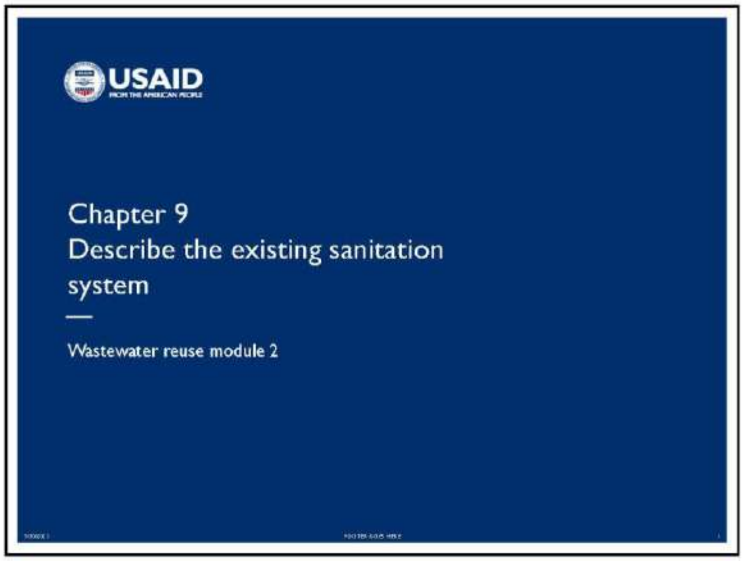
Thank you!

12

2.5 – Describe the Existing Sanitation System



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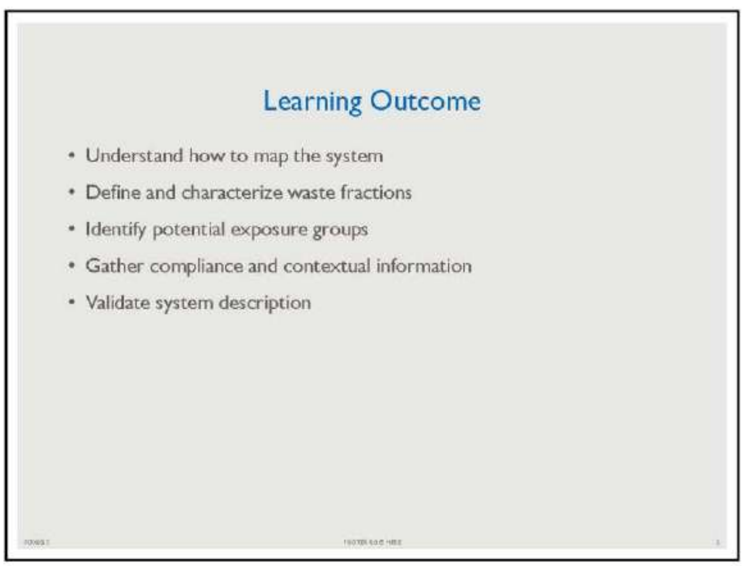


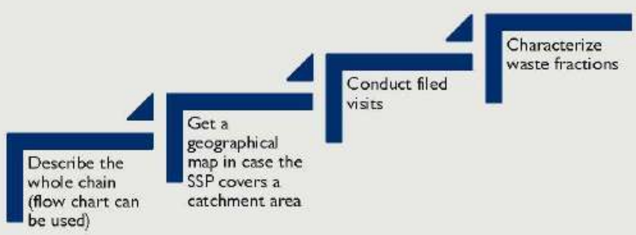
2

Outline

1. System mapping
2. Characterize waste fractions and identify hazards
3. Gather compliance and contextual information
4. Validate the system description

3

1-System Mapping (1/3)



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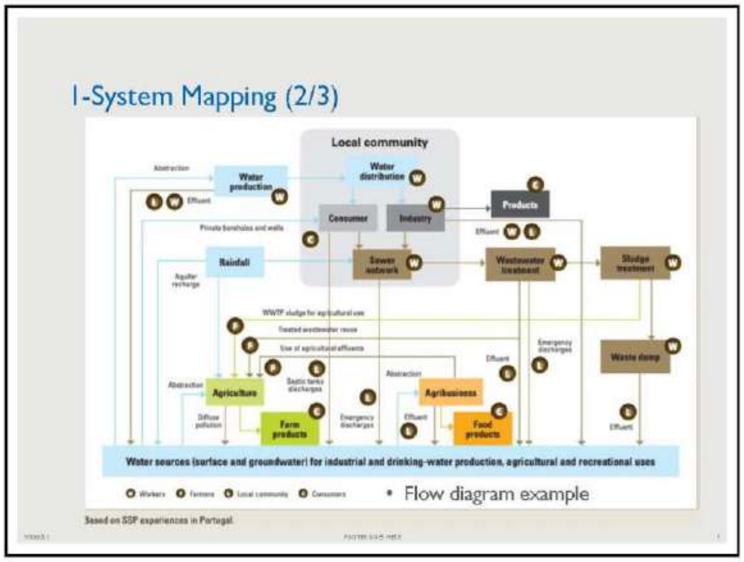
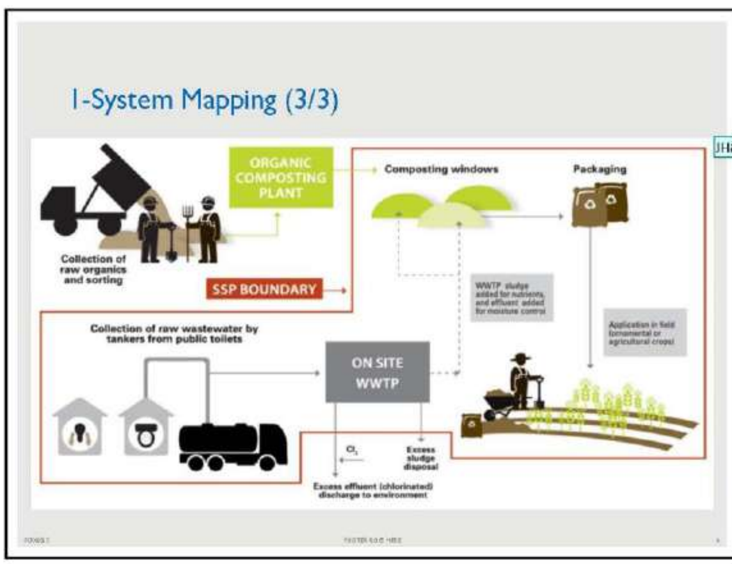

I-System Mapping (2/3)
Local community
Water production
Water distribution
Consumer
Industry
Products
Rainfall
Sewer network
Wastewater treatment
Sludge treatment
Waste dump
Agriculture
Farm products
Agribusiness
Food products
Water sources (surface and groundwater) for industrial and drinking-water production, agricultural and recreational uses
• Flow diagram example
Based on SSP experiences in Portugal

5

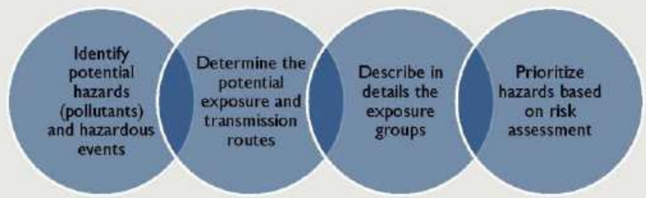

I-System Mapping (3/3)
ORGANIC COMPOSTING PLANT
Composting windows
Packaging
Collection of raw organics and sorting
SSP BOUNDARY
WWTP sludge added for nutrients, and effluent added for moisture control
Collection of raw wastewater by tankers from public toilets
ON SITE WWTP
Application in field (ornamental or agricultural crops)
Excess sludge disposal
Excess effluent (chlorinated) discharge to environment
JH&1

6

Slide 6

JH81 A simplified system mapping (WHO, 2015)
Jules Hatem, 3/14/2023

2-Characterize waste fractions and identify hazards



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2-Characterize waste fractions and identify hazards

2.1-Potential health hazards (example)

	WASTE COMPONENTS									
	POTENTIAL BIOLOGICAL HAZARDS					POTENTIAL CHEMICAL HAZARDS		POTENTIAL PHYSICAL HAZARDS		
	Viruses	Bacteria	Protozoa	Helminths	Vector-related diseases	Toxic chemicals	Heavy metals	Sharp objects	Inorganic material	Malodours
Liquid waste fractions										
Diluted excreta (human or animal)	■	■	■	■						■
Urine (human or animal)	■	■	■	■						■
Domestic waste water	■	■	■	■	■			■	■	■
Stormwater	■	■	■	■	■	■	■	■		
River water	■	■	■	■	■	■	■			
Industrial wastewater (Note 1)						■	■			
Solid waste fractions										
Faecal sludge	■	■	■	■	■			■	■	■
WWTP sludge	■	■	■	■	■	■	■	■	■	■
Organic domestic waste	■	■			■					
Inorganic domestic waste						■	■	■	■	
Agricultural waste (crop residuals)	■	■	■	■	■			■	■	
Gardening waste					■				■	
Animal manure/slurry	■	■	■	■	■				■	■
Medical waste	■	■	■	■		■	■	■	■	■
Industrial waste						■	■	■	■	■
Slaughter house waste	■	■	■	■	■		■			■
Construction and demolition waste								■	■	

Note 1: The extent of potential hazards associated with industrial wastewater can vary widely. For example, industrial waste hazards may include pathogens and chemicals. See Thompson et al. (2007) to help identify potential chemical contaminants from industries.

8

4

2-Characterize waste fractions and identify hazards

2.2-Identify potential exposure groups

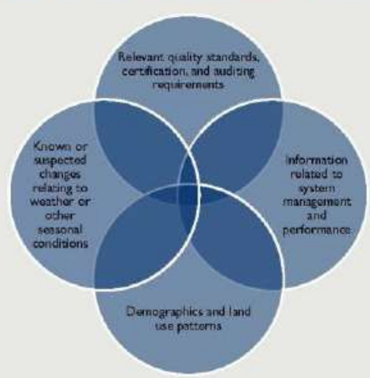
Exposure group categories

SYMBOL	SHORT NAME	SHORT DESCRIPTION
W	Workers	A person who is responsible for maintaining, cleaning, operating or emptying the sanitation technology.
F	Farmers	A person who is using the products (e.g. untreated, partially or fully treated wastewater, biosolids, faecal sludge).
L	Local community	Anyone who is living near to, or downstream from, the sanitation technology or farm on which the material is used, and may be passively affected.
C	Consumers	Anyone who consumes or uses products (e.g. crops, fish or compost) that are produced using sanitation products.

- Categorize people that may be exposed to a particular hazard to enable:
    1. Prioritize control measures
    2. Define potential exposure groups in the risk assessment

9

3-Gather compliance and contextual information



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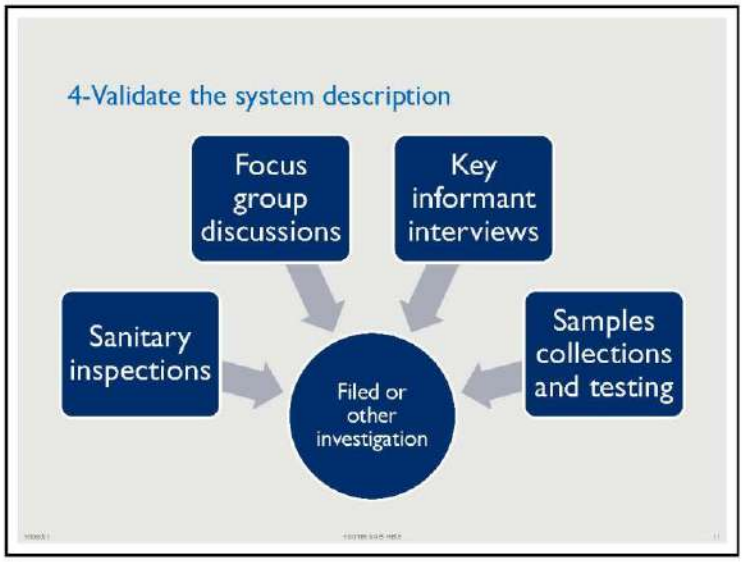

4-Validate the system description
Focus group discussions
Key informant interviews
Sanitary inspections
Samples collections and testing
Filed or other investigation

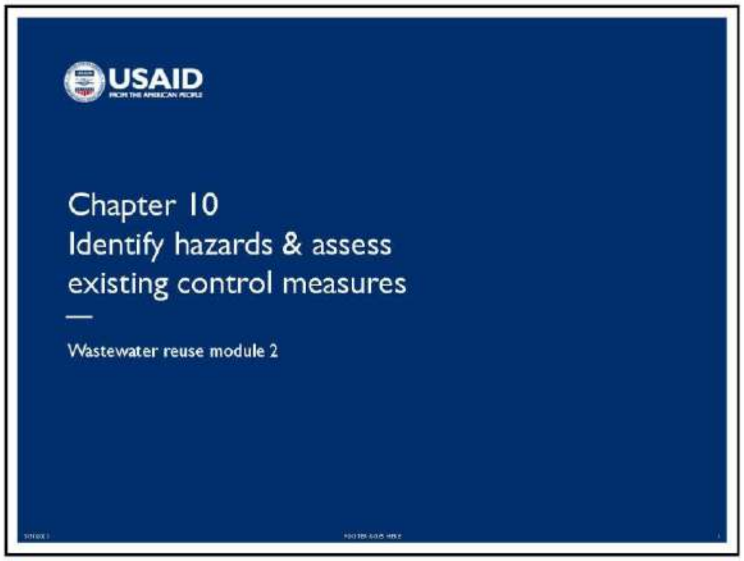
11


USAID
Thank you!

12

2.6 – Identify Hazards & Assess Existing Control Measures

5/31/2023



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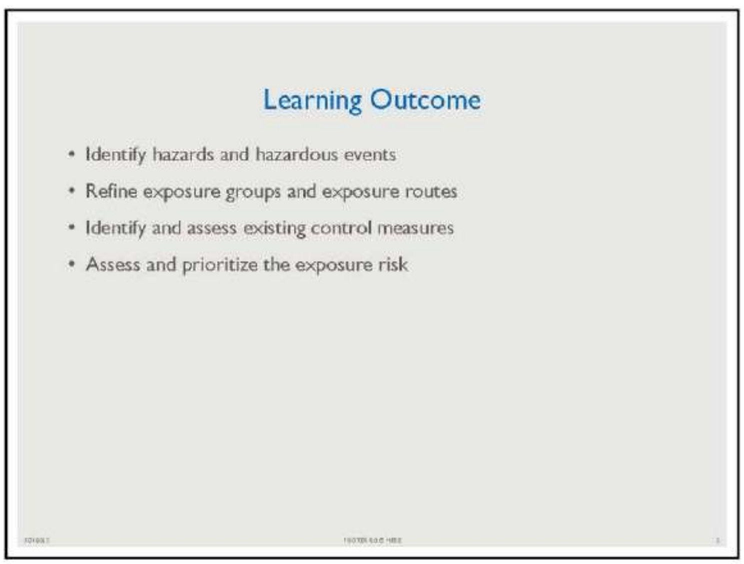

2

1

Outline

1. Hazards V/S Hazardous events
2. Typical hazards type in sanitation systems
3. Refine exposure groups and exposure routes for each hazardous event
4. Identify and assess existing control measures
5. Control measures (example)
6. Descriptive risk assessment

3

1-Hazards V/S Hazardous events

HAZARD	HAZARDOUS EVENT	CAUSE OF THE HAZARDOUS EVENT AFFECTING ITS FREQUENCY OR SEVERITY	APPROACHES TO CONTROL THE HAZARDOUS EVENT	PEOPLE GROUP EXPOSED TO THE HAZARD
Pathogens in raw sewage	Exposure to raw sewage from overflow of a sewer pipe in high rainfall event	• Conveyance system undersized for rainfall events • Lack of screening of overflows	• Design standards to establish overflow frequency • Regular maintenance of sewer system before rainy season	People living adjacent to the sewer or downstream of the overflow
	Exposure to raw sewage during repair and maintenance of a sewage pump	• Pumps in poor condition or unsuitable for the operating conditions resulting in frequent blockages (which affect the frequency of the event) • Poor staff training/ability or equipment • Lack of bypass during maintenance work	• Planned asset maintenance to reduce pump failure frequency • Selection of pump types and screens during the asset creation (design/construction) phase • Personal protective equipment to workers • Standard operating procedures • Design standards of pump stations	Sewage maintenance workers

4

2-Typical hazards type in sanitation systems (1/2)

HAZARD TYPE	EXAMPLES
Microbial pathogens	Bacteria, parasitic protozoa and viruses in wastewater from faecal sources (e.g. *Vibrio cholera*, *Giardia intestinalis*, Coxsackievirus, Hepatitis E). Helminths (e.g. *Ascaris lumbricoides*, hookworm). Vector-borne pathogens (e.g. dengue virus, *Schistosoma* spp.).
Chemicals	Heavy metals in sludge or biosolids from industrial sources (e.g. arsenic, cadmium, mercury). Herbicides and pesticides. In specific situations compounds relate to crop productivity (e.g. boron).
Physical	Sharps (e.g. needles). Odours. Physical injury to workers from equipment. Skin irritants (these are a mixture of microbial and chemical hazards).

Note: Algal toxins may also occur. Cyanobacteria (also known as blue-green algae) occur widely in lakes, reservoirs, ponds and slow-flowing rivers. Many species are known to produce toxins, a number of which have potential health concerns.

5

2-Typical hazards type in sanitation systems (2/2)

	WASTE COMPONENTS									
	POTENTIAL BIOLOGICAL HAZARDS					POTENTIAL CHEMICAL HAZARDS		POTENTIAL PHYSICAL HAZARDS		
	Viruses	Bacteria	Protozoa	Helminths	Vector-related diseases	Toxic chemicals	Heavy metals	Sharp objects	Inorganic material	Malodours
Liquid waste fractions										
Diluted excreta (human or animal)	■	■	■	■						■
Urine (human or animal)	■	■	■	■						■
Domestic waste water	■	■	■	■	■			■	■	■
Stormwater	■	■	■	■	■	■	■	■		
River water	■	■	■	■	■	■	■			
Industrial wastewater (Note 1)						■	■			
Solid waste fractions										
Faecal sludge	■	■	■	■	■			■	■	■
WWTP sludge	■	■	■	■	■	■	■	■	■	■
Organic domestic waste	■	■			■					
Inorganic domestic waste						■	■	■	■	
Agricultural waste (crop residuals)	■	■	■	■	■			■	■	
Gardening waste					■				■	
Animal manure/slurry	■	■	■	■	■				■	■
Medical waste	■	■	■	■		■	■	■	■	■
Industrial waste						■	■	■	■	■
Slaughter house waste	■	■	■	■	■		■			■
Construction and demolition waste								■	■	

Note 1: The extent of potential hazards associated with industrial wastewater can vary widely. For example, industrial waste hazards may include pathogens and chemicals. See Thompson et al. (2007) to help identify potential chemical contaminants from industries.

