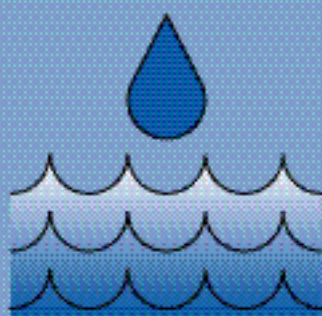


**TECHNICAL EXPERT CONSULTATION
ON INNOVATIVE WASTEWATER MANAGEMENT
FOR SMALL COMMUNITIES IN EMR COUNTRIES**

Amman - Jordan, 6 - 9 November 2000



**GUIDING PRINCIPLES AND OPTIONS
FOR
ACCELERATED EXTENSION OF WASTEWATER MANAGEMENT
SERVICES TO SMALL COMMUNITIES IN EMR COUNTRIES**



World Health Organization
Regional Office for the Eastern Mediterranean
Regional Centre for Environmental Health Activities (CEHA)
March 2001, Amman - Jordan

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Hamed Bakir,
Regional Advisor on Rural Environmental Health



World Health Organization
Regional Office for the Eastern Mediterranean
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March 2001, Amman - Jordan

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EXECUTIVE SUMMARY

Accelerated extension of wastewater management services to small communities in the Eastern Mediterranean Region (EMR) is essential to address serious concerns over water scarcity, pollution and protection of public health. Wastewater services must be developed to deliver the following benefits:

- Protect public health and well being of the communities.
- Meet the increasing demand for convenience.
- Protect the scarce water resources and the household and community environment from pollution.
- Alleviate the pressure on the scarce freshwater resources by maximizing reuse opportunities.

The costly and water intensive centralized wastewater management systems are inappropriate for small communities. The introduction of centralized wastewater systems in small communities in EMR can not be justified for the following important reasons:

- Centralized wastewater systems aggravate the water crisis. Centralized wastewater systems use excessive amounts of water to transport excreta.
- Centralized wastewater systems are costly and unaffordable especially in small communities.

Money and water are not available in EMR countries to provide centralized wastewater systems to small communities. Accordingly the needs will remain unmet and pollution will continue to consume the scarce freshwater resources.

To facilitate accelerated and environmentally responsible development of wastewater services to small communities in EMR countries, the consultation recommends shifting from the centralized wastewater management approach to a more appropriate approach that responsive to the needs and conditions in EMR's small communities. The recommended approach provides wastewater services that are:

- Robust, efficient and equally convenient.
- Cost effective.
- Environmentally responsible and responsive to the water scarcity.

The guiding principles of the new approach are:

- 1- Wastewater management solutions must be tailored to the prevailing social and cultural, economic, and environmental circumstances in small communities in EMR countries. These include: the high demand for convenience accompanied with willingness to pay; the scarcity of water resources; the low water consumption rates; and the financial constraints. Site specific conditions which must also be considered include: the water supply system and water consumption rates; population density and land use pattern; wastewater reuse opportunities and their location.
- 2- Given the water crisis in the region, wastewater must be seen as part of the total water cycle and it should be managed within the integrated water resources management processes. Accordingly :

- Freshwater should be minimally used as a transportation medium for excreta.
 - Wastewater should be viewed as a resource that must be recovered and added to the water budget.
- 3- Pollution must be retained within the smallest domain and wastes should be diluted as little as possible. Accordingly:
- Wastewater should be managed as close as possible to its source.
 - Export of waste from the generating communities should be minimized to reduce the spread of pollution and the associated costs.
 - Wastewater must be managed within the minimum practicable size (household, cluster, neighbourhood, community).
- 4- Solutions must be cost effective and must permit phased development to overcome the financial constraints while not compromising the stated objectives. Significant reduction in wastewater transportation and collection must be realized.
- 5- Wastewater management services must be planned holistically but may be implemented incrementally. Accordingly:
- Wastewater management must collectively consider waste generation, transportation, treatment, and reintegration into the water cycle.
 - Phased and incremental development of wastewater services must not compromise any of the above four guiding principles.

The main features of the new approach are:

- 1- **Incremental or phased development to overcome financial constraints.** To overcome the financial constraints faced in providing wastewater services to small communities, it is essential to develop these services in a phased manner while not compromising at any phase the stated objectives and guiding principles. Onsite systems can be improved in the first phase. A community treatment plant can be added when onsite systems become overloaded or the soil may no longer accept the effluent. The effluent from the onsite systems can initially be collected by vehicles. When financial resources become available, a network of cost effective settled sewers can be added to collect the effluent from the onsite systems to the community treatment facility.
- 2- **Decentralizing wastewater management:** Decentralized wastewater management for small communities fully satisfies the above objective without compromising the guiding principles and its wide application should be considered wherever possible. Centralized wastewater management conflicts with the majority of the guiding principles and thus its application should be avoided wherever possible.
- 3- **Reducing wastewater generation:** Wastewater flows must be reduced through comprehensive domestic water demand management interventions including awareness drives, water pricing, the use of low-volume flush toilets and other water saving devices and fixtures. Reduced wastewater flows reduces the spread of pollution, and the infrastructure requirements and cost of wastewater services.

- 4- **Improving onsite wastewater systems:** Onsite sanitation systems are the smallest decentralized wastewater sub-systems for managing wastewater as close as possible to the source of generation. Improving onsite systems is the first phase in incremental development of wastewater services. Onsite sanitation must be improved and monitored to ensure the protection of water resources and receiving environment from pollution and to ensure maximum recovery and reuse of wastewater.
- 5- **Wastewater transportation/collection only when needed:** Should the circumstances no longer allow the use of onsite wastewater management systems, the onsite wastewater management service must be upgraded and the effluent from the onsite systems must be transported and managed through a community system applying the principles of decentralized wastewater management.
- 6- **Wide application of settled sewer systems:** The well tried and robust settled sewers offer highest level of convenience at low cost and low water demand for waste transportation. Settled sewers comply with the guiding principles and offer great opportunities for faster and sustainable EXTENSION of wastewater services to small communities in EMR where water supplies are scarce. Settled sewers can be used to upgrade the overloaded onsite wastewater systems. The use of settled sewerage systems becomes appropriate not only for small communities in EMR but also in suburban development around big cities.
- 7- **Efficient wastewater treatment process for maximizing wastewater reuse opportunities:** Decentralized wastewater management requires the choice of extremely efficient, affordable, and compact wastewater treatment technologies which can be placed within or close to the human settlements without causing nuisance to the community of demanding large and space. Identification of treatment technologies for settled sewers effluent is a priority for researchers and developers.

Institutional reforms are required to encourage wider application and effective operation and maintenance of decentralized management. Like centralized systems, decentralized wastewater systems require effective operation and maintenance that must not be under estimated by planners, operators and the public. The operation and management requirements of decentralized systems vary in nature from those of centralized systems. Current institutional setup, which is geared for centralized wastewater management, can not effectively manage decentralized wastewater systems. Institutional reform must be introduced to recognize the decentralized systems and their management requirements.

Accelerated development of sustainable and environmentally responsible wastewater management services in small communities requires the adoption of rational planning processes which analyse the spectrum of available options in order to tailor the solutions to the social, cultural, environmental and economic circumstances in the target areas. To develop these planning processes, knowledge of the decentralized wastewater management options must be introduced to the policy makers, project planners and designers, project implementers, operators, and the community members through the following interventions:

- 1- Education at both undergraduate and graduate engineering schools to equip future wastewater professionals and engineers with the knowledge of the spectrum of options available for wastewater management in small communities.
- 2- Training to build the capacity of public and private sector wastewater management professionals who are engaged in the selection, development, building, and operation of small community wastewater systems.

- 3- Advocacy to increase the awareness of policy and decision makers, the public, educational institutions, engineering service providers both public and private, and donors of the spectrum of sound wastewater management options offered by decentralized wastewater management approach and to gain their support to wider consideration and implementation of decentralized management systems in small communities.
- 4- Networking to develop an informed community of researchers, educators, engineers, and policy makers who are aware of available wastewater management options for small communities, and who can act as agent of change to promote and help realize cost-effective and speedy extension of wastewater services to small communities.
- 5- Information exchange services to provide the concerned community of policy makers, educators, engineers, planners, and the public with the latest available information on wastewater management options available in order to facilitate informed decision making and to provide guidance in the development of wastewater services to small communities.
- 6- Applied research and demonstration on the available options for wastewater management in small communities in order to provide evidence and supportive information on the appropriateness of the available options for wastewater management in small communities and to refine and adapt the options to the needs of small communities in EMR countries. The research and demonstration will also provide the necessary information and evidence for the advocacy and information exchange efforts suggested above.

INTRODUCTION

Accelerated extension of sustainable and environmentally responsible wastewater management services to small communities in EMR countries is essential in order to protect public health and address concerns over contamination of the scarce water resources. The adoption of water intensive life styles, improved access to water supplies, and the population growth have brought about increased wastewater generation in the small communities of EMR. Existing traditional onsite wastewater systems, often cesspits, became overloaded and now present a major pollution source that threatens the scarce water resources and the immediate community environment. Emptying of onsite facilities is often neglected and wastewater overflows from the pits to the roads or gardens presenting a health risk to the population. An increasing proportion of surface and ground water resources in the region is being polluted mainly due to inappropriate disposal of municipal wastewater and infiltration from poorly constructed and maintained onsite sanitation facilities.

Several governments in EMR are now considering the provision of wastewater services to their small communities after providing such services to their main and secondary cities. The costly and water intensive centralized wastewater services are inappropriately introduced in small communities resulting in severe operational problems and further aggravation of the water scarcity and pollution problems.

