14. SOLID WASTE MANAGEMENT

Varying degrees of Solid Waste Management is currently practiced in different parts of the country. With the exception of municipal solid waste (MSW) management in the extended Greater Beirut Area, and to a lesser extent in Greater Tripoli, solid waste continues to be managed in a manner that is not protective of either human health and/or the environment. Even in the extended GBA, serious questions are raised about the financial sustainability and replicability of the Emergency Plan for SWM implemented since 1997. The GoL has yet to make serious policy commitments to promoting, and eventually requiring, sustainable and environmentally-friendly SWM practices throughout the country and by all sectors (population, industry, agriculture, construction, tourism, energy).

14.1 Municipal Solid Waste Characteristics

Municipal solid waste (MSW) makes up about 90 percent of the total solid waste stream generated in Lebanon. The main sources of MSW are households, commercial establishments, street markets, street cleaning operations, and public garden pruning.

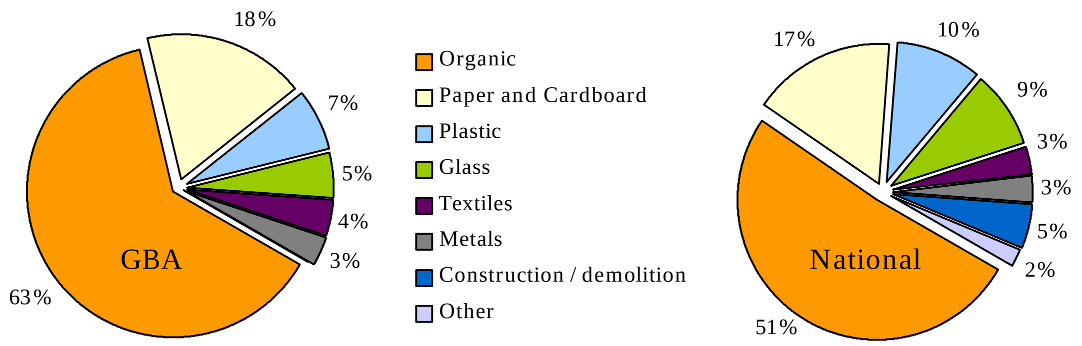
14.1.1 MSW Quantity

This report estimates that Lebanon generated about 1,44 million tonnes of MSW in 2001 (about 3,940 tonnes per day), or about 0.92 kg per person per day (see Section 1.3 on population pressures). This estimate is higher than the 1.2 million tonnes of MSW (3,300 tonnes per day) reported by the MoE National Strategy for SWM (see Section 14.3.1) and -Term Strategy

14.1.2 MSW Composition

Various research and educational institutions have conducted studies on the composition of the MSW stream in Lebanon since 1995. Organic waste is by far the single largest component of the MSW stream, representing over 63 percent of the total MSW quantity in GBA and slightly over 50 percent at the national level (Figure 14.1). Organic content at the national level may be lower than in GBA because people feed some of their organic waste (vegetable cuts, fruit remains, etc.) to their domestic animals in rural areas (the best possible form of recycling). The high organic content suggests potentially strong opportunities for recycling the organic materials present in the MSW through composting. To be effective, however, composting requires a high degree of waste separation, preferably at the source, to avoid contamination of the organic material (with broken glass, plastic shreds, and heavy metals). Such contamination would lead to a compost of poor quality that most end users would not want to apply to their lands. Source separation also would improve the marketability of certain recyclable materials, such as paper and cardboard and plastics. Apart from select small villages (Section), however, source separation has not been implemented with any success in any urban area of Lebanon.

Figure 14. 1
Composition of Municipal Solid Waste in GBA and Nationally



Source: MoE and World Bank (LEDO Indicator #30, 2001)

14.2 Municipal Solid Waste Management in GBA

In the Greater Beirut Area (GBA), municipal solid waste has been managed in accordance with the 1997 Emergency Plan for Solid Waste Management in the GBA. While the basic features of the plan were implemented, key SWM indicators remain well below target, especially with regard to recycling and composting. Lower levels of recycling and composting have drastically reduced the projected lifetime of the sanitary landfill built under the Plan. Section 14.2.1 presents an overview of the Emergency Plan for SWM in GBA. Sections 14.2.2 to 14.2.7 describe specific components (collection, sorting and baling, composting, disposal) and actual costs of the SWM system for GBA.

14.2.1 The Emergency Plan for SWM in GBA

An Overview

In 1997, in consultation with the MoE, CDR adopted the Emergency Plan for SWM in GBA (Decision No. 58, dated 2/01/97). The plan called for closing the Bourj Hammoud dump and for establishing an integrated MSW management system, comprised of the following facilities (see Figure 14.2):

- Two facilities for sorting and processing raw MSW (Aamroussiyeh and Karantina),
- One composting plant for sorted organic material (Coral);
- One warehouse facility for storing and shredding bulky and recyclable materials (located along seashore, next to the entrance of the Borj Hammoud dump site);
- One landfill site for the disposal of sorted MSW in the form of baled waste consisting primarily of inert materials (Naameh); and
- One landfill for the disposal of inert and bulky materials (Bsalim).

The emergency plan assumed that 1,700 tonnes per day (620,000 tonnes per year) of raw MSW would be processed at the two sorting plants. Of this amount of waste, the plan called for recovering 160 tonnes per day of recyclable materials (58,00 tonnes per year) and transferring 300 tonnes per day of organic material to the composting plant

(110,000 tonnes per year). The plan envisioned the provision of additional surface area to build a second composting plant, thereby increasing composting capacity from 300 to 850 tonnes per day, thus decreasing the quantity of waste sent to the Naameh landfill from 1,240 to 690 tonnes per day (see Table 14.1). Finally, the plan called for shredding and transporting 200 tonnes per day (73,000 tonnes per year) of inert and bulky material to the Bsalim landfill.

