Wastewater Sector

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1. INTRODUCTION

The "Vision Report" sets out a new approach for the public investment. This approach consists of the diagnosis of the actual situation of the concerned sectors and the identification of coherent technical, economical and institutional options to rationalize the investments. Our discussion in this chapter follows the requirements of this approach.

In addition, this Vision Report sets out concepts which lead to the following objectives:

- Environmental and Ecological Sustainability; this requires that the external effects of the wastewater sector be taken fully into account when public or private decisions are made to determine future developments. The aim is to ensure that environmental issues are addressed as an integral part of the formulation of the wastewater vision.
- Economic and Financial Sustainability; this requires that available resources be used efficiently and that assets be maintained properly. The aim is to make wastewater cost-effective, continuously responsive to changing demands and capable of, at least, financing its operation and maintenance.
- Social Sustainability; this requires that the benefits of improved wastewater reach all sections of the community. The aim is to target the wastewater problems of low income groups, and to protect these groups against the negative impacts on the environment.

These general objectives are consistent with the macro objectives of this sector and should lead to an efficient wastewater vision.

1.1 CHAPTER OBJECTIVES

The objective of this chapter is to present the rationale and procedure for developing the vision/objectives for the wastewater sector, along with the development of the relevant options. Essentially, the intention is to answer the following question: "*knowing where we are at present, what are the objectives that should be achieved in 10-15 years time horizon in the wastewater sector, and what are the different options for achieving them?*"

1.2 METHODOLOGY

The methodology followed here follows the steps shown in Figure 1. The stakeholders pertinent to the wastewater sector are identified, and classified into main and secondary. This is important when identifying the roles and responsibilities. The problem is then identified, and its root causes diagnosed using the problem-tree approach. The existing conditions of the wastewater sector are then assessed, using published reports and information gathered in Phase I of this work. The planned projects, policies, or programs relevant to the wastewater sector are also identified. If any conflict exists between the

policies proposed/developed for other sectors and the wastewater sector, they must be identified and reconciled.

The barriers and constraints that currently exist, and within which the sector operates, are then identified. This leads to the definition of the sector overarching vision and objectives.

Once those are defined, the various options which can be used to accomplish the objectives are identified. Those options and the considerations related thereto are classified into the following three categories: technical, institutional, and economic. A set of performance criteria are developed, which can be used later on to evaluate the options and select the preferred ones, based on location and local conditions.

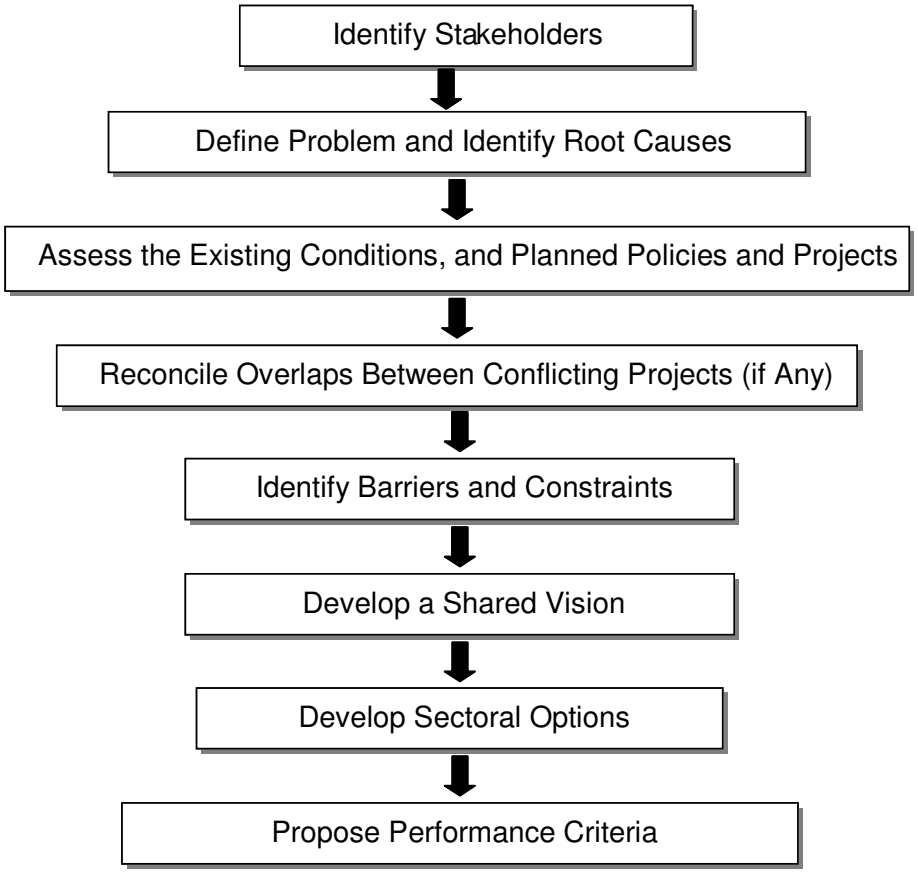


Figure 1. Schematic of the Approach Followed to Develop the Wastewater Sector Vision and Options

1.3 STAKEHOLDERS

1.3.1 Stakeholder Identification

The main stakeholders involved in the wastewater sector include the following:

1.3.1.1 Government agencies

This includes the Ministry of Energy and Water, the CDR, the four regional water establishments formed in 2002 (North Lebanon, South Lebanon, Beirut and Mount Lebanon, and Bekaa), the Ministry of the Environment, the Ministry of Agriculture, the Ministry of Industry, and the Litani River Authority charged with the provision of the irrigation requirement in Litani Basin and South Lebanon districts.

1.3.1.2 Public sector

This category includes Municipalities. It has been separated from the Governmental agencies because municipalities are not employees of the government but elected by the population. However, Municipalities report to the government and in practice all municipal decisions and activities have to be endorsed by the Ministry of Interior and Municipal Affairs and their relevant funds disbursed by the Ministry of Finance.

1.3.1.3 Private sector

This includes the private companies which may provide design, construction, and/or operation services of sewerage systems, be it full scale or package units. Furthermore, training institutions are considered stakeholders, as there is a pressing need to build the capacity of everyone involved in the wastewater sector on the operation and maintenance of sewerage systems.

1.3.1.4 Donors and international organizations

This includes, for example, the European Community, the USAID, and international organizations whose work may benefit the achievement of the wastewater objectives, such as the Global Environment Facility (GEF) which places strong emphasis on international waters, and which may provide funding for reducing the pollution load to the Mediterranean.

1.3.1.5 Beneficieries

This refers to the people who will be served by the wastewater projects developed as a part of achieving the sector objectives. This category also includes the farmers who will use the treated wastewater for irrigation purposes, and owners of large industrial firms for which pre-treatment of industrial wastewater may be required.