The Regional Centre for Environmental Health Activities (CEHA) of the World Health Organization Regional Office for the Eastern Mediterranean (WHO/EMRO) deemed it necessary to identify and promote appropriate wastewater management practices to facilitate the accelerated extension of environmentally responsible and sustainable wastewater services to small communities in EMR countries under the water resources and economic constraints of the region.

WHO/CEHA convened the Regional Technical Expert Consultation on Appropriate and Innovative Wastewater Management for Small Communities in EMR Countries. The consultation was convened at CEHA premises in Amman 6-9 November 2000.

The regional technical consultation was attended by a group of 21 wastewater and environmental sanitation specialists. Experts were drawn from a wide range of national, regional and international agencies involved in environmental sanitation and wastewater management representing governmental agencies, academic and research institutions, private consulting firms, and multi-lateral agencies. Annex 1 contains the names and designations of the members of the expert group.

The specific objectives of the consultation were:

- 1- To generate a better understanding amongst the government senior planners, academics and the wastewater professionals of the social, economic, and environmental context under which the wastewater management services are developed.
- 2- To develop a strategy and principles for accelerated extension of wastewater management services to small communities under the water and economic constraints in EMR countries.
- 3- To identify appropriate wastewater management practices and technologies for implementation in small communities in EMR countries.

- 4- To identify lines of action for promotion and dissemination of the strategy by national agencies, academic and research institutions, and external support agencies.
- 5- To mobilize a community of sector planners, professionals, researchers and academics for the promotion of sound and sustainable practices for wastewater management in small communities in EMR countries.

The consultation process combined plenary and work group sessions. WHO/CEHA presented a working paper on opportunities and approaches for accelerating the extension of wastewater management to small communities in EMR countries. Nine technical papers were presented on the following aspects of the wastewater management strategy for small communities in EMR countries: onsite wastewater systems; grey water reuse; reduction of wastewater generation; settled and simplified sewer systems; decentralized wastewater management; anaerobic wastewater treatment; increasing the opportunities for wastewater reuse; economic aspects of wastewater services; and role of the private sector in wastewater management in small communities; role of the universities in advancing good wastewater management practices. Two case studies from Jordan and Tunisia and six country reports on the current wastewater management practices in small communities in Iran, Syria, Morocco, Palestine, Yemen, and Sudan were presented at the consultation. A list of papers and their authors is attached in annex 2.

The working groups sessions discussed in details the following:

- 1- The recommended approach for accelerating the extension of wastewater management to small communities in EMR countries
- 2- Essential promotional efforts including: training and education requirements; research and demonstration opportunities; networking and advocacy requirements.

The conclusions and recommendations of the consultation were presented in two plenary sessions. This document describes the recommended new approach for accelerated extension of sustainable and environmentally responsible wastewater management services to small communities in EMR countries. The document also describes the required education, training, research, demonstration, advocacy and networking efforts for wider promotion of the recommended approach.

EXTENDING WASTEWATER MANAGEMENT SERVICES TO EMR's SMALL COMMUNITIES IS A PRESSING NEED

Accelerated extension of sustainable and environmentally responsible wastewater management services to small communities in EMR countries is essential in order to protect public health and address concerns over contamination of the scarce water resources.

Due to rapid and unpredictable growth patterns in the EMR region, many closely-knit, sparsely populated rural communities and villages have developed into small towns characterized by a more densely populated center, with scattered residential areas outside the traditional village boundaries.

Coupled with this development have been rising standards of living and improved housing with corresponding demand for public utilities. Most small towns now benefit from such services as electricity and piped water supply, although houses on the outskirts of these towns are not always connected to these services. Piped water supplies reach the majority of the urban population and a significant proportion of rural population in EMR. Tunisia, Syria, and Jordan, for example, have achieved near universal urban coverage and about 80% rural coverage. In Tunisia, 88% of the population has access to piped water supply. In urban areas, almost full water supply service coverage has been achieved. In rural areas, 66% of the population is connected to a water supply network through house connections, and 34% rely on public standpipes and wells.

The adoption of water intensive life styles, improved access to water supplies, and the population growth have brought about increased wastewater generation in the small communities of EMR. Existing traditional onsite wastewater systems, often cesspits, became overloaded and now present a major pollution source that threatens the scarce water resources and the immediate community environment. Emptying of onsite facilities is often neglected and wastewater overflows from the pits to the roads or gardens presenting a health risk to the population. An increasing proportion of surface and ground water resources in the region is being polluted mainly due to inappropriate disposal of municipal wastewater and infiltration from poorly constructed and maintained onsite sanitation facilities (World Bank, 1996; UNEP, 1999).

SOCIAL AND ENVIRONMENTAL CONDITIONS IN EMR's SMALL COMMUNITIES MUST BE CAREFULLY CONSIDERED

Water-based sanitation is prevalent

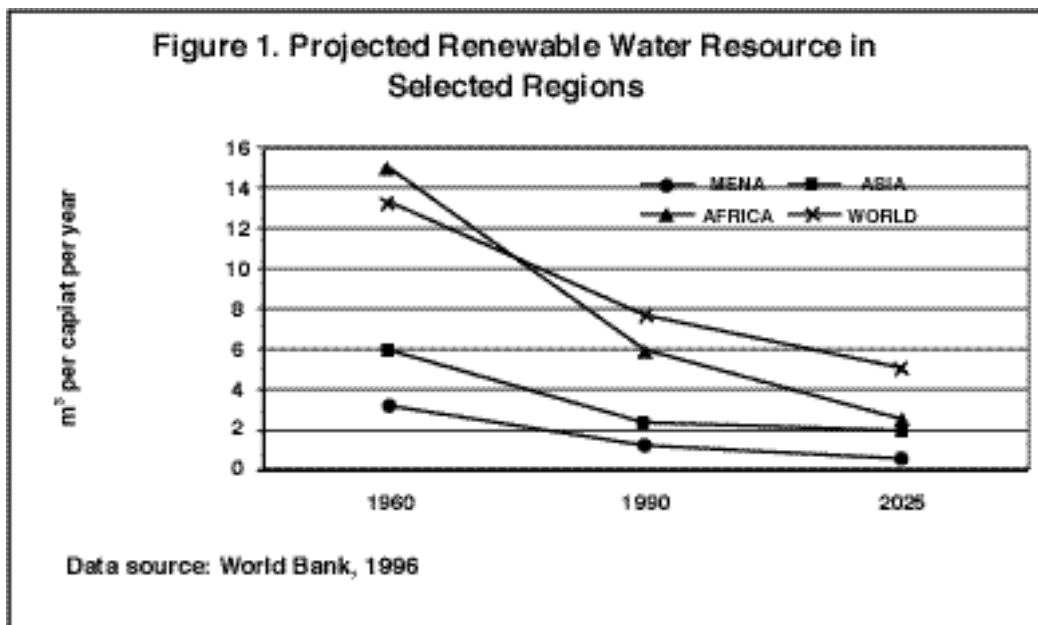
Several social and cultural factors have shaped the development of sanitation services in EMR and will influence the development of wastewater management services in the future. Historically, private household sanitation facilities in EMR were built to satisfy households demand for privacy and convenience. For example, a 1996 survey of 41 very low-income agricultural communities in northern Jordan valley found that 97.2% of the households had private toilets (Cansult, 1997). Cultural and religious traditions, which require the use of water for anal cleansing and washing after defecation, explain the prevalence of water-based sanitation.

High demand for public services and convenience accompanied with willingness to pay

The high demand for public utilities in EMR is often accompanied by willingness to pay for services. Consumers in almost all the countries of the region pay for water, electricity, sewerage, and solid waste services.

The water crisis

Water is a scarce commodity in EMR and its availability is declining to a crisis level. According to the World Bank (1996), EMR is the driest region in the world with only 1% of the world's fresh water resources. The regional average annual per capita renewable water dropped significantly over the last 40 years from 3300 m³ in 1960 to 1250 m³ in 1995 and is projected to drop to 650 m³ in 2025. Projections of the World Resources Institute (1996) suggest that by 2025, 19 EMR countries will be amongst the 45 countries worldwide which will suffer chronic water stress. In 1995, 9 EMR countries suffered absolute water stress (annual per capita availability <500 m³). In 1995, the average water availability in Jordan, Yemen and Saudi Arabia, for example, was far below the projected regional average for 2025.



Pollution threatens the scarce water resources

Current wastewater management practices in EMR aggravate the water crisis. Existing onsite wastewater and water-borne sewerage systems are designed to meet people's demand for convenience by removing waste from the immediate household and community environments with little or no concern for the receiving environment. An increasing proportion of surface and ground water resources in the region is being polluted mainly due to inappropriate disposal of municipal wastewater and infiltration from poorly constructed and maintained onsite sanitation facilities.

Water consumption rates remain low despite the significant supply coverage

Due to the water scarcity, water supplies are intermittent, unreliable, and insufficient and water consumption rates are still comparatively very low. For example, the average per capita domestic water consumption in Jordan is about 70 liters per capita per day (lpcd) (Jordan Ministry of Water and Irrigation, 1998). In Tunisia, the average urban specific consumption is 85 lpcd and ranges from 53 to 105 lpcd. In the rural sector, served by the National Water Supply Company (SONEDE) and the Rural Engineering Directorate, the average specific consumption is only 28 lpcd (5-94 lpcd). The remainder rural population is supplied by other means (cisterns, wells, public standposts, wadis or springs), and the consumption ranges between 13 and 18 lpcd.

