



Ministry of Water & Irrigation  
وزارة المياه والري



# Decentralized Wastewater Management Policy

2016  
Jordan

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2016



This document is an integral part of the National Water Strategy, related policies and action plans

1. National Water Strategy 2016-2025.
2. Water Sector Capital Investment Program (2016-2025).
3. Water Demand Management Policy.
4. Energy Efficiency and Renewable Energy in the water sector Policy.
5. Water Substitution and Re-Use Policy.
6. Water Reallocation Policy.
7. Surface Water Utilization Policy.
8. Groundwater Sustainability Policy.
9. Climate Change Policy for a Resilient Water Sector.
- 10. Decentralized Wastewater Management Policy.**
11. Action Plan to Reduce Water Sector Losses (Structural Benchmark).



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# **1 Foreword**

This is the first statement of Decentralized Wastewater Management Policy for Jordan.

The need for establishing a decentralized wastewater management approach has been seen for some time. Indeed a decentralized wastewater management approach was envisaged in the Water for Life - Jordan's Strategy 2008-2022. Since 2012 there have been significant changes in the water sector's operational environment due to the demands associated to the overwhelming influx of dislocated population to Jordan. To expand wastewater management by implementing the practice of recycling and reusing water beyond the existing conventional wastewater service system has become imperative for the viability of our water resources as emphasized in the new National Water Strategy 2016-2025.

Jordan's water balance will benefit greatly from successful implementation of this Policy and hence this Policy will guide and direct my decisions as Minister and those of my Ministerial Colleagues. It will shape our national approach to planning, implementing and operating decentralized wastewater management infrastructure over the next decade.

The scope of this Policy is broad, reflecting the wide spectrum of decentralized wastewater management and the many tasks to be performed for successful implementation and sustainable operation. In light of an integrated water resources management approach, this Policy is carefully formulated taking comprehensive account of regulation, standards, and inter-sectorial responsibilities while maintaining the imperative of the protection of public health and water resources.

Involvement is the core principle underlying this Policy: The involvement of all concerned Government Sectors in developing this Policy, the involvement of communities in planning and implementing local wastewater solutions, and the involvement of the private sector in investment and operation and maintenance of decentralized wastewater management infrastructure.

Many substantial submissions were received to develop this Policy which have improved the final Policy in several significant respects. I am grateful to all the people and organizations who contributed to this Policy. I am particularly obliged to the member organizations and



representatives of the **National Implementation Committee for Effective Decentralized Wastewater Management in Jordan** for their formidable and outstanding work at building the core of this Policy.

The Policy induces a complex process that involves many different types of activities. It charges persons with a variety of professional and technical backgrounds – individually and collectively – with diverse responsibilities. Each person plays a distinct and important role in helping to achieve the goals set in this Policy. It is the actions and outcomes to emanate from this Policy that will ultimately make the difference.

**Dr. Hazim El- Naser**  
**Minister of Water and Irrigation**



## 2 Introduction

The national target for wastewater services as stated in the Water Sector Strategy (2016-2025) is to increase the number of people connected to sewer networks to 80% by the year 2025.

This document sets out Government Policy for the provision of decentralized wastewater management, i.e. the collection, treatment, disposal and reuse of wastewater, with the aim to fulfil the national target for wastewater services.

This Policy will be used by the decision-maker as the primary reference for deciding upon wastewater management and infrastructure projects that involve decentralized wastewater management infrastructure as defined in Section 8 below.

## 3 Integration with other Policies, Strategies and Plans

This Policy is supported by the Water Sector Strategy (2016-2025), the Wastewater Policy, the National Framework for Effective Decentralized Wastewater Management in Jordan (NICE Framework) and the document "Establishing the Post-2015 Development Agenda: Sustainable Development Goals (SDG) towards Water Security - The Jordanian Perspective" issued by the Ministry of Water and Irrigation.

This Policy is integrated with the Wastewater Treatment - National Plan for Operation and Maintenance, the Water Reallocation Policy, the Water Substitution and Reuse Policy, the Groundwater Sustainability Policy, the Climate Policy for a Resilient Water Sector, and the Surface Water Utilization Policy.

## 4 Policy Objectives

Suitable wastewater treatment is indispensable for public health, sustainable water resources and the protection of the natural environment, all of which seriously impact economic and social well-being. In the following, the Government's key objectives associated to decentralized wastewater management are outlined.

The Government's key objectives are:

**Sustainable Development** - to seek wastewater management infrastructure that allows Jordan to live within its environmental limits and that helps ensure a strong, healthy and just society balancing its environmental, social, and economic development.

**Public Health and Environmental Protection** - to meet our obligations under the National Water Strategy and the Sustainable Development Agenda by providing suitable collection and treatment systems to protect public health and limit pollution of the environment.

**Coping with Water Scarcity** - to substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater and to significantly reduce the number of people suffering from water scarcity.

**Improving Local Livelihoods** - to improve overall living conditions especially in suburban and rural areas by enhancing local water availability by seeking opportunities to recycle and reuse water resources and to recover energy and raw materials where possible.

**Water Quality** - to improve water quality of surface and groundwater by reducing pollution, eliminating dumping, minimizing release of hazardous chemicals and materials, and minimizing the proportion of untreated wastewater.

**Improving Wastewater Services** - to establish efficient wastewater services by establishing standards for network and technology performance, treated effluent quality, for the operation and maintenance of sewage networks as well as for disposal and treatment facilities.

**Public Participation** - to support and strengthen the participation and ownership of local communities in improving water and sanitation management.

**Private Sector Participation** - to seek substantial involvement of the private sector in wastewater service provision in order to improve the economic performance of the water sector.

**Adaptation to Climate Change** - to seek measures to adapt to the increasing pressures from climate change such as more intense rainfall events and greater climate variability on public sewer and wastewater treatment facilities.

## **5 Responsibilities under this Policy**

The Ministry expects all members and staff to lead by example and, wherever possible, to embrace the spirit of this Policy and to implement the practices it proposes. Day to day responsibility for the monitoring and revision of the Policy and its Action Plan will rest in equal shares with the Secretary General of the Ministry of Water and Irrigation and the Secretary General of the Water Authority of Jordan supported by the Secretary General Assistant for Strategic Planning of the Ministry of Water and Irrigation.



## **6 Monetized Benefits Accruing from Decentralized Wastewater Management**

There are a number of estimated monetized benefits accruing from decentralized wastewater management.

Foremost, decentralized wastewater management contributes significantly to alleviate water scarcity by an estimated amount of up to 64 MCM per year followed by associated improvements in groundwater protection and incremental accommodation of new growth in communities. Decentralized wastewater management system can service locations that cannot be serviced by centralized systems due to technical and financial limitations.

The annual health cost from inadequate wastewater disposal (overflowing household cesspits, return flow in sanitary pipes) that could be avoided through decentralized wastewater management are estimated at 3,757 JOD (suburb) and 2,652 JOD respectively (village) per 500 population equivalent.

Agricultural benefits (gross margins) were estimated at 679 JOD per dunum for greenhouse 173 JOD per dunum for fruit trees. Additional benefits accrue from savings for fertilizer (1,000 to 3,000 JOD per year) and avoided annual cost of cleaning cesspits is calculated to be 20,039 JOD per 500 Population Equivalent.

Furthermore, it is estimated that an investment of 50 million JOD in decentralized wastewater management infrastructure would generate up to 1,250 sustainable jobs in the water sector.

## **7 Demand Drivers for Decentralized Wastewater Infrastructure Projects**

Effectively enforced statutory requirements, such as environmental laws, administrative provisions and technical standards set to improve water resources protection and to expand the safe reuse of treated effluent, are the main drivers of establishing decentralized wastewater management.

Financial incentives, such as subsidies, tax deductions and special depreciation, can be very effective drivers for the private sector and communities to engage in planning, establishing, and operation and maintenance of wastewater infrastructure.

