YMCA- Lebanon

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

SOLID WASTE TREATMENT FACILITY IN AIN BAAL, CAZA OF TYRE, SOUTH LEBANON

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INTRODUCTION

This Environmental Impact Assessment (EIA) has been prepared to address the potential environmental impacts that could arise from the construction and operation of a solid waste treatment facility. The intended facility will be located in the village of Ain Baal, planned to serve the inhabitants of Tyre Caza, South Lebanon. Additionally, the EIA evaluates various alternative treatment technologies and presents technical criteria on which to base the selection of most suitable site and technology.

The purpose of the project is to alleviate the severe impacts of uncontrolled solid waste disposal into the environment. Proper design/selection, construction, and management of the solid waste treatment facility (and upgrading of solid waste collection networks) would mitigate such negative impacts. The main sections of the EIA include definition of the legal and institutional frameworks, description of the project and the environment, impacts assessment, identification of mitigation measures, and presentation of an environmental management plan (EMP).

LEGAL AND INSTITUTIONAL FRAMEWORKS

In the legal framework, the EIA decree has been revised by the Unit of Planning and Programming (UPP) at the Ministry of Environment (MoE), and is waiting for legislative approval. This decree sets the procedures and guidelines for the proponent of every proposed project that could have significant impacts on the environment, to prepare its own EIA or Environmental Statement (ES). The MoE is the main institution responsible for the revision and approval of the EIA.

There are potential risks associated with poor waste management practices in rural areas, aggravated by the limited level of assistance from the central government. As a result, most rural areas in Lebanon are deprived of adequate sanitary infrastructure. A response more consistent with the United States Agency for International Development (USAID) strategic objectives would be to look for individual or cluster solutions. The implementation of complete and self-sustainable treatment plants in this area is funded by USAID and is under the direct supervision of Young Men Christian Association (YMCA). Institutionally, the project mainly involves the Municipality Union of the Tyre Caza, the Urban Planning

Directorate, the Ministry of Interior and Municipalities (MoIM) and the MoE, and coordinates with the Council for Development and Reconstruction (CDR).

PUBLIC INVOLVEMENT

The project is the foremost issue being requested by the Municipality Union of Tyre (Sour) Caza. During this study, the MEEA consultants met frequently with representatives of the Council of Municipality Union of Tyre and with technology provider. During these meetings, the forecasted projects for the area were presented to the public. In compliance with EIA guidelines, a notice was posted at the concerned Municipality offices in April 2005 informing the public of the EIA study, the proposed solid waste treatment facility, and soliciting comments. A public hearing was held on May 13 2005 where a presentation was given by GROSSIMEX. Thirty two people including Municipality officials and members of the community attended the public hearing.

DESCRIPTION OF THE PROJECT

Currently, municipal solid waste generated within the Tyre Caza villages such as is inappropriately disposed off either in Tyre open dumpsite or directly in the environment. The Tyre dumpsite has been serving Tyre city, six other villages and three Palestinian camps; and has been operational for 7 years approximately. The remaining villages of the Tyre Caza has located areas along roadways, valleys and other natural places where open dumping and burning of their wastes occur. The situation is exposing the public to associated negative health impacts and is leading to the deterioration of natural ecosystem in the area. Tyre is also considered an archeological and touristic area, and therefore impacts on the cultural and aesthetic value is observed.

The proper waste collection, treatment and disposal of the municipal solid waste in the area is of utmost importance to avoid such impacts, and will be addressed by the construction of the solid waste treatment facility to serve the area. The evaluated solid waste treatment facility in the village of Ain Baal employs the In Vessel, forced air, agitated bed and aerobic composting system. The facility will be designed to serve a total design population of 300,000 people.

In the context of analysis or alternatives, the following solid waste treatment process were screened: (1) Sanitary Landfilling, (2) Composting, (3) Anaerobic Digestion, (4) Incineration, and (5) Pyrolisis. The “Do Nothing” scenario is not considered a legitimate option, since solid waste is currently being disposed of at the Tyre open dumpsite or directly in the environment. With the protection of the environment being the main issue, an integrated approach was adopted using more than one waste treatment and disposal method. Therefore, after the separation of the MSW, the organic portion will be composted, the recyclable non-organic portion will be sent to recycling industries and the remaining non-organic reject material will be landfilled.

Accordingly, an analysis of alternative composting technologies by different manufacturers was performed. The alternative systems included: (1) Bediminister AB Process, (2) In-Vessel Stationary Composting Process by ADENESY Co. and (3) the IPS In Vessel Stationary Composting Process by GROSSIMEX. To ensure advanced odor control and to meet the compost compliance standards set by the Ministry of Environment, the IPS In Vessel Stationary Composting Process by GROSSIMEX was adopted by the YMCA and Municipalities Union.

In addition, different site locations for the solid waste treatment facility were analyzed and the most appropriate was choose according to each of access, construction work requirements and distance to residential areas.

The produced compost will be graded according to standards set by the Ministry of Environment (MoE). Table A presents the compost quality standards as set by the MoE. Accordingly, the produced compost will be utilized. The separated non-organic material will be sent to recycling industries, and the non-recyclable rejects will be appropriately landfilled.

Table A. Compost Quality Standards as set by the MoE

Type of compost	***Characteristics***	***Main Fields of Utilization***
Grade A	• Native organic raw material, generated by source-separation; • Mature compost (maturation degree V*); hygienised, biologically stable; • Corresponds to European Eco-label for composts	Food production in • Agriculture • Horticulture • Viticulture
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 • Viticulture
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 soil can be exc luded; e.g. in • Landscaping • Recultivation 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) • 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 recultivation material on controlled landfills and as intermediate layer of deposited waste. No to be utilized as top layer of recultivated landfill sites in order to prevent contamination of humans, fauna and flora as well as spreading of pollutants.

*** Maturation Grade I & II: Immature compost; in early stages of decomposition
** Maturation Grade III: Semi- mature compost; incomplete stage of decomposition (i.e. temperature rise between 10oC - 20oC at DEWAR self heating test)
* Maturation Grade IV & V: Mature compost; in advanced stage of decomposition (i.e. temperature rise smaller than 10o-C at DEWAR self heating test)
DEWAR self heating test: used to determine maturation stage of compost by investigating temperature rise of compost under standard conditions

DESCRIPTION OF THE ENVIRONMENT

The study area is located in the Tyre Caza, with land elevations ranging between than 0 m and 1300 m above sea level. The village of Ain Baal is specifically located at an average elevation of 200 meters above sea level. A generally good road network connects the village to neighboring villages. Yet, road access to the proposed solid waste treatment facility site needs to be developed.

The total annual precipitation in the area is ranges between 600 - 800 mm. Temperature ranges from a minimum of 10 ºC in winter to a maximum of 26.7 ºC. Average temperature in the area is 20.5^{0}C. Dominant winds are South and Southwesterly.

No rivers, streams or wells have been located in the village of Ain Baal. Only one geological formations outcropping within the surveyed area was identified Chekka formation (C_6) of the late Cretaceous age. This marly formation can only form an aquiclude, thus no underlying aquifer is possible.

There are no wastewater treatment facilities in the area, and no collection network exists. Developed infrastructure within the village is mainly limited to road network, telephone, electricity, and water supply. An appropriate local solid waste management system does not exist; most villages in the Caza of Tyre rely on municipal waste collection, open dumping and burning, either along roadways or in the Tyre dumpsite.

Local habitants are mainly members of the active population (between 18 and 50 years old). The economy in most municipalities of the Tyre Caza is driven by agriculture, trade and services. In the city of Tyre tourism is prevalent. Most schools and hospitals are in the city of Tyre and the Village of Abbassieh.

IMPACT ASSESSMENT

The assessment of impacts indicated that negative impacts should not be significant as long as process performance is continuously controlled. Significant impacts on water resources, soil, biodiversity, human amenity and health are anticipated if compost compliance standards and utilization methods are not met as set by the MoE. However, design and management of the facility will take necessary procedures to ensure the elimination of these impacts.

On the other hand, positive impacts with respect to public nuisance and human health are a direct consequence and key goals of the project implementation.

MITIGATION MEASURES

Potential adverse environmental impacts induced by the construction and operation of the proposed solid waste treatment facility include: (a) Dust emissions from construction works. (b) Generation of odors from treatment process (c) Generation of noise from increased vehicular traffic, construction works, and mechanical equipment such as pumps or compressors (d) Increased traffic by waste delivery operations. (e) Contamination of water resources by application of contaminated compost. (f) Contamination of receiving land by inappropriate application of compost. (g) Contamination of crops and vegetation by inappropriate compost utilization. (h) Occupational and public health hazards. Finally, (i) adverse aesthetic impacts in the neighborhood of treatment works. The analysis of these impacts showed that they can be easily mitigated for. Table B includes mitigation measures to reduce further the likelihood and magnitude of such impacts.

Table B. Summary of Main Mitigation Measures

Impact	***Mitigation Measures***
Traffic	♦ Proper routing of waste deliver system ♦ Restricting waste collection and delivery to hours to day time
Noise Generation	♦ Temporary noise pollution due to construction works should be controlled by proper maintenance of equipment and vehicles, and tuning of engines and mufflers. Construction works should be completed in as short a period as possible, during the dry season, by assigning qualified engineers and foremen ♦ Noise pollution during operation would be generated waste delivery operations that should be restricted to day time hours. ♦ Noise problems should be reduced to normally acceptable levels by incorporating low-noise equipment in the design and/or locating such mechanical equipment in properly acoustically lined buildings or enclosures ♦ Landscaping and fencing to act as wind and sound barrier.
Odor Generation	♦ Store of waste and compost in enclosed areas ♦ Provision of biofilter and a continuous negative internal pressure ♦ Provision of a leachate collection pond
Contamination of land, water resources and crops	♦ Prohibition of uncontrolled dumping of waste ♦ Provision of compost quality monitoring as set by the MoE. (Aappendix E) ♦ Proper compost utilization and application
Inappropriate waste collection	♦ Increase capacity and number of waste collection fleet

ENVIRONMENTAL MANAGEMENT PLAN

In order to ensure the proper operation of the solid waste treatment plant, a management system must be implemented. This management scheme shall assure regular monitoring of compost quality and compliance, and process performance. Proper staff training and organized record keeping will also take place.

Compost quality compliance will take place quarterly. However, this frequency of monitoring should not be reduced after the facility has been operational for several years. Sampling will be performed by certified laboratories; however, in house sampling will take place to ensure process performance. A list of analytical parameters for compost quality is:

- Water content
- Man- made impurities
- Stone content
- Maturity grade
- Plant compatibility
- Organic mater content
- Heavy metal content
- Nutrient and salt content
- pH
- Hygiene

Monitoring efforts would be in vain in the absence of an organized record keeping practice. It is the responsibility of the treatment facility management to ensure the development of a database that includes a systematic tabulation of process indicators, performed computations, maintenance schedules and logbook, and process control and performance monitoring outcomes. Such a historical database benefits both the plant operator and design engineers in order to predict any adjustments needed to be performed ahead of time. In addition, in accordance with the requirements of the regulatory authority, the treatment facility should submit a periodic Compliance Monitoring Report to the assigned authority. The institutional setup for the project is presented in Figure I.

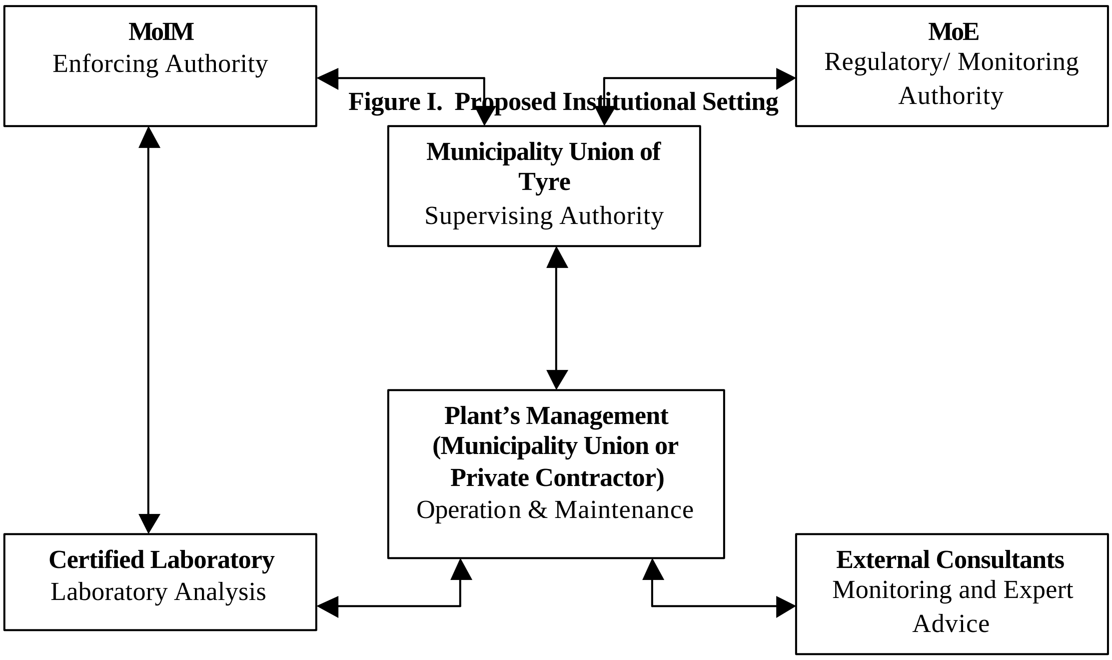


Figure I. Proposed Institutional Setting

1. INTRODUCTION

1.1. THE OVERALL CONTEXT

Lebanon has recently made significant progress towards sustainable development, and has paid more attention to environmental matters and the need to reduce the burden on the environment. Since its establishment in 1993, the Ministry of Environment (MoE) has been successful in considerably improving its capabilities to fulfill its main role of protecting the environment from the various sources of pollution. Financed by international organizations, several working units within the MoE are setting new environmental standards, building an informational database for the country, and providing the framework to prevent and control the spread of pollution in Lebanon.

In particular, the Unit of Planning and Programming (UPP) has revised and further developed the Decree for Environmental Impact Assessment (EIA) that is currently being considered for ratification by the Government. The decree states that any planned project that could cause environmental impacts should be subject to the preparation of an EIA that would anticipate these impacts and allow provision of mitigation measures to minimize the significance of these impacts, or even eliminate their likelihood.

1.2. BACKGROUND AND RATIONALE

Recent government initiatives in the fields of solid waste and wastewater management in Lebanon have primarily covered major cities and urban areas in the country. The Integrated Solid Waste Management Plan (ISWMP) that serves the Greater Beirut Area (GBA) and the National Wastewater Management Plan (NWMP) illustrates this challenge, for example. Limited achievements have been experienced so far in rural areas except for the community-based initiatives financed primarily by international donors.

The environmental pressure experienced in Lebanese rural areas can be illustrated by the fact that approximately 700,000 tons of municipal solid waste (MSW) and over 100 Mm^3 of raw municipal sewage are directly disposed off in the environment every year (MoE/ Ecodit, 2002). A wide range of environmental, public health and socio-economic impacts result from the current situation, some of which are listed below:

- Contamination of water resources: Lebanon's groundwater resources are mainly of karstic nature (over 75 percent of the resources), which offer limited possibility for natural attenuation of pollutants before reaching water resources; recent surveys and studies have shown that over 90 percent of the water resources below 600 meters of altitude are contaminated (Jurdi, 2000); surface water streams are also affected by the direct discharge of untreated wastewater. As water becomes polluted, expensive treatment to make it fit for use will inevitably lead to the increase in the price consumers will have to pay when privatization of water services occur and mechanisms such as full-cost accounting are adopted to set water prices.
- Increased health problems among the population: inadequate disposal of solid waste and wastewater lead to the release of numerous organic and non-organic contaminants that can eventually reach human beings through diverse pathways including direct ingestion of contaminated water, ingestion of crops contaminated with polluted irrigation water and inhalation of polluted air (from open waste burning activities); for example, it is estimated that 260 children die every year in Lebanon from diarrhea diseases due to poor sanitary conditions leading to the consumption of polluted water (MoH, 1996; CBS/Unicef, 2001).
- Negative impact on local economic activities: uncontrolled spread of solid waste and wastewater in valleys, water courses and along roads negatively affects economic activities such as those related to tourism development or eco-tourism by reducing the attractiveness of these areas. Similarly, irrigated areas can be at risk if the source of irrigation water is polluted due to poor waste management practices, thus potentially affecting the agriculture sector in some areas; additional economic impacts are attributed to poor health conditions that can affect human productivity in addition to increasing social costs. It has been recently estimated that the cost of inadequate potable water quality, sanitation and hygiene (largely due to inadequate waste management) could exceed 1 percent of national Gross Domestic Product (GDP), or as much as 170 million USD per year (World Bank/METAP, 2003).

Overall development constraints and obstacles in Lebanon do not favor government assistance to rural areas. Political turmoil, regional instability, and huge public debt are affecting the smooth progress of planned projects in the country, most of which are stagnant with little achievement accomplished. This has lead for instance to the removal of the Solid

Waste Environmental Management Plan (SWEMP) financed by the World Bank (WB), which has experienced limited progress since its inception in the late 1990s.

There are potential risks associated with poor waste management practices in rural areas, aggravated by the limited level of assistance from the central government. The result is that most of the rural areas in Lebanon are deprived of adequate sanitary infrastructure. A more consistent response with USAID strategic objectives would be to look for individual or cluster solutions.

A recent survey on waste management practices in 111 villages outside GBA (El-Fadel and Khoury, 2001) highlighted the following major challenges, in decreasing order of importance, budget deficit, lack of technical know-how, lack of equipment, lack of employees, negligence, mismanagement, lack of land and lack of public participation. These can be summarized in two major categories: 1) limited resources (financial and human) and 2) limited technical skills (technical know-how, management, and environmental awareness).

Another important issue highlighted by the survey was the high level of co-disposal of hazardous and special waste stream (over 75 percent). This significantly increases the health risk associated with poor MSW disposal. Rural areas do not have the needed infrastructure to deal with special wastes such as those generated by olive press mills, hospitals, or slaughterhouses. An additional challenge posed by these types of wastes is the low volume-generated which do not attract private sector investment for their treatment and/or valorization.