Wastewater is widely accepted as a water source

Wastewater in EMR is widely recognized as a significant, growing and reliable water source. Wastewater production is the only potential water source which will increase as the population grows and the demand on fresh water increases. Use of treated or untreated wastewater in landscaping and agriculture is common in many countries such as the United Arab Emirates, Oman, Bahrain, Egypt, Yemen, Jordan, Syria and Tunisia (FAO, 1997). Water resources management strategies in several countries, such as Jordan and Tunisia, consider wastewater as part of the water budget (Jordan Ministry of Water and Irrigation, 1998 & Tunisian Ministry of Agriculture, 1998).

Wastewater reuse opportunities are situated within or around small communities

Agricultural land in small communities in EMR is often situated within the village surrounding individual family homes. Larger agricultural lands often surround the community. Wastewater reuse opportunities in small communities are often located within the generating community for landscaping and agriculture or near the generating community for larger scale irrigation.

PROVIDING WASTEWATER SERVICES TO SMALL COMMUNITIES: CURRENT APPROACHES ARE INAPPROPRIATE

Current trends: Centralized wastewater management

Several governments are now in the process of providing wastewater management services to their small towns and communities after providing these services to the main and secondary cities. Centralized sewerage systems, the preferred choice of planners and decision makers, are inappropriately provided to individual small communities and wastewater is transported from several scattered communities to centralized treatment facilities. The Jordan Valley rural sanitation project - box no.1 (Najjar, 2000 & Cansult, 1997) and a similar project in Egypt (Abd El Gawad et al., 1995) demonstrate the prevalence of this trend.

Centralized wastewater management is costly and unaffordable especially in small communities

The high cost of conventional sewers is regarded as one of the major constraints to expanding wastewater services to small communities in the region.

A World Bank review of sewerage investment in 8 capital cities in developing countries found that costs range between US\$ 600-4000 per capita (1980 prices) with a total household annual cost of US\$ 150-650 (Mara, 1996).

The conventional sewerage systems are more costly in small communities. Because of their size and layout, small communities do not enjoy the economies of building large systems. The low population density means that longer sewers are needed to serve each household. The household cost of building sewerage systems in a town of 3,500 is twice the cost in a city of 100,000. Moreover, the per household cost of sewers in a town of 500 is three times the cost for a city of 100,000 (USEPA, 1992a).

The per household cost in Jordan Valley rural sanitation project was projected at US\$ 2200, four times the average of all urban wastewater projects constructed in Jordan between 1976 and 1996 (Cansult, 1997; Loreda and Thompson, 1998; Najjar, 2000).

Centralized management is water intensive thus inappropriate where water sources are scarce and water consumption rates are low

Conventional sewerage systems are designed as waste transportation systems in which water is used as the transportation medium. Reliable water supply and a consumption of 100 lpcd are basic requirements for problem free operation of conventional sewerage systems. Conventional sewerage is not appropriate for small communities in EMR where water supply is intermittent and only limited amounts of water are available.

Box 1: JORDAN VALLEY SANITATION PROJECT

The Jordan Valley sanitation is expected to provide wastewater services to sixteen farming communities (with a total population of 60,000 to reach 123,000 by the year 2020) in the Northern part of the Jordan Valley where the major surface and ground water resources of the country are situated. The services will be developed in four phases as shown in the table below.

Planned Wastewater Services for JV Communities		
Phase (Priority order)	No. of Communities	Population by 2020
1	5	86000
2	5	27000
3	4	9400
4	3	3000
	Total	125400

The farming communities have grown from relatively small-scattered villages to densely populated towns. The economy is dependant on farming, household gardening, and livestock keeping.

Piped water supplies are provided to virtually all residents in this area. The metered water consumption is estimated at 66 lpcd. Known, but generally un-quantified factors such as low meter readings, or use of illegal connections would increase the effective water consumption to 90 lpcd.

Graywater is discharged to roadside ditches or gardens. Toilet waste is discharged to seepage pits built to allow maximum infiltration into the soil. As the population density and wastewater generation increased, the risk of polluting the scarce ground and surface water resources increased.

The project will provide conventional sewers to individual communities and three treatment plants. The wastewater stream from a cluster of neighboring communities will be transported through trunk sewers to central treatment plants. Clustering of communities is proposed for controlling wastewater reuse, reducing the cost of wastewater treatment, and attenuating the wastewater flows. The potential benefit of reducing the cost treatment through centralization was quickly overtaken by the very high cost of trunk sewers not to mention the complexity and cost of pumping stations of the service area becomes too large.

The cost of providing the services for these communities was estimated at JD 120/person (US\$170) for the sewers and JD 98/ person (US\$ 140) for the treatment facilities. The per household capital cost is estimated at JD1500 (US\$2200) where the sewers (connections, lateral and trunk sewers and lift stations) will be serving the design population of 125400 by 2020, while the treatment facilities will be serving the first phase population of 86000. The per household capital cost in these 16 communities is four time the average cost for providing wastewater collection and treatment calculated for all systems constructed between 1976-1993. The operation and maintenance for the proposed system was estimated at JD 6.5/ person per year (US\$ 9), and the cost of wastewater treatment was estimated at JD 0.2/m³ (US\$ 0.3).

The high capital costs are due to:

- 1 The high cost of the sewers designed to serve the area 30-40 years in the future.
- 2 The high cost of lift stations in flat areas
- 3 The high cost of treatment to meet the high quality effluent standards.

The socio-economic situation for the area shows the inability of the population to even pay for the services in order to recover the operation and maintenance cost. Hence, a heavy subsidy will be required. The size of the subsidy will depend on the funding, whether a donor grant or a bank loan to be repaid later.

Operational problems may arise due to the large size of the trunk sewers and the low wastewater flows in the first few years. The trunk sewers, designed for 30-40 years will be intially underutilized. The wastewater flows during the first few years will not be sufficient to secure a cleansing velocity and settling and blockages may be expected. The numerous lift stations add to the cost and the complexity of the operation and maintenance requirements of the system.

Source: Najjar (2000).

Centralized wastewater management has been problematic even in EMR's urban areas

The provision of centralized wastewater management services in the region has been problematic. Due to the low water consumption rates, several operational problems have been encountered with such systems in rural and even urban areas. Blockage of urban sewers is a common occurrence and fresh water is often pumped into the sewers to unblock them. Blockages are more frequent in smaller towns and cities which do not enjoy reliable water supplies.

Due to financial constraints, development of wastewater services with the collection network. Treatment works were generally added years or decades after the commissioning of the wastewater collection systems and after extensive pollution of the receiving environment and the scarce water resources.

Centralized wastewater management may reduce wastewater reuse opportunities

By transporting the wastewater away from the generating community, several reuse opportunities can be lost. Reuse opportunities are often located within the generating community for landscaping or near the generating community for agriculture or other applications. Reuse of treated effluent within a centralized system requires construction of extensive pressure mains, pumping stations, storage and distribution network for bringing the treated effluent back to the locations where it will be used.

Centralized systems increase the risk to humans and the environment in case of system failures

Recent research and development in the field of wastewater management suggests that centralized wastewater management is environmentally unsustainable (Hedberg, 1999; Braden & van Ierland, 1999; Venhuizen, 1997b). Wastewater is viewed as a problem which must be removed from the generating community and dumped somewhere else. Water is used to transport the waste. Faecal matter is diluted and pollution spreads to a larger domain. Centralized wastewater management concentrates sewage outflows to point source discharges overloading the receiving environment that can not cope in case of breakdown or overload. The probability of failure of a systems serving 1 million people is significantly higher than the probability of simultaneous failure of several systems serving the same population.

A NEW APPROACH FOR ACCELERATING THE EXTENSION OF WASTEWATER SERVICES TO SMALL COMMUNITIES

Qualities of the new approach

A new approach is needed to facilitate the extension of wastewater services to small communities in EMR countries in order to protect public health and to stop the degradation of the scarce water resources. The new approach requires rethinking the inappropriate application of centralized wastewater management systems in small communities. The new approach call for a paradigm shift to decentralized wastewater management systems which are:

- 1- Environmentally responsible developed within the constraints of the water resources in the region; and
- 2- More cost effective.

Objectives of wastewater management

- 1- Protection of public health and well being of the communities.
- 2- Meeting the increasing demand for convenience.
- 3- Protecting the scarce water resources and the community environment from pollution.
- 4- Reducing the pressure on scarce freshwater resources by maximizing wastewater reuse opportunities.

The guiding principles for the new approach

- 1- Wastewater management solutions must be tailored to the prevailing social and cultural, economic, and environmental circumstances. These include: the high demand for convenience accompanied with willingness to pay; the scarcity of water resources; the low water consumption rates; and the financial constraints. Solutions must be site specific. Site specific conditions which must also be considered include: the water supply system and water consumption rates; population density and land use pattern; wastewater reuse opportunities and their location (see box 2).
- 2- Given the water crisis in the region, wastewater must be seen as part of the total water cycle and it should be managed within the integrated water resources management processes (Figure 2). Accordingly:
 - i - Freshwater should be minimally used as a transportation medium for excreta.
 - ii- Wastewater should be viewed as a resource which must be maximally recovered and safely reintegrated into the water cycle as a component of the water budget.
- 3- Pollution must be retained within the smallest domain and wastes should be diluted as little as possible. Accordingly:
 - i - Wastewater should be managed as close as possible to its source.
 - ii- Exports of waste from the generating communities should be minimized to reduce the spread of pollution and the associated costs.
 - iii- Wastewater must be managed within the minimum practicable size (household, cluster, neighbourhood, community).