6

3

3-Refine exposure groups and exposure routes for each hazardous event (1/2)

QUESTION	DESCRIPTION OF QUESTION	EXAMPLE
Exposure group ID	**Give a reference – e.g. W1, C1, L1**	**L1 (Local community group No 1)**
Who are they?	Give a description of who these people are and what they do in relation to exposure. Consideration should be given to vulnerable sub-groups considering age, gender and factors of social exclusion.	ABC village residents and visitors to the stream Female seasonal fruit-picking workers
How many are there?	Give actual numbers, if known, otherwise estimate and give basis of estimate Number of people (individuals) likely to be exposed directly or indirectly	250 householders (including 90 children) in ABC village
Where are they?	Explain where the exposure occurs within the sanitation system to explain how they might be exposed to hazards.	Recreational use of ABC stream
What they are exposed to?	What contaminant and in what circumstances (e.g. chemical, microbial due to barrier failure, extreme weather etc.).	Microbial contamination when ponds overflow
What is the route of contamination?	Infection route to be considered (e.g. through skin, ingestion of crops, soil or water, intermediate vector).	Dermal contact, ingestion
How often are they exposed to this?	Exposure frequency. Is it every time, daily, weekly or perhaps just once a year? If do not know, have a "guesstimate".	Daily contact during summer months
What dose? See Note	Defines the likely dose of exposure. This depends on the local situation and is sometimes difficult to estimate. The dose will also differ between groups of individuals but an "estimate" is still of value.	Pond water is likely to have: • x *E. coli*/100 ml, and • x Helminth eggs/ litre Assumed inadvertent ingestion is 100 ml

Note The dose question would normally only be relevant for more rigorous quantitative assessments like Health Impact Assessments

Based on Stenström et al. (2011)

7

3-Refine exposure groups and exposure routes for each hazardous event (2/2)

EXPOSURE AND TRANSMISSION ROUTE	DESCRIPTION
Ingestion after contact with wastewater/ excreta	Transfer of excreta (urine and/or faeces) through direct contact to the mouth from the h ingestion of contaminated soil via contact with hands (e.g. farmers or children).
Ingestion of contaminated groundwater/ surface water	Ingestion of water, drawn from a ground or a surface source, which is contaminated fro unintentional ingestion of recreational waters by swimmers/bathers.
Consumption of contaminated produce (vegetables)	Consumption of plants (e.g. lettuce) that have been grown on land irrigated or fertilized
Dermal contact with excreta and wastewater	Infection where a pathogen (e.g. hookworms) enters through the skin via the feet or oth wastewater, excreta, open defecation, contents of leaking sanitation technologies or du

8

4

4-Identify and assess existing control measures

Alternative	Effectiveness/ log reduction	Remarks	Further reading
Waste stabilization ponds, aerated ponds, wastewater storage and reservoirs	HIGH 2–5 logs	Effectiveness depends on configuration and storage time, loading rates and retention times, hydraulic design details and sedimentation efficiency. Other associated issues to consider for risk management for workers and local community include: • mosquito vector breeding potential; • *Schistosoma* spp. host snail potential and associated vegetation controls; • fencing; • possible exfiltration from ponds impacting on groundwater (e.g. use of pond liners with clay or other material).	Mahassen et al. (2008). Stenström et al. (2011), 68-70, 79, 129-130. WHO (2006) Vol. 2, 84-87.
Constructed wetlands	MEDIUM 1–3 logs	Effectiveness depends on design configuration (e.g. surface flow or subsurface flow wetlands), loadings and retention times. Other associated issues to consider for risk management for workers and local community include: • mosquito vector breeding potential; • *Schistosoma* spp. host snail potential; • vegetation controls; • impact of wildlife excreta; • possible leakage from wetlands impacting on groundwater.	Stenström et al. (2011), 71-72, 79, 131-132. WHO (2006) Vol. 2, 87.
Biological chemical treatment	MEDIUM 1–3 logs	Control measures dependent of design and treatment configuration.	Stenström et al. (2011), 73-75. WHO (2006) Vol. 2, 82-84 & Table 5.3.
Advanced processes	HIGH 3–>6 logs		

9

5-Control measures (example)

Improvement plan options				
Possible control measures for farmers and their families	**Comments/discussion**	**Likely effectiveness of option in reduction of risk of the hazardous event**	**Reference/validation**	**Priority for improvement plan**
Improved treatment: Full treatment in upgraded Waste Stabilization Ponds to achieve < 1000 *E. Coli*/100 ml and < 1 egg/ litre (including maturation pond)	This is an improvement of the existing control measure. Full treatment would be expensive, and seen as unlikely is short to medium term.	High effectiveness (> 4 log reduction).	2006 WHO Guidelines (Vol 2 page 81) and texts on Waste Stabilization Ponds.	Long term.
Partial treatment: Reinstate maturation pond as part of normal process train	This is an improvement of the existing control measure but to a lesser extent than full treatment. No substantial adjustment to existing ponds, just reinstatement of existing maturation pond. Will make substantial reduction to helminth eggs. A further 5 day detention will reduce egg count to 1 / litre. *E. coli* will reduce to 5.8x 10[illegible] /100 ml. See Note 1.	High effectiveness for farmer protection. ***E. coli***: Total new log reduction of approx 3.3 (compared with existing of approx. 1.7 log reduction). **Helminth eggs**: will achieve about target of about 1 egg/litre.	Calculation on egg reduction in 2006 WHO Guidelines (Vol 2 page 85) and Waste Stabilization Ponds texts.	Short/medium term.
Crop restriction	Not relevant to farmer protection except when used in conjunction with localized irrigation.	Not applicable for farmer protection, but does provide high protection for consumers of the crops.	2006 WHO Guidelines (Vol 2 page 78).	Not relevant – not proposed for further consideration.
Improved spray irrigation techniques	Use low throw, micro sprinklers, part circle sprinklers.	Low to moderate effectiveness for farmer and local community – approximately 0.5 log reduction.	2006 WHO Guidelines (Vol 2 page 64 and 77).	Immediate/short term

10

6-Descriptive risk assessment

RISK DESCRIPTOR	NOTES
High priority	It is possible that the event results in injuries, acute and/ or chronic illness or loss of life. Actions need to be taken to minimize the risk.
Medium priority	It is possible that the event results in moderate health effects (e.g. fever, headache, diarrhoes, small injuries) or unease (e.g. noise, malodours). Once the high priority risks are controlled, actions need to be taken to minimize the risk.
Low priority	No health affects anticipated. No action is needed at this time. The risk should be revisited in the future as part of the review process.
Unknown priority	Further data is needed to categorize the risk. Some action should be taken to reduce risk while more data is gathered.

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Thank you!

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2.7 – Monitor Control Measures

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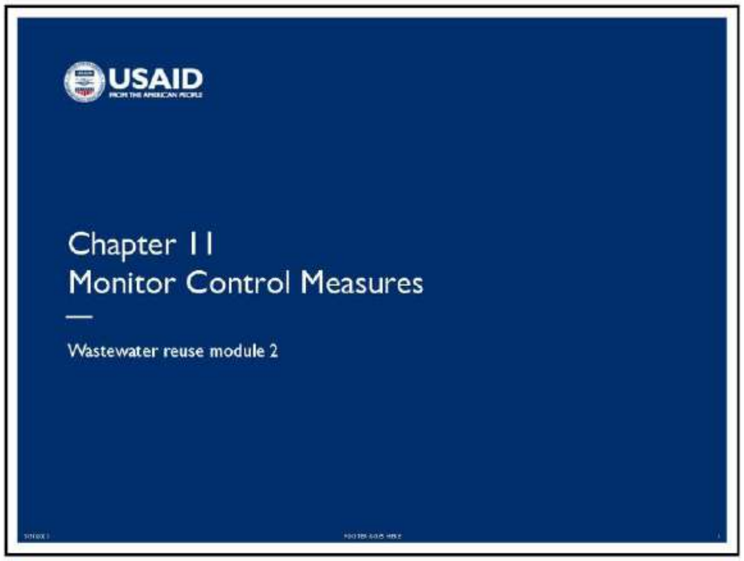

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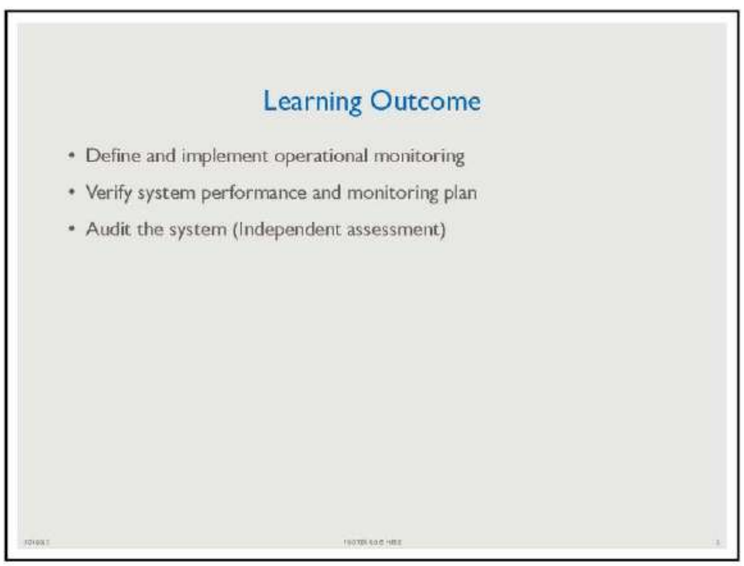


2

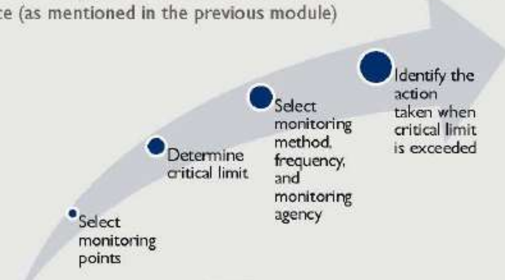
Outline

1. Introduction
2. Operational monitoring
3. Operational monitoring template
4. System verification
5. Typical verification data

3

1-Introduction

- Monitoring points shall give simple and rapid feedback on the performance of key control measures
- It is essential to define limits that lead to the safe agricultural use. Limits don't necessarily mean concentration of hazard but might ne a certain practice (as mentioned in the previous module)



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2-Operational monitoring

- It might also use some sampling and testing

5

3-Operational monitoring template

OPERATIONAL MONITORING PLAN IN COMPOST PLANT				
Operational monitoring plan for:				
CONTROL MEASURE SHORT DESCRIPTION				
Operational limits (see note)	Operational monitoring of the control measure		Corrective action when the operational limit is exceeded	
	What is monitored?		**What action is to be taken?**	
	How it is monitored?			
	Where it is monitored?		**Who takes the action?**	
	Who monitors it?		**When it is taken?**	
	When it is monitored?		**Who needs to be informed of the action?**	

Note: If the monitoring is outside this limit(s), the control measure is deemed to be not functioning as intended.

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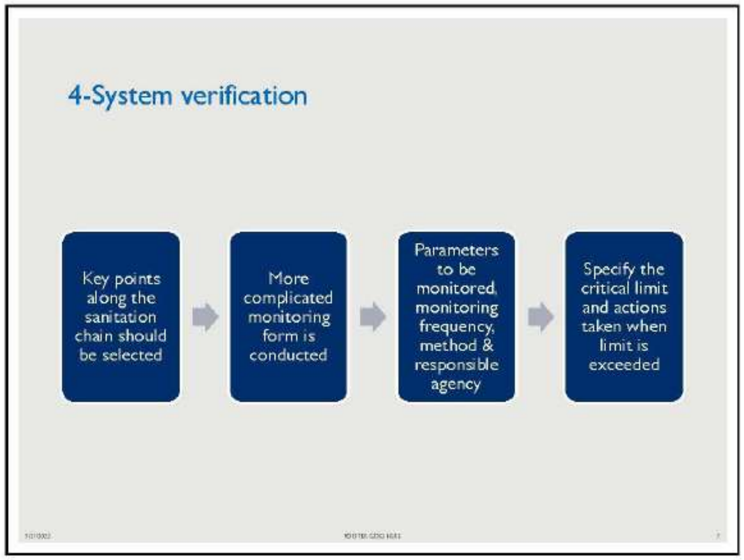
4-System verification
Key points along the sanitation chain should be selected
More complicated monitoring form is conducted
Parameters to be monitored, monitoring frequency, method & responsible agency
Specify the critical limit and actions taken when limit is exceeded

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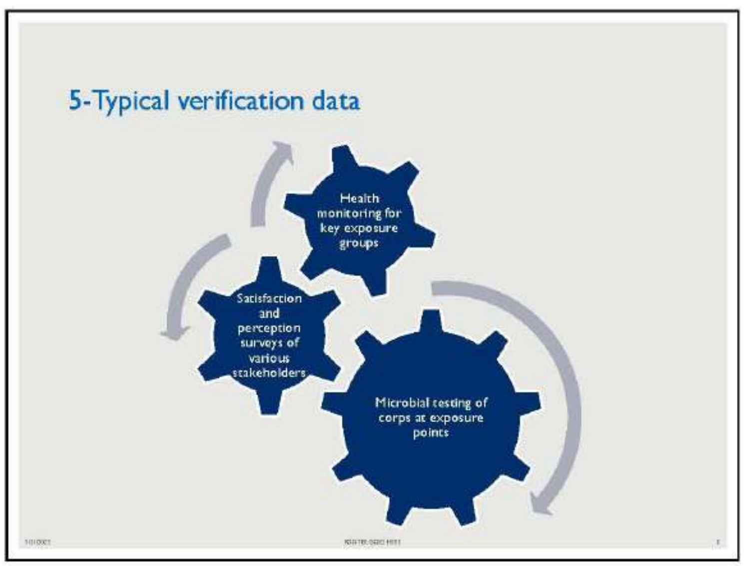
5-Typical verification data
Health monitoring for key exposure groups
Satisfaction and perception surveys of various stakeholders
Microbial testing of corps at exposure points

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2.8 – Methods to Increase Stakeholders Acceptance

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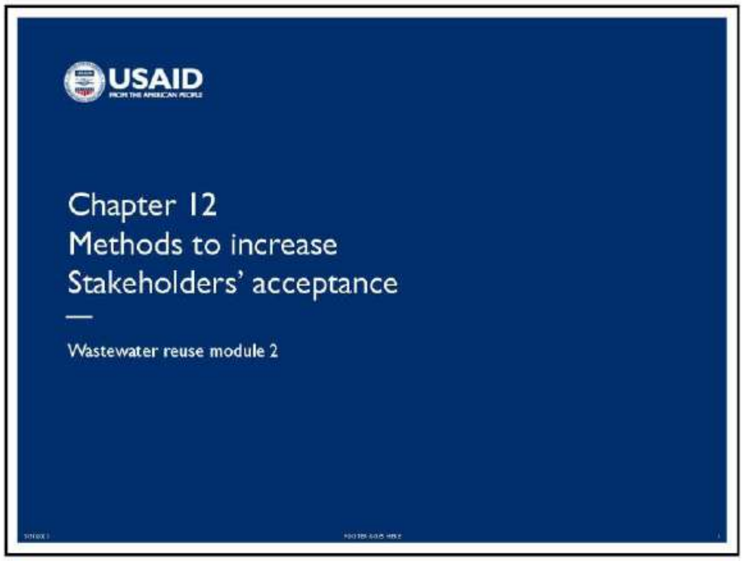

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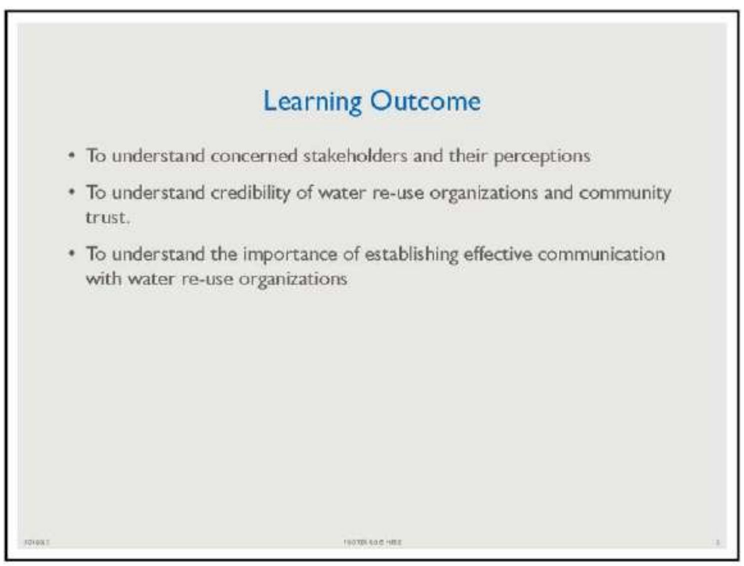

2

1

Outline

3

1-Introduction

Public involvement is critical to the successful implementation of reclaimed water reuse programs

In order to achieve public involvement, there is a need to establish an Effective communication channel

A growing number of water reuse projects around the world have failedas a direct result of a lack of community confidence and trust

Communication is a complex process that takes place between two or more parties

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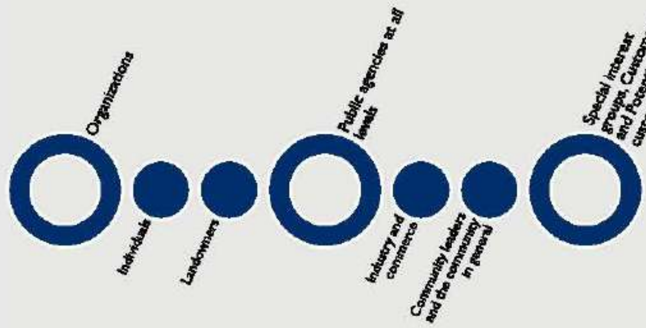
2-Who are our stakeholders



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3-Understanding the Perceptions of Stakeholders

- Research show that the general public's knowledge on water resources is poor
- The general public show a strong acceptance of non-contact and non-potable reclaim water reuse, but their is not high acceptan of the three major water reuse types:

  1-River water supplement

  2-Park water supplement

  3-Agriculture irrigation

It is essential that the knowledge, attitudes and perceptions of stakeholders to be understood, acknowledged and addressed

6

4-Important Aspects for Understanding the Perceptions of Stakeholders

Issues that may influence community response to water reuse are likely to include those associated with:

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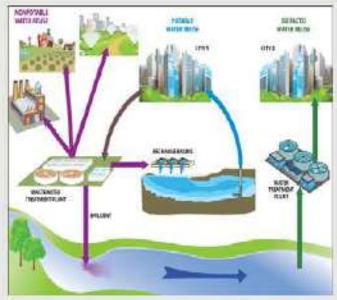
- Public health
- Environmental health
- Economy and finance
- Available technology
- Emotional factors
- Culture and Religion



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5-Communication of Water Reuse Organizations with Stakeholders

5.1-Defining and identifying successful communication

- The degree to which a communication effort has been successful must be judged according to its objectives
- The objective of a more complex communication strategy is to provide stakeholders with sufficient knowledge and creation of common understanding
  - Perception
  - Religion and cultural beliefs
- Stakeholders will be able to see both the decision-making process as being transparent and fair

8

Slide 7

JH81 https://nap.nationalacademies.org/read/13514/chapter/1
Jules Hatem, 3/12/2023

5-Communication of Water Reuse Organizations with Stakeholders

5.2-Early and continuous communication

- The timing of communication activities can be of equal importance to their substance
- Community confidence and trust can only be built over time
- Delays in passing on information may give rise to rumors

9

5-Communication of Water Reuse Organizations with Stakeholders

5.3-Listening and seeking clarification

- It is important for communication to be established as a two-way flow between the reuse organization and the engagement of all stakeholders
- Two crucial characteristics of effective communication are listening and seeking clarification

10

5-Communication of Water Reuse Organizations with Stakeholders

5.4-Risk communication

- How to align the community's perception of risk
- •The willingness of all stakeholder groups to respect the views of others and for all concerns to be included in the decision making process

11

6-Identifying key messages to stakeholders

- Engaging stakeholders in any decision-making process to enable them to make informed judgments
- Positive key messages about water reuse
- Let stakeholders know that there is a serious, long-term water shortage problem that is in urgent need of being addressed
- Stakeholders must be assured that the problem will be addressed

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7-Key messages for the promotion of water reuse activities

7.1-Water reuse organizations earn their good reputation

- The community will need to place its trust in the water reuse organization to protect public health and the environment
- It is important for water reuse organizations to communicate good reasons why it is worthy of a community's trust

13

7-key messages for the promotion of water reuse activities

7.2-The reuse project has a critical need and clear purpose

- The burden would lie on the water reuse organization to make an effective case for clear need for the project.
- Raising and maintaining community awareness of the importance of the underlying issues should remain a high communication priority

14

7-key messages for the promotion of water reuse activities

7.3-Reuse water is safe for its intended uses

- Safety: Highlight an excellent or unblemished safety record for water reuse
- Emphasize that the health-related aspects of an operation are closely regulated and overseen by appropriate authorities

15

7-key messages for the promotion of water reuse activities

7.4-Water reuse helps conserve drinking water supplies

- Water is in short supply in many parts of the world
- The role of a water reuse scheme in conserving drinking water supplies may not be obvious to the community

16

7-key messages for the promotion of water reuse activities

7.5-Water reuse may have significant positive economic impacts

- Economic implications of a water reuse scheme are important to stakeholders
- Water reuse can protect public and private
- Its use for approved applications may substantially reduce the overall water expenses for many households

17

7-key messages for the promotion of water reuse activities

7.6-Water reuse is preferable to alternative options

- There are two major water management issues to be addressed
- One is to overcome impending shortages of supply
- The other is to limit the environmental implications of continuing to dump volumes of treated sewage into the world's rivers and oceans
- Only water reuse can meet these challenges simultaneously

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8-Conclusion

- It is crucial to understand concerned stakeholders and their perceptions
- Effective communication builds trust between organizations and stakeholders
- Effective two-directional communication enables water reuse organizations to develop an understanding of their stakeholders

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Thank you!

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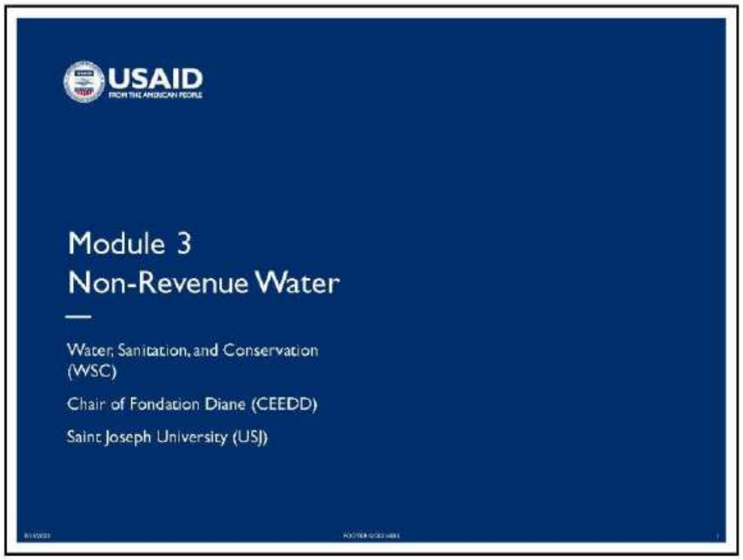
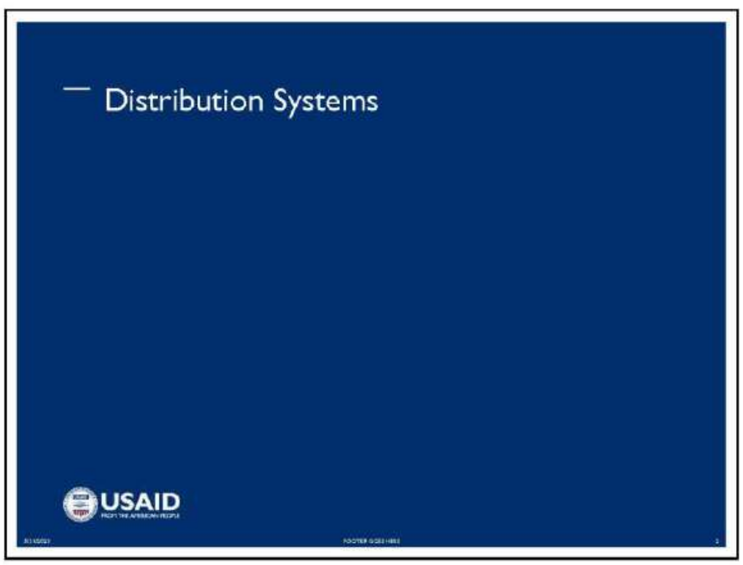
Annex 3 – Non-Revenue Water





Mapping the system

3

Why do we have water towers?

4

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Vicious Cycle

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5

Future Wheel – What happens when things fail?

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Converging into a Cycle

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Water Balance

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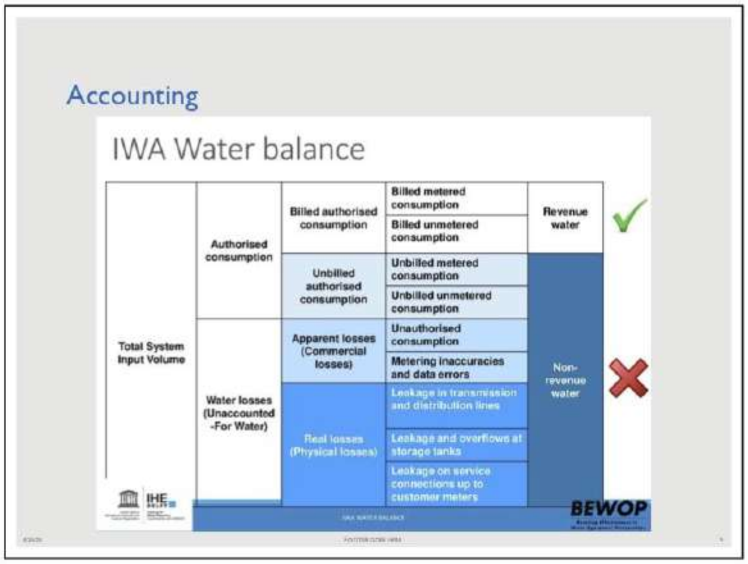
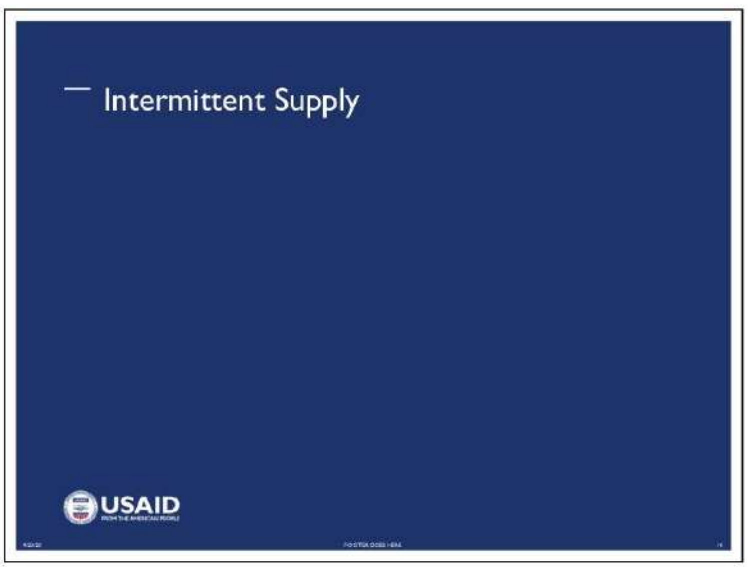

Accounting
IWA Water balance
Total System Input Volume
Authorised consumption
Water losses (Unaccounted -For Water)
Billed authorised consumption
Unbilled authorised consumption
Apparent losses (Commercial losses)
Real losses (Physical losses)
Billed metered consumption
Billed unmetered consumption
Unbilled metered consumption
Unbilled unmetered consumption
Unauthorised consumption
Metering inaccuracies and data errors
Leakage in transmission and distribution lines
Leakage and overflows at storage tanks
Leakage on service connections up to customer meters
Revenue water
Non-revenue water
IHE
BEWOP

9


Intermittent Supply
USAID

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5

Pass the bucket

- What is the effect of the water delivery system being invisible?
- What is the most effective delivery system?
- What are the most impactful measures to improve efficiency?

11

Managing Flow

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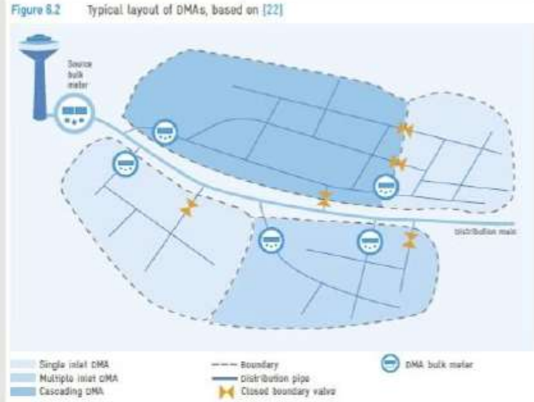
How is flow managed?

Figure 6.2 Typical layout of DMAs, based on [22]



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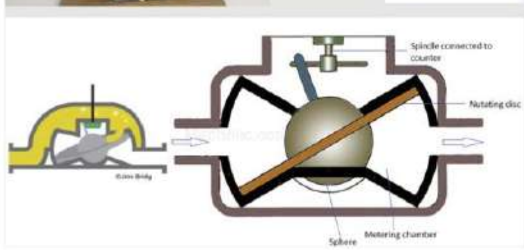
How is flow managed?



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Managing Pressure

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How is pressure managed?

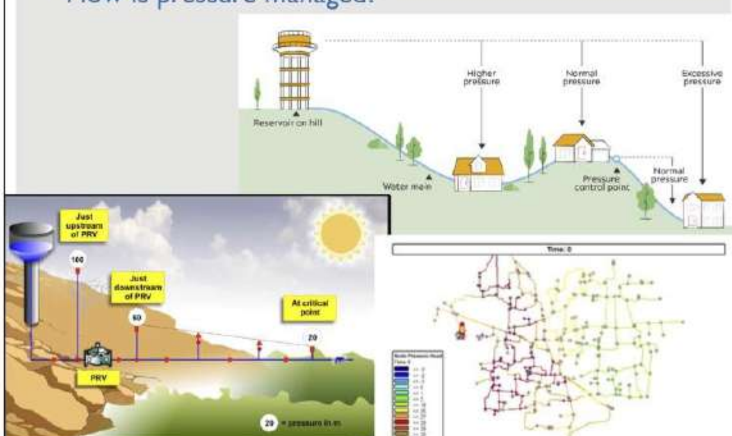

Figure 1: Typical pressure during peak demand periods

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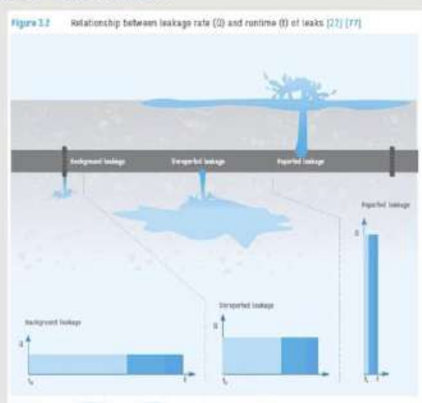
Managing Losses

17

Another game: Where's the water?

- Is it a Leak?
- Is it a connection?
- How do we find it?



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4/23/23

Beneath the Asphalt

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Jawad Taher

Water & Development

Advisor & Consultant

waterandbased.com

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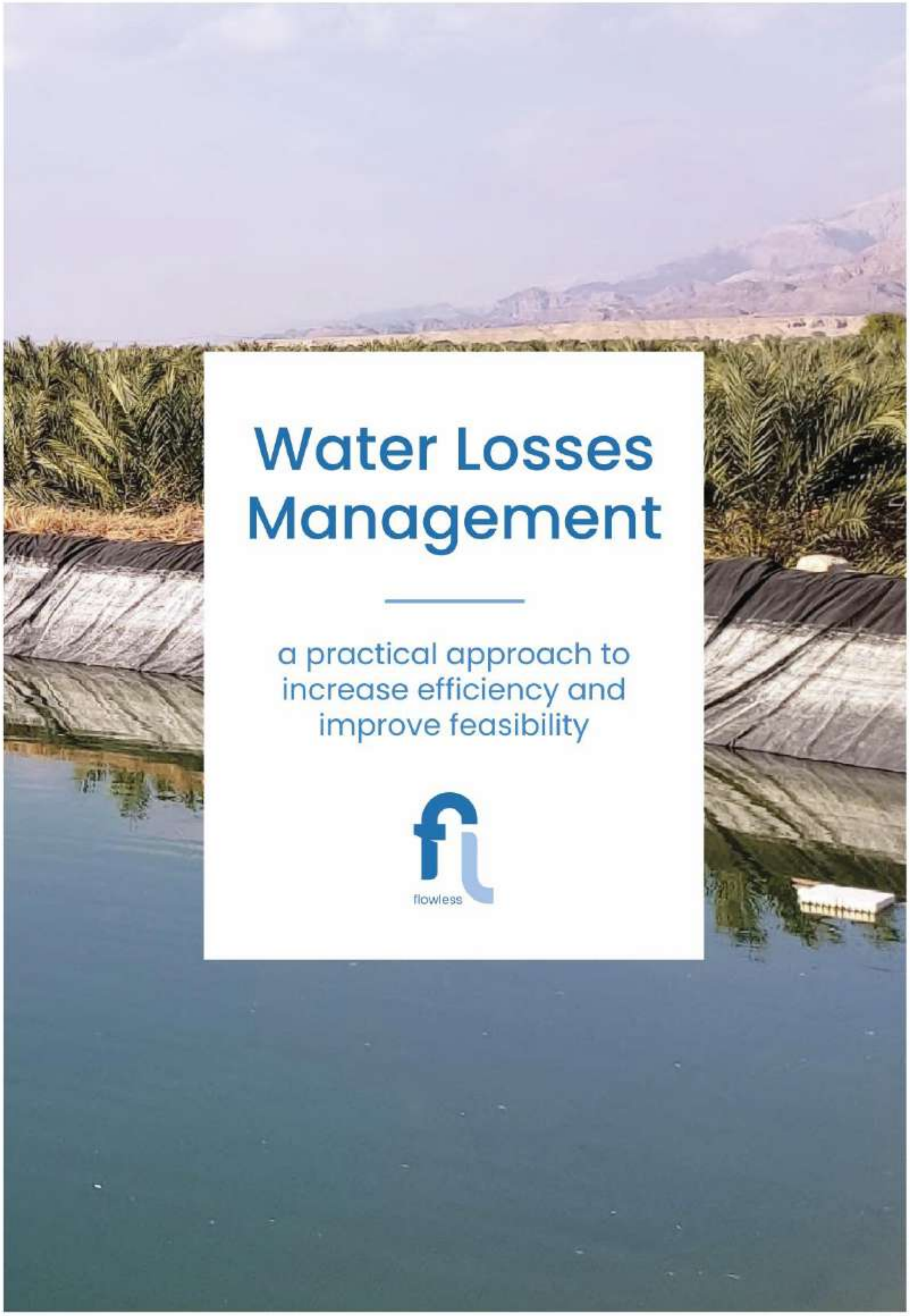
3.1 – Water Losses Management



OVERVIEW

Utilities can start minimizing their expenses, and improving water efficiency through affordable, simple yet effective measures

Let's get it straight: Water resources management is a complicated process. In many cases, things can easily go wrong. The cost would be overwhelming for both the environment and the community. Manual operations complicate matters by consuming a lot of time and effort, producing inaccurate results, and causing delay in necessary actions.

Water loss is a problem that many water utilities suffer from. While smart technology provides a great support, utilities still do not always get the desired outcome. Often hindered by limited financial and technical capacity, they don't know where or how to start.

Even if your utility lacks fundamental technological and financial capacity, you can still deploy smart technology to help you better manage your network and improve system operations. In this white paper, we lead you provide a unique approach to make the solution more affordable through agile deployment and adaptive planning. We lead you through a process to identify your needs and provide customized solutions for the context.