1.3.1.6 Research institutes and universities

This includes both private and public research bodies which can provide assistance in devising means to improve the performance of the wastewater management scheme during all of its phases, including collection, pumping, treatment, and final disposal.

1.3.2 Stakeholder differentiation

The stakeholders could further be categorized, in terms of effect, into two categories. The criteria for classification is the perceived ability to impact the decision making, or provide leverage to achieve the objectives set forth by the sector. The first category includes the Ministry of Energy and Water, the CDR, the Municipalities, the Ministry of the Environment, and the Litani River Authority. The second includes the beneficiaries (due to the low level of pressure exerted by the people and the special nature of this sector), the Ministry of the Industry, international organizations and donors, research institutes, and the private sector.

1.4 PROBLEM CAUSES

Review of existing conditions revealed that the level of service by piped sewerage system varies widely across Lebanon. Whereas major cities have sewerage networks, they do not have sewage treatment plants; although some are under construction or in development. Most smaller communities, however, have neither piped sewerage networks nor treatment plants. The problem of “inadequate wastewater service” can be traced to its root causes, and the effects thereof identified, using the problem-tree approach, as shown in Figure 2.

The problem tree tool is a useful exercise in analyzing the existing situation in the sector by identifying the causes and the cause-effect relationships and their main causal relationships. The output is a visual arrangement of problems and arrange to show the causes-effect hierarchies. This technique helps understand the broader context, the interrelationship of problems and the potential implications when considering other sector issues.

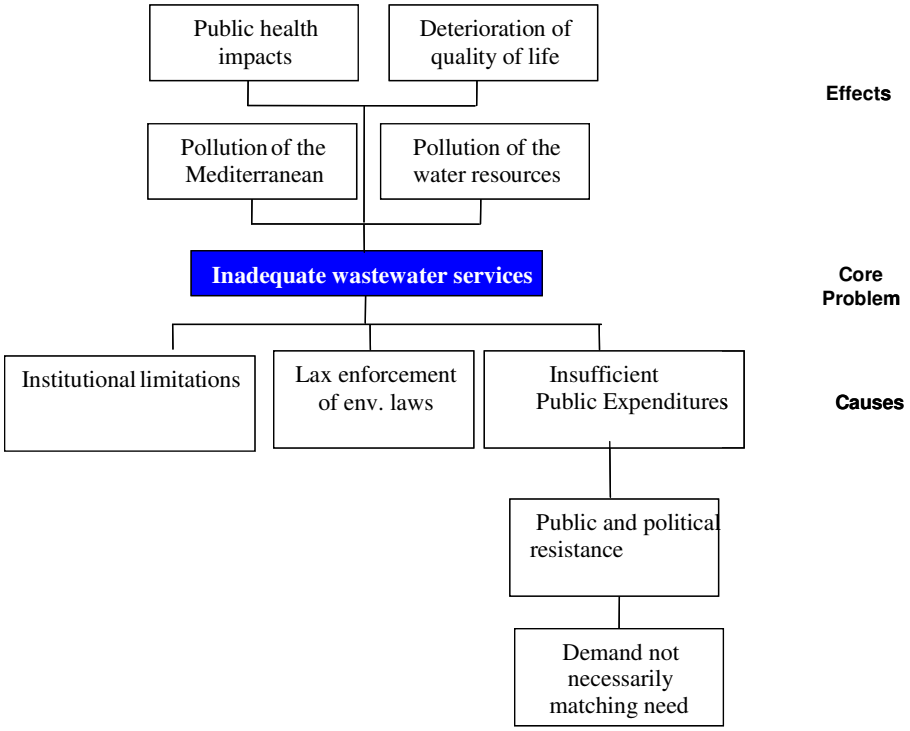


Figure 2. Problem Tree for the "Inadequate Wastewater Services" Core Problem

As shown in Figure 2, the root causes of the existing inadequate services include the following:

1.4.1 Lax Enforcement of the Environmental Controls

Most of the wastewater in Lebanon is currently discharged to the Mediterranean through sea outfalls, or to local waterways. The Ghadir preliminary treatment plant discharges into the sea through its 1.5 km sea outfall, while all other coastal communities discharge their raw wastewater at the seafront. This activity is done in violation of the local Lebanese environmental laws, as well as the international conventions which Lebanon signed on the protection of marine water and the Mediterranean. Furthermore, the disposal of wastewater into aquifers and on waterways violates environmental regulations.

The Ministry of Environment issued a set of regulations for domestic and industrial wastewater disposal. The regulations are supposed to be applied to newly licensed industries and provide a grace period of 10 years for existing industries. However, several constraints are hindering their applications. For instance the physical infrastructures may not be available to enforce the law banning the discharge of raw sewage into ground or

surface water, the administration may not have the technical know-how to implement the regulations, the Ministry of Environment does not have the implementation mechanisms, etc..

However, since the enforcement of the relevant pollution prevention laws may be lax, then there is no incentive to improve the sanitation practices from the view point of reducing pollution. This is an important root cause of the problem.

1.4.2 Insufficient Public Expenditures

Although sufficient fund for wastewater service improvements were allocated by the Government, expenditure of this fund is considerably lagging behind. The current expenditures in this sector are distributed essentially between new investments and operation and maintenance of the works. The following table presents the total estimated expenditure of the CDR in the wastewater sector during the 1992-2004 period.

Table 1: Total Expenditures of the CDR in the wastewater sector between 1992-2004 (2005a[1]))

Studies (MUS$)	Construction (MUS$)	Operation and maintenance (MUS$)	Total (MUS$)
25	284	90	399

This can be traced to the institutional limitation in the sector, along with other substantial obstacles, such as social constraints and lack of funds for expropriation. This issue can be further diagnosed into its root causes as follows.

1.4.2.1 Political and social resistance

The demand for sanitation projects is not sufficient to generate the necessary pressures to realize the needed investment and to overcome local resistance, in spite of the reallocation of funds in the programs. This is due principally to the political and social resistance. This essentially stems from the following underlying cause.

1.4.2.1.1 Demand not necessarily matching need

Presumably, regions which have a need for the wastewater services should be the same ones that demand such projects. However, experience with many development programs revealed that in many instances, the municipalities with the most need may or may not be those exhibiting the most demand. A highly populated village located uphill may discharge its wastewater into ground water or natural streams and would not feel the pollution it is causing and consequently the need for the treatment. On the other hand, a

[1] CDR (2005a). Progress report.

small village located downhill may have its ground water resources used for domestic supply and / or its natural stream used for irrigation polluted by the village located uphill. Likewise, a coastal community, not interested in developing its coastal beaches or preserving its marine fauna, could discharge its raw wastewater at the sea front without concern to the need for treatment.