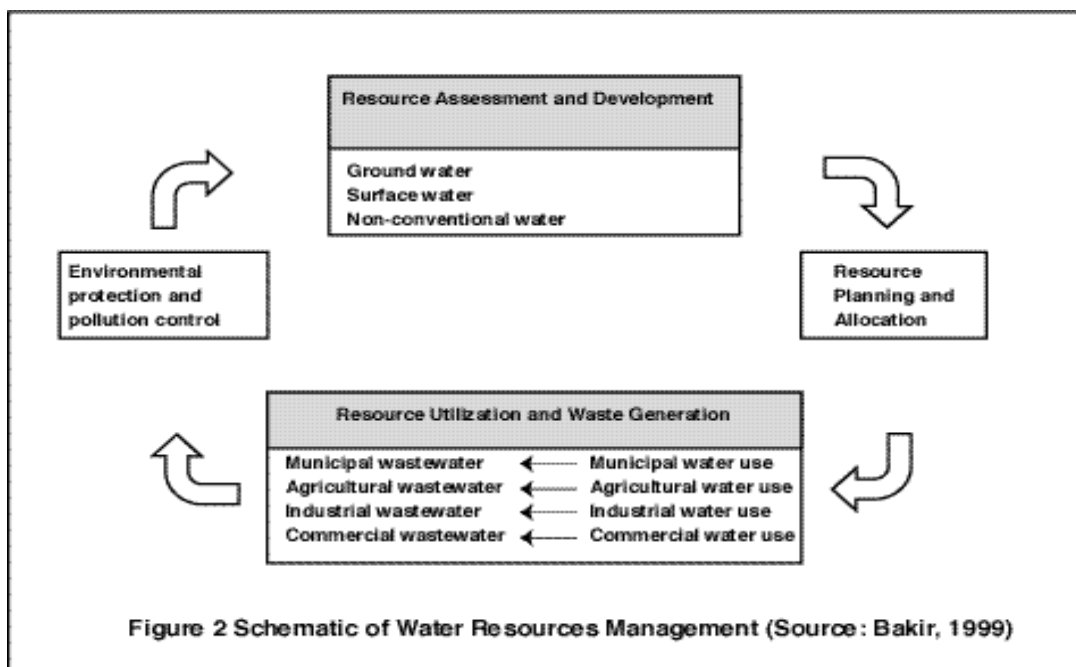
Box 2: The Tunisian National Strategy for Sanitation and Wastewater Management in Rural Areas and Small Communities

According to 1994 national census, only 1.8% of rural households are connected to sewers network, 23.6% have septic tanks and 74.6% have inadequate wastewater management facilities. After developing the urban wastewater sector, the Tunisian government entrusted the National Sewerage Agency (ONAS) to prepare a national rural sanitation strategy. The study included four phases : (i) diagnosis of current situation and basic data collection, (ii) identification of technical solutions, (iii) national strategy elaboration, (iv) pilot program design.

The strategy was developed on the basis of existing data and a survey of 322 households in 84 rural areas. The diagnosis phase concluded that the rural communities are characterized by a great variations in terms of : the housing standards; demography and population density; standards of income and living; and water supply services. The strategy recommends the following wastewater management practices for the various rural settings:

WASTEWATER SYSTEM	CONDITIONS OF APPLICATION
Conventional sewers with treatment facilities or connection to the sewer network of a neighboring city.	Densely populated communities with piped water supplies and high water consumption.
Small diameter gravity with pretreatment in interceptor tanks and post treatment facilities.	Grouped housing with piped water supplies; impervious soil; high water table; high risk of water pollution.
Septic tanks with subsurface infiltration.	Scattered housing; served with piped water or public stand posts; permeable soil; deep water table (more than 4 meters).
Septic tanks with sand filtration.	Scattered housing with piped water or public stand posts; impervious soil; high water table; high risk of water pollution.
Seepage or infiltration pits.	Can only be used for effluent disposal from a septic tank or a sand filter.

Source: Ghariani, (2000)



- 4- Solutions must be cost effective and must permit phased development.
 - i - Significant reduction in wastewater transportation and collection must be realized. Wastewater transportation accounts for 80-90% of the capital cost and over 65% of the annual operational costs of centralized wastewater collection and treatment facilities.
 - ii- To overcome the financial constraints faced in providing wastewater services to small communities, it is essential to develop these services in a phased manner.

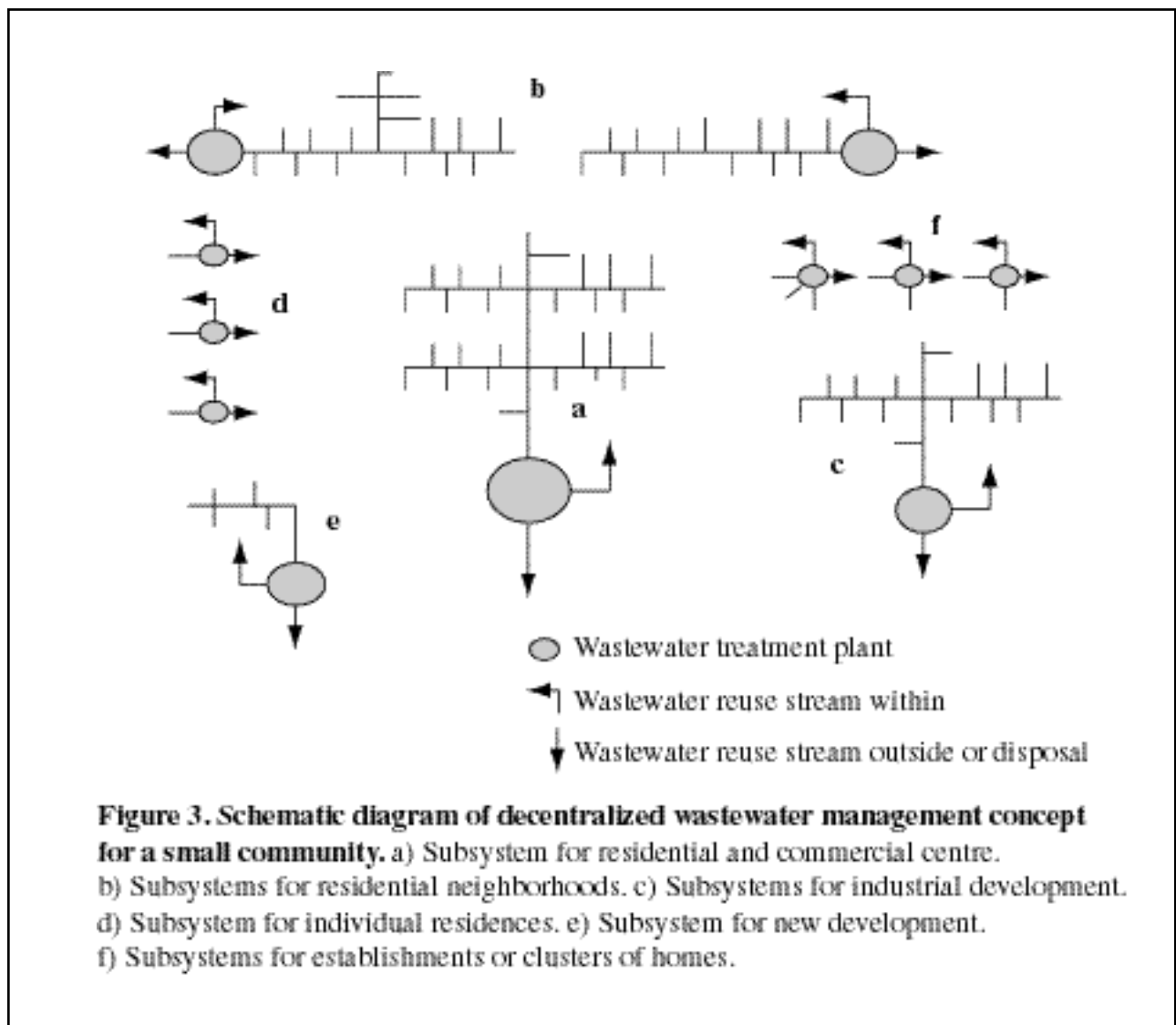
- 5- Wastewater management services must be planned holistically but may be implemented incrementally. Accordingly:
 - i - Wastewater management must collectively consider waste generation, transportation, treatment, and reintegration into the water cycle.
 - ii- Phased and incremental development of wastewater services must not compromise any of the above four guiding principles. Onsite systems can be improved in the first phase. A community treatment plant can be added when onsite systems become overloaded or the soil may no longer accept the effluent. The effluent from the onsite systems can initially be collected by vehicles for example. When financial resources become available, a network of cost effective settled sewers can be added to collect the effluent from the onsite systems to the community treatment facility.

