UNION OF MUNICIPALITIES OF JBEIL CAZA

ENVIRONMENTAL IMPACT ASSESSMENT FOR HBALINE SOLID WASTE TREATMENT FACILITY (SORTING PLANT)

FINAL REPORT

ACKNOWLEDGEMENTS

Special thanks are extended to the Head and staff of the Union of the Municipalities of Jbeil Caza and to the Staff of OMSAR for their assistance and support throughout the preparation of the present Environmental Impact Assessment.

EXECUTIVE SUMMARY

With the increasing problem of MSW management at a country scale, the Government of Lebanon (GoL) through its Council of Ministers appointed a steering committee constituted of representatives from the Council for Development and Reconstruction (CDR), the Ministry of Environment (MoE), the Ministry of Interior and Municipalities (MoIM) and the Directorate General of Urban Planning (DGUP) to prepare a Solid Waste Management Plan dictating on every region (Caza) to manage its own waste within its boundaries (with the exception of the Caza of Beirut which is combined with the Cazas of Mount Lebanon).

This report presents an Environmental Impact Assessment (EIA) for the Hbaline Solid Waste Treatment Facility (Sorting Plant) with the objectives to ensure environmental protection and management and assist in the design, construction and operation of the proposed facility.

Note that the Hbaline landfill was proposed as part of the Solid Waste Environmental Management Project (SWEMP) to serve the Jbeil Caza; as such design specifications for various facility systems (gas collection and management, leachate collection, liner, surface drainage, cover, and odor control) have already been conducted. In addition, an EIA for the landfill was prepared in 2002 (CDR, LibanConsult 2002). To date, the landfill has not been constructed, and the Hbaline site continues to be used as a haphazard dump for solid wastes generated within the Caza.

In the context of the current Solid Waste Management Plan, several additional activities are proposed for the Hbaline facility. However, the facility which was designed to include a landfill and a composting plant will be designed to house a materials recovery facility, and a mechanical sorting plant under the oversight of the “Office of the Minister for Administration Reform” (OMSAR) using European Union Funding .

A compost plant has been recently constructed by the Union of Municipalities of Jbeil Caza with the financial support of USAID to treat the organic material. The EIA will target the proposed activities (mechanical sorting plant); it will also highlight various facility management plans to be implemented during construction and operation.

The scope of work implemented in the preparation of the EIA report included a description of the proposed mechanical sorting plan, description of the facilities already designed as well as the facilities planned in the context of the proposed plan, definition of the existing legal and administrative framework, description of the environment surrounding the project site, identification of potential environmental impacts, analysis of alternatives and corresponding environmental management plans (mitigation, monitoring, and institutional strengthening).

At this stage, analysis of impacts that may be incurred due to implementation of the Hbaline facility (which will include a materials recovery and a mechanical sorting plant) revealed that limited adverse environmental impacts would occur during the short-termed construction phase. Some less serious impacts of concern include soil, noise, visual intrusion, biodiversity, traffic, waste management, socio-economics, and health and safety. These impacts can be minimized by careful planning and staging of construction activities, adopting proper management practices during operation, and relying on effective environmental monitoring and training to support management decisions.
During operation, the facility may be associated with serious impacts due mainly to leachate generation with potential surface and/or groundwater contamination and gaseous/odorous

emissions. Other less serious impacts of concern include soil, noise, visual intrusion, biodiversity, traffic, waste management, socio-economics, and health and safety. These impacts can be minimized by careful planning and staging of construction activities, adopting proper management practices during operation, and relying on effective environmental monitoring and training to support management decisions.

A mitigation plan was developed to earn the facility more acceptability, by reducing or eliminating to the extent possible many of the potential impacts. Monitoring of indicators of potential impacts was defined at the Hbaline sorting facility with corresponding location and frequency of monitoring.

The tables below summarize the different potentially impacted parameters classified according to project phase.

Project phase	*Duration*	*Potentially impacted parameter*
Construction	Short term	• Surface & groundwater quality • Soil quality • Air quality • Health and safety • Noise • Solid waste generation • Landscape and visual intrusion • Biological environment • Socio economics • Traffic
Operation	Long term	• Surface & groundwater quality • Soil quality • Odors • Air quality • Health and safety • Noise • Solid waste generation • Landscape and visual intrusion • Biological environment • Socio economics • Traffic

Parameter	*Potential impacts according to phase*	
	Construction	*Operation*
Surface & groundwater quality	-	- - -
Soil quality	-	-/+
Odors	- -	- - -
Air quality	-	- -
Health and safety	-	- -
Noise	-	-
Waste management	-	+ + +
Landscape and visual intrusion	-/0	-/+
Biological environment	- -	- -
Socio-economic	-/+	-/+ +
Traffic	-	-

+ + +: High potential positive impact — - - -: High potential negative impact
+ +: Moderate potential positive impact — - -: Moderate potential negative impact
+: Low potential positive impact — -: Low potential negative impact
0: No significant potential impact

In the context of the overall plan, appropriate environmental management dictates that construction and operation activities be implemented in accordance to the current state of the art and knowledge regarding environmental protection. This can be accomplished by hiring competent personnel with the appropriate educational and professional background, instituting periodic training programs, and developing site-specific plans that are adequate for protecting the general public and the environment as well as contributing to the mitigation of potential environmental impacts.

It is recommended that environmental monitoring, training and institutional strengthening plans be implemented by an entity independent of but in coordination with the contractor/operator involved in any component or task of the project to ensure quality control and uniformity.

Site investigation has been conducted and preliminary design of the operational sorting units has been developed. This preliminary design along with the environmental management plans will constitute the foundation for the detailed design. The management plans will provide adequate environmental protection if properly designed and maintained during the entire life span of the proposed Hbaline facility.

The plans include but are not limited to:

- Monitoring plan
- Site closure and rehabilitation plan
- Public relations plan
- Community awareness plan
- Site-specific management plan
- Waste transport and traffic control plan
- Waste placement operations plan
- Health and safety plan
- Emergency and contingency plan
- Personnel qualification and training plan

Apart from the sorting technology which is the subject of the present EIA, various alternatives for MSW treatment/disposal have been analyzed in the general framework of an integrated strategy for a proper municipal solid waste management in Lebanon.

Note that the "do-nothing" scenario was also assessed. The "do nothing" scenario implies that the current waste management practices used in the area at present will remain the same. Open dumping of wastes in the area has adverse effects on the environment and constitutes a public nuisance, diminishing landscape aesthetics, and causing unpleasant odors. Although the "do nothing" scenario will avoid temporary environmental impacts associated with construction activities, on the long-term it will result in a marked deterioration of the environmental, health and socio-economic conditions at the national scale.

A comparative matrix for assessing four general solid waste management options for municipal solid waste management in general has been developed. The matrix (table below) includes 1) sorting coupled with composting and landfilling (existing plan), 2) landfilling alone, 3) incineration and landfilling and 4) "do nothing". A weighted-rating checklist was used to select among the four scenarios. Each selection criterion was assigned an importance weight reflecting its significance. Weights ranged between 1 and 3, with 3 assigned to the highly important decision factors while 1 was assigned to the less important decision factors. The scenario with the highest number of points, which is the proposed plan, was considered as the most favorable scenario.

Comparative matrix for solid waste management plan evaluation

Criteria	*Weight*	*Score*							
		1[a] (proposed plan)		*2[b]*		*3[c]*		*4[d]*	
		R	W	R	W	R	W	R	W
Area requirements	1	3	3	2	2	4	4	1	1
Operational costs	2	3	6	2	4	1	2	4	8
Leachate generation	2	3	6	2	4	4	8	1	2
Air pollution	2	3	6	2	4	1	2	1	2
Odor	2	2	4	3	6	3	6	1	2
Surface and groundwater contamination	3	3	9	2	6	4	12	1	3
Capital costs	3	2	6	3	9	1	3	4	12
Health and sanitation	3	3	9	3	9	3	9	1	3
Public perception	3	4	12	3	9	1	3	1	3
Total			**61**		**53**		**48**		**36**

- Weight = Represents the importance of each selection criterion whereby 1 represents the least importance criterion and 3 the most important criterion
- R = Raw score ranging between 1 and 4 whereby 1 represents the worst alternative and 4 the best alternative for each of the selection criteria
- W = Weighted score representing the product of the weight and the raw score
- [a] Composting coupled with sorting and landfilling
  [b] Landfilling alone
  [c] Incineration and landfilling
  [d] "do nothing"

In this report, a solid waste sorting line (SWSL) which is the series of operational units in a sorting process has been defined for Hbaline sorting facility. The SWSL outlines the different components of the sorting line according to a typical MRF process flow diagram. The proposed SWSL is a combined system of automated and manual sorting and has been conceived in the aim to meet the requirements of environmental protection and ensure proper sorting processes. The main sorting techniques that are going to be used are conveyor belts, a shredder and a magnetic separator. Screening (trommel) is considered as optional because of its high capital and operation costs. Air classification is not proposed to be used in the sorting line. The proposed SWSL, when properly operated is expected to have a significant effect on reducing the reliance on the existing landfill.

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LIST OF ABBREVIATIONS

BOD	=	Biological oxygen demand
CDR	=	Council for Development and Reconstruction
CH_4	=	Methane
CO	=	Carbon monoxide
CO_2	=	Carbon dioxide
EIA	=	Environmental Impact Assessment
FHWA	=	Federal Highway Administration
GBA	=	Greater Beirut Area
GIS	=	Geographic Information Systems
GOL	=	Government of Lebanon
GPS	=	Global Positioning System
H_2S	=	Hydrogen sulfide
HC	=	Hydrocarbons
HDPE	=	High Density Polyethylene
MoA	=	Ministry of Agriculture
MoE	=	Ministry of Environment
MoIM	=	Ministry of Interior and Municipalities
MoPH	=	Ministry of Public Health
MoPWT	=	Ministry of Public Works and Transport
MRF	=	Materials recovery facility
MSW	=	Municipal solid wastes
NO_2	=	Nitrogen dioxide
OSHA	=	Occupational Safety and Health Administration
PC	=	Personal Computer
PM	=	Particulate matter
PPE	=	Personal protective equipment
QA/QC	=	Quality assurance and quality control
SO_2	=	Sulfur dioxide
SWEMP	=	Solid Waste Environmental Management Plan
TSP	=	Total Suspended Particles
USAID	=	United States Agency for International Development

1 INTRODUCTION

1.1 Background

The unsanitary disposal of municipal wastes is one of the most pressing environmental stresses facing the environment at the national scale. Historically, refuse collection and disposal in Lebanon has always been the responsibility of municipalities. However, the continuously decreasing financial and human resources of municipalities coupled with a continuously increasing population and waste stream is limiting their capacity to effectively manage solid waste at the local level. Consequently, municipalities are currently unable to provide a much-needed service and have in most cases resorted to burning and uncontrolled dumping on hillsides and seashores, resulting in serious land, sea, and air pollution problems.

Official and public concerns about Municipal Solid Waste (MSW) has peaked in recent years bringing about the need to close existing dumpsites and a great need to identify alternative methods for the disposal of refuse. With the increasing problem of MSW management at a country scale, the Government of Lebanon (GoL) through its Council of Ministers appointed a steering committee constituted of representatives from the Council for Development and Reconstruction (CDR), the Ministry of Environment (MoE), the Ministry of Interior and Municipalities (MoIM), and the Directorate General of Urban Planning (DGUP) to prepare a Solid Waste Management Plan dictating on every region (Caza) to manage its own waste within its boundaries (with the exception of the Caza of Beirut which is combined with the Cazas of Mount Lebanon).

This report presents an Environmental Impact Assessment (EIA) for the Hbaline Solid Waste Treatment Facility (Sorting plant). To date, the Hbaline site continues to be used as a haphazard dump for solid wastes generated within the Caza. Such practices are necessitating proper measures to limit the existing environmental problems. In this aim, a composting plant has been recently constructed with the financial support of USAID fund and will be commissioned in few months.

In the context of the Solid Waste Management Plan proposed for Hbaline, several activities were proposed in the past. The facility which was designed to include a landfill will be used to accommodate a composting plant – already constructed- and a materials recovery facility

(MRF) - a mechanical sorting plant which is the subject of this report.

1.2 EIA objectives

While the overall desired process has been defined in the proposed plan, the present EIA has been conducted prior to the final design of project components. As such, several elements of this document will be refined to reflect the final design at the Hbaline sorting facility. Subsequently, an environmental management plans (mitigation, monitoring, and institutional strengthening) has been developed for the facility to be implemented during the project life cycle. The objectives of the management plan are to ensure environmental protection and assist the design and construction processes and to assist as well the contractor/operator recognize environmental, social, and economic impacts of the facility by mitigating and monitoring the resulting environmental impacts

1.3 Scope of work

Due to the emergency nature of the present undertaking, public consultation is in the arrangement process and will be defined based on a special approval by the MoE. As such, besides this introductory Chapter, the scope of work implemented in the preparation of the EIA report includes the following:

- Description of the proposed plan (Chapter 2)
- Definition of the existing legal and administrative framework (Chapter 3)
- Description of the environment (Chapter 4)
- Identification and analysis of potential environmental impacts (Chapter 5)
- Analysis of potential alternatives (Chapter 6)
- Development of environmental management plan including mitigation, monitoring, and Institutional strengthening (Chapter 7)
- Public Participation (Chapter 9)

2 DESCRIPTION OF THE PROPOSED PLAN

The proposed solid waste management plan consists of constructing a solid waste management facility for sorting 77 tones of solid waste per day for the Caza of Jbeil. For this purpose, the Union of Municipalities of Jbeil Caza has proposed a suitable location for the sorting facility. The proposed site is the Hbaline site which is being used by the Union of Municipalities as an open dump and which has been selected to accommodate the composting plant.

2.1 Current Status of Solid Waste Management at the Union

According to a Feasibility Study conducted by ECODIT, 2004 on Solid Waste Management at the Union of Municipalities of Jbeil Caza, the wastes are being collected by one of the following three ways; either by the municipality itself, or by a private collector contracted by the municipality or by a private collector contracted by certain industries or individual rural households. All the collected waste is hauled to the dumpsite at Hbaline where the proposed sorting plant, subject of this report, is to be located. The existing dumpsite was first activated in 1982 during the Lebanese Civil War and is sill being used to date.

2.2 Quantity and characteristics of incoming wastes

The facilities within the proposed plan are expected to treat MSW (mechanical sorting). Estimation of the total quantity of MSW generated within the Jbeil Caza have been conducted, using a base case population for the year 1997 and projecting the total population until 2015, using different growth rates for each Mohafaza (Table 1). The resulting population estimates were then multiplied with corresponding waste generation rates (Table 2).

The Hbaline sorting facility, which constitutes the subject of this report, is expected to receive the solid wastes generated from the Jbeil Caza for subsequent sorting. The remaining waste stream generated by the sorting activities is expected to be transferred to the site composting plant for treating the compostables (organic materials) and to the exiting open dump or future Hbaline sanitary landfill for refuse.

Table 1: Population forecast

Mohafaza	*Population 1997*	*Growth rate (%)*	*Population 2002*	*Population 2005*	*Population 2010*	*Population 2015*
Beirut	**403,338**	**0.40**	**411,300**	**416,600**	**424,700**	**433,500**
Mount Lebanon	**1,507,558**		**1,596,300**	**1,652,000**	**1,749,100**	**1,852,000**
Jbeil	80,178	1.15	84,900	87,900	93,000	98,500
Kesrouan	161,416	1.15	170,900	176,900	187,300	198,300
Metn	429,322	1.15	454,600	470,400	498,100	527,400
Baabda	518,671	1.15	549,200	568,400	601,800	637,200
Aaley	165,745	1.15	175,500	181,600	192,300	203,600
Chouf	152,226	1.15	161,200	166,800	176,600	187,000
North	**807,203**		**856,900**	**888,000**	**942,600**	**1,000,600**
Akkar	254,439	1.20	270,100	279,900	297,100	315,400
Tripoli	262,934	1.20	279,100	289,300	307,000	325,900
Minieh-Dannieh	118,225	1.20	125,500	130,100	138,100	146,500
Zgharta	55,565	1.20	59,000	61,100	64,900	68,900
Bcharre	21,934	1.20	23,300	24,100	25,600	27,200
Koura	48,722	1.20	51,700	53,600	56,900	60,400
Batroun	45,384	1.20	48,200	49,900	53,000	56,300
Bekaa	**539,449**		**562,800**	**577,300**	**602,200**	**628,200**
Hermel	36,348	0.85	37,900	38,900	40,600	42,300
Baalbeck	229,349	0.85	239,300	245,400	256,000	267,100
Zahle	174,462	0.85	182,000	186,700	194,800	203,200
West Bekaa	65,934	0.85	68,800	70,600	73,600	76,800
Rashaya	33,356	0.85	34,800	35,700	37,200	38,800
South	**472,104**		**498,600**	**515,300**	**544,200**	**574,900**
Jezzine	20,212	1.10	21,300	22,100	23,300	24,600
Saida	249,154	1.10	263,200	271,900	287,200	303,400
Sour	202,738	1.10	214,100	221,300	233,700	246,900
Nabatiyeh	**275,373**		**288,00**	**295,800**	**309,500**	**323,600**
Hasbaya	31,108	0.90	32,500	33,400	35,000	36,600
Beint Jbeil	65,742	0.90	68,800	70,600	73,900	77,200
Marjayoun	52,852	0.90	55,300	56,800	59,400	62,100
Nabatiyeh	125,671	0.90	131,400	135,000	141,200	147,700
Total	**4,005,025**		**4,213,900**	**4,345,000**	**4,572,300**	**4,812,800**

Table 2: MSW generation

Mohafaza	*Generation rate (Kg/capita/day)*	*Quantity 2002 (tons/year)*	*Quantity 2005 (tons/year)*	*Quantity 2010 (tons/year)*	*Quantity 2015 (tons/year)*
Beirut	**1.15**	**172,500**	**174,900**	**178,400**	**181,900**
Mount Lebanon		**657,600**	**680,700**	**720,600**	**763,100**
Jbeil	0.75	23,200	24,100	25,500	27,000
Kesrouan	1.15	71,700	74,300	78,600	83,200
Metn	1.15	190,800	197,500	209,100	221,400
Baabda	1.15	230,500	238,600	252,600	267,500
Aaley	1.15	73,700	76,200	80,700	85,500
Chouf	1.15	67,700	70,000	74,100	78,500
North		**250,000**	**258,900**	**274,800**	**291,700**
Akkar	0.75	73,900	76,600	81,300	86,300
Tripoli	0.90	91,700	95,000	100,800	107,100
Minieh-Dannieh	0.75	34,400	35,600	37,800	40,100
Zgharta	0.75	16,200	16,700	17,800	18,900
Bcharre	0.75	6,400	6,600	7,000	7,400
Koura	0.75	14,200	14,700	15,600	16,500
Batroun	0.75	13,200	13,700	14,500	15,400
Bekaa		**154,000**	**158,000**	**164,800**	**171,900**
Hermel	0.75	10,400	10,600	11,100	11,600
Baalbeck	0.75	65,500	67,200	70,100	73,100
Zahle	0.75	49,800	51,100	53,300	55,600
West Bekaa	0.75	18,800	19,300	20,100	21,000
Rashaya	0.75	9,500	9,800	10,200	10,600
South		**150,900**	**155,900**	**164,700**	**174,000**
Jezzine	0.75	5,800	6,000	6,400	6,700
Saida	0.90	86,500	89,300	94,300	99,700
Sour	0.75	58,600	60,600	64,000	67,600
Nabatiyeh		**78,800**	**80,900**	**84,800**	**88,500**
Hasbaya	0.75	8,900	9,100	9,600	10,000
Beint Jbeil	0.75	18,800	19,300	20,200	21,100
Marjayoun	0.75	15,100	15,500	16,300	17,000
Nabatiyeh	0.75	36,000	37,000	38,700	40,400
Total		**1,463,800**	**1,509,300**	**1,588,100**	**1,671,100**

Table 3 presents the general composition of the MSW at the national and Greater Beirut Area (GBA) levels. The distinctive feature in the composition of the waste lies in the presence of a high proportion of organic putrescibles. In this respect, the organic rich content of the MSW presents an opportunity for biological treatment prior to usage/disposal, thus reducing the total waste quantity requiring landfilling, increasing the lifespan of the Hbaline landfill, and providing a useful byproduct that can be used as a soil conditioner in land application or reforestation, a soil cover within the landfill, or for rehabilitation of existing quarries.

Table 3: Composition of MSW in Lebanon and the GBA (Ayoub *et al*. 1996; Baldwin *et al*. 1999; El-Fadel and Chahine 1999;El-Fadel and Khoury, 2001; MoE, 2001a)

Type of waste	*Percentage %*	
	GBA	*Lebanon*
Organic	63	53
Paper and cardboard	18	17
Plastic	7	10
Glass	5	9
Textiles	4	3
Metals	3	3
Other	0	5

According to CDR (2002), the Jbeil caza has a population of about 69,000 inhabitants at the end of 2001 (as compared to 84,900 in Table 1). The average waste production estimated for the year 2000 was 0.825 Kg/capita/day and 0.869 Kg/capita/day for the year 2001. This translates into a total household waste production of 59 tons/day and a total waste production of 63 tons/day (including cleaning products) in 2001. The projected increase in waste generation is up to 1 Kg/capita/day in 2004 and 2.1 percent per year for the served population. In the context of the EIA prepared for the Hbaline facility (CDR, 2002), waste composition in the Zahle caza was used as a representation of typical waste composition. Waste composition in the Zahle caza was determined through collection of one waste sample (500 Kg) taken from the Zahle haphazard dump in the months of August and September 1994; the results are presented in Table 4.

Table 4. Waste composition for Zahle (CDR, 1998)

Type of waste	*Weight (Kg)*	*Weight (%)*	*Moisture (%)*
Organic matter	155.6	63.5	67.4
Paper and cardboard	37	15.1	11.9
Plastics	25.5	10.4	35
Glass	12.5	5.1	3.3
Metal	4.9	2.0	6.6
Textiles	6.6	2.7	52.83
Inert materials	2.9	1.2	11.4
Total	245	36.5	50.1
Density	250		

The MoE-MSW Strategy (Appendix I) has outlined the composition of MSW in Lebanon and determined the quantities generated in the different areas of Lebanon.

Figure 1 illustrates the general composition of MSW nationwide as well as in the GBA as stated in the MoE SWM Strategy (Appendix I).

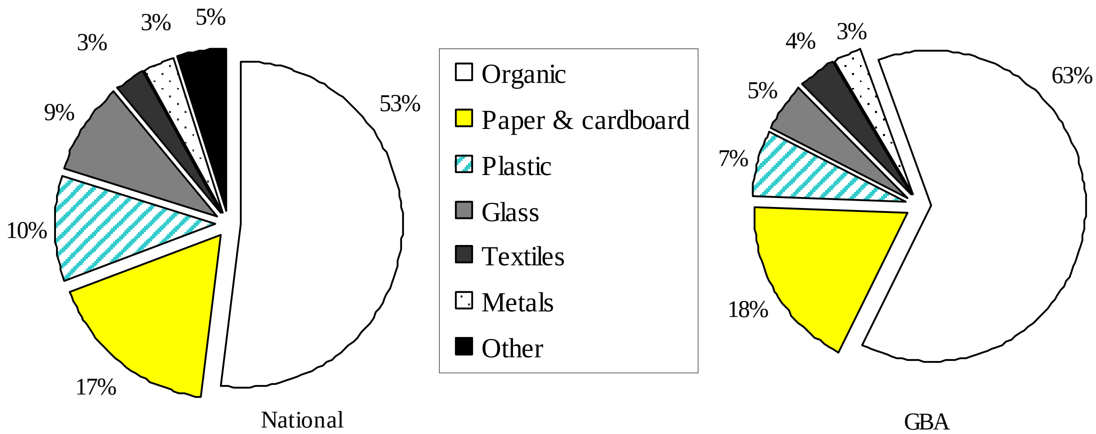

Figure 1: Composition of MSW in Lebanon and the GBA

2.3 Project components

The Hbaline sorting facility will be designed to house a MRF i.e. a sorting line for the segregation of wastes and further recovery of recyclables, waste reception area, control office and weighbridge, administrative buildings, cleaning area for trucks, workshop, and workers facility. The proposed integrated waste management scheme is illustrated in Figure 2.

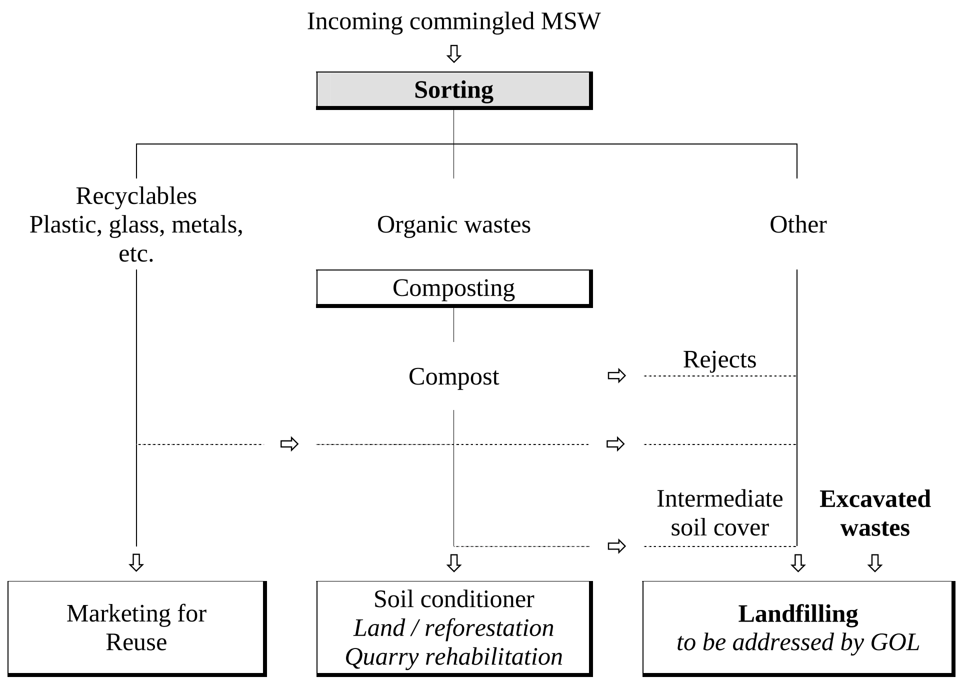

Figure 2. Waste management scheme for the Hbaline facility

2.3.1 Sorting

The separation, processing and recovery of materials from the municipal solid waste stream constitute an important part of an integrated solid waste management plan (ISWM). In a commingled state, MSW is biologically unstable, can become odorous, and is unusable. MRFs are used to separate commingled MSW into usable materials, whereby plastics, glass and metals can be recycled and organic materials can undergo composting.

Figure 3 depicts a typical simple flow diagram proposed for the Hbaline MRF. The process starts with receiving the wastes in a dedicated receiving area where bulky items are removed. The incoming bags are first opened and the contents manually segregated along sorting conveyors and separated into metals, plastics, glass and other recyclables. Since the organic

and inorganic portions of the waste have different size distributions, the use of a trommel or similar screens for their differential separation is considered suitable option. The purpose of magnetic separation is for the removal of small pieces of metals, thus reducing any potential environmental and health impacts that may be posed by the presence of heavy metals in the future compost and in the landfilled wastes (
Figure 3 and Table 5).