Water Losses Reduction: The Roadmap

The AGILE Approach

01 **Identify the problem**
- assess the context
- identify the gaps

02 **Assess the needs**
- define targets
- set priorities

03 **Take actions**
- start small
- measure results

04 **Scale it up!**
- expand outcomes
- track progress
- Iterate!

To learn on the roadmap and how to apply it go to page 16

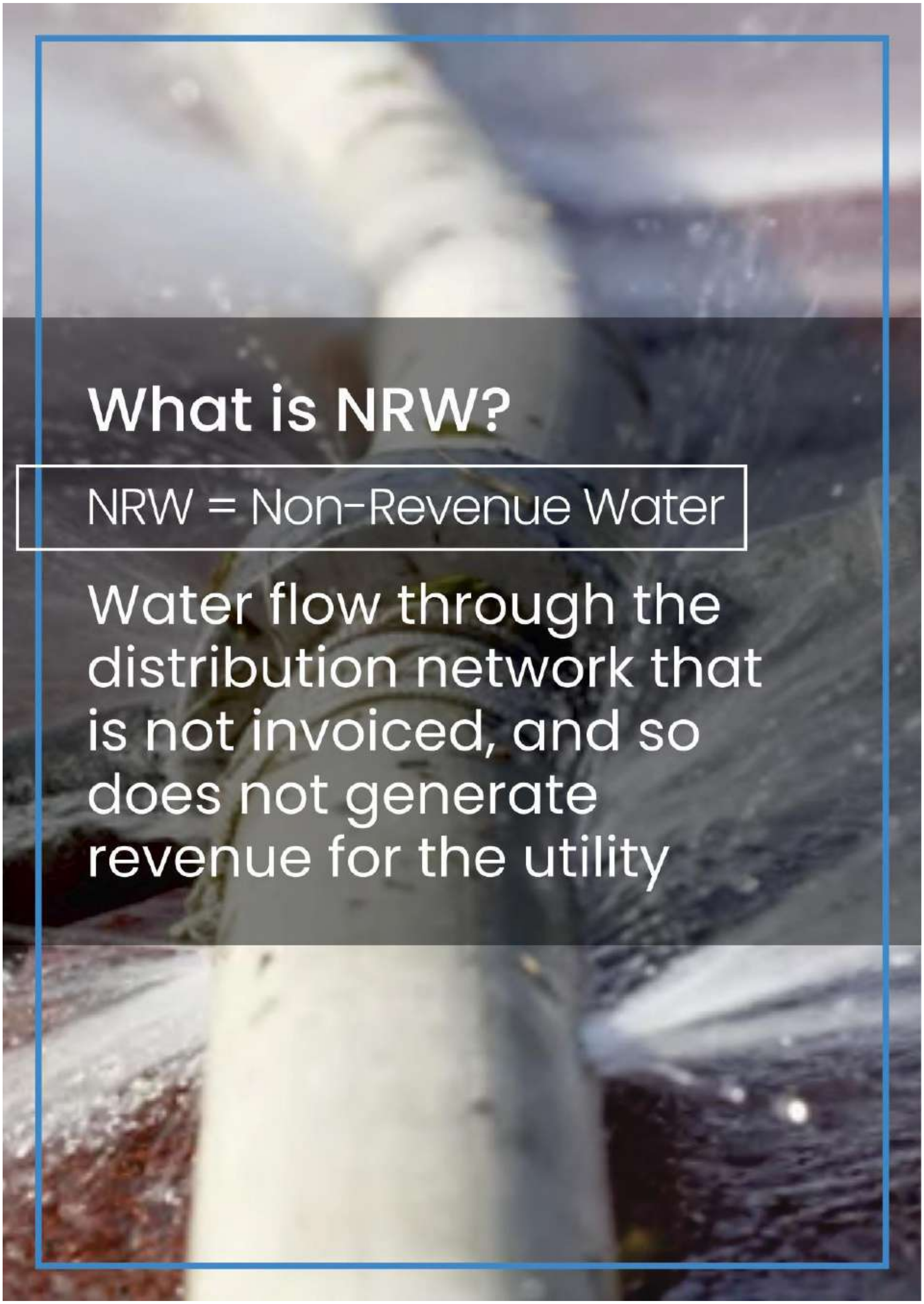
INTRODUCTION

Water losses is an indicator of water distribution efficiency. Conventional operations are inefficient, and ad-hoc solutions fail to satisfy utilities targets. The results are compromised feasibility and low quality of service. This should be the trigger for initiating an active leakage control program.

However, a leak-free network is not an achievable objective. Low level of water losses cannot be technically and economically avoided even in the best-operated and maintained systems where water utilities invest heavily in water loss control.

So what should water networks operators aim for? The focus should be on reducing water losses through a practical approach, where utilities aim for the low hanging fruit. This can be achieved by prioritizing leak detection and losses management activities to achieve the maximum gains, utilizing the limited resources to maximize feasibility.

With the increasing trend towards sustainability, the problem of water losses is of major interest worldwide. We know one thing for sure: water is precious and we should realize its value.


What is NRW?
NRW = Non-Revenue Water
Water flow through the distribution network that is not invoiced, and so does not generate revenue for the utility

Water Losses Components

We can better understand water loss by breaking it down into **two types:**

01 Real water losses
e.g. water leaks, pipes bursts

02 Apparent losses
e.g. meters inaccuracy, illegal use

Water Losses Reduction

To tackle these challenges, we follow the following **steps:**

01 Water Balance Calculations

02 Active Monitoring & Data Collection

03 Educated Actions, Applied Gradually

SHORTCOMINGS & IMPACT

Why do we aim to reduce water losses?

Economic Impacts:

Utilities spend capital on exploiting, treating, and transporting water. These expenses are considered losses when part of the water is lost on its way to the customer without generating any revenue for the water utility. Pipe bursts and leaks call for expensive repair works and may also cause considerable damage to nearby infrastructure.

Technical Impacts:

Leakage leads to reduced coverage of the existing water service, causing disturbance in water supply continuity. Leak detection helps in enhancing the water system operations efficiency, thus improving water quality and filling the demand gap.

Social Impacts:

Water losses result in adverse effects on the community: low pressure, service interruptions, and unequal supply. Also, health risks may result from the infiltration of sewage and other pollutants into pipes under low pressure or intermittent supply.

Ecological impacts:

Compensating water losses by further increasing water extraction adds additional stress on water resources and requires additional energy, thus increasing carbon dioxide emissions that could have been avoided.

WATER BALANCE

It is possible to work with Non-Revenue Water in a more structured and effective way by breaking down water supply into smaller components.

Water losses management best practice involves regular water balance calculations. These calculations quantify volumes of total water supply into the system, then it breaks it down into authorized consumption (billed and unbilled, metered and unmetered), and water losses (apparent and real).

All water balance calculations are approximate to some degree because of the difficulty of assessing all the components with complete accuracy.

The water balance should include:

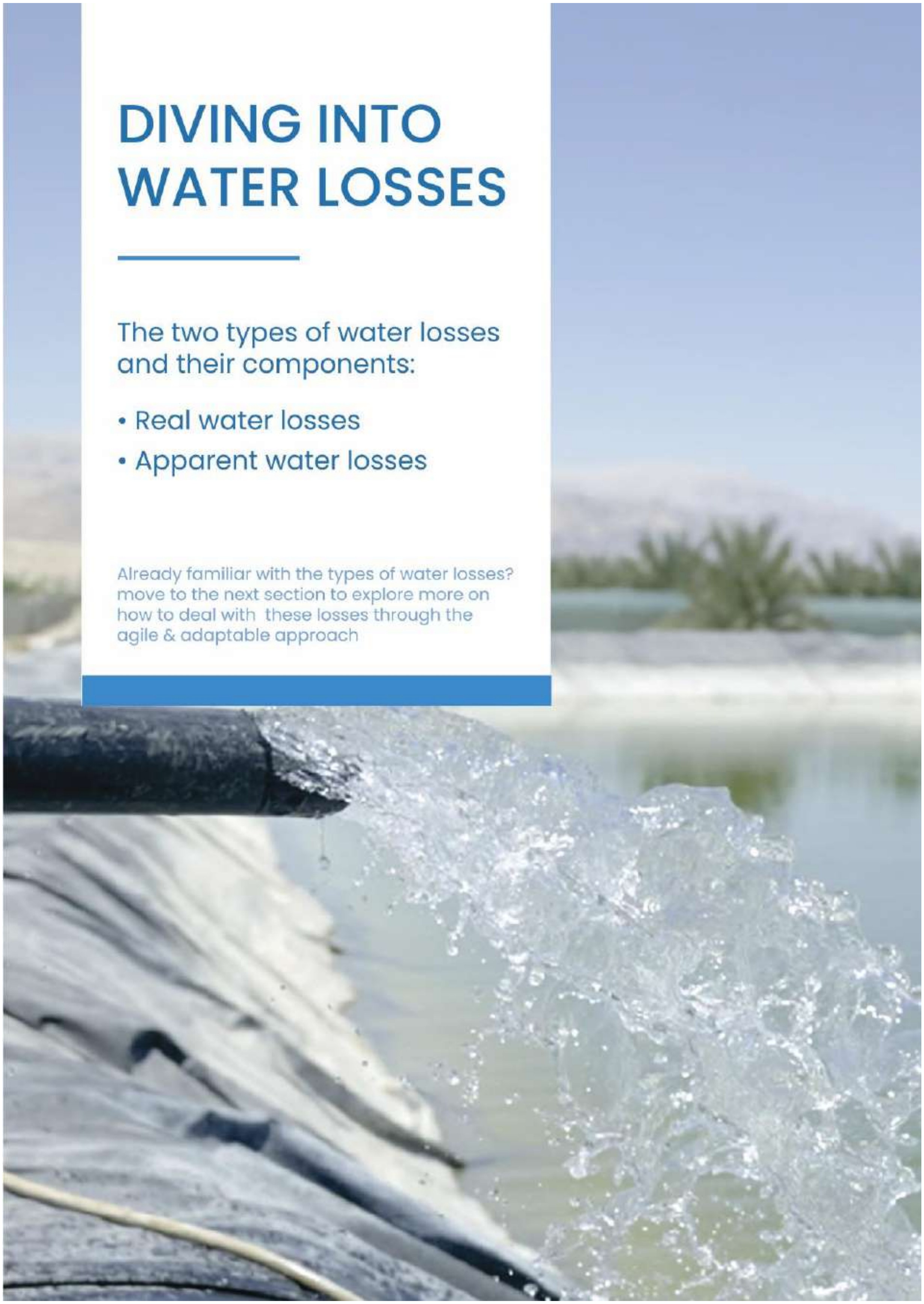
- A thorough accounting of all water into and out of a utility system, including inspection of system records
- An ongoing meter testing and calibration program
- Due allowance for the time lags between production meter reading and customer meter reading

DIVING INTO WATER LOSSES

The two types of water losses and their components:

- Real water losses
- Apparent water losses

Already familiar with the types of water losses? move to the next section to explore more on how to deal with these losses through the agile & adaptable approach



REAL LOSSES

Real losses are water volumes lost within a given period through all types of leaks, bursts, and overflows. They can be classified according to their location within the system and their size and runtime.

1. Location

Leakage from the transmission and distribution mains may occur at pipes (bursts due to extraneous causes or corrosion), joints (disconnection, damaged gaskets), and valves (operational or maintenance failure) and usually have medium to high flow rates and

Leakage from service connections up to the point of the customer meter: service connections' joints and fittings often have high failure rates. These are difficult to detect due to their comparatively low flow rates and thus often have long runtime.

Leakage and overflows from storage tanks are caused by deficient or damaged level controls. In addition, seepage may occur from masonry or concrete walls that are not watertight. While they are easy to detect, their repair is usually elaborate and expensive.

REAL LOSSES

2. Size and runtime

Visible leaks primarily result from sudden bursts or ruptures in mains or distribution pipes. Leaking water will appear at the surface quickly depending on water pressure, leak size as well as on surface characteristics. Special equipment is not required to locate the leak.

Hidden leaks: The presence of hidden leaks can be identified by analyzing trends in water consumption behavior within a defined water supply zone. A wide range instruments is used to detect hidden leaks.

Background leakage: these small leaks (seeping or dripping water from joints, valves, or fittings) cannot be detected using acoustic leak detection methods. Therefore it is often not economically feasible to reduce these leaks.

Many water utilities have yet to implement sustainable water loss management strategies despite the obvious benefits. Here we summarize practical and effective techniques to deal with real water losses.

Reducing Real Losses

The key for effective losses reduction is customized solutions to fit the context and actively address major issues

Various methods are developed and economically available for utilities to detect real water losses. Nevertheless, many water utilities have yet to implement sustainable water loss management strategies despite the obvious benefits. Here we summarize practical and effective techniques to deal with real water losses.

Pressure management: managing system pressures to the optimum levels of service while ensuring sufficient and efficient supply for consumers. High water pressure causes pipe breaks and bursts. Also, leak flow rates increase as pressure increases, which means that pressure management can potentially reduce all three components of real water losses: background leakage, reported and unreported leakage.

Active leakage control is vital to cost-effective and efficient leakage management. This involves monitoring flows into zones, or district meter areas (DMAs), to reduce the search area and to determine where leak detection activities should be carried out. The quicker the operator can analyze DMA flow data, the quicker bursts or leaks can be located. This, together with speedy repair, limits the total volume of water lost.

Apparent Losses

Apparent losses are losses that are not caused by physical leaks in the network but are caused by other factors. Apparent losses can be grouped based on their origin:

- **Meter inaccuracies** due to broken or inaccurate customer and bulk water meters.

- **Data handling errors:** those are human errors throughout data collection or accounting.

- **Unauthorized consumption** due to water theft and illegal connections.

Summarizing the above, apparent losses comprise all water that is successfully delivered to the customer but which is not metered or recorded accurately and thus causes an error in the amount of customer consumption.

In water supply networks without consequent, system-wide metering and with numerous illegal connections, apparent losses may represent significant amounts of water. Apparent losses are creating production costs without generating revenue for the utility.

Reducing Apparent Losses

Effective auditing, regular check ups, and active regulations are attainable measures to reduce apparent water losses

Meter inaccuracies

Metering losses are frequently the most common form of apparent losses. To reduce meters inaccuracies, it is vital to wisely select customer water meters that have high accuracy and adequate measurement mechanism. Also, Utilities should carry out regular checkups on customer meters and replace aging and broken meters.

Data handling errors

Utility staff carrying out meters data collection are prone to making meter-reading errors. Unmetered consumption (e.g. supplies for fire fighting, street cleaning, etc.) should be reduced for more accurate water accounting. To avoid data errors, utilities should build structured procedures where field data goes through multiple stages of screening and auditing to detect these errors and phase them out.

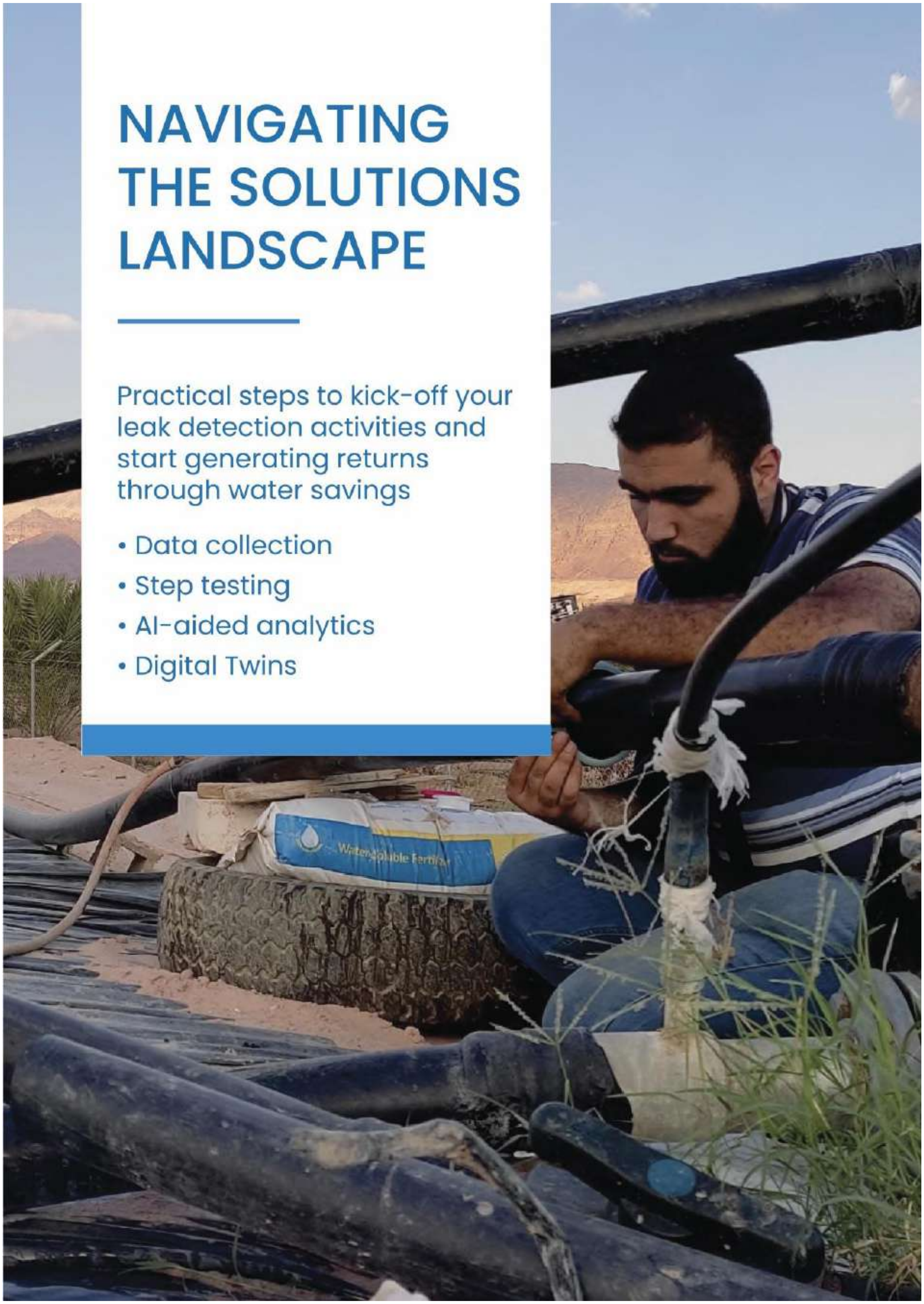
Unauthorized consumption

Unauthorized water extraction represents a considerable source of losses in contexts. To effectively detect and reduce unauthorized consumption, utilities should perform regular field campaigns and utilize law enforcement through fines and other measures.