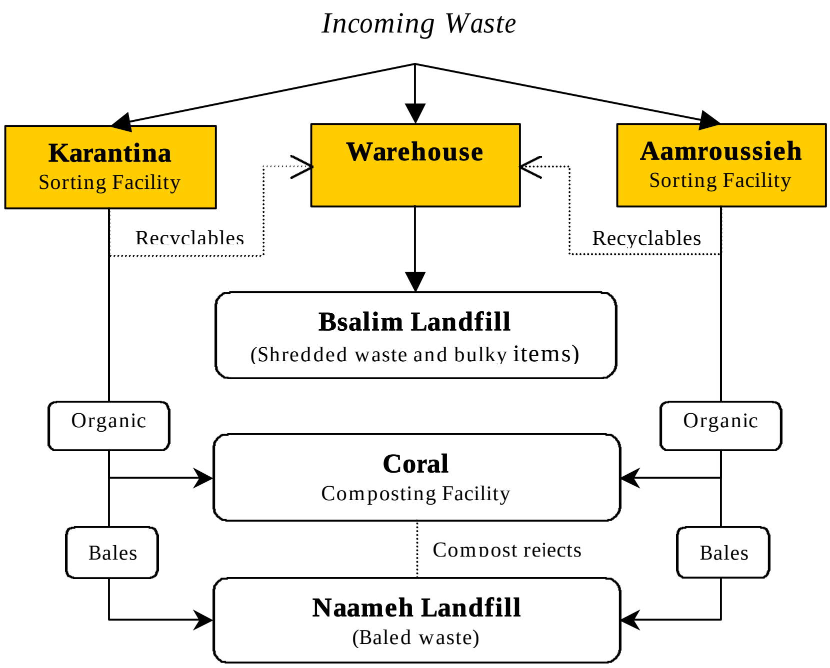
Table 14. 1
Targets of GBA Emergency Plan for SWM

Waste Destination	*Before expansion of composting capacity*		*After expansion of composting capacity*	
	Tonnes/day	Percent [a/]	Tonnes/day	Percent [a/]
To recycling	160	9.5	160	9.5
To landfill	1,240	72.9	690	40.5
To composting plant	300	17.6	850	50.0
Total received and processed at sorting plants	*1,700*	*100%*	*1,700*	*100%*

a/ The plan described the targets in terms of quantities (tonnes per day) and not percentages (%)

Source: CDR/LACECO, 1999b

Figure 14. 2
Current Solid Waste Management Scheme for GBA



<u>Implementation of the Emergency Plan</u>

CDR commissioned SUKOMI to design, build and operate the Naameh landfill (January 1998) and the waste sorting and composting facilities (June 1998) under two 10-year contracts. In fact, SUKOMI had started operating these facilities as early as February 1997 for the Karantina and Aamroussieh plants, and August 1997 for the Naameh landfill. Earlier, in December 1995, CDR had commissioned SUKLEEN to provide waste collection services in the GBA under a five-year contract.

The performance of the GBA SWM system has increased year after year but remains well below the targets set in the Emergency Plan, as illustrated in Figure 14. 3**.** The following observations are noteworthy *(Year 1 extends from June 1, 1998 to May 31, 1999)*:

- The amount of waste received and processed at the two sorting facilities has increased steadily since Year 1, reaching about 713,000 tonnes in Year 3 (1,955 tonnes per day). This amount is greater than the 620,000 tonnes/year envisioned under the Plan;
- About 110,000 tonnes of organic material were sorted and composted in Year 3. This amount is almost identical to the quantity of organic material composted in Year 2 and corresponds in fact to the treatment capacity of the Coral composting plant (300 tonnes per day or 110,000 tonnes per year). Therefore, and contrary to the Plan, a significant fraction of organic materials is not composted but rather is baled and wrapped with the rest of the reject materials, and shipped to Naameh for landfill disposal. This deficiency results directly from not expanding composting capacity, as envisioned by the Plan. Furthermore, in Year 3, composting of 110,000 tonnes of organic material has produced about 41,000 tonnes of compost and 31,000 tonnes of rejects (the remaining tonnes are losses due to leachate, evaporation, and waste decomposition). These 31,000 tonnes of compost rejects were shipped to the Naameh landfill for disposal!
- The amount of recyclable materials recovered has quadrupled between Years 1 and 2 and increased by 50 percent between Years 2 and 3. Although about 41,000

  713,000 tonnes). Furthermore, of the 41,000 tonnes of recyclable materials that were recovered, about 4,700 tonnes (11 percent) could not be sold to the recycling industry and were shipped to the landfill for disposal. This percentage was much higher in Year 2, when 30 percent of the recovered materials were disposed at the Naameh landfill (8,500 out of 27,000 tonnes of recovered recyclable materials)!
- As per the two bullets above, in Year 3, while about 551,000 tonnes of waste were disposed in Naameh after being baled and wrapped at one of the two sorting facilities, an additional 36,000 tonnes of compost rejects and non-marketed recyclables were disposed there (without prior baling or wrapping). Overall, about 587,000 tonnes of waste were disposed at the Naameh landfill, or 82 percent of the MSW stream.

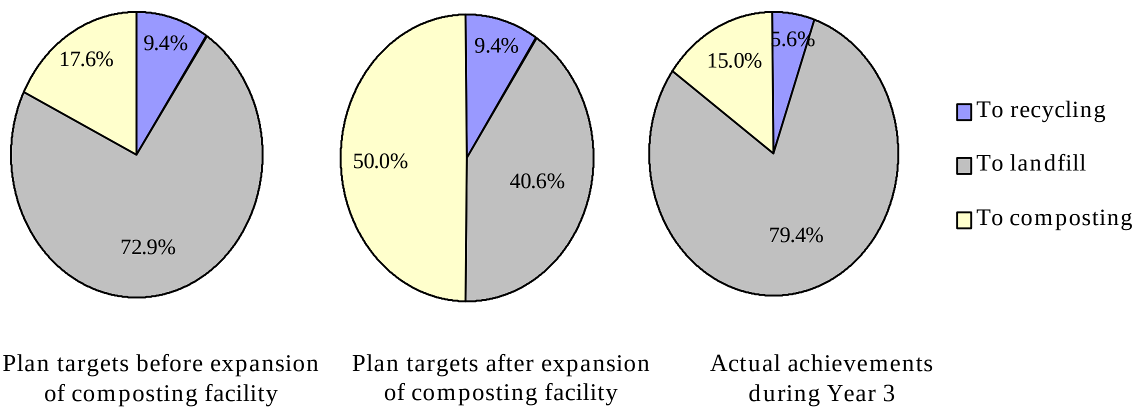
In retrospect, while the Plan has laid the foundation for an integrated approach to MSWM in the GBA, it has suffered from a number of built-in deficiencies, including:

- The Plan and the service Contracts defined SWM targets in quantity (i.e., tonnes of waste sent to recycling, composting, or landfill disposal) rather than percentage terms. This has created some confusion and the need to negotiate adjustments to processed

  of the Plan was to define targets in percentage terms;

- The Plan and the service Contracts defined targets based on inputs (tonnes of waste *sent to* recycling, composting and landfill disposal) rather than outputs (tonnes of recovered materials sold to recycling industry, finished compost applied on land, and waste land disposed). This may have created incentives for the Contractor to process more waste through the recycling and composting lines, irrespective of the amounts of recycled materials or compost produced / sold); and
- The Plan did not follow through with the necessary incentives to promote the recycling of recovered materials or the use of compost in various land applications (e.g., agriculture, landscaping, forestation).