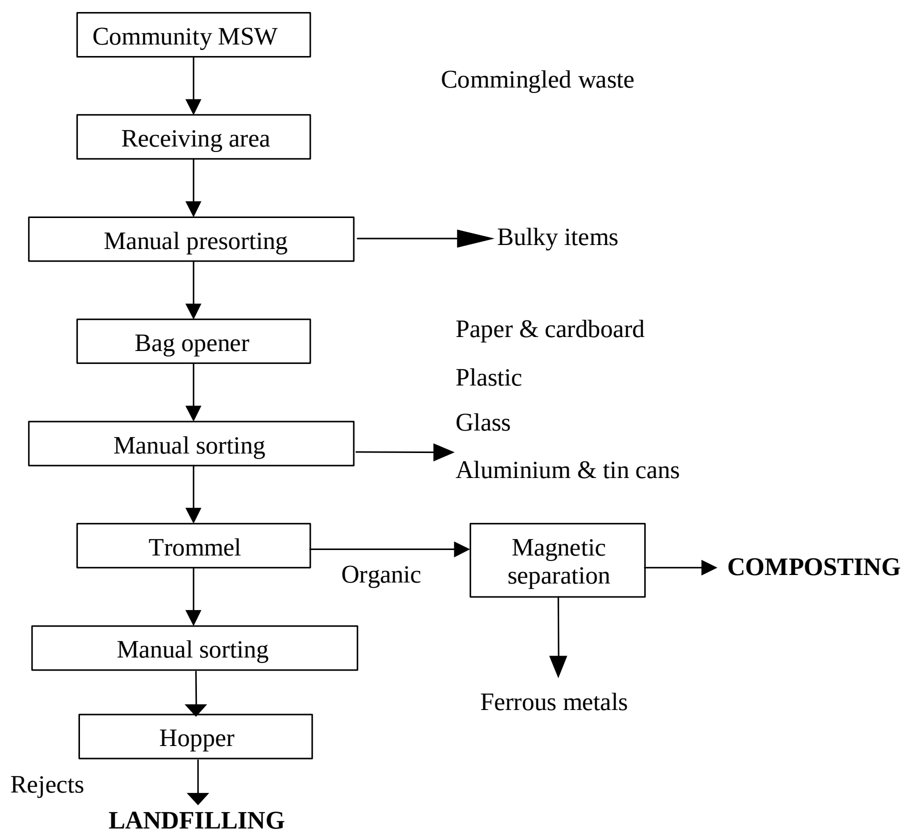

Figure 3. Typical MRF process flow diagram

Table 5. Description of the basic stages of sorting

Stage	*Description*
Bulky items removal	• Received waste that may obstruct any further separation during the process is removed
Bag opening	• The mechanical processing entailed in this initial step is through a bag-opening machine
Manual picking I	• Incoming wastes are exposed to a group of pickers where the plastic, glass, cardboards, and metals are picked up and collected for the interested industries to recycle
Screening (optional)	• The waste goes through a rotary drum (trommel) • The operation trommel screen is a large-diameter drum positioned nearly horizontally in which the refuse is introduced into the elevated end • The surface of the drum consists of a sieve with holes in well determined sizes. As the drum rotates, the particles are carried up the side of the drum until they reach a certain height, where they then fall to the bottom to repeat the cycle. Throughout the turning process the screening and the separation of the waste will be executed according to the size of the waste • Small particles that pass through the sieve openings are considered the compostable material which is basically rich in the organic matter • The remaining are the rejects which also contain the recyclable products
Magnetic separation	• The compostable material pass under the magnetic separator where the ferromagnetic items such as batteries, tins, steel cans and others are being separated and pressed for recycling purposes
Manual picking II	• After the magnetic separator, the non-ferrous material like aluminum cans and other non organic material are picked up manually to enhance the quality of the end product

The MRF facility will be designed as a closed building made of cement, natural stones, and hermetically closed metallic hangars. The number of inner pillars will be minimized as well as obstacles hindering the proper movement of vehicles as well as loading and unloading activities. Specific areas are designated for storage of the sorted wastes (Appendix II).

It is worth stating that a proper sorting operation will lead to the production of good quality compost, provided that composting process meets appropriate treatment requirements. Composting is an integral part of an integrated solid waste management. It is primarily considered as a waste management method to stabilize organic wastes.

The quality of the generated compost should comply with the recently drafted MoE Compost-Ordinance which defines four different types of compost. These types range from Grade A characterizing high quality compost appropriate for any agricultural utilization, to Grade D characterizing low quality compost which must only be used as intermediate landfill cover or as landscaping material (Table 6). It is worth noting that the stabilized end-product (compost) can be widely used as a soil cover in landfills or as amendment to improve soil structure, provide plant nutrients, and facilitate the revegetation of disturbed or eroded soil. It can also be used for quarry rehabilitation.

Table 6. Definition of compost types (MoE Compost-Ordinance)

Type of compost	*Characteristics*	*Main fields of utilization*
Grade A	• Native organic raw material, generated by source-separation • Mature compost (maturation grade* V) • Hygienised, biologically stable • Corresponds to European Eco-label for composts	• Food production in Agriculture, Horticulture, Viniculture
Grade B	• Organic raw material, generated by mechanical treatment of household waste • Mature compost (maturation grade IV or V) • Hygienised, biologically stable • Corresponds to European Eco-label for composts	• Food production in Agriculture, Horticulture, Viniculture
Grade C	• Organic raw material, generated by mechanical treatment of household waste or appropriate waste from industrial sources (e.g. residues from the food and animal feed industry) • Semi-mature compost (maturation grade III) • Hygienised Material • Limits given for heavy metals correspond to doubled values of European Eco-label for composts	• Utilized only if any risks to humans and any contamination of food or agricultural soils can be excluded e.g. in landscaping, re-cultivation of abandoned quarries • Soil for green space along traffic roads
Grade D	• Organic raw material, generated by mechanical treatment of household waste or appropriate waste from industrial sources (e.g. residues from the food and animal feed industry) after appropriate treatment • Immature compost (maturation grade II) • Hygienised Material • Limits given for heavy metals correspond to fivefold values of European Eco-label for composts	• Only to be used as re-cultivation material on controlled landfills and as intermediate layer of deposited waste • Not to be utilized as top layer of re-cultivated landfill sites in order to prevent contamination of humans, fauna, and flora as well as spreading of pollutants

* Maturity grade ranges between I and V and whereby I corresponds to fresh compost and V corresponds to mature compost. Maturity grade is determined through the DEWAR self-heating test

2.3.2 *Leachate or liquid waste collection and treatment*

The leachate or liquid waste generated during the sorting operations should be collected and treated on-site. The leachate could be preferably called facility-resulting liquid waste since it is not expected to be chemically strong in terms of BOD and COD. To the facility-resulting liquid waste, could be added the wash water of the plant. This should be collected into a leachate pond sealed with an impermeable liner. The leachate pond should have a capacity as to receive the average leachate quantity of 20 consecutive days or the quantity after 3 days rainfall. Leachate treatment on-site includes biological and/or thermal processes. Additional description of leachate treatment-management systems are presented in Section 7.1.1.2.2 (mitigation of potential groundwater impacts). Figure 4 illustrates the process flow diagram for a typical leachate treatment system.

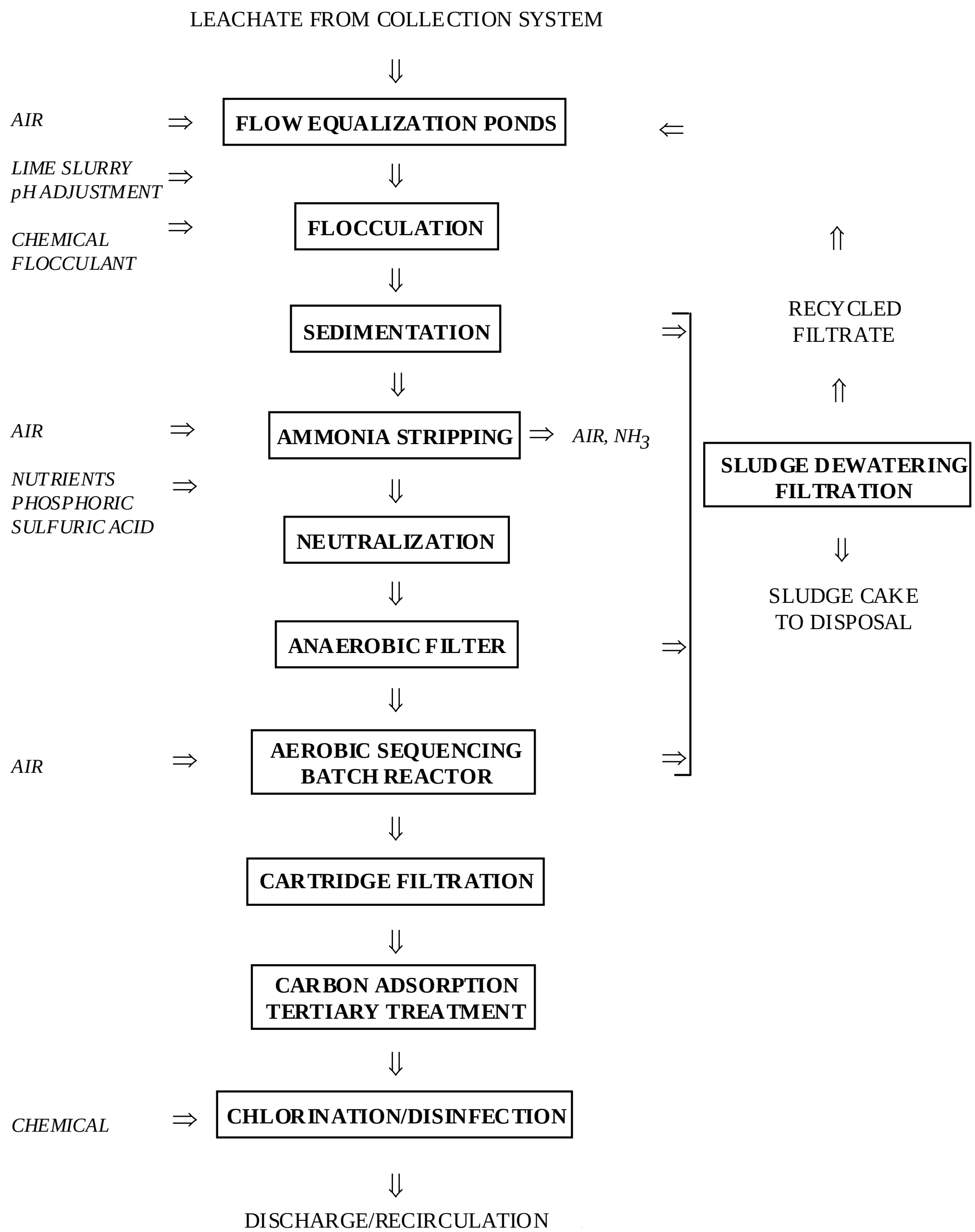

Figure 4: Process flow diagram for a typical leachate treatment system (El-Fadel *et al.*, 1997)

2.3.3 Waste storage

The Hbaline sorting facility will incorporate storage areas for the resulting recyclables and for the remaining waste stream that include compostables and refuse. The compostables i.e. organic materials will then be transferred to the composting plant of the Hbaline Facility and the refuse will be transferred to the existing open dump that is expected to become a sanitary landfill in the future. The storage areas will be designed with a capacity of at least three nominal days throughput. The design should take into account 1) roofing to prevent rainwater infiltration, limit the uncontrolled release of gases, and suppress the proliferation of vectors, 2) impermeable paving to minimize the infiltration of leachate into the subsurface, and 3) proper drainage and ventilation systems.

3 ADMINISTRATIVE AND LEGAL FRAMEWORK

This chapter provides a synthesis of the legal and administrative frameworks related to solid waste management in Lebanon. Relevant policies, regulations, and standards related to the implementation of the plan are also outlined.

3.1 Administrative framework

Historically, refuse collection and disposal in Lebanon has been the responsibility of the municipalities. The Municipal Law (Law No. 118 of 1977) provides municipalities the authority to manage solid waste collection and disposal. At present, direct responsibility for MSW management in the Mohafaza of Beirut and much of a large area of Mount Lebanon lies with the CDR[1], and to a lesser extent, the MoE[2], the MoIMA, and the DGU. The role of the Municipalities in these areas is restricted to overseeing the work of a private company contracted for solid waste management services. They are also responsible for refuse collection from public gardens, slaughterhouses, coasts, watercourses, and public-private obsolete lands. In the rest of Lebanon, the municipalities constitute the main authority responsible for managing solid waste. At this stage, it is expected that the adopted plan will involve primarily the CDR in consultation with the MoE, MoIMA - Municipalities.

3.2 Legal framework

To date, there is no specific legislative framework that deals directly with solid waste management in Lebanon. While the government often relies on indirectly related legislation (Table 7) such as public health acts or anti-litter decrees and the recent environmental Law Number 444 (2002), enforcement of these laws is relatively weak and responsibilities are not well-defined. Generally, the regulations lack clarity and precision, coordination between authorities is minimal, and enforcement is practically non-existent due mostly to staffing constraints, lack of proper training, low level of fines, and political interferences. Equally important is the lack of awareness of regulations amongst personnel who are supposed to enforce them (i.e. health inspectors, police officers, as well as the general public that is

[1] Plans and arranges for financing of projects including relations with donors and loan management; Executes projects in all sectors; Manages contracts in all sectors, including the solid waste sector, which involve planning, design, construction, and supervision of construction

[2] Monitoring and control of environmental protection, preservation of natural sites and amenities, prevention of pollution, protection of wildlife and preservation of environmental balance; Responsible for setting environmental standards, specifications and guidelines for

supposed to abide by them). In short, the lack of a solid waste legislation constitutes a major obstacle to implement a proper MSW management system in Lebanon.

sectors that might have an impact on the environment. Coordination of environmental awareness programs.

Table 7. Summary of selected laws and policies related to solid waste management

Legislation	*Date*	*Official Gazette*	*Brief description*
Decree 2775	1928		• Dumping of pollutants into public water courses is prohibited.
Decree 7975	5/5/1931		• Household sanitization • Waste should not be dumped around houses, but be buried or removed by the municipality.
Decree 21	22/7/1932	8/8/1932	• Classification of establishments that are dangerous or may pose public health problems or cause nuisance • Defines associated penalties and fines (penalties and fines updated later)
Decree 2761	19/12/1933		• Regulations for disposal of sewage and dirty substances • This regulation lists the penalties involved in illegal disposal of municipal and industrial wastes.
Law 6	8/1/1968		• Organize the sale of fertilizers (relates to fertilizers and composts)
Decree 15659	21/9/1970		• Classify the sale, manufacture, bagging, and import of fertilizers
Decision 425 / 1	8/9/1971		• Garbage must be placed in plastic bags for disposal. • Waste must not be dumped on the street or other public places • It is the responsibility of municipalities to collect waste
Decree 8735	23/8/1974	Issue 72 dated 9/9/1974	• Preservation of public cleanliness • Municipalities are responsible for collection and disposal of domestic wastes. • Household and Construction wastes may not be dumped in public places or private land adjacent to roads and residential districts. • It is an offense to drop liter in streets, government buildings and public areas. • Only tightly closed containers should be used for the storage of refuse. Municipalities may not pile waste on the roadside before it is collected. • Wastes should not be transported in open vehicles, but in vehicles that are tightly covered. • Disposal sites must have the approval of the Health Council of the Mohafaza.
Decree 11	1978		• No insecticide may be imported into Lebanon if it is banned for use in the country of origin.
Law 64	12/8/1988		• Preservation of the environment against pollution from hazardous waste and toxic substances • It is the duty of every person to preserve the safety of the environment from pollution. • A list of hazardous waste materials was published (based on English Law). • Import or possession of radioactive or poisonous wastes was prohibited. In extreme cases the death penalty could be applied.
Law 216	2/4/1993	Issue 14 dated 8/4/1993	• Creation of the Ministry of Environment (MoE). • MoE responsible for environmental protection and monitoring.

Legislation	*Date*	*Official Gazette*	*Brief description*
Decision 1292	6/11/1993	Issue 47 dated 25/11/1993	• Ministry of Municipal and Rural Affairs (MoMRA) decision related for the organization of construction and demolition waste within the city of Beirut.
Law 197	18/2/1993	Annex to Issue 7 18/2/1993	• Creation of the Ministry of Municipal and Rural Affairs (MoMRA). • It is charged with the of the development municipal sector in areas such as strategic planning, budgeting, and programming, as well as auditing the functions of the various municipalities in Lebanon. • Law 247 of 9/8/2000 (Issue 35 dated 14/8/93) cancels the MoMRA and merges its departments into the Ministry of Interior, thus creating the Ministry of Interior and Municipalities (MoIM).
Law 387	4/11/1994	Issue 45 dated 10/11/1994	• Ratification of Basel Convention for the Transport of Hazardous Waste by Lebanon.
Law 359	1/7/1994	Issue 32 dated 11/8/1994	• Ratification of the Climate Change Convention by Lebanon (this means that green house gas emissions should be reduced; i.e methane and carbon dioxide in the case of solid waste landfills).
Decree 4917	24/3/1994	Annex to Issue 13 31/3/1994	• Amendment of Table 1 in Decree 21 dated 22/7/1932, Classification of establishments that are dangerous or may be public health issue or cause nuisance. • Specifically, Table 1 of Annex, Item 204.
Law 501	6/6/1996	Issue 24 dated 17/6/1996	• Establishes an agreement to accept a loan from the World Bank to implement a Solid Waste Environmental Management Project (SWEMP) in Lebanon. • Components of the project include establishing sanitary landfills nationwide and institutional capacity building for the government relating to solid waste management.
Decision 52/1	29/6/1996	Issue 45 dated 12/9/21996	• Revised standards for water, air and soil pollution (partly updated in Decision 8/1 dated 30/1/2001).
Law 667	29/12/1997	Issue 59 dated 30/12/1996	• Amends Law 216, The creation of MoE.
Decision 71 / 1	19/5/1997	Issue 28 dated 7/6/1997	• Amends Decision 22 /1 of 17/12/1996. • Regulates the import of waste and defines associated penalties.
Law 247	9/8/2000	Issue 35 dated 14/8/2000	• Annuls the MoMRA and merges its departments into the Ministry of Interior , thus creating the Ministry of Interior and Municipalities (MoIM).
Decision 8/1	30/1/2001		• Amendment to part of MoE Decision 52/1 dated 29/6/1996. • Revised standards for air emissions, liquid effluents and wastewater treatment plants.
Decree 8006	21/6/2002	Issue 36 dated 21/6/2002	• Definition of waste categories generated by medical establishments and treatment and disposal options
Decree 9093	15/11/2002	Issue 63 dated 21/11/2002	• Amends Decree 1917 dated 6/4/1979. • States that any municipality that constructs a sanitary landfill or a waste treatment facility on its lands will get 5 times its allotted share of municipal funds from the Independent Municipal Fund, and if this municipality accepts wastes from 10 other municipalities its share will be 10 fold its allotted share.

Legislation	*Date*	*Official Gazette*	*Brief description*
Law 444	29/7/2002	Issue 44 dated 8/8/2002	• Environment Protection Law (7 parts, 68 articles): – Fundamental principles and public rules – Organization of environmental protection – Environmental information system and participation in the management and protection of the environment – Environmental Impact Assessment – Protection of environmental media – Responsibilities and fines – Other regulations (miscellaneous, institutional)
Draft decree	2003		• Environmental impact assessment (EIA) decree for Lebanon. • Solid waste treatment facilities and landfills must conduct an EIA and submit an EIA report. • MoE is to review and assess the EIA reports.
Draft decree	2003		• Management of industrial and hazardous waste decree • The decree pertains to the classification of industrial and hazardous waste • MoE is responsible for enforcement and monitoring • Identification, handling, storage, transport, treatment, disposal, record keeping procedures are addressed • MoE is responsible for plans and strategies , enforcement and monitoring • Producer is responsible for waste treatment/disposal • Sanctions placed in cases of violation
Draft decree	2003		• Permitting institutions managing industrial and hazardous waste • MoE grants permits • Procedures for requesting permits for transport, storage, treatment and disposal of industrial and hazardous waste are addressed • MoE is responsible for enforcement and monitoring • Sanctions placed in cases of violation • Provides guidelines for disposal operations • Provides guidelines for industrial and Hazardous waste landfill sites

3.3 Environmental standards

The MoE has introduced national quality standards for air, water, and soil in the context of Decision No. 52/1 dated July 1996 (MoE, 1996). In addition, Decision No.8/1 dated March 2001 included emission standards for air and wastewater (MoE, 2001b). Note that recently the MoE has drafted an ordinance on the quality assurance and utilization of compost in agriculture, horticulture, and landscaping.

3.4 EIA procedures and guidelines

Law 444 for the Protection of the Environment was issued in August 2002. The law defines the organization of environmental protection, environmental information system and participation in the management and protection of the environment, protection of environmental media, as well as the corresponding responsibilities and fines. Within this decree, provisions are proposed to conduct EIA studies for a variety of developmental projects. Furthermore, while there are currently no approved EIA procedures in Lebanon, efforts are underway at the MoE to pass an EIA draft decree that defines such procedures. It should be noted that the current EIA draft decree, follows to a great extent the guidelines recommended by the World Bank Operational Directives (World Bank, 1991a; b). The EIA draft decree provides a list of project types that require an EIA. Included in this list are projects that involve the construction and operation of solid waste treatment and disposal facilities. The decree outlines the elements to be examined in an EIA report, which are consistent with the scope of work described above with the exception of public participation and site selection process which were exempted from this EIA due to special circumstances of the proposed plan for solid waste management in the country.

4 DESCRIPTION OF THE ENVIRONMENT

This chapter presents a description of the environmental (physical and biological) and socio-economic settings of the Hbaline facility. While many field visits were conducted to the site, additional baseline data were compiled from previous studies conducted for the Hbaline facility. The collected data will be used to assess the baseline environmental quality of the area and identify environmentally significant impacts that the project may introduce to its region of influence.

4.1 Location

The Hbaline facility where municipal solid waste from the Jbeil Caza will be processed and composted is located at the outskirts of the Hbaline village in-between Hbaline and Kfar Mashoune in the Jbeil Caza, Mohafaza of Mount Lebanon (Figure 5). The site is located in a valley (Wadi Edde) within a natural drainage channel which currently being re-routed in order to avoid waterlogging the landfill (Figure 6). The area where the sorting facility will be based is owned by the Union of Municipalities, it amounts up to 11.7 ha.

The lots that make up the whole area owned by the Union are:

- Lots No. 133, 134, 275.276, 277.278 and part of lots No. 280.141 of Hbaline
- Lots No 484 and 486 and part of lots No. 483.485., 487. 471, and 472 of Kfar Mashoune

The site is currently accessible by the main Aamchit-Hbaline road from which the access road to the site branchesis about 500 m long and is in average condition (asphalted but needs widening and proper drainage) (Figure 7).

The site is located at a distance of 5 Km from the Jbeil coastline. The surrounding area is highly and extensively vegetated; however few residential units in the villages of Hbaline and Kfar Mashoune overlook the site (Figure 8). The nearest villages/towns to the site include:

- Hosrayel: 2.5 Km north-west
- Aamshite: 3 Km south-west
- Ghorfine: 1 Km south-west
- Kfar Mashoune: 1 Km south
- Hbaline village: 1 Km north-east

Considering the above mentioned proximity distances, the villages that may be most affected include Hbaline, Ghorfine, and Kfar Mashoune.

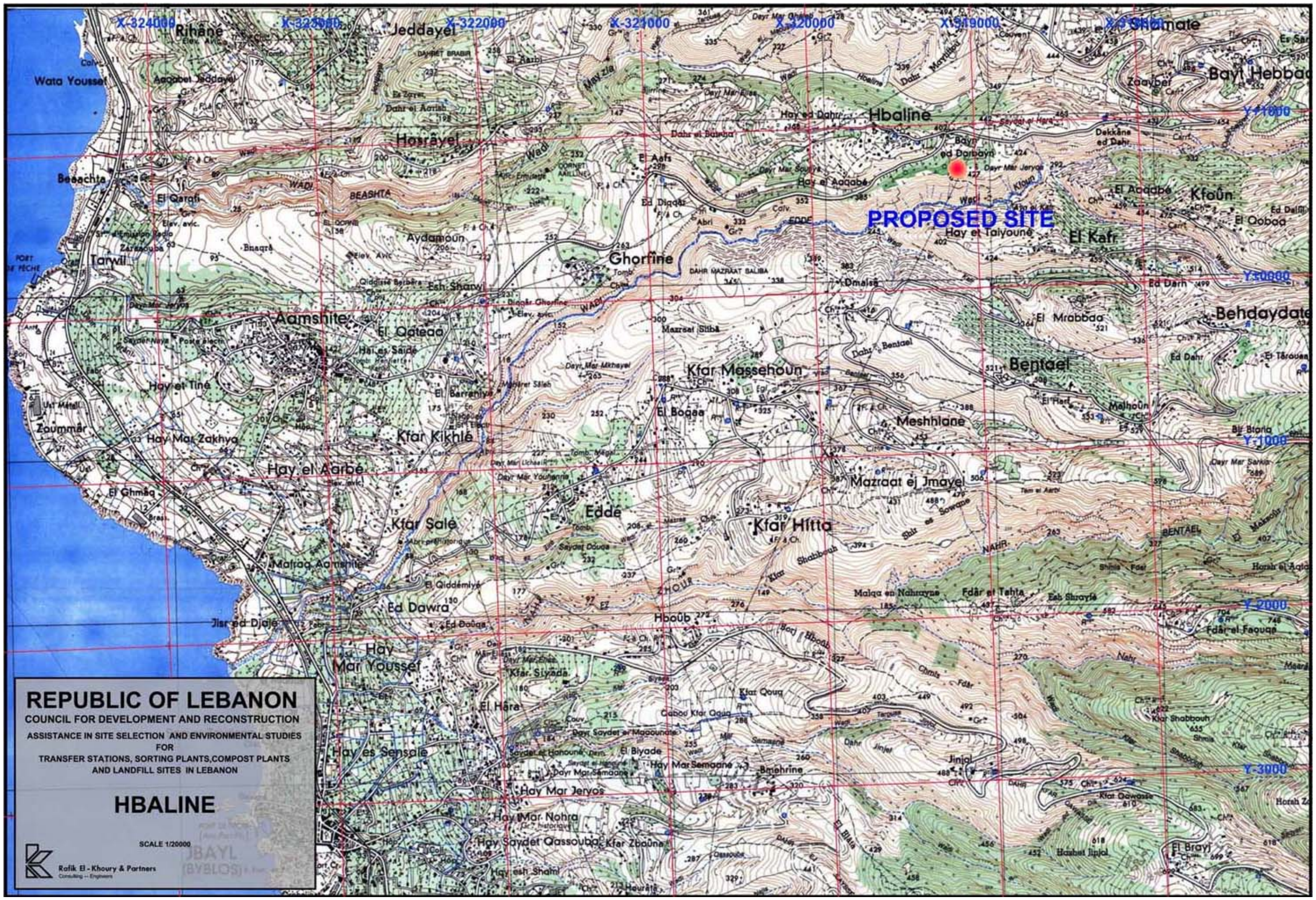

Figure 5. General map of the area surrounding Hbaline facility

Figure 6. View of the Hbaline site

Figure 7. Access road to the Hbaline facility

Figure 8. Residences overlooking the site

4.2 Physical environment

4.2.1 Climate and meteorology

The proposed site is located within the Wadi Edde valley at an altitude of about 230 m above sea level. The climate of this area is thermo-Mediterranean, moderately cold, windy and wet in the winter and warm in the summer and autumn. In the case of the existing landfill, the most significant meteorological parameters that influence the direct environmental impacts at the landfill are wind (because of its ability to carry odors and landfill gas to nearby communities) and rainfall (because of its ability to enhance the formation of leachate within the facility depending on site operation procedures). Note that adequate mitigation measures can reduce the rainfall seepage and subsequent leachate formation (Sections 7.1.1, 7.1.2).

The behavior and occurrence of wind and rainfall are influenced by and inter-related to other meteorological parameters such as temperature, humidity, and barometric pressure. At the site proper, these parameters have not been monitored and until a monitoring program is in place, data from weather monitoring stations located nearby could be used to conduct a preliminary evaluation of climatic conditions at the site. The nearest such monitoring stations appear to be located in Amioun (altitude 300m), Batroun (altitude 20m), and Tripoli (altitude 4m). Typical data from these stations are presented below whereby such data have been synthesized and published by the Ministry of Public Works and Transport (MoPWT).