This observation usually results from the action of political and social drivers to the development process. For example, the need for sewerage in some municipalities may not be translated into demand because of lack of political pressures from the civic groups, NGOs, or the local community. Furthermore, irregular enforcement of the environmental laws may not provide a strong enough incentive for initiating action by the respective municipality, resulting in low demands for wastewater projects.

In areas where the population is knowledgeable, environmentally educated or is adversely impacted by the pollution, the bottom-up approach would contribute matching the demand to the need. On the other hand, in areas where the need is sensed and expressed by the population, a top-down approach is more adequate, but is likely to be applied only if the relevant administration were knowledgeable.

Optimally, the subset of projects which should be considered are those that address both the demand and need aspects. This is shown schematically in Figure 3.

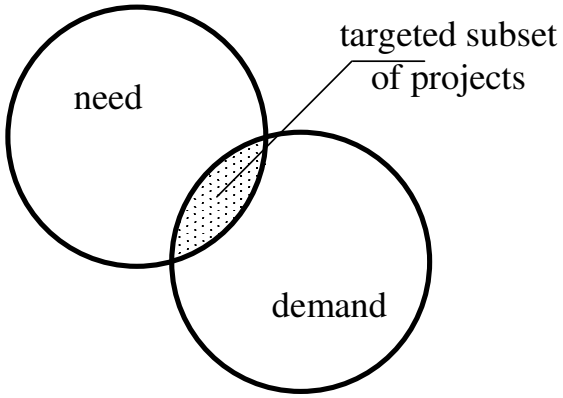


Figure 3. Demand versus Need for Wastewater Projects

1.4.3 Institutional limitations

The institutional arrangement in the wastewater sector may lead to uncertainty regarding roles and responsibilities, and inadequacies in operation. The ownership of the assets is not always clear. The wastewater collection networks are owned by Municipalities; the wastewater treatment plants were previously owned by Municipalities (Hammana, Marjayoun, etc) and presently by either Municipalities (plants constructed by NGOs for municipalities) or Water Establishments. The exact responsibilities are not clearly

defined yet. In addition, the CDR operate and maintain on behalf of the Ministry of Energy and Water, the Municipalities, and the Water Establishments some networks and treatment plants.

The wastewater master plan had foreseen large treatment plants to serve relatively large drainage basins. This entails the construction of collector pipelines, expropriations for service roads and treatment plants, lift stations, but most of all requires a cooperation mechanism among the municipalities served by the common collector and treatment plant. The cooperation mechanism that institutionalize the contribution and participation of every municipality located within the basin served by a common collector and sewage treatment plant does not exist. This applies for instance to the Ghadir sewage treatment; for which an operation contract has been prepared and awarded by the CDR instead of the concerned municipalities and the operator is paid from the municipality corporate funds instead of the concerned municipality or group of municipalities served by the treatment plant.

Furthermore, the municipalities that were responsible for the wastewater facilities had neither experience nor the funds in their budget to operate a sewage system. Moreover, the municipalities collect an indicative tax for wastewater and sidewalk, which is a percentage of the rent value of the house/apartment/commercial building.

The Water Establishments responsible for the wastewater sector have no experience in the sewage sector.

1.5 PROBLEM EFFECTS

The discharge of untreated wastewater to the Mediterranean results in contamination of the sea, thus affecting the shores. Seawater quality is very critical, both from a local perspective, and from an international one, since Lebanon is a signatory to sea conservation conventions. Furthermore, the disposal of wastewater into aquifers and on waterways have detrimental effects on the human health, as people may use this water for drinking and irrigation purposes. This could result in the accumulation of toxic materials in the food chain, ultimately resulting in negative public health implications.

Groundwater quality is already in an alarming situation, due to the infiltration of pollutants (wastewater, industrial wastes, solid wastes, leachates, etc.) and the increase of uncontrolled drilling of wells (more than 45 000 private wells, according to the 1996 CAS Census). This pollution has direct effects on public health and health expenses[2].

A study was commissioned by the World Bank[3] in 2003 to estimate the cost of environmental degradation in Lebanon. The study revealed that the total cost of environmental degradation due to health impacts and degradation of quality of life is

[2] Dar Al-Handasah, May 2004, *National Physical Plan for the Lebanese Territory*, Final Report
[3] METAP, the World Bank, *Cost of Environmental Degradation in Lebanon*, June 2003.

about 2.1% of the Gross Domestic Product (GDP) of Lebanon. Economic effects of pollution of water on health and quality of life was estimated at about 1.07% of the GDP.

1.6 CURRENT CONDITIONS

Review of reports and publications on existing conditions revealed that most large cities are served with piped sewerage systems, but not with sewage treatment plants; where some are either under construction or in the pipeline of planned projects. Many smaller cities and villages are not provided with piped sewerage systems. Instead, buildings are provided with percolation pits. Few villages have treatment plants (Ghadir, Hamana, etc.).

Some of the cities or villages discharge into the ground water through percolation pits or wells. Due to the geological formation of most of Lebanon, the percolated raw sewage infiltrates directly into the aquifers. The discrepancy of coverage across municipalities is a function of population density, geographic region, political will, public pressures, and fund availability and allocation.

1.6.1 Existing Wastewater Conditions

Table 2 summarizes the existing condition, as of December 2002[4]. Note that the level of coverage with piped sewerage network appearing in that table is based on a 1996 survey carried out by the Central Administration of Statistics. The following common attributes were identified for all projects:

- Network materials: Most networks are made of cement, asbestos cement (AC) and, for the newer ones, glass reinforced plastics (GRP).

- Availability for operation and maintenance: In all districts, although the wastewater system is under the responsibility of the regional water authorities, the latter do not have the necessary personnel or operating department to carry out this function. Therefore, the operation and maintenance of the system still remains with the municipalities on whose territory the sewers are located.

- Data on pumping stations: No data is available on pumping stations, except for Beirut, which has 5 pumping stations.

- Availability of septic tanks: Septic tanks are available for some households in each district. Private contractors assume the role of frequent emptying of septage.

- Water quality data: Except for a very few districts, no water quality data is available, in spite of the fact that all districts indicate the water quality analyses are frequently conducted. Water quality data may be used as a possible indicator

[4] Jacobs Gibb, *Technical Report on Privatization of the Water and Wastewater Sector*, December 2002.

of pollution of water resources and in the water supply networks, due to leaks and faulty cross connections between the water and wastewater networks.

- Existence of a wastewater treatment plant: Ghadir treatment plant is the only large plant currently operating in Lebanon. It is only a preliminary treatment. It was supposed to cover 30% of Beirut and all the western slopes of the Cazas of Aley and Baabda. The coverage implemented to date is limited to Beirut and part of its southern suburbs. Other coastal plant are under construction or in the pipeline for implementation. Several package plants were constructed by NGOs, however it has been reported that their operation is not adequate due to lack of the experienced operation personnel. Most wastewater is not treated and is discharged directly to the Mediterranean or local water courses,.