Financial support from international sources have assisted in supplying infrastructure and equipment to rural areas for solid waste and wastewater management, yet, additional challenges have been disclosed and lessons can be extracted from these experiences:

- Limited financial resources in municipalities can lead to poor operation of solid waste and wastewater technologies when funding is over;
- Insufficient training, know-how and/or commitment from municipalities can also lead to poor operation of technologies;

- Poor quality of compost, particularly due to the presence of inert materials, leads to significant problems in marketing the product to farmers; insufficient or no public participation in source separation activities contributed to this problem;

- Limited number of recycling factories in the country and the long distances usually existing between treatment facilities and these factories lead to very high and unaffordable transportation costs. Recyclable materials are poorly marketed to the consumers;

- Lack of public participation and public awareness or consensus can delay or even stop the execution of such infrastructure projects.

Another important challenge that rural cluster development programs may experience, is the need to obtain approval from the government. The government has demonstrated skepticism towards decentralized projects, fearing that these could be a short-term solution leading to long-term problems. Both the Ministry of Interior and Municipalities (MoIM) and the Ministry of Environment (MoE) have shown their reservations with respect to such initiatives, fearing that they could become out of their control due to difficulties in monitoring the performance of scattered projects across the country.

Implementing sustainable infrastructure projects in Lebanese rural areas requires a multi-disciplinary and clearly oriented approach with a long-sighted vision in order to overcome all the constraints presented above. The proposed approach calls for the involvement of several partners to ensure the sustainability and success of development initiatives. Figure 1-1: summarizes the overall situation of rural areas with respect to such infrastructure projects.

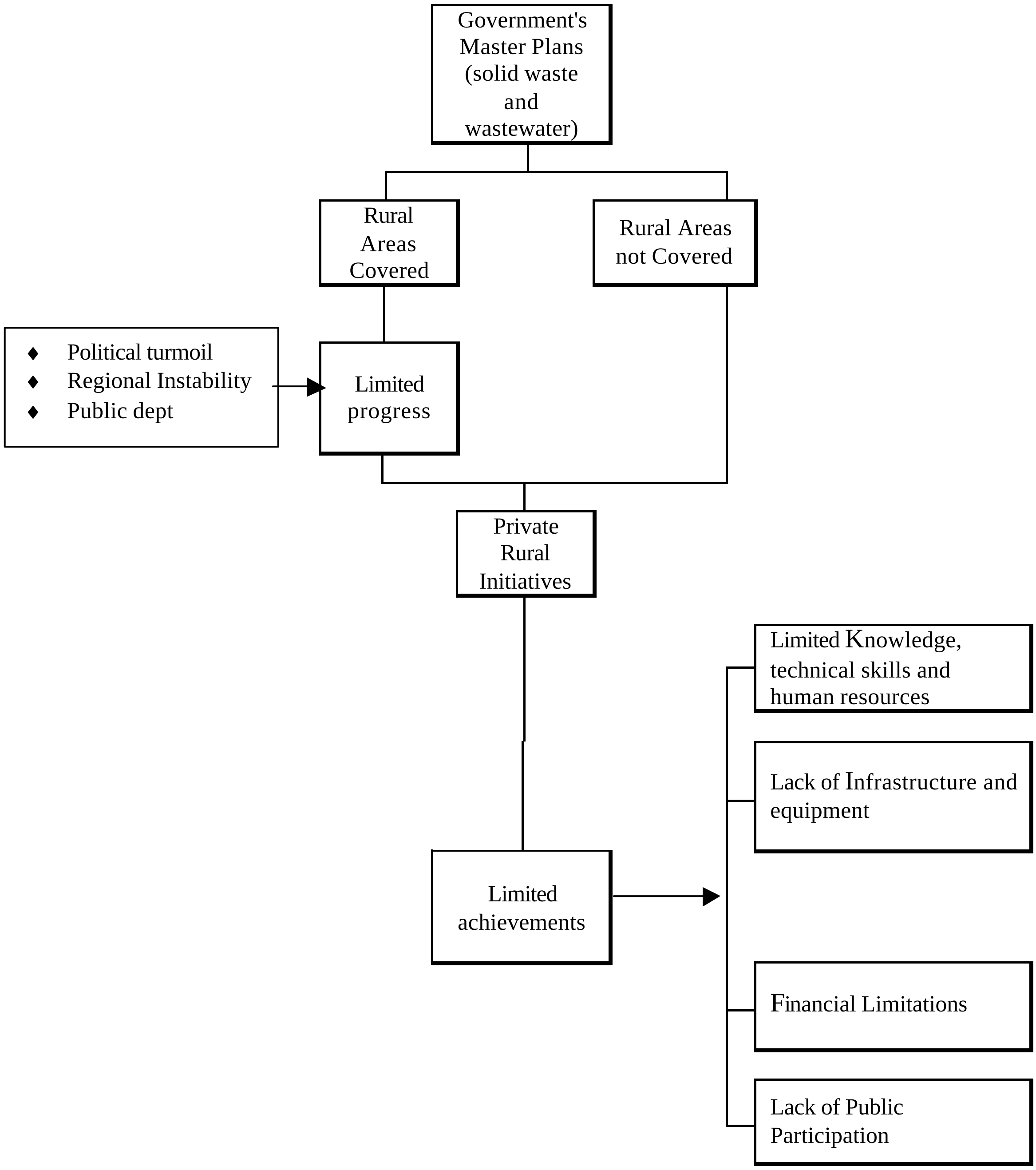


Figure 1-1. Constraints Hindering Infrastructure Development in Rural Communities in Lebanon

1.3. THE PROJECT

The project is a proposed solid waste treatment facilities to be established in the Tyre Caza, Lebanon as part of Young Men Christian Association (YMCA) Improved Environmental Practices and Policies Program. Funded by the USAID, YMCA is providing comprehensive municipal solid waste management solution with the purpose of alleviating the severe impacts of uncontrolled waste disposals in the Caza of Tyre.

This EIA has been prepared to address the potential environmental impacts that could arise from the construction and operation of this solid waste treatment facility planned to serve the most of the inhabitants of Tyre Caza, Lebanon. Additionally, the EIA evaluates various alternative treatment technologies and presents technical criteria on which to base the selection of the most suitable one. Proper design selection, construction, and management of the solid waste treatment facility would mitigate such negative impacts.

The solid waste treatment facility forecasted in Ain Baal is located at the edge of the village. The design population to be served from this project would be around 221,450 people at the time of operation of the facility, however, the project design population is 300,000. The project also has a projected expansion to serve a design population of 323,416 people by the year 2025, considering the facility will serve for 20 years.

1.4. THE PROJECT LOCATION

The solid waste treatment facility (SWTF) is to be located at the outskirts of Ain Baal village, Tyre Caza, Lebanon. The municipality of Ain Baal is located approximately 76 kilometers southwest of Beirut. The proposed location of the facility is presented on the Geological Map that is included as Appendix A and on a topographic map presented in Appendix B of this report. The geographical coordinates of the proposed location are noted in Table 1-1. The area of Ain Baal under study lies approximately between 145 500km Northing, and 107 500km Easting.

The site was proposed and selected by the proponent, assuring for the presence of a connecting road network system, and distances from residential areas. The surface area of the selected location is around 32,000 m^2 required by the SWTF; this parcel was provided by the municipality of Ain Baal (Appendix D). The location is shown in Photograph 5-1 in section 5.3; an official land parcel for the selected area is present in this selected area and is presented in Appendix D.

Table 1-1. Property Location , Projected Populations, and Available Land Area

Area Served	*Geographical Coordinates*	*Actual Population served** *Year 2005*	*Projected Population*** *Year2015*	*Projected Population* *Year 2025*	*Available Land area (m^2)*
Tyre Caza	N 145 500km E 107 500km	217,711	265,314	323,416	32,000***

* Considering the design population is 300,000
** Considering approximate average population growth is 0.02 % (design assumption).
*** Provided parcel by the municipality

1.5. THE STUDY AND THE EIA REPORT

This study was prepared in close collaboration with Young Men Christian Association (YMCA) and the Tyre Caza Municipality Union, who contributed significantly to the overall quality of the report, the identification of the most feasible treatment systems and environmental management practices, and the detection of case specific adjustments. The report was prepared through continuous and harmonious coordination with the Tyre Municipalities Union officials. It provides YMCA, USAID and other stakeholders including the local community a thorough discussion of the significant environmental effects of the proposed interventions. The purpose of this EIA study is to ensure that the potential impacts from the installation and operation of the solid waste treatment facility are identified. As a result, their significance was assessed, and appropriate mitigation measures are proposed to minimize or eliminate such impacts. Additionally, the EIA has been a catalyst for YMCA and the Municipality Union to review alternative technologies and other vendors thus selecting the most appropriate design for deployment.

The remainder of this EIA report is structured in eight main sections. Section 2 provides the legislative and institutional framework. Section 3 presents background information to this project. Section 4 describes the project and associated elements. Section 5 describes the environmental setting. Section 6 assesses the impacts. Section 7 proposes mitigation measures. Moreover, section 8 presents an environmental management plan (EMP) that will allow managers of the facility to monitor the treatment activities to ensure process efficiency and environmental safety throughout the project's lifetime, Section 9 presents the public participation program implemented to allow direct involvement of the concerned community in the implementation of the projects.

2. LEGISLATIVE AND INSTITUTIONAL FRAMEWORKS

2.1. LEGISLATIVE FRAMEWORK

The MoE was created by *Law 216* of 2 April 1993 marking a significant step forward in the management of environmental affairs in Lebanon. *Article 2* of *Law No. 216* stipulate that the MoE should formulate a general environmental policy and propose measures for its implementation in coordination with the various concerned public administrations. It also indicates that the MoE should protect the natural and man-made environment in the interests of public health and welfare and fight pollution from whatever source by taking preventative and remedial action. Specifically, the MoE is charged with developing, among others, the following aspects of environmental management:

- A strategy for solid waste and wastewater disposal treatment, through participation in appropriate committees, conducting studies prepared for this purpose, and commissioning appropriate infrastructure works;

- *Permitting conditions for new industry*, agriculture, quarrying and mining, and the enforcement of appropriate remedial measures for installations existing before promulgation of this law;

- Conditions and regulations for the use of public land, marine and riverine resources, in such a way as to protect the environment;

- Encouragement of private and collective initiatives which improve environmental conditions; and

- Classification of natural sites, landscapes and setting decisions and decrees concerning their protection.

Furthermore, new emission standards for discharge into surface water and air have been established by the MoE (ministerial decision no. 8/1/2001), through the assistance of the SPASI (Strengthening the Permitting & Auditing System for Industry) unit at the MoE, to update the previous standards set by Law 52/1. These standards will be used as a basis to control pollution loads in the country.

Table 2-1 describes the main categories of legislation in Lebanon. In terms of environmental legislation, Table 2-2 summarizes the two main documents that would complement the existing environmental legislation, namely the Environment Code and the EIA decree.

Table 2-1. Categories of Legislation in Lebanon

Laws	Laws are passed by the Lebanese Parliament. The Council of Ministers or deputies can propose a project of law that should pass through the appropriate parliamentary committee. In the case of environmental legislation, this committee is generally the Agriculture, Tourism, Environment and Municipalities Committee, the Public Works, Transport, Electric and Hydraulic Resources Committee, or the Planning and Development Committee. The committee reviews, assesses, and presents the law, with the amendments it introduces, for final approval by the parliament.
Decree laws	The Parliament has empowered the Council of Ministers to issue decree-laws without the prior approval or supervision of the Parliament. Decree laws have the same legal standing and powers as laws.
Decrees	The Council of Ministers issues decrees that have the power of law provided they do not contravene existing laws. The Council of State should be consulted before the issuing of a decree.
Resolutions	Ministers issue resolutions without the pre-approval of the Council of Ministers. Resolutions have the power of law provided they do not contravene existing laws. The council of state should be consulted before the issuing of a resolution.

Table 2-2. Code of Environment and EIA Decree

Code of Environment (1997)
The environmental legislation will be administered by the MoE. Permitting of new facilities with potential environmental impacts will be approved by the MoE in addition to other relevant agencies depending on the type of the project. The application of environmental legislation will be supervised by the MoE; however, the modalities of the supervision exercised by the MoE are not set. Enforcement of legislation is not addressed. It is clear that the MoE will have no enforcement role. The Ministry of Interior will continue to be responsible for the legislation enforcement. A new fund, the National Environment Fund, will be created. The fund covers expenses that should be included in the budget of the MoE. It seems that the establishment of such a fund aims at collecting donations that are specifically targeted to finance environmental projects. Moreover, the fund would also be sustained by the fines and taxes established in the Code. Environmental tax incentives are mentioned for the first time in Lebanese legislation.
The EIA decree (2000)
The MoE decides upon the conditions to be met and information to be provided by a project to receive a permit. The MoE must supervise the projects that are undergoing an EIA. The EIA should contain at least the following sections: institutional framework, description of the project, description of the environment, impact assessment, mitigation measures, and EMP. The EIA is to be presented to the institution in charge of granting a permit to the project depending on the type of the project. A copy of the EIA is sent by this institution to the MoE for consultative and revision purposes.

2.1.1 Legislation Related to Solid Waste Management

Municipalities play a central role in solid waste management activities in Lebanon. Traditionally, solid waste collection and disposal has been the responsibility of the municipalities, set by the Municipal Law, Law No. 118. Moreover, a more recent Decree 9093 (2002) encouraged many municipalities to take the initiative and establish a solid waste treatment facility. Municipality of Ain Baal is one of such municipalities that will benefit from this decision. Table 2-3 presents the existing and proposed legislation pertinent to solid waste treatment facilities

Table 2-3. Summary of Selected Legislation Related to Solid Waste Management

Legislation	*Year*	*Brief Description*
Law No. 118	1977	Municipal Law
Law No. 216	2/4/1993	The Creation of the MoE
Ministerial Decision No. 52/1	29/7/1996	Environmental Quality Standards & Criteria for Air, Water and Soil
Law No. 667	29/12/1997	Amendment to Law No. 216, Organization of the MoE
Project Law	1997	Code of Environment
Project Decree	7/2000	Environmental Impact Assessment
Law No. 444	29/7/2002	Chapter 4, Item No. 21 - 23, states the need for the conduct of an EIA for development projects, including solid waste treatment facilities.
Decree No. 9093	15/11/2002	Any municipality that constructs a sanitary landfill or a waste treatment facility on its lands will get 10 times the allotted share of municipal funds from the Independent Municipal Fund. In addition, if a municipality accepts wastes from 10 other municipalities, its share will be 10 fold its allotted share.

2.1.2 Standards for Compost set by the MoE

There are no final regulations made by the Lebanese authorities on the quality of compost. The MoE, through its Management Support Consultants (MSC) program has developed a draft document entitled, Compost Ordinance Assurance and Utilization of Compost in Agriculture, Horticulture, and Landscaping (CO). The CO is present in Appendix E. The CO regulates the application of treated and untreated bio-wastes and mixtures to soils by agriculture, horticulture, viticulture or forestry. It treats as well the use of compost, having a low quality, in landscaping and landfill operations. In addition, the CO identifies suitable raw material, quality and hygiene requirements, and treatment and investigations of such bio-wastes and mixtures. The CO regulates from the precautionary perspective the waste side of the application. Therefore, all treated and untreated biodegradable wastes from animals or plants, and all mixtures under the collective name of 'bio- wastes' applied to soils through agriculture, forestry or horticulture, landscaping and landfilling operations are subject to the requirements of the Compost Ordinance.

2.1.2.1 Type and Quality Standards for Compost

The CO states four different types of compost defined by quality criteria. The range of quality is from 'Grade A' compost, being a high quality and most appropriate for any agricultural utilization, to 'Grade D' compost, which must only be used for on controlled landfills as intermediate cover or as landscaping material. The product of a composting process, which does not correspond to the specifications of 'Grade D' compost, cannot be considered an organic recycling product and must be categorized as waste. Table 2-4 summarizes the defined criteria for compost type and quality.

Therefore, the only difference between 'Grade A' and 'Grade B' compost is that 'Grade A' compost is obtained from native organic raw material or source separated municipal solid waste (MSW), while 'Grade B' compost is obtained by MSW. 'Grade B' and 'Grade C' compost differ in the level of maturation namely 'Grade B' is mature (Grade IV or V) compost while 'Grade C' is semi- mature (Grade III) compost. Finally, 'Grade D' compost is considered immature (Grade II) compost. Detailed definition for each of the four different types of compost is present in Appendix E. ***Important to note that only compost of 'Grade A' and 'Grade B' can be used in food production process; agriculture, horticulture and viticulture.***

2.2. INSTITUTIONAL FRAMEWORK

In addition to the MoE, other organizations play a role in environmental protection and management, in particular the Ministries of Public Health (MoPH), Interior and Municipalities (MoIM), Public Works and Transport (MoPWT), Agriculture (MoA), Industry and Petroleum (MoIP), and Ministry of Energy. At a regional level, the Mohafaza, Municipality Union and each local Municipality have direct responsibilities relating to the environment. The Council for Development and Reconstruction (CDR) is leading the reconstruction and recovery program, and has taken over certain responsibility from line ministries in areas with direct environmental implications. Table 2-5 summarizes the main responsibilities and authorities of key institutions in the country.

Table 2-4. Definition of Compost Types (Summary)

Type of compost	***Characteristics***	***Main Fields of Utilization***
Grade A	• Native organic raw material, generated by source-separation; • Mature compost (maturation degree V*); hygienised, biologically stable; • Corresponds to European Eco-label for composts	Food production in • Agriculture • Horticulture • Viticulture
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 • Viticulture
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 soil can be excluded; e.g. in • Landscaping • Recultivation 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 recultivation material on controlled landfills and as intermediate layer of deposited waste. No to be utilized as top layer of recultivated landfill sites in order to prevent contamination of humans, fauna and flora as well as spreading of pollutants.

*** Maturation Grade I & II: Immature compost; in early stages of decomposition

** Maturation Grade III: Semi- mature compost; incomplete stage of decomposition (i.e. temperature rise between 10°C - 20°C at DEWAR self heating test)

* Maturation Grade IV & V: Mature compost; in advanced stage of decomposition (i.e. temperature rise smaller than 10°C at DEWAR self heating test)

DEWAR self heating test: used to determine maturation stage of compost by investigating temperature rise of compost under standard conditions

Table 2-5. Responsibilities and Authorities of Key Institutions in Lebanon

Institution	Water Resources	Urban Planning/ Zoning	Standards and Legislation	Enforcement	Biodiversity	Solid Waste Disposal
Council for Development & Reconstruction	√	√				√
Council for the Displaced	√					
Ministry of Agriculture			√		√	√
Ministry of Environment	√	√	√		√	√
Ministry of Housing and Cooperatives		√				
Ministry of Energy & Water	√		√	√	√	
Ministry of Industry & Petroleum		√	√	√		√
Ministry of Interior & Municipalities				√		√
Ministry of Public Health	√		√		√	√
Ministry of Public Works & Transport	√	√	√			√
Ministry of Tourism		√	√		√	
Municipality	√	√		√	√	√

3. BACKGROUND INFORMATION

3.1. PROJECTS INITIATION

On April 14, 2005 upon the request of the Municipalities Union of Tyre Caza, the YMCA presented a Technical Proposal and an Organizational Commitment to USAID seeking funding for the implementation of a Solid Waste Treatment Facility (SWTF) in the village of Ain Baal in the specified region. Subsequently, USAID agreed to finance the implementation of this SWTF in the village of Ain Baal. On that basis, YMCA has commissioned Middle East Engineers and Architects (MEEA) Consulting Environmental Engineers, to perform the EIA for this project.

