15. WASTEWATER MANAGEMENT

Domestic wastewater management is one of the greatest headaches of Lebanese municipalities and concerned ministries (Energy and Water, Interior and Municipalities, CDR). As indicated in Section 1.3 on population pressures, Lebanon generates an estimated 249 Mm^3 of wastewater per year, with a total BOD load of 99,960 tonnes. In addition, and as described in Section 3.2.5 on solid and liquid wastes, industries generate an estimated 43 Mm^3 of wastewater per year.[1] In the absence of waste surveys and industrial production statistics, it is difficult to estimate the composition and BOD load of industrial wastewater. It has been reported that the total BOD load of industrial wastewater is about 5,000 tonnes per year (METAP / Tebodin, 1998).

15.1 Wastewater Collection, Treatment and Disposal

Wastewater management is expensive! It requires adequate collection and treatment of wastewater, and disposal of treated effluent and sludge. To date, while significant improvements are being made to the sewer network, little has been achieved in terms of wastewater treatment. Nevertheless, several wastewater treatment plants are expected to become operational over the coming years.

15.1.1 Wastewater collection

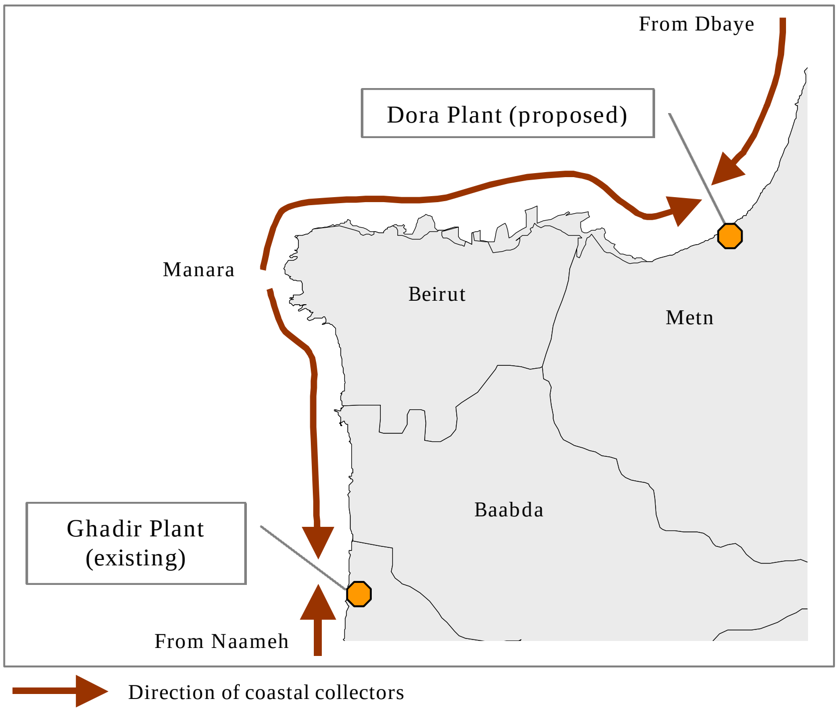
According to the CAS census of Buildings and Establishments (1996-97), about 37 percent of the nearly half-a-million buildings in Lebanon were connected to a sewer network (see Section 4.2.5). The remaining buildings (62 percent) either use cesspools and septic tanks or simply release raw sewage directly into the environment, including rivers and streams, dry river beds, and underground (through dry wells). Since 1997, extensive wastewater works have been achieved, which has presumably improved the wastewater collection capacity. The current extent of buildings connected to sewer networks is not known, but presumably higher than 1996-97 levels.