- Main collectors: Due to lack of funds and resistance of the population, expropriation for the construction of collector pipelines and treatment plants could not be applied. Instead, the administration is laying the collector pipelines within the beds or banks of rivers and streams. These pipelines are often eroded thus either discharging wastewater into the water streams or water from streams infiltrates into the pipelines, overloading the capacity and ultimately would disturb the performance of the treatment plants.
- Wastewater Master Plan: The wastewater master plan prepared in 1982 and updated in 1994 could not be implemented due to various technical, financial, administrative, political and social reasons. These should be assessed and the Master Plan updated accordingly.

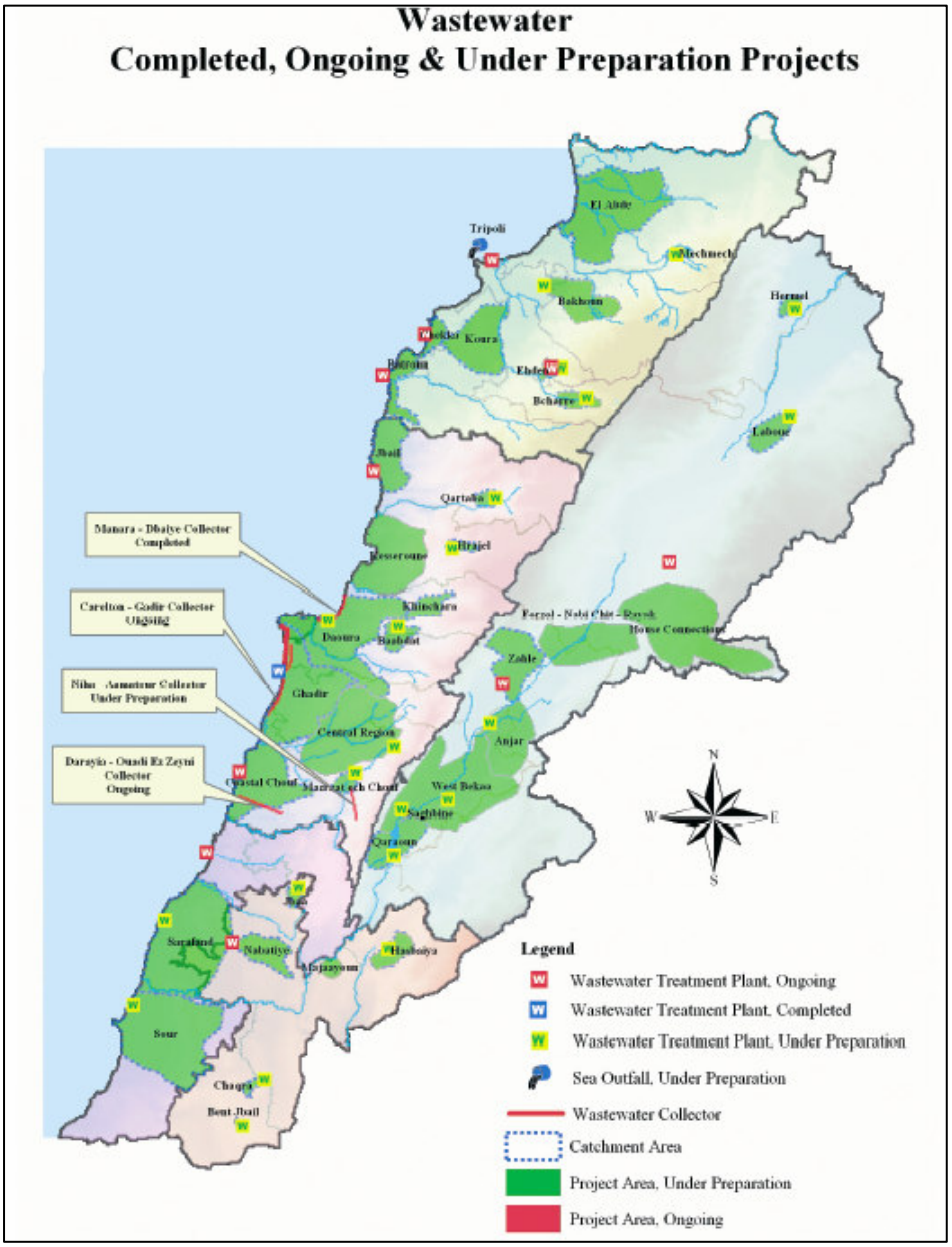
Table 2. Existing Conditions per the December 2002 Report by Jacobs Gibb

District	Estimated level of service with piped sewerage network (1996 survey carried out by the Central Administration of Statistics)	Estimated length of wastewater network (as of Dec. 2002)	Sewage treatment plants (STPs)	Regional Water Company
Akkar	20%	21,009 m	2 STPs serve 1,800 households	North Lebanon
Baalabeck	20%	73,269 m	1 STP serves 15,000 households & 1 small private ST not in operation.	Bekaa
Barouk	20%	129,707 m	3 STP serve 2,950 households	Mount Lebanon
Batroun	5%	4,512 m.	None.	North Lebanon
Bcharre	35%	8,871 m	None.	North Lebanon
Beirut	90%	311,892 m	A major treatment plant is under construction.	Mount Lebanon
Chamsine	30%	84,175 m	None	Bekaa
Minieh	30%	16,457	A small STP serving 250 households	North Lebanon
Ein El Delbe	20%	245,381	One primary STP.	Mount Lebanon
Jabal Amel	70%	75,956	3 private STPs serving a total of 720 households	South Lebanon
Jbeil	0%	None	1 STP serving 25,467people was planned in 2000.	Mount Lebanon
Kesrouan	20%	41,367	None.	Mount Lebanon
Kobeyat	20%	12,021	None.	North Lebanon
Koura	15%	11,357	None.	North Lebanon
Metn	65%	34,009	None.	Mount Lebanon
Nabeh El Tasse	30%	53,800	None.	South Lebanon
Saida	20%	64,526	An STP for primary treatment is under construction, that serves 234,000 people.	South Lebanon
Sour	5%	20,523	None.	South Lebanon
Tripoli	80%	212,712	One STP under construction.	North Lebanon
Zahle	60%	90,902	An STP is planned with a design capacity of 32,000 m3/d.	South Lebanon
Zogharta	40%	35,779	None.	North Lebanon

1.6.2 Completed and Proposed Projects

A more updated summary of the wastewater projects completed to-date, in progress, or planned is presented in Figure 4.

Figure 4. Wastewater projects completed, in progress, or planned (source: CDR, June 2005 report).