There are twenty eight villages targeted by the program. They are located in the Caza of Tyre, with land elevations ranging from 0 m to 1300 m above sea level. The SWTF is to be located in the village of Ain Baal. The facility would serve total design populations of 300,000 people, however the actual population it will serve is 217,711 that might reach 265,314 by the year 2015 and 323,416 by the year 2025 (Table 3-1).

3.2. IMPORTANCE OF THE PROJECT

Currently, municipal solid waste generated within the Tyre Caza villages, are inappropriately disposed off either in Tyre open dumpsite or directly in the environment. The Tyre dumpsite has been serving Tyre city and the villages of El Abassieh, Borj El Chemali, Ain Baal, El Qlaileh, El Bazourieh, Batoulieh, and the Palestinian Camps (Rachidieh, Borj El Chemali, and Bass) and has been operational for 7 years approximately. The remaining villages of the Tyre Caza have located areas along roadways, valleys and other natural places where open dumping and burning of their wastes occur. Section 0 gives a detailed description of the existing situation of the Tyre dumpsite along with observed and documented environmental and social impacts.

3.3. OBJECTIVES OF THE PROJECT

The main objective of the project is to provide the necessary means and proper disposal of the MSW generated in the Tyre Caza, and halt the current practices of uncontrolled disposal of MSW in the Tyre open dumpsite and MSW uncontrolled disposal in the environment. These practices are posing risk to the public health and the environment, mainly through the contamination of potable water, the groundwater, and associated springs as well as affecting Agricultural production. An additional objective is to reduce disease vectors and halt the nuisance associated with open dumping onto roadways, valleys and open trenches resulting in the generation of odors, mosquitoes, flies and other insect populations. The concern of the municipality for the health of the public, the protection of the environment and their drive for developing local tourism is a driving force behind this project.

3.4. THE EXECUTING OFFICE

The Municipality Union all along with YMCA is the responsible authorities with respect to the proper construction and operation of the facility. They will oversee the works and ensure its execution and operation according to specifications.

Table 3-1. Design Populations of villages in Tyre Caza

Village	*Year 2005*	*Year 2015**	*Year 2025**
Abassieh	28000	34132	41607
Ain Baal	10000	12190	14859
Aiteet	4500	5485	6687
Arzoun	1000	1219	1486
Batolieh	3500	4266	5201
Bazzourieh	10000	12190	14859
Burj el chamaley	15000	18285	22289
Burj rahal	4250	5181	6315
Chahoor	8000	9752	11888
Chehabieh	10000	12190	14859
Deir Qanoun el Naher	7000	8533	10402
El Hemayre	1200	1463	1783
El heneyeh	1500	1828	2229
El majadel	4500	5485	6687
Halossieh	3000	3657	4458
Hannaouyieh	3500	4266	5201
Jouaiya	10000	12190	14859
Maarakeh	9500	11580	14117
Maaroub	4000	4876	5944
Qana	10000	12190	14859
Qulalieh	5000	6095	7430
Sarifa	5000	6095	7430
Terfelsayeh	4700	5729	6984
Toura	7500	9142	11145
Tyre	45000	54855	66868
Yanouh	2000	2438	2972
Total	217650	265314	323416

* Considering approximate average population growth is 0.02 % (design assumption

4. DESCRIPTION OF THE PROJECT

4.1. GENERAL DESCRIPTION OF THE FACILITY

In general, the proposed solid waste treatment facility in the village of Ain Baal employs a forced air, agitated bed and aerobic composting scheme. GROSSIMEX proposes a composting facility utilizing an IPS Composting System as the primary in-vessel composting technology. The land area required for the proposed facility with buildings, paved areas and buffer is less than the 32,000 m^2 of land available for this project. The detailed facility plan and diagrams are present in Appendix C. The facility has a design population of 300,000 people, receiving 150 tons of MSW per day. The system is designed to process 150 tons in a single work shift, 8 hours/ day. Table 4-1 presents the list of municipalities, population and amount MSW generated that the Ain Baal SWTF will serve. The SWTF will however not serve the population of the entire Caza of Tyre, only 26 municipalities of the total.

Comprised of ten adjacent, parallel bays, the composting facility can dedicate each individual bay to specific organic recycling materials. Each bay acts as an independent composting vessel so that yard waste, source-separated and/or pre-consumer food residuals can be segregated then processed separately. The facility and process design are based on the following assumptions:

- Incoming Daily Unsorted Municipal Waste = 150 tons
- No medical, industrial or hazardous dangerous waste is to enter the facility
- Density of incoming waste = 300 kg/m^3
- Waste Composition 65 % organics and 35 % non-organic (Table 4-2)
- Density of organic material prior to composting = 700 kg/m^3
- Volume reduction during composting process = 25%

Table 4-1. Population and MSW generated per Municipality

Municipality	*Population (2005)*	*Generation Rate/ Capita/ Day*	*Generated MSW/ Municipality/ Day (tons)*
Abassieh	***28000***	***0.7***	***19.6***
Ain Baal	***10000***	***0.5***	***5.0***
Aiteet	***4500***	***0.5***	***2.3***
Arzoun	***1000***	***0.5***	***0.5***
Batolieh	***3500***	***0.5***	***1.8***
Bazzourieh	***10000***	***0.5***	***5.0***
Burj el chamaley	***15000***	***0.7***	***10.5***
Burj rahal	***4250***	***0.5***	***2.1***
Chahoor	***8000***	***0.5***	***4.0***
Chehabieh	***10000***	***0.5***	***5.0***
Deir Qanoun el Naher	***7000***	***0.5***	***3.5***
El Hemayre	***1200***	***0.5***	***0.6***
El heneyeh	***1500***	***0.5***	***0.8***
El majadel	***4500***	***0.5***	***2.3***
Halossieh	***3000***	***0.5***	***1.5***
Hannaouyieh	***3500***	***0.5***	***1.8***
Jouaiya	***10000***	***0.7***	***7.0***
Maarakeh	***9500***	***0.5***	***4.8***
Maaroub	***4000***	***0.5***	***2.0***
Qana	***10000***	***0.5***	***5.0***
Qulalieh	***5000***	***0.5***	***2.5***
Sarifa	***5000***	***0.5***	***2.5***
Terfelsayeh	***4700***	***0.5***	***2.4***
Toura	***7500***	***0.5***	***3.8***
Tyre	***45000***	***0.8***	***36.0***
Yanouh	***2000***	***0.5***	***1.0***
Total	***217650***		***134.8***
Design Population	***300,000***		***150****

* Considering the 0.5 kg MSW Generation/ capita/ day (design assumption)

Table 4-2. Waste Composition of Waste Stream

Waste Portion	***Type***	***Percentage (%)***	***TotalPercentage (%)***
Organic Waste	Household waste	65	65
Non Hazardous Inorganic Waste	Inert rejects (plastic bags, cloths a& shoes)	5	34
	Paper and cartons	11	
	Glass	5	
	Plastics	8	
	Metals	5	
Hazardous Inorganic Waste	Batteries and paint residues	< 1	1
		Total	**100**

4.2. PROCESS THEORY

The treatment of MSW is primarily performed to reduce the waste volume and ensure a safe disposal method. The waste characteristics, social requirements and financial means are important criteria in choosing the type of treatment process. Composting depends on the natural process of biological degradation of organic material. Traditionally, composting was adopted as a farming practice for recycling nutrients extracted from the soil by plant uptake. Compost is considered a soil amendment, improving in nutrient base (soil fertility) and its physical characteristics.

In the MSW stream, a high portion is organic (approximately 60%), the remaining inorganic portion is compromised of recyclables and non- recyclables. Initially, the separation of the organic fraction from the waste stream is performed after which the composting of the organic portion takes place. The quality of compost is directly related to the thoroughness of the separation process. Micro-organisms, naturally present in organic material will start the decomposition process, either aerobic or anaerobically. In anaerobic digestion of organic material, methane gas is produced, while aerobic digestion produces carbon dioxide. In both aerobic and anaerobic digestion, continuous agitation of organic material is essential to ensure microbial decomposition of all the material.

In the case of aerobic digestion, the provision of sufficient aeration is essential to inhibit anaerobic decomposition. During the digestion process, significant heat is produced. This rise in temperature may destroy the micro-organisms responsible for decomposition if the temperature rises are too high. However, continuous aeration and organic material agitation will reduce increases in temperature, sometimes to levels too low to maintain sufficient microbial decomposition. Therefore, it is essential to maintain temperatures levels, between 60 - 70 ^{o} C that sustain appropriate decomposition. Once sufficient basic digestion has been reached within two weeks, the organic material is cured. This is a process where decomposition of organic material continues however at a lower rate since only a small fraction remains undigested.

The produced compost is graded according to different criteria. The most important of which are the level of impurities, the absence of unhygienic bacterial such as Salmonella , and the maturity. Maturity relates to the compost stability. The longer the curing phase, the lower the active microbial digestion, the more mature compost is considered. Appendix E contains a detailed description of different compost grades. It is important to note that compost of different grades have different application/ utilization methods for safeguarding the environment.

4.3. DETAILED PROCESS DESCRIPTION

The proposed SWTF project is divided into six sections. Figure 4-1 presents a flowchart of the process flow for the proposed SWTF. The sections and areas of the proposed SWTF are as follows:

1. Unloading Bay, 790 m^2
2. Tipping floor, 812 m^2
3. Sorting Line, 247 m^2
4. Composting Plant, 1745 m^2
5. Curing Area , 2700 m^3
6. Product Refining

Other areas concerned within the facility and their respective areas are as follows:

1. Recyclable Material Pits, 1014 m^2
2. Administration Building, 62 m^2
3. Personal Facilities, 150 m^2
4. Maintenance Structure, 150 m^2

The MSW will be delivered to the facility by municipal trucks, estimated average of 150 tons/ day to the receiving area, and will deposit the material onto the tipping floor. These MSW will undergo the preprocessing process of sorting. All roads are at minimum 6 meters wide. The movement of the trucks is limited to the unloading bay.

Other private vehicles will delivery organic residue such as agricultural waste to the special area designated for segregated materials. These high quality organic wastes will not undergo preprocessing and will be delivered directly to the loading area of the composting plant by a front-end loader.

4.3.1 Unloading Bay

In order to minimize the truck's circulation inside the plant and to reduce any odorous emissions, an unloading bay has been specially incorporated in the design. Incoming trucks empty their content on the tipping floor without actually entering the building, by tipping the waste over a wall onto the tipping floor, thus reducing circulation inside the building and the site, and reducing any contaminations that might occurs during trucks circulation in the site. Prior to the unloading, the trucks will pass over a weight bridge where the exact weight of the garbage will be registered for billing purposes.

4.3.2 Tipping floor

Incoming MSW will be unloaded on a tipping floor, which has adequate capacity to store up to *two day receipts at the 150 tons per day* level. Received waste will be stacked at a maximum height of 2m with a density of 300 kg/m3 (Table 4-1), a total area of 250m^2 is required. However, a two day receipt is a recommended engineering practice, thus a 500m^2 area is provided for stacking incoming waste. The remaining 312 m^2 of the allocated 812 m^2 will be used for loader circulation inside the facility.

A front end loader will operate on this floor to perform both the stacking of the MSW during heavy receiving hours and the delivery of MSW from the storage pile to the system in-feed conveyor. The loader operator will also perform a preliminary inspection of the MSW to remove any large, non-processible materials, such as carpets, furniture, and appliances. The front-end loader will break open compactor loads and spread them out for inspection. Floor sorting staff needs to be vigilant in removing materials that are inappropriate for composting, and to ensure the incoming putrescible MSW are not creating odor problems or attracting vectors (birds, rats, flies, etc.).

4.3.3 Sorting Line

Picking line staff will manually remove contaminants such as plastics and glass. The negative sort will pull contaminants off the line and into refuse containers located near the picking line conveyor. The picking line will be equipped with a variable speed electrical motor to allow for more flexibility during stream variations. The sorting lines are 14 m in length and 1m in width, and are made of a heavy-duty rubber belt with a 10.0 mm thickness. The sorted organics will then pass over a pulley type magnet, prior to being shredded and dumped in the tunnel loading bay.

The recyclable material pits are located below the sorting line, and will be stacked to a maximum height of up to 3 meters. With the incoming volumes of recyclables, it is expected that the pits will be emptied once every month. Non-recyclable material like tires, cloth, shoes, can be stocked in one single bay and sent to a landfill.

4.3.4 Compost Processing Area

The IPS Composting System is a forced air, agitated-bed and aerobic system of composting and is contained in 1745 m² of building. This area includes the loading area, ten compost bays and unloading area at the end of the bays. The in-vessel system operates under controlled aerobic conditions, in open-topped concrete bays. The system is sheltered in a weatherproof building to allow year-round operation and effective odor control.

Each of the ten 53m long, 2 m wide and 2.13 m deep concrete bays are considered separate composting units. Each bay has three independently controlled aeration zones and can receive up to $15m^3$ of combined material. The bays will be loaded approximately every other day, which totals about 128 m³ per day that can be processed in the facility. A front-end loader (Bobcat type) with a bucket will pick up the mixture is used to load the sorted organic waste directly into a bay from the loading area.

An IPS automated agitator/mixer machine with a movable, toothed drum and conveyor, mixes and moves the material down the bay at an average of 3.65 m/ day, maximizing and maintaining the same depth throughout the bay. After each agitation, space to load another $15m^3$ of waste material into the bay is made available.

When the machine reaches the front of the bay, a trip switch activates controls to raise the drum and conveyor unit and the machine moves on to its transfer dolly. The dolly moves to the next bay, and the agitator then proceeds down the bay to the finishing end. The drum and conveyor lowers and the process is then repeated. Because of the automatic control, an operator is not required to be present while the unit is working. The machine is capable of processing ten bays in an eight-hour shift.

For the proposed SWTF, the compost will remain in the bays for at least 14 days. This retention time is based on operating the agitator once daily during a seven-day workweek. The retention time for each of the separate composting units/ bays can be adjusted by operating the machine less or more frequently. The daily agitation process in the bay thoroughly mixes and exposes all of the compost mixture to microbial degradation. The mixing accelerates the compost process by providing a loose, porous material that facilitates optimal movement of air to create aerobic conditions and a more uniform distribution of temperature in the compost mass.

After the mixture has been conveyed through the system for approximately 14 days, it is then ready for discharge and further refining and curing. The finished mixture is conveyed onto the concrete discharge pad at the end of the bays and directly off-loaded from the bays by a front-end loader to the curing area.

4.3.4.1 Bay Aeration, Temperature Control and Computer Control System

Each bay has individual aeration zones and controls that allow a multiple bay facility to process varied waste streams simultaneously. An organic waste mixture loaded in one bay can move through the bay without affecting other organic wastes in adjacent bays. To maintain optimum and controlled temperature and ventilation, a series of blowers controlled by an automatic feedback system in addition to a timing sequence, to provide positive, forced aeration. Thermocouples permanently mounted in the bay walls interface with a Siemens type Programmable Logical Control, activate blowers when temperature set points are exceeded.

For the provision of continuous aeration during the composting process, each bay is independently aerated with four aeration zones each with its independently controlled 3 HP blower. The aeration blowers, one for each zone, are located along the walls of the outer bays. The airflow moves upward from the bottom of the bays via a grid of perforated PVC pipes embedded in a stone plenum to allow even distribution of air. For precise temperature management during the entire composting process, each blower is independently controlled by a thermocouple.

The aeration piping system, located at the base of the compost bays, is comprised of network of perforated PVC piping embedded in a round, washed, uncrushed stone plenum. The aeration blowers force air into a PVC header, which feeds a grid of PVC laterals in each aeration zone. The zones are 15.25 meters in length to provide an average 1.7 m^3/min per ton of bio-solids. A drainage system for the stone bed is provided to collect and remove any leachate.

The system ensures temperatures are maintained at or above 65^oC to insure pasteurization, while simultaneously preventing excessive heat build up that could inhibit biodegradation of organic wastes. The combination of aeration and agitation minimizes the occurrence of "hot spots" and negates the possibility of spontaneous combustion.

Airflow rates are adjusted as compost moves down the bay. Flow rates of up to 1.7 m^3/min/ wet ton of material are obtained in this system. Higher rates of aeration are provided at the front end of the process, where higher rates of heat generation occur. Each blower can be turned on or off, depending on need.

The system is operated in accordance with the "Rutgers" strategy, using thermocouple sensors installed along the length of each compost bay. The sensors are installed flush with, but insulated from, the concrete to yield continuous reliable compost temperature data. Each sensor controls a single blower.

For the aeration system, the controller is designed to maintain the desired compost temperatures in four longitudinal zones within each bay. The temperature of each zone is sensed through a thermocouple mounted on the bay wall. An aeration blower is automatically activated when the compost temperature needs adjusting.

For the ventilation system, the controller is designed to control humidity levels in the building. While the exhaust blowers are typically set to operate continually during the operating shifts, they are also set to respond to temperature readings from both inside and outside the building during off hours for humidity control.

4.3.4.2 Water Addition

It often becomes necessary to add water to the compost mixture to insure adequate moisture control and dust prevention. The project includes a manual spraying system above the mid range of the bay; this unit is fixed on the top of the bay walls, below the rails, and consists of PVC pipes with nozzles. The operator will determine frequency, amount of water to be added, time of application and then will program the proper application of water to all bays as deemed necessary redundancy.

4.3.5 Curing Area

The composted material removed from the refining area will be further processed in the curing area for an additional 30+ days. The curing area will be comprised of a covered concrete pad.

4.3.6 Refining Area

After 30 days or so, the front-end loader will deposit the composted material in a fine trommel screen where remaining fine particles (stones, plastic and glass) will be removed. The screen will remove the final rejects from the compost prior to distribution.