4.2.1.1 Precipitation

Generally, snowfall is a rare occurrence in the general site area and therefore precipitation is limited to rainfall. The mean total rainfall is reported at 847 mm and 1015 mm in the Amioun and Batroun stations respectively. The rainy season typically spans from November to March during which 80 to 90 percent of the rainfall occurs. Less than 5 percent falls between May and September. Figure 9 depicts the average monthly amount of rainfall recorded at the Amioun and Batroun monitoring station for the years 1946-1970.

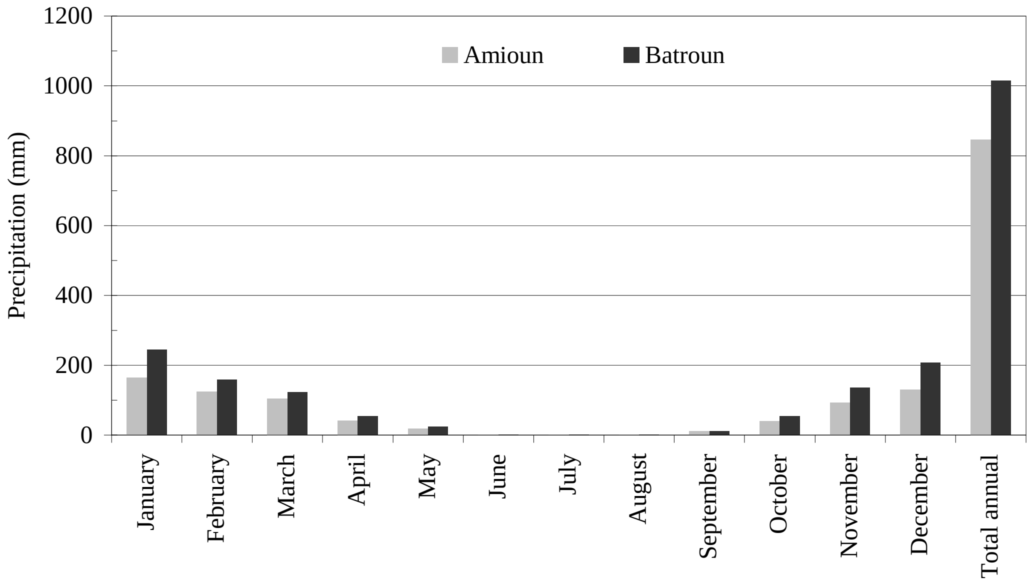

Figure 9. Monthly precipitation recorded at the Amioun and Batroun stations

4.2.1.2 Wind

According to the data recorded at the Tripoli station, dominant winds in the region of Wadi Edde are south-easterly and south-westerly, depending on the seasons. The local topography, characterized by a smooth valley surrounded by hills, aggravates the effects of winds at the project site. Figure 10 illustrates the wind rose recorded at the nearest Tripoli station for the year 1962.

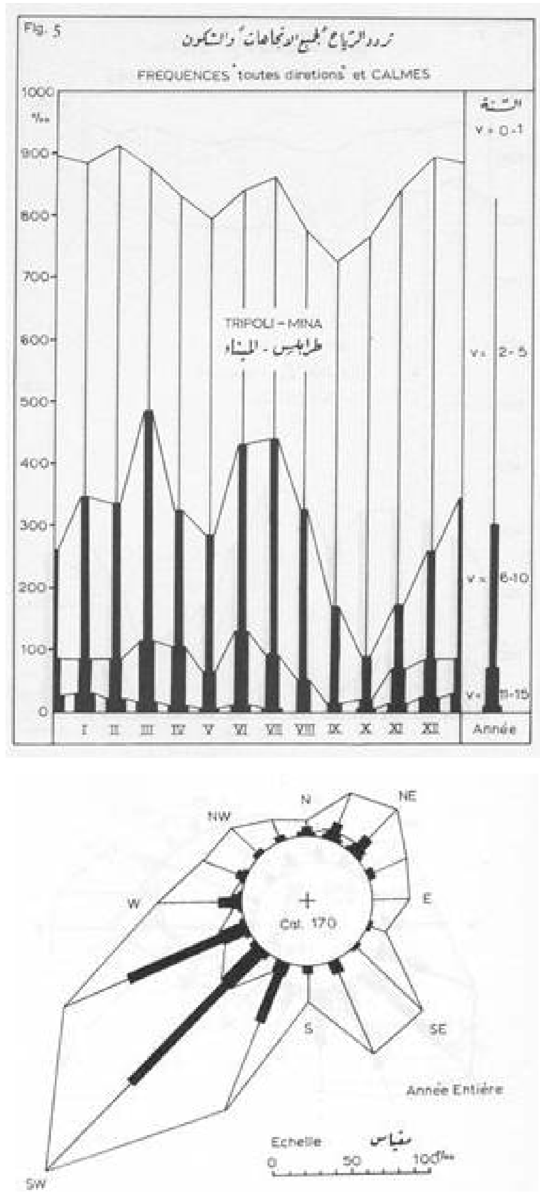

Figure 10. Wind roses recorded at the Tripoli station

4.2.1.3 Temperature and relative humidity

The mean monthly temperature in the area ranges between 11 (in January) and 23 °C (in August). The annual average temperature at the Amioun station is 18.5°C. Figure 11 presents the minimum and maximum monthly temperatures recorded at the Amioun station for the years 1965-1970.

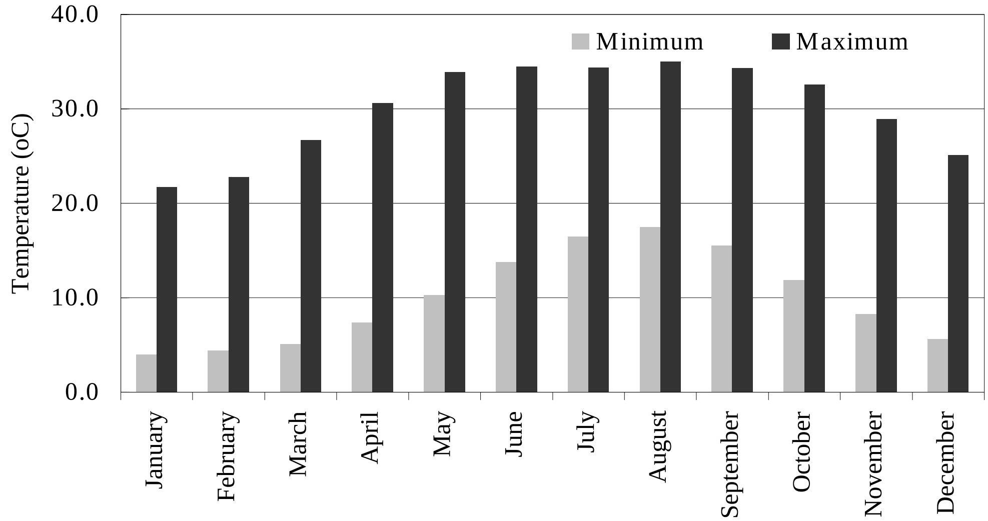

Figure 11. Monthly minimum and maximum temperatures (Amioun)

The mean monthly relative humidity recorded at the Tripoli station reaches 64 percent in October and 74 percent in June; the annual average being 70 percent. Table 8 presents the average monthly relative humidity recorded at the Tripoli station over a period of 15 years.

Table 8. Monthly relative humidity (Tripoli)

Month	*Humidity (%)*
January	71
February	70
March	67
April	71
May	72
June	74
July	73
August	70
September	66
October	64
November	67
December	70

4.2.2 Geology

In general, the oldest rocks seen at the surface in Lebanon are Early Jurassic, of about 200 million years old. Other formations include the Cretaceous and Tertiary. The overall stratigraphy of Lebanon is presented in Figure 12, while the geological map of Lebanon is presented in Figure 13.

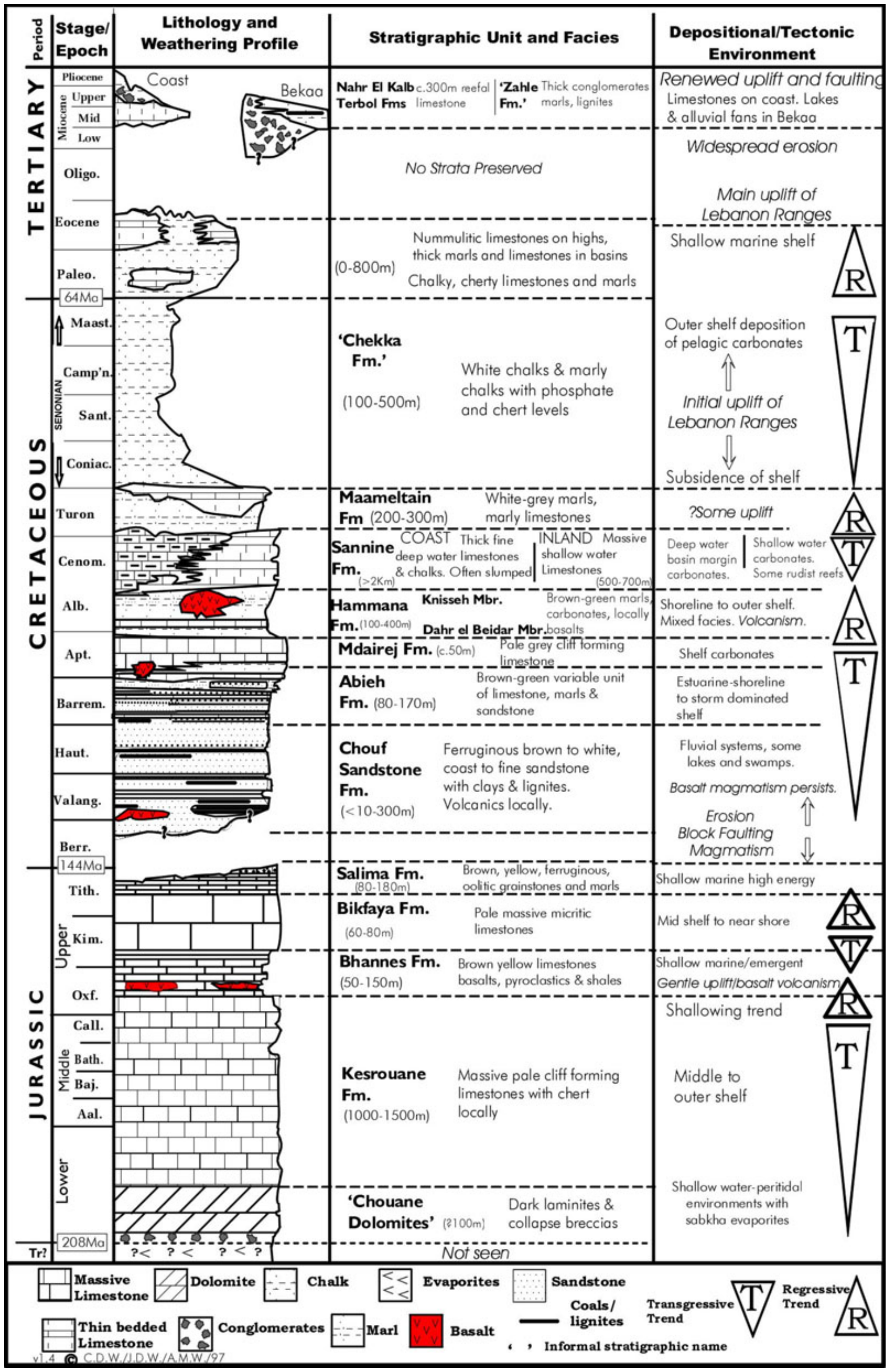

Figure 12. Stratigraphy of Lebanon (Wally, 1998)

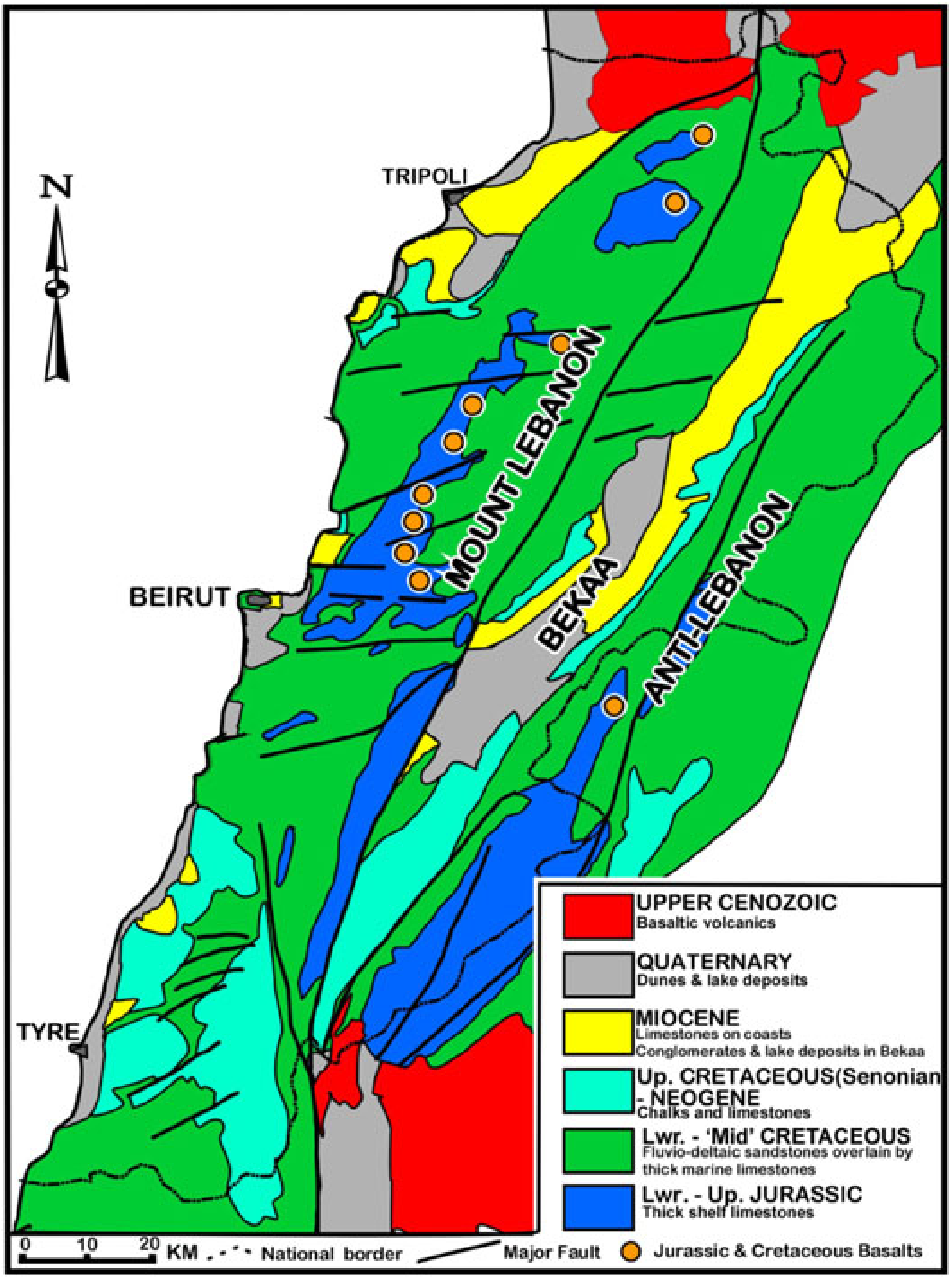

Figure 13. Geological map of Lebanon (Walley, 1998)

As presented in the geological map of Lebanon (Figure 13), the rocks outcropping in the study area range in age from the Middle Cretaceous (Cenomanian) to the Turonian (Recent). The upper layer (Turonian, thickness around 45 m) consists of marly limestone and brown to off-white limestone that is relatively hard and finely stratified (Figure 14), while the lower Cenomanian limestone layer is greatly stratified.

Figure 14. Rock formations in the area

The rocks outcropping in the study area range in age from the upper cretaceous to the Turonian (Figure 15). The Cretaceous formation in the study area consists of the following strata:

- The Sannine Formation (C_4)

  The Sannine Formation belongs to the Cenomanian Epoch and is divided into 4 layers that are:

  a. C_{4a}: this formation is composed of pale chertified, thick bedded, cliff-forming limestone with geodes.
  b. C_{4b}: bluish green Marl and marlstone with geodes. This formation reaches a thickness of 80 – 100m.
  c. C_{4c}: whitish grey, chertified, thick bedded, cliff- forming limestone with geodes of calcite or quartz
  d. C_{4d}: white marl and marly limestone which are thick bedded with geodes. The proposed site in located on this formation. Thickness is about 120-200m.

- The Maameltein Formation C_5:

  The Maameltein belongs to the Turonian Epoch that has white to grey, chertified limestone with greenish blue marl and marlstone. This formation reaches a thickness of 100-150m in the study area. The limestone beds are generally fractured and karstified.

Formations in the study area are gently dipping towards the west with inclinations mainly less than 20°.

The Quaternary deposits in the area are mainly alluvial deposits of conglomerates, sands and clays. Thickness of these deposits is not expected to exceed 5m. It is to be noted that geotechnical investigations and testing will be conducted during the design phase to allow for the geologic characterization of the area.

Lebanon is cut by various faults as presented in Figure 16. The longest fault in Lebanon is the Yammouneh Fault that runs along the western margin of the Bekaa and links the major fault of the Jordan Valley to the Ghab Valley Fault of Northern Syria. This is a lateral or transform fault and makes up the Lebanese segment of the Dead Sea Transform Fault. Another major fault is the Roum Fault, which runs from Marjayoun towards Awali River. The Roum fault is probably witnessing most of the plate tectonic motion and may be the present plate boundary between the Arabian and the African Plate. The other major fault in Lebanon is the Serghaya Fault which bands the eastern side of Bekaa. Other faults are present with displacements ranging from a few centimeters to several kilometers. There exist two dominant trends for faulting in the study area: NE-SW and NW-SE. NW-SE faults showed major strike slip components.

Figure 15: Geological Map and Cross-Section of the Proposed Site

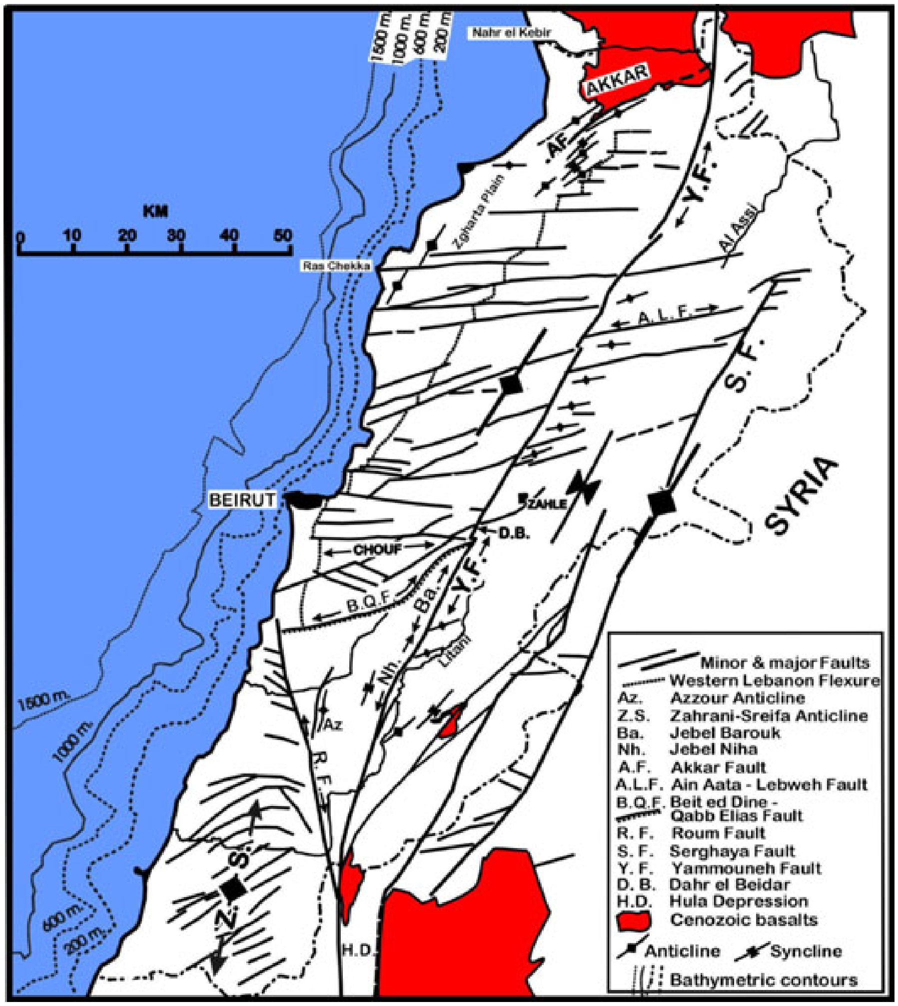

Figure 16. Major faults in Lebanon

4.2.3 Hydrogeology

The level of the aquifer in the area is the same as sea level (+ 10 m maximum). Consequently, the water table in the aquifer is relatively around 220m deep. The aquifer consists of Sannine Limestone and Maameltein formations, the limestone beds are generally intensely fractured and karstified. The rock has a range of permeability from 10^{-4} to 10^{-6} m/s. The white Ghazir marl (C_{4d}) are considered relatively impermeable. The proposed site is located on this formation. During the field survey, cement and other chemical spills (Figure 17) were observed on-site which may be associated with potential groundwater contamination. Sampling of groundwater from various wells was previously conducted in the area; results indicate no indications of leachate contamination to date despite the haphazard dumping of wastes (Table 9).

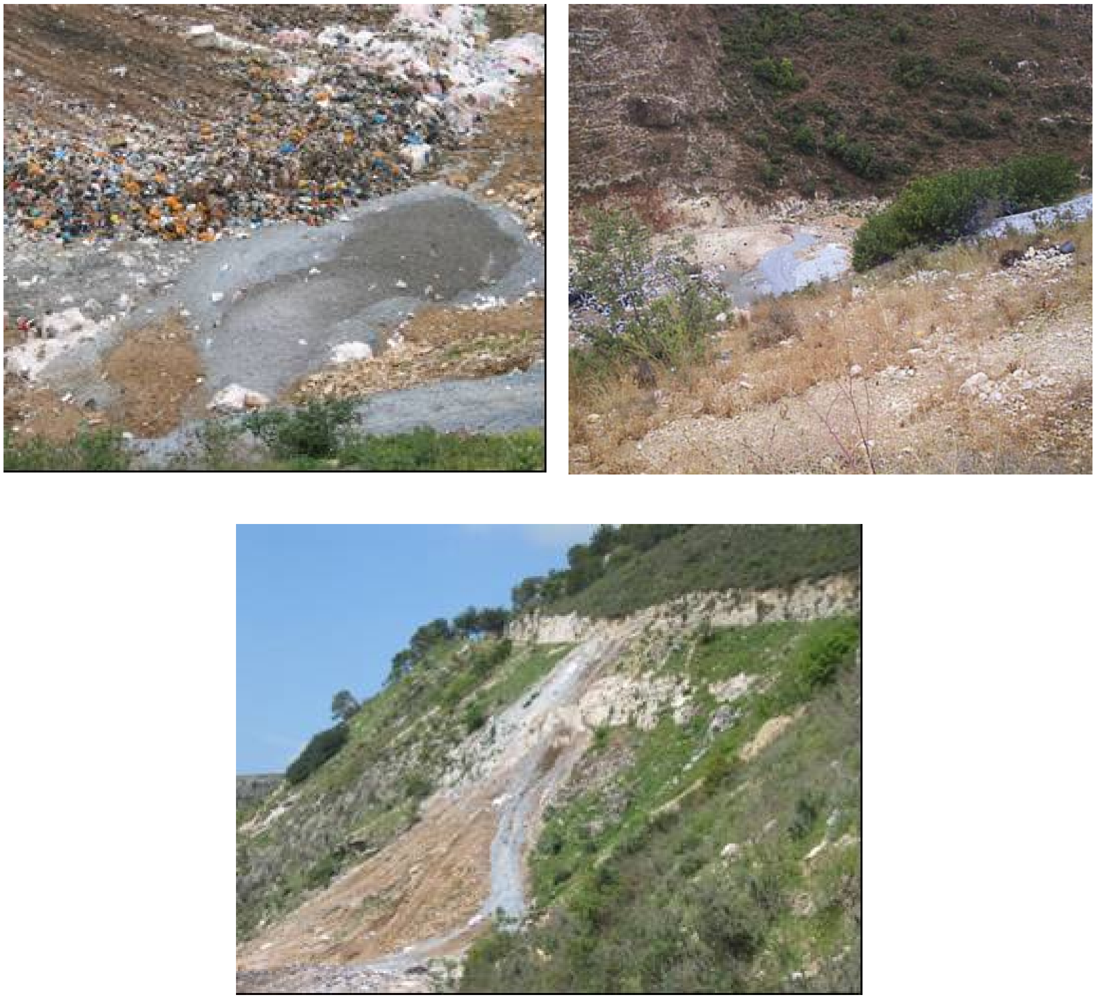

Figure 17. Cement and chemical spills on-site

Table 9. Groundwater quality in the area (CDR-LibanConsult, 2002)

Sampling location	*pH*	*Calcium (mg/L)*	*Magnesium (mg/L)*	*Chlorides (mg/L)*
MoE standard (MoE. 52/1)	*6.5-8.5*	*100*	*30*	*25*
Ghorfine well	6.8	72	39	20
Doukkan El Dahr well	7.62	32	31.1	16
Kour Al Hawa well	7.62	38.7	34.4	15
Kour Al Hawa station	7.77	67	16.5	14
Kour Al Hawa station	7.97	51	29	20
Tartah well	7.63	91	16.52	20
Afqa spring	8.0	25.6	17.1	6
Afqa spring	8.14	38.4	9.7	4

4.2.4 Surface water

The site is located within the natural drainage channel of Wadi Edde and partly occupies the valley bed. The basin feeding into the valley has a surface area around 20 Km^2. This drainage channel should be re-routed to avoid any potential infiltration into the landfill (Figure 18).

4.2.5 Ambient air quality and noise

The area in the vicinity of the proposed site is currently being exposed to a variety of air pollutants and odors resulting from the operation of the existing dump and the construction of the composting plant (underway). Such activities are associated with emissions in the form of dust, carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbons (HC), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), methane (CH_4), and particulate matter (PM) generated by heavy diesel equipment and occasional open burning of municipal wastes on-site. Other non-significant sources of air pollution include traffic on the main Aamchit-Hbaline road linking the Jbeil-Tripoli highway to the villages/towns located on the hills in the Jbeil Caza. Traffic emissions are typically associated with the release of CO, CO_2, HC, SO_2, NO_2, and PM. Odors are in the form of hydrogen sulfide (H_2S) and other sulfur-containing constituents. Concerning, noise pollution, the daily operation of the heavy machinery used on-site to dispose and cover the generated wastes is considered to be the most significant contributor to baseline noise levels in the area.

Analysis of biogas generated by the haphazard dump was conducted in the context of the EIA previously developed for the Hbaline landfill proposed as part of the SWEMP project. In this respect, gas levels were measured at 20 gas wells within the area, 3 of which are located within the dump site. Results indicate significant CH_4 levels in some locations and relatively low levels in other locations (CDR-LibanConsult, 2002). In general, ambient CH_4 concentrations ranging between 5 and 15 percent pose explosion hazards, while concentrations exceeding the 15 percent limit result in fire risks. The presence of such levels in certain locations within the dump may have been responsible for past occurrence of fires.

Figure 18: Surface water; watercourses and springs

4.2.6 Topography

The site is located at an average altitude of 200 m above sea level. It is located within a valley (Wadi Edde) surrounded by steep mountains, and is slightly inclined to the west (Figure 19 and Figure 20).