1.6.3 Summary of Current Conditions

The current condition of the wastewater sector can be summarized as follows:

- Most large scale municipalities have sewerage networks, without sewage treatment plants.
- For these municipalities, sewage treatment plants are either under construction or in the pipeline of planned projects.
- Smaller communities, however, neither have sewerage networks nor treatment plants. As such, these municipalities present a considerable risk of groundwater contamination.
- The communities in the rural areas use the onsite sanitation (septic tanks for example). Whereas, the authorities doesn't control any of them.
- Several communities (Hamana, villages in south of Lebanon and eastern Bekaa) treat their effluents in small treatment plants, but without proper operation and maintenance.

1.7 SECTOR OBJECTIVES

The overall vision of the wastewater sector is to provide a reliable wastewater collection, treatment, and disposal service for all the population of Lebanon. To achieve this mission, the following objectives of the wastewater sector are presented.

1.7.1 Improve Wastewater Coverage

There is a large discrepancy among regions in the percentage of the population served with a piped wastewater system in Lebanon, as indicated in the previous sections. On the other hand, small villages that dispose of their sewage through percolation pits may not necessarily require sewerage networks if they do not put the water resources at risk. Needless to say, geographic, political, and administrative factors may have combined to result in this situation.

The Government of Lebanon aims at improving the level of coverage in wastewater sector throughout Lebanon. One target is to increase the percent of the population served with piped or individual wastewater system. Another target is to increase the percent of treatment for the wastewater collected. The latter is especially important since in some regions wastewater is collected, but is discharged without treatment to the Mediterranean or to watercourses, whether surface or ground waters.

1.7.2 Protect Water Resources

Lebanon's already scarce water resources are seriously threatened by the repeated abuse from the discharge of untreated wastewater in the surface waterways and in the aquifers. It is commonly known that water resources, whether surface or ground[5], are polluted and their domestic use is a health risk. In fact several waterborne diseases were reported. The use of this water for irrigating vegetables and fruits that are eaten raw present as well a health risk.

Pollution prevention concept, of reducing the likelihood of pollution is a vision of the Lebanese Government. As such, a proactive approach, rather than a reactive one, should be followed to protect the waterways from pollution.

Likewise, the protection of the surface water resources will eventually help regenerate the fauna and flora and the natural ecosystems of the streams that have been deteriorated by the discharge of raw sewage.

1.7.3 Improve the Public Health and the Quality of Life

The pollution of the surface and ground water resources in Lebanon takes its toll on the health of the people, who experience increased incidents of water borne diseases, such as gastroenteric diseases. The provision of correct disposal or the wastewater will reduce the water pollution in the receiving environment, which will result in the reduction of water borne diseases and the all around improvement of the quality of life of the people.

1.7.4 Prevent Pollution of the Mediterranean

The Mediterranean is a source of revenue for Lebanon as it is an important tourist attraction in the country. Lebanon has signed international and regional conventions to protect the sea from pollution. Therefore, the Government aims to reduce the pollution of the Mediterranean, through prevention, or at least reduction, of the flow or untreated domestic and industrial wastewater to the sea.

1.7.5 Maximize the Use of Treated Effluent for Irrigation

Treated wastewater represents a valuable resource in Lebanon, where water resources are scarce. This alternative water resource is used in many countries around the word, with some religious restrictions in some countries, especially to irrigate the agriculture for food products. Re-using treated effluent would avoid the use of raw sewage for irrigation, as presently practiced in several areas in Lebanon. It would also relieve the demand on fresh water for drinking, municipal, and industrial purposes.

[5] Several studies carried out by AUB indicate that the ground water resources are polluted by Nitrate.

The availability of treated effluent could be matched to the availability of agricultural land and landscaping. For example, agricultural land along the coastline (e.g., in Saida) would be an obvious choice for the reuse of treated wastewater. However, for remote areas the cost of pumping the treated effluent should be compared to the cost savings from the reuse of the treated wastewater.

As for the sludge, a master plan has recently been prepared by CDR for its disposal and reuse. It concerns especially the residual sludge from sewage plants treating domestic or urban wastewater, the residual sludge from septic tanks, and the sludge from industries. In accordance with guidelines of the Ministry of Environment, the sludge could be used for agriculture in such a way to minimize the risk of negative effects on public health and the environment. If sludge does not meet the standard requirements, it must be disposed by incineration or on sanitary landfill.

1.7.6 Reduce the Negative Impact of Untreated Industrial Wastewater

The number of industrial establishments in Lebanon is in the tens of thousand range (around 30,000). However, the main environmental impacts arise from only a few hundreds of these establishments. Most of the main polluting industries do not have on-site industrial wastewater treatment plant. This results in the discharge of untreated industrial wastewater to waterways, or to sewerage systems. In both cases, the impact on the receiving environment (and to the receiving networks) is detrimental.

Therefore it is imperative that the main polluting establishments install pre-treatment units of their industrial wastes on-site, prior to the discharge of the industrial wastewater to the sewerage network. The practice of discharging industrial wastewater to waterways or to the Mediterranean should be stopped.

A master plan for industrial wastewater management has been prepared. It presents a diagnostic analysis of the present conditions and recommends solutions for various types and qualities of waste. The proposed plan is designed to encompass the necessary provisions for future expansion and upgrading, and to cope with the projected industrial growth. The main findings of this plan is that the majority of industrial wastes generated in Lebanon may be classified as non-hazardous, and that the industrial wastewater was projected to increase from 61,000 m3/d in 1994 to 192,000 m3/d in 2020. The recommended control method was "*Command and Control*". In addition, discharge standards and pre-treatment requirements were established. A special unit within the Ministry of Environment, to be legally empowered to implement the selected National Plan, was proposed.

1.8 BARRIERS AND CONSTRAINTS

The following are the barriers that may hinder achieving the wastewater objectives, and the constraints within which the Government and other stakeholders will work.

1.8.1 Regulatory Constraints

- Lax enforcement of the relevant Lebanese environmental controls, which generates a lack of incentive to reduce pollution.
- Absence of the "Polluter Pays Principle"; although this principle is mentioned in the environmental law, the Ministry of Environment has no means to implement it and the Government has not established its implementation mechanism.

1.8.2 Technical Constraints

- Lack of previous experience on running wastewater projects.
- Lack of a well established mechanism for capacity building to address this gap.
- Lack of public awareness.
- Absence of pre-treatment for industrial wastewater in factories.
- Absence of technical instructions and of regional master plans for each water establishment.

1.8.3 Institutional Constraints

- Lack of cooperation mechanisms among the different municipalities.
- Lack of cooperation mechanisms between the municipalities and the regional water establishments.
- Potential conflict of interest in the management of treated wastewater between the Litani River Authority and the Water Establishments and Municipalities in the Bekaa and South Lebanon located within the Litani Basin.

1.8.4 Economic/Financial Constraints

- Shortage of funds for the municipalities.
- Lack of mechanisms for securing revenues for the municipalities.