Additional drivers for decentralized wastewater management projects are unforeseen demographic developments causing immediate needs to extend public supply and disposal infrastructures. Decentralized wastewater management systems are flexible and can be designed to grow in modules along such demographic developments.

## 8 Definition of Decentralized Wastewater Management

A decentralized approach to wastewater management is generally most appropriate for suburban and rural communities, particularly toward the upper edge of catchments, where the costs of wastewater pumping over long distances to large centralized treatment plants outweigh the plant's potential economies of scale. Hence decentralized and centralized wastewater management approaches are complementary to each other.

This policy refers to WWTPs with a capacity of up to 5,000 Population Equivalent (PE).

However, for WWTPs with a design capacity up to **5,200** an individual assessment by the national regulator is required to determine whether the WWTP is to fall under this policy due to its technical and spatial specifications (amount and reuse of treated effluent, rural or suburban context, community participation).

Furthermore, a group of several different neighbouring WWTPs with a design capacity of up to 5,000 PE **each** is considered a decentralized wastewater management **cluster**.

The requirements for the sustainability of decentralized wastewater management infrastructure are:

- Capacities in the public and the private water sector to effectively, plan, implement and operate decentralized wastewater management infrastructures.
- Reuse standards that will enable farmers to establish healthy and profitable long-term reuse practices.
- Sound and continuous operation and maintenance of decentralized wastewater management infrastructure based on their robustness and on effective O&M schemes.
- Community ownership in the sense of taking direct and autonomous responsibility for their local wastewater solutions.
- Effectively enforced building standards that preclude infiltration of wastewater through leaking cesspits and septic tanks.
- Effectively enforced regulations that end environmentally unsafe, under-priced and partly illegal alternatives of wastewater disposal.

## 9 Policy Themes

### 9.1 Purpose of Decentralized Wastewater Management Systems

**Protection of Groundwater from pollution with untreated wastewater** - to preclude untreated wastewater from polluting groundwater by way of improper disposal of wastewater by yet unconnected domestic, commercial and industrial dischargers and entities in charge of wastewater disposal.

**Provision of cost-efficient wastewater management options** - to establish the best combination of decentralized and centralized wastewater management with the aim to provide most cost-efficient adequate wastewater collection and treatment systems covering to the best extent possible all types of wastewater management demands.

**Provision of locally available alternative water resource for safe reuse** - to provide alternative water resources for fresh water substitution especially in suburban and rural areas for local reuse.

### 9.2 Improvement of Wastewater Services

**Increase the connection rate** - to expand connection to sewerage by implementing decentralized wastewater management where centralized sewerage cannot reach due to technical obstacles or where it is less economical than decentralized sewerage.

**Cost-efficiency** - to assess decentralized and centralized wastewater management options for the development of new infrastructure with the aim to design most cost-efficient solutions for all new wastewater infrastructure that are based on dynamic cost comparison considering investment and operation and maintenance cost over the new infrastructure's complete life-cycle.

### 9.3 Enhance Private Sector Participation

The involvement of the private sector in new wastewater management infrastructure investments and O&M services shall be enhanced and expanded with the objective to strengthen performance-based, consumer-oriented, and cost-efficient operations and to alleviate the burden of the general public and the public water sector through accounting for economic feasibility (e.g. adapted business models) and financial viability (e.g. sustainability).

## 9.4 Public Participation and Community Engagement

**Awareness campaigns** - to launch awareness campaigns that address the importance of issues such as water saving, water harvesting, conserving and protecting resources from contamination. Jordanians are aware of water scarcity and associated problems and have to be made aware that water is shared by all those living in Jordan.

**Stakeholder participation** - to encourage and to effect public participation in planning, implementation and monitoring of decentralized wastewater management systems and the development of wastewater management plans on community, governorate and national level including safe reuse options, safe use of products irrigated with treated wastewater, health and hygiene, and the need for financial contribution to wastewater collection and treatment.

## 9.5 Governance and Legislation

**Regulation and Control** - to evaluate, prioritize and control public and private investment plans and project proposals for the establishment of decentralized wastewater management systems, the implementation of these plans and projects as well as the associated operation and maintenance contracts and works.

**Treated wastewater specifications and standards** - to revise and where necessary to amend existing legal provisions and standards that ensure safe reuse and economic feasibility of new wastewater infrastructure and to abrogate existing legal provisions and standards for the treatment and disposal of wastewater that are not conducive to attaining the goals of this Policy.

## 10 Qualification

This Policy provides a general appraisal for any future decentralized wastewater management project. However, this Policy is strategic in nature and does not pre-empt or replace the need for the developer or investor to conduct site-specific assessments as part of the public approval application process when the exact details of each project scheme are known.

In making decisions on wastewater systems, the decision maker must also take into consideration any local impact report submitted by a relevant local authority, any relevant matters prescribed in regulations of the water sector and any other matters which are both important and relevant to the decision at hand.

The measures to be taken for implementation of this Policy are stated in the "Action Plan on Decentralized Wastewater Management" issued by the Ministry of Water and Irrigation.

## **11 Groundwater Protection**

In addition to improving public health and reducing environmental pollution, wastewater management is most beneficial where it supports the protection of groundwater, Jordan's main fresh water resource, and in particular where it facilitates the implementation of groundwater protection zones. To realize these benefits, priority shall be given to locations where decentralized wastewater management supports the remediation of groundwater pollution from wastewater or the prevention of groundwater risks associated to wastewater.

Based on the Guidelines for Drinking Water Protection of 2011, twenty-one (21) groundwater protection zones are identified as of the year 2016, including ten (10) well fields, nine (9) springs and two (2) dams.

Groundwater protection zones are categorized into three zone types, with a different level of land use restrictions for each zone: Protection Zone I protects the dam, well or spring from direct pollution. Activities in zone 1 are limited to the operation of the dam, well or spring. Protection Zone 2 protects water resources from microbiological contamination, i.e. bacteria and viruses. Activities in zone 2 are limited to human living activities and organic agriculture. Protection Zone 3, protects the water resource's catchment area by controlling its developmental, industrial, and agricultural activities.

Despite the positive effects of wastewater management for groundwater protection from collateral pollution, e.g. leaking cesspools, new wastewater treatment plants are to be planned carefully as regards to possible adverse effects on groundwater. To identify most adequate treatment sites the hydrogeological and hydrological information and where available, groundwater vulnerability maps, are to be considered.

### **11.1 Definition of Groundwater Risk Sites**

Proper application of decentralized wastewater management in support of groundwater protection requires the identification of sites where groundwater would benefit most from wastewater treatment, so-called Groundwater Risk Sites, where groundwater is being contaminated and/or is at high risk of contamination from untreated domestic wastewater.

Groundwater risk sites are defined as areas that have caused or are expected to cause contamination to the groundwater resource nearby through, e.g. leakage of wastewater from cesspools, septic tanks, or sewage networks or through inappropriate handling of wastewater.

**Table 1: Main Provenances of Contamination of Groundwater Resources in Jordan**

Main categories of pollution	Features
<b>Collateral pollution</b>	
<i>Pollution risks due to infiltration to the groundwater aquifer (known infiltration points)</i>	Potential sources of pollution such as faeces and other pollutants that may directly impact the water resource (e.g. cesspool located near water resource, leakages in the sewage network in a groundwater protection zone)
<b>Path pollution</b>	
<i>Risks along the drinking water production and supply line</i>	Potential entry of pollutants to the water supply path (e.g. eroded backfill areas of protected springs, leaking pipes or intermittent pumping).
<b>Unverified pollution</b>	
<i>Pollution risks due to unknown infiltration of wastewater to the groundwater</i>	Potential entry of pollutants due to lack of control measures (e.g. offload of sewage suction vehicle cargo in wadis)

The identification of such Groundwater Risk Sites is based on the Jordanian “Microbiological Guideline for the Quality of Raw Water for Drinking Water” issued by the Higher Committee for Water Quality in 2011. For the impact of wastewater on groundwater, agents such as E.Coli and heavy metals, are the main indicators.