Figure 14. 3
Targets of GBA Emergency Plan for SWM Versus Achievements



14.2.2 Collection

Under the first contract between CDR and SUKLEEN (December 1995), the GBA was defined to encompass Beirut and its immediate suburbs.[1] Over time, several contract addenda were negotiated expanding the geographic coverage of waste collection by SUKLEEN. In 2001, the company was already collecting MSW from the additional Cazas of Aley, Shouf, Baabda, Metn and Kessrouan. The geographic area served by SUKLEEN today includes about 2 million people generating nearly 2,000 tonnes of MSW per day.

SUKLEEN collects MSW from curbside containers and transports it to one of the two sorting facilities. It also collects bulky waste from the curbside and transports it to the warehouse facility. Initially due to expire on December 31, 2000, the contract for MSW collection and street cleaning in GBA was extended for a period of six months. The MoIM was tasked with preparing tender documents for an international bid for the provision of those services beyond that date (CDR, 2001). Tender invitations were issued but subsequently aborted as only two bids were received (see box 14.1).

[1] Information on the exact coverage of waste collection services was not available

Box 14. 1
Tendering for the Future Provision of MSW Collection in GBA

Tendering for the future provision of MSW collection and street sweeping services in the GBA offers opportunities to learn from past experiences. For example, would the service be contracted out to a single company, as in the past six years, or to two or three organizations, each serving a different geographic area? In the latter instance, the organizations selected to provide the service would be driven to compete to offer the best quality services at the lowest prices possible. At the same time, the oversight agency (CDR or MoIM) would be able to compare the quality and price of the services offered by different organizations. In fact, a public enterprise could provide the service in one of the sub-areas, which would provide a benchmark for comparison.

14.2.3 Sorting and Baling

Process components available at the Aamroussieh and Karantina sorting facilities are similar. First, incoming trucks are weighed at the entrance weighbridge and unloaded in the receiving area. Manual pickers then remove large and bulky items before the waste is fed onto drag conveyors and into bag opening machines. The waste is then mechanically separated on sorting lines using a trommel screen and the organic fraction is send to a pre-polish line before sending to the Coral composting plant. Manual sorting is further practiced to remove recyclable materials. Residual waste is then baled, wrapped and transported to the Naameh Landfill.

As explained previously, the two sorting facilities combined received about 713,000 tonnes of MSW during Year 3 (about 1,955 tonnes a day), up from 660,000 tonnes in Year 1. In Year 3, SUKOMI recovered about 41,000 tonnes of recyclable materials, sorted about 110,000 tonnes of organic matter and sent them to the composting plant, and baled and wrapped about 551,000 tonnes of waste and sent them to the Naameh landfill.

<u>Recyclables</u>

While the two sorting plants recovered about 41,000 tonnes of *recyclable materials* in Year 3, only about 36,700 of tonnes were actually sold for recycling purposes. By adding about 1,800 tonnes of recyclable materials arriving directly to the warehouse facility and sold there, about 38,500 tonnes of recyclable materials were actually sold in Year 3. The total amount of *recycled materials* has almost quadrupled between Years 1 and 2 and almost doubled between Years 2 and 3. As indicated previously, the 41,000 tonnes of recovered recyclable materials fall short of the target of about 67,000 tonnes of recyclables to be covered (i.e., 9.41 percent of the incoming MSW).

Table 14.2 presents the composition of recovered recyclable materials. Information is available neither on the quantities of materials actually sold in each category nor on the revenues earned by the Contractor from selling those materials. Most of the plastic, except PET and PVC, is recycled into secondary plastic products such as flowerpots and
g paper
recycling plants currently operating in Lebanon (about three). However, these industrial plants rely primarily on informal networks for the supply of waste paper and cardboard. Scavengers remove high value waste directly from commercial establishments and the street (i.e., before the waste is picked up by the municipality or the collection company).

Because the raw MSW is commingled (no source separation), it is very difficult to recover recyclable materials of relatively good quality. When the waste arrives at the sorting facilities, it is already in a state of decomposition, releasing leachate and foul odors. Leachate spoils the quality of recyclable materials, so many recycling industries shy away from buying them. Also, it is conceivable that the Lebanese recycling industry has not evolved in sync with the Emergency Plan for MSW in GBA. For example, there were no specific incentives to promote the recycling industry, in particular recyclable materials (see Box).

In the mid nineties, a private company proposed to build a recycling plant for low-density polyethylene (LDPE) and requested that the GoL accept a charge of US$10 per tonne of recycled LDPE. The project was never built. Unless and until there is capacity to recycle LDPE waste, such waste would continue to be disposed at the Naameh landfill (or any future landfill for GBA), at an average disposal cost of about US$37.5 per tonne of LDPE.

Table 14. 2
Average Composition of Recovered Recyclable Materials a/

Material	*Composition by weight (%)*	
	Aamroussieh	Karantina
Plastic	18.2	17.4
Cardboard	32.9	45.1
Tins	28.5	20.7
Aluminum	0.8	1.0
Glass	13.8	11.0
Wood	4.5	4.0
Tires	1.3	0.8

a/ Quantity of recyclable materials recovered in Year 3:
-- 12,000 tonnes at the Aamroussieh plant
-- 29,000 tonnes at the Karantina sorting plant

Source: CDR/LACECO, 2001b

At a January 28, 2000 meeting, CDR, the Contractor, and the Supervising Engineer

- Recyclable materials that were not recovered from the raw MSW, as of sorting (not done), baling/wrapping and hauling those materials to the landfill site, and of disposing them there);
- Recyclable materials that were recovered but were not sold (deduct the costs of hauling those materials to the landfill site and disposing them); and
- Void space utilization due to landfilling waste recyclables that should have been recovered and marketed but that were ultimately landfilled either because they were never recovered or because they were not sold.

14.2.4 Composting

The Coral composting plant uses the windrows system for fermentation (12 windrows, 4-5 m wide and 2.5-3 m high), a trommel screen and a densimetric table for polishing. A Scatt turning machine and blowers are used to aerate the windrows. The composting cycle lasts around 65 to 70 days. In Year 3, the Coral composting plant treated about 110,000 tonnes of organic materials and produced about 41,000 tonnes of finished compost (37.5 percent). About 30,000 tonnes of compost rejects (28 percent) were sent to the Naameh landfill for disposal. Losses to evaporation, decomposition and leachate formation account for the balance (38,000 tonnes).

Compost production has leveled off in Years 2 and 3, reaching the design capacity of the Coral composting plant. It has increased by nearly five-fold in comparison to Year 1 (only 7,800 tonnes of finished compost, mainly due to plant closure during six months to install bio-filters). All the compost produced was distributed, free of charge, to organizations and individuals, who pick it up themselves at the plant in bulk form. No information is available on the ultimate use of the compost by these individuals and organizations, or on their level of satisfaction. Of the nearly 240 individuals and organizations who acquired compost from the Coral plant in Year 3, about one-third came back for more at least once. During the same year, seven individuals and organizations acquired more than 1,000 tonnes of compost each, for a total of about 9,000 tonnes (22 percent of the total compost produced).