NAVIGATING THE SOLUTIONS LANDSCAPE

Practical steps to kick-off your leak detection activities and start generating returns through water savings

- Data collection
- Step testing
- AI-aided analytics
- Digital Twins



Water Losses Reduction 101

How to tackle water losses and where to start?

Enhancing water supply efficiency is directly related to water losses, and reducing these losses is always challenging. Limited financial and technical capacity is always a burden when it comes to deploying smart monitoring systems, not to mention the lengthy mundane procurement processes!

Nevertheless, the process of introducing smart leak detection technology can get smoother and more affordable than it appears! To start with, utilities need to break it down into stages:

Problem Identification:

Start by identifying your current challenges. What are the problems you face in your water system? What are the most intimidating challenges? What are your priorities and how have they connected to your organization's goals and strategy?

Needs Assessment:

What holds you back from solving these problems? What are the causes? Which of these problems is the easiest to start with? Which problem, if solved, could drive more impact?

Implementation:

Heard of "agility"? start small, do what you can do NOW. Refer to the priorities

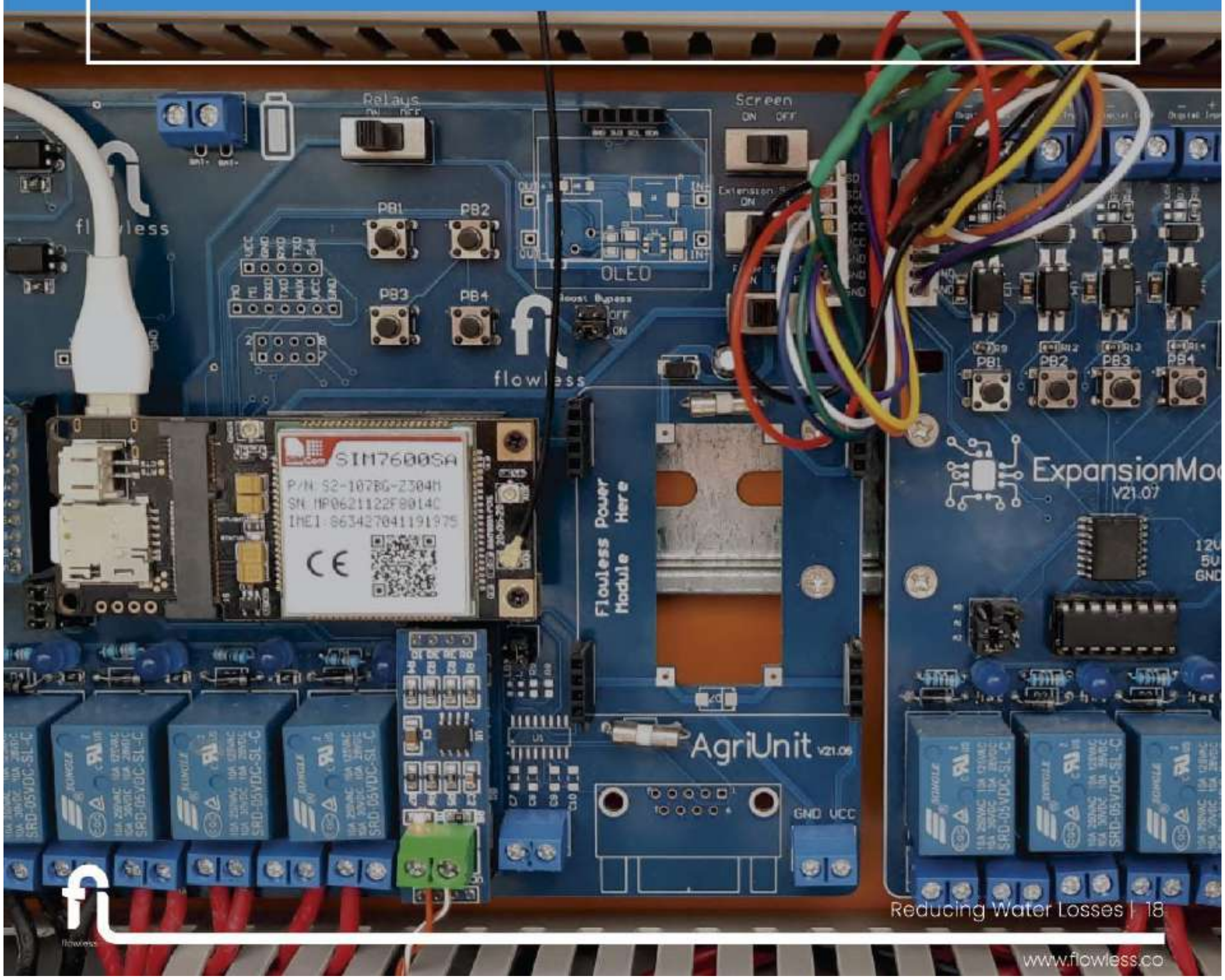
Scale it Up!

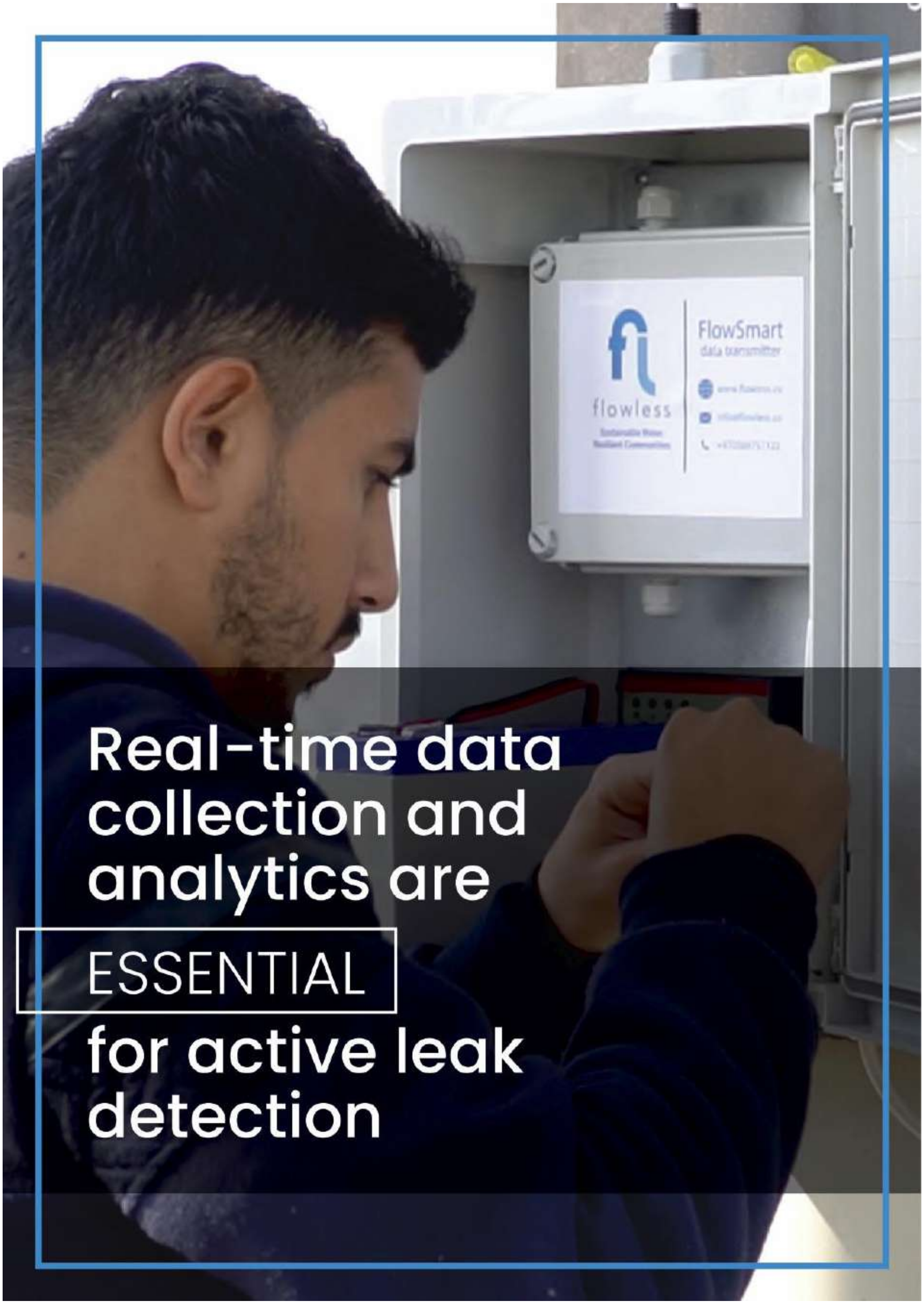
Data Collection

Data collection is essential for utilities to understand the context and prioritize interventions for their needs. Based on initial data collection, utilities can start setting plans to deploy and improve water losses reduction programs.

Utilities can start with affordable and manageable interventions. Relatively simple activities like pressure management and step testing have great potential to reduce water losses in some contexts. Water loss management is a huge and often intimidating task. It is essential for utilities to start prioritizing their interventions toward water loss management.

To achieve this, utilities need data! Thus it is essential to continuously collect data from the water system to take educated actions based on field data.




FlowSmart
flowless
Real-time data collection and analytics are
ESSENTIAL
for active leak detection

Step Testing

After collecting essential data on water supply and consumption tracking, water utilities can start utilizing this data to take actionable steps and reduce water losses. The goal here is to gradually reduce search radius, that is the area within which water utilities search for leaks.

A simple yet powerful way to reduce the search area is step testing: a method where gate valves are controlled to cut water supply to selected parts of the network, then real-time water flow data is monitored to spot changes in water supply patterns. If water supply flow drops after closing a certain valve, then this would indicate the existence of water losses through pipelines downstream of the closed valve.

Repeating this simple process of closing valves and monitoring changes in water supply flow eventually helps the utility in spotting potential sources of water leaks.


A simple, affordable, yet powerful process
STEP TESTING
helps utilities to identify sources of water leaks

Continuous Monitoring

Lack of precise and continuous field data poses challenges to efficient operation and active decision-making. Appropriate data collection frequency is vital to get accurate interpretations and detect faults as soon as possible.

Manual handling and analysis of the collected data. This introduces an additional load on human resources, which can be invested more wisely if the analysis is carried out automatically.

Water systems monitoring is a continuous process. Problems and issues always emerge in water system. The best practice is to deal with these issues as soon as they emerge. This cannot be achieved without active monitoring through a smart data collection system.


Automating data
collection through a
DATA-DRIVEN APPROACH
helps in optimizing
operations & water
efficiency

Technology Scale Up

Start small, measure outcomes, learn as you go, and then scale it up!

For most utilities, introducing smart technology for leak detection and managing water networks is an intimidating process. The key here is to start: network operators can easily manage to carry out simple steps demonstrated earlier in this white paper, including step-testing.

What happens next? You would start getting materialized benefits from these simple interventions and will have a better understanding of the context and assessment of your needs. This would help you scale-up these small interventions.

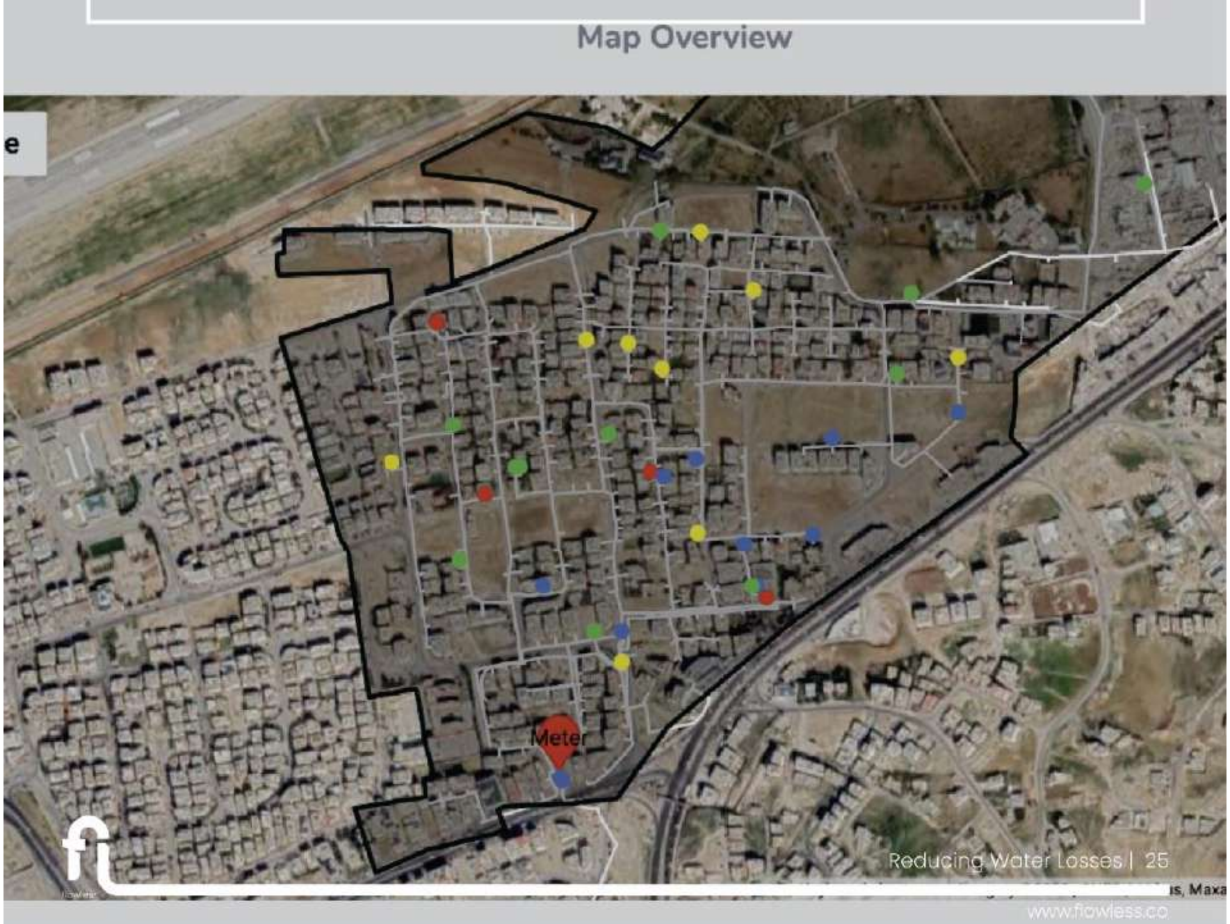
Need help throughout this process? We're here to help! Flowless supports utilities by guiding you through the process of identifying your needs, finding tailored solutions to fit your requirements, and following up with you to ensure continuous improvement.

AI-Aided Analytics

Can we get REAL benefits from applying artificial intelligence in water systems? Are the costs affordable? Sounds intimidating, right? Let's simplify it! After collecting real-time data from the field on water flow and pressure, water utilities can utilize this data to detect abnormal events in the network and take educated actions to fix issues as soon as they emerge

Flowless takes this to the next step! Flowless platform utilizes AI-aided analysis to detect leaks in water networks. A smart algorithm is used to analyze collected data, automatically detect leaks, and provides alerts.

Leaks are represented in Flowless web platform through maps where leak locations are highlighted on the water network map. Graphs and data tables are provided through customized reports.



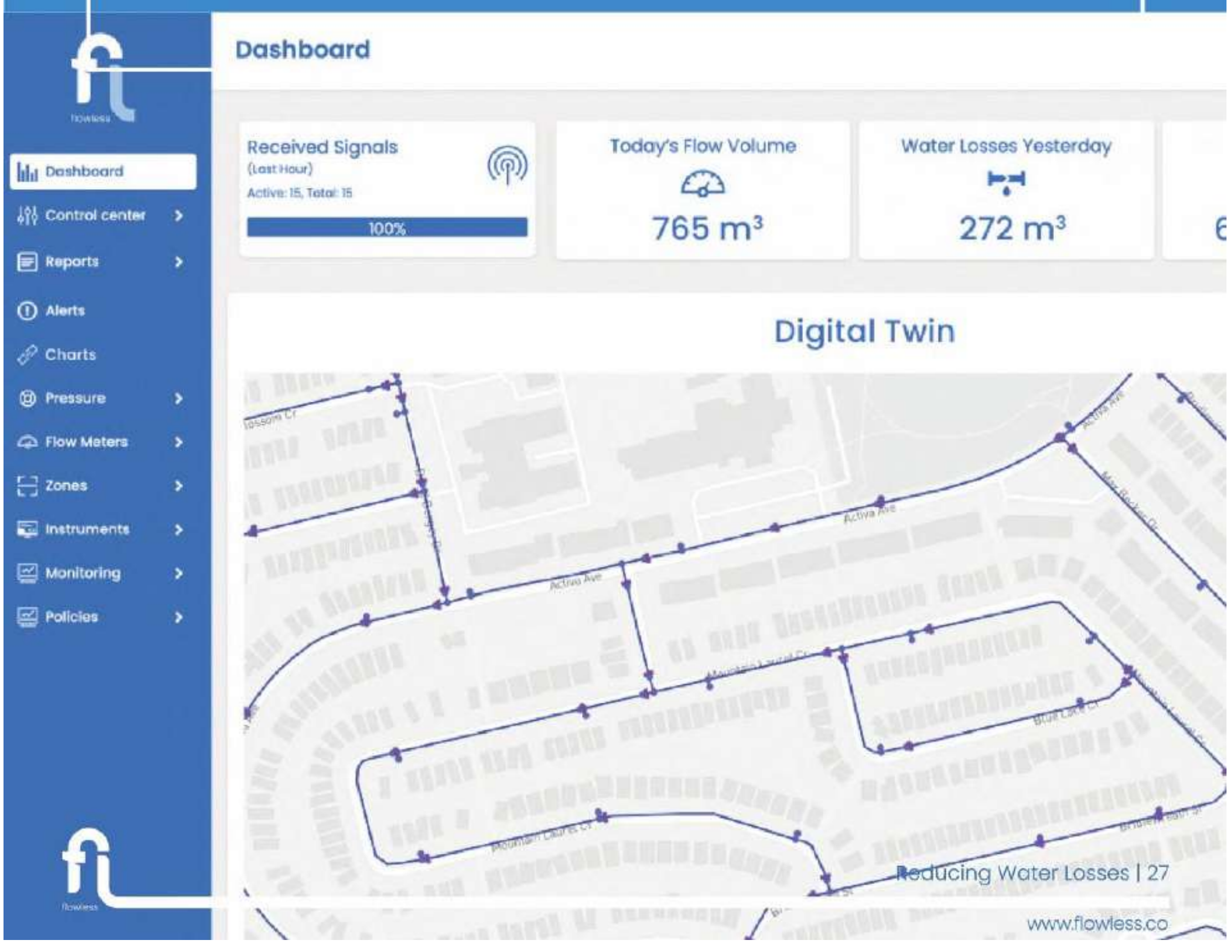

Better management of
water networks using
Artificial Intelligence analysis
to identify accurate
leak locations and
predict potential issues
flowless
FlowSmart
data transmitter
www.flowless.co
+970569757122

Digital Twins

How can digital twins help water systems operators run their systems efficiently, minimizing losses and improving services for communities?