The identification of such groundwater risk sites is based on the Jordanian “Microbiological Guideline for the Quality of Raw Water for Drinking Water” issued by the Higher Committee for Water Quality in 2011.

To soundly identify the risk of pollution, the following data shall be assessed:

- The quality status of all protected public and private drinking water sources, groundwater aquifers and springs (name, operator, location, pumping rates, status/volume of resource, technical description) shall be collected by Governorate. The status of the recharge area, the source productivity and its risk of pollution is based on available testing results for several years for raw water of the concerned authorities (i.e. Ministry of Health, the Ministry of Environment and the Ministry of Water and Irrigation, the Water Authority, the Jordan Valley Authority).
- Hydrological, hydrogeological data and environmental isotope data for the water resource to derive flow patterns, aquifer characteristics, and static water levels in order to identify the source of pollution based the groundwater flow, the drainage in the catchment area and the recharge zone, the degree of sewage connection and the associated potential for wastewater infiltration from leaking cesspools and networks.
- Data on water delivery services, i.e. piped water supply or by tanker, average water consumption per capita as well as water use in agriculture, for landscaping and industry.

## **11.2 Selection of Wastewater Treatment and Reuse Sites within Groundwater Protection Zones**

Due the prevalent karstic geology and ensuing high vulnerability to pollution, the establishment of wastewater treatment plants is confined to Protection Zone 3 and the location least vulnerable within Protection Zone 3 shall be selected. Furthermore, treated effluents should not be discharged in to wadis leading to Protection Zone 2.

In this context, especially land stability, flooding risk and potential negative impacts of geo-risks need to be considered. Wastewater collectors, passing through Protection Zone 2, must be directed in such a way, that they cannot cause pollution, e.g. via geo-risks (rock falls, landslides, earthquakes, tectonic movements).

For reuse of treated effluent originating from a wastewater treatment plant with a capacity of up to 5,000 population equivalents, reuse shall be performed following the quality parameters for treated effluent as suggested under Section 16 of this Policy "Regulatory specifications and programs for treated domestic wastewater from treatment plants with a capacity of up to 5,000 population equivalents".

The open discharge of treated effluent to the valleys adjacent to the Protection Zones 1 and 2 is prohibited by Article 30A/3 in Water Authority Law no. 18 of 1988 and amendments thereof.

In general, it is allowed to use treated effluent for the purposes of artificial recharge provided that the water in the aquifer is used for irrigation purposes only. Technical studies must be performed before using reclaimed water to verify that there is no effect on groundwater aquifers used for drinking purposes.

For aquifers used for drinking water supply, managed recharge of treated water is prohibited in Protection Zone 2 and 3 due to its negative impact on water resources. However, in view of the extreme and increasing water scarcity in Jordan, it is worthwhile examining each case separately and to establish exceptional cases, e.g. in Protection Zone 3, where feasible.

## **12 Economic Feasibility**

The design of technologically sound and cost-efficient wastewater solutions is a challenge for any wastewater infrastructure planner. Finding the most adequate size and configuration of wastewater infrastructure will determine the cost-efficiency of the investment as well as the expenditures for operation and maintenance throughout the system's entire operational life-time. Hence, the development of wastewater infrastructure projects should be based on comprehensible data and realistic assumptions.

In order to identify most cost-efficient wastewater management solutions and to determine whether a centralized or a decentralized approach is economically more appropriate for a specific case, the "Assessment of Local Lowest-Cost Wastewater Solutions" (ALLOWS) decision-support tool, that is specifically designed for the purpose shall be applied. The ALLOWS tool is particularly made to achieve the following:

- To develop local wastewater management solutions that can grow alongside changing demographic and wastewater conditions.
- To minimize cost for wastewater disposal by comparing the different options of sewage disposal, e.g. centralized with decentralized.
- To optimize investment costs and operation and maintenance requirements by means of generating economy of scale for local wastewater solutions.
- To design highly flexible local wastewater management solutions for fast growing conurbations.

ALLOWS generates financial indicators for different wastewater scenarios and thus enables planners and decision-makers to perform a comparative analysis to identify best solutions for the wastewater management problem at hand. Main factors that are required for finding sustainable solutions to wastewater problems are integrated in the ALLOWS analysis. These are: Current and projected long-term demographic developments, connection degree, groundwater status and vulnerability to pollution from domestic wastewater, local reuse options (land use), potential treatment technologies based on local wastewater quantity and quality, existing infrastructures (sewage networks, centralized treatment plant, cesspools/septic tanks) and geographical conditions (topography, natural drainage). With these factors different decentralized and centralized scenarios can be developed, monetized and compared.

## **12.1 ALLOWS Scenario Development and Comparison**

The ALLOWS scenarios are built based on the following operations:

- Estimation of the required treatment capacity for wastewater solutions using data that allow estimating the specific wastewater quantity and quality, population statistics and data on land ownership to project housing development.
- Identification of micro catchments on settlement scale that allow for wastewater conveyance without or with minimal pumping (gravity flow sewer networks).
- Design of urban infrastructure clusters for wastewater management scenarios.
- Estimating costs of construction, operation and maintenance (O&M) and reinvestments for different wastewater management scenarios.
- Establishment of annualized cost for each scenario and determining their cost-efficiency by means of comparison among different scenarios.



- Optimization of cluster sizes to minimize O&M cost of wastewater management systems.

The GIS-based assessment involves a geo-database, fed with geographical, urban, socio-economic, and statistical data of the area of interest. This geo-database contains satellite imaging to determine the area's physical infrastructure, the number of residents per building, land use data to identify reuse options, potential plots for wastewater treatment (e.g. undeveloped municipal land), topographical conditions, gravity flow information through combining the geo-database with digital elevation models, land ownership (e.g. parcel index), international and national benchmark prices for all cost items (treatment technology, reuse infrastructure, network construction, pump and lifting stations, operation and maintenance labour, electricity and water, etc.).

The assessment generates financial indicators for different wastewater scenarios that enable planners and decision-makers to perform a comparative analysis so as to identify best solutions for the wastewater management problem at hand. Main factors that are required for finding sustainable solutions to wastewater problems are integrated in the analysis. These are: Current and projected long-term demographic developments, connection degree to sewer networks, groundwater status and vulnerability to pollution from domestic wastewater, local reuse options (land use), potential treatment technologies based on local wastewater quantity and quality, existing infrastructures (sewage networks, centralized treatment plant, cesspools/septic tanks) and geographical conditions (topography, natural drainage). With these factors different wastewater scenarios are developed that can be monetized and compared among each other.

## **12.2 ALLOWS Cost Analysis**

ALLOWS scenarios are compared using the Total Project Value Method elaborated by the guideline of the German Association for Waste, Water and Wastewater for costs comparison of wastewater infrastructure projects. Scenarios are compared in terms of total project value and specific treatment costs calculated in Jordanian Dinar per cubic meter treated wastewater (JOD/m<sup>3</sup>) in order to reveal the economic competitiveness of the different wastewater management scenarios.

At applying the Total Project Value Method to the ALLOWS scenario analysis the cost components are total capital cost, reinvestment cost, and O&M cost. A discount rate ranging from 3% to 5% and a 25 to 30-year project period shall be assumed in order to determine the total financial scope of each solution for different macroeconomic conditions.

Total Capital Cost represents all infrastructure components, required to build a treatment system, including cost for the sewer network which is one of the main cost factors of wastewater management systems.

Total Capital Cost involves mechanical and electrical components of a wastewater treatment plant and wastewater collection and the associated civil work.