As per the contract, the Contractor conducted physical, chemical, and biological analyses of the finished compost from all outgoing windrows, in the laboratories supplied and equipped under the construction contract. The compost appears to meet most of the contractual specifications for physical parameters, except for moisture, and organic content (see Table 14.3). There are no contract specifications for permissible levels of heavy metals in the finished compost. Measurements of select heavy metals including lead, chromium and cadmium ranged from 98-490 mg/ml, 13-56 mg/ml, and 0.3-2.8 mg/ml, *respectively*. Typically, when the organic waste is not separated from other materials (e.g., batteries, paints) at the source, the resulting compost is likely to contain high levels of heavy metals. Also, if large quantities of urban garden waste were co-composted with organic materials from other sources (households, markets), the resulting compost likely would fail the standard for lead content.

Table 14. 3
Compost Quality (Contractual and Measured Values)

Parameter	*Contractual Value*	*Measured Value*	*Remarks*
C/N ratio	< 20	16.3	Good, sufficient N left for microbial growth in compost
Nitrogen content (%)	< 1.5	1.67	Good, higher than contractual limit
pH	< 8.5	7.6	Indicates matured compost,
Organic matter content (%)	> 40	58.6	Compost may need additional curing and aeration
Moisture content (%)	< 40	51.3	Too wet
Density	0.5-0.8	0.46	Good, compost texture is fluffy

Source: CDR/Laceco, 2001b

Operational problems at the Coral composting plant include foul odors and stench from the curing process, space limitation, proximity to residential areas, and mechanical failures. During its first year of operation, the plant was shut down for six month (May to November 1998) to install a bio-filter odor control unit (at a cost of US$500,000 per year). The plant also generates about 55 m^3 per day of leachate and treats it using both anaerobic and aerobic processes (using a sequential batch reactor). The effluents from this primary treatment are then combined with the bio-filter discharge water and shipped by tanker trucks to the Ghadir wastewater treatment plant south of Beirut.

Considering that the Ghadir treatment plant uses only a preliminary treatment step (grit and scum removal), the leachate effluents sent to Ghadir undergo minimal, if any, treatment before being discharged into the sea (submerged 2.6 km-long outfall). Therefore, it is urgent to build a treatment facility for the leachate and bio-filter discharge water generated at the Coral composting plant. The Contractor has submitted a conceptual design for the treatment of leachate and bio-filter discharge water (anaerobic plus aerobic post-treatment), but has not proceeded to implement the proposed design despite repeated requests by the Supervising Engineer.

14.2.5 Disposal at the Naameh Landfill

The Naameh Landfill Site is situated between two seasonal rivers, Nahr el Hamam to the South and Nahr el Wadi to the North, about 20 km south of Beirut. It consists of

building Landfill 1, activities have been restricted to Landfill 2. In response to emergency conditions (closure of Bourj-Hammoud dump), disposal of waste in Landfill 2 (Cell 1) began before all construction quality control procedures were completed. As a result, Cell 1 was built with a substandard design and could not be upgraded once it began receiving waste. However, the design of Cells 2 and 3 could be upgraded to accommodate the higher-than-planned organic loading of the waste. Landfill 2 is designed as a sanitary landfill with bottom liners and leachate collection, treatment and off-site disposal. Cells 1 and 2, covering an area of 120,000 m^2, were filled up as of April 2001. Cell 3 would provide an additional 62,000 m^2.

Box 14. 2
Land Expropriation for Naameh and Bsalim Landfill Sites

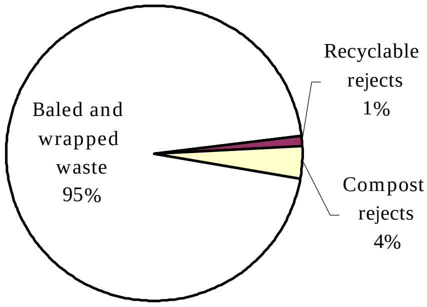
Landfill 2 includes *waqf* (church estate) and private lands. Lands belonging to a nearby monastery are rented. Expropriation of private lands has been completed (except for Cell 3). In

renewed annually. In 1999, a delay in the renewal led to the Bsalim landfill being shut down for almost two months until all papers were cleared. During this time, bulky materials were not collected from the curbside, which resulted in large stockpiles of materials on the streets.

-year

contract with SUKOMI to operate the Naameh landfill has a starting date of January 19, 1998 (Year 1 extends from January 19, 1998 to January 18, 1999, etc.). Between June 1, 1998 and May 31, 2001 (Years 1 to 3 of the treatment contract), a total of 1,788,000 tonnes of waste were disposed at the Naameh landfill, including 82,000 tonnes of compost rejects and 15,000 tonnes of recyclable rejects (0.8 percent) not baled (see Figure 14.4).

Figure 14. 4
Waste Disposed at the Naameh Landfill
(June 1, 1998-May 31, 2001)



Source: CDR/LACECO, 2001a

Baling reduces the volume of waste through compacting. Without wrapping, it would not be possible to transport the baled waste on open flatbed trucks (risk of pollution during transportation to the landfill). The landfill generated 91,000 tonnes of leachate in year 2000 (250 tonnes per day); monthly rates vary between 6,500 and 8,500 tonnes per month. The initial landfill design predicted smaller quantities of leachate with a lower biological load, based on the assumption that a higher percentage of organic materials would be recovered from the raw MSW for composting. The Contractor tested a Sequential Batch Reactor to provide physical and chemical treatment of the leachate generated at Naameh (lime addition, agitation, settling and addition of aluminum sulfate for pH regulation, followed by the sequential batch reactor). Treated leachate is then transported by tanker truck (about 10-20 truck shipments per day) to the Ghadir WWTP, where it is mixed with raw sewage undergoing preliminary treatment before being discharged at sea through a 2.6-km submersed sea outfall (CDR/LACECO, 2000a).

Box 14. 3
Naameh Landfill Service Life

The Emergency Plan envisioned that the Naameh landfill would last 10 years. It assumed a total disposal capacity of 4 million tonnes (2 million tonnes in each of Landfill 1 and Landfill 2) and an average annual disposal rate of 400,000 tonnes per year. In reality, Landfill 1 was not and will not be built for environmental reasons. Landfill 2 was filled up as of April

since it began operation. The addition of Cell 3 would provide an additional capacity of 1.3 million tonnes, which would extend the lifetime of the landfill to mid 2003.

The Naameh Landfill received more waste than planned because:

- Bsalim was supposed to host a second sanitary landfill for the North Beirut area, but the EIA showed a very high risk of ground water contamination and recommended using the site to dispose of inert materials only;
- Because composting capacity was not expanded as planned (from 300 to 850 tonnes per day), more organic materials are disposed at the Naameh landfill; and
- Recovery of recyclable materials by the Karantina and Aamroussieh sorting plants is

  materials are disposed of at the Naameh landfill.