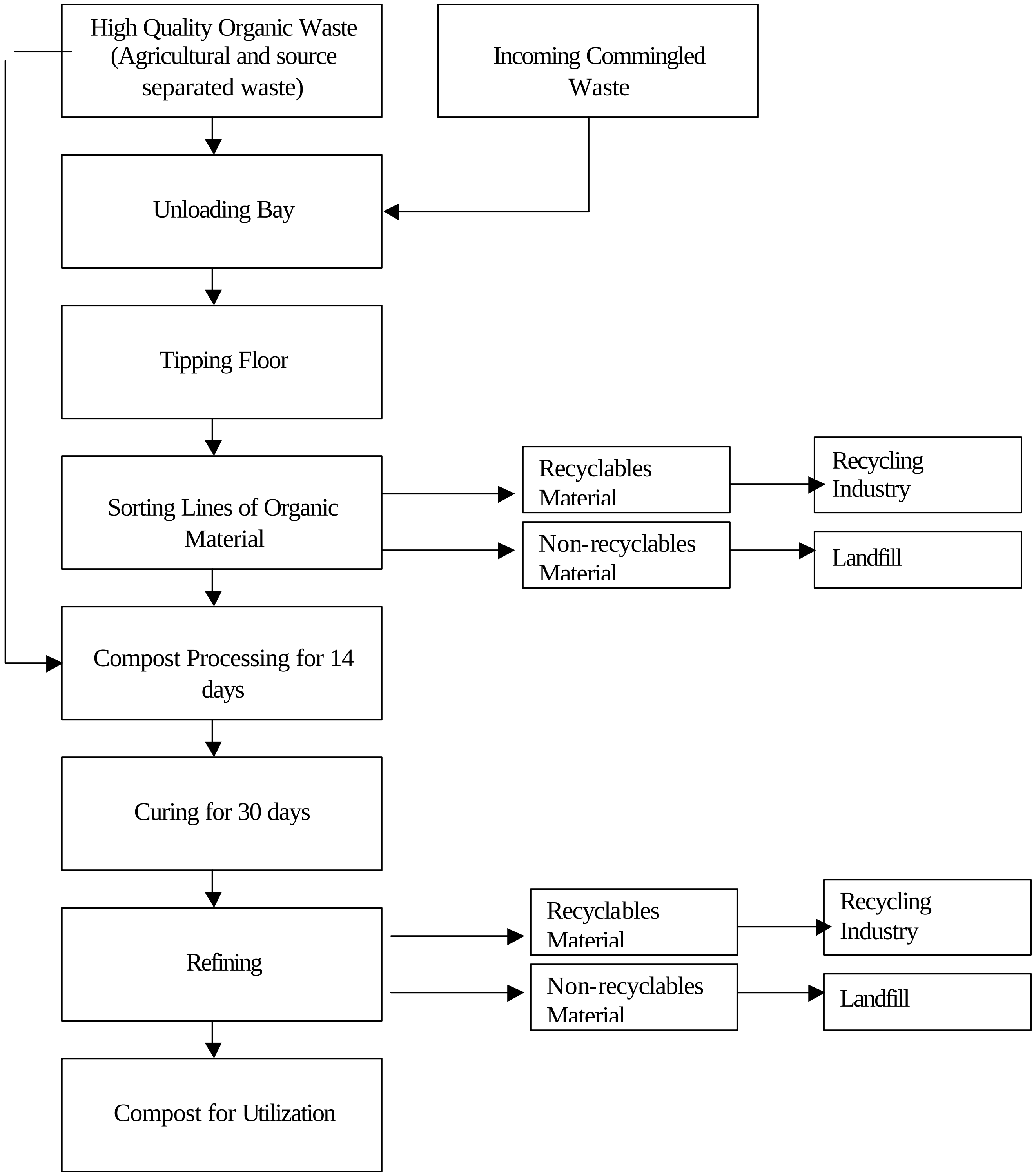


Figure 4-1. Flow Diagram of Proposed SWTF using IPS In Vessel Composting System

4.4. MANAGEMENT OF NON- ORGANIC WASTE

Once the non- organic waste portion has been separated, recyclables will be stored separately in the recyclable materials pits area. The recyclable materials pits are located below the sorting line, and will be stacked to a maximum height of up to 3 meters. With the incoming volumes of recyclables, it is expected that the pits will be emptied once every month.

Non-recyclable material like tires, cloth, shoes, can be stocked in one single bay and sent to a landfill. At the time of plant operation, the non-recyclable rejects will be delivered to the Tyre dumpsite, however, future plans will include an appropriate disposal method of these wastes in a sanitary landfill.

4.5. ODOR CONTROL PLAN

4.5.1 Building Ventilation and Odor Control Systems

The ventilation, exhaust and odor control systems for the proposed SWTF has been divided into two zones:

1- Zone 1: the tipping floor, sorting area and bay loading area,

2- Zone 2: the composting bays

Since the site on which the facility is expected to be erected is at 400 m of the nearest residential household, the ventilation of all the facilities (sorting and composting) will be kept under negative pressure to avoid any foul odors to exit the facility when one or more doors are opened. As for Zone 2, it will be delimitated by two vinyl strip curtains that are located across the entire 26 meters width of the compost building. One curtain is located in the vicinity of the beginning of the IPS bays and the other at the discharge of the active compost portion of the structure. The purpose of the strip curtains is to help contain the moist odorous air over the active composting portion of the facility for direction to the biofilter. A minimum of three air changes per hour of air will be exhausted from the active composting area to the biofilter.

4.5.2 Air/ Biofilter

A biofilter odor control system, consisting of a 310m^2 biofilter bed, will be used to mitigate odor generated within the Composting Zone of the facility. The biofilter is divided into three cells for segmented medium replacement.

The biofilter consists of a piping network that is covered with stones and allowed to settle. The piping network has been designed for uniform air distribution. Then the media, a thoroughly mixed combination of wood chips, wood bark, and other appropriate material, will be placed over the stone to a depth of 5ft. At normal operation, the rated surface loading to the 5ft deep biofilter is 3.5 CFM/ ft^2 of biofilter surface area. This will ensure the loading will not exceed 5.5 CFM/ ft^2 of biofilter when media replacement is necessary. This will also insure that desired odor levels as measured will be maintained at the surface of the biofilter. The biofilter shall be equipped with four fans each 1325 CFM. The biofilter will be kept moist especially during hot summer using a water hose.

The biofilter will be constructed in three cells or sections in order to facilitate maintenance and periodic media replacement as deemed necessary. Each section will be operated independently so that a cell can be taken out of operation without interruption of service to the other two sections.

4.6. WATER TREATMENT PLAN

Two $10m^3$ septic tanks holding a total of $20m^3$/ day of wastewater flow will be installed. However, if additional tanks are required they will be added. Floor drains will be located throughout the facility to collect ancillary wastewater. It will enter the sanitary sewer sanitary discharge from the locker rooms, bathrooms, floor washing, and cooling water are collected at a septic tank that will be periodically pumped out. The other septic tank will collect wastewater from the compost bays and leachate from the biofilter and reuse to increase the piles moisture. Table 4-3 presents the water and wastewater budget for the proposed SWTF.

Table 4-3. Water and Wastewater Budget

Usage	*Water Requirements*			*Wastewater Requirements*		
	Average Daily m3	*Average Monthly m3*	*Source*	*Average Daily m3*	*Average Monthly m3*	*Discharge Point*
Staff	1	25	Potable	1	25	Septic Tank
Visitors	0.4	10	Potable	0.4	10	Septic Tank
Bldg. Wash Down	4	100	Potable	4	100	Septic Tank
Bay Spray	4	100	Non-Potable	---	---	None
Biofilter Application	8	200	Non-Potable	---	---	None
Building Equipment Wash Down	2	50	Non-Potable	2	50	Septic Tank
Yards & Grounds	1	25	Potable	---	---	None
Totals	***20.4***	***510***		***7.4***	***185***	

4.7. WASTE DELIVERY NETWORK

4.7.1 Existing Waste Collection System

Based on the survey conducted, a fleet of 37 vehicles used in the collection and transport of MSW were identified in the municipalities benefiting from the proposed SWTF. The waste delivery vehicles range from tractors to modified pick ups to large compactors, representing a 47%, 40% and 9% respectively. The remaining 4% presents a variety of different vehicles such as small front loaders, skip loaders and small vehicles. Most of the non-compactor vehicles in the existing fleet have been exposed to steel body modification to increase the volumetric capacity of these vehicles. These vehicles are either privately owned representing 45% of the total fleet, or owned by their respective municipalities representing 55%.

Several municipalities in the project area are facing inappropriate waste collection in terms of frequency. The existing vehicle capacity and/or number was found to be incapable of serving all the concerned municipalities on daily bases, leading to the storage of the MSW in collection bins for several days. A special case worth mentioning is Maarakeh village with an estimated 9,000 people and a large geographical area with only one tractor serving the whole village; the municipality was forced to divide the village into ten sectors each sector served per day. As a result the waste is stored for almost ten days in each sector before it is collected.

4.7.2 Waste Deliver to the Proposed SWTF

The proposed SWTF in Ain Baal will be served by two access roads stretching approximately 0.8 - 2.0 km from the main roads to the proposed site. The first access road will provide an entry for all trucks and vehicles coming from villages located in the northeast side of the project area, through Aiteet-Maarrakeh intersection. The second access road will serve as an entry for south-west villages and the coastal zone. Appendix C illustrated the access roads to the proposed SWTF. Both access roads will be 6m wide and completely paved to prevent any dust scattering during transportation to the SWTF. The two roads will join at the lower northeastern corner of the proposed site at the main access gate of the facility were each vehicle will be weighed upon entry using a 30 ton weighing bridge (Appendix C).

Based on the survey prepared the traffic size that will reach the facility site is expected to reach 52 trucks per day delivering MSW from the 26 municipalities included in the project. As illustrated in Appendix C, the municipalities included in the project have been categorized into 3 blocks based on the road network used. Table 4-4 illustrates the municipalities within each category included in the project design, the waste delivery vehicles and the number of trips per municipality to the SWTF required.

Table 4-4. Waste Delivery Vehicles of each Municipality and Block

Municipality	Vehicle Type	Capacity	Number	Specifications	Ownership	Number of trips/day to SWTF
BLOCK A (East Access Road)						
Abassieh	Compactor truck	7 tones	1	Closed steel structure body + hydraulic rear pusher	Municipality	2
	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper		2
Ain Baal	Compactor truck	10 m^3	1	Closed steel structure body + hydraulic rear pusher	Municipality	2
	Pick-up	2.0 tones	1	Modified open-top steel body + hydraulic rear tipper		1
Aiteet	Tractor	3.0 tones	1	Modified open-top steel body	Private contractor	1
Batolieh	Pick-up	10 m^3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	3
El hennieh	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Private contractor	1
Hannaouyieh	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	1
Qana	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	4
	Tractor	5.0 tones	1	Modified open-top steel body	Private contractor	4
Burj rahal	Pick-up	9 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	2
Qulalieh	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	3
Tyre	Compactor truck	15 m3	2	Closed steel structure body + hydraulic rear tipper	Municipality	2
	Skip loader	6.0 tones	1			1
	Pick-up	2.5 tones	1	Hydraulic rear tipper		1
Subtotal						**30 trips/day**

Table 4-4. Waste Delivery Vehicles of each Municipality and Block (Continued)

Municipality	Vehicle Type	Capacity	Number	Specifications	Ownership	Number of trips/day to SWTF
BLOCK B (West Access Road)						
Bazzourieh	Pick-up	10 m^3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	2
Burj el chamaley	NA					NA
Chehabieh	Pick-up	5.0 tones	1	Modified open-top steel body + hydraulic rear tipper	Municipality	3
	Tractor	5.0 tones	1	Modified open-top steel body		2
Deir Qanoun el Naher	Pick-up	10 m3	2	Modified open-top steel body + hydraulic rear tipper	Municipality	1
El majadel	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Private contractor	1
Jouaiya	Tractor	5.0 tones	1	Modified open top steel body	Private contractors	2
	Tractor	5.0 tones	1	Modified open top steel body	Private contractors	2
Maarakeh	Tractor	5.0 tones	1	Modified open top steel body	Municipality	2
	Tractor	5.0 tones	1	Modified open top steel body	Private contractors	2
Toura	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	2
Yanouh	Tractor	5.0 tones	1	Modified open top steel body	Private contractor	1
					Subtotal	**20 trips /day**

Table 4-4. Waste Delivery Vehicles of each Municipality and Block (Continued)

Municipality	Vehicle Type	Capacity	Number	Specifications	Ownership	Number of trips/day to SWTF
BLOCK C (West Access Road)						
Chahoor	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	-
El Hemayre	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Private contractor	-
Halossieh	Tractor	5.0 tones	1	Modified open top steel body	Private contractor	-
Maaroub	Tractor	5.0 tones	1	Modified open top steel body	Private contractor	-
	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	-
Sarifa	Compactor truck	10 m3	2	Closed steel structure body + hydraulic rear tipper	Municipality	-
	Compactor truck	10 m3	1	Closed steel structure body + hydraulic rear tipper	Municipality	2
Terfelsayeh	Pick-up	10 m3	1	Modified open-top steel body + hydraulic rear tipper	Municipality	-
					Subtotal	**2 trips /day**
					TOTAL	**52**

4.8. ANALYSIS OF ALTERNATIVES

Selection of the most appropriate solution to meet a certain long-term objective is not a simple and straightforward task. Several factors must be taken into consideration, including technical criteria, environmental considerations, and economic observations. The aim of this section is to weigh the potential of all relevant alternatives concerning the treatment process, the system selection and the site location. As a result, a sustainable solution can be implemented to treat the MSW crisis in the Caza of Tyre. Since the current situation is not desirable, the "Do Nothing" scenario involving the disposal of the MSW at the existing open dump and uncontrolled into the environment is not considered a legitimate or a sustainable waste management practice.

4.8.1 Treatment and Disposal Method Selection

The choice of solid waste disposal scheme depends on the financial capability of the local communities and the availability of skills. Advanced systems require high capital and skilled labor for their operation and maintenance. In the case of the Tyre Municipalities, both financial and technical capabilities are weak. The conventional solid waste treatment practices, that are applied worldwide, include sanitary landfilling, composting, anaerobic digestion, incineration, pyrolysis and various combinations of these basic processes in order to come up with a solution for integrated management of solid waste. The first three disposal methods involve biological activity and the last two involve chemical reaction. Open dumping of solid wastes is not considered as a sustainable waste management practice.

In the context of analysis of alternatives, five alternative MSW treatment schemes have been screened. Table 4-5 provides a comparison of the different alternatives. The alternatives are:

<u>Alternative 1</u>: Sanitary Landfill

<u>Alternative 2</u>: Composting

<u>Alternative 3</u>: Anaerobic Digestion

<u>Alternative 4</u>: Incineration

<u>Alternative 5</u>: Pyrolysis

4.8.1.1 Sanitary Landfilling

Sanitary landfilling is the oldest and cheapest method for safe disposal of MSW. This disposal method involves the stacking of waste into an appropriately designed and constructed landfill whereby a geo-membrane, leachate collection system and gaseous emissions collection system have been installed. Collected wastes can either be directly landfilled, or may undergo separation for the recovery of secondary material such as glass, paper, metal and others. Organic material can also be recovered, as is the case in the proposed project.

Waste designated for landfilling may undergo pre- disposal procedures such as bailing or milling. This disposal method requires the daily compaction of deposited wastes and the application of a daily cover on the active landfill face. The main aim behind these practices is volume reduction.

Once MSW has been landfilled, the biological decomposition of the organic portion of waste will commence. This process will lead to the production of leachate and methane gas. The contamination of groundwater through infiltration of leachate remains a high risk in landfill operations. Methane, considered a greenhouse gas affecting the climate significantly, is also produced, and may lead in many cases to explosions within the landfill posing a direct risk on human safety. Neutralization of biodegradable wastes requires many years, approximately 15 years after the closure of the landfill. After this period, the landfill site can be used as a recreational ground; however, caution is advised to ensure site stability.

The current trend in the industrialized countries, is abandoning the sanitary landfilling operations and reclamation of the old landfills. The current cost for proper landfilling operations in Lebanon is about US$30/ton of solid waste, Zahle Landfill.

4.8.1.2 Composting

Section 4.2 gives a detailed description of composting. Composting of organic portion of MSW requires the thorough separation of the MSW stream. The remaining non-organic portion requires other treatment and disposal methods. Therefore, this treatment method does not eliminate the need of a sanitary landfill. However, the aerobic, thermophilic biological degradation of organic waste can be performed large or small scales.

The produced compost is considered a soil conditioner. Depending on the compost grade, compost can disposed of on soils. Compost quality is directly related on to the quality of organic material used. The lower the level of impurities and harmful microbes such as salmonella the better the compost grade. Compost maturity is also an important criteria in the grading system. Mature and clean compost, 'Grade A' or 'Grade B' is considered premium quality and has a wider range of allowable utilizations. Appendix E gives a detailed description of composts quality and utilization methods.

4.8.1.3 Anaerobic Digestion

Similar to composting of MSW, anaerobic digestion is the biological degradation of the organic portion of the waste stream. However, this process utilizes anaerobic micro-organisms. This process similar to composting also does not eliminate the need for sanitary landfill.

The primary difference in anaerobic digestion is the production of methane gas, which is considered a greenhouse gas, significantly affecting the climate. However, the produces methane gas may be collected and utilized as a renewable source of energy, biogas fuel, which can be utilized to generate electricity. The end product from this digestion process is compost, graded according to level of impurities, presence of harmful microbes and level of maturity. Anaerobic digestion compost of high quality is as a soil conditioner in agricultural production systems.

The cost for anaerobic digestion in Europe is comparable to that of landfilling operations. This technology can be easily applied in Lebanon, particularly for large populations of urban areas. However, to date no anaerobic digestion facilities for the treatment of MSW in Lebanon have been adopted.

4.8.1.4 Incineration

Incineration is the process of waste combustion, producing high gaseous emissions and mineral residues, resulting into approximately a factor of 10 in volume reduction. Once the waste has been incinerated, the remaining residues are deposited in a sanitary landfill. Therefore, the incineration treatment method does not eliminate the need for landfilling.

Incineration is a high energy demanding process. Highest efficiency may be reached when the organic portion of the waste stream is separated and the only the dry portion is incinerated. However, the incineration process will produce large quantities of potentially toxic gases, and therefore, require very high quality gaseous filtration system, which is very costly. The remaining incinerated ash destined for sanitary landfilling may also contain high levels of toxins and it is advised to be disposed of in a hazardous wastes sanitary landfill.

In the case of Lebanon, where the waste stream contains high quantities of organic material, it would be expensive and inconvenient to apply the incineration. In addition, incineration is a costly process that requires high capital cost and skilled labor for the establishment and operation of the facility.