Expenses that are not directly associated with the construction of wastewater treatment plants are included as ‘other cost’ and cover land acquisition costs, cost for construction of administrative buildings, engineering design cost, overheads, profits and contingencies. For each technology in the scenarios a specific cost function is to be developed. Cost functions allow modelling of different possible wastewater treatment plant capacities and are widely used estimating cost of wastewater infrastructure. Operation and maintenance cost for all scenarios include cost for personnel, energy consumed by electrical devices (pumps, aerators, and ultraviolet lamps), and laboratory analysis as well as sludge treatment. All personnel cost are calculated in JOD/month. O&M costs should be based on actual Jordanian salaries and current energy prices in Jordan. In addition, spare parts are to be included assuming 9% of total annual O&M cost.

Reinvestment cost are calculated based on the “Guidelines for performing dynamic cost comparison” (DWA 2012), considering 40% of the construction cost for replacements in the years 12 and 25 and 60% of the construction cost for reconstruction after 25 years.

In order to compare different scenarios, the calculated total project values are annualized and the cost expressed as annual cash flow over the entire project period, i.e. 30 years. The annualized cost indicator also provides the possibility to compare scenarios by means of specific treatment cost that represent the total cost per cubic meter of treated wastewater.

### **12.3 ALLOWS Decision-Support Tool**

The ALLOWS GIS-based decision-support tool allows the following:

- Comparing different wastewater project options based on the total project value and prioritizing investment decisions based on the total project value for system’s life-time (~20 to 30 years) instead of the initial capital investment only.
- Adapting wastewater solutions to natural conditions such as topography and natural drainage in order to minimize infrastructure requirements (pumping, sewerage) and hence overall cost and risk of technical failure.
- Applying scenario analysis to compare different wastewater management options.
- Defining a treatment and reuse solution that is appropriate and feasible for the actual local wastewater context.
- Achieving the targeted connection degree alongside the projected population dynamics.
- Closing local water cycles by exploring on-site reuse opportunities (irrigation, managed aquifer recharge, landscaping, forestry) to substitute precious fresh water resources.

## **13 Urban Planning**

The lack of holistic schemes for urban planning has led to an imbalance in distributing the country's development gains. There is an urgent need to adopt a flexible urban planning to improve land management thus tackling many problems of Jordan among others the increased pressure on infrastructure and resources due to the progressive increase in population. One major aspect at that is to link urban and land use planning with infrastructure planning.

Wastewater infrastructure and urban planning need to be integrated across responsible authorities in order to manage housing development and the development of wastewater infrastructure more efficiently and sustainably. Implementation of wastewater projects are likely to face land acquisition problems as they are not included in current planning procedures for residential areas as alternative systems for often insufficient septic tank treatment.

### **13.1 Characterization of Urban Planning in Jordan**

The planning process in Jordan is considered to be highly centralized. Although the law specifically allows municipalities to execute and apply city planning, the Ministry of Municipal Affairs has already developed inclusive schemes for all of them, as it is the most competent authority in this field while municipalities usually do not have this capability. Hence, municipal councils were given limited responsibility in this regard. Planning decisions are presented through committees for public comment as a legal duty rather than an effective attempt made by the municipal council to identify the priorities and requirements of the residents.

The main problem areas of planners due to planning irresponsible of local conditions can be classified into four categories:

- Provision of infrastructure and basic services.
- Pollution resulting from urban wastes and emissions.
- Deterioration of resources.
- Creation of environmental hazards.

There is an urgent need to move away from centralized planning and for planning tools appropriate for the individual needs and resources of Jordan's municipalities. This could be achieved by the new planning law drafted in 2010.

Among other matters it envisages to link physical planning with infrastructure planning, and to develop a timetable for implementation involving an infrastructure planning system and committees at the municipal level with representatives of the relevant authorities for planning. The new planning law draft is subject to consideration since 2010.

### **13.2 Bottlenecks of Wastewater Infrastructure Planning from an Urban Planning Perspective**

The bottlenecks of infrastructure planning and sustainable infrastructure operation from an urban planning perspective are manifold and diverse and can be clustered by four groups:

1. Institutional framework
  - a. Absence of a modern and holistic law for urban planning in Jordan
  - b. Lack of clear allocation of responsibilities and funds for urban planning at responsible administrative levels and among concerned authorities (municipalities, governorates, ministries)
2. Uncontrolled expansion and migration
  - a. Uncontrolled and unplanned horizontal and vertical expansion of residential areas often distant to public infrastructure due to lack of control
  - b. External population growth (displaced persons) which results in new residential areas beyond the national planning frame (refugee camps)
3. Coordination
  - a. Inefficient or lack of coordination among public authorities in the area of land use
  - b. Land acquisition problems for establishing new wastewater treatment infrastructure as they are currently not included in residential planning schemes
4. Technical obstacles due to existing inappropriate wastewater infrastructure
  - a. Inappropriate wastewater infrastructure already in place in many rural and suburban residential areas (infiltrating cesspools) that make arguing for investment in more appropriate wastewater systems difficult.

### **13.3 Recommendations for Urban Planning**

- To stipulate and enforce a national planning law that covers all land uses and is based on state-of-the-art urban planning methods and tools.
- To establish one planning umbrella for land use and urban planning in Jordan or one existing regulatory body or the Higher Council alone to be solely responsible for urban planning.
- To entrust the planning process to planning specialists in order to consider all dimensions and state-of-the-art planning standards including the integration of all vital infrastructures, i.e. water supply and wastewater disposal, transportation, electricity, etc.
- To reduce indiscriminate expansion of cities through comprehensive development schemes and respective urban plans as well as the control and enforcement of implementation of these schemes.

## **14 Participatory Planning**

Community involvement and participatory planning are indispensable for local measures involving wastewater collection, treatment and the reuse of treated wastewater. Yet not all relevant levels of Jordan's society are closely involved in wastewater management planning. Where implemented successfully, it generates local ownership of the solution and hence sustainable, cost-efficient and environmentally sound operation. In Jordan, where centralized treatment is not always the most cost-efficient option, decentralized solutions should be explored and where feasible and socially integrated they should be implemented. Their sustainability and effectiveness, however, will be out of the hands of the central government and will depend on the local and regional actors. At that a participatory planning will be one of the keys to successful implementation.

### **14.1 Historical and Social Bottlenecks**

Due to the high increase in wastewater generation in Jordan in the 1990s wastewater treatment plants became overloaded and odour impacting communities was reported for several plants. Concern about odour and other environmental affects has persisted albeit replacements of many wastewater treatment plants by advanced systems. Therefore measures to involve the public in the planning process are required for new wastewater projects in order to secure acceptance and to mobilize local resources for their sustainability.

Participatory Planning in the area of wastewater management is yet not widely established in Jordan. Conventional wastewater projects, usually did not account for local stakeholder interests and many local communities have yet to adapt to an active role in planning processes. In order to overcome obstacles to successful implementation of new wastewater solutions, participatory planning measures require significant attention and resources. Experience has shown that the main barriers to changes in wastewater management in Jordan are the following:

Discrepancies between planning and reality: Even though willingness to pay for improved wastewater services, i.e. connection to sewer, is positively assessed, residents may be reluctant to pay for the planned wastewater infrastructure improvements even despite an established support scheme, e.g. microcredits. Affordability needs to be reconfirmed, by calculating the impacts of economic burdens from new wastewater systems on disposable household income.

Willingness to pay for new wastewater projects will be established where the community will benefit from such a system and understands well how it will improve their lives.

Cultural and religious factors influence how people view the reuse of wastewater in agriculture. It is important to know, for instance, that the Council of Leading Islamic Scholars

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in Saudi Arabia (13th session, decision no. 64, dated 25/10/1398H) issued a Fatwa in 1978 concerning the use of treated wastewater. It concludes that treated wastewater can be used even for ritual washings and drinking, provided that this poses no health risks. In 2002 another Fatwa encouraged the reuse of treated wastewater as a method of cleaning and preservation (ibid.). In 2015, Fatwa no. No.7/2015 was issued allowing the irrigation of crops with treated wastewater and their consumption, provided that this poses no risks to human health.