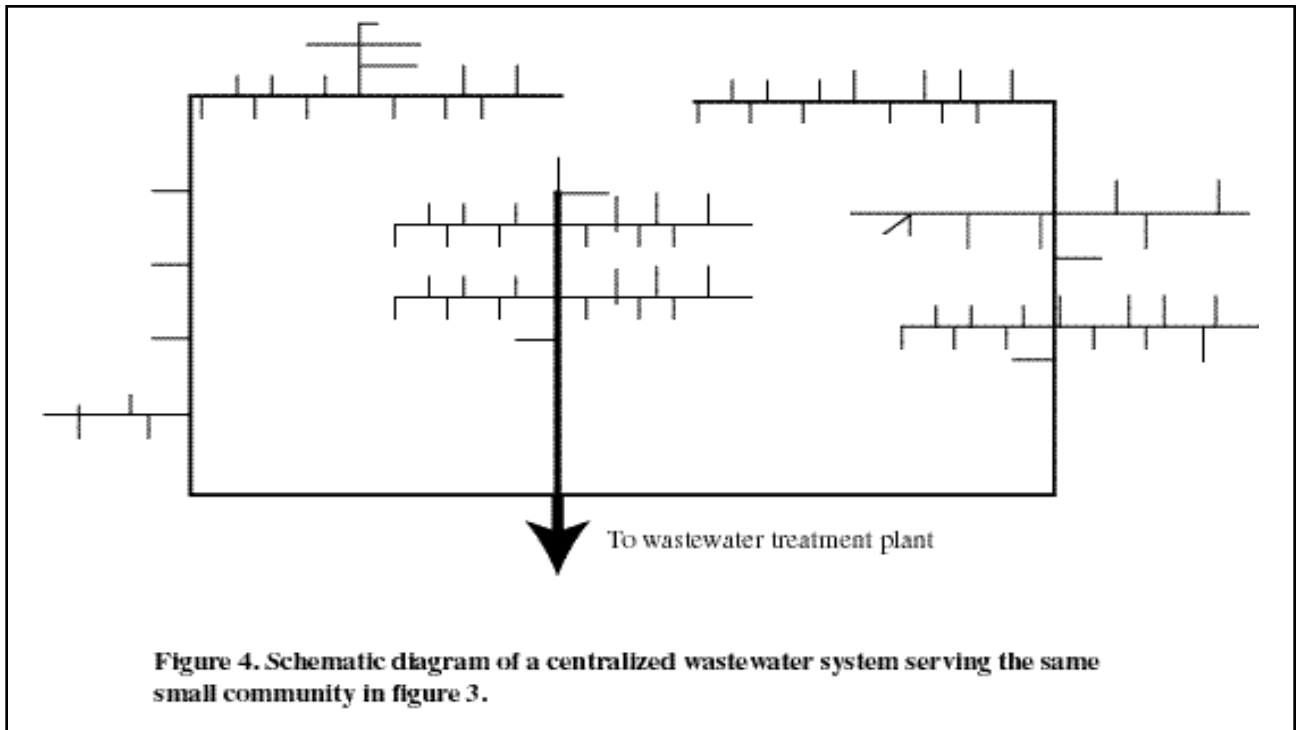
THE CASE FOR DECENTRALIZED WASTEWATER MANAGEMENT

Decentralized wastewater management is receiving increased attention from wastewater professionals and researchers because of its potential for reducing water inputs in wastewater management, reducing environmental hazards in case of accidents, increasing reuse opportunities, and cost effectiveness and efficiency (Butler and MacCormick, 1996; Venhuizen, 1997a and 1997b; Otterpohl et al, 1997; Wilderer and Schreff, 1999; and Hedberg, 1999).

Decentralized wastewater management defined

Decentralized wastewater management implies managing wastewater as close as practical to where it is generated and to where its potential beneficial reuse is located. The wastewater management system for a community may comprise several smaller subsystems for collection, treatment and reuse. The size of each subsystem is determined by the administrative, drainage boundaries, and other prevailing social and economic conditions. The smallest system may serve a single household. Figures 3 and 4 provide a schematic presentation of both the decentralized and centralized wastewater management concept for a community.





Decentralized wastewater management broadens the technology options and permits tailoring the solutions to the problems

Decentralized management may employ a combination of cost effective solutions and technologies which are tailored to the prevailing conditions in the various sections of the community. For example, a conventional sewerage system and treatment works can be provided to the highly developed and densely populated commercial and residential center of the community. The sparsely populated housing neighbourhoods can be served by a settled sewerage system or onsite systems where the soil and groundwater conditions permit.

Treatment processes can be tailored to the quality of the wastewater stream generated from each separate subsystem. For example fewer treatment processes are required for treatment of settled sewage. Industrial waste will not be mixed with other waste streams. Wastewater treatment becomes more cost effective and reuse opportunities increase.

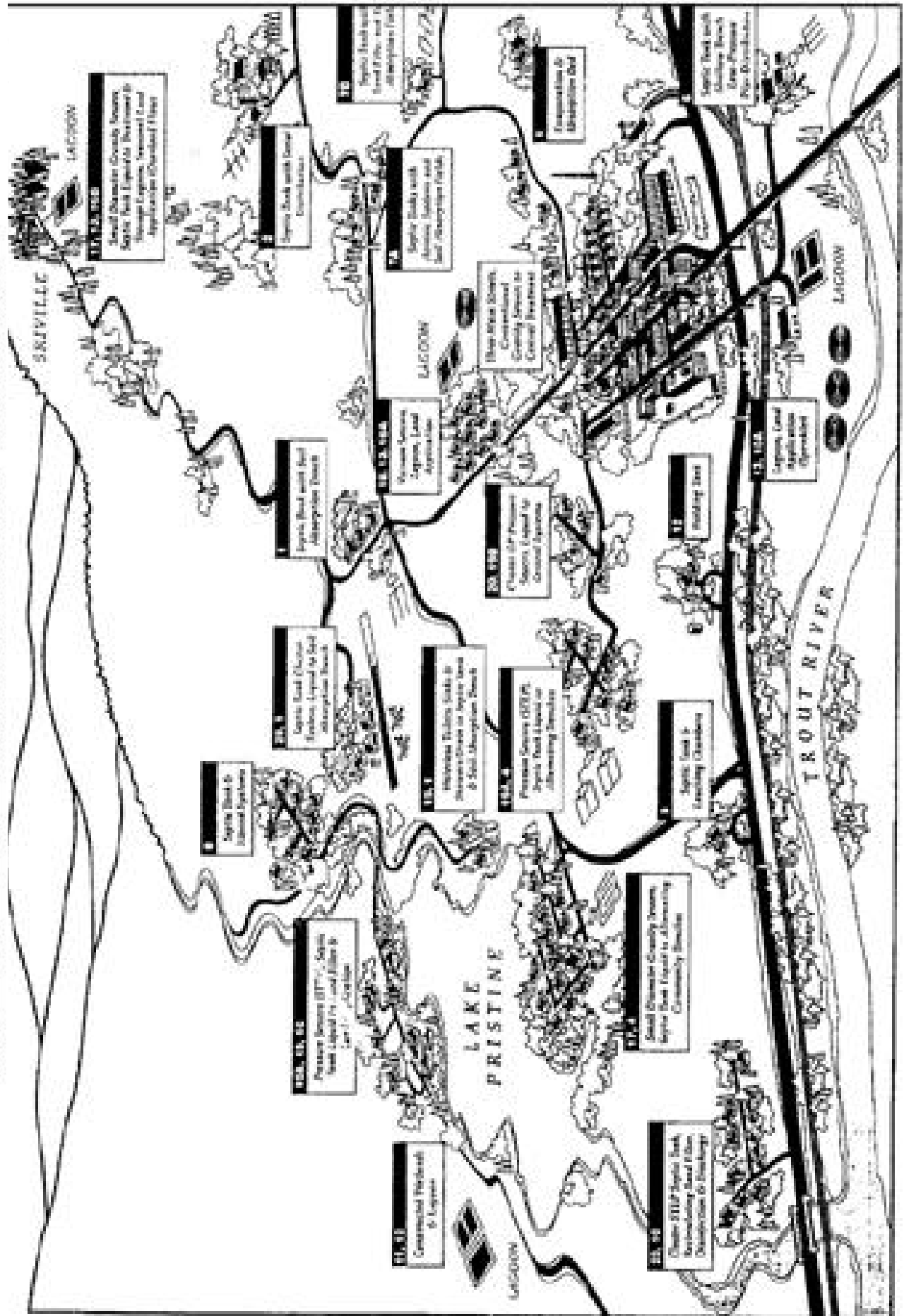
Decentralized wastewater management reduces the freshwater requirements for waste transportation

Decentralized wastewater systems for small communities reduce the freshwater requirements for waste transportation by permitting increased use of onsite wastewater management and the utilization of alternative sewers which are not water intensive (e.g. settled sewers). Consumption of 100 lpcd will not be required and the needed water conservation measures can be accommodated. Decentralized management is appropriate for water stressed areas such as EMR where water supplies are intermittent and water consumption is low.

Decentralized wastewater management reduces the risks associated with system failure

Decentralized management of wastewater changes the nature of and decreases the risks to humans and the environment. Decentralization implies there may be several smaller sewage flows to smaller treatment centers. The probability of simultaneous failure of all smaller systems is significantly lower than that of failure of one system serving the entire community.

Figure 5
The Small Community and Typical Uses of Alternative Wastewater Systems



Decentralized management increases wastewater reuse opportunities

Decentralized management increases wastewater reuse opportunities by keeping wastewater as close as practical to the generating community. Reuse opportunities in EMR's small communities are often located within the generating community for landscaping or near the generating community for agriculture and groundwater recharge.

Decentralized wastewater management is cost effective

Decentralized management permits the use of a wide range of efficient and cost effective technology options such as onsite systems and settled sewers. Decentralized wastewater management eliminates the need for large investments in main trunk sewers and lift stations to transport wastewater from the communities to the wastewater treatment plants.

Decentralized wastewater management permits incremental yet holistic development

Decentralized management permits incremental development and investment in the community wastewater system. Settled sewers can be used to upgrade onsite sanitation systems when necessary. New, independent and properly sized systems can be added to serve new and well defined residential, industrial or commercial developments. In contrast, investment in centralized systems has to be made in a short period of time thus burdening the local economy. Centralized systems are usually designed to handle projected wastewater flows up to 30 to 50 years in the future. Centralized systems are often initially oversized but eventually become undersized.