4.8.1.5 Pyrolysis

Pyrolysis, or destructive distillation, process converts the wastes into three types of energy products: gaseous, liquid and solid. Waste is loaded into an enclosed vessel where it is exposed to heat anaerobically. The waste material is cooked to produce gaseous emissions, that are used to fuel the process. Liquid fuel is also produced that resembles fuel oil and the solid fuel similar to coal. These can be sold as ordinary fuels. The remaining residues are landfilled. Pyrolysis and incineration are the most expensive treatment technologies. They are suitable for urban areas where large quantities of wastes are generated.

Table 4-5. Analysis of Different Scenarios of MSW treatment Schemes

Characteristic	***Sanitary Landfill***	***Composting***	***Anaerobic Digestion***	***Incineration***	***Pyrolysis***
Cost of technology	Very low	Moderate	Moderate	High	High
Cost / ton of waste	Moderate	Moderate	Moderate	High	High
Predisposal procedures	1. Secondary resource recovery 2. Bailing & milling of waste material	1. Secondary resource recovery	1. Secondary resource recovery	1. Secondary resource recovery	
Requirements for disposal	1. Application of daily cover 2. Daily compaction of active face	1. Low levels of impurities 2. Free of harmful microbes (salmonella) 3. compost maturity	1. Low levels of impurities 2. Free of harmful microbes (salmonella) 3. compost maturity	1. Special hazardous waste sanitary landfill	Special hazardous waste sanitary landfill
Potential Environmental Impacts	1. Contamination of water resources 2. emission of methane gas 3. Occupational health and safety	1. Contamination of water resources 2. Contamination of receiving soils	1. Contamination of water resources 2. Contamination of receiving soils 3. Emission of methane gas	1. Production of Toxic gases 2. Contamination of water resources	N/A
Scale of operation	Large	Small - large	Small - large	Large	Large
Volume reduction	High	Moderate	Moderate	Very high	Very high
Time for neutralization	15 years	1 - 3 months	1 - 3 months	-	-
Gaseous production	⎫	⎫	⎫	⎫	⎫
Leachate production	⎫	⎫	⎫	-	-
Mineral residues	-	Compost	Compost	Ash	Ash
Destination of rejects	-	Sanitary Landfill	Sanitary Landfill	Rejects and Ash send to landfill	Rejects and Ash send to landfill
Energy production	Biogas fuel		Biogas fuel	Stream / electric energy	1. Coal fuel 2. Oil fuel 3. Biogas fuel

After analyzing the different waste treatment and disposal schemes, an integrated approach was adopted using more than one waste treatment and disposal method. Therefore, after the separation of the MSW, the organic portion will be composted, the recyclable non-organic portion will be sent to recycling industries and the remaining non-organic reject material will be landfilled. The main considerations accounted for in the alternative treatment and disposal selection analysis were:

- Limited capital and operational cost
- Limited skilled manpower to operated advanced treatment technology
- Composition of the waste stream, > 60% of wastes are organic matter
- Availability of agricultural lands to receive the high quality compost
- The need to rehabilitate the Tyre open dumpsite, therefore the use of lower grade compost

4.8.2 Composting Technology Selection

As discussed earlier, composting of the organic component of solid waste is the most favorable treatment method for the Tyre Municipalities. The remaining non-organic recyclables will be sent to recycling industries and the non-organic rejects sent to a landfill. Many types of composting technologies are practiced worldwide. Three innovative composting technologies have been applied in Lebanon during the last seven years and are analyzed in this section. Table 4-6 provides a brief comparison of the different technology alternatives for composting systems. The three alternatives technologies are:

Brand 1: The Bedminster AB Process

Brand 2: Stationary In-Vessel Composting Process of ADENSYS Co

Brand 3: IPS In-Vessel Composting Process of GROSSIMEX Co.

4.8.2.1 The Bedminster AB Process

The first alternative composting technology is the by Bedminster AB Company. This technology is based on the invention of Eric Eweson of Sweden. The composting process discussed occurs in an insulated rotating drum.

The process begins with the removal of bulky items from the incoming solid waste stream, and then the unsorted solid waste is introduced into the insulated rotating drum that consists of 3 consecutive chambers. A typical rate of loading for small-scale operations is 5 tons/day. Wastes stay in the drum (the reactor) for an average period of 3 to 5 days.

Because of the aerobic fermentation, ongoing in the composting drum, the temperature inside the drum may reach up to 60 to 70 ^{0}C, which is sufficient temperature for eliminating pathogens. On the third/ fifth day, the rough compost is emptied and sifted using a Trommel screen. The composted material of size less than 25 mm is sorted out and the inert materials are rejected. The screened rough compost is cured for 6 weeks with occasional turning and provision of proper humidity. After curing of the compost, it is screened again removing all foreign materials (plastics, glass, and metals). The rejected inert material is separated, which consists of plastics, stones, rags, etc. are taken to the landfill.

The Bedminister composting process has a high capital cost because of the use of the rotating drum and control system. In addition, operational costs in terms of energy requirements are also high. This advanced technology requires skilled man power for operation and maintenance. However, the process is fully automated thus less labor intensive.

The typical plant size for 5 tons/day capacity would be about 400m^2. Additional information on the Bedminster process is provided in Appendix G Figure 4-2 presents a flow diagram for the Bedimnister AB Process.

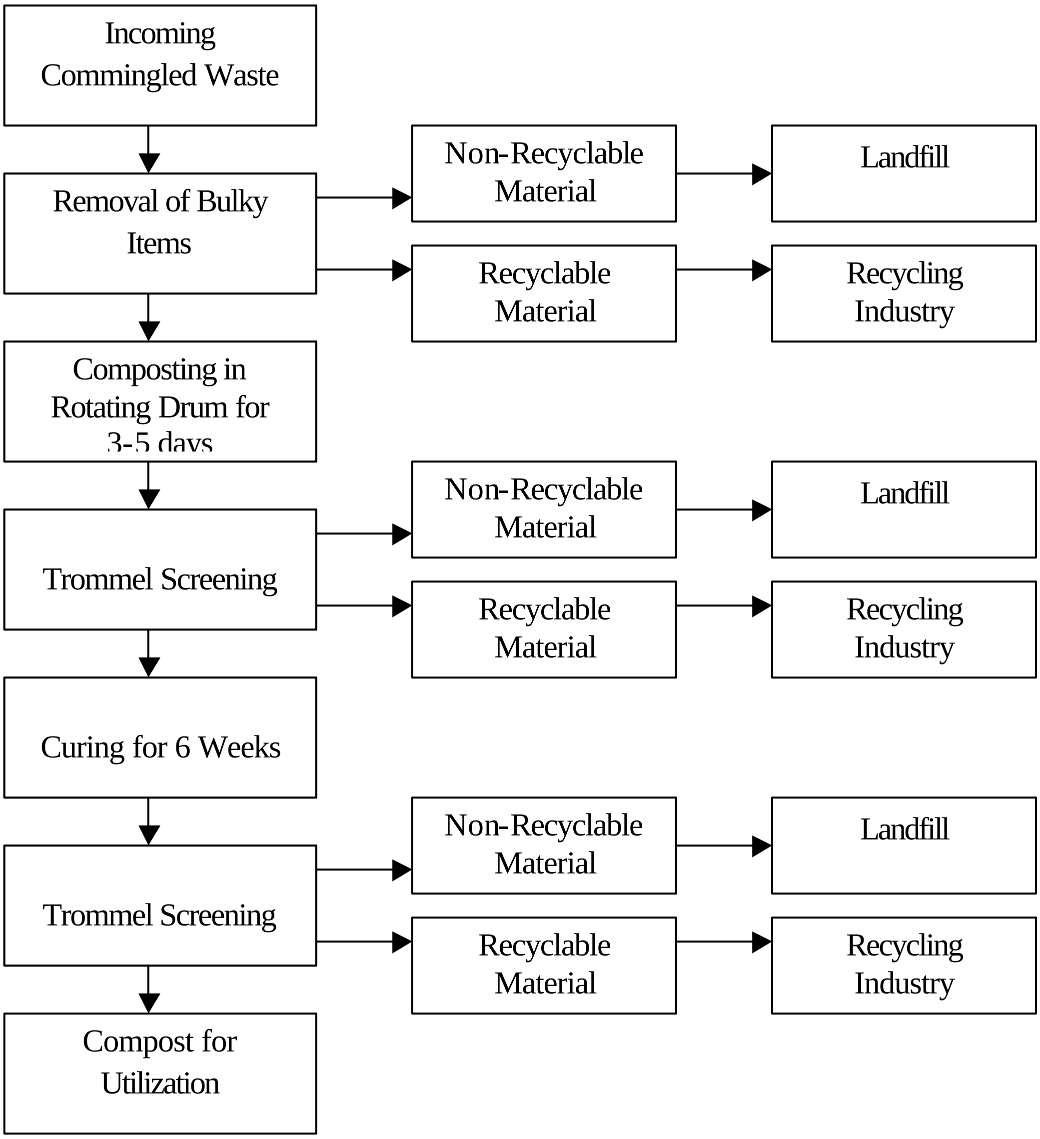


Figure 4-2. Flow Diagram of Bedminister AB Composting System

4.8.2.2 Stationary In-Vessel Composting Process of ADENSYS

The Stationary In-Vessel Composting technology is a controlled process of biologic decomposition of organic material under aerobic conditions. In other words, the decomposition will take place in the tightly closed vessels (stationary chambers).

In the first place, waste delivery truck will unload the waste onto the concrete floor of SWTP. Initial removal bulky non-organic (recyclable and non-recyclable) material, such as large tin cans, home appliances, large plastic bottles and glass jars and various large metallic items. Then the waste is loaded onto a conveyor belt (or a metallic table) for manual removal of the recyclable material. These recyclables are stored properly in separate cells and periodically sent for recycling.

Once recyclables and other non-organic material have been removed, the organic waste (bio-waste) along with cardboard and paper waste (bulking material) is shredded. Then these shredded materials are loaded in to a mixer for mixing of the bulking material with the bio-waste.

The mixture is then loaded into a composting vessel or chamber, where it undergoes aerobic degradation for 21 days. Air is blown through the mixture to keep it in the aerobic state. Aerobic decomposition of the waste will generate heat and a temperature of higher than 65 ^{0}C is maintained for more than 7 days. This process will destroy the pathogens and weed seeds present in waste material. Once the in-vessel composting process is complete, the compost is screened in a Trommel screen and piled in open cells for curing for 15 to 20 days. The cured compost is further screened out with the trommel screen and sorted into two or three grades according to the particle size (less than 10mm, 10-15mm and 15-20mm).

The aerobic fermentation of the waste inside the vessel prevents the formation of smelly emissions. In addition, the produced leachate is channeled in a multiple pond, where it receives biologic treatment and then re-used in the curing process of the compost.

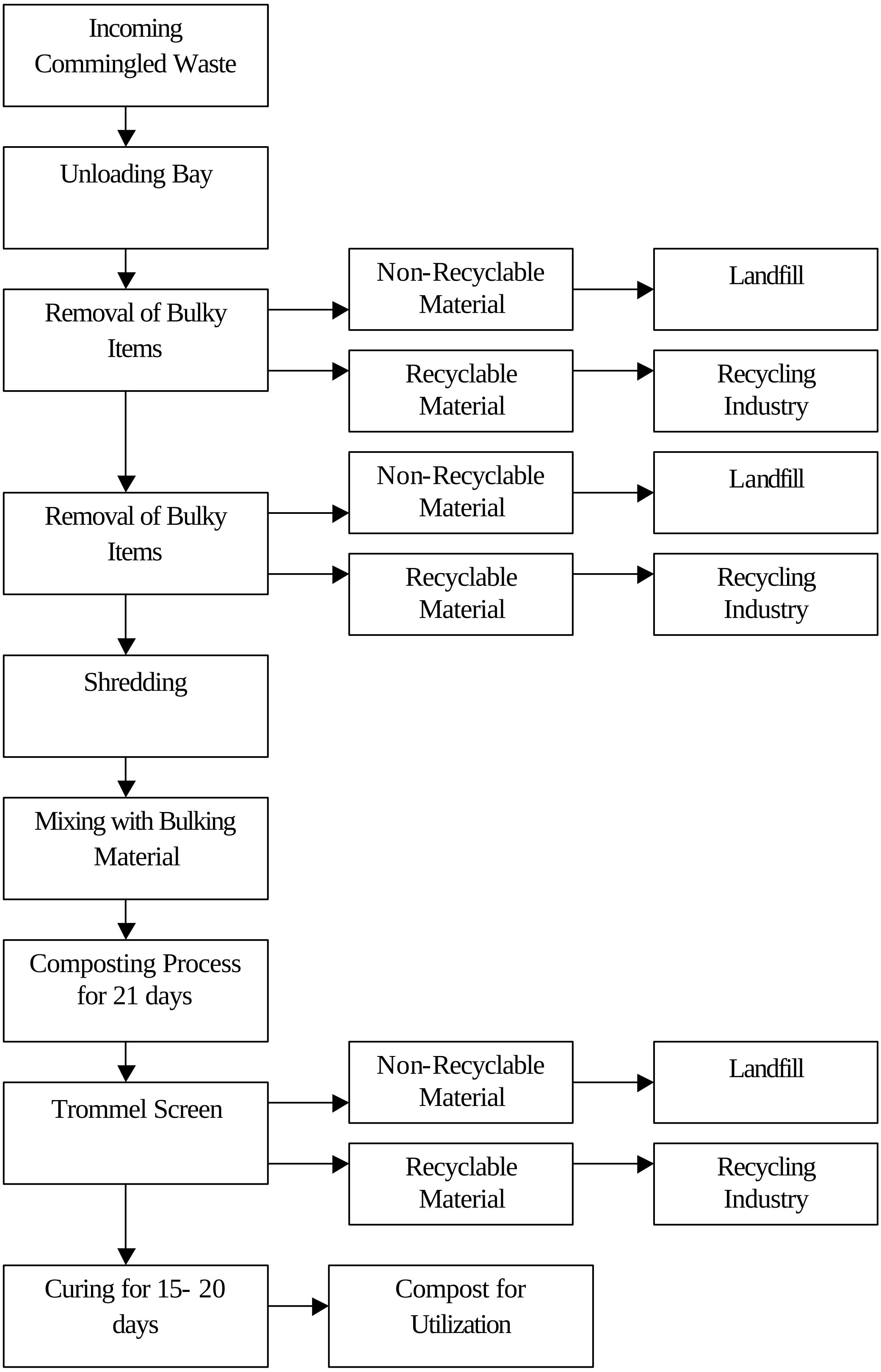


Figure 4-3. Flow Diagram of ADENSYS Co Stationary In-Vessel Composting System

4.8.2.3 IPS In- Vessel Composting Process of GROSSIMEX

The IPS in- Vessel composting process of GROSSIMEX is described in detail in Section 4.3. Figure 4-1 presents a flow diagram illustrating the composting process proposed. However, the IPS In-Vessel composting process presents several advantages as listed below:

- The process affords immense flexibility for long-term management of the MSW.

- The system can produce a wide range of compost quality grade since each composting bay can be considered a separate composting unit

- The process meets the Lebanese Ministry of Environment requirements that in order to achieve the Pathogen Reduction Factor and killing of weed seeds, the compost must be maintained at a temperature of 65^0C for at least 7 days.

- The process allows for high quality organic material such as agricultural wastes, to bypass the pre-processing phase and enter directly into the composting process into a separate bay.

- The process is designed to handle 150T/ day in a single 8 hour working our shift, in the situation a larger load is received the system can handle up to 300T/ day in two working shift increasing the work time to 16 hours of operation per day.

From Table 4-6 the IPS In Vessel Composting Process of GROSSIMEX scored 63 while the Bediminister AB Process and the Stationary In Vessel Composting Process by ADENESYS scored 55 and 62 respectively. This was mainly observed due to IPS modular nature, low electric requirements, requirement of skilled labor while complying with MoE set standards. .

Table 4-6. Analysis of Different Composting Technology Systems (data supplied by system providers)

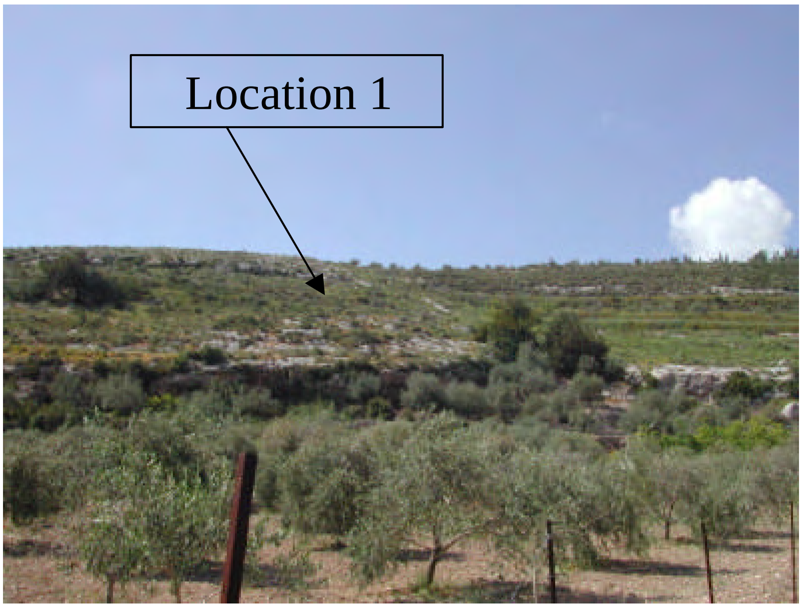
Function	*The Bedminster AB Process*	*Stationary In-Vessel Composting Process of ADENSYS*	*IPS In- Vessel Composting Process of GROSSIMEX*
Compactness	5	3	3
Odor Control	5	5	5
Requirement of Skilled Labor	3	4	4
Capital Cost	3	4	4
Operational Cost	4	3	3
Creation of job opportunities	3	5	5
Speed of Composting Process	5	4	4
Speed of Curing Process	2	4	4
Control of leachate problem	4	4	4
Temperature Maintenance at 65^{o}C for > 7days, requirement of MoE	0	4	5
Handling of Inert Material	3	3	3
Convenience and Aesthetics	4	4	4
Modular Nature of Facility	5	5	5
Pest Control	4	3	4
Electric Power Requirement	2	3	3
Ability for local management	3	4	3
Total Grades	**55**	**62**	**63**

Grading system is from 1 to 5, 1 being the lowest and 5 the highest

4.8.3 Site Selection

The most practical location for the facility would be a land parcel large enough for the construction of the SWTF requiring the least excavation work, distant from nearby residential households, and with an appropriate connecting road network. There is a scarcity of suitable public land suitable for the construction of the SWTF. Three locations in the Caza of Tyre have been located and are as follows:

Location 1: In the village of Ain Baal. Photograph 4-1 shows the setting of Location 1. This location is situated West of the village center, at a distance of approximately 1 Km. However, this site is located on a hill directly facing the residential area of the village. In addition, it is adjacent to agricultural lands, mainly olive orchards. Land slope inclination is approximately 30%. The main road is only 200m away from this site, however no connecting road exists.