Source: ECODIT analysis of data published in LACECO supervision reports

14.2.6 Warehousing and Disposal at the Bsalim Landfill

The warehousing facility is located along the seashore, Northwest of Beirut, next to the entrance to the old Bourj Hammoud dump. The facility was initially conceived for the storage of bulky and recyclable materials. Recyclable materials are sold to interested manufacturers. The remaining waste are transported to the Bsalim landfill either as bulky material or as shredded material (tires and wood).

During contract Year 3 (June 1, 2000-May 31, 2001), the facility received about 49,800 tonnes (137 tonnes per day) of waste material, including 34,300 tonnes (69 percent) of bulky materials from the streets. The facility sold about 12,900 tonnes of recyclables to clients and sent most of the remaining waste to the Bsalim landfill (45,000 m^2), which is located in a former quarry in the Nahr el Mott valley. Shredded materials and rubbles make up 89 percent of the waste sent to Bsalim. Recyclable materials sent for disposal include PET, dirty plastic, tins, and cardboard (plus shredded wood and shredded tires). The Bsalim landfill has received 69,000, 35,000 and 35,000 tonnes of waste materials in Years 1, 2 and 3 (CDR/Laceco, 2001a).

14.2.7 Costs and Financing of the SWM System for GBA

and adjusted by the Supervising Engineer, the combined costs of the SWM treatment system for Years 1, 2, and 3 of the contract were equal to US$74,400,000 (Table 14. 4), or about US$24.8 million per year. This amount covers operation and maintenance of the following activities: sorting, baling, wrapping, haulage of sorted organic materials to the Coral composting plant, composting, and manual sorting and shredding at the warehouse facility. It does not include solid waste collection and transportation from the streets to the treatment facilities, transport of sorted/treated waste from the treatment facilities to the Naameh or Bsalim landfills, or disposal at the Naameh or Bsalim landfill. Nor does it include capital costs, which were covered under separate, earlier construction contracts.

> Sorting, baling, and wrapping represent a very large share of the total MSWM system costs. To the extent that the recovery of recyclable materials is capped by the capacity of the Coral composting plant and the ability to market the recovered materials, questions are raised about the cost-effectiveness of continuing to sort, bale, and wrap mixed waste for eventual disposal at the Naameh landfill.

Table 14. 4
MSW Treatment Costs in the Extended GBA (Years 1-3)

Description	*YEAR 1*	*YEAR 2*	*YEAR 3*	*TOTAL*
Actual Treatment Cost (US$)	21,500,000	25,500,000	27,400,000	74,400,000
Waste Handled (tonnes)	661,000	708,000	713,000	2,082,000
Unit Treatment Cost (US$/Tonne)	32.5	36.0	38.4	37.5
Overall Collection Cost (US$)	20,000,000	20,000,000	20,000,000	60,000,000
Overall Landfilling Cost (US$)	14,000,000	14,000,000	14,000,000	42,000,000
Overall System Cost (US$)	83.9	84.0	86.1	84.7

Note: Actual collection and landfilling costs were not available. Numbers here indicate envisioned costs under Emergency Plan.. All numbers were rounded to nearest US$ 100,000

Source: CDR/LACECO, 2001b

Annual treatment costs are comparable to the treatment costs envisioned by the Emergency Plan ($24 million per year for treatment). In addition, the Plan projected collection and disposal costs of US$20 and US$14 million, respectively. No information was available on the actual costs of those components of the MSWM system. For reference purposes, Table 14.5 provides the contract unit costs of various components of the treatment and disposal process. Note that all the waste does not go through all the components of the treatment process.

Table 14. 5
Contract Unit Costs of MSWM System in GBA

Sorting	US$18/tonne
Baling	US$12/tonne
Wrapping	US$9/tonne
Hauling to Coral composting plant	US$4/tonne
Composting	US$18/tonne
Landfill disposal	US$25-35/tonne

Note: Landfill disposal costs vary according to three waste handling brackets. It is US$ 25/tonne for the portion of landfilled waste between 400,000 and 500,000 tonnes, and US$ 30/tonne for the additional quantities exceeding 500,000 tonnes.

Box 14. 4
Financing the SWM System for GBA

CDR uses the Independent Municipal Fund to pay the costs of the SWM system for GBA. The MoIM then deducts those costs from the amounts owed by the Fund to various municipalities and federations of municipalities served by the

on their budget ledgers. The law on municipalities did not explicitly allow for the municipalities to raise solid waste service fees.

14.3 Municipal Solid Waste Management beyond GBA

The Solid Waste Environmental Management Project (SWEMP), launched in 1996, was designed to provide solid waste management solutions outside GBA. While SWEMP has not been able to fully accomplish its mandate, concerned government agencies are coming together to develop and implement a national SWM strategy. At the same time, several community-based initiatives for SWM were launched in the past few years, some with remarkable success.

14.3.1 National SWM strategy

In 1999, the MoE developed a national strategy for SWM (dated 1/7/1999) building on the recommendations outlined during a national workshop on *Waste Management Strategy for Lebanon*, organized jointly by MoE, METAP and the World Bank in Beirut (May 7-9, 1999). However, current waste management programs and schemes indicate that a lack of consensus still prevails among key institutional stakeholders (i.e., CDR, MoE, MoIM) on how to handle the SWM sector.

As part of its strategy, MoE formed an inter-ministerial committee composed of representatives and/or the Directors General from the MoE, MoIM, CDR, and ALIND. While its mandate is not explicitly defined, the committee would follow up on all SWM issues (including projects and bottlenecks) in the country. The strategy also recognizes the need to secure express approval from the MoIM before any SWM project or activity is implemented. The strategy advocates implementing short-term SWM goals and activities until a long-term national strategy for SWM is approved. While the strategy does not explicitly favor any singly waste treatment technology, it does recognize sanitary landfills as an integral component of any future strategy (i.e., the disposal of by-products from other technologies, bulky items, etc.). Moreover, the adopted technology(-ies) should be proven elsewhere, cost effective and ISO-Certified 14001.

The Strategy further recommends the promotion of waste minimization programs (with the support of local NGOs and municipalities), the gradual phase-in of source separation, the introduction of waste-to-energy programs, and the elaboration of cost recovery programs. The strategy falls short of setting waste reduction targets, or defining specific regulatory and non-regulatory incentives for introducing recycling programs and supporting recycling/transformation industries.