Figure 19: General Topography of the study area showing the Composting Plant

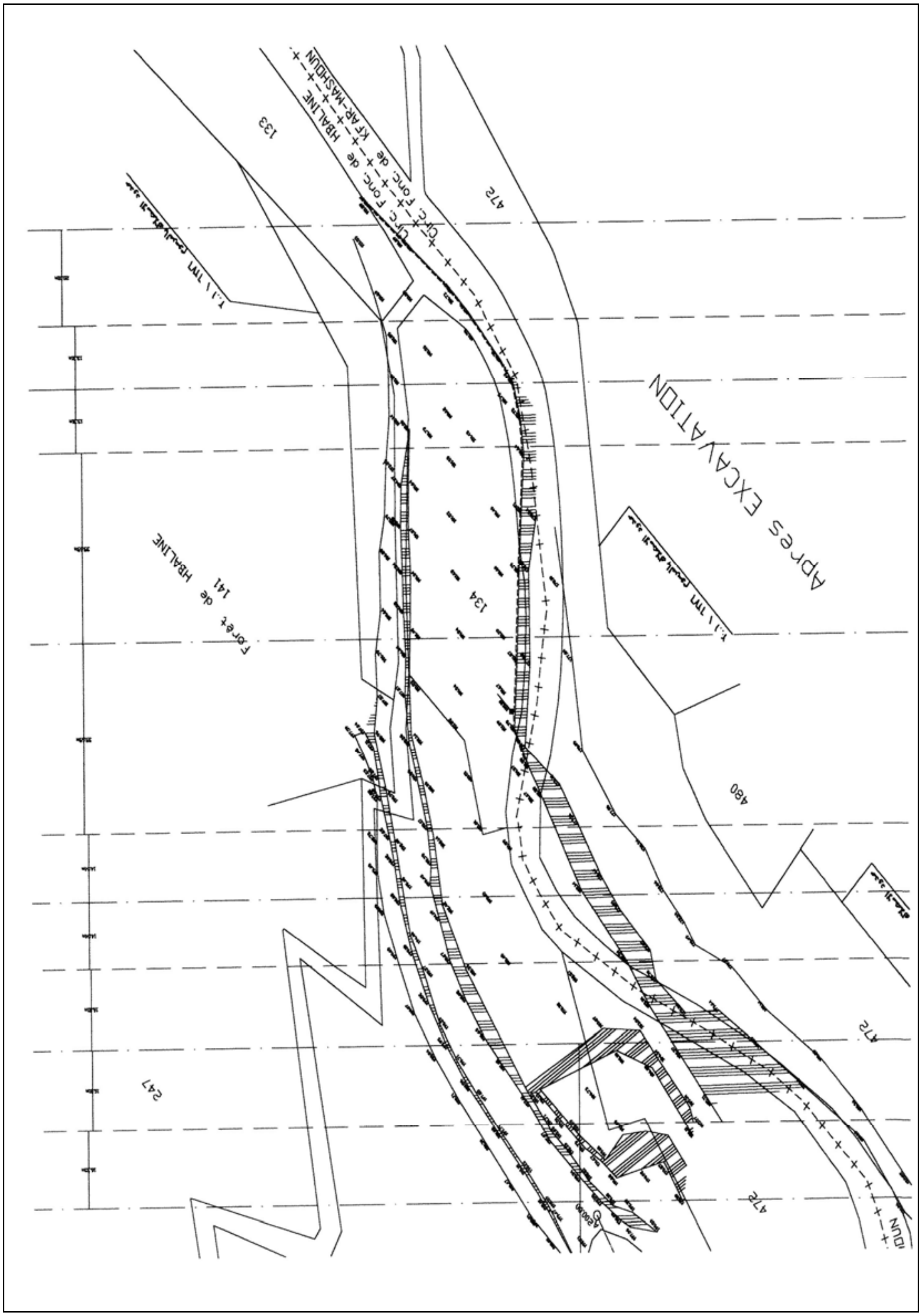

Figure 20: Topographic survey of the proposed site (Scale 1: 1000)

4.3 Biological environment

Previous studies at the Hbaline dump included a survey of existing biodiversity along the slopes of both flanks of the valley housing the site. It was observed that the left flank of the watercourse represented a highly degraded Mediterranean maquis type of plant associations dominated by flora characteristic of such types of systems that occur in all degraded lower mountain coastal habitats of Lebanon. Such an impoverished condition was attributed to severe perturbations caused by either repeated burning or overgrazing, or extensive cutting for charcoal making, or to the alternation of all three degrading practices. In fact, the left flank had traces of what once was an extensive system of terraces that were probably used for growing wheat. These terraces have long been abandoned and most have fallen apart and given way to wild shrubs and bushes (Figure 21). On the other hand, the right flank of the watercourse is a hill slope constituting of a grove of mainly pine trees of the *Pinus brutia* type. This grove represents the mixed type forest of young plant association characteristic of Mediterranean coastal climate and calcareous soil type. This system of plant association generally provides rather relatively high plant diversity common to all such systems that abound on the western lower reaches of Mount Lebanon Chain (Figure 22). Various species of trees, shrubs, climbers, bushes, flowering plants, grasses, and bulbous plants were identified on both flanks of the water course as detailed in CDR- LibanConsult (2002).

Figure 21. Vegetative cover of the left flank of the watercourse

Figure 22. Vegetative cover of the right flank of the watercourse

4.4 Socio-economic environment

4.4.1 Demographic description of the Caza

The Central Administration for Statistics (CAS) has estimated the population at the Caza of Jbeil during the years 1996 and 1997 to be equal to 81,000 persons in the winter season that is the resident population while the peak population during the summer season is equal to 106,000. The Feasibility Study conducted by ECODIT (April 2004) states that there is an estimated annual growth rate of 0.7% which leads to a resident population of 85,000 for the year 2004.

4.4.2 General site usage

For the past twenty years, the proposed site was used as an unsanitary dump for the disposal of solid wastes generated from several villages in the Jbeil Caza (Figure 23). The area surrounding the site is rural in nature and highly vegetated. Waste management practices included the discharge of solid wastes at the site with no compaction or cover. In addition, open burning was a common practice either intentionally or unintentionally as a result of methane build-up. Starting the year 2000, open burning was halted and compaction of dumped wastes was adopted. However, in 2000 a major fire broke, and as a result, gas wells were installed within the dumped wastes.

Figure 23. Haphazard dump in Hbaline

4.4.3 Economic activities within the Jbeil Caza

The major economic activities within the Caza include agriculture, industries, trading, as well as tourism. Jbeil is benefiting from the development of industrial activities such as cables industry, paper and cardboard, tapestry, cosmetics, beer, metal works, as well as the development of greenhouses that have expanded the agricultural area. The old Souks of Byblos constitute the historic commercial centers of the Caza. They are composed primarily of paved narrow alleyways with small commercial activities selling artisanal clothes and shoes, small gifts, coppersmiths, and local food (Figure 24). With the exception of few restaurants located near the port of Byblos, no entertainment or leisure activities exist in the historic core of the ancient city. In addition to the souks, the Byblos Citadel constitutes a major touristic attraction thus enhancing economic activities in the area. Note that bathing and seaside sports/activities are also significant in the area whereby sandy beaches receive numerous visitors in the summer.

Figure 24: Artisanal products and restaurants in Byblos

4.4.4 Cultural and historical attractions

No cultural or historical attractions are located in the immediate vicinity of the site. It is worth mentioning that the famous old Byblos Souks and the citadel are located along the coast, relatively far from the site.

5 IMPACT ANALYSIS

The construction and operation of medium scale solid waste management facility is designated as a Category A project both under the provisions of the EIA Draft Decree developed by the MoE and the World Bank Operational Directive/Policy 4.01 (World Bank, 1991a; b). This chapter examines the potential environmental impacts associated with the proposed facility at the construction, operational, and post-closure phases. The typical parameters that may be affected in this context are presented in Table 10. As is the case with most solid waste management facilities, the major impacts are associated with leachate generation with potential surface and/or groundwater contamination and gaseous/odorous emissions. Other less serious impacts of concern include noise, visual intrusions, biodiversity, traffic, socio-economics, waste management, soil, as well as health and safety. Note that during the construction phase, the potential impacts from the facility are limited in nature and extent since corresponding activities typically involve regular construction works such as land clearing, drilling, ground excavation, cut and fill operations (i.e., earth moving) as well as the construction of each facility.

Table 10. Potential environmental impacts according to project phases

Project phase	*Duration*	*Potentially impacted parameter*
Construction	Short term	• Surface & groundwater quality • Soil quality • Air quality • Health and safety • Noise • Solid waste generation • Landscape and visual intrusion • Biological environment • Socio economics • Traffic
Operation	Long term	• Surface & groundwater quality • Soil quality • Odors • Air quality • Health and safety • Noise • Solid waste generation • Landscape and visual intrusion • Biological environment • Socio economics • Traffic

5.1 Surface and groundwater quality

During the *construction phase*, the impacts on the surface and groundwater quality are relatively minor and limited to accidental chemical leakage or spillage resulting from concreting, painting, tarring, plastering, clearing, blasting, cleaning work and other similar activities along with the possibility of unintentional spillage of oils and other petroleum products. These impacts are confined to the relatively short period of construction and can be effectively mitigated.

During the *operation phase*, leachate occurrence is by far the most significant threat to ground and surface waters alike. In the absence of proper drainage and collection systems, leachate has reportedly been associated with the contamination of aquifers as well as nearby surface water resources. Note that exposing compostable materials to precipitation will result in a marked increase in the leachate generation rate at the composting plant being under construction. Another possible source of leachate includes stored commingled MSW (exceeding the allocated storage area) in unequipped parcels during system failure or peak throughputs. The main concern is the treatment of the generated leachate prior to discharge or reuse. Note that failing to treat the leachate to acceptable levels will result in surface and groundwater pollution.

Other minor impacts may result from the haphazard disposal of the collected leachate from vehicles transporting waste, oil and lubricants generated from equipment maintenance workshops on-site, washing waters of vehicles and buildings, as well as drainage water collected from the MRF.

Note that the Hbaline site is located in a natural drainage channel; as such, failing to divert the existing waterway away from the site and the absence of proper containment of the generated leachate will lead to the mixing and contamination of the running water with the said leachate.

Estimation of the quantity of leachate generated within the existing landfill was conducted in the case where organic materials are landfilled along with the remaining waste stream. Estimations were conducted using the Hydrologic Evaluation of Landfill Performance (HELP3) model. The model accounts for the total affected surface, precipitation, evapotranspiration, and permeability of materials. Results indicated that the total quantity of leachate generated is higher prior to addition of the final cover system and during the rainy season. The maximum quantity of leachate was generated during the second year of operation (CDR-LibanConsult, 2001).

5.2 Soil quality

During the *construction phase*, potential soil impacts include accidental chemical leakage or spillage resulting from concreting, painting, tarring, plastering, clearing, blasting, cleaning work and other similar activities along with the possibility of unintentional spillage of oils and other petroleum products.

During the *operation phase*, leachate generated at the sorting plant may impact the soil quality in the case of accidental spillage or percolation. A possible source of leachate includes stored commingled MSW (exceeding the capacity of the allocated storage areas) in unequipped parcels during system failure or peak throughputs. Other minor impacts may result from the haphazard disposal of the collected leachate from vehicles transporting waste, oil and lubricants generated from equipment maintenance workshops on-site.

5.3 Odors

Odors are by far the most common cause of public complaint against waste management operations. During the *construction phase,* excavation of the existing haphazardly disposed solid wastes for land clearing will result in the generation of offensive odors. These odors will be generated as a result of exposing anaerobic pockets known to generate odorous gases such as hydrogen sulfide (H_2S). However, the sorting facility will not extend beyond the allocated land that is generally enough distant from the open dump.

The *operation phase* will be associated with significant potential odor impacts as a result of sorting and leachate treatment and storage activities. Anaerobic decomposition during storage will be associated with the release of offensive odors. This is due to the formation of anaerobic pockets within the piled wastes before their processing that may lead to the generation of foul odors (resulting from the generation of hydrogen sulfide, H_2S, or other odorous gases including esters, organosulphurs, alkylbenzenes, limonene, and other hydrocarbons).

In general, odor generation is especially accentuated under conditions characterized by low carbon to nitrogen ratios, poor temperature and airflow control, excessive moisture, as well as poor mixing. The odorous nature of the emitted gases may vary widely from relatively sweet to bitter and acrid depending on the concentration of the odorous constituents within the gas. These concentrations will vary with waste composition and age, decomposition stage and the rate of gas generation, and the nature of microbial populations within the waste, amongst other factors.

Since Hbaline facility is close to the main road and to nearby receptors mainly located in the Hbaline village, north-east of the site, the generated odors may pose a nuisance especially that prevalent wind direction in the area blows from the south-west. As such, it is anticipated that odor suppression measures such as enclosing the odor sources and providing odor control systems will be incorporated in the design to mitigate odor nuisance.

5.4 Air quality

Construction activities are usually associated with the release of high levels of PM generated from land clearing, excavation schemes, cut and fill operations and facility erection. In addition, air emissions from the use of construction equipment on-site are expected to release vehicular induced pollutants (CO, NO_2, SO_2, PM and HC). Air emissions during the construction phase are temporary in nature and tend to be confined to the immediate vicinity of the site. Owing to the random nature and short duration of construction activities, the negative impacts associated with the degradation of ambient air quality in the vicinity of the construction site are expected to be minimal. It is to be noted that since the Hbaline sorting facility is close to the main road and to nearby receptors in the Hbaline village and nearby villages, north-east of the site, then the generated air emissions may pose a nuisance especially that the most prevalent wind direction in the area blows from the south-west.

The *operation phase* may result in the emission of several air pollutants mostly generated as a result of the decomposition of the organic matter in the stored wastes. The decomposition process also releases HC, bacteria, and fungi into the surrounding environment. Other air emissions sources during the operation phase include the machinery and combustion engines used on-site. In general, ambient methane concentrations ranging between 5 and 15 percent pose explosion hazards, while concentrations exceeding the 15 percent limit will result in fire risks. Moreover, CO_2, CH_4, and other trace compounds are greenhouse gases (USEPA, 1995).

In addition, the operation of the MRF (sorting plant) as well as its associated auxiliary and support units may be associated with the possible gaseous emissions resulting from the combustion of fossil fuel for electricity generation. Typical air pollutants that are expected to be emitted include CO, PM, SO_2, NO_2, along with HC.

5.5 Health and safety

During the *construction phase*, health and safety issues are mainly related to accidents resulting from the improper handling and storage of construction materials as well as accidents occurring with the operation of moving equipment. While the magnitude of this impact is difficult to quantify, adoption of proper occupational construction procedures are essential to minimize such risks. In this respect, specific health and safety guidelines for contractors involved in construction projects were developed by the CDR and other governmental institutions, based on international standards adopted by the World Bank and the European Union.

Proper *operations* at the Hbaline sorting facility are expected to reduce health risks associated with the open unsanitary disposal of municipal wastes that promotes the breeding of disease vectors and pests as well as the contamination of groundwater, surface water and soil which all lead to an increase in the incidences of parasitic infections, hepatitis, malaria, plague along with gastrointestinal diseases including cholera and typhoid. In addition, improper handling of waste and leachate may lead to occupational hazards ranging from skin rashes to serious dermatological diseases.

Methane generation may pose serious fire and explosion risks if not well managed, particularly due to the presence of the existing Hbaline open dump. In fact, methane has often been considered as a liability because of its flammability and its ability to form explosive mixtures with air. In general, ambient methane concentrations ranging between 5 and 15 percent pose explosion hazards, while concentrations exceeding the 15 percent limit will result in fire risks. Note that landfill methane formation and associated risks will be minimized in the overall waste management scheme in Hbaline site due to the introduction of the separation process; which is the subject of this report as well as composting plant that is under construction.

The lack or improper training of the staff in charge of the operation and maintenance of the sorting facility could expose them along with nearby residents to adverse health risks. In addition, the presence of mechanical equipment in the sorting process may expose the workers to sharp objects, fans, as well as fire and explosion risks. Uncontrolled access to the facility may result in various safety and health hazards.

5.6 Noise

Construction noise can be a significant source of community noise. Impacts on construction workers and people residing near the construction site can be of concern. The construction phase noise impacts are a function of the excavation scheme and the machinery used on site. Typical construction activities associated with the construction of the Hbaline sorting facility include ground clearing, excavation, foundations, erection, and finishing. During this process various machinery and heavy equipment are used. Table 11 provides a summary of the estimated noise levels for the various construction phases.

Table 11.Typical noise levels for various construction phases
(USEPA, 1972 *cited in* Canter, 1996)

Phase	*Sound Pressure Level dB(A)*
Ground clearing	84
Excavation	79
Foundations	78
Erection	75
Finishing	75

The noise levels generated from the construction activities exceed the Lebanese daytime noise standard set for rural residential areas (35-45 dBA) and residential areas with few construction sites (50-60 dBA) (Table 12). Since the construction phase is generally short and the area surrounding the site is not inhabited, then adverse impacts are expected to be minimal.

Table 12: Lebanese noise guidelines in different zones (MoE, 1996)

Area classification	*Maximum accepted noise level dB(A)*		
	Day[1]	*Evening*[2]	*Night*[3]
Business district	55 – 65	50 – 60	45 – 55
Residential area with few construction sites, commercial activities or on a highway	50 – 60	45 – 55	40 – 50
Urban residential area	45 – 55	40 – 50	35 – 45
Residential suburb	40 – 50	35 – 45	30 – 40
Rural residential, hospital, public garden	35 – 45	30 – 40	25 – 35
Industrial zone	60 - 70	55 - 65	50 - 60

[1] 7 a.m. to 6 p.m. [2] 6 p.m. to 10 p.m. [3] 10 p.m. to 7 a.m.

The *operational phase* is linked with noise generating activities associated with the operation of various machinery, generators, as well as loading and unloading activities. The most adversely affected receptors include the residences located in Hbaline, Ghorfine, and Kfar

Mashoune. In addition to the noise generating activities at the site proper, the circulation of solid waste collection trucks and/or pickups may cause noise nuisance depending on the circulation schedule.

5.7 Waste generation/management

Construction activities are inherently associated with the generation of wastes. Possible wastes arising during the construction phase include excavated soil and dumped solid wastes, construction and demolition waste[3], chemical wastes[4], and general refuse. The impact of the generated waste is dependent primarily on the management option that is adopted during the construction phase. Excavation of the existing dumped solid wastes is expected to release odors (Section 5.3). In addition, haphazard disposal of the excavated wastes will generate leachate and potentially contaminate soil and groundwater.

Construction wastes pose adverse impacts if not well managed. The haphazard disposal of construction wastes may cause visual intrusion, increase health and safety risks, result in degradation of the receiving environment, as well as decrease the property value. As such, it is important to allocate adequate disposal sites prior to the construction phase.

In addition, chemical wastes may be generated and may pose serious environmental, health and safety hazards if not properly stored and managed. Improper handling of chemical wastes can lead to toxic effects among exposed workers, adverse effects on air, water and land as a result of accidental spills, as well as fire hazards. It is difficult to quantify the amount of chemical waste which will arise from the Hbaline facility and associated construction activities, as these amounts will be highly dependent on the contractor's on-site maintenance procedures and the number of equipment and vehicles utilized at any one time.

The presence of a construction site with workers on site, site offices and canteens will result in the generation of a variety of general refuse requiring proper management. General refuse consists mainly of food wastes, aluminum cans and waste paper, which can result in potential

3

- Wood from formwork and falsework
- Equipment and vehicle maintenance parts
- Materials and equipment wrappings
- Unusable/surplus concrete/grouting mixes/demolition waste/membranes

4

- Scrap batteries or spent acid/alkali from their maintenance
- Used paint, engine oils, hydraulic fluids and waste fuel
- Spent mineral oils/cleaning fluids from mechanical machinery
- Spent solvents/solutions from equipment cleaning activities

adverse environmental impacts. These include odor if the waste is not collected frequently, windblown litter, water quality impacts if the waste enters water bodies, and visual impact. The site may also attract pests, vermin, and other disease vectors if waste storage areas are not well maintained and cleaned regularly. In addition, disposal of wastes at sites other than the existing dump or any approved landfills in the future, can also lead to similar adverse impacts at those sites.

During the *operation phase*, the facility is expected to process the MSW into three final products namely: 1) the compostables (organic materials), 2) the recyclables, and 3) the inert materials i.e. remaining refuse. The proposed operation plan stipulates that only the remaining refuse will be disposed of in the existing dump that is planned to become a sanitary landfill in the future. The compostables will be sent to the composting plant being under construction at present. Some recyclables may be disposed of in the landfill in case no market develops for their end-use. During system failure or peak throughputs, incoming wastes may exceed the allocated storage area thus leading to storage in unequipped parcels that may lead to groundwater, surface water, soil, odor, and health and safety risks.

5.8 Landscape and visual intrusion

Landscape disturbance and visual intrusions are inevitable at the site proper particularly during the *construction phase*. The presence of equipment, material, soil heaps, and ground pits presents an unsightly view. Such impacts are common to any construction site and are limited to the construction period. During this phase, visual impacts can be avoided if proper mitigation measures are implemented. During *operation*, visual impacts may arise from the open storage of wastes, transport trucks as well as from the site itself. Note that at the Hbaline site, the landscape has been visibly altered due the unsanitary disposal of MSW. Therefore, the effects on the landscape from constructing a medium sized sorting plant are expected to be minimal. The only adversely affected residences are located on top of the right and left flanks of the watercourse. As such proper screening of the site is necessary to avoid visual impacts.

5.9 Biological environment

During the *construction phase*, the primary potential sources that may have effects on the biological environment include land-take or excavation and removal of vegetation. Potential loss of habitat may occur to a lesser extent due to litter blow, exposure to gaseous emissions, accidental spillages and leakage, installation of roads, fences, drains, and various other construction activities. Since the area surrounding the Hbaline site is highly vegetated, then appropriate control measures should be implemented to avoid significant impacts.

5.10 Socio-economics

Limited positive socio-economic impacts are associated with the *construction* of the facility. Such impacts include providing local job opportunities. The proper *operation* of the facility will have indirect positive socio-economic benefits to the local community. These benefits include the abatement of nuisance and public health hazards in the serviced area, providing compost at low prices, and generating additional revenue resulting from the sale of compost and recovered recyclables (assuming a market is established). Furthermore, the operation of the facility will create local job opportunities. However, possible negative impacts include a drop in the land value in the area particularly during the construction and operation phases, limitation of recreational activities in the direct vicinity of the facility as well as the perception of being exposed to health risks, which may lead to psychological stress. Table 13 describes general examples of potential social and economic impacts of a landfill site.

Table 13. Potential socio-economic impacts at a solid waste treatment facility (Petts & Eduljee, 1994)

Impact	*Beneficial*	*Adverse*
Economic	• Employment generation • Expenditure of wages in local area • House purchase and rental • Equipment and services procurement • Local authority business tax/rates revenue • Reduction in waste transport costs to local communities	• Loss of agricultural income • Decrease in property value • Perception of pollution-sensitive individuals leading to out-migration • Deterrent to inward investment • Impact upon tourist or recreational income
Social	• Indirect beneficial community impacts from employment and provision of skilled workforce	• Decreased level of resident satisfaction with character and amenity of area • Perception of risk leading stress • Out-migration leading to reduced social cohesion in small communities • In-migration of temporary construction workforce

5.11 Traffic

During the *construction phase*, transportation of construction equipment and materials will have an impact on the traffic flow in the area. The operational phase of the facility will mostly impact traffic flow along the Aamchit-Hbaline main road due to the movement of solid waste collection trucks. The site is currently accessible by the Aamchit-Hbaline main road branching from the Jbeil-Tripoli highway. The direct access road is 500m long and needs rehabilitation, equipping with a drainage system, widening at certain locations to reach enough width (8 m), and re-asphalting. In addition, traffic impacts are also expected along secondary and tertiary roads of the waste management service area, depending on the collection schedule and routing in the villages of the Union of Municipalities of Jbeil Caza. These impacts include a marked increase in congestion, noise, and air pollution.

5.12 Summary of impact analysis

At this stage, analysis of impacts that may be incurred due to implementation of the Hbaline facility revealed that limited adverse environmental impacts would occur during the short-termed construction phase. During operation, the sorting facility may be associated with serious impacts due mainly to leachate generation with potential surface and/or groundwater contamination and gaseous/odorous emissions. Other less serious impacts of concern include soil, noise, visual intrusion, biodiversity, traffic, waste management, socio-economics, as well as health and safety. Table 14 presents a summary of potential environmental impacts associated with the proposed plan based on the analysis presented above.

Table 14. Summary of potential environmental impacts

Parameter	*Potential impacts according to phase*	
	Construction	*Operation*
Surface & groundwater quality	-	- - -
Soil quality	-	-/+
Odors	- -	- - -
Air quality	-	- -
Health and safety	-	- -
Noise	-	-
Waste management	-	+ + +
Landscape and visual intrusion	-/0	-/+
Biological environment	- -	- -
Socio-economic	-/+	-/+ +
Traffic	-	-

+ + +: High potential positive impact
+ +: Moderate potential positive impact
+: Low potential positive impact
- - -: High potential negative impact
- -: Moderate potential negative impact
-: Low potential negative impact
0: No significant potential impact

6 ANALYSIS OF ALTERNATIVES

The analysis of alternatives in the context of the proposed solid waste management plan includes a selection of a suitable site for the implementation of the solid waste treatment (sorting) facility as well as a technical comparison between the various available solid waste management options and determination of the most suitable option.

6.1 Site selection

The site was proposed by the Union of Municipalities of Jbeil Caza. As described in Chapter 4, the proposed Hbaline sorting facility is located in the vicinity of the existing dump and the Hbaline composting plant which is under construction. The site is currently accessible by a paved road that runs parallel to the river and joins the Aamchit-Hbaline road.

However, the selection of the proposed site was fine-tuned on the basis of a four-step methodology including 1) technical-desktop review, 2) field visit, 3) revisiting the previous reports and studies prepared in this respect, and 4) compliance with urban planning regulations.

- **Step 1** *Technical/desktop review:* Geographic Information Systems (GIS)-based land use maps were used to select potential sites based on remoteness to residential units, waterways, marshes, and main roads.
- **Step 2** *Field visit:* Field visit was conducted to investigate the site and its suitability. The main objective of the visit was to ensure the compliance of the site with various pre-defined selection criteria.
- **Step 3** *Revisiting previous reports and studies prepared in this respect.* The previous reports and studies were revised to strengthen and justify the selection process. The main studies that has been revised are:
    1. EIA for Solid Waste Treatment Center, Hbaline, prepared by LibanConsult and funded by CDR in April 2002
    2. EIA for Solid Waste Treatment Center “Jbeil-Hbaline”, prepared by ELARD, in March 2004
    3. Feasibility Study of Solid Waste Management in the Caza of Byblos, ECODIT Inc., in April 2004.

- **Step 4** *Compliance with urban planning regulations:* the selected location was checked for its compliance with the urban planning regulations in the area.

6.2 Technology selection

Apart from the sorting technology which is the subject of the present EIA, various alternatives for MSW treatment/disposal have been analyzed in the general framework of an integrated strategy for municipal solid waste management in Lebanon. These alternatives include the proposed scheme (sorting plant) vs. other alternative management options. Note that the "Do-Nothing" scenario was also assessed.

In case landfilling alone is opted for in the area, it is expected that the area requirement will be greater as compared to the proposed management plan and will significantly increase the generation rates of leachate and landfill gas, thus requiring a more elaborate system for their management.

At present, the adoption of incineration is not considered a very favorable option in the context of Lebanon since the costs of implementing it are prohibitively high. Furthermore, the adoption of incineration technology is highly dependent on achieving effective source separation of organic matter (putrescibles) from other waste types for efficient operations. The disadvantages of incineration are mainly its high costs, high technical skill requirements, as well as the emission of a variety of air pollutants.

The adoption of composting and recycling are crucial elements in any integrated solid waste management plan since they are capable of diverting a significant portion of the waste stream into useful by-products. Table 15 presents a comparison between the available MSW treatment and disposal methods based on international experience. In this table, sorting is compared against other treatment and/or disposal methods.