<u>Greater Beirut Area</u>

Wastewater from Beirut as well as parts of the Cazas of Metn, Baabda and Aley is collected and transported to a series of coastal collectors. The northern main collectors comprise two lines that converge on Dora, where a wastewater treatment plant and associated outfall will be constructed. Specifically, these lines extend from the Manara area in Ras Beirut to Dora, and from Dbaye to Dora. Together, these northern collectors extend over about 17 kilometers and are designed for a future population of 891,000 people (CDR, 2001). Likewise, the southern collectors comprise two lines converging on Ghadir, where a preliminary wastewater treatment plant already exists. These converging lines originate from the Manara area and Naameh, respectively. The two southern collectors are about nine kilometer long and will serve an estimated population of 784,000. Figure 15.1 illustrates the overall design for wastewater collection and treatment in the GBA (design capacity 1.68 million people):

[1] Industrial wastewater was estimated at 61,000 Mm^3 and almost 192,000 Mm^3 for years 1994 and 2020, respectively (CDR / Dar Al Handasah, 1997). Wastewater for 2000-01 was estimated assuming a linear increase between 1994 and 2020.

Figure 15. 1
Wastewater Collection and Treatment Scheme for Beirut



> The CDR has issued an invitation to tender for the Dora wastewater treatment plant specifying that the contractor should finance the design and construction of the plant (CDR, 2001).

Although works on the northern coastal collectors were completed in 2001, the collectors will remain out of operation until the proposed Dora wastewater treatment plant is constructed. To date, no funding has been secured for the construction of the Dora plant,[2] which means that the collectors will remain idle for several years. Meanwhile, the newly built collectors will require repair and routine maintenance works (e.g., flushing). CDR is currently contracting out the construction of the southern coastal collector from Ras Beirut to Ghadir.

Beyond Greater Beirut Area

Wastewater collection systems are under preparation for major coastal cities including Tripoli, Jounieh/Kesrouane, Saida and Tyre. Wastewater collectors are under execution in Akkar, Beddawi, Laboue and Baalbeck (CDR, 2001).

15.1.2 Wastewater treatment

Thirty-five wastewater treatment plants (WWTP) are currently planned or under construction: seven under construction, 18 under preparation and funded, and 10 with no funding secured to date (see Table 15.1). The GOL initiated the construction of seven wastewater treatment plants in 2001: Saida, Chekka, Batroun, Jbeil, Chouf coastal area, Baalbeck and Nabatiyeh.

[2] *Pers. comm*. Mr. Ismail Makki, CDR, October, 2001

The only large-scale wastewater treatment plant that is currently operational is the Ghadir plant, south of Beirut. The Ghadir plant provides only preliminary treatment (i.e., grit and scum removal). A current study is exploring the economic feasibility of upgrading the Ghadir wastewater treatment plant to provide secondary treatment before discharge into the sea. There are also several small community-level wastewater treatment plants that became operational in 2001 (see Section 15.1.4).

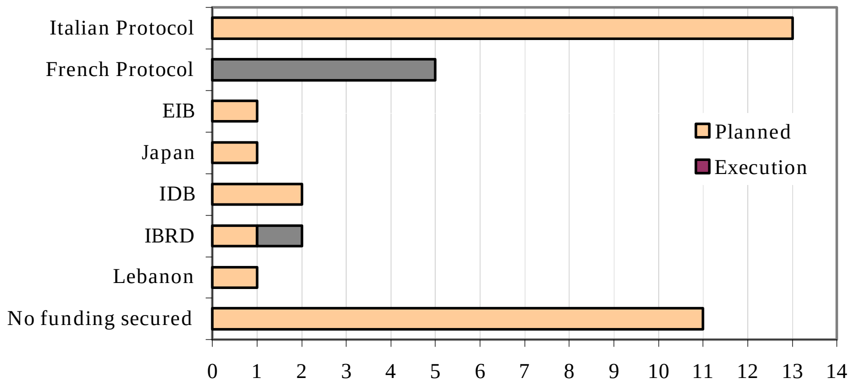
Table 15. 1
Current Status of Wastewater Treatment Plants