14.3.2 Solid Waste Environmental Management Project

SWEMP was supported by a loan secured by the GoL from the International Bank for Reconstruction and Development (IBRD). The loan agreement was initially worth US$55 million for a three-year period (Law 504, dated 6/9/1995). The agreement envisioned the construction of about 15 sanitary landfills, the closure and rehabilitation of existing waste dumps, the construction of two composting plants (Saida and Zahle) and one incinerator for hospital waste. In 1998, a Project Coordination Unit (PCU) was set up at the MoIM to provide technical and administrative assistance to the CDR during project implementation.

Political turmoil, public opposition (NIMBY syndrome, see Box 14.5) and conflicting opinions about the most adequate treatment technology brought the PCU and the project to an impasse. SWEMP was suspended in December 1999. Recently, however, new efforts are underway to salvage and review the loan agreement (see Outlook Section 14.5.1). Table 14.6 presents actual achievements under SWEMP.

Box 14. 5
NIMBY Syndrome In Kfar Hazir

Not in my Back Yard (NIMBY). Landfilling is a land exhaustive waste disposal option. SWEMP envisioned to construct one landfill in the Koura region to serve three Cazas (Koura, Bsharre and Batroun). From a list of candidate sites prepared by the Design Engineer, the CDR selected a site in Kfar Hazir for constructing a sanitary landfill. An EIA was prepared, recognizing certain hydrogeological concerns that had to be mitigated. Public consultation was initiated after the site had been selected. When local communities got word of the full extent and location of the proposed landfill, they united against the project. Several prominent academicians from local universities joined them in their efforts to halt the project. However, neither the local inhabitants nor the project supporters proposed an alternative waste management scheme. As a result, the project was aborted at the end of 1999 and no alternative waste management system has been proposed since. To date, local municipalities continue to dump their waste in open lands and valleys.

Source: ECODIT

Table 14. 6
SWEMP Initial Plan and Actual Achievements

Envisioned Plan [/a]	*Achievements*
Construction of 12 landfills including Zahle, Baalbeck/Hermel, West Bekaa/Rachaya, Koura, Byblos, Tripoli, Akkar, Tyre, Nabatiyeh, Sidon	One landfill was completed in Zahle
Construction of 2 sorting facilities	One sorting facility was built next to Zahle landfill
Construction of several transfer stations	None
Closure and rehabilitation of uncontrolled dumps	None
Provision of street cleaning and washing vehicles, as well as waste collection trucks and curbside containers	waste collection trucks, loaders, scrapers, and street cleaning/washing vehicles, as well as curbside waste containers were transferred to several municipalities (Tripoli, Zahle)
Provision of technical training	Training manual prepared but never disseminated

a/ Source: PCU Draft Inception Report, July 1998

14.3.3 Community-Based Initiatives for MSWM

Local municipalities and/or federations of municipalities are responsible for waste collection and disposal. Local municipalities and federations sometimes subcontract waste collection (from curbside) to local entrepreneurs and small businesses. Waste is then transported to nearby open dumps, usually located in the outskirts of the village. Faced with no overall long term strategy for waste management, mayors all over the country are being approached by private businesses who wish to market their own waste treatment technologies. While some of these technologies may be potentially suitable in small to medium sized communities (e.g., dynamic composting in Kfarsir), many proposals are poorly founded and unreliable. Even working proposals and technologies are facing operational problems (e.g., fate of by-products, market for recyclables, hygienic concerns) and financial difficulties (i.e., how to sustain the projects after funding stops).

Several villages have initiated their own waste management projects. Diverse sources of funding have provided technical and financial support to small and medium sized waste management projects, such as composting facilities and recycling schemes (see Table 14.7). The most prominent sources of funding include the UNDP/LIFE program in Lebanon and USAID. Together, UNDP/LIFE and USAID have allocated in the past five years SWM grants worth approximately US$1 million. This does not include co-financing by local communities.

Table 14. 7
Community-Based Solid Waste Management Projects

Program	*Project Description*
UNDP / LIFE[2]	
❑ Bsharre	Council for Environmental Protection in Bsharre. The NGO launched in 1996 a management project to sort MSW. Awareness programs encouraged local inhabitants (8,000 in winter and 15,000 in summer) to segregate household waste into two containers (wet and dry waste). Dry waste was then manually sorted. Wet (organic) waste is dumped from roadside (only a few kilometers from the Cedars). Main limitation the high cost of transporting sorted waste (mainly glass and plastics) to recycling factories (more than 100 km away). Municipality has shown little commitment to sustain the project. *Total project cost: US$ 90,000 (including 25,000 LIFE grant)*
❑ Arab Salim	Call of the Land Association. The NGO launched in 1997 a MSW sorting and recycling project, including awareness programs. Plastics, glass and metals are recovered and shipped to recycling factories. Transportation costs are prohibitive. Recycling factories do not always buy the recovered materials. *Total project cost: US$ 28,500 (inc. 25,000 LIFE grant).*
❑ Maghdoucheh	Environnement Sans Limites. In 1998, the NGO launched a MSW project. It included source separation, recycling and awareness campaigns. Difficulty includes transportation costs. *Total project cost: US$ 45,000 (inc. 24,000 LIFE grant).*
❑ Nabatiyeh	Environmental Protection Council. The NGO launched in May 1997 a SWM project. Project includes management of solid waste through source separation, recycling and awareness campaigns. In all, 107 households, 14 schools, 30 institutions and 30 restaurants and shops took part. Difficulties include technical project management and transportation costs. *Total project cost: US$ 69,000 (inc. 25,000 LIFE grant)*
USAID[3]	
❑ Kfarsir	YMCA supported a low-cost composting facility to treat municipal waste (population 10,000). The facility uses a rotating drum with a 5-tonne per day capacity. Commingled MSW is manually sorted on a conveyor belt. Recyclable materials are stored for collection or resale. Compost is allegedly produced in three days and fit for land reclamation. Several operational difficulties remain (sorting, curing, etc.). This technology has been replicated in Akkar. *Project cost: US$ 210,000.*
❑ Akkar el Atika	Mercy Corps is introducing biogas production for the treatment of organic waste to farmers in Akkar. Anaerobic digestion of organic residues (animal waste, kitchen and agricultural waste) occurs in digesters to produce biogas, a mixture of methane, carbon dioxide and other gases. Biogas units supply renewable energy (appropriate for lighting and heat production) and liquid fertilizer while improving hygiene.

[a] USAID is financing the construction of three other community-based composting plants, in Chakra (Sour) , Jbaa / Maghdousheh (Saida) and Mays el Jabal (Bint Jbeil). Total cost: US$ 690,000.

[2] Data was supplied to ECODIT by UNDP / LIFE Programme, Lebanon, 2001
[3] Data was supplied to ECODIT by USAID Office, 2001

14.4 Industrial Solid Waste Management

Unlike MSW, most if not all of the industrial waste generated in Lebanon is managed with little or no environmental controls. Industrial solid waste continues to be either co-
otherwise dumped into the environment, either directly or indirectly through sewer networks. Sections 3.2.5 and 3.2.6 provided information on industrial and hazardous waste as well as wastewater quantities generated in Lebanon. This section focuses on management aspects related to hazardous and medical wastes, as well as special wastes such as slaughterhouse waste, special household waste, and used tires.