Decentralized wastewater management requires efficient, cost effective, and compact wastewater treatment processes

Decentralized wastewater management requires the choice of extremely efficient, affordable, and compact wastewater treatment technologies which can be placed within or close to the human settlements without causing nuisance to the community or demanding large land space. Developing such treatment technologies requires extensive research and utilization of both simple and sophisticated technologies which may prove effective and efficient. (USEPA, 1992) describes a variety of well established processes of conventional and non-conventional wastewater treatment for small communities in the USA such as oxidation ditches, rotating biological discs, trickling filters, lagoons and ponds, constructed wetlands, and activated sludge. The appropriateness of these technologies to the conditions of small communities in EMR must be examined in view of the following: the characteristics of wastewater flows which are usually high in BOD due to the low water consumption; and the availability of resources for operation and maintenance.

(Zeeman and Lettinga, 1999) suggested that anaerobic treatment in upflow sludge blanket (USB) reactors offers great opportunities for efficient and safe domestic wastewater treatment. However, USBs usually require secondary treatment often in the form of facultative ponds with large land requirements.

(El Hamouri, 2000) combined high rate anaerobic and aerobic processes in a system called High Rate Pond Technology (HRPT). Judging from the experience in Morocco, the system seems to offer great opportunity for wider application in small communities in EMR countries.

Box 3: High Rate Anaerobic and Aerobic Process (Morocco)

The High Rate Pond Technology (HRPT) uses high rate units at both the anaerobic and aerobic stages of wastewater treatment. This reduces pond retention times and minimizes the land area required by pond technology. The anaerobic system adopted is called a two-phase anaerobic reactor (TAR). Two cylindrical, up flow covered reactors are adopted. They allow odour control and biogas recovery. A hydraulic retention time of 1.7 days was found to be sufficient to remove up to 70% of organic matter while organic nitrogen and phosphorus were highly mineralised (up to 80%). The excess digested sludge that exits in the TAR effluent is trapped in a settler and removed to drying beds eliminating the need for desludging. Biogas is produced at a rate of 0.13 m³ Kg of admitted COD, containing approximately 85% methane

The aerobic unit is an Oswald's High Rate Algal Pond (HRAP). It is an efficient photosynthetic reactor which converts sunlight and substrates produced at high concentrations in the TAR (N, P and bicarbonate) to produce a dense algal biomass which generates supersaturated oxygen levels, up to 30 mg/l, creating optimal high rate conditions during daylight hours. In small communities with no industry, the algal biomass can be recuperated and safely used for animal feed (50 to 60 tons per hactar per year of dried algae containing from 30 to 50% proteins).

In Lattouia, Morocco, an HRPT treatment plant was recently constructed for a municipality of 14,000 inhabitants. The plant required 1.5 hectares (1.1 m²/capita) at a cost of \$350,000. These figures are 25 and 50% respectively less than those required for a similar plant based on a classical Waste Stabilization Ponds.

Source: El Hamouri, (2000).

Decentralized wastewater management requires institutional reforms for effective operation and maintenance

Like centralized systems, decentralized wastewater systems require effective operation and maintenance that must not be under estimated by planners, operators and the public. Operation and maintenance requirements can be met by a utility or contracted out to a private operator for a service fee. Households may also be required to assume the responsibility for their individual systems.

Constraints to wider application of decentralized wastewater management

Objections to decentralized wastewater management systems are based on the following arguments:

- 1- The operation and maintenance requirements of numerous small treatment plans will be more than those of one centralized treatment plant.
- 2- The cost of a few smaller treatment plants will be significantly higher than the cost of one centralized treatment plant.

Such arguments must be taken seriously, and decentralized systems must prove that they are cost effective and their operation and maintenance requirements are reasonable. However such arguments concern the treatment component of the wastewater system and neglect the collection systems requirements. Centralized wastewater collection is the costly component of a wastewater management system accounting for 80-90% of the capital cost and more than 65% of the annual costs of collection and treatment facilities (Otis 1996). Decentralized management will significantly reduce the cost of collection systems.

THE CASE FOR WATER CONSERVATION AND REDUCING WASTEWATER FLOWS

Sustainable wastewater management within the constraints on water resources in EMR starts with water conservation and wastewater flow reduction at the household. Water demand management and conservation strategies such as water pricing, the use of low-volume flush toilets and other water saving devices and fixtures (low flow shower heads and taps, front loading washing machines) will conserve fresh water, reduce wastewater flows, and reduce the infrastructure requirements and cost of wastewater services. Major water demand management efforts are underway in several countries in the region such as Jordan, Tunisia, Morocco, Cyprus, and Bahrain.

Box 4: The Decentralized Wastewater Management System in Muscat, Oman

A decentralized wastewater system currently serves Muscat, the capital of Oman. Muscat municipality operates 12 separate collection and treatment works serving 30% of the city's population with capacities ranging from 8 m³ to 12,000 m³ per day and a combined output of 25,000 m³ per day. The treated effluent meets Omani requirements of 15/15/5 (Suspended solids/BOD/ Ammonia nitrogen). The activated sludge treatment plants are located within the city's neighborhoods and the effluent is all used for urban landscaping through an extensive drip irrigation system. The remaining 70% of the population is served by septic tanks for individual homes. The septage from the septic tanks is trucked to the municipal treatment plants. There are other 137 wastewater treatment plants owned and operated by commercial, industrial, and residential developments in the city.

Source: Al Qasimi, (1998)

Conventional wastewater engineers and professionals in EMR would argue that water conservation may aggravate the operational problems, such as repeated sewer blockages and high BOD loading, which are caused by the low water consumption. The answer to these arguments is that wastewater and water resources managers must avoid building the water-intensive conventional centralized sewers which place unnecessary demand on freshwater. Rather than increasing the consumption of water to run conventional sewers, planners and engineers must consider those wastewater strategies which accommodate water conservation efforts and minimize the freshwater inputs in wastewater management such as decentralized management, improved onsite systems, and utilization of non-water intensive wastewater collection systems (e.g. settled sewers, trucking).

Box 5: Very low volume flush toilet

Conventional designs of low volume flush toilets require an adequate volume of water to generate sufficient hydraulic pressure to clean and flush waste from the toilet bowl; they generally require around 6 litres of water to flush effectively. Alternative methods of toilet operation reduce water consumption through dry separation of waste, or by using vacuum air pressure (instead of water) to flush waste from the toilet. However, these systems are unusual to use and do not encourage public acceptance of the technology.

Research at the University of East London has shown that the design layout of the conventional 6-litre flush toilet can effectively operate with 75% less water if air is displaced from the toilet bowl during flushing. This generates sufficient air pressure to achieve a powerful two-stage flushing cycle, which obviates the need for water to be used as a transportation medium for waste, while also allowing effecting washing of the bowl. The benefits of using air pressure in this way reduce water consumption to 1.5 litres per flush while simultaneously improving flushing performance and as the conventional toilet characteristics of wet operation and water trap seal are retained, users can immediately relate to the familiar design layout, which encourages public acceptance of the technology.

Source: Moore, (2000).

THE CASE FOR IMPROVED ONSITE WASTEWATER SYSTEMS: THE SMALLEST SUB-SYSTEM IN DECENTRALIZED WASTEWATER MANAGEMENT

In a decentralized wastewater management setting, the onsite systems are the smallest sub-systems serving individual homes, clusters of homes, residential buildings, commercial or institutional establishments such as hotels, hospitals, shopping centers, and restaurants.

Experience with existing onsite systems in the region has been less than desirable. Onsite disposal systems are commonly used in rural areas, un-sewered small communities and un-sewered developments in urban areas. Unsealed cesspits are the most common onsite disposal system. Cesspits allow percolation of water into the soil. Properly designed septic tanks with effluent disposal facilities are rarely used. As housing densities and household water use have increased, onsite systems have begun to threaten the groundwater resources. Emptying of onsite facilities is often neglected and sewage overflows to the roads or gardens.

Onsite wastewater systems are a sound method of household waste management in where the development density is low, land is available for system construction, and where soil and groundwater conditions permit such systems to be used. Onsite systems in EMR must be designed to deliver the following benefits in addition to meeting people's demand for convenience and removing the human waste from the immediate household environment:

- Stopping the pollution of the scarce water resources and the community environment
- Recovering the water for wastewater for non-potable water uses.

Improved design, construction, operation and maintenance of onsite systems are thus essential.

A typical onsite system comprises a septic tank for partial treatment of wastewater followed by either an effluent disposal facility or further treatment and reuse. Septic tank designs can be standardized and their mass production and commercial availability will result in significant cost reduction and improved performance of onsite systems.

(Venhuizen, 1997) suggested re-circulating sand filters for polishing of septic tank effluents. Although re-circulating sand filter have a long proven record in the USA, they must be tested prior to wider application in EMR. Various processes for aerobic treatment systems have also been developed and are now available commercially as package treatment plants for onsite application (Hagare and Dharmappa, 1999).

Grey water recycling and reuse at household level is an important development that has witnessed considerable research. Grey water can be used for non-potable water applications such as household landscaping, gardening, and toilet flushing. Grey water reuse reduces the demand on freshwater and reduces the need for larger onsite facilities. Households in many EMR countries can easily utilize grey water in landscaping without major retrofitting and with little or no treatment. Dual plumbing for waste drainage is common where toilet wastes are kept separate from other wastes until the manhole chambers where they get mixed.