Caza	*Location/Name*	*Implementation Status*		
		Under Execution	Under Preparation	No Funding Secured
Akkar	Jebrayal			X
	Abdeh			X
	Michmich		X	
Minieh-Dinnieh	Bakhoun		X	
Tripoli	Tripoli		X	
Becharre	Becharre			X
	Hasroun			X
Koura	Amioun			X
Batroun	Chikka	X		
	Batroun	X		
Jbeil	Jbeil	X		
	Kartaba		X	
Kesrouane	Khanchara			X
	Harajel		X	
	Kesrouane/Tabarja			X
Metn	Dora			X
Aley	Ghadir			X
Chouf	Chouf coastal area	X		
	Mazraat el Chouf		X	
South	Saida	X		
	Sour			X
Hermel	Hermel		X	
Baalbeck	Laboue		X	
	Yammouneh		X	
	Baalbeck	X		
Zahle	Zahle		X	
	Aanjar		X	
West Bekaa	Jib Jinnine/Deir Tahnich		X	
	Karoun		X	
	Sohmor/Yohmor		X	
Hasbaya	Hasbaya		X	
Nabatiyeh	Jbaa		X	
	Nabatiyeh	X		
Bint Jbeil	Shakra		X	
	Bint Jbeil		X	

Source: Adapted from CDR, 2001

According to CDR, wastewater management works are hampered by lack of funds. Although the GOL has secured funding for 25 wastewater treatment plants, to date at least 10 proposed plants remain without funding (see Table 15.1). Sources of funding are diverse and include the Italian Protocol, French Protocol, European Investment Bank (EIB), Japan, Islamic Development Bank (IDB), International Bank for Reconstruction and Development (IBRD), and the Government of Lebanon. All five wastewater plants financed under the French Protocol are under execution, in addition to one plant financed by the IBRD for Baalbeck (see Figure 15.2).

Figure 15. 2
Number of WWTPs by Source of Funding



Source: CDR, 2001

15.1.3 Wastewater disposal

In the absence of operational wastewater treatment plants, effluents from coastal agglomerations are discharged into the sea while effluent from inland communities are disposed in rivers, streams, on open land or underground. While the number of sea outfalls has been surveyed, there is no information on the state of these outfalls (i.e., length, dimensions, loading volume, etc.). As indicated in Figure 15.4, there are approximately 53 outfalls along the coast, 16 of which are located between Dbayeh (North of Beirut) and Ghadir (South of Beirut). The number of sea outfalls in each Caza is indicated between parentheses (CDR/LACECO, 2000c). Most outfalls extend only a couple of meters or terminate at the surface of the water (i.e., no submersed outfall and therefore no effective dilution of wastewater).

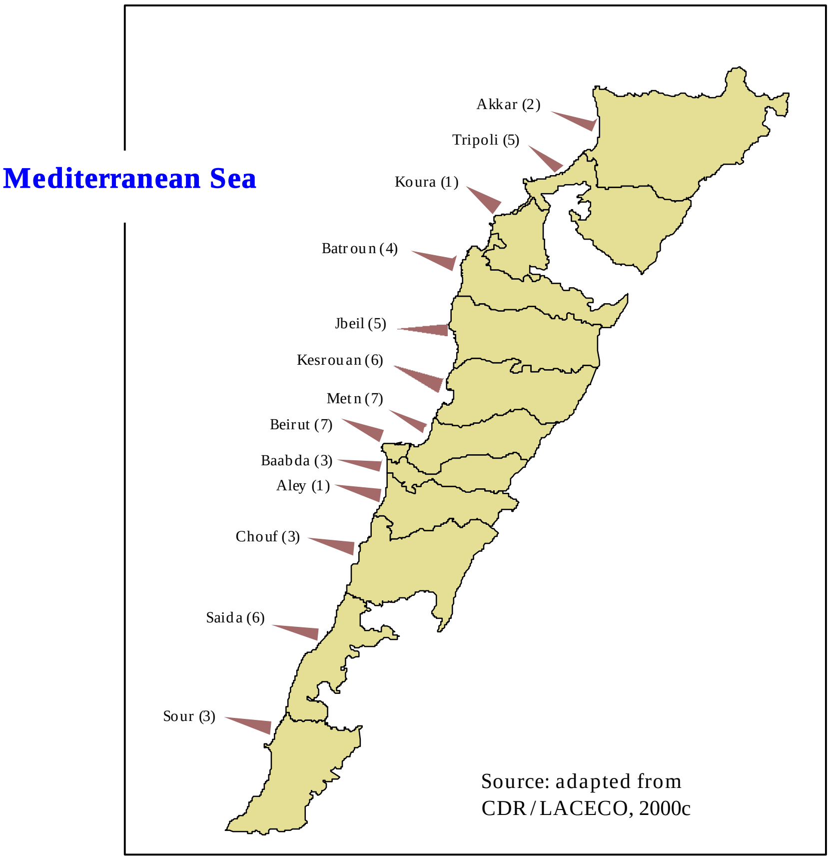
The Ghadir outfall is a 1,200-mm diameter submersed pipeline which extends 2.6 km into the Mediterranean Sea. The outlet point is approximately 60 meters deep thereby achieving some dilution of the disposed wastewater (CDR/BTD, 2001). Table 15.2 presents the average flow rates and BOD levels of wastewater pumped through the outfall (Ibrahim and El-Fadel, 2001).