Table 15. Comparison of available MSW treatment and disposal methods

Parameters	*Treatment / Disposal Method*							
	Landfilling	*Thermal*			*Biological*		*Re-use, Recycling, Recovery*	
		Grate Incineration	*RDF*	*Pyrolysis*	*Aerobic Composting*	*Anaerobic digestion*	*Source separation*	*MRF separation**
Proven Technology	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Technology track record	Very common	Very common	Few	Few	Very common	Common	Common	Common
Technical reliability	High	High	High	Low -Medium	Low - Medium	Medium	Low	Medium
No. of personnel required for operation	Low	High	Medium	High	Medium	Medium	Low	High
Energy recovery	Low	High	High	High	No	Very High		
Life span	High	Medium	Medium	Medium	High	Medium		Medium
Flexibility of process to waste quantity	Very High	Low	Low	Low	Medium	Medium	High	Medium
Maintenance requirements	Low	High	High	High	Medium	High		Medium
Restrictions on waste composition	Very Low	Medium	High	Medium	High	High	High	High
Acceptance of wet household waste	Yes	Technically Yes but generally No	No	No	Yes	Yes	Yes	Yes
Capital cost	Medium	High	High	Very High	Low	High	Low	Medium
O & M cost	Low	High	High	High	Medium	High	Low	Medium
Economic recovery rate	Low	High	High	High	Medium	Medium	Medium	Low
Pollution abatement costs	Medium	Very High	Medium	Very High	Medium	Medium - High	Low	Medium
Monitoring costs	Medium	High	Medium	High	Medium	High		Low
Land acquisition costs	Very High	Medium	Medium	Medium	High	Medium		Low
Surrounding land depreciation	High	High	Medium	High	High	High		Medium
Disposal fee	Low	High	Low	Very High	Medium	High		Low
Cost of treatment/disposal	Low	Medium to high	Low	Medium-high	Low to high	Medium to high		Medium
Air emissions	Low	Medium - High	Low	Medium	Low	Medium		
Control of odor	Bad - good	Good	Good	Medium-good	Bad - good	Bad - good	good	Bad - good
Liquid effluent	High	High	Low	Medium-High	Medium	High		Low
Waste volume reduction	Low	High	High	Low	Low	Low		
Local public acceptability	Very Low	Very Low	Medium	Very Low	Low	Low	Medium	High
Public nuisance	Medium	High	Medium	High	Medium	Low	Low	Medium

RDF = Refuse Derived Fuel MRF = Materials Recovery Facility

The “Do Nothing” scenario implies that the current waste management practices used will remain the same. Open dumping of wastes in the area has adverse effects on the environment and constitutes a public nuisance, diminishing landscape aesthetics, and causing unpleasant odors. It also causes public health impacts by allowing the breeding of rats, flies, and other disease vectors, and the generation of toxic gases and irritating smokes. Other effects include the contamination of soil, surface and groundwater by leachate. Although the “Do Nothing” scenario will avoid temporary environmental impacts associated with construction activities, on the long-term it will result in a marked deterioration of the environmental, health and socio-economic conditions at the national scale.

A comparative matrix for assessing four solid waste management options for the facilities namely, 1) sorting coupled with composting and landfilling 2) landfilling alone, 3) incineration and landfilling and 4) “do nothing” is presented in Table 16. A weighted-rating checklist was used to select among the four scenarios. Two groups of weights were used. First, each alternative was rated on a scale from 1 to 4, with 1 denoting the least plausible and 4 the most plausible, relative to 9 selection criteria. Then, each selection criterion was assigned an importance weight reflecting its significance. Weights ranged between 1 and 3, with 3 assigned to the highly important decision factors while 1 was assigned to the less important decision factors. The scenario with the highest number of points, which is the proposed plan, was considered as the most favorable scenario.

Note that Hbaline facility is expected to incorporate a sanitary landfill on-site that will replace the currently used open dump. A composting plant was constructed and will be commissioned in few months. The organic wastes remaining after sorting will be composted in the aforementioned composting plant and the refuse landfilled in the expected sanitary landfill.

Table 16. Comparative matrix for solid waste management plan evaluation

Criteria	*Weight*	*Score*							
		1[a] (proposed plan)		*2[b]*		*3[c]*		*4[d]*	
		R	W	R	W	R	W	R	W
Area requirements	1	3	3	2	2	4	4	1	1
Operational costs	2	3	6	2	4	1	2	4	8
Leachate generation	2	3	6	2	4	4	8	1	2
Air pollution	2	3	6	2	4	1	2	1	2
Odor	2	2	4	3	6	3	6	1	2
Surface and groundwater contamination	3	3	9	2	6	4	12	1	3
Capital costs	3	2	6	3	9	1	3	4	12
Health and sanitation	3	3	9	3	9	3	9	1	3
Public perception	3	4	12	3	9	1	3	1	3
Total			**61**		**53**		**48**		**36**

- Weight = Represents the importance of each selection criterion whereby 1 represents the least importance criterion and 3 the most important criterion
- R = Raw score ranging between 1 and 4 whereby 1 represents the worst alternative and 4 the best alternative for each of the selection criteria
- W = Weighted score representing the product of the weight and the raw score
- [a] Composting coupled with sorting and landfilling
  [b] Landfilling alone
  [c] Incineration and landfilling
  [d] “do nothing”

6.3 Alternative Sorting Techniques

Conveyors

Belt conveyors are the most widely used materials-handling equipment, are used for conveying commingled MSW as well as recycled materials. Conveyors are used to convey materials on manual sorting lines, where recycled materials can be hand-picked. Belt conveyors are designed on the basis of belt speed, mass throughput, horsepower and average thickness of materials on the belt.

Screening

Screening is a unit operation used to separate mixtures of materials of different sizes into two or more size fractions by means of one or more screening surfaces. Screening may be accomplished either dry or wet, with the former being more common in solid waste processing systems. The types of screens used most commonly for the separation of sold waste materials are:

- vibrating screens
- rotary screens
- disc screens

Vibrating screens are most often used to separate relative dry materials such as glass or metals (Figure 25). They can be designed to vibrate from side to side, vertically, or lengthwise. Vibrating screens used for the separation of MSW are inclined and use a vertical motion.

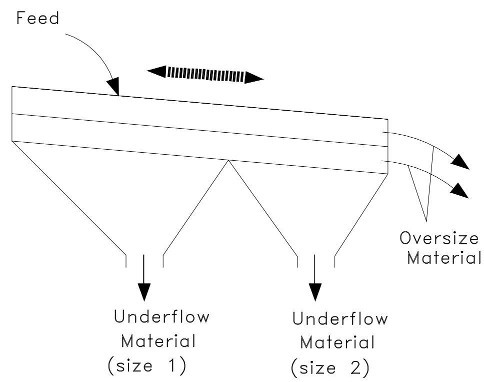

Figure 25: Typical Vibrating Screen

Trommel screen is the most versatile type of screens for solid waste processing. Trommels are used to separate waste materials into several size fractions (Figure 26). Operationally, the material to be separated is introduced at the front end of the inclined rotating trammel. As the screen rotates, the material to be separated tumbles and contacts the screen numerous times as it travels down the length of the screens. Small particles will fall through the holes in the screen, while the oversized material will pass through the screen.

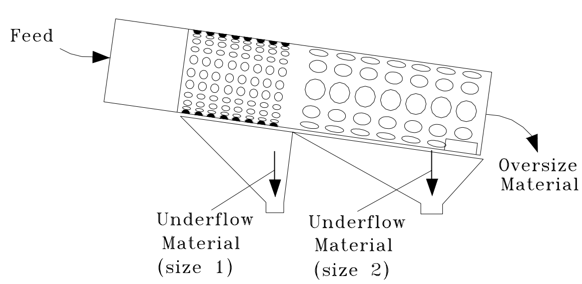

Figure 26: Typical Rotary Drum Screen - Trommel

Disc screens are an alternative to reciprocating screens (vibrating screens). A disc screen consists of sets of parallel, interlocking, rotating disks. The materials to be separated fall between the spaces and oversized materials are carried over the top of the disks as in a conveyor belt.

Magnetic Separation

Magnetic Separation is a unit operation whereby ferrous metals are separated from other waste materials by utilizing their magnetic properties (Figure 27). It is the most commonly used technology for separating ferrous from nonferrous metals. It is used to recover ferrous materials from source-separated, commingled and shredded MSW. Magnetic separation is commonly used to separate aluminum cans from tin cans in source-separated waste where the two types of metals are mixed.

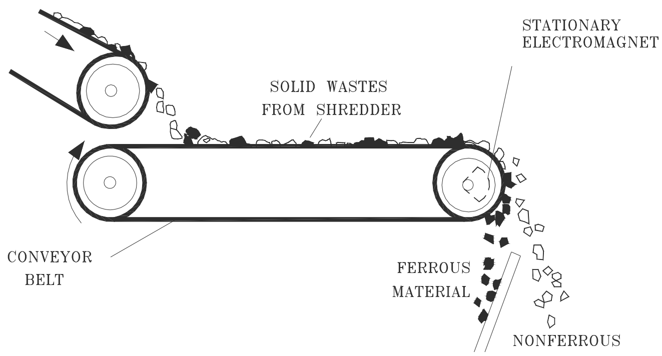

Figure 27: Typical Magnet Seperator

Density Separation (Air Classification)

Air classification is the unit operation used to separate light materials from heavier materials based on the weight difference of the material in an air stream. A complete air classification system is comprised of the air classifier and cyclone separator (Figure 28). Since there is movement away from the shredding of commingled MSW, air classifiers are not commonly used today at the start of the sorting lines.

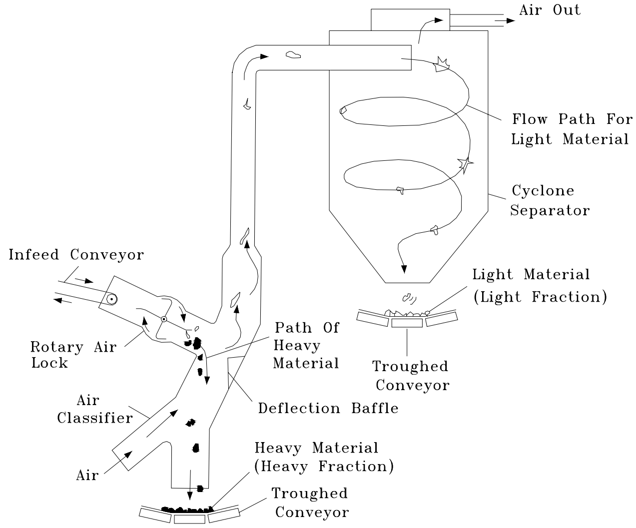

Figure 28: Typical Air Classification System

6.4 Compostables Stream Management Alternatives

In the light of the construction of the composting plant, two alternatives for compostable stream management have been considered for the proposed project (Appendix II – Alternatives 1 and 2). The first compostable management alternative, Alternative 1, suggests building the sorting plant separately from the composting plant and transferring the compostables via a covered conveyor. The sorting and composting plants will be both located in the same area made available by the Union, but close enough for practical and safe transfer of the resulting compostables to the composting plant.

The second compostables management alternative, Alternative 2, suggests transferring of the resulting compostables from the sorting plant to the composting plant by trucks with firmly sealed containers. As mentioned before, the composting plant was constructed with a different fund and for different settings. The purpose behind Alternative 1 is to have immediate transfer of the resulting compostables to the composting unit and to facilitate the management of the different operational units as if it were one plant. However, Alternative 2 will require institutional, administrative and engineering work coordination between the two projects; the sorting and composting plants.

6.5 Solid Waste Sorting line (SWSL)

A solid waste sorting line (SWSL) is the series of operational units placed one after the other in order to perform the sorting process. SWSL separates recyclables from a stream of raw commingled solid waste. Materials processed as recyclables include paper, cardboard, steel and aluminum cans, brown, green and clear glass, and various plastic and polyethylene (PE) items. Properly operated SWSLs can have a significant effect on reducing the volume of waste destined for landfilling and hence reducing the reliance on landfills.

SWSL can be designed using different components so as to meet the end-of-line requirements including the level of sorting (extensive or preliminary), the type of components to which the waste is to be segregated, the specifications to which the sorted products must conform such as glass that can be divided into three classes based on color (green, clear, and brown), and the level of energy requirement to be consumed (manual vs. fully automated).

Hence, sorting lines may be assembled of entirely manually operated components to minimize energy consumption or be fully automated, that is, including a full range of mechanically and electrically operating components. Another option is the combination of both to design a partially automated system. A combined system of automated and manual sorting usually begins with automated sizing and sorting and ends with manual sorting (hand picking).

The section below is a description of each type of sorting line:

1. Manual Sorting Line

   This line may be composed of the following components: a plateau for pre-sorting followed by manual bag opening, then manual separation into organic material, recyclables and non-recyclables or refuse.

2. Partially Automated Sorting Line

   This line includes pre-sorting plateau, followed by manual/mechanical bag opening after which waste is laid on a conveyor belt used as standalone or to feed the trommel screen which leads to a large table for further manual separation into reusable materials and recyclables. Resulting refuse and organic material are then shredded and magnetically separated.

3. Fully Automated Sorting Line

This line will start with pre-sorting followed by a mechanical bag opener which directs the waste onto a conveyor belt into the trommel screen that will sort the waste into reusable and refuse and organic matter. The reusable material may be passed into an air classifier for further separation while the organic material is shredded and passed below a magnetic separator to remove the remaining bits of metal (that may still remain) in preparation for composting.

An air classifier, the most common density sorting system used at a SWSL, is used to split the solid waste stream into heavy and light fractions, which allows the other sorting operations to specialize in the most common materials found in the respective fraction.

Manual sorting follows automated sorting. The waste travels down a flat conveyor belt and workers remove the recyclables as they pass. The length of the belt depends on the loading rate, types of recyclables and the percentage composition of each type of recyclables to be sorted. Magnetic separation systems are commonly used in automated SWSLs.

Table 17 presents a comparative analysis with respect to different criteria for the three alternatives of sorting lines.

Table 17: Analysis of different alternatives of solid waste sorting lines

Selection Criteria	**Manually operated sorting line**	**Partially automated sorting line**	**Fully automated sorting line**
Extent of sorting	insufficient	sufficient	Extensive
Speed of processing	slow	fast	Fast
Energy consumption	low	moderate	High
Land requirement	low	moderate	High
Ability to handle flow variations	fair	good	Good
O/M requirements and costs	low	moderate	High
Capital investment	low	medium	High
Reliability of the process	acceptable	very good	very good

It is worth noting that once the recyclables are separated, they must be processed into materials for sale. Processing typically includes baling for paper, steel cans, and plastic bottles, flattening or densifying for aluminum cans; granulating or perforating for plastic bottles; and crushing for glass bottles. Once processed, the materials are sold directly to specialty recyclers for reuse. In addition to balers, SWSLs employ other processing equipment including shredders, pelletizers and compactors. A shredder reduces the volume and increases the size uniformity of the residual solid waste. Pelletizers receive shredded waste and extrude it under high pressure to form small pellets. The pellets may then be used as fuel for a furnace or power plant.

The Hbaline sorting facility is planned to have a partially automated sorting line. Schematic details and drawings of the SWSL proposed for the Hbaline sorting facility is presented in Appendix II. They show the different components of the sorting line according to a typical MRF process flow diagram. The sorting line will consist of conveyors where manual picking will be practiced, a shredder and magnetic separator. A trommel for size-based separation of organic material is optional and not considered as mandatory being expensive and of high maintenance and power cost. Air classification is not proposed to be used in the sorting line.

7 ENVIRONMENTAL MANAGEMENT PLAN

7.1 Environmental mitigation

The primary adverse environmental impacts that are associated with the construction and operation phases of the Hbaline sorting facility can be minimized by careful planning and staging of construction activities, adopting proper management practices during operation and relying on effective environmental monitoring and training to support management decisions. The mitigation plan proposes several potential impact-mitigation or control measures that should earn the facility more acceptability, by reducing or eliminating to the extent possible many of the impacts that have been discussed in Chapter 4. Mitigation measures are intended to reduce the effect of potentially significant impacts on the environment. Thus, they are highly dependent on the significance of the predicted impact, the nature of the impact (permanent vs. temporary), or the phase of the project (construction, operation).

7.1.1 Surface and groundwater quality

7.1.1.1 Construction

During construction activities, the primary sources of potential impacts to water quality will be from pollutants in site runoff, which may enter surface waters directly. As such, the surface run-off from the construction site should be directed into storm drains with adequately designed sand/silt/debris removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on-site to properly direct stormwater to silt removal facilities before discharge into the surrounding waters. Silt/debris removal facilities should be maintained whereby deposited silt and grit/debris are regularly removed after each rainstorm to ensure that these facilities are functioning properly at all times. In addition, the rainwater pumped out from trenches or foundation excavations should be discharged into storm drains with silt/debris removal facilities and not directly to the environment. Open stockpiles of construction materials on-site should be covered with tarpaulin or similar fabric during rainstorm events to prevent the washing away of construction materials, while earthworks should be well compacted as soon as the final surfaces are formed to prevent erosion especially during the wet season that stretches between late November and May.

Water used in vehicle and plant servicing areas, vehicle wash bays and lubrication bays should be collected and connected to foul sewers via an oil/grease trap. Oil leakage or spillage should be contained and cleaned up immediately. Spent oil and lubricants should be collected and stored for recycling or proper disposal. In addition, all fuel tanks and chemical storage areas should be provided with locks.

The contractor/operator shall prepare guidelines and procedures for immediate clean-up actions following spillages of oil, fuel or chemicals.

Sewage from toilets, canteens and similar facilities should be contained in sanitary cesspools before being transported by trucks to a nearby wastewater treatment plant or treated locally. As for the wastewater generated from concreting, plastering, internal decoration, cleaning work and other similar activities, it should undergo large object removal by bar traps at drain inlets.

7.1.1.2 Operation

During operation, mitigation measures focus on collecting and treating the leachate that will be generated during the different operational steps of the facility as well as preventing it from percolating into the subsurface. Leachate is expected to be generated during storage and sorting. As such proper design and implementation of leachate collection and treatment should be adopted.

7.1.1.2.1 Leachate collection

Within the sorting plant and depending on the preprocessing storage time; leachate collection and storage should be conducted in lined collection tanks. MRF, reception and storage areas should be paved with an impermeable material, in order to prohibit leachate infiltration. Furthermore the facility should be equipped with two independent drainage systems in order to ensure that leachate and wash waters will not mix.

7.1.1.2.2 Leachate treatment

Leachate treatment should be conducted on-site, prior to discharge unless off-site treatment is opted for (transferred to a local wastewater treatment plant). The treated effluent should meet the MoE standards set for discharge into surface water bodies prior to release at a rate exceeding 0.1 m^3/sec (Decision 8/1). It is to be noted that the river is a temporary runoff that occur during the rainy season. The most commonly used on-site treatment options include biological treatment (aerobic vs. anaerobic) and to a lesser extent, evaporation. Note that in the case were off-site treatment is adopted, a leachate holding tank with a volume capable of accommodating the throughput of 20 consecutive days should be provided on-site along with dedicated cistern(s) (acquired or rented) for the transport of the generated leachate.

For a leachate of high biological oxygen demand (BOD) which will not be generated in a sorting plant, anaerobic biological treatment is most commonly used because of its energy efficiency and lower sludge generation rate. Leachate of medium BOD level may be treated in aerobic biological systems, including activated sludge, rotating biological contactors, or sequenced batch units. Reduction of 90 percent or more of BOD, suspended solids, and precipitated metals is accomplished, but energy consumption may be high and comparatively larger amounts of sludge are produced (UNEP, 1996).

An aeration or facultative pond can be used to polish leachate treated by other methods, if the leachate has not yet reached a contaminant level suitable for discharge. Ponds can also be used to treat relatively low-strength leachate. Such ponds may have surface aerators depending on the BOD, retention time, and configuration. If the leachate is to be discharged to surface water, additional treatment consisting of activated carbon adsorption or membrane filtration processes will be required, and air stripping or chemical precipitation may also be needed (UNEP, 1996).

An inexpensive method of leachate treatment includes collection in a concrete-lined holding pond, and evaporation. Evaporation in a lagoon can be utilized during dry weather (summer) to reduce leachate volumes, but the method suffers from the disadvantage of an increase in stored volume during periods of heavy rain due to self catchment and increased leachate generation. In addition open lagoons are dangerous, subject to fly infestation and generate unpleasant odors. The risk of overflow into surface water can be avoided by constructing ponds large enough to handle all expected leachate and rainfall. During rainy times, the holding pond solution is not expected to work perfectly, since evaporation may be lower than the combination of leachate and rainfall. However, even in this circumstance, the leachate from an overflowing pond is usually diluted by rainfall (UNEP, 1996). This alternative may be a suitable and economic temporary solution until a leachate treatment plant is constructed on-site.

In addition, the mitigation measures should focus on avoiding the malfunctioning, breakdown or the improper operation of the leachate treatment plant that will lead to adverse impacts resulting from the disposal of untreated leachate into the environment. Mitigation is in the form of adopting proper inspection and maintenance programs to ensure system functionality. In addition, providing appropriate training to a qualified staff is also a crucial mitigation measure. The training should incorporate basic familiarization with the operating system of the Hbaline sorting facility and its leachate treatment plant along with fundamentals of occupational health and safety in solid waste and leachate treatment facilities. In addition, implementing a monitoring program the treated leachate effluent would ensure their environmental and health acceptability before reuse or discharge. The proposed monitoring parameters are presented in Chapter 0. The treated leachate effluent shall meet the Lebanese standards set for wastewater discharge.

The Hbaline facility should accommodate for adequate MSW storage areas (roofed, impermeable paving, proper drainage and ventilation) with capacities of at least one nominal day throughput to ensure that incoming wastes are not haphazardly stacked in case of system failure or peak throughputs thus leading to leachate seepage.

7.1.1.2.3 Other mitigation measures

Other minor impacts that may result from the haphazard disposal of the collected leachate from vehicles transporting waste, contaminated cleaning and drainage water, as well as oil and lubricants generated from equipment maintenance workshops on-site should be mitigated to curb any surface and groundwater pollution. As such, leachate collected from the storage tanks of the vehicles transporting waste as well as cleaning water and drainage water collected from the MRF, and vehicle washing facility should be treated on-site along with the leachate collected from the compost plant. Every effort should be made to minimize water use during cleaning of working areas and vehicles (e.g. adopting dry cleaning practices prior to water cleaning). In addition, oil-water separators and sand precipitators should be constructed at all workshops on-site in order to limit mixing with cleaning water. Spent motor oils should be collected in sealed containers and stored in workshops until a management plan is devised for recycling or disposal of used oils. Finally, the designs for the MRF should accommodate for slightly inclined ground surface to ensure proper leachate drainage.

7.1.2 Soil quality

The prevention of soil contamination is crucial since the restoration and treatment of soils is an expensive process. During the construction phase the main mitigation measures relate to good housekeeping practices that include the proper storage of chemicals on site, limiting accidental spillage as well as prohibiting the open disposal of spent oils in the surrounding environments.

Different separation processes exist including manual sorting, mechanical sorting, as well as electromagnetic separation. **Based on international experience, initiating household sorting through local and national campaigns along with in-process separation has resulted in the production of good quality compost.**

Note that besides compost quality, the proper use and application rates of compost are crucial elements in mitigating soil quality impacts. In this respect, compost application rates should comply with the MoE standards for application in areas with subtropical climates (characterizing the Lebanese coastal zone) (Table 18) and in areas with arid climate (characterizing the interior Lebanese areas) (Table 19). In both cases, yearly application rates should not exceed 17 g/m^2 for total nitrogen, 6 g/m^2 for phosphate, and 12 g/m^2 for potassium oxide. In order to ensure appropriate application rates, the contractor should provide assistance and training programs for end-users.

Table 18. Recommended use for compost in Lebanese coastal zones (MOE Compost-Ordinance)

Area of use	*Vegetation*	*Purpose*	*Amount[1] (Kg fresh substance/m^2)*	*Frequency*	*Method*
Horticulture	Vegetable beds	Supply of humus	3-5	Annual	Work in superficially
	Vegetables with high nutrient needs	Fertilizing, soil improvement, supply of humus	4-6	Annual	Work in superficially
	Vegetables with medium nutrient needs	Fertilizing, soil improvement, supply of humus	2-4	Annual	Work in superficially
	Vegetables with low nutrient needs	Fertilizing, soil improvement, supply of humus	1-2	Annual	Work in superficially
	Trees/bushes	New planting	2-8	Once	Mix 3 parts soil and 1 part compost and add to hole for plant
	Sandy, heavy, shallow and contaminated sites	Soil improvement	10-15	Every 2 years	Work into loose topsoil
Fruit growing	Stone and soft fruit	Supply of humus, fertilizing	3-5	Annual	Spread on surface
Viniculture	Fertilizing of existing vineyards	Supply of humus	3-6	Every 2 years	Spread superficially
	New planting	Supply of humus	5-10	Once	Work into loose topsoil
Tree nursery	Nutrient poor soil	Soil improvement	8-10	Once	Work into loose topsoil
	Open land	Supply of	3-4	Every 2 years	Spread or work

Area of use	*Vegetation*	*Purpose*	*Amount[1] (Kg fresh substance/m²)*	*Frequency*	*Method*
	cultivation	humus, fertilizing			in superficially
	Container cultivation	Container substrate	25-50 vol%	Once	As component for mixing with soil
Agriculture	Crop growing, generally	Soil improvement	Up to 15	Once	Work into loose topsoil
	Crop growing, generally	Supply of humus	4-8	Every 3 years	Work into loose topsoil
	Root crops, field vegetables	Supply of humus	3-5	Every 2 years	Work in superficially
	Root crops, field vegetables	Fertilizing, soil improvement, supply of humus	3-6	Annually	Work in superficially
	Cereals	Fertilizing, soil improvement, supply of humus	2-4	Every 2 years	Work in superficially
	Pasture	Fertilizing, soil improvement, supply of humus	3-6	Every 2 years	Work in superficially

[1]:The amount refers to fresh compost, with a dry substance of 60%

Table 19. Recommended use for compost in Lebanese interior areas (MOE Compost-Ordinance)

Plant culture	*Amount (Kg fresh substance/m²)*
Root and tuberous vegetables	6-25
Cereals	10
Fodder plant	20
Pasture	3-5
Viticulture	8-30
Fruit growing	20-100
Vegetable growing	20-50
Tree nursery	Up to 30

Other mitigation measures aiming at limiting soil pollution during the operational phase include:

- Adequate treatment of the leachate prior to discharge
- Adopting a proper leachate monitoring program
- Provide the facility with an adequate MSW storage area (roofed, impermeable paving, proper drainage and ventilation) with a capacity of at least one nominal day throughput to ensure that incoming wastes are not haphazardly stacked in case of system failure or peak throughputs thus leading to leachate seepage
- Treat the leachate collected from the storage tanks of the vehicles transporting waste on-site along with the leachate collected from the sorting plant
- Provide oil-water separators and sand precipitators at all workshops on-site in order to limit mixing with cleaning water

7.1.3 Odor generation

During the construction phase, offensive odors are not expected to be generated. During the operational phase, adequate handling and aeration of the received wastes should always be maintained in order to limit the development of anaerobic pockets responsible for the generation of odorous gases such as H_2S. In addition, enclosure with proper odor control equipment will limit the atmospheric release of odorous gases. Vents in the sorting facility should be fitted with biofilters (to be maintained on a yearly basis) to limit odor emissions that can be also significantly reduced by ensuring that all sorting activities are conducted within 12 hours following waste delivery.