Water utilities are increasingly counting on digitization in their pursuit to overcome emerging challenges in the water and wastewater sector. Digital Twins provides a full package of services that supports an accurate assessment and active interventions for improved operations and assets life cycle management.

You can think of it as fledged dashboard for monitoring and control of your water network, including real-time assessment, operations control, and process automation. Smart analytics, continuous monitoring, and predictive assessment enable municipalities to be one step ahead of emerging issues by predicting them and automating interventions based on operational scenarios.



Reducing Water Losses | 27

www.flowless.co


Combining powerful tools with real-time data to
build predictive models
to simulate events and produce mitigations scenarios

Affordable & Handy Solutions

Technology adoption can be more attainable through agile deployment and innovative financing. Let us help you through the process!

The capital investment needed for deploying technology solutions can be intimidating, especially for small-scale water utilities. The key here is to make these technologies more affordable through innovative financing mechanisms.

So how can utilities meet their most demanding goals?

Do utilities really care about fancy technology? OR do you want a solution that really works, a solution that generates high impact FAST!

Utilizing alternative payment modalities like performance-based contracts and lease contracts distributes the costs over a long period of time while ensuring a more positive impact and feasible operations.

We've simplified the process: You have a problem, we have the solution. Let us know how we can help you navigate the process of smart networks management!

Interested? Reach out to book a demo and get hands-on advice.


flowless
Sustainable Water Technology
Reach out for more details on smart water management and losses reduction technology
info@flowless.co
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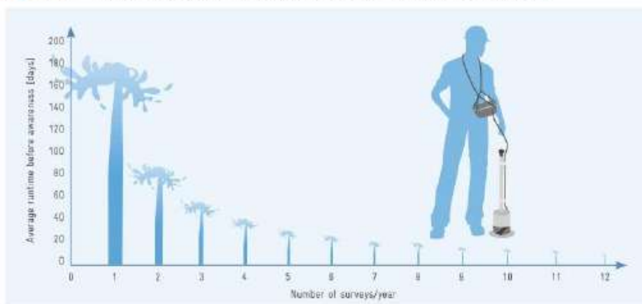
3.2 – Active Leakage Control (ALC)

6.5 Active leakage control (ALC)

6.5.1 Definition and purpose of active leakage control

Active leakage control is an intervention method to counteract real water losses in which a water utility deploys funds, personnel and technical equipment to actively detect and repair leaks that are currently running undetected into the ground. [77] The main purpose of ALC is to reduce the runtime of hidden leaks in order to minimise real water losses. *Figure 6.19* shows how regular surveys influence the awareness time for new leaks in a distribution network or DMA.

Figure 6.19 Effect of the number of surveys on awareness time for new leaks [58]



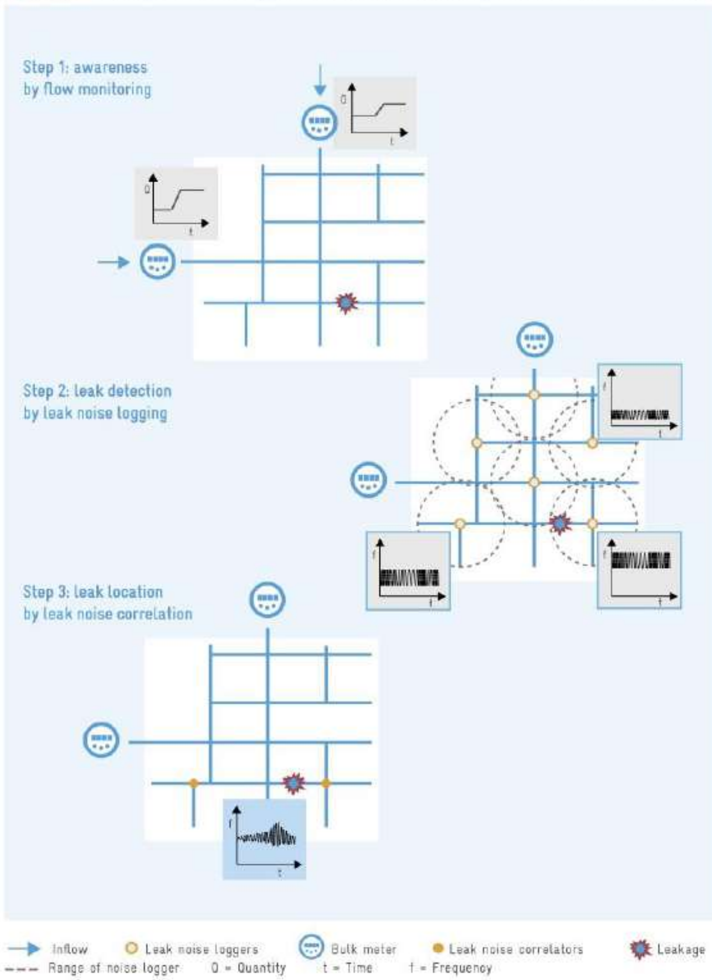
The process of ALC can be divided into three major steps:

1. Awareness: continuous monitoring and analysis of flows is essential to gain awareness of new leaks at an early stage. DMAs and PMAs provide a good opportunity to monitor discrete areas of the water distribution network and facilitate early awareness of even small leaks.

2. Leak detection: this is the process of narrowing down leaks to a certain area of the network or to a certain pipe section. Options include subdividing DMAs by temporarily closing valves (step testing), using leak noise loggers or conducting sounding surveys.

3. Leak location: various acoustic and non-acoustic methods are available for pinpointing leaks: listening sticks, ground microphones, leak noise correlators, ground radar and gas injections, to name a few. Thorough leak detection is a precondition for efficient leak location efforts.

Figure 6.20 Example of three-stage active leak control: awareness, leak detection and leak location



6

To implement efficient leak detection and location efforts, it is important to ensure that leak detection workers are equipped with accurate and up-to-date maps of the system and its components. Most acoustic leak location technologies depend on the availability of precise information about pipe material, diameter and length. Poor input information leads to incorrect leak location which results in cumbersome and needless excavation works, known as dry holes.

6.5.2 Awareness methods

Three main methods are available to gain early awareness of new leaks and reduce runtimes effectively: flow monitoring, pressure monitoring and noise monitoring.

Flow monitoring

Pipe breaks and bursts cause a more or less abrupt rise in the flow rate, which can be detected by constantly monitoring inflow into an open network or DMA. To this end, inflow should be monitored continuously or for at least one hour during minimum night flow conditions and should be compared to a previously measured reference value. If the increased flow rate remains stable for more than three days, the change is probably caused by a leakage and not by exceptional customer usage. *Kober* and *Gangl* describe a new approach of setting up an early warning system based on ultrasonic flow meters installed at hydraulically relevant positions in an open network. [41] Flows can thus be monitored without having previously implemented a DMA.

Pressure monitoring

Head losses in the network will also be at a minimum during the period of lowest consumption, and the overall pressure may almost reach the hydrostatic level in low leakage systems. High leakage flow rates will cause increased flow velocities and thus reduce pressure. Monitoring pressure in a network can only detect major leaks because small leakage flow rates will not significantly reduce pressure. Information from pressure monitoring may be used to prioritise work: it is advisable to commence leak detection works at the point where the maximum drop in pressure was measured.

Noise monitoring

The discharge of water from a leakage produces acoustic waves or oscillations. These acoustic waves propagate in the water column in either direction of the leakage, and can be detected by leak noise loggers which are usually installed on valves or hydrants. The acoustic waves only travel a limited range, depending on pipe material, diameter, wall thickness, pressure, surrounding ground and other factors. Therefore, a relatively dense grid of noise loggers has to be temporarily or permanently put in place. The advantage of noise monitoring is that it can be implemented and managed with few personnel because installation is simple and data can be read by a vehicle driving past the location. One disadvantage is that the intensity of noise is not directly connected to the leak flow rate, making it impossible to distinguish major breaks from less important minor leaks.

6.5.3 Leak detection methods

Three methods are at a water utility's disposal to narrow down leaks to a certain area of the network or to a specific pipe section: step testing, leak noise loggers and sounding surveys.

Step testing

Once a new leak has been identified within a DMA or open network by means of the awareness methods outlined above, the zone can be temporarily subdivided into smaller areas. Flow meters have to be installed at the inlet points of each subdivision to monitor inflow. Each subdivision can now be systematically reduced by closing off valves. A large drop in the flow rate indicates a leak in the section that just has been closed. [22] Night work is required because step testing should be executed during minimum night flow conditions. Furthermore, it usually involves service disruption for customers.

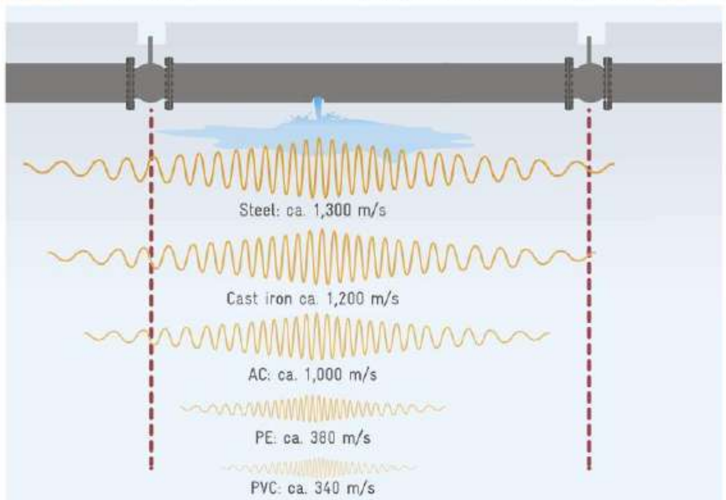
Leak noise loggers

Once a new leak has been identified, the leak detection team may place leak noise loggers at the strategic points of the network to determine the leak's approximate location. Leak noise loggers are compact units consisting of an acoustic sensor (accelerometer) and a programmable data logger. [28] When assigning the loggers, it has to be considered that sound wave propagation is significantly influenced by the predominant pipe materials used in a water distribution network *(see Figure 6.21 on the next page)*. The range between two leak noise loggers may be up to 200 m in predominantly metallic networks, while the range may decrease to 80 m in networks with large amounts of PE and PVC pipes. Internal concrete lining may also weaken the quality and propagation of acoustic waves. [33]

Noise loggers can be broken down into two groups: (1) noise sensors which usually have a magnetic base to facilitate their installation on valves, hydrants or fittings and (2) hydrophones, which are microphones inserted into the pipes in order to have direct contact with the water and to take advantage of better acoustic waves propagation in the water column.

Noise loggers can be programmed to monitor system noise between 2 and 4 am when interfering ambient or consumption sounds are at a minimum. [77] The leak will be closest to the noise logger where the highest intensity of noise has been recorded.

Figure 6.21 Relationship between material and propagation of acoustic waves, based on [33]



Sounding surveys

Sounding surveys involve listening for leak noises directly at valves, hydrants and stop-taps of service connections or at the surface above the pipe alignment. [22] Sounding is usually executed with listening sticks (simple mechanical sticks or electronically amplified sticks with a microphone and a headset) or ground microphones. The sounding survey is an effective, but time-consuming method because practically every valve has to be accessed. Stop-taps, in particular, should be sounded because a good portion of leakage occurs from service connections. The shorter the distance between single soundings, the better the chances of receiving even weak acoustic waves from a leakage. The success of acoustic surveys often depends on the experience and the skilled ears of leak detection workers. [33]

6.5.4 Leak location methods

Once the approximate area of a leak has been determined, leak location methods should be used to find the exact location (± 1 m) in order to reduce excavation efforts. Several acoustic methods can be performed, for example listening sticks, ground microphones, and leak noise correlation. If acoustic methods are unsuccessful, several non-acoustic methods are also available.

Supplementary materials 6.4

Leak detection and location methods

Listening sticks and ground microphones

Water flowing out of a leak under high pressure causes vibrations in the pipe and the surrounding soil. This vibration is transmitted along the pipe as structure-borne noise and in the surrounding underground as ground-borne noise. Making direct contact between a listening stick and the pipe at valves or hydrants allows structure-borne noise to be heard, provided that it is loud enough and distinguishable from background noise. Amplifying the noise with an electro-acoustic microphone allows leak noise to even be detected in PE and PVC networks with unfavourable acoustic propagation characteristics. Having identified the pipe section between two valves where the leak is located, the pipe alignment should be surveyed for ground-borne noise by means of a ground microphone. For this purpose, the microphone, which is protected against traffic noise and wind by an isolated housing, is placed above the pipe on the surface at intervals of one or two meters until the exact position of the leak has been identified. [3]

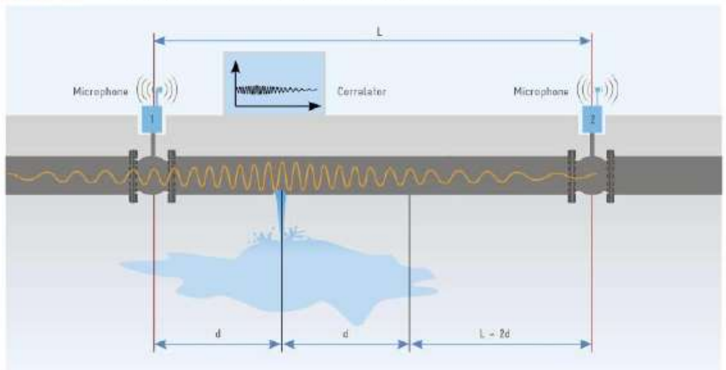
Leak noise correlation

Correlation is a mathematic method for calculating the time delay between two signals emitted from the same source. In practice, two microphones are attached to a valve or a hydrant at both ends of a pipe section. The microphones are equipped with transmitters to transfer measured results to the correlator. Acoustic waves (signals) emitted from a leakage (source) on this section of the pipe travel along the pipe and reach the microphones after a certain amount of time. The signal will first reach the microphone located closer to the leak. The correlator analyses the structure of the noise and measures the time delay Δt until a noise of the same structure is recorded at the second microphone. The use of correlation is thus impossible if the signal is too weak to reach both microphones.

6

The correlator is able to calculate the exact position of the leakage by means of *Equation 6.1 on the next page* considering the time delay Δt between the two microphones, the length of the pipe section as well as pipe diameter and material.

Figure 6.22 Schematic illustration of the functionality of leak noise correlators



Equation 6.1

$$d = \frac{L - v \times \Delta t}{2}$$

Where:

d	[m]	Distance from the leak to microphone 1
L	[m]	Length of pipe section
Δt	[s]	Time delay
v	[m/s]	Acoustic wave propagation velocity

Precise input information about the pipe material, diameter and length, e.g. from the network register, are essential for producing correct results for the leak noise correlator.

Non-acoustic methods

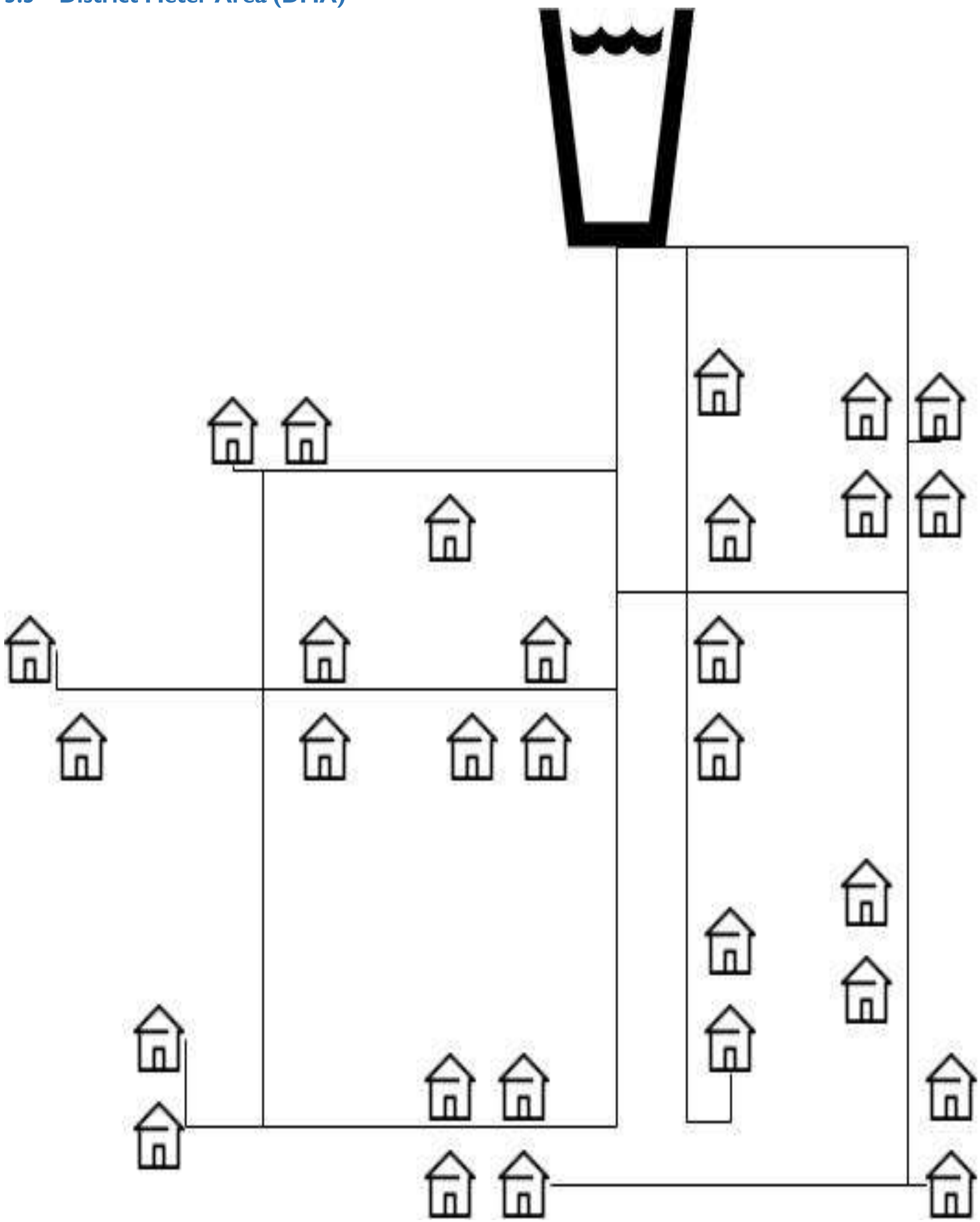
The methods described above can detect leaks which produce a certain amount of noise. Other methods have to be applied if the emitting water does not generate an audible sound, or if acoustic waves are absorbed by the pipe material.