Photograph 4-1. Location 1 in the village of Ain Baal

Location 2: In the village of Jouaiya. Photograph 4-2 shows the setting of Location 2. This location is distant from residential areas, however a few animal husbandry sheds have been found surrounding the site. The location is approximately 300m from the main road, however a connecting road to the site need rehabilitation. Land slope inclination is approximately 60% and would therefore require a lot of excavation works for the construction of the SWTF. In addition, Jouaiya is distant from many villages included in the project, and would require distant waste delivery.

Photograph 4-2. Location 2 in the village of Jouaiya

Location 3: In the village of Ain Baal. Photograph 4-3 shows the setting of location 3. This location is situated distant from the village center, approximately 1km. However, it is approximately 400m from the single residential household. The location is situated close to the main road; however, a connecting road needs rehabilitation. Part of the land at this site is a plateau and the remaining has a slope inclination of approximately 18%, requiring less excavation works than Location 2. Small patches of agricultural lands can be found in the vicinity, however not adjacent to the location.

The Municipality Union of Tyre Caza could not allocate other locations for the construction of the SWTF. Therefore, based on the criteria of accessibility, distance to residential areas and least excavation works during construction Location 3 is the most suitable for the proposed SWTF.

Photograph 4-3. Location 3 in the village of Ain Baal

5. DESCRIPTION OF THE ENVIRONMENT

5.1. GENERAL SETTING

Two parallel mountainous ranges, Mount Lebanon and Anti Lebanon, separated by the Bekaa plain are the dominating topographic features of Lebanon (Figure 5-1). These topographic features extend in a NNE-SSW direction. The study area is located on the Caza of Tyre, on the Eastern slopes of the South Lebanon. The Caza of Tyre includes the coastal city of Tyre and the other villages with land elevations ranging between 0 m and 1500 m above sea level.

The village of Ain Baal is located in the central region of the Caza of Tyre, approximately 8 Km from the city of Tyre, at an elevation of 200 m above sea level. A generally good road network exists in the region (Figure 5-2) connecting the villages to each other. However, the agricultural road that connects the main road to the proposed site of the SWTF needs rehabilitation. A good road network is essential to connect the SWTF site in order to allow machinery to reach the site and perform the excavation and building works during the construction phases. A regional road network system is also very important for the collection of waste from all the villages and cities designated for this SWTF.

Figure 5-1. Topographic Map of Lebanon

Figure 5-2. Map showing the road network connecting the different villages of the area

5.2. METEOROLOGICAL SETTING

The topographic features of Lebanon, in general, influence largely the climate of the country. The climate of the Lebanese coast is of Mediterranean subtropical type, where summers are hot and dry; and winters are mild and wet. On the other hand, snow covers the mountains of the two ranges at times for several months per year. The two mountain ranges tend to have a cool and wet climate in contrast to that of the coastal zone.

Meteorological information including primarily precipitation, ambient temperature, as well as wind direction and speed, are essential data for adequately assessing environmental impacts. Unfortunately, meteorological records are seldom available, except for few locations in the country where stations were operating, in particular Naquora station of the Service Meteorologique and the American University of Beirut (AUB) stations. Recently, new stations have been installed across different regions of the country, providing a better coverage of meteorological parameters.

5.2.1 Precipitation

The two mountain ranges of Lebanon are perpendicular to the path of atmospheric circulation. The coastal area in south of Lebanon has a mean annual precipitation of 650 mm, ranging from 600 to 800 mm (Figure 5-3). The average number of rainy days is 74 along the coast. The annual average precipitation observed in El-Qasmiyeh over a period of 27 years (1944-1970) was 654 mm with the maximum observed 992 mm (1949) and the minimum 488 mm (1951) (General Directorate of Civil Aviation).

Figure 5-4 depicts monthly rainfall distribution from data collected at the AUB station (1996 - 1998 and 1877 - 1970), and at the Naquora station (1934 - 1963). Precipitation data was obtained from Service Météorologique du Liban (1977) and from AUB records. The following observations can be made:

- The total annual precipitation is 608, 660, and 887 mm at Naquora (1934-1964), AUB (1996-1998), and AUB (1944-1977), respectively.
- Precipitation patterns show large seasonal variations with more than 80 percent of the annual rainfall typically occurring between November and March.

- A marked decrease in precipitation levels is noticed at the AUB station, with approximately 25 percent decrease between the two reported periods.

- Based on the above observations, about 80 percent of precipitation that is 608 mm at Naquora is probably distributed between November and March. On the other hand, if the same pattern of precipitation levels decrease has occurred in the South, similarly to the decrease noticed in the coastal area precipitation in Naquora is 456mm.

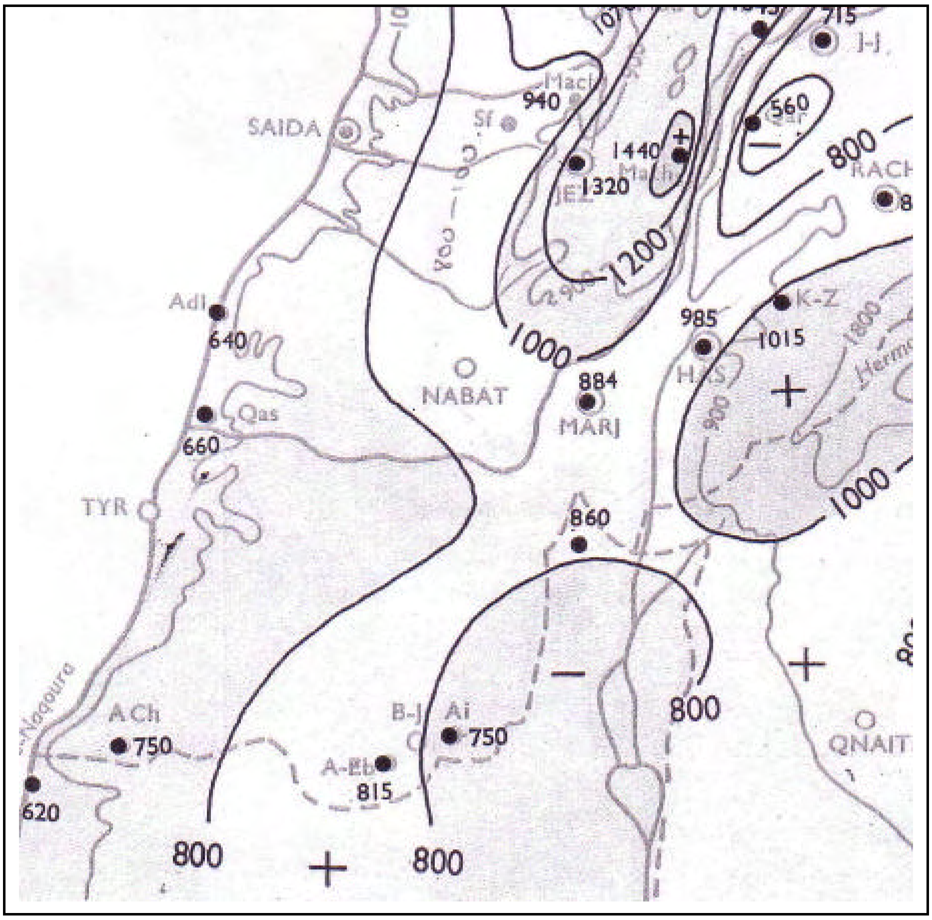


Figure 5-3. Precipitation Map of Tyre (scale 1: 750 000)

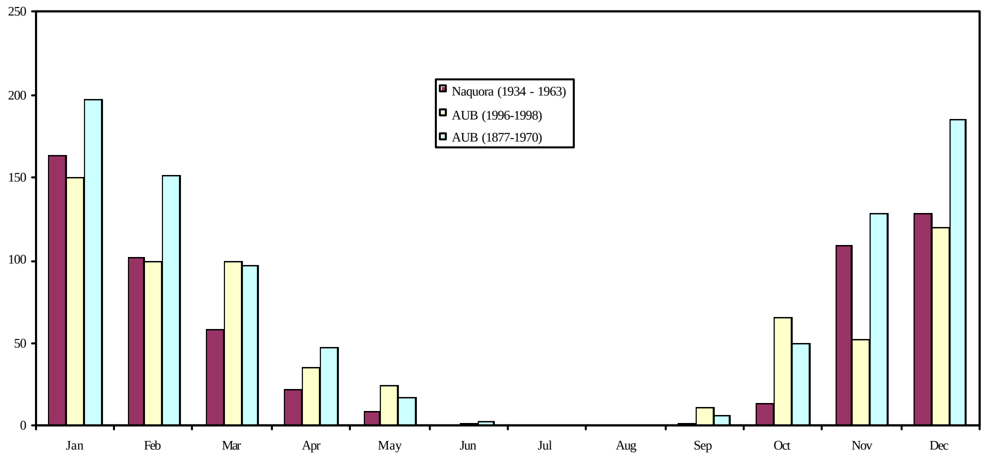


Figure 5-4. Precipitation Data from AUB (34 m) and Naquora (60m), (Elevations are from sea level).

5.2.2 Temperatures

The mean temperature along the coastal plains is 26.7° C in summer and 10° C in winter. The temperature gradient is around 0.57 °C per 100-m altitude (Blanchet, 1976). January is typically the coldest month with daily mean temperatures falling to -4 ºC in the mountains and 7 ºC in Saida, on the west coast. The warmest months are July and August, when mean daily temperatures can rise to 28 ºC in the mountains and 33 ºC on the coast. Temperature variations between day and night are mild along the coast in general ranging between 6 and 8°C. The average temperature observed in Naquora over a period of 19 years (1943-1964) is 20.5°C (General Directorate of Civil Aviation). Figure 5-5 depicts average temperature distribution for the project area by the Service Météorologique du Liban (1977).

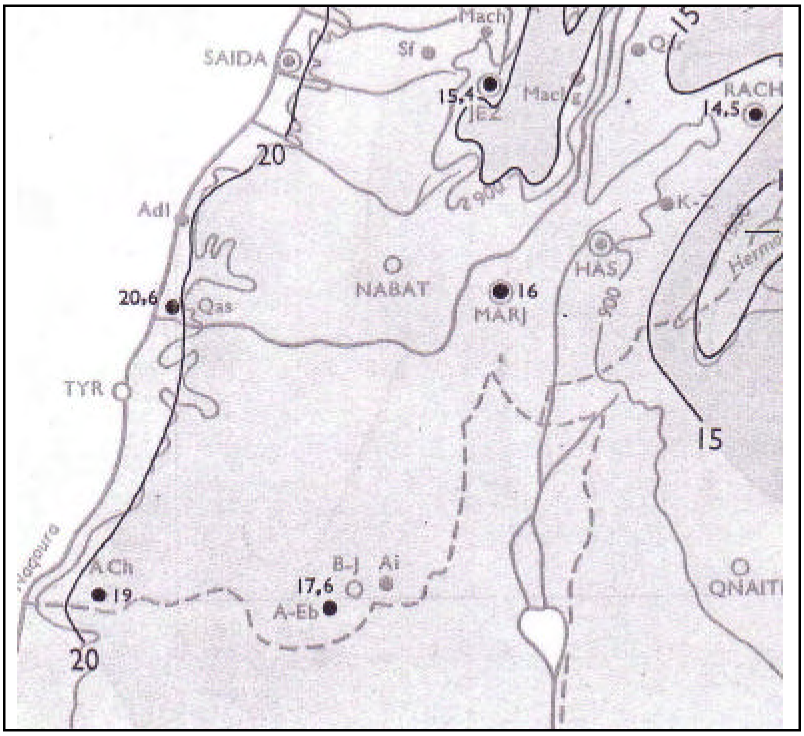


Figure 5-5. Temperature Distribution Map

5.2.3 Winds

Dominant wind directions are southwesterly; continental east and southeasterly winds are also frequent. The two mountain ranges have a major impact on wind direction, and contribute to reducing the incidence and strength of the southeasterly and northwesterly winds on the mountain-backed shoreline and in the Bekaa valley. Strongest winds are generally observed during the fall season. Wind data is available at AUB and BIA stations, and Saida station. Wind data close to the study area is available at the Saida station. Dominant wind direction is oriented in the S and SW (Figure 5-6) (Service Météorologique du Liban, 1977). Stronger winds are more frequent in the summer months. On the other hand, relatively weaker winds are prevalent in the winter season.

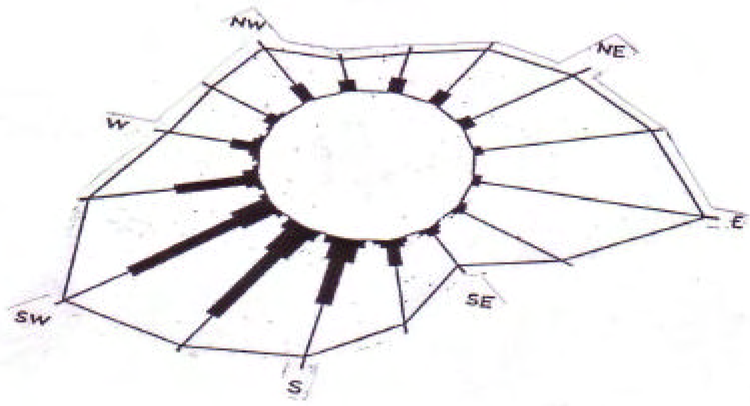


Figure 5-6. Wind Direction for Saida Station

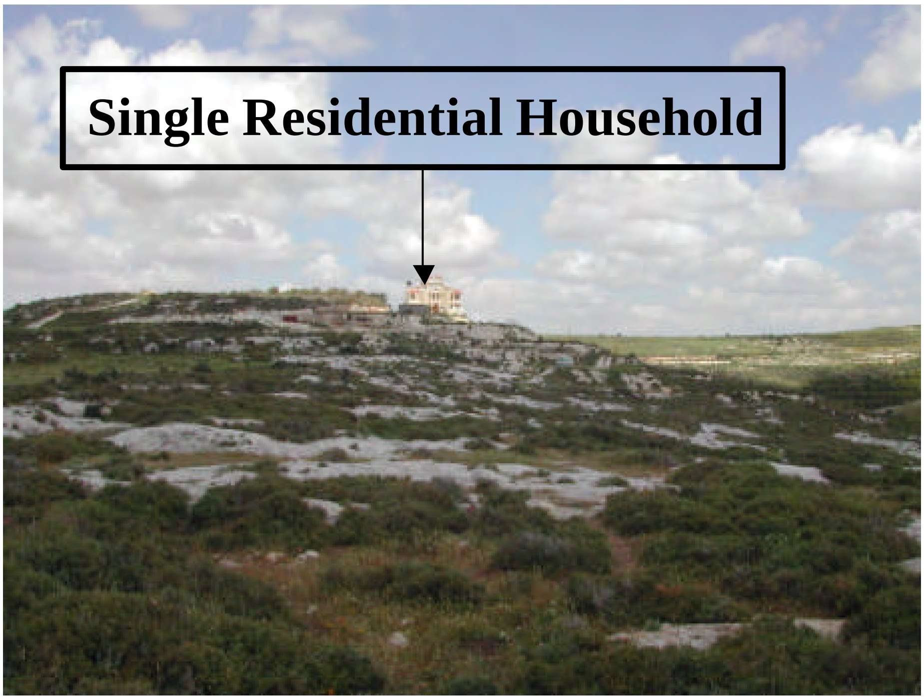
5.3. SITE SETTING

As mentioned above, with the tight collaboration with YMCA and the environmental consultants, the Caza of Tyre Municipality Union officials proposed a location for the SWTF. The data presented in this section was either collected through field visits, location assessments, research, and/or in consultation with municipality officials or local citizens. Climate data were mainly obtained from records from Naquora and AUB stations.

A land parcel (No. 765) of an area of 32,000 m^2 was donated by the Municipality of Ain Baal to the Municipality Union of Tyre Caza to build the SWTF. The site is located at the Northwestern outskirts of the village, distant to most of the populated area (Photograph 5-1). The area surrounding the site is non residential except for one residential household located at approximately 400m North of the proposed location (Photograph 5-2). The proposed site is located on a plateau, sloping on the Eastern side approximately 30° Northeasterly (Photograph 5-3). The location is not delineated by any river, and the main village road is down gradient on the Southeastern side.

The average land elevation is approximately 200 m above sea level. Appendix B presents a Topographic Map of Ain Baal area showing the proposed location of the treatment facility. Precipitation in the area is approximately 608 mm/year (Service Meteorologique du Liban, 1977). Wind direction varies between orientations of S and SW (Service Meteorologique du Liban, 1969). Average annual temperature at the village of Ain Baal is approximately 20.5 ^{o}C (Service Meteorologique du Liban, 1977).

Photograph 5-1. General view of the proposed site for the SWTF



Photograph 5-2. Location of Single Residential Household North of site location

Photograph 5-3. Proposed SWTF Location Southern View

5.4. TECTONIC SETTING AND SEISMICITY

Lebanon is located on the eastern coast of the Mediterranean Sea, along the Dead Sea Transform fault system. The Dead Sea Transform fault system in Lebanon has several surface expressions, represented in major faults (Yammouneh, Roum, Hasbaya, Rashaya and Serghaya faults), in uplifts as high mountainous terrain (Mount Lebanon and Anti Lebanon), and from the seismic activity record. Recent work has categorized the Lebanese section of the Dead Sea Transform fault as being a strong seismic activity zone (Khair *et al.,* 2000).

The area of study lies west of the Roum fault, which is one the main five faults of Lebanon. The Roum fault, is the only one trending NNW-SSE, whereas all the others are trending NNE-SSW. The Roum fault has caused several fractures around the zone of its path, which are mostly strike-slip faults and have a general E-W trend. The nearest fault to the zone of interest is located at about 1.5 km to the south of it. It is a minor strike- slip fault with a strike of N74°E. No recent motion is observable. Figure 5-7 illustrates the geologic and tectonic map of Lebanon (not to scale) and the study area.