7.1.4 Air quality

7.1.4.1 Construction

In general, control techniques for minimizing PM emissions during construction generally involve watering of surfaces, chemical stabilization, or reduction of surface wind speed with windbreaks or source enclosures. Watering, the most common and generally the least expensive method, provides adequate temporary dust control. Regular watering practices cause aggregation and cementation of fines to the surfaces of larger particles, thus achieving a reduction of more than 50 percent in the rate of fugitive dust emissions. The use of chemicals to treat exposed surfaces provides longer dust suppression, but may be costly, have adverse effects on plant and animal life, or contaminate the treated material. Continuous chemical treatment of materials loaded into piles, coupled with watering or treatment of roadways, can achieve a reduction up to 90 percent in the total particulate emissions from aggregate storage operations (Jutze *et al.*, 1974). Windbreaks and source enclosures such as trees, fences, plastic meshes, etc. are also good mitigation measures that can limit PM emissions as a result of wind erosion. Surface improvements offer long term control techniques. These include covering the road surface with a new material of lower silt content, such as covering a dirt road with gravel or slag. Also, regular maintenance practices, such as grading of gravel roads, help to retain larger aggregate sizes on the traveled portion of the road and thus help reduce emissions. The amount of emission reduction is tied directly to reducing surface silt content. Other mitigation measures include, maintaining good house keeping practices throughout the construction phase. These low cost measures include the elimination of mud/dirt carryout on paved roads at the construction site, periodic removal of dust-producing materials, covering hauling trucks while transporting construction materials, as well as regular clean-up of spillage on paved or unpaved travel surfaces. Table 20 presents several housekeeping mitigation measures for the construction phase.

Table 20. Mitigation measures for minimizing PM emissions during the construction phase (USEPA, 1998)

Emission source	*Recommended mitigation measure*
Debris handling	• Wind speed reduction through wind breaks • Wet suppression
Stockpiling	• Stockpiles should be properly treated and sealed with latex, vinyl, bitumen or other suitable surface stabilizer, if a stockpile of dusty materials is more than 1.2 m high and lies within 50 m from any site boundary that adjoins a road, street, or other area accessible to the public • Socks of more than 20 bags of cement should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides • Silos used for the storage of cement should not be overfilled
Truck transport	• Wet suppression • Enclose material transported with totally impervious sheeting • Paving heavy used haul roads • Vehicle washing facilities should be provided at every vehicle exit point • Chemical stabilization • Vehicle speed should be limited to 10 Km/hr except on completed access roads
Bulldozing	• Wet suppression during bulldozing activities
Cut and fill material handling	• Wind speed reduction • Wet suppression
Cut and fill hauling	• Wet suppression • Paving heavy used haul roads
General construction activities	• Wind speed reduction • Wet suppression • Early paving of permanent roads
Quarrying	• The area to be quarried should be wetted with water within 30 m from the blasting area prior to blasting • Blasting should not be carried out when strong wind prevail

Other types of pollutants are expected as a result of construction activities. These pollutants comprise CO, NO_2, SO_2, PM and HC and are mainly emitted by car and truck traffic to and from the site and on-site equipment such as concrete trucks, dump trucks, excavators and backhoes. Measures to reduce truck traffic emissions include proper maintenance and the adoption of a traffic management plan while avoiding congested routes. Concerning on-site construction equipment, proper maintenance procedures and the quality of diesel fuel used are important to reduce emissions. In addition, equipment should be turned off when not in use, which would reduce power needs and emissions of pollutants.

7.1.4.2 Operation

During operation, the production and potential release of CH_4, CO_2, and other trace gases as a result of waste decomposition in the sorting plant should be mitigated through adopting adequate gas collection and management. Gas control measures are essential at any solid waste treatment facility in order to:

- Reduce atmospheric emissions
- Control the release of odorous emissions
- Control subsurface gas migration and potential fire and explosion hazards
- Minimize potential damage on floral cover
- Allow the recovery of energy from methane, if methane collection is adopted

In addition, the MRF plant should be provided with an air cleaning system comprising at least a fabric filter. All machinery and combustion engines used on-site should be regularly maintained in order to limit the release of combustion by-products. In addition, end-of-pipe emission control measures (such as soot-filters) should be adopted to achieve the MoE National Standards for Environmental Quality (Decision 8/1). Finally, all collection trucks used should be no more than 10 years of age.

7.1.5 Health and safety

7.1.5.1 Construction

Health and safety during the construction phase is considered primarily in terms of potential exposure to PM and noise, as well as accident occurrence to workers on-site. Mitigation measures include but not limited to:

- Restriction of access to the construction site by proper fencing whereby site boundaries adjoining roads, streets or other areas accessible to the public should undergo fencing not less than 2.4 m high from ground level along the entire length except for a site entrance or exit
- Establishing buffer areas around the site
- Provision of guards on entrances to and exits from the site
- Installation of warning signs at the entrance of the site to prohibit public access
- Provision of training about the fundamentals of occupational health and safety procedures
- Provision of appropriate personal protective equipment (PPE) (impermeable latex gloves, brightly colored working overalls equipped with light reflecting stripes, safety boots, safety helmets, and ear plugs)
- Keep uniforms and PPE clean and in good condition and replace them at least on a semi-annual basis
- Provision of personal ID cards for all employees
- Provision of adequate loading and off-loading spaces

- Development of emergency response plans for the site particularly in case fire or explosion as a result of the proximity of Hbaline open dump to the sorting plant
- Provision of on-site medical facility/first aid
- Installing retaining nets to hold falling debris during site clearing, excavation, and construction
- Provision of appropriate lighting during night-time works
- Implementation of speed limits for trucks entering and exiting the site
- Implementation of standard health and safety guidelines

7.1.5.2 Operation

During operation, periodic monitoring and maintenance is a high priority to limit possible malfunctioning and associated problems. Other mitigation measures that will reduce potential health and safety impacts include site security, site safety, enhancing safety at site facilities, environmental controls, waste transportation, waste tracking system, emergency/contingency plans, workers hygiene, personnel protection, as well as fire fighting.

7.1.5.2.1 Site security

The contractor shall develop and implement a site security plan for the site to restrict access of unauthorized personnel. These measures include but are not limited to:

- Restricting of access to the facility by proper fencing
- Maintaining the buffer areas around the facility
- Installing warning signs in Arabic, French and English at the entrance of the facility to warn people about the health risks associated with solid waste and leachate mishandling
- Displaying emergency telephone numbers for Police, Ambulance and Fire services in Arabic, French and English.
- Locking gates outside working hours
- Erecting a fence along the perimeter of the site consisting of non-combustible wire screens, 3 m high, and with a mesh of 50 mm or less to intercept litter. In order to enhance the efficiency of the fence, trees may be planted along its perimeter
- Erecting site identification board of durable material and finish at the entrance of the site giving the name of the site, and the name, address and telephone number of the site operator
- Providing at least one 24 hour guard for the facility

- Keeping a daily record of persons and vehicles entering/leaving the site

7.1.5.2.2 Site safety

The contractor shall develop and implement a site specific safety plan to limit occupational accident risks on site. These measures include but are not limited to:

- Visitors must report to the site office where they should sign-in and be issued with a pass. Visitors should also sign out on departure and surrender their pass. No visitors should be permitted to access the operational areas unless they have received the express permission of the site manager(s) and they have attended the site safety course or are accompanied by a site employee
- Staff and employees working on-site should attend a safety and operational course before commencing work
- Personnel and visitors to the operational areas of the site should wear personal protective clothing inclusive of high visibility clothing, protective footwear, and safety helmets

7.1.5.2.3 Enhancing safety at site facilities

Facilities on-site should have adequate safety precautions to limit potential occupational accidents. Several key safety procedures are presented below:

- Site offices, stores, maintenance facilities, hygiene facilities, toilets, vehicle parking, vehicle washing, etc. should be provided at suitable locations. Confined spaces, such as buildings and workshops may require automated methane monitoring equipment to be installed
- All confined spaces where waste handling occurs in the presence of workers, should be equipped with ventilation systems with air exchange rates exceeding 2 air changes per hour. The MRF should be ventilated at a rate of 40 m^3/hr/person
- A drinking water supply should be provided at the site
- Tanks should be clearly labeled with details of contents, potential hazards (e.g. explosive, flammable, toxic etc.), and emergency services telephone numbers
- Compacted hardcore service roads should be provided and maintained from the site entrances to waste reception areas
- Site subsidiary roads of appropriate width and construction should be provided from the waste reception areas to the tipping points

- Roads should be properly maintained and sprayed with water in dry weather to suppress dust emissions.

7.1.5.2.4 Environmental controls

Key environmental controls that shall be adopted by the contractor at the site include but are not limited to:

- A record should be kept of the types and quantities of wastes deposited
- All refuse transportation vehicles traveling to or from the site should be fully sheeted (i.e. flat bed) or well-contained from point of departure to arrival
- All vehicles leaving the site should be cleaned of debris from chassis and underparts and should have the loading surfaces washed in an appropriate way before leaving the site. All such washing and cleaning activities should take place in properly constructed and equipped locations and all such solid and liquid effluents will be deemed as waste or leachate and will be managed in an appropriate manner
- Operations should be carried out without affecting nearby drainage systems
- The pile up of incoming solid wastes outside the premises should be prevented to avoid insect and vector breeding
- Appropriate steps should be adopted to control infestation by insects, pests and vermin. The areas should be inspected at regular intervals and corrective action taken when required, which may include the application of insecticides and the setting of baited traps to control vermin populations
- A gas monitoring program should be implemented to monitor buildup of explosive gases
- No waste materials should be burned within site boundaries. A fire at the site should be regarded as an emergency and immediate action should be taken to extinguish it
- Regular maintenance of sorting equipment should be conducted to prevent H_2S and methane build-up and minimize fire and explosion risks
- Stagnation of exposed water/leachate volumes should be prevented to hamper insect and vector breeding
- No smoking should be permitted on site, except in dedicated places
- Inspection of incoming wastes should be conducted at weighbridges. Any load where unaccepted wastes (including medical wastes, industrial wastes, animal carcasses, fish waste, or other obnoxious and environmentally hazardous materials) are identified shall not be transferred to the landfill. Concurrently, a temporary storage area (enclosed with

proper ventilation) should be constructed to accommodate for these wastes (should be stored in closed containers) until further instructions are issued from the responsible agencies concerning the fate of such wastes.

- In the processing areas, odors should be controlled through the application of appropriate products (i.e. chemical odorants)

7.1.5.2.5 <u>Waste transportation</u>

Several key safety measures that should be adopted during the transportation of the wastes to the site and on-site include the following:

- Drivers should be issued and required to use safety equipment (boots, gloves, overalls)
- Vehicles should be cleaned at the end of daily operations and disinfected weekly
- Vehicles should be fitted with two way communication equipment, automatic backing lights and warning sound device, equipment to manage a spill situation, detailed instructions prominently displayed in the cabin, for use in the case of spills, accidents, fire and other emergencies (including a list of contact personnel and phone numbers)
- Vehicles should be licensed for the transportation of municipal solid waste materials, and have appropriate third party insurance
- Drivers must be in the possession of a current relevant truck driving license, carry proof of having attended the site safety and operation course, be trained in safe and advanced driving skills appropriate to the nature of the waste being transported, be trained in spill procedures and use of spill kit equipment, and report to site gateman upon entering and leaving the waste facilities
- A certification system should be implemented to adequately identify source and transportation path to disposal. A duplicate waste transfer note system will be operated. Transfer notes shall record drivers name, vehicle registration, description of waste (i.e. municipal solid waste), and tonnage of waste

7.1.5.2.6 <u>Waste tracking system</u>

- The site shall maintain a computer based record of wastes delivered which includes the vehicle identification number and time of arrival at site
- Daily quantities of incoming wastes should be recorded at the entrance of the facility. In this respect, waste delivery vehicles entering the site are required to weigh incoming and outgoing waste trucks over a weighbridge. The weighbridge should be of electronic type

and linked to a personal computer to provide automatic recording of the weight loads.

- Waste records shall be kept for 15 years after closure.

7.1.5.2.7 Emergency/contingency plans

- Waste delivered to the site on fire should be discharged and extinguished using water or suitable extinguishers. The generated liquid effluent should be collected and treated with the leachate
- Contingency plans should be established for emergencies which are likely to occur as a result of transporting, segregating, treating and disposing of solid wastes
- The contingency plans should address scenarios of accidents for which the facility is at most risk and serve as a reference for risk assessment and employee training
- A contingency plan should be established to deal with fire and explosion risks that may arise either at the facility or at the neighboring Hbaline open dump or Hbaline composting plant due to the possibility of having a synergetic effect
- The contingency plans will require establishing and maintaining occupational health and safety procedures for all aspects of operations; identification of likely accidents, outlining emergency scenarios, establishing command hierarchy, organizing communication lines, determining response actions, delegating responsibilities, designating evacuation signal and identifying rendez-vous points mark on appropriate maps for each work area; and co-ordination with local fire service, police and ambulance services.

7.1.5.2.8 Workers hygiene

- Hygiene facilities should be provided through which workers must pass to enter or leave the dirty area of the site (waste delivery drivers are exempt from this provided windows are kept closed and drivers do not leave their vehicles). The facility should be constructed in three stages: changing room for workers clothes, washing facilities with hot and cold showers, and a changing room for storage of contaminated overalls, boots, etc.
- A boot wash with fixed or hand brushes should be provided at the entrance of the facility from the dirty area to the third area
- A restroom should be provided on the clean side of the site which can only be entered by passing through the hygiene facility
- Eating, drinking or smoking should be prohibited near the MRF and compost plant

7.1.5.2.9 Personnel protection

- Individuals working within the MRF plant should be provided with: safety Wellington's with protected sole plates, overalls (disposable or cleaned daily), PVC type overalls for wet weather working, respiratory masks, eye protection plugs and defenders, ear protection plugs and defenders; and high visibility waistcoats
- Uniforms and PPE should be kept clean and in good condition and replaced at least on a semi-annual basis
- Personal ID cards should be provided for all employees
- A trained first aid provider should be present on-site at all times during operational hours. A first aid kit should be kept in the site office. The first aid kit should be regularly inspected and any deficiencies immediately replenished
- Workers should be advised about diseases associated with wastes such as leptospirosis, tetanus etc., inoculated against tetanus, and regularly health-monitored
- A record should be kept of all illnesses, accidents etc. occurring on-site
- Persons feeling sick (nausea, giddiness etc.) should report it immediately to the supervisors who should take appropriate action. Cuts, grazes etc. should be immediately treated
- Regular medical checkups should be provided for staff on a semi-annual basis
- Debris should be cleared along walkways which should be fitted with handrails and toe boards in the compost plant and MRF

During both the construction and operation phases, standard guidelines for health and safety should be followed. The contractor/operator is responsible for observing local safety regulations and taking all necessary measures to safeguard personnel working on site. In particular, the contractor should ensure that only properly trained contenders are employed and that the correct tools and procedures are used. The contractor should provide a safety specialist responsible for the preparation, implementation and maintenance of a safety program, which should be periodically evaluated. The responsibility of the safety specialist includes performing safety training and conducting safety inspections, sessions and practice. He should also be responsible for the investigation of accidents. A safety committee should be formed and regular safety meetings should be organized. All safety equipment and tools should be provided and maintained by the contractor.

In addition, environmental friendly fire-fighting equipment such as dry powder extinguishers should be provided within the premises of the facility. Annual fire fighting training drills for the operating staff should be conducted. Smoking and litter build up should be prohibited as these may pose fire risks. The safety specialist at the facility should prepare, implement and maintain a comprehensive fire protection and prevention program. The safety specialist should also be responsible for the inspection and maintenance of the fixed and portable fire protection equipment and for the investigation of fire incidents. The safety specialist should develop and implement an emergency action plan and fire hazard inspection procedures to be present on-site and available at all times for all employees.

7.1.6 Noise levels

7.1.6.1 Construction

The erection of noise barriers to screen noise sources is generally practiced to minimize noise emissions from construction activities. Usually, purpose-built noise barriers or screens constructed of appropriate material to be located along active work sites could give a noise reduction of up to 10 dBA. It is anticipated that a movable noise barrier with a suitable footing and a small cantilevered upper portion can be located within a few meters of a static plant and within about 5 m of mobile equipment, such that the line of sight could be blocked by the barriers viewed from the noise sensitive receivers. The estimated noise reduction by means of screening, provided that the barriers are carefully located, can provide a 10 dBA noise attenuation for a static plant and 5 dBA for a mobile plant.

Noise barriers alone may be insufficient to reduce noise levels below both daytime and evening time standards, and as such, additional mitigation measures are proposed. These include good site practices, selecting quieter mechanical equipment, as well as adopting proper scheduling of construction activities. Scheduling noisy activities during the daytime periods (7:00 am to 6:00 pm) will ensure that the noise standard set for the evening will not be exceeded at several instances. The contractor/operator shall adopt proper on-site management to minimize noise emissions from the works during all times including but not limited to:

- Only well-maintained mechanical equipment should be operated on-site
- Equipment that may be intermittent in use should be shut down between work periods or should be throttled down to a minimum
- Silencers or mufflers on construction equipment should be utilized and be properly maintained during construction works
- Material stockpiles and other structures should be effectively utilized, where feasible, to

reduce noise from on-site construction activities

7.1.6.2 Operation

During the operation phase, the mitigation measures include scheduling collection and transport of the solid wastes either in the early morning hours or late in the afternoon (requires provisions for storing the collected wastes for the next working shift) so as not to create traffic jams, nor to disturb the public during hours of sleep. Noise from the site should not reach objectionable levels, and working hours (7:00 am to 6:00 pm) should not be exceeded. Noise barriers should be installed around air blowers, pumps, and generators to reduce noise impacts at nearby receivers. If possible, noisy equipment should be enclosed. In addition, a rigorous inspection and maintenance program applicable to equipment on-site should be implemented.

7.1.7 Solid waste generation

7.1.7.1 Construction

During the construction phase, construction debris will be generated as a result of various construction activities. The generated materials can be used for filling purposes or may be stockpiled and stored for future use as daily cover within the existing or proposed landfill. Nevertheless, care should be taken to ensure the absence of contaminated fill material and the adequacy of the physical and chemical properties of such material. Construction and demolition wastes can also be minimized through careful planning during the design stage, whereby reducing or eliminating over-ordering of construction materials will minimize waste generation and reduce project costs (cost of surplus materials). The contractor should carry out sorting of construction and demolition wastes into various categories and adopt re-use/recycle on-site whenever deemed feasible.

Chemical wastes generated during the construction phase include containers that were used for storage of chemical wastes on-site, the chemical residue as well as contaminated material. These materials should be segregated and properly stored and disposed of. Storage should take place in separate areas that have impermeable floors, adequate ventilations and roofs to prevent rainfall from entering. In addition all chemical wastes should be clearly labeled in English and Arabic, stored in corrosion resistant containers and arranged so that incompatible materials are adequately separated. Every effort should be made to arrange for the recycling of any chemical waste generated on-site.

General refuse generated on-site during the construction phase should be stored in enclosed bins or compaction units separate from construction and chemical wastes. An agreement should be drafted between the contractor and the solid waste collector in the area to identify collection sites and schedule the removal of wastes to minimize odor, pest infestation and litter buildup. The burning of refuse on the construction site should be strictly prohibited and penalized. General refuse is generated largely by food service activities on-site, and as such reusable rather than disposable dishware should be promoted if feasible. Aluminum cans may be recovered from the waste stream by individual collectors if they are segregated and made easily accessible, so separate, labeled bins for their storage should be provided if feasible. Boundary fencing should be provided around the construction site to intercept litter scattering and could consist of posts bedded in a concrete strip footing. The structural design of fences, gates, and wickets should consider the most unfavorable case of crosswind, pressing larger pieces of waste and matter flying against the fencing line.

7.1.7.2 Operation

During operation, recyclables will be stored in dedicated areas within the facility. **The contractor/operator shall provide adequate advertisement and marketing to motivate off-takers or purchasers of the recyclables.** The remaining wastes should be placed within the existing or proposed landfill.

The Hbaline sorting facility should accommodate for an adequate storage area (roofed, impermeable paving, proper drainage and ventilation) with a capacity of at least one nominal day throughput to ensure that incoming wastes are not haphazardly stacked in case of system failure or peak throughputs. **In case of long term unscheduled outages in the facility the contractor/operator shall ensure at his own expense alternative disposal of wastes in accordance with applicable regulations until operation is resumed in the facility.** In addition, the contractor/operator should clean continuously the litter within closed facilities as well as on roads within the site including access roads.

Boundary fencing should be provided around the operation site (and around working cells) to intercept litter scattering. The fence should consist of non-combustible wire screens, 3 m high, and with a mesh of 50 mm or less. In order to enhance the efficiency of the fence, trees may be planted along its perimeter. The structural design of fences, gates, and wickets should consider the most unfavorable case of crosswind, pressing larger pieces of waste and matter flying against the fencing line. Regular collection excursions should be conducted to collect litter from the screens around the perimeter of the site.

7.1.8 Landscape and visual intrusions

7.1.8.1 Construction

During the construction phase, the site will witness heavy construction activities that will be associated with the presence of a multitude of heavy construction equipment, and construction spoils. The visual impacts associated with the construction of the Hbaline sorting plant will be minor when compared to the open dump in the area. Fencing the construction area will not significantly reduce the effects on the general landscape of the area, which has been already deteriorated. However, the site should be preferably enclosed with non-transparent fencing to minimize the visual impacts on nearby areas. Construction equipment, construction materials, and transport vehicles should be prohibited from parking outside the fenced boundary of the facility.

7.1.8.2 Operation

During operation, buildings within the facility should be maintained regularly to preserve their architectural and visual appeal. The visual intrusion and landscape alteration at the construction and operational phases of the project can be minimized by adopting several mitigation steps outlined in Table 21.

Table 21. Mitigation for landscape and visual intrusions

Mitigation Measure	*Stage to be Implemented*	
	Construction	*Operation*
Preserving existing floral cover when feasible	√	NA
Avoiding onsite storage of wastes and equipment	√	√
Selecting appropriate paint colors for the exterior of the buildings to help them blend with the surrounding	√	√
Selecting construction materials for the buildings to help them blend with the background	√	NA
Selecting architectural designs that will make the buildings blend with the surrounding architectural features of the milieu	√	NA
Complying with the building codes of the area and reducing the construction of elevated structures	√	NA
Planning and implementing an appropriate landscaping program for the site that takes into account restoration or creation of native floral cover with local fauna and flora	√	√
Provisioning a greenbelt to bar any unsightly intrusion the project may have on the milieu Planting one row of tree seedlings with at least 1 m of height, one per 3m, along the fence line of the site Dedicate an area corresponding to at least 10 percent of the total site area for landscaping and greenbelt	√	√

√ = Applicable NA = Not applicable

7.1.9 Biological environment

The proposed site has lost its biological significance due to the current practices of open dumping. As such no specific mitigation measures are required in this respect at the site proper. Note that the proposed site is part of Waddi Edde that used to be ecologically significant due to its diversified biodiversity. The area requires a comprehensive rehabilitation and restoration plan that is beyond the scope of this project. The sorting facility should comply with the findings and measures proposed by such a plan.

7.1.10 Socio-economics

Mitigation measures must be taken into consideration to ensure the dissemination of the positive socio-economic impacts of the project on the region both during the construction and operation phases. During the construction phase, movement and transportation of construction machinery outside the site must be restricted to off-peak traffic hours and nighttime (if noise levels do not exceed the standards). In addition, during both construction and operation, the local community in the immediate vicinity of the facility should be given priority in terms of providing job opportunities, especially to individuals or families that may be negatively affected by the project development. As such, economic incentives should be provided by the operator to the local community by adopting policies to recruit locally and to hire local contractors as far as is possible. An on-the-job training program should be implemented for those that do not have adequate skills. Provision of packages of information to workers moving into the area should help them to integrate into the local community more quickly.

The operation of the Hbaline facility will be linked with negative social impacts that include the perception of being exposed to health risks which may lead to psychological stress. In this case, good management practice in terms of sensitive design, control, and monitoring of the site will be the primary means of ensuring that stress and concern about potential problems are mitigated. The instigation of a formal system which responds in a timely fashion to complaints about nuisances (odor, noise), is an important means of building confidence in the operations and management. Publication of data and reports on environmental performance can also be important in terms of providing direct evidence of commitment to effective management. A liaison between the contractor and the community should be established, whereby people can ask questions and voice their complaints. In addition, systematic environmental awareness campaigns may be conducted by the contractor to introduce the public at large to the benefits of and the need for solid waste facilities.

The contractor/operator shall examine means for potential economic benefits at the local level with concerned institutions (direct/indirect tax incentives, employment). In this respect, the introduction of a “host community fee” should be considered. In general, this fee consists of a set payment to the local community or municipality for each tone of waste deposited in the area. Such an approach may prove to be a successful means of helping local communities adapt to the presence of solid waste facilities in their areas, and allows facilities to be planned, constructed, and operated with maximum support from the local community.

7.1.11 Traffic

7.1.11.1 Construction

Primary measures adopted to mitigate traffic impacts during the construction phase include the proper dissemination of information regarding the construction schedule, as well as providing alternate routes when needed and when feasible during all phases of construction. In this respect, proper planning and development of a traffic control plan that takes into account the reservations and inputs of nearby residents is essential to minimize the effects and potential inconvenience of construction activities on commuters as well as ensure the safety of motorists, pedestrians and workers in the vicinity of construction zones. For this purpose, adequate warning, signing, delineation and channeling are needed down and up-gradient from the construction site. Preliminary routing schemes covering various construction phases must be developed and communicated early on to the public. Limiting the movement of heavy machinery during the construction phase to off-peak hours and providing prior notification are crucial measures to minimize the potential negative impacts of traffic. The contractor shall develop a traffic re-routing plan for the construction phase and take into consideration the possibility of night construction provided it does not disturb neighboring residents and commercial facilities. Without compromising the safety of workers, pedestrians, or vehicles, traffic roads shall be re-opened as early as possible to minimize the impact on traffic during the construction period. A summary of specific measures to be undertaken to control traffic impacts during construction are presented in Table 22.

Table 22. Measures to be undertaken by the consultant and contractor

Supervising consultant with municipality	*Contractor*
• Dissemination of information regarding construction schedule	• Guiding traffic through construction zones
• Planning and development of traffic control and re-routing plan during all phases of construction	• Installation of warning signs in and around the site
• Traffic monitoring and guidance outside the boundaries of the site	

7.1.11.2 Operation

During operations, environmental impacts associated with waste transport will be controlled by good vehicle maintenance and housekeeping, adherence to permitted routes, observation of highway restrictions and maintaining responsible driving practices. Traffic control measures should be applied to site operations from the point of collection of the waste to the point of return of any vehicle having deposited the waste. As such, one-way traffic networks within the site should be favored whenever deemed applicable. The recognition of highway speed restrictions and agreed/approved routing will be incumbent on all drivers irrespective of local practices. The recognition of inter-site traffic procedures will also be incumbent on all drivers and the operator. Failure to observe the rulings in the area will be an uncompromising disciplinary matter. Control should be exercised over the number of vehicles permitted into the discharge area at any one time. Traffic mitigation measures fall into two categories namely, those designed to control traffic entering and leaving the site and those designed to mitigate impacts around the site area. Table 23 provides examples of each category.

Table 23. Traffic control measures

Control measure	*Typical examples*
On-site	• Independent access road to the site accommodating for heavy duty vehicles of up to 40 tonnes brut weight • Installation of a wheelwash on-site • Entrance and exit located so as to provide maximum turning space and sight lines • Vehicle movement in the direction of predominant traffic flow • Adequate off-loading and loading space to ensure vehicles can wait on-site • Adequate off-street parking for employees • One-way traffic within the site to prevent obstruction to vehicles entering and leaving • Speed restrictions on vehicles entering and leaving the site
Off-site	• Routing of traffic to avoid residential areas • Scheduling of deliveries and departures such that night time movements or over-night parking are avoided • Sheeting of vehicles delivering wastes and removing residues • Paving or use of suppressants to mitigate dust emissions • Ensuring that vehicles and containers are appropriate to the waste transported and that they are adequately maintained • All vehicles transporting waste or materials that could leak-out should be equipped with drainage tanks • Use of locally designated traffic routes

The contractor/operator shall develop a site-specific waste transport plan to ensure safe transportation of solid wastes to the site.