→ **Tracer gas:** the pipe section to be surveyed has to be taken out of service and isolated by closing off valves. Helium or hydrogen gas is then injected into the isolated pipe section. Gas escaping through the leaks permeates to the surface and can be detected by using gas detectors. [77]

- → **Ground penetrating radar (GPR):** GPR is a reflection technique which uses high frequency electromagnetic waves to acquire subsurface information. The radar waves are reflected by changes in the subsurface material or conditions. Leakage can thus be identified by either finding underground voids created by the emission of water or by detecting anomalous changes in the properties of the surrounding material due to water saturation. [19]

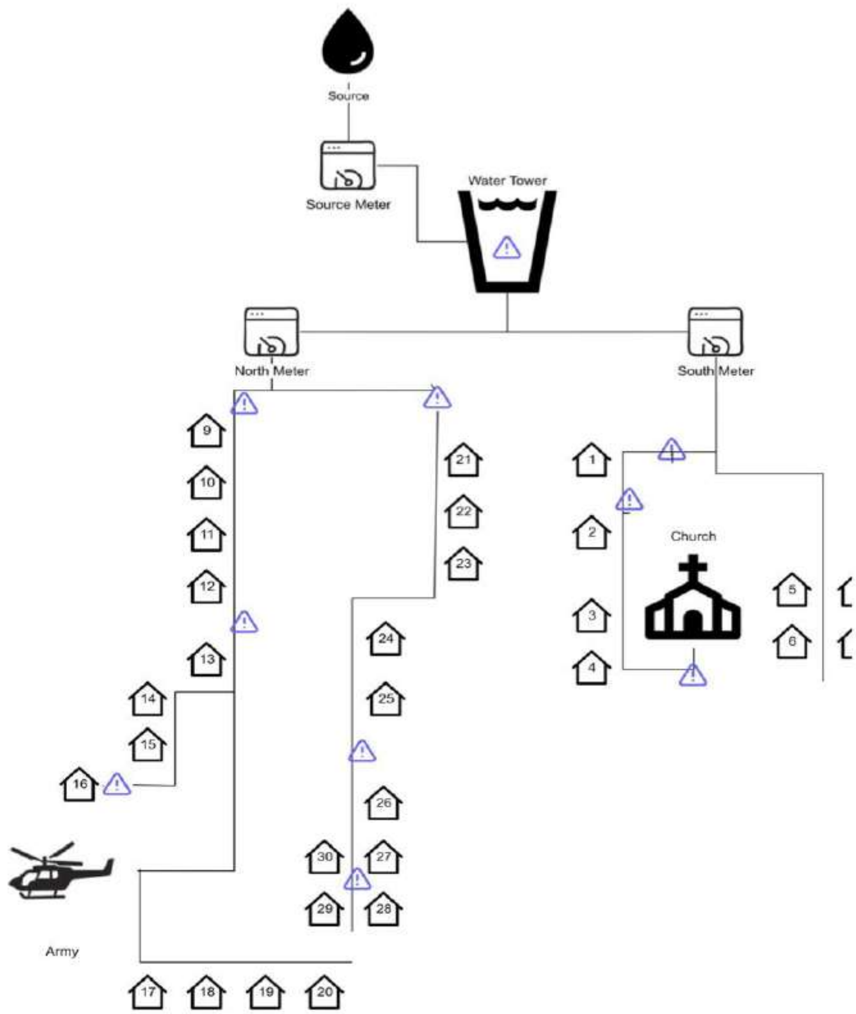
Non-acoustic leak location methods like tracer gas usually require especially skilled personnel and also involve great effort. Nevertheless, they may be a viable alternative to acoustic methods in networks with very low pressure, intermittent supply or for locating hard-to-find background leakage.

3.3 – District Meter Area (DMA)



3.4 – Meter Data

Code	Item	Monday	Wednesday	Friday	Subscription		Revenue
	Source Meter	199,841	200,049	200,143			
	North DMA Meter	150,953	151,058	151,131			
	Overflow	-	80	81			
	South DMA Meter	48,888	48,911	48,931			
	Leak	-	2	1			
1	Nadia Abi Khalil	7,228	7,228	7,233	Volumetric	LBP	50,000
	Theft	-	6	10			
2	Rami Moussa	3,543	3,546	3,547	Volumetric	LBP	40,000
	Church	3,404	3,406	3,408	Unbilled	LBP	-
3	Aya Khoury	5,036	5,036	5,038	Unbilled	LBP	-
4	Samir Kanaan	4,351	4,351	4,352	Volumetric	LBP	10,000
	Leak	-	3	1			
5	Nada Kassar	7,161	7,164	7,164	Volumetric	LBP	30,000
6	Ali Hassan	7,013	7,014	7,016	Volumetric	LBP	30,000
7	Lara Chahine	8,295	8,296	8,297	Volumetric	LBP	20,000
8	Tarek Haddad	2,857	2,859	2,864	Volumetric	LBP	70,000
	Leak	-	3	1			
9	Mariam El Khoury	9,691	9,691	9,694	Volumetric	LBP	30,000
10	Josephine Saliba	9,224	9,226	9,231	Flat	LBP	50,000
11	Omar Farhat	6,024	6,024	6,027	Volumetric	LBP	30,000
12	Maya Fakhoury	3,454	3,455	3,460	Volumetric	LBP	60,000
	Theft	-	8	5			
13	Jad Zeidan	8,836	8,838	8,839	Volumetric	LBP	30,000
14	Dania Abou Rizk	3,784	3,786	3,790	Volumetric	LBP	60,000
15	Elias Haddad	4,182	4,183	4,184	Volumetric	LBP	20,000
	Inaccuracy	-	1	1			
16	Sarah Khalifeh	8,298	8,299	8,303	Volumetric	LBP	50,000
	Lebanese Army	31,731	31,774	31,789	Unbilled	LBP	-
17	Hassan Saadeh	1,259	1,259	1,260	Volumetric	LBP	10,000
18	Nabil Daher	6,752	6,753	6,757	Volumetric	LBP	50,000
19	Rami Moussa	3,543	3,546	3,547	Volumetric	LBP	40,000
20	Antoine Maalouf	2,624	2,627	2,632	Volumetric	LBP	80,000
	Theft	-	17	6			
21	Rania Sarkis	3,060	3,061	3,066	Volumetric	LBP	60,000
22	Pierre Semaan	5,731	5,734	5,738	Flat	LBP	100,000
23	Maya Harb	8,120	8,120	8,125	Volumetric	LBP	50,000
24	Michel Chidiac	5,306	5,309	5,314	Flat	LBP	200,000
25	Lina Abou Jaoudeh	9,590	9,590	9,595	Volumetric	LBP	50,000
	Leak	-	2	1			
26	Georges Sader	2,264	2,264	2,269	Volumetric	LBP	50,000
27	Ahmed Khalil	4,272	4,275	4,280	Volumetric	LBP	80,000
	Leak	-	2	2			
28	Fatima Ali	6,681	6,682	6,682	Unbilled	LBP	-
29	Mohammad Hassan	3,562	3,564	3,567	Flat	LBP	100,000
30	Aisha Ahmad	2,965	2,965	2,966	Volumetric	LBP	10,000
		199841	199966.5	200060.5		LBP	1,460,000


Source
Source Meter
Water Tower
North Meter
South Meter
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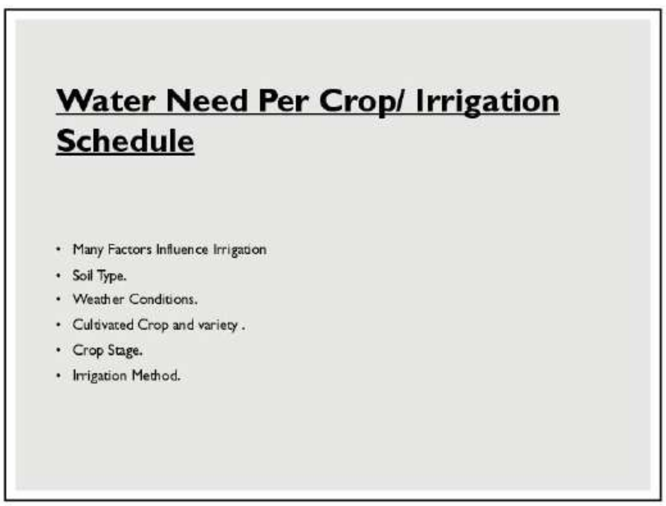
Church
Army

Annex 4 – Innovative Technologies in Irrigation

5/25/23

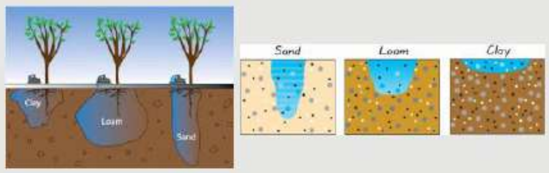
1



2

1

Relation between irrigation and Soil Type



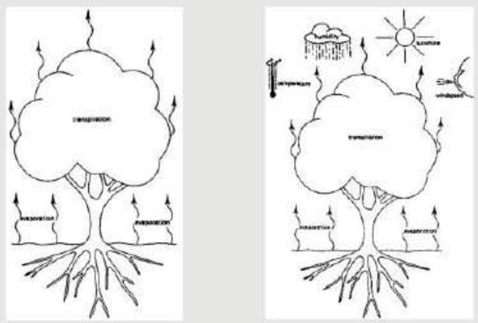
3

Relation Between irrigation and Soil Type

- Light Soil:
- Increase Emitters Number.
- Use of Low Flow Rate Emitters.
- Decrease time of Irrigation with Short Irrigation Interval.

4

Relation Between Irrigation and Weather Conditions



5

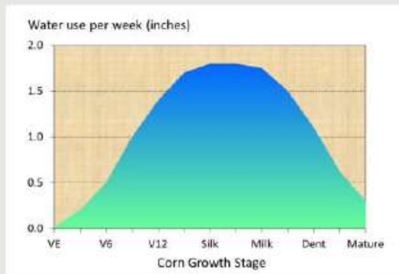
Relation Between Irrigation and Weather Conditions

Crop Water Need		Weather Conditions
Low	High	
Cloudy	Sunny	Sun Waves
Cold	Hot	Temperature
Humid	Dry	Humidity
Low	High	Wind Speed

6

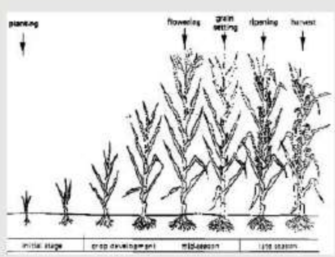
5/25/23

Relation Between Irrigation and Crop type and Crop Stage



7

Relation Between Irrigation and Crop type and Crop Stage



8

4

Crop Water requirement related to Evapotranspiration

- It is very necessary to determine water requirement for the cultivated crop in order to know how much water must be delivered per day.
- Water requirement is calculated by using the following formula:
- $ETc = Kc * ET0$

9

Crop Water requirement related to Evapotranspiration

- Etc: is the crop water need expressed in mm/day.
- Kc: crop factor, it depends on crop type, growth stage of the crop (there is 4 stage for each crop: initial stage, crop covers 10% from ground – development stage, crop covers 70 to 80% from ground – mid season stage, starts from the end of crop development stage and ends at maturity – late season stage starts at the end of mid season stage and lasts until the last day of harvesting), and climate..
- ET0: is the reference evapotranspiration. Usually this coefficient is available at the metrology station of the area. The ET0 can be taken from the cropwat software belonging to FAO.

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Practical example considered as reference

- Crop: Maize.
- Total growing period: 150 day as average.
- Approximate duration for each growth stage: initial = 25 day – crop development = 40 day – mid season = 50 day – late season = 35 day / total = 150 day.
- Kc values for maize at the various stage: initial = 0.4 – development = 0.8 –mid season = 1.15 – late season = 0.7 (those numbers are given by the literature).
- Planting date (referring to farmers on paragraph 6-2): 15 February.
- ET0 (according to cropwat) are: February = 4.09 mm/day - March = 5.18 mm/day - April = 5.36 mm/day - May = 5.95 mm/day - June = 6.82 mm/day - July = 6.59 mm/day.

11

Practical example considered as reference

- <u>Estimated dates to each stage according to data listed above:</u>
- Initial stage = 25 day estimated date will be: 15 February – 9 March.
- Development stage = 40 day estimated date will be: 10 March – 19 April.
- Mid season stage = 50 day estimated date will be: 20 April – 9june.
- Late stage = 35 day estimated date will be: 10june – 14july.

12

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Practical example considered as reference

- To note that Kc has to be calculated on monthly base. So on our example we can see that March has 9 days for a KC of initial stage = 0.4 and it has 21 day for a Kc of development stage = 0.8
- Then March's Kc will be: (9/30)*0.4 + (21/30)* 0.8 = 0.12 + 0.56 = 0.68
- Now by applying the same calculation for all month, Kc on monthly basis will be as following
- February Kc = 0.4
- March Kc = 0.68
- April Kc = 0.92
- May Kc = 1.15
- June kc = 0.84
- July kc = 0.7
- <u>Now we can calculatethe crop water need on monthly basis:</u>

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Practical example considered as reference

- ETc = Kc * ET0
- February: ETc = 0.4 * 4.09 * 30 = 49 mm/month
- March: ETc = 0.68 * 5.18 * 30 = 106mm/month
- April: ETc= 0.92 * 5.36 *30 = 148mm/month
- May:ETc = 1.15 * 5.95 * 30 = 205 mm/month
- June:ETc = 0.84 * 6.82 * 30 = 172 mm/month
- July: ETC = 0.7 * 6.59 * 30 = 139 mm/month
- It is assumed that all months have 30 days.

14

7

Practical example considered as reference

- the highest ETC is for May with Etc = 205 mm/month.
- So the highest amount of water for maize per day is at May for Etc = 6.8333 mm/day.
- This means 68333 liter/day/Ha.
- With drip irrigation then efficiency will be 90 % and quantity of water will be:68333/0.9 = 75925 liter/day/Ha.

15

Practical example considered as reference

- After we determine:
- water availability per day.
- Area to be irrigated

- Then we can set the irrigation schedule and the interval between each shift of irrigation

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Practical example Apple

- Crop: Apple.
- Total growing period: 220 day as average.
- Approximate duration for each growth stage: initial = 30 day – crop development = 50 day – mid season = 110 day – late season = 30 day / total = 220 day.
- Kc values for Apple at the various stage: initial = 0.45 – development = 0.7 –mid season = 0.95 – late season = 0.7 (those numbers are given by the literature).
- Blooming: 1 April.
- ET0 for April is 6.3.

17

Practical example Apple

- <u>Estimated dates to each stage according to data listed above:</u>
- Initial stage = 30 day: estimated date will be: 1 April – 1 May.
- Development stage = 50 day: estimated date will be: 1 May – 20 June.
- Mid season stage = 130 day: estimated date will be: 21 June – 10 October.
- Late stage = 30 day: estimated date will be: 11 October – 11 Nov.

18

Practical example Apple

- To note that Kc has to be calculated on monthly base.
- Then April's Kc = February Kc = 0.4
- May Kc = 0.7
- June Kc = (20/30*0.7)+(10/30*0.95)
- July Kc = 0.95
- August kc = 0.95
- September kc = 0.0.95
- October KC = (10/30*0.95)+(20/30*0.7)
- November KC = 0.7
- <u>Now we can calculate the crop water need on monthly basis:</u>

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Practical example Apple

- ETc = Kc * ET0
- April: ETc = 0.45 * 6.3 * 30 = 85.05 mm/month
- 85.05 mm/month = 85050 ltr / dunum / month
- It is assumed that all months have 30 days.
- With drip irrigation then efficiency will be 90 % and quantity of water will be: 85050/0.9 = 94500 liter/month/Du.

- NB: Same calculation will be applied for other months by using ET0 of each month.
- Irrigation duration will be adjusted according to flow rate/hour used per tree or per dunum.

20

Practical example Apple

- After we determine:
- water availability per day.
- Area to be irrigated

- Than we can set the irrigation schedule and the interval between each shift of irrigation

21

Practical example Eggplant

- Crop: Eggplant.
- Total growing period: 140 day as average.
- Approximate duration for each growth stage: initial = 30 day – crop development = 45 day – mid season = 40 day – late season = 25 day / total = 140 day.
- Kc values for Eggplant at the various stage: initial = 0.6 – development = 0.8 –mid season = 1.05 – late season = 0.9 (those numbers are given by the literature).
- Planting date : 15 March.
- ET0 March = 5.8 mm/day

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Practical example Eggplant

- Estimated dates to each stage according to data listed above:
- Initial stage = 30 day estimated date will be: 15 March – 15 April.
- Development stage = 45 day estimated date will be: 16 April – 30 May.
- Mid season stage = 45 day estimated date will be: 1 June – 15 July.
- Late stage = 25 day estimated date will be: 16 July – 10 August.

23

Practical example Eggplant

- To note that Kc has to be calculated on monthly base.
- Then March's Kc will be = 0.6
- April Kc = (15/30*0.6)+(15/30*0.58)= 0.7.
- May Kc = 0.8
- June Kc = 1.05
- July Kc = (15/30*1.05)+(15/30*0.9) = 0.975.
- August kc = 0.9
- Now we can calculate the crop water need on monthly basis.

24

Practical example Eggplant

- ETc = Kc * ET0
- March ETc = 0.6 * 5.8 * 30 = 104.4 mm/month
- 104.4 mm/month = 104400 ltr/dunum/month

- With drip irrigation then efficiency will be 90 % and quantity of water will be: 104400/0.9 = 116000 liter/month/Du.

- NB: Same calculation will be applied for other months by using ET0 of each month.
- Irrigation duration will be adjusted according to flow rate/hour used per tree or per dunum.

- It is assumed that all months have 30 days.