2. INSTITUTIONAL AND TECHNICAL APPROACH

2.1 REDEFINITION OF THE TERM: PROJECT

For the wastewater sector, the term "project" should be used to mean an integrated collection, treatment, and disposal/reuse within a wastewatershed basin. Therefore, the stakeholders and planners should think in terms of integrated projects rather than separate contracts for collection, treatment, and disposal; to ensure the integrity and sustainability of the wastewater activities (Refer to Section 5.2 - Volume 1 of the Report).

2.2 DEFINITION OF THE RESPONSIBILITIES OF THE GOVERNMENT

2.2.1 Introduction

Sanitation is an infrastructure service which is provided by Governments the world over, and Lebanon is no exception. Provision of the service at a large scale by the private sector is rare. However, considering the treated effluent as a resource is gaining popularity, particularly in countries with scarce water resources. In this case, the treated effluent is used instead of, or in conjunction with, fresh water for irrigation of agricultural and landscape irrigation.

The provision of adequate wastewater service is also essential to the health and wellbeing of population; hence the interest of the Government in that sector.

2.2.2 How is the sector managed?

The wastewater sector was until recently the responsibility of the Municipalities. However, being unable to fund such projects, the municipalities always depended on the support of the Ministry of Municipal Affairs as well as others, such as the Ministry of Housing, the Ministry of Energy and Water and the Ministry of the Displaced. As of 2004, the Regional Water Establishments are charged with the operation and maintenance of main sewer collectors/trunks, and wastewater treatment plants. The Municipalities being the owners of the collection networks, are charged with operation and maintenance of the house connections and collection networks. The interface among the two administrations is not clearly defined and would require greater precision of responsibilities.

According to Law 221, the Regional Water and Wastewater Establishments are responsible for the preparation of regional master plans, operation and maintenance of the infrastructure, and the activities of the project management. Currently, the Terms of Reference for all wastewater projects are prepared and issued by the Ministry of Energy and Water, or by the Council for Development and Reconstruction (CDR). Law 221 gives this responsibility to the regional water establishments in charge of this task along

with, at a later stage, the actual design of the wastewater components (sewers and sewage treatment plants).

2.2.3 How is cost recovered?

Investment for the construction of new sewerage systems (networks and/or sewage treatment plants) is dominated by the Government and the NGO's; either from the Country's annual budget, or from external funds administered by the CDR. As an indicative value, the budget allocated by CDR for the wastewater sector for 2002 was $84.3 million.

Cost is recovered for the operation and maintenance of the sewerage system. The municipalities collect an indicative tax for wastewater and sidewalk, which is a percentage of the rent value of the house/apartment/commercial building. No other tax is collected for wastewater investment or operation and maintenance. Currently, an average of 30 millions US$ is spent annually for the operation and maintenance of the sewerage system. The investment cost of the existing wastewater infrastructure stock has been estimated by the Société Générale at US$ 339 millions (Société Générale, 2002). Its present value is estimated at US$ 293 million.

On average, preliminary estimates indicate that the construction cost of sewerage network is around $150 / meter length; the construction cost of sewage treatment plants is around $100 /person served; and the operation and maintenance for sewage treatment plants is in the order of $0.5 /person/year; this is relatively on the low side, taking into account the limited electro-mechanical equipments.

2.3 ASSESSMENT OF THE INSTITUTIONAL MODALITIES OF OPERATION

The institutional options developed in this section aren't exhaustive. However, we examined only preferred options that could be subject for discussions by the stakeholders. Consequently, the possible institutional options to achieve the vision are as follows:

2.3.1 Institutional Option 1 (I-1)

The first option is to maintain the existing arrangement, where municipalities handle the operation and maintenance of the house connections and the collection networks, whereas regional water establishments handle the operation and maintenance of the main collectors and sewage treatment plants. The points of interface would have to be defined on maps indicating the tasks and the possible overlap.

This option maintains the present arrangement, although not yet in application. Its advantage is that it is in line with the Governmental planning for the sector.

However, the option has a number of disadvantages. Firstly, the division of responsibility and clear identification of roles could be a challenge and the cooperation mechanism has to be defined; the interface between the municipalities and the water establishments has to be more clearly defined. Furthermore, as explained later in the technical options, when considering sewage treatment plants collecting sewage from multiple municipalities, the definition of responsibilities may be an even greater challenge. Another disadvantage is that the regional water establishments have no expertise in managing wastewater facilities. Therefore, the sustainability of the existing institutional arrangement requires building the capacity of the regional water establishments by hiring qualified trained personnel, and by holding training programs to bring the competency of the staff responsible for the wastewater sector to the acceptable level.

2.3.2 Institutional Option 2 (I-2)

The second institutional option would concentrate all activities related to the wastewater sector in the hands of the regional water establishments. Moreover, it would be necessary to identify the responsibilities of the municipalities and the value of their infrastructure. Furthermore, developing the mechanisms of collaboration with them is essential.

The advantage of this option is that the regional approach has an advantage of the effective execution and the smooth operation of the wastewater sector. One disadvantage, however, is similar to that in Option I-1 but to a greater extent, in that the regional water establishments have no expertise in managing wastewater facilities. Therefore, the sustainability of the existing institutional arrangement requires building the capacity of the regional water establishments by hiring qualified trained personnel, and by holding training programs to bring the competency of the staff responsible for the wastewater sector to the acceptable level.

2.3.3 Institutional Option 3 (I-3)

The third institutional option reverts back all activities related to the wastewater sector to the municipalities. This option has the advantage that municipalities have a history of maintaining and operating part of the wastewater sector (the house connections, and collector sewers). The role of the municipalities would then extend to include the operation and maintenance of the main sewers, pumping stations (if available), and sewage treatment plants. However, the responsibilities of the water establishments would be the preparation of master plans and the control of their implementations by the municipalities.

The disadvantages of this option include the inadequate resources of the municipalities. This constraint will be even greater when municipalities have to contend with managing the whole wastewater sector. As such, identifying funding opportunities and cost recovery mechanisms is essential. In addition, the municipalities would face difficulties in identifying the area of their intervention, principally when a sewer line serves more than one municipality.

2.3.4 Institutional Option 4 (I-4)

This hybrid option fosters the role of the private sector, regardless of the authority in charge of the wastewater sector. So, whether the management of the wastewater sector is carried out by the municipalities, water establishments, or both, this option includes a role for the Private Public Partnership (PPP). A case in point of the PPP model is the Ghadir sewage treatment plant, for which the operation and maintenance is contracted out by the CDR to the private sector. The issue emphasizes the feasibility of the PPP model.

Furthermore, this issue also highlights an example of a situation where an organization (CDR) had to be delegated by the government to handle an activity (contracting out the operation and maintenance) although it is not within its domain, simply because of the lack of a clear regulatory and administrative framework.

2.4 IDENTIFICATION OF THE BEST TECHNICAL OPTIONS

The technical options considered are as follows.