7.1.12 Summary of mitigation measures and associated costs

Table 24 and

Table 25 present a summary of proposed mitigation measures during both the construction and operation phases. The cost of the implementation of mitigation measures will be part of the cost allocated for the design proper. The implementation of the mitigation measures will be the responsibility of the contractor/operator, under the supervision of OMSAR in coordination of the MoE and the MoIMA.

Note that the environmental guidelines recommended by the MoE for the establishment and/or operation of solid domestic waste sorting plants are respectively presented in Appendix III.

It is to be noted that decommissioning was not considered in the analysis, for the facility is planned to expand in the same selected area to serve the population increase in the area. There will be no decommissioning but replacement of used equipment and an expansion of the proposed scheme to meet future requirements

Table 24. Summary of the construction phase mitigation measures

Impact	*Mitigation measures*
Surface and groundwater quality	• Direct surface run-off into storm drains via adequately designed sand/silt/debris removal facilities • Provide channels, earth bunds or sand bag barriers on-site to properly direct stormwater to silt/debris removal facilities • Regularly maintain silt/debris removal facilities • Discharge rainwater pumped out from trenches or foundation excavations into storm drains via silt removal facilities • Cover open stockpiles of construction materials with tarpaulin or similar fabric during rainstorms events • Prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals • Compact earthworks as soon as the final surfaces are formed to prevent erosion • Contain sewage from toilets, kitchens and similar facilities in sanitary cesspools before being transported by trucks to a nearby wastewater treatment plant
Soil quality	• Proper storage of chemicals on site • Limiting accidental spillage • Prohibiting the open disposal of spent oils in the surrounding environment
Air quality	• Water surfaces • Use chemicals to treat exposed surfaces • Install windbreaks or source enclosures (such as trees, fences, plastic mesh, etc.) to reduce surface wind speed • Pave heavily-used roads • Cover the road surface with a new material of lower silt content • Maintain roads regularly • Maintain good housekeeping practices • Properly maintain trucks and on-site equipment • Adopt a traffic management plan while avoiding congested routes • Ensure quality of diesel fuel used with on-site equipment • Turn off all equipment when not in use

Impact	*Mitigation measures*
Health and safety	• Restrict access to the construction site by proper fencing • Establish buffering areas around the site • Provide guards on entrances and exits to the site • Install warning signs at the entrance of the site to prohibit public access • Provide training to a dedicated staff about the fundamentals of occupational health and safety procedures • Provide appropriate personal protective equipment • Keep uniforms and PPE clean and in good condition and replace them at least on a semi-annual basis • Provide personal ID cards for all employees • Monitor explosive and flammable gas buildup • Provide adequate loading and off-loading space • Develop an emergency response plan • Provide on-site medical facility/first aid • Provide appropriate lighting during night-time works • Implement speed limits for trucks entering and exiting the site and from the highway • Follow international guidelines for health and safety • Provide environmental friendly fire-fighting equipment such as dry powder extinguishers within the premises of the plant • Conduct annual fire-fighting and leak checks training drills for the operating staff • Prohibit smoking as well as litter or weed build-up in the area as these may pose fire risks
Noise	• Erect noise barriers along active work sites • Install vegetative screens • Operate on-site well-maintained mechanical equipment only • Shut down equipment that may be intermittent in use between work periods or throttle them down to a minimum • Utilize silencers or mufflers on construction equipment • Properly maintain construction equipment during construction works • Use material stockpiles and other structures to screen noise from on-site construction activities • Schedule noisy activities during daytime periods • Construct noise barriers along roadside • Provide noise enclosures or semi-enclosures • Provide earth berms • Install noise reducing road surfaces such as quiet pavements
Waste generation/ management	• Use to the extent possible the generated construction debris in filling activities or stockpile and store for future use as daily cover within the Mejdlaya and Rawda landfills • Reduce or eliminate over-ordering of construction materials • Store chemical wastes (Section 5.7) in a separate area that has an impermeable floor, adequate ventilation and a roof to prevent rainfall from entering • Clearly label chemical wastes in English and Arabic • Every effort should be made to arrange for the recycling of any chemical waste generated on-site • Store general refuse generated on-site in enclosed bins or compaction units separate from construction and chemical wastes • Draft an agreement between the contractor and the solid waste collector to identify collection sites and schedule the removal • Prohibit burning of general refuse • Promote reusable rather than disposable dishware • Fence the construction site to intercept litter scattering

Impact	*Mitigation measures*
Landscape and visual intrusions	• Enclose site with non-transparent fencing to minimize visual impacts • Prohibit vehicles from parking outside the fenced boundary of the site • Preserve existing floral cover when feasible • Select appropriate paint colors for the exterior of the buildings to blend with surroundings • Select construction materials that will blend with the background • Select architectural designs that will blend with the surrounding features of the milieu • Incorporate underground utilities (to the extent possible) to house electrical, storage, and operational equipment • Comply with building codes of the area and reduce construction of elevated structures • Open areas adjacent to the erected structures of the facility should be grassed and planted with shrubs, trees and ground covers • One row of tree seedlings with at least 1 m of height, one per 3m, should be planted along the fence line of the site • Dedicate an area corresponding to at least 10 percent of the total site area for landscaping and greenbelt
Socio-economics	• Give priority to the local community in the immediate vicinity of the site in terms of providing job opportunities • Private stakeholders that are going to be impacted by possible relocation plans should be adequately compensated
Traffic	• Dissemination of information regarding the construction schedule • Providing alternate routes when needed and when feasible • Proper planning and development of a traffic control plan that takes into account the reservations and inputs of residents • Adequate warning, signing, delineation and channeling at least 500 m down and up-gradient from the construction site • Restrict movement and transportation of construction machinery outside the site to off-peak traffic hours and during nighttime • Independent access road to the site accommodating for heavy duty vehicles of up to 40 tonnes brut weight

Table 25. Summary of the operation phase mitigation measures

Impact	*Mitigation measures*
Surface and groundwater quality	• Collect and store leachate generated within the compost plant and MRF • Leachate treatment should be conducted on-site prior to discharge • Treated leachate effluent should meet the MoE standards set for discharge into surface water bodies (Decision 8/1) • Minimize the amount of precipitation coming into contact with the waste • Pave reception area with impermeable material and equip it with a drainage system • Perform monthly maintenance checks to ensure system functionality • Implement a rigorous monitoring plan (Section 7.2.3) • Provide appropriate training of staff about operating conditions, particularly at the leachate treatment plant and occupational health and safety • Provide the facility with an adequate MSW storage area (roofed, impermeable paving, proper drainage and ventilation) with a capacity of at least one nominal day throughput • Treat on-site the leachate collected from the storage tanks of the vehicles transporting waste, cleaning water and drainage water collected from the MRF, compost plant, and vehicle washing facilities along with the leachate collected from compost plant • Provide oil-water separators and sand precipitators at all workshops on-site in order to limit mixing with cleaning water • Minimize water use during cleaning of working areas and vehicles (e.g. adopting dry cleaning practices prior to water cleaning • Adopt designs for the MRF plant that accommodate for slightly inclined ground surface to ensure proper leachate drainage.

Impact	*Mitigation measures*
Soil quality	• Proper storage of chemicals on-site, limiting accidental spillage as well as prohibiting the open disposal of spent oils in the surrounding environment • Treat the leachate on-site prior to discharge • Provide the facility with an adequate MSW storage area (roofed, impermeable paving, proper drainage and ventilation) with a capacity of at least one nominal day throughput • Treat the leachate collected from the storage tanks of the vehicles transporting waste on-site along with the leachate collected from the sorting plant • Provide oil-water separators and sand precipitators at all workshops on-site in order to limit mixing with cleaning water
Odor generation	• Maintain adequate aeration rates during the sorting process • Install proper odor control equipment • House the storage and sorting areas and adopt proper odor control • Ensure that all sorting activities are conducted within 12 hours following waste delivery
Air quality	• Collect gases from the landfill using either passive or active systems • Flare gases using either continuous flare burners or self-lighting burners • Provide the MRF plant with an air cleaning system comprising at least a fabric filter • Adopt end-of-pipe emission control measures to achieve the MoE National Standards for Environmental Quality • Use collection trucks that are no more than 10 years of age
Health and safety	• Site security • Site safety • Site facilities • Environmental controls • Waste transportation • Waste tracking system • Emergency/contingency plans • Workers hygiene • Personnel protection • Fire fighting
Noise	• Schedule collection and transport of the solid wastes either in the early morning hours or late in the afternoon • Install mufflers and noise barriers around air blowers and pumps • Enclose noisy equipment • Implement a rigorous inspection and maintenance program applicable to all equipment on-site
Waste generation/ management	• Store collected recyclables in a dedicated area within the facility until purchase • Provide the facility with an adequate MSW storage area (roofed, impermeable paving, proper drainage and ventilation) with a capacity of at least one nominal day throughput • In case of long term unscheduled outages ensure alternative disposal of wastes in accordance with applicable regulations • Clean continuously litter within closed facilities as well as on all roads within the site including access roads • Conduct inspection of incoming wastes at weighbridges. Any load where unaccepted wastes (including medical wastes, industrial wastes, animal carcasses, fish waste, or other obnoxious and environmentally hazardous materials) are identified shall not be transferred to the Mejdlaya and Rawda landfills. The identity of the vehicle and driver as well as the identity of the rejected wastes shall be notified to MoE immediately. Concurrently, a temporary storage area (enclosed with proper ventilation) should be constructed to accommodate for these wastes (should be stored in closed containers) until further instructions are issued from MoE concerning the fate of such wastes • Record daily quantities of incoming wastes at the entrance of the facility • Maintain fences constructed to intercept litter scattering
Landscape and visual intrusions	• Maintain the buildings within the site to preserve their architectural and visual appeal

Impact	*Mitigation measures*
Socio-economics	• Conduct systematic environmental awareness campaigns to introduce the public at large to the benefits of installing and operating a solid waste treatment and disposal facility • Instigate a formal complaints system which responds in a timely fashion to complaints about nuisances • Publish data and reports on environmental performance of the facility • Provide economic incentives to local communities by adopting policies to recruit locally and to hire local contractors when possible • Adopt an on-the-job training program for those that do not have adequate skills to be recruited • Examine means for potential economic benefits at the local level
Traffic	On-site measures include: • Independent access road to the site accommodating for heavy duty vehicles of up to 40 tonnes brut weight • Installation of a wheelwash on-site • Entrance and exit located so as to provide maximum turning space and sight lines • Vehicle movement in the direction of predominant traffic flow • Adequate off-loading and loading space to ensure vehicles can wait on-site • Adequate off-street parking for employees • One-way traffic within the site to prevent obstruction to vehicles entering and leaving • Speed restrictions on vehicles entering and leaving the site Off-site measures include: • Routing of traffic to avoid residential areas • Scheduling of deliveries and departures such that night time movements or over-night parking are avoided • Sheeting of vehicles delivering wastes and removing residues • Paving or use of suppressants to mitigate dust emissions • Ensuring that vehicles and containers are appropriate to the waste transported and that they are adequately maintained • Use of locally designated traffic routes

As a conclusion, proper supervision, high workmanship performance, and provision of adequate safety measures will alleviate public and occupational risks. It is imperative that all individuals be trained in their respective fields of work in order to perform the required tasks. Table 26 lists the main mitigation and monitoring measures along with their estimated costs.

Table 26: Mitigation Measures, Monitoring, and Estimated Costs for Actions Affecting Environmental Resources and Human Amenity

Action	Potential impact	Mitigation measures	Monitoring of mitigation measures / responsibility	Estimated cost of mitigation (USD)
A. During Construction				
Excavation and earth movement	• Dust emission	• Wetting excavated surfaces • Using temporary windbreaks • Covering truck loads	Supervision engineers	Required in tender/ Included within contract
	• Noise generation	• Restriction of working hours to daytime • Employing low noise equipment • Proper maintenance of equipment and vehicles, and tuning of engines and mufflers	Supervision engineers	Priced within contract
	• Erosion	• Proper resurfacing of exposed areas • Inducing vegetation growth	Supervision engineers	Priced within contract
	• Disturbance to biodiversity	• Conservation of present trees and use as wind brakes and esthetic cover for the facility. • Inducing vegetation growth	Supervision engineers	Negligible
Dumping of excavated and construction material into nearby watercourses	• Surface and groundwater pollution	• Prohibition of uncontrolled dumping. Disposal at appropriate locations • Education of workers on environmental protection	Supervision engineers	Included within plant operation and capacity building
Discharge of wastes (chemicals, oils, lubricants, etc.) on-site	• Soil and water pollution	• Prohibition of uncontrolled discharge. Proper disposal of hazardous products • Education of workers on environmental protection	Supervision engineers	Included within capacity building
Storage of hazardous material, traffic deviation, deep excavation, movement of heavy vehicles, exposure to running sewers, etc.	• Hazards to public and occupational safety	• Proper supervision for high workmanship performance • Provision of adequate safety measures, and implementation of health and safety standards	Supervision engineers	Priced within contract and included in plant operation procedures

Action	Potential impact	Mitigation measures	Monitoring of mitigation measures / responsibility	Estimated cost of mitigation (USD)
B. During Design & Operation				
Inadequate process design and control	• Generation of obnoxious odors	• Improving operation and maintenance design procedures • Provision of covers for waste storage areas • Landscaping a proper natural windbreaker around the facility • Use corrosion-resistant material in the sorting line to reduce incidences of malfunction and the need for maintenance.	Design engineers	Priced within contract and plant operation and maintenance 0.5 – 3 USD / tree
		• Maintaining proper cleanliness and housekeeping • Transportation of the odorous organic component in enclosed container trucks • Masking or treatment of odorous emissions	Administration and operating staff	
	• Impaired aesthetics	• Maintaining cleanliness around and within the plant • Proper fencing and landscaping • Preservation of the Olive trees around the plant site.	Administration and operating staff	Priced within contract and plant operation 2 - 8 USD / m
	• Noise generation	• Incorporating low-noise equipment • Locating mechanical equipment in proper acoustically-lined enclosures • Preservation of the Olive trees around the plant site	Design engineers	Priced within contract

Action	Potential impact	Mitigation measures	Monitoring of mitigation measures / responsibility	Estimated cost of mitigation (USD)
	• Public & occupational hazards	• Restricting unattended public access • Providing adequate safety measures and monitoring equipment • Emphasizing safety education and training for system staff • Implementing health and safety standards	administration and operating staff	Included in plant operation and capacity building
Inappropriate refuse management practices	• Improper bailing • Untimely transport to composting plant • Untimely transport to landfills	• Monitoring of quality of sorting works • Monitoring of timing and schedule adherence • Hauling in closed-top trucks and disposal at an allocated municipal solid waste disposal site.	Facility administration and operational staff	Included in operation and maintenance of facility
Inappropriate recyclables management practices	• Loss of recyclables to refuse • Increase in quantity of refuse • Reduction in sales of recyclables	• Monitoring of quality of sorting works • Training of staff for proper distinguishing between recyclables and refuse	Facility administration and operational staff	Included in operation and maintenance of facility
Inappropriate organic matter management practices	• Soil and groundwater pollution due to leaching at storage sites	• Proper design and operation of organic handling units • Training staff for the proper differentiation and handling of organic matter • Monitoring of quality prior to storage or delivering to composting unit	• Design engineers • Facility administration and operational staff	Included in operation and maintenance of facility

7.2 Environmental monitoring plan

Impact and compliance monitoring are necessary during the construction and operation phases of the Hbaline sorting facility with the main objectives to:

- Monitor the performance and effectiveness of environmental management plans including mitigation measures
- Identify the extent of environmental impacts predicted in the EIA on sensitive receivers
- Determine project compliance with regulatory requirements
- Adopt remedial action and further mitigation measures if found to be necessary

Monitoring of air quality, noise levels, groundwater quality, leachate quality, soil quality, odors, waste management practices, traffic, health and safety, landscape, and socio-economic indicators is outlined below for the Hbaline sorting facility. For certain parameters, sampling and chemical analysis are necessary to assess the extent of the impact. For other parameters, only visual inspection and photographic documentation by experienced personnel are needed. In the case of non compliance, efforts should be made to:

- Identify the most probable source
- Check on the proper implementation of the specified mitigation measures
- Review the effectiveness of environmental management plans including mitigation measures and propose alternative actions as appropriate
- Increase the monitoring frequency to assess the effectiveness of remedial measures

Information about monitoring procedures, analysis methods, and equipment outlined in this chapter shall be updated by the Contractor/Operator as necessary. Flexibility in implementation is essential as long as the objectives are met.

7.2.1 Air quality

During construction, air quality should be monitored in terms of construction dust or PM-10. During the operation phase, the main source of air pollution will be the gaseous emissions resulting from the adopted composting scheme, as well as emissions resulting from on-site combustion sources.

7.2.1.1 Criteria

Lebanese standards promulgated by the MoE and international standards (Table 27) will be adopted in evaluating ambient air quality indicators. In addition, the MoE National Standards for Environmental Quality will be adopted in evaluating on-site emissions from combustion sources (Table 28).

Table 27. Standards for atmospheric pollutants

Pollutant	*MoE (52/1) ($\mu g/m^3$)*	*USEPA ($\mu g/m^3$)*	*Averaging time*
Total suspended solids	120		24 hours
Suspended particulates PM < 10 microns	80	150 50	24 hrs 1 year

Table 28. MoE standards for stack emissions from combustion plants
(Energy production > 1MW and <50MW thermal capacity) (MoE 8/1)

Parameter	*Emission limit value*
O_2 correction	3%
dust [mg/m³]	150
CO [mg/m³]	250

7.2.1.2 Methodology

7.2.1.2.1 Construction

The 1-hr and 24-hr Total Suspended Particles (TSP) /PM-10 levels should be measured to delineate the temporary impact of construction dust. Both measurements should be conducted by drawing air through a high volume sampler fitted with a conditioned pre-weighed filtered paper, at a controlled rate. After sampling for 1 hour (or 24 hours), the filter paper with retained particles is collected and returned to a laboratory for drying in an oven at 110^{o}C followed by accurate weighing. The average TSP/PM-10 level is calculated from the ratio of mass of the particulates retained on the filter paper to the total volume of air sampled. When positioning the sampler, the following points should be noted:

- A horizontal platform with appropriate support should be provided to secure the samples against gusty winds; airflow around the sampler should be unrestricted (a portable high-volume sampler can also be used)

- Any wire fence or gate to protect the sampler should not obstruct airflow
- The distance between the sampler and an obstacle (i.e. building) should be at least twice the height that the obstacle protrudes above the sampler
- No furnace or generator should be nearby
- A secured supply of electricity is needed to operate the sampler

An alternative means of measuring 1-hr averaged TSP/PM-10 concentrations is through a hand-held particle counter (capable of sampling in the range of 0.1-100 mg/m^3). This method does not require laboratory analysis and gives instant TSP/PM-10 readings. Air samples are drawn for a period of one hour and the device provides the time-averaged TSP/PM-10 level. Calibration of the monitoring equipment should be conducted prior to implementation of the monitoring program and as specified by the manufacturer.

Wind speed and direction should also be recorded at monitoring locations. Wind sensors should be installed on masts at an elevation of 2 and 10 meters above ground so that they are clear of obstruction or turbulence. The wind monitoring equipment should be calibrated once every six months. In the case of unavailability of elevated wind sensors, it might be possible to use calibrated hand-held anemometers on the condition that no obstructions are present. All relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and stop of the sampler, identification and weight of the filter paper, date and time of sampling, and work progress at the concerned area should be recorded in detail.

7.2.1.2.2 Operation

Monitoring of emissions generated from on-site machinery and generators should be conducted in terms of flue gas temperature, oxygen level, combustion efficiency, flue gas concentrations of CO, NO_2, SO_2, TSP/PM-10. Parameters such as weather conditions, elapsed-time meter reading for the start and stop of the sampler, date and time of sampling, and work progress of the concerned area should be recorded. A continuous meteorological monitoring station should be installed on-site to monitor wind speed and direction, ambient temperature, rainfall, and incoming solar radiation. Recorded data may be collected remotely through a central Personal Computer (PC) located within the facility or downloaded periodically (in the lab or in a control room).

The 1-hr and 8-hr indoor CH_4 and flue gases emitted from combustion sources should be measured on-site. CH_4 measurements should be conducted using an infrared absorption gas analyzer (hand-held or stationary) or similar. Most analyzers give instantaneous readings which are stored and averaged over the sampling period (8 or 1 hour). Flue gases on the other hand, should be measured using a combustion gas analyzer fitted with a probe. Equipment calibration should be conducted prior to implementation of the monitoring program, and as specified by the manufacturer. When positioning the sampler, the following points should be noted:

- Any wire fence or gate to protect the sampler should not obstruct airflow
- No combustion source should be present in the vicinity of the sampling equipment

Relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and stop of the sampler, date and time of sampling, and work progress of the concerned area should be recorded in detail.

7.2.1.3 Monitoring locations

TSP/PM-10 monitoring stations during the construction phase should be located at the site proper and nearby area. Furthermore, monitoring should be conducted whenever complaints from nearby inhabitants are filled. During the operation CH_4 measurements should be conducted within the compost plant. Emissions from combustion sources should be conducted individually at the stack of each source.

7.2.1.4 Frequency

During construction, a sampling frequency of once a month will be observed at all monitoring stations for 24-hour TSP/PM-10 monitoring. In case of complaints or whenever the highest impacts are likely to occur, 1-hr TSP/PM-10 monitoring could be conducted on a weekly basis. During operation, monitoring of CH_4 should be conducted on a monthly basis within the composting plant. Combustion sources should be monitored on an annual basis.

7.2.2 Noise

During both construction and operation, noise levels should be monitored at sensitive receptors.

7.2.2.1 Criteria

The standards or criteria against which noise (measured as A-weighted equivalent sound pressure level, Leq, in dBA) monitoring will be assessed are the Lebanese noise guidelines in different zones (Table 12), as well as the Federal Highway Administration (FHWA) noise abatement criteria (Table 29). In addition, occupational noise exposure should be assessed with respect to the standards promulgated by the MoE and Occupational Safety and Health Administration (OSHA) (Table 30).

Table 29. Summary of FHWA Noise Abatement Criteria (FHWA, 1997)

Land Use Category	*FHWA Standard Leq (dBA)*	*Description of Land Use Category*
A	57 (exterior)	Land where serenity and quiet are of extraordinary importance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, recreational areas, playgrounds, parks.
C	72 (exterior)	Developed lands, properties or activities not included in A and B
D	_	Undeveloped land
E	52 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums

Table 30. Occupational noise exposure limits
(MoE 52/1and Occupational Safety and Health Administration)

Standard, dB(A)	*Averaging time (hour)*
90	8
105	1

7.2.2.2 Methodology

Sound level meters should be used to measure noise levels in terms of Leq, in dBA. Calibration of the meters should be conducted before and after each monitoring round, using a portable calibrator or similar. Calibrated hand-held anemometers should be used for the measurement of wind speed during noise monitoring periods. Noise monitoring should be carried out for at least one hour in order to determine the average noise level.

Noise measurements should not be made in the presence of fog, rain, wind with a steady speed exceeding 5 m/s or wind gusts exceeding 10 m/s. The monitoring locations should be at a point located 1m from the exterior of the sensitive receiver building façade and at a height of approximately 1.2 m above ground or at a height that has the least obstructed view of the construction activity in relation to the receiver. Relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and stop of the sampler, date and time of sampling, and work progress of the concerned area should be recorded concurrently with noise measurements.

7.2.2.3 Monitoring locations

Noise monitoring stations should be located within and around the MRF, the Hbaline sorting plant. In addition, 3 monitoring locations should be selected around the perimeter of the site at varying distances to examine noise propagation and dissipation along with the contribution of background levels. In addition, noise measurements should be readily conducted whenever a complaint is filed.

7.2.2.4 Frequency

A sampling frequency of once a month during both the construction and operation phases should be observed at all monitoring stations for 1-hour noise monitoring. In case of complaints or whenever the highest impacts are likely to occur, 1-hr noise monitoring should be conducted on a weekly basis.

7.2.3 Surface water, groundwater and leachate quality

Before and during construction, the monitoring of surface water and groundwater quality should target gathering baseline data. A comprehensive surface water, groundwater and leachate sampling program should be implemented during the operational phase. It is to be noted that the existing dump and the wastewater treatment plant will cause a significant perturbation to the baseline data.

7.2.3.1 Criteria

The standards or criteria against which surface water and groundwater quality will be assessed are presented in Table 31 and Table 32, while the final quality of treated leachate is presented in Table 33. The surface and groundwater sampling effort along with leachate characterization should target the physical, chemical, and biological parameters presented in Table 34.