Table 15. 2
Average Flow Rate and BOD_5 of Wastewater Through the Ghadir Sea Outfall

Month	*Flow Rate (m^3/day)*	*BOD_5 (mg/l)*
June, 2000	24,419	371
July, 2000	30,348	527
August, 2000	39,247	494
September, 2000	41,612	418
October, 2000	41,000	445
November, 2000	40,967	411
Average	**36,266**	**444**

Source: CDR/Subal, 2000

Figure 15. 3
Distribution of Wastewater Outfalls Into the Mediterranean Sea



15.1.4 Community-Based Initiatives in wastewater management

> Several wastewater treatment plants supported by the USAID provide secondary treatment resulting in water that is suitable for irrigation.

Delays in wastewater works in several regions in the country have prompted several municipalities (elected in 1998 after a 35-year hiatus) and local communities to make their own arrangements to improve wastewater collection and treatment. Perhaps the best example is the recent inauguration of a small wastewater treatment plant in Hammanah (May 2001) in Mount Lebanon. The plant uses a combination of extended aeration and activated sludge treatment technologies. It is designed to serve 8,000 people and can be expanded to serve 12,000 people in the future.

The Hammana WWTP was constructed before the war but was destroyed in 1976 before starting operations. USAID co-financed its rehabilitation in 2001 and also funded other small-scale wastewater treatment plants including one plant in Jabbouleh, Baalbeck region, and one in Bhchetfine, Shouf region (see Table 15.3).

Table 15. 3
Small-Scale Wastewater Treatment Plants Funded by USAID

Area	*Village*	*NGO*	*Cost (US$)*	*Beneficiaries*
Bekaa	Jabbouleh	CHF	74,000	NA
Dennieh	Markibta	Pontifical Mission	113,000	260 families
Akkar	Qobayat	Pontifical Mission	195,000	NA
	Charbila	Mercy Corps	80,000	5,759 families
	Bqerzla	Mercy Corps	23,811	330 families
	Akkar el Atika	YMCA	80,000	NA
	Koss Akkar	YMCA	143,000	NA
Baabda	Himmana	Pontifical Mission	168,000	1,400 families
	Kornayel	Pontifical Mission	NA	NA
Chouf	Bchetfine	Creative Associates	350,000	240 families
Marjaayoun	Borj el Moulouk	Pontifical Mission	185,000	NA
	Marj el Zouhour	YMCA	130,000	NA
Hasbaya	Wazzani	Mercy Corps	31,677	NA
Total	**13 WWTPs**		**1,573,488**	

Note: Costs include community contributions, which may reach 40 percent of the total
NA: Not Available

Source : Data supplied to ECODIT by USAID Lebanon Mission, August 2001

15.2 Key Government Policies and Actions

In 1995, a Damage Assessment Report was prepared to formulate a policy framework for the wastewater sector (Khatib & Alami, 1995). Implemented over three phases, the resulting National Emergency Response Program (NERP) launched two major programs:

- ❑ Coastal Pollution Control Program (CPCP); and
- ❑ Water Resources Protection Program (WRPP).