## **14.2 Structural Bottlenecks**

One major problem of community involvement in Jordan is the case of absentee landowners, who typically own large properties in the rural and suburban areas, but live in Amman or elsewhere. Their participation and support for participatory planning processes can be decisive when their consent is needed, e.g. for use of the land or for implementing a treatment facility close to their property.

Participatory Planning requires the investment of time and financial resources. Facilitators of such processes often have to overcome opposition and involving a community where such planning processes are new, can be very time-consuming. However, where such participatory planning is implemented successfully, it will create local ownership and will contribute significantly to the success and the sustainability of the local wastewater solution.

## **14.3 Enabling Environment for Community Involvement and Participatory Planning for Wastewater Management in Jordan**

Community involvement and participatory planning require an enabling environment that sets the stage for local planners and citizens to take and implement decisions towards improving their current living conditions. In the case of wastewater management in Jordan, such an enabling environment includes the following elements:

Element 1: A national wastewater policy that supports participatory planning processes and that embraces and clearly defines the necessary scales of wastewater management systems for Jordan, e.g. on-site, decentralized, semi-centralized, and centralized treatment.

Element 2: A national wastewater master plan that defines wastewater implementation projects for all scales, i.e. on-site, decentralized, semi-centralized, and centralized, including the allocation of financial funds for investment and O&M for new wastewater systems covering their complete life-time.

Element 3: Standards for effluent quality of treated wastewater that consider public and environmental health issues but allow for cost-efficient wastewater management for different reuse purposes as well as adequate parameters for monitoring the compliance to effluent quality requirements of the Ministry of Health, the Ministry of Environment, the Ministry of Water and Irrigation, and the Ministry of Agriculture.

Element 4: Arrangements for transferring competences and respective funds to local and/or regional authorities and communities to establish local units that are responsible for initiating and supervising the implementation of wastewater systems from the perspective of the benefitting community.

Element 5: Provision of funds (e.g. development bank loan or grant) that will enable national and local authorities and communities to prepare and induce wastewater projects.

Element 6: Provision of facilitators and trainers to implement training in order to develop the skills required on the part of municipal and regional representatives for implementing a community-led approach towards improved wastewater management.

## **15 Technology Selection**

A great many technological alternatives for wastewater treatment are available, ranging from high-tech treatment options to nature-based eco-technologies. Each technology requires specific approaches on planning, design and operation. For a particular location and effluent quality and in the absence of a technology certification procedure, it is usually difficult to select the most appropriate technology from among the set of available technologies. Factors, such as technology and site requirements and sustainability criteria, e.g. robustness and O&M requirements and their interdependencies are involved in the decision-making process.

Selecting the most appropriate technology might be difficult for decision makers in administrations, government and donor agencies, and engineering companies etc., as the extensive range of commercially available technologies challenges the personnel responsible for implementation that may not have comprehensive knowledge on comparing technology types and their individual features. This is particularly the case for technologies applied decentralized wastewater management solutions. Therefore a Technology Selection Methodology shall be applied.

### **15.1 Technology Selection for Decentralized Wastewater Management**

The selection of an appropriate treatment technology or a treatment train is a process involving a wide range of issues, such as technical, institutional, socio-economic, educational, and financial aspects.

Wastewater is a very complex and inhomogeneous media, which varies remarkably between locations, regions, and dischargers. Standard treatment solutions that ensure cost-efficiency and reuse specific effluent qualities regardless of local conditions do not exist.

Treatment technologies cannot be selected from a shelf or a textbook, and every project requires a careful selection of treatment technologies and modules suitable to the specific treatment situation.

In order to support wastewater treatment selection a technology selection approach is recommended that structures and thus reduces the process' complexity.

- Phase I: Creation of an up-to-date list of appropriate and available treatment technologies/modules for Jordan: Definition and selection of treatment modules, that in principle are suitable for the Jordanian wastewater context and are currently available on the international market.
- Phase II: Selection procedure for specific wastewater management projects: A five- step selection procedure is provided that allows to find the most appropriate treatment technologies/modules for a specific wastewater project from the technologies of the general list.
- Phase III: Recurrent revision of the general list of appropriate treatment technologies/modules for Jordan: The general list of appropriate treatment technologies/modules must be revised and adapted to new technology developments as well as to a more performance-based approach latest in the year 2020 and subsequently every 5 years. This section will provide comprehensive guidance on how such a revision may be done.

In the following, phase II, the five-step selection procedure, is presented in more detail. More information on the application of this procedure including illustrations for each step are provided in the National Framework for Effective Decentralized Wastewater Management in Jordan (NICE Framework Annex I).

## **15.2 Five-Step-Technology Selection Procedure**

The selection procedure is based on a multi-criteria decision matrix that uses a list of values in rows and columns to systematically identify, analyse, and rate technology options in order to tackle the trade off between different values (selection criteria) and to produce best options.





**Figure 1: Five-Step-Technology Selection Procedure for wastewater treatment plants with a design capacity of up to 5,000 PE**

### **Step One: Data Acquisition and Quality of Basic Technical Data**

Technology selection needs to be based on accurate input data. The following aspects need careful considerations when selecting a technology for any given wastewater infrastructure project.

The required information includes:

- Specific wastewater quality and quantity (actual and future, 10 years)
- Effluent requirements, including hygiene and public health requirements
- Peak flows and distribution of wastewater generation over 24 hours and 12 months
- Combined and separate sewer system in place or planned
- Site conditions (soil characteristics, available floor space/land, land slope, available road and power infrastructure, features of the groundwater catchment area)
- Identification of discharge points and/or local reuse options for treated effluent
- Reuse aspects (quantitative reuse requirements, quality requirements, etc.)

There is a severe risk of choosing inappropriate treatment technologies in consequence of incomplete data and/or data that does not meet the required level of accurateness or detailedness. This is often the case where necessary field and on-site investigations are not or

cannot be carried out, or where the incoming wastewater changes in quality and/or quantity due to changed conditions (e.g. refugee influx, accelerated population growth, etc.)

In cases where the required data for selecting and designing a treatment process is insufficient, it is recommended to postpone the project until the required data is available. Alternatively, a very robust treatment technology shall be selected that is able to deal with a wide range of hydraulic and quality conditions.

## Step Two: Develop and Confirm Selection Criteria

Technology selection for any wastewater project must be based on agreed, understandable and comprehensive criteria that can be evaluated and compared with each other as regards to their applicability and appropriateness for the particular wastewater project at hand and under Jordanian conditions.

For Jordan the following selection criteria best serve the current needs for developing wastewater management systems with a design capacity up to 5,000 PE. However, these criteria might not be entirely fitting a given local wastewater situation and need to be adapted according to Step 1:

**Table 2: Technology Selection Criteria for Jordan**

<b>Criterion</b>	<b>Description</b>
<b>Robustness</b>	Capability of a wastewater treatment plant to tolerate shock loads, instable electricity supply, operating errors, technical failures, changing framework conditions and other potential impacts on treatment efficiency. Operational problems are more common in rural areas and insufficient or incomplete design data can partly be compensated with robustness against changing operational conditions. Robustness is particularly important where treatment plants are not permanently manned or O&M capability is limited. The lower the number of mechanical and electrical equipment (pumps, aerators, process control, etc.), the lower the potential for malfunction. The availability of spare parts (especially when imported) significantly affects the reliability of a treatment plant.
<b>Specific Total O&amp;M Cost</b>	Cost efficiency in terms of “best performance achieved for amount of money spent on O&M”. Technologies are compared regarding their need for manpower, preventive maintenance, and energy consumption for meeting the targeted effluent standard. Cost efficiency assessment is usually done by comparing specific O&M cost of different treatment technologies in terms of JOD per cubic meter wastewater treated or JOD per population equivalent (PE).
<b>Specific Energy Cost for O&amp;M</b>	Energy consumption (or specific energy costs) of a wastewater treatment plant contributes to the overall O&M cost and is included in the criterion “Specific Total O&M Cost”. In Jordan, energy cost have been increasing during the past years and a steep increase in future can be expected. In anticipation of this, energy consumption is crucial for technology selection.
<b>Capital Cost</b>	Capital cost includes all expenses for the initial establishment of the treatment plant (design, engineering, supervision of construction, construction cost, materials, equipment, labour, financing cost, land acquisition cost). Capital (investment) costs financed by soft-loan schemes through development banks or international donors incentivize oversized high-tech solutions that produce high O&M cost.
<b>Land Requirements</b>	Space requirement (“footprint”) of a wastewater treatment plant is important, especially in Jordan where land is limited and expensive. Highly mechanized and power consuming

	treatment plants (e.g. SBR) come with relatively small footprints, while nature-based solutions (e.g. constructed wetlands) have a relatively larger footprint.
<b>O&amp;M Requirements</b>	Technologies requiring a stable power supply, skilled and experienced staff, complex process control, imported spare parts, etc. may not be preferable for local operators. There is a risk of treatment plants to fall idle following a short time of operation during which it has become evident that the operator does not have the technical and managerial capabilities to perform, or when project budgets are spent. For Jordan, simple technologies and processes that require simple O&M services are preferable.
<b>Socio-Economics</b>	Socio-economics include the willingness and affordability to pay for O&M costs through tariffs or taxes or community commitment. Awareness of environmental protection and public health among the connected population is vital as is the willingness to connect to public sewer, which is to be secured by meeting the needs of the targeted community.
<b>Local Environmental Impact, Occupational Health &amp; Safety (OHS) and Public Health</b>	Environmental impacts are adverse effects caused by the release of hazardous substances to the environment. Wastewater treatment plants may have an impact on the local environment during construction and operational life-time (odour, insects, rodents, noise, visual impacts, etc.), via discharge of treated effluent to a water body or via land application or due to failure or inadequate operation of the plant. Risks need to be assessed via a risk management in the O&M scheme. Treatment plant operation comes with certain OHS risks, such as accidents, water borne diseases, exposure to chemicals. Especially for community-based O&M solutions, minimal exposure to such risk must be ensured. Closed systems (e.g. ABR, Constructed Wetlands, etc.) are given priority over open systems (e.g. aerated tanks or ponds) that bear the risk of direct contact with wastewater and the emission of aerosols. Closed systems can be located closer to settlements as they minimize potential impacts in proximity of the plant.
<b>Sludge Generation and Quality</b>	Sludge comprises organic and/or inorganic residue from septic tanks, sewer cleaning, lake or channel dredging, or wastewater treatment. Sludge may differ in characteristics and in degree of contamination. Generation and treatment of sludge are major concerns given their potential adverse effects on the environment and public health. Hence, priority is given to technologies that produce less or no sludge (anaerobic treatment, constructed wetland) or stabilize sludge (e.g. oxidation ditch, "French" constructed wetland).
<b>Construction Requirements</b>	The quality of construction directly influences the treatment performance and the potential for environmental hazards (e.g. groundwater pollution) through leaking tanks and pipes. Some technologies require special contractor skills for, e.g. the construction of gas-tight biogas digesters, the welding of polyethylene liners, the set-up of supervisory control and data acquisition (SCADA) systems, electrical installations, and others.

### **Step Three: Develop and Confirm Weighting of Selection Criteria to Determine their Importance**

A weighting factor (ranging from 1 to 10) for each selection criterion is applied, reflecting the current importance of each criterion in comparison to the other criteria. The definition of weighting factors for selection criteria is a process that is based on sector framework conditions and experiences of the persons involved in the definition process. Application of the weighting factor is by multiplying it with its individual score.

### **Step Four: Analysis of the technology against each of the agreed and weighted criteria**

The assessment by selection criteria for every technology/module is performed by scores, ranging from zero (0) to five (5). The score (5) indicates best suitability under Jordanian

conditions, while (0) stands for “no information available”, or “not applicable”. The number of scores is limited to 6 in order to keep this approach manageable.

Scores are to be added up so that each selection criterion can be compared and ranked with respect to every technology in question in order to identify most suitable technologies.

Scores attributed to individual treatment modules should be based on past experiences, data from existing wastewater treatment plants in several countries including Jordan.

**Table 3: Scoring System for Technology / Module Assessment**

Score	Definition
5	Most favourable / suitable in Jordan or under comparable conditions
4	Favourable
3	Less favourable, but applicable under certain conditions
2	Limited efficiency / limited applicability under Jordanian conditions
1	Not suitable under Jordanian conditions
0	No information available / not applicable

#### **Step Five: Ranking of technologies according to of the technology against each of the agreed and weighted criteria**

In this step, the above scoring will be multiplied by their respective weighting factors and the weighted scores for each technology will be added up.

## **16 Regulatory specifications and monitoring programs for treated domestic wastewater from treatment plants with a capacity of up to 5,000 population equivalents**

In Jordan, there exist no specific regulation for effluent standards and monitoring schemes for wastewater treatment plants with a design capacity of up to 5,000 PE. This poses a major investment obstacle to investment in smaller, decentralized wastewater infrastructure. Many existing standards are based on those developed for urban centres and agglomerations in industrialized countries where conditions are very different from those applicable today in a suburban and rural context of developing and water scarce countries, and so are often inappropriate. Furthermore, many international standards can often not be complied with because associated technologies are too complex and expensive for the given socio-economic conditions.

High-tech solutions are more complex and delicate and require experienced staff and sophisticated process control. Such systems may not be suitable for local operators and their

technical and managerial capabilities. Furthermore, high-tech solutions also come with lower cost efficiency in terms of 'best performance achieved for amount of money spent on O&M'.

For any system of any size, environmental and public health risks need to be controlled. Adequate monitoring programs for smaller systems secure public and environmental health while exploiting the leeway to ensure efficiency and manageability of those systems.

In light of this, in 2006 the World Health Organization (WHO) has issued new guidelines for reuse in agriculture.

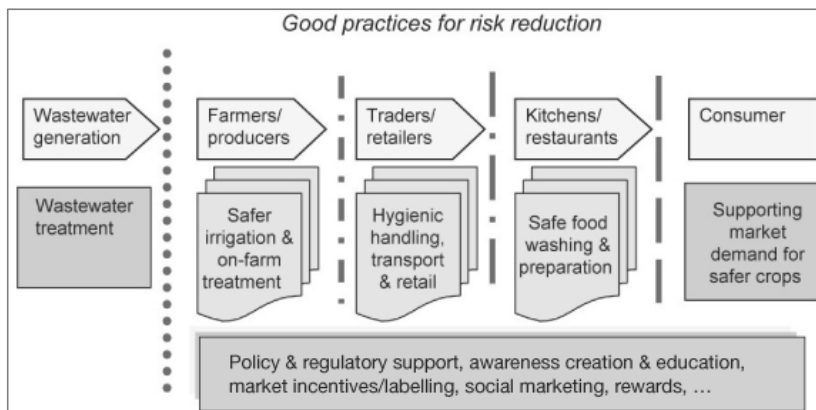
<b>WHO Guidelines 2006</b>
The health based targets apply a reference level of acceptable risk. Depending on the health-based target, E. Coli threshold value varies from 1,000 to 100,000 MPN/100 mL
Takes into account all available bacterial reduction barriers (Multi-Barrier-Approach)
Provides an integrated approach combining risk assessment and management to control water-borne diseases (Stockholm Framework)
Can be adopted and applied to suit local socio-economic conditions.

**Table 4: Summary of WHO Guidelines for Reuse of 2006**

The WHO Guidelines of 2006 are based on the principle of bacterial reduction barriers from the source of wastewater until arrival of the agricultural product to the consumer's table.