Table 31. Bathing water quality in rivers, lakes and seawater (MoE 52/1)

Parameters	*Unit*	*Threshold level*	*Max. admissible value*
Total coliforms	Colony/100ml	500	1,0000
Thermophilic coliforms	Colony/100ml	100	200
Fecal streptococcus	Colony/100ml	100	NA
Salmonella	Colony/ L	0	NA
Enterovirus	Colony/ 10L	0	NA
pH	pH unit	6 - 9	NA
Mineral oils	mg/L	$\leq$0.3	NA
Reactive surface reagents	mg/L Lauryl Sulphate	$\leq$ 0.3	NA
Dissolved Oxygen	$\%O_2$	80 – 120	NA
Tar and other floating materials		Absence	NA
Colour		No change	NA

Table 32. Standards for drinking water quality (MoE 52/1)

Parameter	*Unit*	*Guide Level*	*Max. Admissible Value*
Microbiological parameters			
Total coliforms	cfu/ 100 ml	0	0
Faecal streptococcus	cfu/ 100 ml	0	0
Faecal coliforms	cfu/ 100 ml	0	0
Sulphide-reducing bacteria	cfu/ 20 ml	-	1
Thermophilic coliforms	cfu/ 100 ml	0	0
Salmonella	cfu/ 5 L	0	0
Staphylococcus	cfu/ 100 ml	0	0
Faecal bacteriophages	cfu/ 50 ml	0	0
Enterovirus	cfu/ 10 L	0	0
Physio-chemical parameters			
Temperature	ºC	12	25
pH	pH unit	6.5<pH<8.5	9
Electrical conductivity	mS/ cm at 20ºC	400	-
Chlorides (Cl)	mg/L Cl	25	200
Sulphates (SO_4)	mg/L SO4	25	250
Sodium (Na)	mg/L Na	20	150
Potassium (K)	mg/L K	10	12
Magnesium (Mg)	mg/L Mg	30	50
Calcium (Ca)	mg/L Ca	100	-
Total Aluminum (Al)	mg/L Al	0.05	0.2
Dry residues	mg/L at 180ºC	-	1500

Undesirable parameters			
Nitrates (NO_3)	mg/L NO_3	25	50
Nitrites (NO_2)	mg/L NO_2	-	0
Ammonium (NH_4)	mg/L NH_4	0.05	0.5
Kjeldahl Nitrogen (N)	mg/L N	-	1
Oxidation Potential	mg/L O_2	2	5
Hydrogen Sulfide (H_2S)	mg/L H_2S	-	cannot be determined using organoleptic methods
Phenols	µg/L phenol index	-	0.5
Dissolved/ Emulsified Hydrocarbons	µg/L	-	10
Reactive surface reagents	mg/L Lauryl Sulphate	-	0.2
Iron (Fe)	µg/L Fe	50	200
Manganese (Mn)	µg/L Mn	20	50
Copper (Cu)	mg/L Cu	0.1	1
Zinc (Zn)	mg/L Zn	0.1	5
Phosphorus (P)	mg/L P_2O_5	0.4	5
Silver (Ag)	µg/L Ag	-	10
Fluor (F)	µg/L F	-	1500 (8°C-15°C) 700 (25°C-30°C)
Barium (Ba)	µg/L Ba	100	-
Organo-chloric compounds (other than pesticides)	µg/L	1	-
Polycyclic aromatic hydrocarbons (PAH) *Fluoranthene* *Benzo (3,4) Fluoranthene* *Benzo (11,12) Fluoranthene* *Benzo (3,4) Pyrene* *Benzo (1,12) Perylene* *Indeno (1,2,3) Pyrene*	µg/L	-	0.2
Benzo (3,4) pyrene	µg/L	-	0.01
Pesticides and similar compounds			
Chlorinated organic pesticides	µg/L	-	0.1
Organophosphates	µg/L	-	0.1
Carbamates	µg/L	-	0.1
Herbicides	µg/L	-	0.1
Fungicides	µg/L	-	0.1
PCB	µg/L	-	0.1
PCT	µg/L	-	0.1
Aldrine	µg/L	-	0.03
Dieldrine	µg/L	-	0.03
Hexachloro-benzene	µg/L	-	0.01
Total measured substances	µg/L	-	0.5

Toxic substances			
Arsenic (As)	µg/L As	-	50
Cadmium (Cd)	µg/L Cd	-	5
Cyanide (CN)	µg/L CN	-	50
Total Chromium (Cr)	µg/L Cr	-	50
Mercury (Hg)	µg/L Hg	-	1
Nickel (Ni)	µg/L Ni	-	50
Lead (Pb)	µg/L Pb	-	50 (in current waters)
Selenium (Se)	µg/L Se	-	10
Antimony (Sb)	µg/L Sb	-	10
Organoleptic parameters			
Colour	mg/L Pt/Co	1	15
Turbidity	Jackson	0.4	4
Odor	Dilution rate 2 Dilution rate 3	0 at 12ºC 0 at 25ºC	2 at 12°C 3 at 25°C
Taste	Dilution rate 2 Dilution rate 3	0 at 12ºC 0 at 25ºC	2 at 12°C 3 at 25°C

Table 33. Environmental Limit Values (ELV) for wastewater discharges into the sea, surface water, and sewers (MoE 8/1)

Parameter	*ELV for sea discharge*	*ELV for surface water discharge*	*ELV for sewer discharge*
pH	**6 – 9**	6 – 9	6 – 9
Temperature	35°C	30°C	35°C
BOD_5 mgO_2/L	25	25	125
COD mgO_2/L	125	125	500
Total Phosphorous mgP/L	10	10	10
Total Nitrogen mgN/L (Sum of Kjeldahl-N)	30	30	60
Suspended Solids mg/L	60	60	600
AOX	5	5	5
Detergents mg/L	3	3	Not available
Coliform Bacteria 37°C in 100 ml*	2,000	2,000	Not available
Salmonellae	absence	absence	absence
Hydrocarbons mg/L	20	20	20
Phenol index mg/L	0.3	0.3	5
Oil and Grease mg/L	30	30	50
Total Organic Carbon (TOC) mg/L	75	75	750
Ammonia (NH_4^+) mg/L	10	10	-
Silver (Ag) mg/L	0.1	0.1	0.1
Aluminium (Al) mg/L	10	10	10
Arsenic (As) mg/L	0.1	0.1	0.1
Barium (Ba) mg/L	2	2	2
Cadmium (Cd) mg/L	0.2	0.2	0.2
Cobalt (Co) mg/L	**0.5**	0.5	1
Chromium total (Cr) mg/L	2	2	2
Hexavalent Chromium (Cr^{VI}) mg/L	0.2	0.2	0.2
Copper total (Cu) mg/L	1.5	0.5	1
Iron total (Fe) mg/L	5	5	5
Mercury total (Hg) mg/L	0.05	0.05	0.05
Manganese (Mn) mg/L	1	1	1
Nickel total (Ni) mg/L	0.5	0.5	2
Lead total (Pb) mg/L	0.5	0.5	1
Antimony (Sb) mg/L	0.3	0.3	0.3
Tin total (Sn) mg/L	2	2	2
Zinc total (Zn) mg/L	5	5	10
Active Cl_2 mg/L	1	1	Not available
Cyanides (CN^-)mg/L	0.1	0.1	1
Fluoride (F^-) mg/L	25	25	15
Nitrate (NO_3) mg/L	90	90	-
Phosphate (PO_4^{3-}) mg/L	5	5	-
Sulphate (SO_4^{2-}) mg/L	1,000	1,000	1,000
Sulphide (S^{2-})mg/L	1	1	1

* For discharge in close distance to a bathing water a more strict ELV could be necessary

Table 34. Surface, groundwater, and leachate sampling parameters

pH	Iron
Temperature	Manganese
Electrical Conductivity (EC)	Cadmium
Dissolved Oxygen	Chromium
Ammonia Nitrogen	Copper
Chloride	Nickel
Chemical Oxygen Demand	Lead
Biological Oxygen Demand	Zinc
Total Oxidized Nitrogen	Mineral Oil
Total Organic Carbon	Mercury
Total Alkalinity as CaCO3 at pH 4.5	Phenols
Sodium	Arsenic
Potassium	Cyanide
Calcium	Total Coliforms
Magnesium	

7.2.3.2 Methodology

Surface, groundwater, and leachate samples should be collected and placed in pre-cleaned (1 liter) plastic/glass bottles depending on the target analysis. After collection, the bottles should be properly sealed and placed in a cooler at a temperature below 4^{o}C and transported to the laboratory facility for analysis preferably within 6 hours after the sampling time. A Global Positioning System (GPS) should be used to approximate the geographic coordinates of each location. In addition, groundwater samples should clearly indicate the location of the well and its corresponding depth. Relevant data including monitoring location/position, depth, time, weather conditions (wind speed and direction, ambient temperature, precipitation), and work progress should be recorded concurrently. In situ monitoring instruments should be checked and calibrated prior to usage and as per manufacturer specifications. Responses of sensors and electrodes should be checked with standard solutions before each use. In addition to on-site analysis, duplicate samples should be sent to reputable off-site laboratory facilities for quality assurance and quality control (QA/QC) purposes.

7.2.3.3 Location

Surface water quality downstream the site should be monitored to identify chemical spills or soil erosion problems during both the construction and operation phases. Note that since the proposed sorting facility is located in the area of the existing Hbaline dump, it is expected to be difficult to pinpoint the contribution of the facility to the total pollution level. Groundwater samples should be collected from permanent monitoring well stations around the site as well as at the existing wells in the area. Leachate samples should be collected during the operation phase at the discharge points of the leachate collection system and following treatment prior to discharge. Additional samples may be required (during the operational phase) to monitor the water quality of the leachate receiving water bodies[5].

7.2.3.4 Frequency

The testing frequency of surface and groundwater that should be followed is defined in Table 35, while the testing frequency for leachate during operation is presented in Table 36.

Table 35. Surface and groundwater sampling frequency

Stage	*Frequency*
Pre Works	Once
Construction	Three times
Operation	Monthly

Table 36. Leachate sampling frequency

Parameter	*Frequency*
Leachate volume	Weekly
Leachate quality	Weekly for pH, temperature, electrical conductivity
Leachate quality	Monthly for all parameters defined in Table 34

7.2.4 Solid waste

Following the initiation of construction activities, construction spoils and construction-related materials should be monitored on a quarterly basis during the construction phase. During the operation phase, site audits on the general refuse streams should be conducted to examine existing waste management and handling procedures that include storage, segregation, and recycling. The objectives of the audit are to ensure that the incoming wastes are accounted for and to ascertain that they are handled in an environmentally sound manner that complies with

[5] The contractor/operator shall adopt a scientifically proven leachate treatment option in consultation with the MoE

proposed mitigation measures. Quantities, photographic documentation, and interviews are essential elements of the audits.

During operation, daily quantities of incoming wastes should be recorded at the entrance of the facility. In this respect, all waste delivery vehicles entering the site are required to weigh incoming and outgoing waste trucks over a weighbridge. The weighbridge should be of electronic type and linked to a PC to provide automatic recording of the weight loads. A random solid waste sampling program should also be implemented during the operation phase, whereby two representative samples of minimum 500 Kg each are analyzed on a quarterly basis. Analysis should determine the percent composition by weight and volume (paper, cardboard, plastic bottles, plastic bags, other plastics, multi-material packaging, textiles, composite materials, baby diapers, rubber, leather, wood, vegetable matter, food wastes, glass, ferrous metals, non ferrous metals, construction waste and soils, fine waste< 10 mm, hazardous wastes). Another representative sample should be chemically analyzed on a quarterly basis for the parameters presented in Table 37. These tests help in maintaining a record to establish trends of solid waste characteristics delivered to the site.

Table 37. Solid waste sampling parameters

pH	Cyanide
Arsenic	Mineral Oil
Lead	Manganese
Cadmium	Iron
Chromium	Magnesium
Copper	Calcium
Nickel	Potassium
Mercury	Sodium
Zinc	Total Organic Carbon
Phenols	Chloride
Moisture content	

7.2.5 Soil and compost quality

The compost that will be generated at subsequent composting phases in the composting plant (under construction) should be monitored regularly to assure compliance with the MoE Compost-Ordinance and to provide credibility for potential future compost users (farmers, landscapers, municipalities). In addition, soil samples should be collected in areas that may accidentally get exposed to solid waste or leachate. As such, 12 samples (5 to 10 liters per sample) should be taken at 12 different spots of the final compost heap. The collected samples should then be preserved and analyzed according to standard methodologies. Soil quality should be monitored for Salmonellae, Fecal Coliform, impurities, moisture content, organic matter, pH, salt content, nutrients (nitrogen, soluble phosphate, soluble potassium, soluble chloride, soluble sodium), heavy metal content (mercury, lead, chromium, copper, nickel, zinc and cadmium).

7.2.6 Odor

During operation, odors should be monitored daily through olfactory tests in the vicinity of the site. Complaints should be investigated immediately with official reporting and documentation.

7.2.7 Health and safety

During construction and operation, continuous monitoring of health and safety indicators should be conducted to ascertain the application of mitigation measures and health and safety guidelines. The proper use of PPE should be checked in addition to the presence of signs, first aid kits, fire fighting devices, etc. Record keeping of injuries/illnesses and major occupational accidents should be continuously conducted and filed at the facility. Monitoring explosive-flammable gas concentrations on-site should also be conducted to determine any hazardous buildup. Furthermore, traffic signs, safety instruction signals, security fencing, as well as fire fighting equipment should be monitored through systematic inspections on a semi-annual basis.

7.2.8 Landscape and visual intrusions

Visual inspection and photographic documentation will be undertaken to ensure the effective implementation of mitigation measures related to landscaping and visual resources. Field surveys should be conducted on a monthly basis during construction and quarterly basis during operation. The results from the field visits should be used to continuously refine and calibrate the output of the predictive imaging methods used in the EIA process, if any.

7.2.9 Socio-economics

Monitoring of socio-economic indicators such as employment generation should be conducted on a regular basis through employment records. Monitoring of social indicators such as population perception, should be conducted annually during project construction and operation through field questionnaires, interviews, and public meetings.

7.2.10 Summary of monitoring plan

A summary of the monitoring parameters with corresponding location, and frequency is presented in Table 38. It is recommended that the monitoring plan be implemented by an entity independent of but in coordination with the contractor/operator involved in any component or task of the project to ensure quality control and uniformity. Figure 29 (Chapter 7.3) depicts an institutional framework for implementing environmental management plans.

Table 38: Summary of the proposed monitoring plan

Impact	*Monitoring means*	*Parameters*	*Phase*	*Location*	*Frequency*
Air quality	Sampling	TSP/PM-10	Construction	• On-site • At nearest receptors	• Monthly • Upon complaints
	Sampling	Methane	Operation	• Open Dump emissions	• Monthly
		Combustion sources (flue gas temperature, oxygen level, combustion efficiency, flue gas concentrations of CO, NO_2, SO_2, TSP/PM-10)		• Stack of each combustion source	• Annually
Noise	Sampling	L_{eq} (dBA)	Construction	• 3 monitoring locations around the perimeter of the site • At nearest receptors	• Monthly Upon complaints
			Operation	• At MRF and compost plant • 3 monitoring locations around the perimeter of the site • At nearest receptors	• Monthly • Upon complaints
Groundwater and leachate quality	Sampling	pH, temperature, electrical conductivity, dissolved oxygen, ammonia nitrogen, chloride, COD, BOD, total oxidized nitrogen, TOC, total alkalinity as $CaCO_3$ at pH 4.5, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn, mineral Oil, Hg, phenols, arsenic, cyanide, total coliforms	Construction	• Groundwater wells around the site	• Three times
	Sampling		Operation	• Groundwater wells around the site • Temporary river (during rainy season) • Discharge point of the leachate treatment plant	• Weekly for pH, temperature, electrical conductivity • Monthly for all parameters
	Sampling				
	Measurement	Leachate volume	Operation	• Input to leachate treatment plant	• Weekly

Impact	*Monitoring means*	*Parameters*	*Phase*	*Location*	*Frequency*
Solid waste	Waste audit	Generation, storage, recycling, transport, and disposal	Construction	• Site proper	• Quarterly
	Solid waste characterization Sampling	Quantity and percent composition by weight and volume pH, Arsenic, Pb, Cd, Cr, Cu, Ni, Hg, Zn, phenols, mineral oils, Mg, Fe, Mg, Ca, K, Na, total organic carbon, Cl, moisture content	Operation	• Incoming wastes • Incoming wastes	• Weighbridge Quarterly(2 samples of 500 kg each) • Quarterly (2 samples of 500 kg each)
Soil and compost quality	Sampling	Salmonellae, Fecal Coliform, impurities (stones and plastics), moisture content, organic matter, pH, salt content, nutrients (nitrogen, soluble phosphate, soluble potassium, soluble chloride, soluble sodium), heavy metal content (mercury, lead, chromium, copper, nickel, zinc and cadmium)	Operation	• Spill locations	• 12 samples (5 to 10 L each) from each compost batch • After spills
Odor	Olfactory test	Unpleasant/noxious smells	Operation	• In the vicinity of the site at sensitive receivers	• Daily
Health and safety	Health and safety surveys	Proper use of PPE, presence of signs, first aid kit, and fire fighting devices	Construction Operation	• Site proper	• Continuous
	Sampling	Flammable and explosive gas concentrations	Operation and post closure	• Site proper	• Monthly
Landscape and visual intrusions	Visual inspection and photographic documentation	Ensure the effective implementation of mitigation measures	Construction Operation	• Entire area	• Monthly • Quarterly
Socio-economics	Field questionnaires Interviews	Population perception Employment records	Construction Operation	• Region of influence	• Annual

7.2.11 Data management

The collected monitoring data from the Hbaline sorting facility will be important for future environmental management in the various sectors upon which the proposed project touches. It will formulate the background to determine the accuracy of environmental quality predictions and provide the scientific basis for establishing or modifying environmental measures in the future. Therefore, it is proposed to develop a database of the monitoring data collected during construction and operation of the various components of the facility. Periodic environmental monitoring reports should be prepared to analyze the data, assess monitoring activities and provide recommendations to ensure the effectiveness of the environmental monitoring plan during the project life.

7.2.12 Reporting

The shift leaders in charge of operation during the 24-hour day should prepare a daily journal. Records of all the incoming wastes as well as wastes to be composted, recycled, and sent for landfilling, quantities of leachate generated, flow rates, counter readings, barometric pressure values, temperatures, odors, etc. for all units and equipment should be reported (Appendix IV). In addition, all characteristic operation data of any major item of the facility and all remarks and comments of the shift leaders concerning abnormal readings, overloads, stoppage, outages and other operation events should be recorded.

Environmental monitoring reports should be submitted quarterly during both the construction and operation phases. In addition, yearly comprehensive reports should be generated to present results of the monitoring activities and assess the adequacy of environmental control measures. Monitoring reports should be submitted to OMSAR and the MoE, and the respective Union of Municipalities for feedback on the overall monitoring program. These reports should summarize monitoring data with full interpretation illustrating the acceptability or otherwise of environmental impacts and identification or assessment of the implementation status of agreed mitigation measures. The monitoring reports should include at least the following sections/information:

(a): Executive summary

(b): Transportation vehicles

- Days used/not used
- Reasons for non-usage of vehicles

- Average payloads
- Incoming vehicle IDs, weights (with incoming wastes, empty, with outgoing wastes or products)
- Distance driven
- Replacement of vehicles, containers or staff
- Log of problems, outages, breakdowns, etc.

(c): Sorting facility

- Received waste types and quantities
- Material types separated and products produced and their quantities
- Replacement of vehicles, machinery or staff
- Report on marketing activities
- Log of problems, outages, breakdowns, etc.

(e): Storage facility for wastes to be composted and landfilled

- Stored waste types and quantities
- Log of problems, outages, breakdowns, etc.

(f): Mass balance and ratios

- Mass balance, showing all mass flows within the disposal services
- Ratio of waste to be composted and landfilled to received MSW quantities

(g): Environmental parameters

- Location of sensitive receivers and of monitoring stations
- Implementation status of environmental mitigation measures as outlined in the EIA
- Monitoring results
- Monitoring methodology
- Parameters monitored
- Monitoring locations
- Monitoring date, time frequency, and duration
- Weather conditions during the period
- Monitoring results tabulated with maximum and minimum values
- Diagrams showing the performance of the works

(h): Other parameters

- Daily consumption figures of electricity and chemicals
- Statistics of staff members and labor utilization
- Report of all non compliance or exceedance of the environmental standards

- Record of all complaints received including location, nature, actions and follow-up procedures
- Records of health and safety accidents on-site

7.3 Institutional strengthening

In the context of the overall plan adopted by the GoL, institutional strengthening in environmental management falls within several areas encompassing solid waste and wastewater (leachate) management, atmospheric environment (air quality and noise), transportation (traffic), as well as water resources management (surface and groundwater protection). Appropriate environmental management dictates that construction and operation activities be implemented in accordance to the current state of the art and knowledge regarding environmental protection. This can be accomplished by hiring competent personnel with the appropriate educational and professional background, instituting periodic training programs, and developing site-specific plans that are adequate for protecting the general public and the environment as well as contributing to the mitigation of potential environmental impacts. These plans should include:

- Site specific management plan including security and safety procedures
- Waste transportation plan addressing vehicle containment elements, requirements for driving, routing, and waste tracking
- Waste placement operations plan
- Health and safety plan including emergency and contingency procedures, facility requirements for employees and personnel protection
- Personnel qualification and training plans
- Monitoring requirements which are further addressed in Chapter 8

For this purpose, contractors and consultants who will be involved in the construction, and operation of the various components of the Hbaline facility will be required to attend an environmental training course prior to the initiation of project activities. The objective of this training course is to ensure appropriate environmental awareness, knowledge and skills for the implementation of environmental management plans. Environmental training sessions will be conducted for a two-day period on a semi-annual basis during the construction and operation phases.

In an effort to strengthen institutional capacity and environmental awareness, training sessions should be opened for individuals from concerned ministries and agencies such as the MoE, CDR, OMSAR, MoEW, MoIMA, DGUP, MoPH, MoA, NGOs, etc. In addition, the scope of the training sessions may not be limited to just issues related to solid waste management. Other environmental management topics can also be introduced. Public education in itself creates a valuable positive feedback in environmental management. Training sessions may address various topics including:

- Environmental laws, regulations, and standards
- Pollution health impacts
- Pollution prevention measures
- Sampling techniques and environmental monitoring guidelines (air, noise, water/ wastewater, soil)
- Solid waste management
- Air quality management
- Wastewater management
- Traffic and pedestrians safety measures
- The fundamentals of occupational health and safety procedures
- Risks associated with handling of solid wastes
- Procedures for dealing with spillage, fires and other accidents
- Instructions on the use of protective clothing
- Operating procedures at the facility

In addition, training on the proper use and land application rates of the different grades of generated compost should be established targeting compost end-users. Training workshops are the responsibility of the contractor.

It is recommended that the training and institutional strengthening plans be implemented by an entity independent of but in coordination with the contractor/operator involved in any component or task of the project to ensure quality control and uniformity. Figure 29 depicts an institutional framework for implementing environmental management plans. Guidelines, specifications, and content for systematic and comprehensive environmental training and awareness programs shall be developed with the final design for the facility. Such guidelines will define the contribution of the facility to potential institutional strengthening and capacity building in environmental management in its area of influence in particular and at the country's scale in general.

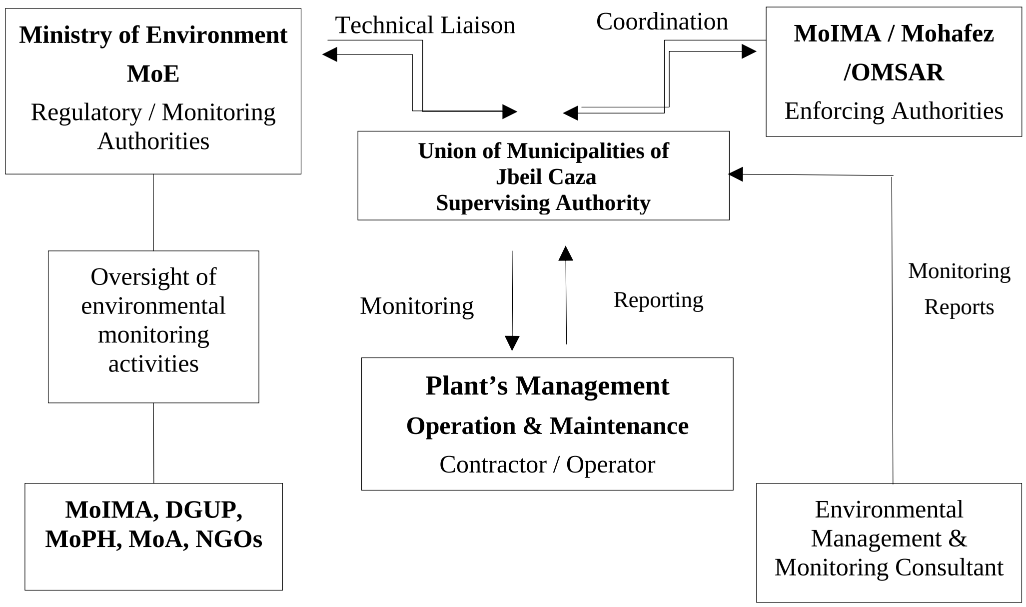

Figure 29. Institutional framework for implementing environmental management plans

7.4 Statement of Compliance

The Union of Municipalities of Jbeil Caza will confirm its adherence to the provisions of this EIA during the construction and operation of the facility. The Union will comply with the national regulations and will adopt the proposed mitigation measures and monitoring plans of the environmental management plan (EMP). It will coordinate and technically liaise with the MoE for a proper application of the proposed environmental management plan. The statement of compliance and commitment of the Union to the application of the EMP is included signed and endorsed in Appendix V.

7.5 Capacity Building

The implementation of environmental management plans on the level of the project or plant could enhance environmental conditions. The objectives of this plan are to reduce the waste volume, recover recyclable material, and develop markets for recyclables.

Three main tasks are suggested to achieve the specified objectives: training, conducting local awareness campaigns, and ensuring markets for recyclables. The training workshops having some common objectives with the awareness campaign should be also opened for the locals.

7.5.1 Training Workshops

Two types of training workshops are required. The first type is to increase environmental awareness of all individuals concerned with the facility (construction, operation, mitigation, monitoring), whereas the second is to train the workers who are specifically involved in the facility operation.

7.5.1.1 Environmental Awareness Workshop

Municipalities' members and the operator's personnel involved in the operation of the facility, and the mitigation and monitoring plans will be required to attend an environmental training workshops prior to the initiation and throughout the project activities. The objective of these workshops is to ensure appropriate environmental awareness, knowledge, and skills for the implementation of environmental mitigation and monitoring measures. In order to increase local environmental awareness, the workshops should also be opened for individuals from the local community. They should be conducted twice a year during the actual operation phase. The workshops will increase environmental awareness of the participants by covering at least the following topics:

- Environmental laws, regulations, and standards
- Pollution health impacts
- Pollution prevention and mitigation measures
- Sampling techniques and environmental monitoring guidelines
- Integrated solid waste management (source reduction, separation, processing, etc.)
- Health and safety measures

7.5.1.2 Facility Operation Training Workshop

Facility operators should receive appropriate training to assume the duties of managing the facility, implementing the suggested mitigation measures, and monitoring potential impacts. The training workshop should cover the following issues:

Waste separation: workers should be informed about appropriate waste separation required to prevent the production of contaminated compost. Furthermore, they should be able to identify all hazardous material, which could contaminate the compost such as batteries, and glass, and that should not enter the composting drums.

Negative impacts: to prevent the occurrence of negative impacts, workers should be aware of all potential impact, their causes, and mitigation measures

Environmental awareness: workers should have a sense of environmental awareness in order to understand the importance of environmental protection

Health and safety regulations

The contractor/operator is responsible for ensuring adequate training of all facility operators. This could be achieved by small workshops conducted, in the facility, mainly during the operation phase for one day on a quarterly basis. The objective of the workshop is to ensure appropriate operation of the facility and implementation of mitigation measures. It should cover all project components with respect to operational activities, and mitigation measures, and maintenance activities. The objective of the one-day workshops is to monitor operation activities and further ensure appropriate operational skills, as well as solve any operational problems or emergencies that might occur.

7.5.2 General Environmental Awareness Campaigns

General environmental awareness campaigns should be conducted targeting all the villagers and various stakeholders. The campaigns should focus on:

- Pollution health impacts
- Integrated Solid Waste Management (reduction, separation, composting,

landfilling)

- Waste reduction: minimizing consumption, re-using, and home waste separation
- Recycling

The core objective of these campaigns is to increase general environmental awareness, induce home waste separation, which will lead to waste volume reduction, and especially a reduction in the amount of generated inert material for landfilling (subsequently, increasing the life span of the landfills around the facility), material recovery, and better quality compost, and inform the locals about the uses of compost.

Community acceptance of the project and participation in waste separation is a vital component of a successful waste reduction process. The negative perception associated with the re-use of waste material should be overcome by explaining to the local community the role of sorting as a component of an integrated solid management plan, and the utilities associated with sorting application (separation options were presented in the impact mitigation section).

7.5.3 Market Provision

The operation of the sorting facility will result in material recovery. Recovered resources should be allocated and diverted to appropriate markets. Several local companies are currently accepting recovered material. The contractor/operator should contact recycling companies and purchasers of recyclables to ensure marketing of the recovered material.

8 PUBLIC PARTICIPATION

Public involvement is a vital component in any community development project especially when the project depends on community participation and cooperation in order to achieve the proposed objectives.

Public participation was first initiated through several meetings having taken place between representatives of the Union of Municipalities of Jbeil Caza and the Consultant Rafik El Khoury and Partners (RELK&P). General concepts and concerns were discussed during these meetings. Furthermore and in conformity with EIA guidelines, a notice was posted at the municipalities informing the public about the EIA study that is being conducted for the solid waste facility (Sorting plant), and soliciting comments. A copy of the notice is included in Appendix VI.

A public meeting attended by the Head of the Union of Municipalities of Jbeil Caza and other Heads of municipalities in Jbeil Caza, the Technical Cadre in the Union, and representatives from the Office of the Minister of State for Administrative Reform (OMSAR) and the Consultant Rafik El Khoury and Partners (RELK&P) was organized to discuss the overall project, its outcomes and advantages, and to solicit public opinions, concerns, perceptions and feedback regarding the proposed project (Figures 30 and 31). It is to be noted that all efforts have been made to address the concerns of the Union and the public in the various parts of the Final EIA report.

Minutes of the public meeting as well as a list of attendees are provided in Appendix VII. It is worth noting that the public meeting was organized on the basis of previous public participation events and workshops organized during the past five years. The public participation events took place as per chronological order in the following contexts:

1. Preparation of EIA for Solid Waste Treatment Center, Hbaline, by LibanConsult and funded by CDR in April 2002
2. Preparation of EIA for Solid Waste Treatment Center “Jbail-Hbaline”, by ELARD, in March 2004
3. Preparation of Feasibility Study of Solid Waste Management in the Caza of Byblos, by ECODIT Inc., in August 2004.

Figure 30: Heads of Municipalities in Jbeil Caza attending the public meeting

Figure 31: Consultant Rafik El Khoury and Partners Experts responding to public concerns

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