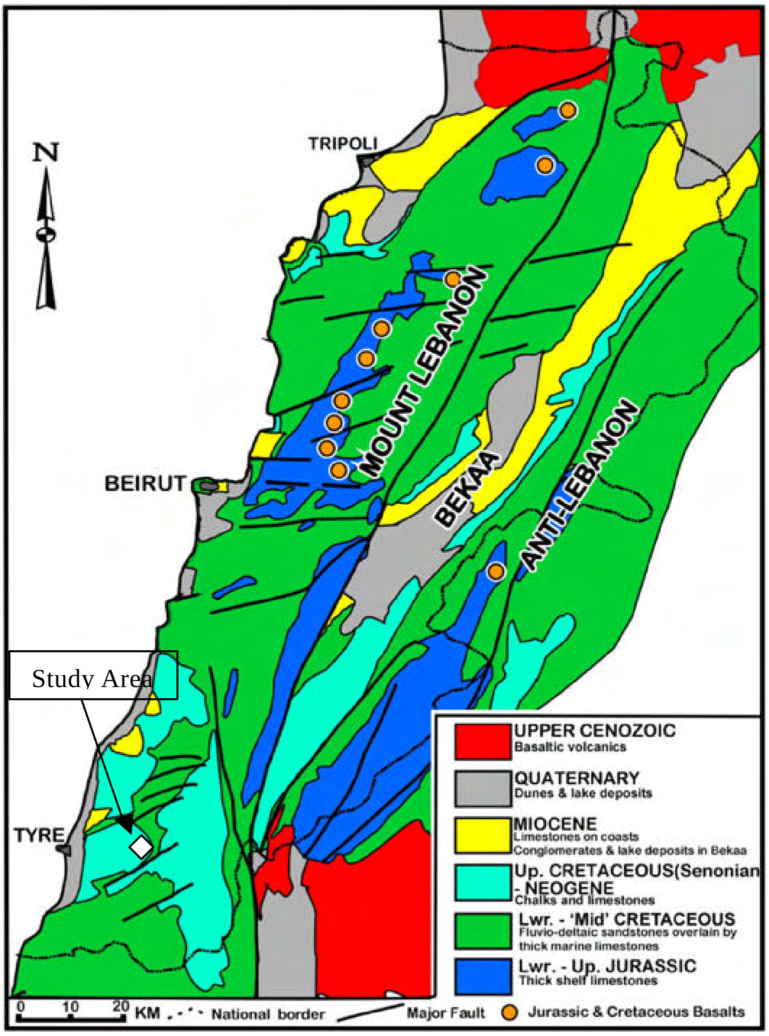


Figure 5-7. Geologic and tectonic map of Lebanon

5.5. GEOLOGICAL SETTING

The geology of the studied area, including subsurface stratigraphy and structure, was developed based on: 1) review of available maps and literature, and 2) geological surveys and site visits conducted by MEEA geologists. The result was the generation of a geological map at a scale of 1:20,000 covering the area of study, reaching approximately 3 Km^2 and lying within grid coordinates 145000 and 146000 Northing and 107000and 108000 Easting. The map is included in Appendix A.

5.5.1 Stratigraphy

The stratigraphy of the area of study is composed of only one formation, which is the Chekka marl (C6) formation of late Cretaceous or Cenomanian in age. The outcropping formations are described in the following section.

5.5.1.1 Cretaceous Formation

5.5.1.1.1 The Chekka Formation (C_6)

This unit is approximately 60 m above the surface. It displays massive grayish limestone rocks on the surface, but a section of it reveals its true chalky and marly composition. It is white in color, very fine grained, and very friable.

Signs of chemical weathering are expressed by local dissolution of the rock, leaving small shallow holes in the rock, and by white patches covering the rock. This sort of weathering is due to the action of rain. Chert nodules of size ranging between 0.5 and 12 cm are found in the rock.

The unit also contains some calcite veins of thickness ranging between 2 and 5 mm. which are parallel and perpendicular to the bedding

5.5.2 Structure

The area of study is located on a hill and has an inclination to the horizontal varying between 16° and 18°. The inclination increases to the West.

The average strike of the formation is N 74° E, and the dip is 8°E.

The rocks are fractured and jointed. The calculated orientations of the joints are strike: N 112° E and N 128°E, and dip: 14°E and 20°E respectively.

There are no faults are going through the location. Some rock falls are observed at the eastern boundary of the land of interest, which is probably due to the quarrying work that has taken place at a higher altitude.

5.5.3 Hydrogeological Setting

The hydrogeology of the surveyed area was developed based on: 1) the review of available maps and literature; 2) the Hydrogeological surveys and site visits conducted by MEEA specialists. No streams, rivers or springs were found in the area. There used to be streams running in the southern and northern valley, but they have completely dried out in the present.

The formation being marly, it can only form an aquiclude. The chalky marl, due to its fine grained composition, traps the water, and reduces its flow to a great percent. The unit has a high storativity, but very low hydraulic conductivity and transmissibility and thus the impossibility of it to be an aquifer.

5.5.4 Site Setting

The rock being marly and fine-grained can easily be eroded. The land being situated on a slope and not on a plateau, the surface run-off of water is slightly rapid, and thus the effect of physical erosion is bigger. Comparing the land to the higher in altitude plateau, we notice less abundant massive rocks, and more particles and fragments deposits which look like soil, due to the chalky nature of the rock. Those fragments have been eroded from the top of the hill and deposited on the slope. They are also the result of the erosion of the slope itself. The erosion rate is very slow and with no undesirable effects.

The marl having low transmissivity, the infiltration process is rather low. But when water percolates, the volume of the marl increases, and local landslides can occur. In the studied area, there is no danger of major landslides, but a retaining wall is advised to be built after quarrying.

5.6. ECOLOGICAL CONTEXT (BIODIVERSITY)

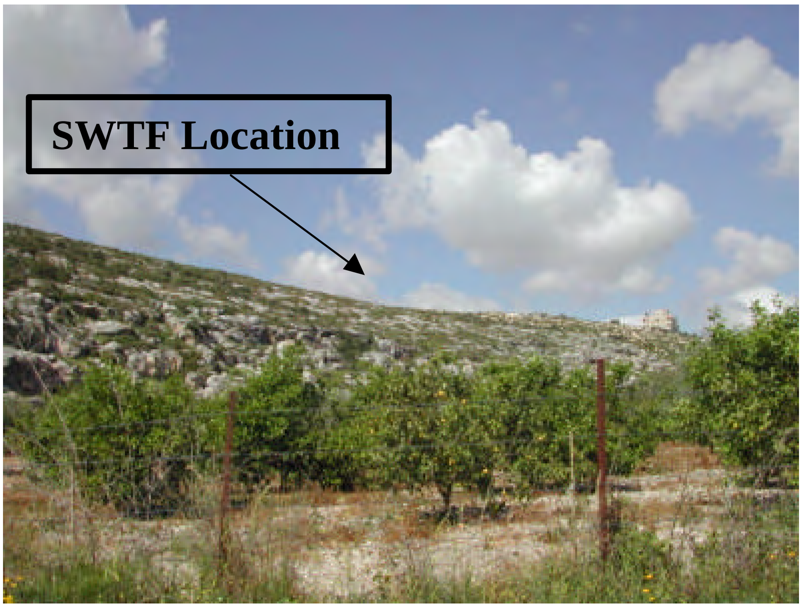
Ecologically, the proposed location is not in an area of special concern, such as areas designated as having national or international importance (e.g. world heritages, wetlands, biosphere reserve, wildlife refuge, or protected areas). The project will not lead to the extinction of endangered and endemic species, nor the degradation of critical ecosystems, and habitats.

The project area is situated in the Eu-mediterranean zone. The site land cover is more that 60% rock outcrop (Photograph 5-3), and is predominantly covered by seasonal herbaceous plant species (Photograph 5-4 and Photograph 5-5). Only one shrub species, *Scriptorium sp.*, was identified however is sparse (Photograph 5-6). The area surrounding the site location is of similar nature except for a few olive orchards present down gradient to the location on the Northeastern and Southeastern side (Photograph 5-7).

Photograph 5-4. *Linum sp*. present at proposed SWTF site

Photograph 5-5. *Chrysanthemum sp*. present at proposed SWTF site

Photograph 5-6. *Scriptorium sp*. present at proposed SWTF site

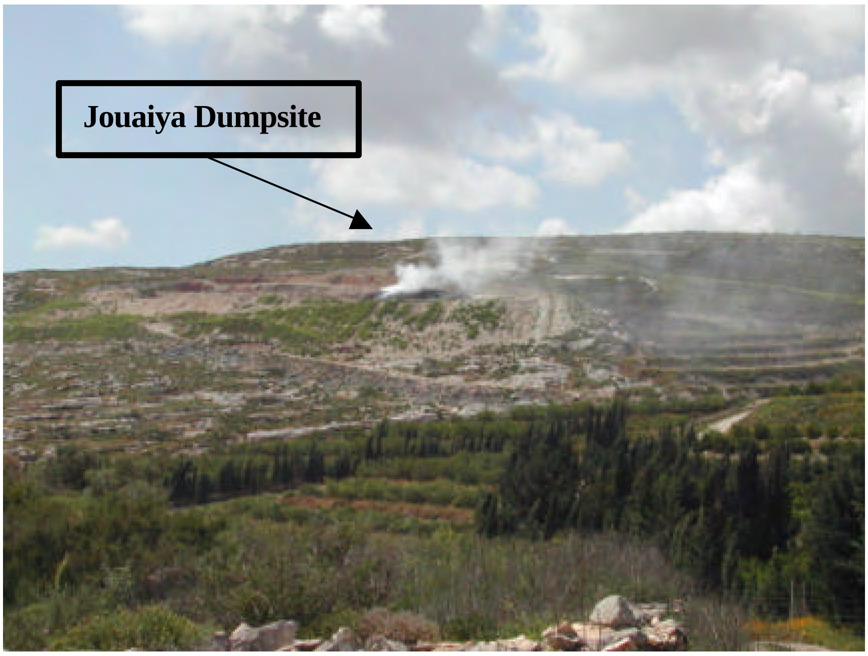


Photograph 5-7. Olive orchard Southeast of proposed SWTF

5.7. INFRASTRUCTURE STATUS

Wastewater treatment facilities are not available in Ain Baal and other villages in the Tyre Caza. Domestic sewage is generally disposed of into "unregulated" septic tanks or discharged directly onto open grounds. In the city of Tyre, a wastewater collection network operates at collecting the domestic wastewater, however, is discharged directly into the sea without prior treatment.

Infrastructure within the towns is mainly limited to road network, telephone, electricity, and water supply. Moreover, an appropriate MSW management system in the area does not exist. The municipalities within the Tyre Caza are responsible for the collection and delivery of its waste to the Tyre open dump (Section 0), or are openly dumped and burnt along roadways and in the environment. Photograph 5-8 shows the Jouaiya dumpsite along a roadway and it is evident that open burning of waste is a common practice.



Photograph 5-8. Jouaiya MSW dumpsite

5.8. SOCIO-ECONOMIC STATUS

Socio-economic information about the municipalities included in the project was obtained during informal meetings with municipal council members during the field visits.

Table 5-1 presents some socio-economic information relevant to this study.

Local inhabitants are mainly members of the active population (between 20 and 50 years old). The economy in of the area is mainly driven by public and private sector employments. Trade and services are also prevalent. Tourism is prominent in the city of Tyre, however is very limited in other villages in the study area. Industry is present mainly in the form of small-varied industries like welding, and carpentry. Abbassieh and Tyre have most of the schools and hospitals in the study area.

With a high percentage of landuse in the project area designated as agricultural, rainfed agriculture presents a major economic driver. All of the adequate land lots of the area are terraced and farmed. Citrus fruits and banana are the main agricultural crops grown along the coast, with banana plantations diminishing with increased elevation. As for the remaining area within the Tyre Caza, olive and citrus orchards comprise most of the agricultural production along with vegetable crops. Of those only olive orchards are under rainfed agriculture. Animal husbandry is also a common practice with goats as the major livestock animal grazing on pastures.

Table 5-1. Socio-Economic Information in 26 villages in the Tyre Caza included in the Proposed SWTF

Village	*Residential Units*	*School*	*Hospitals*	*clinics*	*Slaughter house*	*Butchers*	*Workshops*	*Commercial institutions*	*Restaurants*
Abassieh	3,831	10	4	2	3	15	110	621	18
Ain Baal	2,000	4	0	0	0	2			
Aiteet	650	3	0	2	1	2	3	22	1
Arzoun	217	0	0	0	0	0	0	0	0
Batolieh	500	1	0	1	0	10	13		6
Bazzourieh	1,500	5	0	13	0	6	46	22	6
Burj El Chamaley									
Burj rahal	600	1	0	0	1	1	4	2	
Chahoor	800	1	0	1	0	2			
Chehabieh	2,500	3	0	2	1	5	50	200	10
Deir Qanoun el Naher	700	1	0	2	0	8			
El Hemayre	163	1	0	1	0	1			
El Heneyeh									
El Majadel	550	1	0	0	0	2			
Halossieh	285	2	0	0	0	2			
Hannaouyieh	500	3	0	1	0	2	35		2
Jouaiya	3,00		1			5	5		
Maarakeh	1,878	5	0	2	2	12	31		4
Maaroub	527	2			2	4			
Qana	1,200	5	1	3	0	34		4	
Qulalieh	800	2	0	2	0	2	8		6
Sarifa	500								
Terfelsayeh	500	1	0	1	0	0		5	25
Toura	564	2	0	1	0	2			
Tyre	5,000	13	2	5	1	27	61	200	72
Yanouh	200	1	0	0	0	1	1		
Total	***25,965***	***67***	***8***	***39***	***11***	***145***	***367***	***1076***	***18***

Empty cells information was not obtained

5.9. EXISTING SOLID WASTE TREATMENT PRACTICES AT TYRE DUMPSITE

Tyre Dumpsite falls at an altitude of 17-22 m and is located in the region of Deir Qanoun – Ras El Ain, 5.3 km to the NW of Tyre town, 400 m from El-Bass – Ras El Biyada road, 600 m from the seaside, in a rural and agricultural zone. The parcel (No.1305) is privately owned and has a total surface of 13,569 m2. The dumpsite area is not restricted to the parcel and extends in some places to neighboring parcels. The site has been serving Tyre city and the villages of El Abassieh, Borj El Chemali, Ain Baal, El Qlaileh, El Bazourieh, Batoulieh, and the Palestinian Camps (Rachidieh, Borj El Chemali, and Bass). The Tyre dumpsite has been operational for 7 years approximately, accommodating some 90,000 m3 of all types of waste as estimated in 2002 (Libanconsult, 2003). Photograph 5-9 illustrates the Type open dumpsite.

While in some parts of the site, waste level falls below the initial ground level, the height of the waste is some 22-25 m at other places, with 3-8 m (at variable places) amassed higher than the level of adjacent lands constituting thus an eyesore. Tyre city is designated a touristic area by the United Nations World Heritage Program, and thus is the dumpsite presents a high visual impact.

The Tyre dumpsite is also considered unstable and present a high risk on sliding since slopes vary between 1:1 and 1:1.5. There is also a high risk of waste settlement since waste compaction and daily cover application rarely take place.

In the absence of daily cover application and compaction, wind carries the light components of the waste disposed of in the dumpsite to various places in the site and in the surroundings. This impact is enhanced by the absence of a fencing wall around the site, and the uncovered hauling of waste in vehicles that do not meet the adequate specifications for waste transportation.

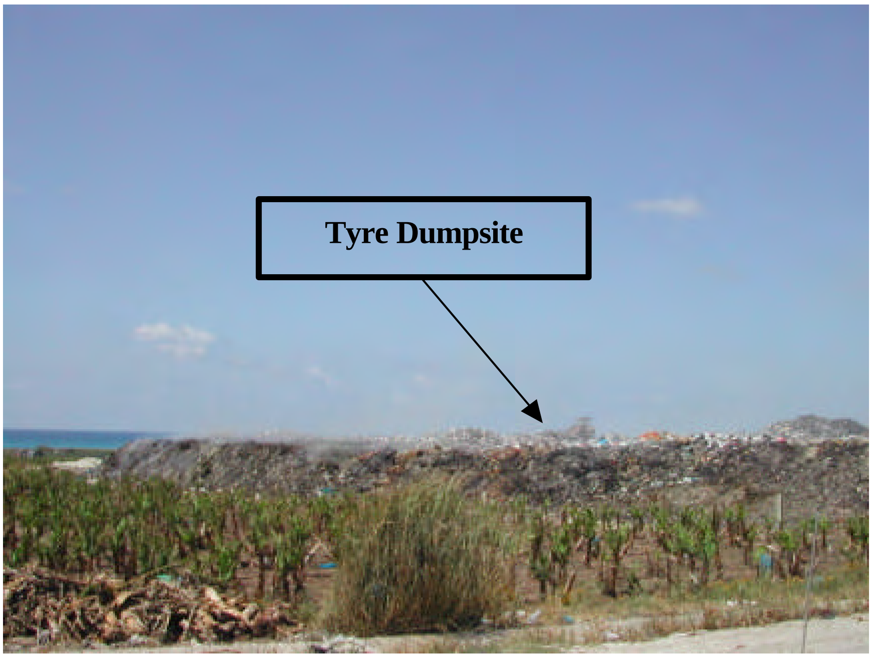
Another significant negative impact to the environment is dust generation from waste incineration and waste hauling trucks and pick-ups movement on unpaved roads. In addition to its potential impacts on human health, this polluting dust impedes the visibility (Photograph 5-10) in the region and can be seen even from a far distance from the site, which is aesthetically unacceptable.

Noxious odors are detected at the site and are caused by aerobic fermentation of waste, generating NH_3 and CO_2 gases; anaerobic fermentation of waste, generating a 40-50% CH_4 40-50% CO_2 , N_2 and other biogas; and open air waste incineration (the causes of the open incineration are either intentional burning, or biogas presence in hot and windy climate periods).

Gases emanating from waste fermentation and incineration, including the pre-mentioned gases and organic gases such as dioxins and furans, are transported by wind to neighboring villages presenting a potential negative impact on the health of the people living there. Biogas infiltration in the ground causes oxygen to escape from ground pores, leading to the drying of plant roots and the degradation of the vegetation, which is clearly visible in the region surrounding the site. Furthermore, biogas may also cause dangerous explosions at the site, when methane proportion reaches 5-15% of ambient air.

Ras El Ain Springs (Photograph 5-11) which constitute the main source of domestic and fresh water for the Tyre region and the surrounding villages are located some 500 to 600 m North of the site. The Water Authority of Tyre who regularly analyses the chemical and bacteriological quality of the water has detected no noticeable effect of the dumpsite on the quality of the water to date. While the possibility of vertical percolation of leachate to the groundwater that feeds the springs is very limited, lateral percolation to the waters of the springs is more probable and needs to be investigated, as was suggested in the engineering study done by Libanconsult in 2003. However, it is clearly observable that a part of the leachate that is generated by the waste of the dump is percolating to nearby water channels (Photograph 5-12) and being transported to the river that flows in the region.