In EMR, Cyprus has initiated a subsidy programme to those households that wish to install grey water recycling and reuse systems for domestic landscaping. Dual plumbing systems have also been introduced in Cyprus to allow the reuse of grey water in toilet flushing (Kambanellas, 1998).

THE CASE FOR SETTLED SEWERAGE SYSTEMS

Settled sewers defined

Settled sewerage is a sewerage system that is designed to receive only the liquid portion of household wastewater. Solids are removed in an interceptor tank which is part of household connection. The clarified effluent flows by gravity into the sewers, which are designed as gravity fluid conduits. The settled sewerage require shallow excavations, small diameter pipe work (commonly 75-100 mm PVC) and simple inspection chambers. The interceptor tank acts as a balancing tank which attenuates the flow and thus the system performs equally well regardless of the water use rate. The solids are anaerobically digested in the interceptor tanks resulting in a great reduction in the sludge volume. Properly designed and sized interceptor tanks allow accumulation of sludge for five to ten years before emptying. The digested and well stabilized sludge can be used directly as soil conditioner without further treatment.

Terminology and worldwide application

Settled sewerage is commonly used in Australia, the United States, Columbia, Nigeria and Zambia. The system is also termed small bore sewers, sewered interceptor tank system (SITS), small diameter gravity sewerage (SDGS) in the USA, solids free sewerage in Columbia, septic tank effluent drainage (STED) in South Africa, and common effluent drainage (CED) in Australia.

Settled sewers are not water intensive

The greatest advantage of the settled sewers lies, in their ability to function at per-capita water use levels much lower than those required for conventional sewerage. Settled sewers can be used at per-capita water consumption figures of as low as 30 litres per person per day and are less likely to be adversely affected by a break down in the water supply than conventional sewers. This is particularly important in the EMR, with its limited water resources and intermittent water supplies in its small communities.

Settled sewers are well tried, robust, and cost effective

Settled sewerage is a well tried and robust sanitation system offering the same benefits and convenience as conventional sewerage at much lower cost and less demand on water for its operation. The settled sewerage costs are quite low in comparison to conventional sewerage mainly due to shallow excavation depths, use of small diameter pipe work (commonly 75-100 mm PVC) and simple inspection chambers.

The system is increasingly used in the United States simply due to its low cost and the fact that, from the users' perspective, there is no noticeable difference between it and conventional sewerage. In the USA, cost savings of 20-50% were realized over conventional sewerage in 12 settled sewerage systems (Otis, 1996). In Columbia, capital cost savings of 50% and 67% were achieved over conventional sewerage in 2 settled sewerage systems (serving two communities of 2500 and 1500) commissioned in 1995 (Rizo-Pimbo, 1996). In South Africa, where it appears that more conservative design standards were used, and cost saving was smaller. Figures indicate percentage cost savings over conventional sewerage in the range 9% to 43% although in one case, a cost saving could only be demonstrated when the reduced cost of water supply resulting from the use of low-volume flush cisterns in association with interceptor tanks was taken into account (Tayler, 2000).

Cost estimates suggest that the settled sewers scheme currently under construction in Artas, Palestine will save 40% of the cost of a conventional scheme covering the same area (Tayler, 2000).

Settled sewers demand less operation and maintenance

Another potential advantage of settled sewers is that the need for maintenance is concentrated at the interceptor tank. This advantage will only apply as long as the interceptor tank is desludged once it is full although there are some indications from the field that systems continue to function even when desludging is delayed beyond the time when the interceptor tank is full. The reason for this appears to be that finely divided digested or partly digested solids are carried out of the interceptor tank, which continues to trap gross solids.

The operation and maintenance requirements of settled sewers are minimal compared to those of the conventional sewers. Like conventional sewers, settled sewers require operation and maintenance by qualified staff of a service agency or a utility. There are only two significant operation and maintenance functions:

- 1- Routine monitoring of the interceptor tanks and periodic emptying of the digested sludge often every 5-10 years if the interceptor tanks are properly sized.
- 2- Periodic inspection of the sewers and periodic flushing of the system is the only other significant operation and maintenance function to be performed by the utility staff.

Although the interceptor tanks are often situated on the property of the households, they are an integral part of the sewer system and their performance affects the entire system. The utility staff, in exchange for service fees, must inspect the tanks to monitor their performance and to correct any problems which may arise. Emptying of interceptor tanks can be effectively contracted out to private contractors under the supervision of the utility operators.

Settled sewers require smaller treatment works at the end of the pipe

Small treatment works are required at the end of the pipe. Recirculating gravel and sand filters have been used for polishing the interceptor tank effluent to a very high quality for direct use in drip irrigation (Venhuizen 1997a and 1997b). Other treatment technologies include constructed wetlands, oxidation ditches, reed beds, pond systems, and trickling filters (USEPA, 1992b).

Opportunities for wider application of settled sewers in EMR small communities

Research and development over the last 50 years, suggest that settled sewerage system offers great opportunities for long-term solutions enabling faster and sustainable and incremental extension of wastewater services (Mara, 1996; UNDP - World Bank, Water and Sanitation Programme, 1998).

Box 6: Settled Sewers in EMR

Attempts to promote settled sewerage systems in the EMR were very fragmented and rather not serious. Earlier resistance to application of settled sewerage systems in the region are due to:

- 1- Preference of the wastewater management agencies and the consulting firms advising them for conventional systems with established design standards and operating procedures;
- 2- The security and safety of selecting familiar solutions; and
- 3- The general perception of planners, engineers, and the public that non-conventional systems offer sub-standard service.

However, the last 5-10 years witnessed increased attention to the settled sewers as a cost effective technology for wastewater management in EMR.

Four settled sewerage systems have been satisfactorily constructed and operated for the last 5 years in Iran and a fifth system is currently under construction. About 300 are being considered under Iran's national plan of action for sanitation in small communities. The 300 hundred systems are being designed and will be installed under phase one of the plan of action in those regions of Iran where excavation is extremely costly and difficult or where the groundwater table is so close to the surface. (Azimi, 2000)

Egypt piloted settled sewerage system in a village in the Nile delta with 15000 population. The capital cost of the sewerage system (inclusive of interceptor tanks) was 66% of the cost of a conventional system considered for the same village (Abdul Alim, 1997).

A settled sewerage system is under construction in Artas, Palestine with cost saving expected at 40% on the cost of a conventional sewer scheme for the village. The unreliability of the water supply to Artas village in Palestine was perhaps the single most important reason for adoption settled sewers. The most important aspect of Artas project is that it was demanded by the community itself and is being developed by a local non-governmental organization with minimum but carefully timed external technical assistance.

The Tunisian strategy for rural sanitation identified the settled sewers are an appropriate technology for wastewater management in those rural communities where water supplies improved and water consumption increased but the population density remain low. Piloting of settled sewers in Tunisia is expected to start shortly as planned under the plan of action for implementing the national rural sanitation strategy.

Settled sewers are particularly appropriate for small communities in EMR where the water resources are scarce and the water supplies are intermittent and often have to be stretched to meet the rising demand. In addition settled sewers are appropriate because of the great potential for cost reduction in terms of both capital and operation investments.

Settled sewers are appropriate in small communities with low -density residential and commercial developments. Settled sewers are also appropriate for upgrading onsite systems where the soil no longer accepts all septic tank effluent. Furthermore, they are appropriate for low density urban development as an alternative to the water intensive and more costly centralized sewer systems.

INSTITUTIONAL REFORMS REQUIRED FOR WIDER ADOPTION OF THE NEW APPROACH AND EFFECTIVE OPERATION AND MANAGEMENT

Wastewater authorities are geared to centralized conventional wastewater management

In several countries of EMR, wastewater management authorities and utilities regard themselves responsible for the centralized wastewater management facilities where a collection system and a treatment plant are constructed. Other forms of wastewater management are often regarded the responsibility of the households and the owners of the systems. Although national legislation often defines the requirements for safe wastewater disposal from individual households, the responsibility for monitoring and ensuring compliance is not well defined.

The institutional structure, management, and operational policies of many wastewater utilities is geared towards centralized wastewater systems with no flexibility to accommodate alternative approaches to wastewater management such as onsite and decentralized management.

Management and operation of decentralized wastewater management requires institutional reforms:

To encourage wider application and effective management of decentralized wastewater systems, wastewater utilities must begin to recognize these systems as viable wastewater systems and assume responsibility for their operation and maintenance.

Recognition must be followed with adoption of appropriate operational policies, which meet the operation and management requirements of decentralized wastewater systems. The operation and maintenance requirements for each element of decentralized wastewater management system were discussed under the earlier relevant sections.

While assuming responsibility for management of decentralized systems, wastewater utilities must not relieve the householders from their personal responsibilities. Householders must continue to pay for wastewater services in the form of service charges.

The private sector has a big role in decentralized wastewater management

Several operation and maintenance functions of decentralized systems can effectively be contracted out to local businesses in return for defined service fees and under close monitoring and supervision of the wastewater authority. While contracting out these functions, the wastewater utility must not abdicate responsibility. Supervision and monitoring of the service contracts can also be contracted out by the wastewater utility.

The following are examples of the operation and maintenance function which might be contracted out:

- 1- Routine inspection and desludging of the individual septic tank systems.
- 2- Routine inspection and desludging of the interceptor tanks in a settled sewers system.
- 3- Periodical inspection and flushing of the settled sewer system.
- 4- Routine operation and monitoring of wastewater treatment plants operations.