2.4.1 Technical Option 1 (T-1)

The first technical option to consider is to construct sewerage networks in each village/urban center. The collected wastewater would then be conveyed to small scale sewage treatment plants (STPs) in each micro-basin, such that one plant would serve each city or village or neighboring villages within the micro-basin.

A number of alternative sewage treatment techniques exist, including trickling filter and activated sludge. Each method has its advantages and disadvantages in terms of capital and operation cost, requirement for land expropriation, suitability for the area in question, etc. Selection of the technique to use for a given plant would have to be determined on a case by case basis, following a multi-criteria analysis framework.

This technical option has the advantage of ease of identification of clear roles and responsibilities. Essentially, each municipality would be responsible for the operation and maintenance of the sewage treatment plant within its boundaries or within the micro-basin that the city or village is located in. No conflict of responsibilities is envisaged. The plant is relatively small and does not require a lot of experience to operate. In few cases the plant may serve a couple of neighboring villages located within the same basin; this would lead the way to set the cooperation mechanism among municipalities. The experience of cooperation among municipalities would start at a limited scale between neighboring villages using a common STP. This experience would then grow progressively as the small STPs are replaced over the years by regional STPs.

This option also defers the problem of constructing large collectors and expropriating service roads for the collectors. In this context, the authorities should avoid laying the main sewers in the river beds. This has lead to other serious problems, including the

washout and displacement of the sewers, the settlement of manholes, the breakage of sewer lines, the high infiltration rates during winter (this would lead to inefficient operation of the treatment plants), etc..

Expropriation of lands for large sewage treatment plants has been problematic; although the lands were identified at the master Plan level in 1982, the authorities could neither expropriate the lands nor allocate the necessary expropriation budget.

This option also avoids the delay in resolving the water resources pollution problems.

It mainly provides a progressive and phased solution to the wastewater sector. The small plants have usually a life span of about 15 years. During this period, the water establishment would have built-up their capabilities and would have progressively worked towards central large scale treatment plants. As such, this technical option would work well with all institutional options identified previously.

2.4.2 Technical Option 2 (T-2)

The second technical option is the same as the previous one, with one difference in using regional sewage treatment plant(s). That is, the option calls for constructing sewer networks in each village/urban center. A main sewage conveyance and pumping station will then convey the collected wastewater from a number of cities/villages to one (or more) regional sewage treatment plant(s). The number of treatment plants should be determined using an optimization approach.

The advantage of this approach is that the operation and maintenance of the regional sewage treatment plant is centralized. The O&M would have to be assumed by either the water establishments or a group of municipalities. This option was adopted by the 1982 Master Plan, yet its implementation faced several constraints and barriers that limit its applicability, including:

(a) The administrative shortcoming.
(b) The lack of experience.
(c) The investment cost required for the main sewage collector/rising main.
(d) The expropriation required for the main sewers; to avoid this, the relevant authorities laid these sewers within the river beds. These were damaged by the river flow; pipes and manholes were broken and dislocated.
(e) The necessity of devising a mechanism for cooperation between municipalities contributing to the treatment plant and also between the municipalities and the regional water establishments.

2.4.3 Technical Option 3 (T-3)

The third technical option to consider is the onsite sanitation in remote areas, combined with either technical options T-1 or T-2 for the urban clusters. This option, as with any others, has its advantages and disadvantages.

The advantages of this option is that it circumvents the need to extend sewerage networks to serve communities characterized by a small number of homes scattered over large distances, where a network is not economically justifiable. Furthermore, the local septic tanks can provide inexpensive and immediate solution to the sanitation needs in remote communities. Finally, the septic tank operation can be readily regulated and managed by the local municipalities.

The disadvantages of this technical option, however, is that the inaccurate or faulty design and construction of septic tanks and percolation pit will result in the contamination of the soil and groundwater. Furthermore, the frequently evacuated sludge (every 6 months to two years, depending on operation) requires proper treatment. The sludge treatment is examined in the master plan for sludge (cf. 1.7.5). Besides, drying beds and other methods would require land and/or equipment which are scarce.

Therefore, this option should be considered for remote villages and on a case by case basis.

2.5 OPTIMIZATION OF THE SUPPLY BY SECTOR AS A FUNCTION OF ADAPTED PERFORMANCE CRITERIA

The performance criteria for the evaluation of the various technical, institutional, and economic options are as follows:

- Implementability and suitability for local conditions, including seasonal weather conditions, seasonal flow variations, capacity, potential re-use, land availability, disposal options, acceptance of the population.
- Requirement for trained personnel; would specialized training be required, how difficult is the training to achieve, are technicians available in the market, can the relevant administration afford them?
- Requirement for land expropriation; such as all legal and administrative papers and procedures and the acceptance of the population of having a sewage treatment plant in the neighborhood of their properties, etc.
- Requirement for imported materials or equipment; such as availability of equipment and spare parts in the market.
- Capital cost; including the options of the water establishments or the municipalities to self finance their sewerage scheme, government loan, or government subsidies.
- Operation & Maintenance cost; such as the possibility of the relevant administrations to include in their annual budget the O&M cost.

- Simplicity of operation; it is preferable to provide, at least in the first phase of the development a treatment process that is simple to operate with as little electro-mechanical equipment as feasible.
- Sludge handling; such as how would the sludge be disposed of? Would the sludge be re-used and for what purpose?
- Sustainability; efforts should not be limited to securing the initial investment, O&M is equally important as well as the availability of technical and administrative staff to secure the continuous and adequate operation of the scheme.
- Externalities; including impacts on surface and ground water resources, health, agriculture and industry.
- Socio-economic impacts; including the acceptance of the population and the improvement of the living conditions.
- Cost recovery implications; including availability of investment funds, willingness of the government to subsidize the investment, willingness of the population / administration for recovering the investment and operation and maintenance.

The technical, economic, and institutional options proposed in this chapter are diverse and are site specific. Therefore, the evaluation of the applicability and merits of these options will be carried out for site specific projects and on a case-by-case basis.

3. ECONOMIC AND SECTORIAL APPROACH

3.1 ECONOMIC OPTIONS

The following economic options are considered for provision of the wastewater services to the communities.

3.1.1 Economic Option 1 (E-1)

The first economic option is for the Government to continue to bear the full cost of investment in the wastewater sector. That is, investment for the construction of new sewerage networks, pumping stations (as necessary), and sewage treatment plants will be publicly funded.

Cost recovery would be only for the operation and maintenance expenditures for the sewerage system, including sewer networks and sewage treatment plants. The cost recovery is proposed to be accomplished through levying a fixed tax through the local municipalities (municipality tax).

This option would be advantageous for its simplicity, and would be appropriate if municipalities were in charge of the operation and maintenance of the wastewater sector (Instuitional Option I-3). The disadvantage of this approach is that it does not reflect the actual wastewater usage by the consumers, but rather treats all equally in that regard.