25

Practical example Eggplant

- After we determine:
- water availability per day.
- Area to be irrigated

- Than we can set the irrigation schedule and the interval between each shift of irrigation

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Practical example Apricot

- Crop: Apricot.
- Total growing period: 120 day as average.
- Approximate duration for each growth stage: initial = 20 day – crop development = 30 day – mid season = 50 day – late season = 20 day / total = 120 day.
- Kc values for Apricot at the various stage: initial = 0.45 – development = 0.7 –mid season = 0.9 – late season = 0.65 (those numbers are given by the literature).
- Blooming: 1 April.
- ET0 for April is 6.3.

27

Practical example Apricot

- <u>Estimated dates to each stage according to data listed above:</u>
- Initial stage = 20 day: estimated date will be: 1 April – 20 April.
- Development stage = 30 day: estimated date will be: 21 April – 21 May.
- Mid season stage = 50 day: estimated date will be: 22 May – 10 July.
- Late stage = 20 day: estimated date will be: 11 July – 30 July.

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Practical example Apricot

- To note that Kc has to be calculated on monthly base.
- Then April's Kc = (20/30*0.45)+(10/30*0.7)= 0.53
- May Kc = (20/30*0.7)+(8/30*0.9)
- June Kc = 0.9
- July Kc = (10/30*0.9)+(20/30*0.65)
- <u>Now we can calculate the crop water need on monthly basis:</u>

29

Practical example Apricot

- ETc = Kc * ET0
- April: ETc = 0.53 * 6.3 * 30 = 100.17 mm/month
- 100.17 mm/month = 100170 ltr / dunum / month
- It is assumed that all months have 30 days.
- With drip irrigation then efficiency will be 90 % and quantity of water will be: 100170/0.9 = 111300 liter/month/Du.

- NB: Same calculation will be applied for other months by using ET0 of each month.
- Irrigation duration will be adjusted according to flow rate/hour used per tree or per dunum.

30

Practical example Apricot

- After we determine:
- water availability per day.
- Area to be irrigated

- Than we can set the irrigation schedule and the interval between each shift of irrigation

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Irrigation Methods

- **Furrow Irrigation**
- **Sprinklers**
- **Drip Irrigation**

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Relation Between Irrigation Method and its Efficiency

- Drip Irrigation : 90%
- Sprinklers : 75%
- Furrow Irrigation : 60%

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Furrow - _ الري جر - الري بالتطويف

34

Sprinklers

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Sprinklers

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Sprinklers - Gun

37

Sprinklers - Gun

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Plastic Sprinklers

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Mini Sprinkler

40

Mini Sprinkler

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One of the solution for water scarcity and climatic change is : Drip Irrigation

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Advantage of Drip Irrigation

- Higher Efficiency
- Save around 50% of Water
- Decrease irrigation cost and fertilizers cost
- Decrease in fuel cost due to low working pressure
- Less diseases due to low humidity
- Less weeds

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Advantage of Drip Irrigation

- Better distribution for fertilizers, and higher efficiency (Spoon Feed).
- Avoid a high amount of water
- Decrease irrigation interval (less stress)
- There is any effect of wind.
- Agricultural techniques can be applied any time

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Advantage of Drip Irrigation

Yield Increase and Homogeneous Products.

45

Disadvantage of Drip Irrigation

- High Cost for the System
- Yearly Maintenance
- Installation of Adequate Filters

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Drip Irrigation

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Technical Info Polyethylene (PE)

❑High-Density Polyethylene (HDPE)

- **PE80 & PE100 ,PE100 : Carbon and Hydrogen are linked with closer Chain which make them more rigid.**
- **Made from Oil.**

❑Low-density polyethylene (LDPE :

- **Made From Petroleum.**
- **More Flexible than HDPE.**

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Standard Dimension Ratio(SDR)

- SDR = Diameter/Thickness .
- SDR11 = means Outside Diameter is 11 Time its thickness.
- Higher SDR , Lower Pressure.
- Lower SDR, Higher Pressure.
- Ex. SDR11 Hold Higher Pressure Than SDR17.

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Technical Pipes Info

50

Standard PE Pipe Dimensions

- 16 and 20 mm = 0.5 inch.
- 25 mm = 0.75 inch.
- 32 mm = 1 inch.
- 40 mm = 1.25 inch.
- 50 mm = 1.5 inch.
- 63 mm = 2 inch.
- 75 mm = 2.5 inch.

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Standard PE Pipe Dimensions

- 90 mm = 3 inch.
- 110 mm = 4 inch.
- 125, 140 mm = 5 inch.
- 160, 180 mm = 6 inch.
- 200, 225, 250 mm etc…

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GR Specs

- GR 16 – 4 – 40.
  - 16 = outside Diameter in mm.
  - 4 = flow rate liter per hour.
  - 40 = spacing between drippers (center to center)

❑Can u explain GR 20-2-60?

53

Tape and GR

54

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Pressure Loss

- Design of Drip Irrigation System must provide the lowest pressure loss.
- Difference of flow rate between closest dripper and farthest dripper must be less than 10%.

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Fittings and Accessories

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Fittings and Accessories

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Fittings and Accessories

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Fittings and Accessories

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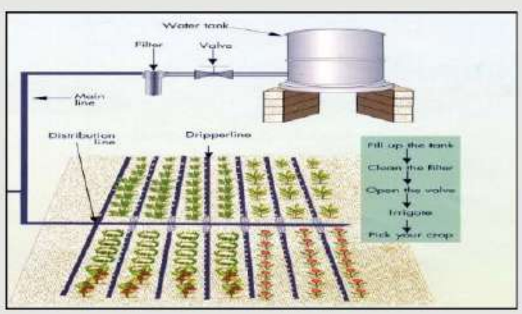
Drip Irrigation scheme



60

30

Practical Exercise

- Plot area is 50 dunum = 500*100 mtr.
- Crop is apple 4*4 mtr.
- Available water between 55000 and 60000 ltr/h.
- Water source is a well on the plot corner
- 2 laterals will be installed, 4 drippers 8 ltr/h/tree.
- Design – BOQ - Irrigation Intervals.

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Practical Exercise

- Area = 500*100 = 50000 sqm
- Spacing between trees is 4*4 = 16 mtr.
- Trees nb = 50000/16 = 3125 tree.
- Emitters nb = 3125*4 =12500 dripper.
- Total water qtt= 12500*8ltr/h = 100000 ltr/h.
- This plot can be irrigated over two shift = qtt of total needed water / qtt of available water.

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Practical Exercise

- Nb of watering shift = 100000/55000 = 1.81, so 2 shift.
- *NB: it is possible that each shift contain many valves.*

63

Practical Exercise

- Available water is 55000 ltr/h, so main line must be 110 mm (refer to annex).
- 8 sub main 63 mm each (12500 ltr/h in each sub main, laterals are 16 mm.
    - *2 irrigation shift means each 4 valve 2 inch will be opened together.*

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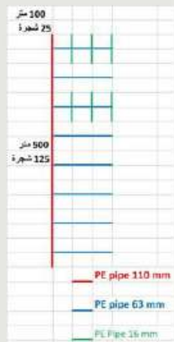
Practical Exercise



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Practical Exercise - BOQ

- PE pipe 110 mm 470 mtr.
- PE pipe 63 mm 800 mtr.
- PE pipe 16 mm 12500 mtr.
- Drippers 8 ltr/h 12500 pcs.
- Saddle 110*2 = 8.
- Nipple 2*2 = 8.
- Valve 2 inch = 8.
- Male Adaptor 63*2 = 8
- Terminal Adaptor 63 mm = 8.
- Terminal Adaptor 110 mm = 1

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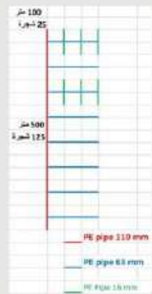
Practical Exercise - BOQ

- Double saddle 63*0.75 = 200.
- Starter 16*0.75 = 200.
- Terminal eight shape 16m = 400.
- Coupling 63*63 = 4.
- Coupling 110*110 = 4.
- Barbed connector 16*16 = 50.
- Valve 4 inch = 1
- Male adaptor 110*4 = 2.
- Fert. Tank, filters, pressure gauge etc …



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Drip Irrigation – increasing wet area

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Advantage of increased wet area

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Advantage of increased wet area

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Fruit Trees

Prediction:

Anti frost sprinklers

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Fruit Trees – Anti Frost

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Irrigation and technology

- Those tips and ideas will increase water efficiency
  - and help in saving water

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Specific Accessories Needed for drip Irrigation

- Double effect air release valve.
- Adequate Filters.
- Pressure Gauge.
- Pressure release valve.
- Check Valve.
- Pressure reducing valve.
- Fertilizers Tank.
- Tensiometers
- Volumeter and Flowmeter

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Air release valve

•**Ventilators:**
•**1", 11/2", 2"**

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Practical Info on Air release valve

- Air inside pipes block the water
- Water Hammer effect
- Vacuum effect
- Pipes can be damaged because of high pressure.
- Volumeters will not work properly.

- Air release valve size is related to pipe size and water flow.

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Installation of air release valve

- At least each 40 meter.
- At each elevation.
- On the opposite way of the check valve.
- On the beginning of the sloap
- At the end of the main line.
- Directly on the water source opening in case of sloap.

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Filters

One of the most important factors to identify filters is:

• Water Source

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Water Source

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Water Source

83

Hydro cyclones filters:

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Iron hydro cyclone filter:

[illegible]	[illegible]	[illegible]
2"	16-25 m^3/h	30 Lt
2 1/2"	20-35 m^3/h	30 Lt
3"	30-42 m^3/h	36 Lt
3"	34-50 m^3/h	36 Lt
4"	45-72 m^3/h	60 Lt
4"	70-90 m^3/h	60 Lt
5"	80-115 m^3/h	80 Lt
5"	105-140 m^3/h	80 Lt
6"	140-160 m^3/h	100 Lt
6"	160-200 m^3/h	100 Lt

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Disk or Screen Filters (Plastic or Steel)

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Semi or full self flushing filters

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Gravel Filters (Sand Media Filters)

Mushroom moss gravel filter:

- Used for filtering algae formations in the water.
- For waters acquired from lakes, channels and rivers.
- Working pressure: up to 8bar.
- Basalt is needed (2-4mm of size).

[illegible]	[illegible]	[illegible]	[illegible]
2"	18"	21	25 m³/h
2½"	18"	21	35 m³/h
3"	24"	37	42 m³/h
3"	36"	81	52 m³/h
4"	24"	37	60 m³/h
4"	36"	81	80 m³/h

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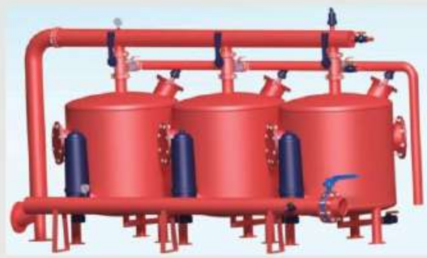
Parallel Sand Media Filters

Example of set of 3 gravel filters:



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Pressure Gauge and Pressure release valve

Pressure relief valve 2”

Pressure gauge with/without glycerin

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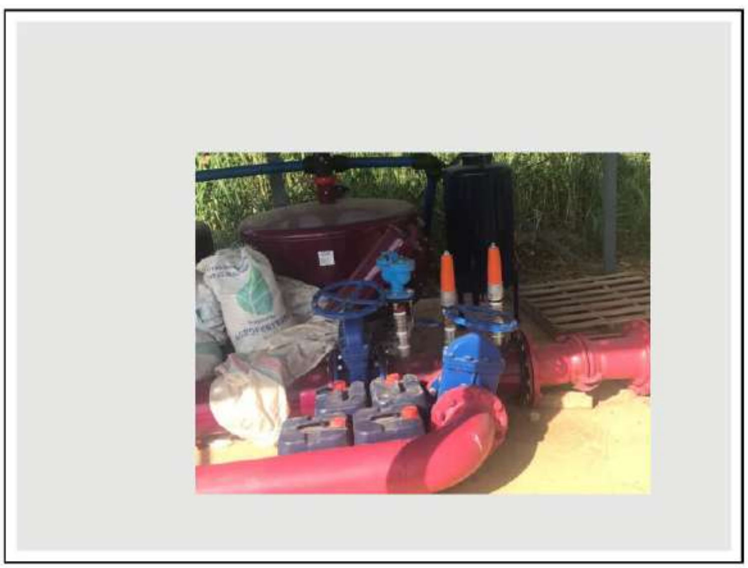

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Uses and Installation or pressure reducing valve

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Uses and Installation or pressure reducing valve

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Uses and Installation or pressure reducing valve

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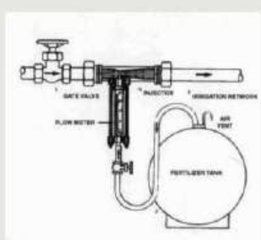
Venturi Fertilizer Injector
خلاط الفنتوري



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مضخة الجرعات (Dosing Pump)

97

(Dosing Pump)

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Fertilizers tanks

99

Fertilizers Tank

100

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Tensiometers

101

Reading Tensiometers

- 0 to 10 centibar : saturated soil.
- 10 to 30 centibar: accepted humidity.
- 30 to 60 centibar: we must irrigate.
- 60 to 100 centibar : we must irrigate in heavy soil.
- Above 100 centibar: dry soil will affect negatively the yield.

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Drip irrigation example

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Butt Welding

Technical Info

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Pipes Butt Welding

105

<u>Pipes Butt Welding</u>

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Pipes Butt Welding

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Welding of end cups and tees

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Electro Fusion

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Clean and Scrub The Pipe

110

55

111

Insert the pipe into the Fitting

112

Fix The Clamp

113

114

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Unplug the clamp after the running of cooling time

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Useful Information

- Written information on each fitting (Fusion time, voltage, cooling time)

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Useful Information

- PN Standard for fitting, doesn't matter SDR or PN of the pipe.
- Can weld pipes with different SDR.
- Requested for underground.
- Can solve fitting problem for high diameter's pipe.
- Pipe welded with EF will be fix, can not remove fittings.

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Hydroponics or NFT System

119

120

Reduce Water consumption, Fertilisers and Pesticides.
Eliminate the Risc of soil born Diseases and Nematodes.

121

Reduce 90% of water consumption in the closed Systems

122

NFT

123

References

- Robinson Agri
- Ziad Farhat
- Automat
- Jain
- Elysee

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Annex 5 – Training Evaluation form

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FROM THE AMERICAN PEOPLE

مشروع ترشيد إدارة المياه والصرف الصحي في لبنان

تقييم جودة وفعالية التدريب حول "ترشيد إدارة المياه والصرف الصحي"

انّ ردّكم على هذا الاستبيان مهم جداً في مساعدتنا على تقييم فعالية ونوعية التدريب. الرجاء الإجابة على جميع الأسئلة.

تتراوح الأرقام بين 1و 4 بحيث أن (1) يرمز الى المعدّل الأدنى و (4) الى المعدّل الأعلى.

شكرا لتعاونكم!

التاريخ:

إسم المدرّب/ـة:

عنوان ومكان التدريب:

1- محتوى التدريب / التوجيه	
هل محتوى التدريب واضح وسهل الفهم؟	1 ☐2 ☐3 ☐4☐
هل محتوى التدريب منظم تنظيماً جيداً؟	1 ☐2 ☐3 ☐4☐
هل قام التدريب بتلبية الاحتياجات الخاصة بك أو توقعاتك؟	1 ☐2 ☐3 ☐4☐
هل زادت مهاراتك / معرفتك بسبب التدريب؟	1 ☐2 ☐3 ☐4☐
هل ستكون/ستكونين قادراً /ةَ على تطبيق ما تعلمته خلال التدريب على وظيفتك؟	1 ☐2 ☐3 ☐4☐
كيف تقيّم/تقيمين التدريب ككل؟	1 ☐2 ☐3 ☐4☐

2- التيسير	
هل كان/ت المدرب/ـة ملماً/ـة بموضوع التدريب؟	1 ☐2 ☐3 ☐4☐
هل شجّع/ت المدرب/ـة المشاركة خلال التدريب؟	1 ☐2 ☐3 ☐4☐
هل قام/ت المدرب/ـة بتحضير جيّد ومنظّم؟	1 ☐2 ☐3 ☐4☐
هل قام/ت المدرب/ـة بالتواصل بوضوح وفعالية؟	1 ☐2 ☐3 ☐4☐
هل تم الرد على أسئلتك بوضوح؟	1 ☐2 ☐3 ☐4☐

3- مكان التدريب	
هل كانت غرفة التدريب والمرافقات كافية ومريحة؟	1 ☐2 ☐3 ☐4☐
هل كانت المساعدات البصرية مفيدة في فهم المواد التدريبية؟	1 ☐2 ☐3 ☐4☐

4- ملاحظات

"أصبح هذا المنشور ممكناً بفضل دعم الشعب الأميركي من خلال الوكالة الأميركية للتنمية الدولية.(USAID)
إنّ شركة DAI Global, LLC هي المسؤولة الوحيدة عن محتويات هذا المنشور والتي لا تعكس بالضرورة وجهات نظر الوكالة الأميركية للتنمية الدولية أو حكومة الولايات المتحدة الاميركية".

Annex 6 – Active Methods Used

Below is a description of the active methods used:

Active methods	Description
Brainstorming	Brainstorming is a method of generating ideas and sharing knowledge to solve a particular problem, in which participants are encouraged to think without interruption. Brainstorming is a group activity where each participant shares their ideas as soon as they come to mind.
Situational analysis	Situation analysis is basically the process of critically evaluating the internal and external conditions that affect an organization, which is done prior to a new initiative or project. It provides the knowledge to identify the current opportunities and challenges to your organization
Conceptual change	Conceptual change is a particularly profound kind of learning–it goes beyond revising one's specific beliefs and involves restructuring the very concepts used to formulate those beliefs. Explaining how this kind of learning occurs is central to understanding the tremendous power and creativity of human thought.
Conceptual map	A concept map is a diagram or graphical tool that visually represents relationships between concepts and ideas. Most concept maps depict ideas as boxes or circles (also called nodes), which are structured hierarchically and connected with lines or arrows (also called arcs).
"Future wheel" or "Problem tree analysis"	Problem tree analysis (also called Situational analysis or just Problem analysis) helps to find solutions by mapping out the anatomy of cause and effect around an issue.
Focus group	A focus group is a research method that brings together a small group of people to answer questions in a moderated setting.
Flipped pedagogy	Flipped classroom is a "pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.
Videos + discussion	
Interactive presentation	

Role play	Role-playing takes place between two or more people, who act out roles to explore a particular scenario.