14.4.1 Hazardous waste

With grant funding from METAP/World Bank and the Italian Government, the MoE is implementing a one-year hazardous waste management project. The project is supported by an advisory board consisting of representatives from CDR, MoIM, MoPH, MoEW, ALIND, and several industrial branches. The project will:[4]

1. Assess the yearly quantities of hazardous waste generated in Lebanon;
2. Recommend a strategy for the sound management of hazardous waste;
3. Develop hazardous waste legislation; and
4. Train MoE staff, other stakeholders and concerned groups on the safe handling and management of hazardous waste.

> *Hazardous waste* is defined as any waste appearing on the European Waste Catalogue (EWC) marked with an asterisk. It includes wastes that can be explosive, gaseous, flammable liquid, flammable solid, oxidizing, poisonous, infectious, and corrosive.

MoE and the project team audited several industrial branches including printing, lead batteries recycling, and metal plating. Using several economic indicators such as Leba
estimated the national rate of generation by comparing corresponding parameters and generation rates in several Mediterranean countries, such as southern Italy and Turkey.

MoE is also drafting pertinent legislation, including: (1) a decree to classify (according to the EWC) and manage industrial hazardous waste, (2) a decree to manage healthcare waste (also termed *medical* waste), and (3) a permitting and authorization decree for handling any kind of hazardous waste. This decree will set environmental guidelines and procedures for the safe handling of hazardous waste including its temporary storage, transport, treatment and final disposal. Medical waste management will be based on source segregation (using five health care waste categories labeled
-infectious

disinfection and landfilling, or thermal treatment in a centralized facility (MoE/ERM, 2001).

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[4] *Pers comm* El Merhebi F, Hazardous Waste Management Project, MoE

Training will encompass hazardous waste classification, storage, packaging and labeling, permitting requirements, waste transportation manifests, as well as data collection and management. Information manuals will be prepared and disseminated through seminars and workshops, to raise awareness of the dangers of hazardous waste and its improper handling. MoE also will draft technical guidelines for managing specific types of waste, such as used oil, asbestos, solvents, lead batteries and printing waste.

14.4.2 Medical Waste

Hospital waste includes non-risk waste, such as waste from cafeteria and administrative departments, as well as risk waste. The MoPH classifies hospital risk waste into five categories: (1) highly infectious waste, (2) non-sharp infectious waste (pathological and anatomical waste), (3) sharps (discarded syringes, broken scalpels, etc.), (4) pharmaceutical and chemical waste, and (5) special waste (radioactive and cytotoxic waste, pressurized containers, etc). New legislation will soon revise this classification system (see Section 14.4.1).

Lebanon generates an estimated 11 tonnes of hospital risk waste per day, or about 4,000 tonnes per year (see Table 14.8); annual quantities are expected to reach 5,000 tonnes in 2010 (CDR/ERM, 1999). This estimate is based on several assumptions, including:

- 160 hospitals in 1999, totaling 13,493 beds;[5]
- average hospital risk waste generation of 1.5 kg of per day per occupied bed;
- average bed occupancy of 56 percent.

Table 14. 8
Estimated Hospital Risk waste Generation in 1998

Region	*No. of Hospitals*	*No. of Beds*	*Hospital Risk Waste*	
			tonnes/day	tonnes/year
Beirut	25	2,318	2.59	944
Mount Lebanon	57	5,998	3.21	1,170
North	26	1,935	1.85	676
Bekaa	24	1,273	1.24	453
South	26	1,969	1.92	701
Total	**160**	**13,493**	**10.81**	**3,945**

Source: CDR/ERM, 1999

14.4.3 Slaughterhouse waste

Lebanon generates about 40,000 tonnes of slaughterhouse waste a year (METAP/Tebodin, 1998). To date there are no centralized facilities for handling slaughterhouse waste. Poultry houses also generate significant quantities of waste from dead broilers (see box for estimated quantities). Because of its putrescible nature, waste generated by slaughterhouses (Beirut, Tripoli, Saida) and butcheries (in all villages) can be a source of odor and disease propagation if not disposed properly. Currently, all such wastes are dumped into the environment.

[5] By the year 2000, the numbers rose to 185 hospitals and 14,277 beds

In 1998, the MoE received a proposal to build and operate a rendering plant for slaughterhouse waste -- as well as fresh hide cuttings and shavings from tanneries (MoE/NAPA, 1998). The plant would produce meat and bone meal, fat, and blood meal. Wastewater from such a plant would need to be treated; the resulting sludge could be co-composted with organic waste from the MSW (see Section). NAPA would not proceed with its proposal until it receives exclusive rights to the slaughterhouse by-products. The plans were scrapped by Council of Minister Decision 42 (dated 1/3/2000). Such exclusivity and possibly other incentives may be necessary to justify the economic and financial feasibility of the project. The GoL should also advocate and support waste exchange programs. For example, a portion of the slaughterhouse waste (skins) could be used in the tanning sector as raw material (hides).

Many broilers die from natural causes or disease outbreaks. Mortality rates are estimated to range from five percent under normal conditions up to 15 percent in case of disease outbreaks.[1] Assuming Lebanon produces 15 million broilers a year, an average mortality rate of 10 percent and an average body weight of one kilogram, about 1,500 tonnes of dead broilers are dumped in the environment each year.

[1] *Pers comm* Dbouk H., Sales and Technical Representative at ELANCO, Lebanon. 2001

The Beirut slaughterhouse, by far the largest in Lebanon, was built in 1975 at the eve of the civil war but was never operated. In 1994, after the war ended, a hangar was built in a different location to provide a temporary slaughterhouse. The facility is run by the government and falls under the direction of the Beirut Governor. It is rather primitive, poorly designed, and unsanitary. Slaughter waste is stockpiled for several months on end, meat merchants load and unload uncovered and un-refrigerated meat, workers do not wear uniforms, animal carcasses are hung on rusted iron hooks, and the hangar lacks basic ventilation, climate control (temperatures and humidity levels soar during summer reaching 35), functional bathrooms, refrigeration facilities, computerized book keeping, and security personnel.[6] Similar conditions can be found at the other centralized slaughterhouses.

14.4.4 Special household waste

Special household waste includes outdated or unused pesticides, chemicals (acetone, battery liquids, wood preserving chemicals, etc.), paints, ink residues, used batteries, used solvents, outdated medicines, cosmetics, aerosols and used fluorescent lights. In most countries, special household waste quantities represent about 0.3-0.8 percent of the total MSW. Assuming a generation rate of 1.0 kg/person/year, Lebanon generates about 4,000 tonnes of special household waste per year (0.33 percent of MSW). About 30 percent of this amount (1,200 tonnes per year) can be regarded as hazardous waste (METAP/Tebodin, 1998).