Barcelona Convention and its protocols. Despite the cancellation in the late nineties of the World Bank loan to fund wastewater management works in Saida, Sour, and Kesrouane, CPCP is proceeding with alternative funding from various sources (see, for example, Section 15.1.2). Works under the WRPP include the rehabilitation of water treatment plants and water sources (springs and wells), as well as the rehabilitation and construction of transmission and distribution networks.

15.2.1 National Emergency Rehabilitation Program

Achievements under the National Emergency Rehabilitation Program (NERP) include the rehabilitation of two wastewater-pumping stations in El-Mina (Tripoli) and Jounieh, and the rehabilitation and construction of 820 kilometers of sewer networks in different areas of Lebanon (CDR, 2001). The construction and equipment of the first large-scale wastewater pre-treatment plant in Lebanon was completed in Ghadir, South of Beirut, as well as the rehabilitation of the associated sea outfall. This plant was brought into service in November 1997. NERP also implemented the installation and/or rehabilitation of sewer networks to serve the North Beirut area as well as the northern suburbs of the capital, up to the coastal agglomeration of Dbaye (see Section 15.1.1).

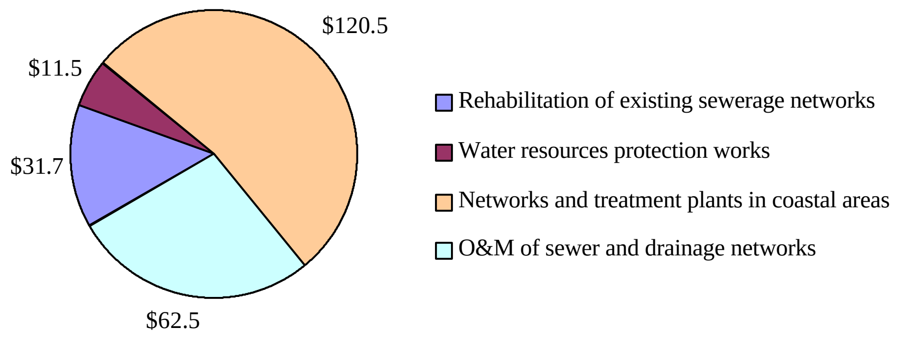
> In 2001, the MoE took the lead in setting up a national follow up committee to look into and facilitate WWM works across the country. Hosted by the MoE, this committee is composed of representatives from the CDR, the MoEW and the MoIM, and holds regular meetings to check on progress and bottlenecks.

15.2.2 Government spending

Between January 1, 1992 and December 31, 2000, CDR has awarded 122 contracts worth a total of US$226.2 million in the wastewater sector. Figure 15.4 presents the total value of all contracts awarded and subdivided in the following categories:

- ❑ Rehabilitation of existing sewer networks;
- ❑ Water resource protection works;
- ❑ Construction of new networks and treatment plants; and
- ❑ Operation and maintenance of sewer and drainage networks.

Figure 15. 4
Total Value of Contracts Awarded for Wastewater Works (US$ million)



Source: CDR, 2001

15.3 Outlook

Wastewater management in Lebanon is still in its very early phases. Plans are well underway to expand the current Ghadir wastewater treatment plant and implementation is expected to commence during 2002. Meanwhile, many other treatments plants are under construction, some of which will become operational in 2002. While sewage pollution load into the sea and rivers will decrease in the coming years, the operation of wastewater treatment plants also will generate large quantities of sludge that will require adequate management to prevent environmental degradation.

15.3.1 Upgrading the Ghadir wastewater treatment plant

A feasibility study for expanding and upgrading the Ghadir wastewater treatment plant was undertaken to determine the most suitable and cost-effective treatment alternatives (CDR/CES-BTD, 2001). Initial project screening indicated that the plant should be located on land gained from the sea opposite the existing preliminary wastewater treatment facility. Specifically, the study then examined two technical alternatives:

- ❑ Activated sludge process with primary treatment; and
- ❑ Activated sludge process with anaerobic pre-treatment.