PROPOSED ACTION FOR PROMOTING AND IMPLEMENTING THE NEW APPROACH

Accelerated development of sustainable and environmentally responsible wastewater management services in small communities requires the adoption of rational planning processes which analyze the spectrum of available options in order to tailor the solutions to the social, cultural, environmental and economic circumstances in the target areas.

To develop these planning processes, knowledge of the decentralized wastewater management options must be introduced to the policy makers, project planners and designers, project implementers, operators, and the community members through the following interventions:

- 1- **Education:** Education at both undergraduate and graduate engineering schools to equip future wastewater professionals and engineers with the knowledge of the spectrum of options available for wastewater management in small communities

At the undergraduate level, the immediate and long-term options include:

- Introduction of material on decentralized wastewater management into existing educational course content. (This can be achieved reasonably quickly, as opposed to changes in the syllabus to include a module on decentralized wastewater management, which will require high-level approval).
- Use of case studies based on local experience.
- Inclusion of material on appropriate international experience.
- Development of reading list on low-cost decentralized wastewater management.
- Syllabus change.

At the graduate level, the following options

- Develop short-courses focusing on decentralized wastewater management.
- Ad modules/sessions on decentralized wastewater management to existing courses.
- Encourage dissertations on aspects of Decentralized Wastewater Management.
- Encourage coursework projects including strategic analysis of options, covering technical, financial, economic and social factors.

- 2- **Training:** Training to build the capacity of public and private sector wastewater management professionals who are engaged in the selection, development, building, and operation of small community wastewater systems.

Immediate option for training include:

- Establish continuing education programmes and short course on wastewater management for small communities at selected national universities in each country.
- Develop appropriate training manuals and guidelines. The programme must include provision for developing and testing appropriate training materials.

- Design training courses aimed at key change agents. The first stage should focus on those who are in a position to be agents for change'. These include trainers, educators and senior figures from the public, private and civil society sectors. (Including senior government engineers, NGO personnel and consulting engineers). Training should be provided to mixed groups, drawn from the various key groups, and should be developed and provided by joint teams of academics and professionals.
- Training courses should also be designed for the following target groups:
 - the public sector personnel who are directly engaged in the selection, design, operation and management of wastewater system.
 - personnel of the engineering services providers (consulting firms).
 - personnel of public sector entities who are involved in evaluation and supervision of consulting firms contracts.

In the long-term, there is a need to develop a more demand-based approach to training. Engineering service providers (consulting firms) and NGOs may be required to present pre-qualification that shows they have personnel who successfully completed certified courses. Similarly, companies and NGOs that are involved in implementation should be provided with training, which again should be certificated.

Training programmes should draw on:

- Successful practice from countries with similar conditions to those found in the EMR.
- The results of pilot projects. The evaluation of pilot projects should include consideration of feedback from service users and this feedback should provide an input into training materials.

3- **Advocacy:** Advocacy to increase the awareness of policy and decision makers, the public, educational institutions, engineering service providers both public and private, and donors of the spectrum of sound wastewater management options offered by decentralized wastewater management approach and to gain their support to wider consideration and implementation of decentralized management systems in small communities.

Immediate options for advocacy include:

- Select priority target groups. Possible target groups include: donors, policymakers, national and local; technical decision makers; private consultants and architects; owners of systems, individual, institutional or governmental; industry, suppliers, manufacturers; educational institutions; contractors and builders; the general public.
- Promote the need for legislation and enforcement mechanisms.
- Promote use of information in decision-making - make information accessible in a usable form (link with Research and Development).
- Research available promotional materials and other documents which can be basis for advocacy and promotional materials (best practices).
- Produce new promotional materials - regional and national levels.
- Facilitate distribution of existing and new promotional material.
- Sponsor national and local promotional activities (e.g. planning seminars).
- Promote private investment into promotion and advocacy.

- 4- **Networking and Information Exchange:** Networking to develop an informed community of researchers, educators, engineers, and policy makers who are aware of available wastewater management options for small communities, and who can act as agent of change to promote and help realize cost-effective and speedy extension of wastewater services to small communities.

Information exchange services to provide the concerned community of policy makers, educators, engineers, planners, and the public with the latest available information on wastewater management options available in order to facilitate informed decision making and to provide guidance in the development of wastewater services to small communities.

Immediate options include:

- Establish a network on wastewater management for small communities in the region with the participants at the consultation as the core group. Each member in the network will work to promote the network and the principles for wastewater management in small communities in his/her country.
- CEHA to designate the core member of the network as focal points at their countries.
- The network members to maintain contact for exchange of information and collaboration in research, education, training, and other promotional efforts.
- Establish web site to which CEHA and eventually network members would contribute:
- Inform on initiative as result of Nov. 2000 meeting, including strategy, papers presented, and plan of action.
- Provide easy access to documents and training materials.
- Provide links to other sources of info and networks (esp. universities).
- Provide a directory of relevant institutions, experts and suppliers.
- Provide a "definition of terms" used to describe small community.
- Wastewater management (to be produced by volunteer from within region).

Note: important links could include: UN agencies, educational institutions; funding agencies (many have documentation systems); private industry including suppliers, consultants, utilities; research and information centers, both private and public; government institutions such as EPA; NGOs.

- Establish ONE e-mail discussion list (Moderated list, with "chief moderator" - volunteer on rotating basis) "Specialist moderators" on particular aspects - experts at Consultation agreed to moderate and generate discussion on the following topics: Education; Advocacy and behavioural change ; On-site Sanitation; Wastewater Reuse; Institutional Issues.
- Establish a regular information bulletin, to be sent by e-mail and by regular mail - (printed newsletter to be in English and Arabic).
- Promote and assist in establishment of national-level websites in selected countries.

- 5- **Applied Research and Demonstration:** Applied research and demonstration on the available options for wastewater management in small communities in order to provide evidence and supportive information on the appropriateness of the available options for wastewater management in small communities and to refine and adapt the options to the needs of small communities in EMR countries. The research and demonstration will also provide the necessary information and evidence for the advocacy and information exchange efforts suggested above.

Immediate option include:

CEHA to mobilize a group of concerned wastewater professionals to identify research priorities, develop project proposals, and mobilize resources from regional and multi-lateral donors. CEHA to coordinate the resources mobilization exercise.

The following research topics are identified:

- Assessment of the performance of the Iranian experience in settled sewers system (small diameter gravity sewers). The objectives of the assessment include:
 - Examining the performance of the existing systems and adapting revised guidelines with local and regional relevance.
 - Documenting the Iranian experience in successfully promoting the small diameter gravity sewers and building the required national capacity.
- Assessment of the Artas / Palestine wastewater management project with settled sewers system.
- Identification of other existing project sites which comprise innovative elements of the recommended decentralized wastewater management approach and documentation of the experience gained.
- Demonstration of settled sewer systems for wastewater management in small communities in selected locations in EMR countries.
- Application of improved onsite wastewater management systems in small communities.
- Identifying and demonstrating appropriate treatment processes for the effluent from settled sewer systems.
- Adaptation and application of the high rate anaerobic and aerobic treatment systems of Morocco in small communities in EMR.
- Anaerobic treatment of wastewater for small communities.
- Piloting of the air displacement toilet system which only uses 1.5 litre of water per flush in combination with the appropriate treatment facilities for onsite wastewater management.
- Grey water reuse and its use in non-potable water applications.

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ANNEXES

Annex 1

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Annex 2

List of Papers Presented and Their Authors *(listed as per the programme of the consultation)*

- 1- Bakir H., Sanitation and Wastewater Management for Small Communities in EMR Countries: Challenges and Strategies for Accelerated Development within the Water Resources Constraints.
- 2- Najjar M., Wastewater management practices in small communities (Jordan's experience).
- 3- Ghariani F., Overview of the national strategy for sanitation and wastewater management in rural areas and small communities in Tunisia.
- 4- Moore G., The impact of reduced wastewater generation through implementation of water saving devices.
- 5- Tayler K., The viability of alternative sewerage systems for wastewater collection in arid areas.
- 6- Bahri A., Strategies for increasing wastewater reuse opportunities in small communities in the Southern Mediterranean Region Countries.
- 7- Azimi A. and Bahrami A., The SDGS in small communities of Iran: Existing experience and potential applications.
- 8- Kresse K., Simplified, condominial and small bore sewer and treatment systems concept and experiences from Brazil, Colombia and Costa Rica.
- 9- El Hamouri B., Wastewater management practices for small communities in Morocco: Existing situation and strategies for the future.
- 10- Bakir H., Decentralized Wastewater Management
- 11- Zeeman G., The role of anaerobic digestion at the treatment and reuse of domestic wastewater in small communities.
- 12- Saidam M., On-site wastewater management for small communities.
- 13- Basahi I. And Hanash A., Wastewater management practices for small communities in Yemen.
- 14- Mahvi A., Prevailing of wastewater management in small communities in Iran.
- 15- El-Hassan B., Sanitation in Sudan.
- 16- Al-Sa'ed R., Wastewater management for small communities in Palestine.
- 17- Kresse K., Consideration for private participation in public sanitation incl. Solid waste management.
- 18- Saqqar M., Economic aspects related to wastewater management with special emphasis on small communities.

- 19- Sharif M., Role of universities in promoting appropriate wastewater management for small communities.
- 20- Abu-El-Sha'r W., The integrated system for collection, treatment and reuse of wastewater at campus of Jordan University of Science and Technology.
- 21- Kambanellas C., Grey water reuse in Cyprus.
- 22- Malkawi M., Lack of access to water and wastewater information in the EMR: Simple bibliometric analysis.