3.1.2 Economic Option 2 (E-2)

The second economic option is to maintain the investment cost borne by the government, but to recover the operation and maintenance cost through a variable tax related to percent usage of the water for each household. This tariff is to be collected by the regional water establishments.

The advantage of this option is that the cost recovery reflects the actual usage level by each user. However, in case water metering is not present, this would constitute limitations since the assessment of the water (and, correspondingly, the wastewater bill), would not be accurate.

Furthermore, this economic option is appropriate if the regional water establishments were in charge of the operation and maintenance of the wastewater sector (Institutional Option I-2).

3.2 IMPACTS ON ECONOMIC DEMAND

The effect on aggregate economic demand of the wastewater sector presents itself in terms of the increased economic activities caused by the investment in the sector,

requiring the construction of (potentially large scale) sewerage networks and sewage treatment plants. This would correspond to increased demand in terms of hiring workers, technicals and engineers both during the construction phase and those required for the operation and maintenance phase. Furthermore, the construction of these projects will enhance the demand on the design firms, construction companies, and electromechanical equipment suppliers.

3.3 IMPACTS ON ECONOMIC SUPPLY

Services are either used for final consumption or utilized for future production. For the wastewater sector, although a portion of the service is used for final consumption, the provision of treated wastewater would have a marked impact on downstream activities, such as agriculture. This is due to the fact that the treated wastewater will provide a resource for irrigation, and will relieve part of the demand on freshwater; which can be dedicated to drinking purposes, municipal and industrial usage.

3.4 EXTERNALITIES

The wastewater sector is unique in that most of the socio-economic aspects are related to externalities. The externalities related to the wastewater sector include:

- Socio-economic impacts resulting from land expropriation, necessary for sewage treatment plants
- Economic impacts resulting from the change (usually deterioration) of land valuation, due to the construction of sewage treatment plants
- Environmental impacts resulting from the potential of pollution of groundwater, waterways and the Mediterranean, in case of faulty construction and/or operation of sewerage systems
- Additional treatment and disinfection of water resources for domestic supply if proper wastewater services are not provided
- Reduced health bill due to the reduction of water borne diseases, once proper wastewater services are provided
- Recovery of water resources and greater availability of irrigation water due to the reuse of properly treated wastewater

4. SPATIAL AND SOCIAL APPROACH

The geographic issue is relevant to the wastewater sector in so much that the need, specific cost, and feasibility of the options may differ from one geographic location to the next. This is evident in proposing onsite sanitation (septic tanks) for small villages and/or remote municipalities. Furthermore, the spatial attribute of the communities should have a bearing on setting priorities for intervention in the wastewater sector, in that communities with the highest potential impact on water resources should be ranked higher. Following is a brief description of specific spatial and social context for the sector.

4.1 SATISFYING THE NEED AND DEMAND

All technical options are aimed at satisfying the need. Many villages and small towns have neither sewerage networks nor sewage treatment plants. Furthermore, most large cities have no sewage treatment plants, although they may have sewerage networks. Therefore, for a considerable portion of the population the collected wastewater ends up being discharged raw in water courses or in the Mediterranean. Therefore, the wastewater service is required, for the next 10-15 years, to satisfy the absolute measure of service, namely the need. It is anticipated that over longer period, relative terms would set in, and the wastewater service would be required to raise the percent coverage in all cities.

4.2 POTENTIAL AND REGIONAL RISKS

The provision of wastewater services is especially urgent in geographic regions where inadequate services have negative ramifications on the natural resources and public health. For example, districts where the inappropriate discharge of untreated wastewater has a direct negative impact on the confined karst aquifer.

4.3 SPATIAL HIERARCHY, AGGLOMERATIONS AND NETWORKS

Providing wastewater services will reduce the pollution load on the water resources and will result in cleaner water supplies. This, along with the improvement of the cleaner water supply, will increase the tendency of agglomeration or formation of cluster of communities.

4.4 DIRECT EFFECTS (DEMAND) AND INFLUENCE ON THE DEVELOPMENT

This consideration relates to demand side issue, meaning that the service provided in a region is driven by a demand for that service. This demand may be driven by a political, economic, or social pressures. This issue was considered in section 1.4.2.1.1. Again, the provision of wastewater service is not expected to have a tangible effect on the demand.

4.5 IMMEDIATE EFFECTS AND RESTRUCTURING EFFECTS

If the Government were to curtail the provision of wastewater service, it is not expected that this would result in a significant pull from one region and push onto another. In other words, the effect of the level of adequate wastewater services on the populations tendency to select a living quarter seems very small in Lebanon. Therefore, this spatial and social consideration is negligible and will not be considered further in the analysis.

5. RECOMMENDATIONS

Based on the examination of the technical options, technical option (TO3) seems the most suitable, where the onsite sanitation is suggested in remote areas, combined with one or multiple wastewater treatment for each watershed. This solution requires that the Ministry of Energy and Water determines the watershed limits for the whole country and the areas of intervention of the wastewater authorities. This limitation would also delineate the shared watersheds. Whereas, we propose that the concerned establishments define a mechanism of coordination to regulate their intervention on these shared areas. and prepare the master plans for their area of jurisdiction.

From the institutional point of view, we propose to implement a phased approach. In essence, this approach favors the staged implementation of institutional structure. That consists of maintaining the present arrangement, where municipalities handle the operation and maintenance of the house connections and the collection networks, whereas regional water establishments handle the operation and maintenance of the main collectors and sewage treatment plants. The points of interface would have to be defined on maps indicating the tasks and the possible overlaps. The Wastewater Establishments should also focus on building their capabilities through recruiting specialized staff and/or hiring the services of expertise to encompass their currents weaknesses.

From the economical point of view, we propose that the Government continues to bear the full investment cost in the wastewater sector. That is, the construction of new sewerage networks, pumping stations (as necessary), and sewage treatment plants will be publicly funded. Cost recovery would be only for the operation and maintenance expenditures for the sewerage system, including sewer networks and sewage treatment plants. For the short term, the cost recovery is proposed to be accomplished through levying a fixed tax through the local municipalities (municipality tax). For the mid and long term, and depending on the installation of water meters in the Establishments, cost recovery could be through a variable tax related to the actual water consumption of each subscriber.

Besides, elaborating and clarifying the mechanisms of coordination among the various stakeholders should have priority and are as important as defining the responsibilities among them. It is important to clarify the responsibilities and reduce the overlapping of duties between the Litani River Authority (LRA) and the Water and Wastewater Establishments of the South and the Bekaa. Furthermore, the coordination mechanisms

should also concern the relationships among CDR, the Council of South, all Water and Wastewater Establishments, the Ministry of Energy and Water, the LRA, and all other relevant administrations.