The first alternative would need to reclaim a lot of area from the sea and the total project cost was estimated at US$168 million for a capacity of 1.3 million people-equivalent. Land reclamation works alone were evaluated at more than US$25 million. The study found that the second alternative was more feasible as it could be implemented in several stages, requires less offshore land reclamation, produces less sludge and would be energy self-sufficient (biogas generation would provide sufficient energy for on-site uses). This alternative would cost an estimated US$52 million to serve one million people-equivalent and an additional US$52 million to be upgraded with an aerobic treatment system.

To minimize costs further and eliminate the need to reclaim land offshore, a sub-alternative was then elaborated. This sub-alternative would eliminate the activated sludge process altogether and thereby consist only of an anaerobic treatment and a sea outfall, while still fulfilling environmental obligations under the Mediterranean Action Plan (MAP). The first stage of implementation (up to one million people-equivalent) would cost an estimated US$52 million. The plant could then be upgraded to serve 1.3, 1.6 and 1.8 million people-equivalent, respectively, in three additional stages. By the end of the third stage, the plant would have incurred additional costs worth a total of US$32 million. Land reclamation would be required during the third and fourth phases only. Using this alternative, the final cost of treating wastewater was estimated at 12 cents per cubic meter, down from 33 cents and 20 cents for the first and second alternatives, respectively.

15.3.2 Management of sewage sludge

In the coming few years, Lebanon will face a new waste management problem: what to do with sludge generated from wastewater treatment plants? The bulk of the suspended solids, which enter a wastewater treatment plant, and the waste solids generated from the biological treatment must be handled as sludge at some point in the treatment process. The character and amount of the solids depend on the number and type of industries within the community, the degree to which their wastes are pretreated before discharge to the public sewers, and to some extent, the primary and secondary processes employed within the treatment plant (McGhee, 1991).

> Sewage sludge contains micro-organisms that may contribute to the transmission of disease, as well as organic and inorganic contaminants that may be hazardous or toxic to humans or have detrimental effects on the environment in general.

Sewage sludge should be conditioned before final disposal. Conditioning could include aerobic and anaerobic sludge digestion, composting, chemical addition, and heat treatment. These processes will improve the chemical and physical characteristics of sludge (i.e., reduce impermeability) and may also reduce total mass of solids. To date, while wastewater treatment plants envisioned for Lebanon will provide secondary treatment technology, it is unknown what type of sludge conditioning will be afforded.

In anticipation of future wastewater treatment plants, a master plan for sludge management is currently being drafted (CDR/Tecsult-Kredo, 2001). The preliminary report indicates that treatment plants will either generate digested sludge at the rate of 35-49 g/person/day, or undigested sludge at the rate of 63 g/person/day. For the GBA (Ghadir and Dora wastewater treatment plants), this would be equivalent to about 113 tonnes of sludge per day (see Table 15.4)! The study is also examining available options for sludge reuse and application as a soil conditioner. For example, digested sludge could be used in agriculture and sylviculture (forest seedling production), provided the sludge meets minimum quality standards such as permissible heavy metal content.

Table 15. 4
Estimated Sewage Sludge Production for 2001 and 2010 (Wet-Weight Basis)

Mohafaza	*2001*		*2010*	
	Mass (Tonnes/day)	Volume (m^3/day)	Mass (Tonnes/day)	Volume (m^3/day)
Beirut (Dora and Ghadir)	113	283,182	136	339,607
Rest of Mount Lebanon	21	162,981	26	198,150
North Lebanon	50	141,892	61	173,389
South	14	66,811	18	83,329
Bekaa	53	297,472	69	465,552
Total	**251**	**952,338**	**310**	**1,260,028**

Note: After drying and digestion processes, sludge volume can decrease by as much as 90 percent

Source: CDR/Tecsult-Kredo, 2001