Industry and households generate comparable quantities of hazardous waste: 3,338 tonnes from industry and about 1,200 tonnes from households. This would suggest the need for a three-track approach to the management of hazardous waste: (1) developing adequate treatment and disposal capabilities, (2) establishing and enforcing requirements for industrial hazardous waste transport and treatment/disposal, and (3) developing procedures and facilities for the collection of household hazardous waste.

Special household waste is not collected separately and is co-disposed with the MSW stream. Although it is generated in relatively small quantities, mismanagement of this waste is

[6] Based on article that appeared in the Daily Star, 28 March 2001

potentially harmful. For example, persistent toxic chemicals, oily products and solvents may leach into ground and surface waters polluting them. These waste also could cross-contaminate organic waste if co-disposed with the MSW, hence reducing options for composting and waste recovery.

14.4.5 Used tires

Decision 1/22 (24/10/1996) bans all waste imports destined for final disposal or for energy recovery (incineration), as well as hazardous waste imports bound for recycling. The decision also specifies which types of documents are required for trading non-hazardous waste materials. This includes certificates from the country of origin and tangible proof that the waste is not contaminated by radioactive, chemical or biological substances.

According to the MoE, vehicles generate about 1,875,000 used tires in Lebanon each year.[7] This estimate is consistent with the quantity of 14,000 tonnes of used tires generated annually, as per Table 3.6 (i.e., 7.5 kg per used tire on average). There are currently no facilities for the recovery or disposal of used tires, which are either stockpiled in various locations or dumped haphazardly in ravines or in the sea. Within the GBA, the company charged with the rehabilitation of the Normandy landfill shreds the used tires it finds in the landfill and uses the shredded tires as an inert fill material on site. Also in the GBA, all tires collected by SUKLEEN under the bulky materials waste stream are stored at the warehouse. A small portion is then sold to tire recycling customers while the remaining portion is shredded and sent to Bsalim landfill also as an inert fill material. One of the cement plants had invested in a facility to receive and shred used tires to be used as fuel in the cement kilns but did not receive GoL full authorization to proceed with the project due to intense local public protests and political pressure (METAP/Tebodin, 1998).

14.5 Outlook

Over the past years, the GoL and Lebanese municipalities have commissioned several detailed studies and/or received specific proposals to collect, treat and manage several waste categories including municipal solid waste (see Sections 14.1 to 14.3), hospital waste (CDR/ERM, 1999), slaughterhouse waste (MoE/NAPPA, 1998), industrial waste (MoE/Tebodin, 1998), waste oil (MoE/ETEC, 1999), olive cake, used tires, etc. However, the absence of a concerted and well-articulated national strategy is blurring the sector as a whole and seriously delaying the implementation of effective, integrated SWM solutions.

The GoL is exploring ways to rehabilitate existing waste dumps. The decomposition of organic waste produces primarily methane (CH_4) and carbon dioxide (CO_2). Both CH_4 and CO_2 are GHGs and hence contribute to the global warming potential. Current efforts are underway to rehabilitate the Normandy landfill (Beirut) and the GoL is securing international funding to implement a waste-to-energy project at the Borj Hammoud landfill (situated north of Beirut). Appendix G provides an overview of coastal dumps and their current status.

[7] MoE, Service of Impact Prevention from Technology and Natural Hazards

14.5.1 Developing a Workable MSWM Strategy Back to the Drawing Board

Municipal solid waste management is at a major crossroads. While great investments have been made to develop MSWM facilities in GBA and, more recently in other urban poles such as Tripoli, Zahle and Saida, the overall strategy is still fuzzy. CDR and the World Bank have agreed to reduce the budget of SWEMP to about half of its original size and to focus on completing ongoing activities, such as rendering the Zahle landfill operational and rehabilitating the Hbaline dumpsite. Municipalities, large and small, are desperately looking for long-term SWM solutions. In GBA, contracts for solid waste collection are expiring and new contracts will need to be put in place very quickly. There are serious questions about the cost-effectiveness and sustainability of current recycling and composting practices in GBA. The Naameh landfill for disposal of MSW from GBA will reach saturation by mid 2003 (see Box 14.3).

Clearly, the GoL needs to go back to the drawing board and develop a concerted national MSWM strategy, to be approved at the highest possible levels, to include the following technical and policy elements:

- Study and define the appropriate division of the country into operational regions for purposes of *MSW treatment and disposal*, taking into account political, environmental and economic factors;
- Encourage and provide technical, legal and policy support to municipalities and village councils located in the same region to work together to identify, formulate, develop and implement integrated, long-term MSWM solutions;
- Use EIA and public participation as tools to identify and reach consensus on

  closed doors;
- Study the feasibility of recycling and composting and put in place the national and local incentives necessary to ensure the economic and financial viability of MSWM systems;
- Develop local and national financing mechanisms to ensure cost recovery and financial sustainability;
- Provide for ongoing competition in the provision of MSWM services and avoid situations of monopoly;
- Build on lessons-learned from past and ongoing MSWM experiences in GBA and other municipalities, as well as at the local village or community level; and
- Allocate roles and responsibilities at different levels (national, regional, local) and for different MSWM functions (planning, studies, contracting, design, management, operation and maintenance, oversight, monitoring, and reporting).

Developing a fullyarticulated strategy could take up to two years or more, but different components of the strategy could be developed earlier. For example, the upcoming tender for a new SW collection contract for GBA could envision that the service would be awarded to two or three organizations serving an equal number of distinct geographic areas. Also, MoE and MoIM could provide more technical, policy, and legal support to municipalities (and municipal federations) as they study options for long-term integrated MSWM solutions.

14.5.2 Awarding Exclusive SWM Arrangements

Beyond municipal solid waste *per se*, the GoL needs to make important policy decisions to promote effective solid waste management by different sectors. Generally, it is best to let two or more companies provide the same waste management service to encourage more competition, which would lead to better service at a lower cost in the long run. This general rule certainly applies to MSW management, as explained in Box 14.1. In some instances, however, it may be necessary to award exclusive rights to one or more select companies to collect and manage certain types of waste (e.g., slaughterhouse waste, olive oil pressing cakes, used tires, and waste oils).

Due to its small size, Lebanon generates relatively small quantities of these special wastes. Private companies are not willing to invest in treatment and recycling technologies to manage those wastes, without some sort of guarantee from the Government that the waste will be made available to them on an exclusive (or semi-exclusive) basis. Without guaranteeing the supply of raw materials, the return on investment may not be high enough to justify the investment by a private for-profit company. In fact, in some cases, the quantities of waste are so small that the GoL may need to offer additional financial incentives to justify the investment that these companies would need to make.