**Table 5: Pathogen Reduction from Wastewater Treatment to Irrigation**

<b>Control Measures</b>	<b>Pathogen reduction (log-unit)</b>	<b>Remarks</b>
Wastewater Treatment	1-7	Depends on wastewater treatment process
Subsurface irrigation	6	Crops of which grow above soil
Drip Irrigation (low-growing crops)	2	Root crops and crops that grow just above surface but partially in contact with the soil, e.g. lettuce
Drip Irrigation (high-growing crops)	4	Crops of which the harvested parts are not in contact with the soil, e.g. tomato, bean



**Figure 2: Multiple-Barrier Approach in the Reuse Food Chain<sup>1</sup>**

## **16.1 Proposed Effluent Standards for Treatment Plants with a design capacity of up to 5,000 PE**

To facilitate reuse of treated wastewater in agriculture throughout the country effluent standards should be designed for the particular context of decentralized wastewater treatment systems. Since the direct contact of treated wastewater with humans is restricted and a multiple-barrier approach is integrated as a treatment step, the following effluent standards imply that in many cases no tertiary treatment step for denitrification and disinfection is required. Thus, the range of potential technologies becomes much broader and treatment solutions for suburban and rural areas more affordable and feasible, as they require basic O&M and moderate and affordable monitoring efforts (costs and technologies).

In general these standards support the implementation of affordable, cost-efficient treatment systems and contribute to an improvement of the sanitation situation in Jordan.

The following effluent standard values are set for two size categories, i.e. design flow equivalent to the range of 51 to 500 PE (see Tables 6 and 7).

<sup>1</sup> Source: Sanja Ilic, Pay Drechsel, Philip Amoah and Jeffrey T. LeJeune, 2010, Applying the Multiple-Barrier Approach for Microbial Risk Reduction in the Post-Harvest Sector of Wastewater-Irrigated Vegetables, in: Wastewater Irrigation and Health Assessing and Mitigating Risk in Low-Income Countries Edited by Pay Drechsel, Christopher A. Scott, Liqa Raschid-Sally, Mark Redwood and Akiça Bahri, International Water Management Institute and International Development Research Centre, 2010.

**Table 6: Effluent values for wastewater treatment plants with a design flow equivalent to the range of 50 to 500 PE**

Criterion	Abbreviation	Unit	Maximum limit				
			Open discharge	Infiltration trench	Subsurface irrigation	Drip irrigation	Open irrigation
Chemically consumed oxygen	COD	mg/L	150	150	150	150	150
Total suspended solids	TSS	mg/L	60	50	50	50	50
Total nitrogen	TN	mg/L	70	-	-	-	-
Nitrates	NO3-N	mg/L	60	-	-	-	-
Escherichia coli	E. Coli	MPN/100 mL	1000	-	-	1000	100
pH	pH	SU	6-9	6-9			

Open discharge	Discharge in nearby streams and valleys if the discharge area is fenced
Infiltration trench	Maximum daily load = 1 m <sup>3</sup> per 10 m <sup>2</sup> , 365 days per year trees only
Subsurface irrigation	Maximum daily load 1 m <sup>3</sup> per 100 m <sup>2</sup> 365 days a year no determination on the types of plants except root crops (potatoes, carrots, etc.)
Drip irrigation	Maximum daily load 1 m <sup>3</sup> per 100 m <sup>2</sup> , 365 days a year fenced irrigation zone or with plastic mulch
Open irrigation	Maximum daily load 1 m <sup>3</sup> per 100 m <sup>2</sup> , 365 days a year

**Table 7: Effluent values for wastewater treatment plants with a design flow equivalent to the range of 501 to 5,000 PE**

Criterion	Abbreviation	Unit	Maximum Limit			
			Open discharge	Subsurface irrigation	Drip irrigation	Open irrigation
Chemical Oxygen Demand	COD	mg/L	150	150	150	150
Total suspended solids	TSS	mg/L	60	50	50	50
Total nitrogen	TN	mg/L	70	70	70	70
Nitrates	NO3-N	mg/L	60	-	-	-
Escherichia coli	E. Coli	MPN/100 mL	1000	-	1000	100
pH	pH	SU	6-9			

Open discharge	Discharge in nearby streams and valleys if the discharge area is fenced
Infiltration trench	Maximum daily load = 1 m <sup>3</sup> per 10 m <sup>2</sup> , 365 days per year trees only
Subsurface irrigation	Maximum daily load 1 m <sup>3</sup> per 100 m <sup>2</sup> , 365 days a year no determination on the types of plants except root crops (potatoes, carrots, etc.)
Drip irrigation	Maximum daily load 1 m <sup>3</sup> per 100 m <sup>2</sup> , 365 days a year fenced irrigation zone or with plastic mulch
Open irrigation	Maximum daily load 1 m <sup>3</sup> per 100 m <sup>2</sup> , 365 days a year

The parameter for TSS shall be revised and if possible eliminated within the next five to ten years.

Treatment plants servicing more than 5 and less than 50 PE shall include a secondary biological treatment step and shall meet the effluent standards for systems ranging from 50 to 500 PE but are exempted for compliance with the TSS parameter for systems ranging from 50 to 500 PE.

## **16.2 Monitoring frequency for plants with a design flow servicing less than 500 PE**

If the plant is within the borders of a groundwater protection zone 2, its owner shall monitor the plant once every six months. The environmental and health inspector shall be authorized to follow up the performance of the plant on a regular basis and at a rate of once every six months.

## **16.3 Monitoring frequency for plants servicing from 501 to 5,000 PE**

The environmental and health inspector shall be authorized to follow up the performance of the plant on a regular basis, at a rate of once every six months.

Effluent sampling analysis should be done in a accredited laboratory and shall be periodically conducted once every three months.

Once a technology certification system is established in Jordan, the monitoring frequency shall be further reduced.

## **16.4 Environmental Impact Assessment (EIA) for wastewater treatment plants with a design capacity of up to 5,000 PE**

1. Treatment plants with a design flow servicing less than 50 PE and within city limits, require a preliminary EIA only.
2. Treatment plants with a design flow of less than 2,000 PE and outside city limits require a preliminary EIA only.



3. Treatment plants with a design flow servicing more than 2,000 PE per day require a comprehensive EIA.

### **16.5 Additional Regulations for Wastewater Treatment Plants with a Design Capacity of Up To 5,000 PE to Ensure Public Health & Food Security**

- a. To avoid mixing with other partial wastewater streams, treatment plants with a design capacity of up to 5,000 PE shall receive domestic wastewater only.
- b. For the design of wastewater treatment plants with a design flow greater than 50 PE private sector entities require official approval and licenses of the Ministry of Water and Irrigation/The Water Authority of Jordan.
- c. The above standards apply to treatment plants that receive domestic wastewater from a sewage network and not to plants that receive wastewater from seepage tanks.
- d. All operators of treatment plants with a design flow servicing more than 500 PE must undergo O&M training.

## **17 Operation and Maintenance for Decentralized Wastewater Management**

A wastewater system that integrates centralized and decentralized sewage as complementary infrastructures represents a substantial transition in national water resources management. To secure the benefits of such a complementary wastewater infrastructure system (groundwater protection, reuse, fresh water substitution, improvement of sanitation) an integrated O&M strategy is needed to support future investment.

Potential models of an integrated O&M approach for Jordan include various aspects of O&M, i.e. role and responsibilities of the public and the private sector and provisions for comprehensive quality control (professional qualifications, technical standards/requirements, approval and licensing procedure, contract management, tackling of institutional and technical bottlenecks, etc.).

For Jordan, a competitive market for O&M services for wastewater systems smaller than 5,000 PE shall be created in order to outsource these services to the private sector and to alleviate the pressure of the public sector. This market shall, however, be under public control of national regulator in order to ensure that quality and due diligence are maintained.

In contrast to centralized wastewater , the permanent presence of technical personnel is usually not feasible nor required for smaller systems.

The national approach to O&M for decentralized wastewater systems shall contribute to solving a fundamental problem, i.e. wastewater disposal in a safe and affordable manner. Proper O&M services are indispensable for the sustainability of wastewater infrastructure systems in order to avoid water losses as well as health and environmental risks.

Furthermore, the cost-benefit relationship has a significant impact on achieving sustainability for infrastructure systems in general. Cost and the benefits of any wastewater system must be clear and projectable to its owner.

Servicing a number of small-scale domestic treatment plants in remote areas efficiently differs from serving semi-centralized treatment clusters and their associated networks. O&M service gaps and overlaps due to managing scattered plants/clusters and networks simultaneously shall be avoided.

Efficient and suitable O&M services need to account for different plant sizes and their respective O&M requirements in order to plan for labour and material quantities and qualities. To be able to adapt O&M schemes including schedules, material and labour to the requirements of different technologies and different reuse or disposal options of the treated effluent requires provision of different skill levels of specialized personnel and respective technical manuals.

Effective and enforced legislation and standards for construction, O&M diligence, and reuse are required. One major bottleneck is company registration at the Ministry of Trade and Industry in Jordan as it follows different categories. The subcategory "maintenance" only exist under the category "contracting". Today, any company that wants to bid for O&M tenders must be registered under constructor/contracting while there are companies in Jordan, that are registered otherwise but could be competitive providers of O&M services. The subcategory "operation and maintenance for wastewater treatment" for both main categories is needed.

Skilled operators and staff for O&M with the ability to select appropriate wastewater management systems and O&M schemes are essential to successful implementation and sustainable management of decentralized wastewater infrastructure.

A clear definition of roles and responsibilities and strong coordination among institutions/authorities is indispensable to manage decentralized wastewater management effectively.

## 17.1 Types of O&M Providers

Decentralized wastewater management is not yet established and integrated in the wastewater sector in Jordan. However, several WWTPs are operated that could be classified as decentralized wastewater systems, indicating that there is a need for establishing small-scale solutions for suburban and rural areas.

O&M for decentralized wastewater management systems, i.e. systems that comprise one or more WWTPs with a design flow servicing less than 5,000 PE, shall be established through an agreement between the Ministry of Water and Irrigation/the Water Authority of Jordan, the responsible water utility, and private sector companies. The respective contract shall be stipulated between the treatment plant owner (community, municipality, water utility, or household) and one of the above mentioned potential O&M providers. However, O&M for decentralized wastewater systems shall be controlled and monitored by public regulator and should be based on an O&M certification scheme that covers education and training for O&M of decentralized wastewater management systems.

## 17.2 Contract Options for O&M Services for Decentralized Wastewater Management Systems

Among the different contract options (see Table 8), the Full O&M Coverage Service Contract (Management Contract) is the most appropriate for establishing decentralized wastewater management systems in Jordan. A preventive service contract or an inspection service contract are not appropriate for decentralized wastewater management systems in Jordan and shall not be applied.

**Table 8: Potential Private Sector Participation (PSP) service contract models for decentralized wastewater management systems**

A: Full O&M Coverage Service Contract (Management Contract)	Provides 100% coverage of labour, consumables, parts and materials as well as emergency service, that means, comprehensive management services. Such contracts usually include comprehensive preventive maintenance for equipment and systems. Respective management capabilities and experiences need to be verified prior to assigning a company, as the contractor is completely responsible for operating and maintaining wastewater facilities and related installations. Potential contractors should be pre-qualified and the tender should be very specific about the requested O&M standards and routines. When repair and replacement coverage is part of the agreement, it is to the contractor's advantage to perform rigorous preventive maintenance on schedule, since they must replace the equipment, if it fails prematurely. In the short term (< 5 years), full-coverage contracts are usually the most comprehensive and expensive type of agreement. For longer contract periods, however, such a contract may be most cost-effective. Major advantages are ease of budgeting and risk bearing by the contractor.
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B: Full-Labour Service Contract	<p>A full-labour service contract covers 100% of the labour for repair, replacement, and maintenance of the core wastewater facilities and related installations. The facility owner is required to purchase all equipment and parts. Preventive maintenance and operation are usually part of the contract, while the actual installation of major treatment plant equipment such as pumps and control panels are typically. Risk and warranty issues usually preclude anyone but the manufacturer installing such equipment for the period specified in the contract. The cost of emergency repairs may be factored into the original contract in contrast to an agreement to responding to an incident within a defined period with the owner paying for the emergency labour separately. Some preventive maintenance services are often included in the agreement along with minor materials such as lubricants and other consumables. A full-labour service contract is the second most expensive arrangement in terms of short-term impact on the maintenance budget. Because they are responsible only for providing labour, the contractor's risk is significantly low when compared to a full-coverage contract.</p>
C: Preventive Maintenance Service Contract	<p>The preventive maintenance contract is generally purchased for a fixed fee and includes a number of scheduled and rigorous activities such as comprehensive inspections, equipment overhauls, and calibration of measurement devices and servicing of buildings. Generally the contractor provides the materials required for preventive maintenance as part of the contract. The contract may or may not include arrangements regarding emergency repairs.</p> <p>The main advantage of this contract type is that it is initially less expensive than both, the full-service and the full-labour contract, and it provides the owner with an agreement that focuses on quality preventive maintenance. However, budgeting and cost control regarding emergency repairs and replacements is more difficult because these activities are often done on a time-and-materials basis.</p> <p>With this type of contract the owner takes on most of the risk. Without a clear understanding of requirements, a facility owner could end up with a contract that provides either too much or too little service. In order to set up a preventive maintenance properly, a detailed understanding and experience of the preventive maintenance efforts is required.</p>
D: Inspection Service Contract	<p>An inspection contract, also referred to as a "fly-by" contract, is purchased by the facility owner for a fixed annual fee and includes a fixed number of periodic inspections of the wastewater facilities and related installations. However, inspection activities are much less rigorous than preventive maintenance. Simple tasks such as checking treatment plant outfalls on blockages, visual checks on fences, doors and buildings etc. are performed routinely, and for the most part inspection means looking to see if anything is broken or is about to break and reporting it to the facility owner. The contract may or may not require that a limited number of materials, e.g. vehicles, tools, etc., to be provided by the contractor and it may or may not include an agreement regarding other services such as emergency repairs. In the short-term perspective, this is the least expensive type of contract. It may, however, also be the least effective. Low cost is the main advantage to this contract.</p>

**Table 9: Evaluation of potential PSP service contract models for decentralized wastewater management systems**

<b>Description</b>	<b>A: Full O&amp;M coverage service &amp; management contract</b>	<b>B: Full-Labour Service Contract</b>	<b>C: Preventive Maintenance Service Contract</b>	<b>D: Inspection service Contract</b>
<b>Risk level for owner of treatment facility</b>	Medium to Low	Medium	High	High
<b>Risk level O&amp;M service provider</b>	High	Medium	Medium to low	Low
<b>Main compensation basis</b>	Performance	Staff input	Specified service items	Specified service items
<b>Cost level</b>	High	High	Moderate	Moderate
<b>Cost coverage by WW charges (bankability)</b>	To be assessed in detail	To be assessed in detail	Possible	Possible
<b>Overall evaluation for Jordan</b>	Most suitable	Suitable	Not suitable	Not suitable

### **17.3 Commissioning, Testing, Construction, Trial Operation and Start-up of Decentralized Wastewater Management Infrastructure**

**Quality of decentralized wastewater infrastructure** - to ensure that new decentralized wastewater treatment and reuse facilities are usable, durable and, within limits, adaptable to changing conditions (temperature, climate, hydraulic and organic load, wastewater composition).

**Appearance of wastewater infrastructure** - to ensure that new wastewater treatment and reuse facilities are aesthetic and functional and contribute to enhancing the quality of the area and increase acceptance by the community.

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