The pre-mentioned negative impacts of the site are raising many public complaints; the Tyre Municipality and Tyre Caza residents, especially those living in the proximity of the site, seek an urgent solution to the problem of Tyre dumpsite.



Photograph 5-9. Tyre Dumpsite Location

Photograph 5-10. Distant View of Tyre Dumpsite impeding visibility

Photograph 5-11. Ras El Ain Springs

Photograph 5-12. Water Channel adjacent to Tyre Dumpsite

6. IMPACT IDENTIFICATION AND ANALYSIS

On-site and off-site impacts can be induced during the construction of the facility, and later during its operation. On-site impacts result from construction activities carried out within the construction site. The impacts of off-site work result from activities carried out outside the construction site, such as traffic, yet are directly related to the project. In the case of solid waste treatment facilities, the main potential receptors are soil, surface, and ground water bodies, in addition to human amenity. Table 6-2 summarizes the potential impacts on the physical, biological and socioeconomic environments caused by the proposed SWTF. The extent of impacts depends primarily on the MSW management practices that would be adopted during facility operation.

6.1. IMPACTS ON WATER RESOURCES

6.1.1 Impacts during Construction

No on-site impacts on water resources are anticipated during the construction phase of the facility. No streams, rivers or springs were found in the area. There used to be streams running in the southern and northern valley, but are completely dried out presently.

The formation being marly can only form an aquiclude. The chalky marl, due to its fine-grained composition, traps the water, and reduces its flow to a great percent. The unit has a high storability, but very low hydraulic conductivity and transmissibility and thus the impossibility of an underlying aquifer.

Care should however be exercised when handling fuel and oil (hydraulic, transmission, engine, etc.) to power and maintain the different equipment on site. Measures should be taken to avoid spillage of such material to the ground. Additionally, all earth-moving and other equipment should be in good working condition and well maintained (no leaks).

6.1.2 Impacts during Operation

During operation, the main activities that could possibly affect the natural resources are the compost management practices. The produced compost should be free of toxic material and pathogens before land application. In the situation of inferior quality compost application, potential leaching of these toxins into surface or groundwater resources may present significant impacts. This is especially important since the destination of the compost will be over a very large area and not restricted to the project area.

However, with proper operation of the proposed SWTF the need for the Tyre open dump will diminish, enabling plans for its rehabilitation. However, the many negative impacts posed by the Tyre open dump will not be alleviated unless a proper rehabilitation plan is proposed and implemented as described in Section 0.

6.2. IMPACTS ON SOIL

6.2.1 Impacts during Construction

The total volume of soil and rock that would be excavated during plant construction is relatively small and thus should not lead to major erosion problems and impacts on soils.

Soil pollution from on-site as well as off-site works may occur by the intentional or accidental leakage of used chemicals, fuel, or oil products (from equipment and vehicles) on construction sites. Such practices should be strictly avoided and utmost precautions and workmanship performance should be adopted for the disposal of such hazardous products.

6.2.2 Impacts during Operation

The main concern during operation of the facility is related to soil quality rather than soil quantity, and is primarily attributed to generated compost management. However, impacts will occur from accidental leakage of used chemicals, fuel, or oil products used in equipment maintenance operations. Such practices should be strictly avoided and utmost precautions and workmanship performance should be adopted for the disposal of such hazardous products.

Generated compost from the SWTF will be used on agricultural, distributed to areas in the region. However, the compost must be of 'Grade A' or 'Grade B' quality; free of toxic material, microorganism such as E. colli and salmonella; and should mature before its distribution to farmlands. In the situation of compost being of inferior quality, impurities will pose public hazard while handling/ application of compost (i.e. glass). Other material in the compost altering its quality, either mineral or bacterial, will lead to the contamination of the food chain leading to direct health impacts on humans and live stock.

Incorrect application of compost to soil can be detrimental to plant growth. Immature compost once incorporated (mixed) into soils will continue the fermentation process increasing the soil acidity and reduce available oxygen. An increase in soil acidity increases mineral infiltrating into groundwater resources and decreases its availability to grown crops. This would lead to groundwater contamination and lack of soil fertility. In addition, the continued fermentation process will alter the natural biotic nature of soil, causing negative impacts on plant growth.

In the situation that 'Grade C' compost is produced, the compost can only be used in landscaping, re-cultivating of abandoned quarries or for green spaces along roadways. If 'Grade D' compost is produced then it can only be used to re-cultivation material on landfills and as intermediate layer of deposited wastes.

6.3. IMPACTS ON AIR

6.3.1 Impacts during Construction

Dust is the main impact on air quality caused primarily by the excavation works. Increased traffic will also increase dust emissions both on-site and off- site. However, since the construction phase is of limited time, this impact should not be considered of high significance. Odor emissions may also arise during this phase by increased machinery.

6.3.2 Impacts during Operation

The main concern during the operational phase is the emission of noxious odors. The SWTF will be equipped with odor control measures; such as the maintenance of internal negative pressure and the installation of a biofilter. Failure to maintain these measure can lead to significant surges in odor levels.

Increases in traffic levels to and from the facility will also increase dust and gaseous emissions. Waste delivery trucks should all be equipped with adequate exhaust systems to reduce this impact.

6.4. IMPACTS ON BIODIVERSITY

6.4.1 Impacts during Construction

The proposed SWTF is not situated on an area of significant ecological concern. The construction of the facility therefore will not lead to the destruction of critical ecosystems or the extinction of endangered or rare species. Land cover is mainly 60% rock outcrop with the remaining area covers predominantly by herbaceous plant species and occasional shrubs as described in Section 5.6. However, there are olive orchards to the Western side of the site. Potential negative impacts affecting biodiversity during project construction are summarized in Table 6-1. The main construction activities having negative results on the biodiversity are earth-moving activities, erection of the facility, and construction waste material and effluent discharges.

Table 6-1. Potential Negative Impacts on Biodiversity

Impact	**Cause**
Habitat loss or destruction	Construction works
Altered abiotic/site factors	Soil compaction, erosion
Mortality of individual organisms	Destruction of vegetation
Loss of individual organisms through emigration	Following disturbance or loss of habitat
Habitat fragmentation	Habitat removal and/or introduction of barriers like roads
Disturbance	Due to construction noise, traffic, or presence of people
Altered species composition	Changes in abiotic conditions, and habitats
Vegetation loss	Soil contamination due to disposal of oils and hazardous material

On the other hand, the project should include a landscape plan used primarily as a wind barrier for the prevention of odor emissions. The grown tree plants surrounding the site will lead to great positive impacts on the biodiversity level.

6.4.2 Impacts during Operation

With proper management of compost material, negative impacts on biodiversity during operation of the facility should be minimal. On the contrary, the projects could lead to positive environmental impacts on the biodiversity level if landscaping plans are developed. Inclusion of native/ endemic species, such as Junipers, in the proposed landscape plan could be adopted to alleviate visual impacts and compensate loss of habitat and communities. Landscaped plants will also act as windbreak and eventually reduce the dispersion of odors around the facility.

Wastewater from the facility will pose a direct impact on the biodiversity of the surrounding area if a wastewater collection and treatment system is not installed. However, wastewater will be collected in tanks and regularly pumped out.

In addition, the solid waste treatment facility will induce the creation of new habitats for pests. Rodents, roaches and flies amongst other pests may be attracted to the facility and may flourish posing serious impacts on the local community given that they are potential disease vectors. The project operators will have to be meticulous at pest control to avoid undesirable effects on the surrounding area.

6.5. IMPACTS ON HUMAN AMENITY

Human amenity is defined here as general comfort of persons that could eventually be disturbed by factors such as aesthetic, litter, dust, noise, and odors.

6.5.1 Impacts during Construction

The main impacts on human amenity during plant construction are related to dust and noise generation. An increase in ambient particulate matter may be observed primarily during the excavation activities. However, given the fact that excavation will last for a limited period, the impacts from potential dust generation will probably not be significant. On the other hand, appreciable increases in noise levels may be expected during excavation and erection of the facility. The noise impact from excavation and associated truck movements are however not limited to construction phase given that waste delivery truck to the location will increase considerably during the operation phase.

The construction phase will also pose a visual intrusion to the local community, especially to the single household 400m North of the facility. The provision of proper fencing during this phase will alleviate public discomfort.

6.5.2 Impacts during Operation

The main amenity impacts during plant operation are related to noise and odors. Noise may be generated mainly from the IPS agitator and from the generators. However, if adequate noise reduction/suppression measures are undertaken, the generated noise should not significantly affect human amenity. However, the noise level increases caused by the increase in traffic levels of delivery will remain a concern. A proper routing system should be considered and scheduled at appropriate timings.

Odors emitted at a solid waste treatment facility may easily reach the local inhabitants, particularly the single household present 400m North of the proposed facility location (Photograph 5-2), especially if prevalent wind direction is towards the residential areas. However, odors can be reduced or prevented through the provision of negative internal pressure and the installation of a proper biofilter. The provision of a maintenance design procedure will also ensure the reduction or prevention of odor emissions. Odors may be primarily produced from storage of MSW on-site, the composting process and the storage of compost at the curing area; therefore, proper compost management (proper storage, handling and maintenance) should be properly adopted.

There is an existing impact resulting from the accumulation of waste at the collection bins of several municipalities within the project area. These are a result from the lack of adequate capacity and number of waste collection vehicles.

Waste delivery and handling operations may also generate litter dispersion. Waste delivery trucks will empty their content onto the tipping floor over a wall directly into the building. This design should eliminate the dispersion of litter; however, workers should pay attention to possible litter scattering.

The actual SWTF building will pose a visual intrusion to the local community, especially the single household situated 400m North of the proposed site. The provision of a landscape plan will alleviate this impact and may even provide aesthetics.

In addition, with proper operation of the proposed SWTF, the need for the Tyre open dump will diminish, enabling plans for its rehabilitation. However, the many negative human amenity impacts posed by the Tyre open dump will not be alleviated unless a proper rehabilitation plan is proposed and implemented.

6.6. IMPACTS ON PUBLIC AND OCCUPATIONAL SAFETY

6.6.1 Impacts during Construction

In any civil works, public as well as construction staff safety risks can arise from various constructions activities such as deep excavations, operation, and movement of heavy equipment and vehicles, storage of hazardous materials, and disturbance of traffic. Because of the short duration and non-complexity of the construction phase, such activities are controlled and consequently the associated risks are minimal. Proper supervision, high workmanship performance, and provision of adequate safety measures will suppress the likelihood of such impacts on public and occupational safety.

6.6.2 Impacts during Operation

During the operational phase of the facility, public and occupational safety is at a higher risk than during the construction phase. Operation of the facility machinery, especially shredding operations should be handled properly. Fortunately, various mitigation measures can be easily adopted to minimize occupational hazards. Such measures are detailed in Section 7 and should be stringently considered. Public safety risks are mainly posed by the increased traffic caused by the waste collection vehicles. Attention to traffic routing and timing should considerably reduce this impact.

6.7. IMPACTS ON HUMAN HEALTH AND SANITATION

The current lack of proper solid waste management is surely having a negative impact on human health and the environment. Current and historical dumping of wastes, whether in open dumps, is directly polluting the environment and water resources of the area, and is furnishing breeding habitats for rodents and diseases to flourish. Such impacts will be mitigated by the deployment of a proper MSW management system and the construction of the SWTF. Of utmost importance is the coverage of the collection network of the whole project area.

As a whole, the projects would lead to positive impacts with respect to human health. Improvements in health conditions are likely to occur as the result of improvements in sanitation conditions. In addition, with proper operation of the proposed SWTF, the need for the Tyre open dump will diminish, enabling plans for its rehabilitation. However, the impacts on human health and sanitation posed by the Tyre open dump will not be alleviated unless a proper rehabilitation plan is propped and implemented.

6.8. ECONOMIC IMPACTS

Additional positive impacts would be observed at the socioe-economic levels. The proposed SWTF project will create certain job opportunities for skilled and unskilled labor.

Moreover, the produced compost can be used as well in municipal landscape or landfill cover replacement. With careful monitoring of compost quality, the compost would be of a benefit and ensure a quick acceptance by the public.

6.9. IMPACTS ON ARCHAEOLOGICAL, TOURISTIC AND CULTURAL SITES

There are no archaeological, touristic or cultural sites in the proposed SWTF in immediate neighborhood of the proposed SWTF in Ain Baal. In addition, with proper operation of the proposed SWTF, the need for the Tyre open dump will diminish, enabling plans for its rehabilitation. The presence of highly significant archeological, touristic and cultural sites in the city of Tyre, the closure of the Tyre open dump and the implementation of a sound rehabilitation plan will have great positive impacts.

Table 6-2. Environmental Impacts of the proposed SWTF during Construction and Operational Phase

Media	***Potential Impact***	***Cause***	***Significance***
	During Construction		
	Physical Environment		
Soil	Erosion	Earthmoving and excavation works	-
	Soil contamination	Oil and fuel spillage of equipment and trucks	-
Water	Contamination of water resources	Oil and fuel spillage of equipment and trucks	0 / -
		Wastewater discharge from housing facility of contractors	0 / -
Air	Noxious Odors	Construction equipment, machinery and trucks	-
	Dust Emissions	Onsite construction activities	-
		Off site construction activities i.e. hauling material	-
		Truck movement	-
	Gaseous Emissions	Trucks, construction machinery and equipment	-
	Biological Environment		
Flora and Floral Habitat	Loss of habitat	Construction of SWTF	-
Fauna and Faunal Habitat	Loss of habitat	Construction of SWTF	-
	Socio-Economic and Cultural		
Public & Occupational Health & Safety	Public health and safety	Unauthorized entry	-
	Occupational health and safety	Construction activities	-
Economic	Employment opportunity	Employment	+ / -
Social	*Aesthetic*	Site development	- -
	Dust	Increased traffic	-
		Construction activities	- -
	Noise	Construction equipment, machinery and trucks	- -

\+ + High Positive Impact
\+ Positive Impact
0 Neutral Impact
\- Negative Impact
\- - High Negative Impact

Table 6.2 Environmental Impacts of the proposed SWTF during Construction and Operational Phase (Continued)

Media	***Potential Impact***	***Cause***	***Significance***
During Operation			
Physical Environment			
Soil	Soil contamination	Oil and fuel spillage of equipment and trucks	- -
		Leachate escaping containment site	- -
	Compost application	Compost quality	+ +/ - -
		Compost application mode	+ +/ - -
Water	Contamination of water resources	Compost application	0 / -
		Reduced dependence on Tyre open dump	++
Air	Noxious Odors	Deposition and decomposition of waste	- -
		Lack of maintenance of odor control measures	- -
		Waste delivery trucks	-
	Dust Emissions	Waste delivery trucks	-
	Gaseous Emissions	Waste delivery trucks	-
Biological Environment			
Fauna and Faunal Habitat	Pests	Creation of new habitat	- -
Flora and Floral Habitat	Introduced trees	Landscaping of area	+ +
Tyre Nature Reserve	Reduced dependence on Tyre open dump	Future rehabilitation of Tyre dumpsite	+ +
Socio-Economic and Cultural			
Public & Occupational Health & Safety	Public health and safety	Provision of MSW management	+ +
		Unauthorized entry	-
		Introduction of pests and diseases	- -
		Reduced dependence on Tyre open dump	++
	Occupational health and safety	Operation activities	-
Socio- Economic	Employment opportunity	Employment	+
Social	Aesthetic	Visual impact on local settlement and by passers	+/ -
	Noise	Operation machinery	-
		Increased traffic	-
	Dust	Increased traffic	-
	Odor	Waste storage, handling and compost storage	0/ - / - -
		Odor control devices failure	- -
	Litter	Waste delivery and handling operations	-
	Traffic	Waste delivery trucks	- -
	Tyre Nature Reserve	Reduced dependence on Tyre open dump	+ +
	Waste accumulation at collection bins	Inadequate vehicle capacity and number	+/ -

7. MITIGATION MEASURES

7.1. DEFINING MITIGATION

In the Environmental Impact Assessment context, mitigation refers to the set of measures taken to eliminate, reduce, or remedy potential undesirable effects resulting from the proposed action, here the SWTF. Mitigation should be typically considered in all the developmental stages of the facility, namely, the site selection process, as well as the design, construction, and operation phases. Once set, tender documents should clearly describe mitigation measures and workmanship to be adopted by the contractors or operators.

7.2. MITIGATING ADVERSE PROJECT IMPACTS

As identified earlier, potential adverse impacts of the proposed SWTF may include dust emissions, odor and, noise generation, degradation of natural resources, production of inappropriate compost, public health hazards, and adverse aesthetic impacts. Proposed mitigation measures for the above-mentioned adverse impacts are discussed in the following paragraphs. Table 7-3 summarizes such mitigation measures, their monitoring for actions affecting environmental resources and human amenity. Such measures should be set as primary conditions on the contractor, the supervising engineers, the SWTF administration, and operating staff in order to assure a proper management of the facility as well as the implementation of the Environmental Management Plan (EMP) discussed in section 8.

7.2.1 Mitigating Dust Emissions

Dust emissions from piles of soil or from any other material during earthwork, excavation, and transportation should be controlled by wetting surfaces, using temporary windbreaks, and covering truckloads. Piles and heaps of soil should not be left over by contractors after construction is completed. In addition, excavated sites should be covered with suitable solid material and vegetation growth induced after construction completion, no soil surface should be kept bare subject to erosion.

It is the responsibility of the Supervision Engineer to monitor for the mitigation of such impacts.

7.2.2 Mitigating Noise Pollution

Temporary noise pollution due to construction works should be controlled by proper maintenance of equipment and vehicles, and tuning of engines and mufflers. Construction works should be completed in as short a period as possible by assigning qualified engineers and supervisors. Construction works should also be confined to daytime hours. It is the responsibility of the Supervision Engineer to monitor for the mitigation of such impacts.

Noise pollution during operation would be generated by mechanical equipment. Noise problems should be reduced to normally acceptable levels by incorporating low-noise equipment in the design and/or locating such mechanical equipment in properly acoustically lined buildings or enclosures. In the presence of adequate buffer zones between the facility and residential areas, the need for noise control measures is minimized. In this case, the facility site is located at distance of 1 Km from the center of the village and a distance of 400 meters from the nearest household in the village. Furthermore, dispersion of noise can be reduced by implementing a landscaping plan of trees such as Junipers that will act as a wind and sound break.

Increased noise levels will also be observed due to the increased traffic levels by waste delivery trucks to and from the SWTF. Therefore all traffic activities should be limited to daytime working hours.

7.2.3 Mitigating Obnoxious Odors

Odors emitted by the solid waste treatment works may be potential nuisance to the public. However, through the provision of negative internal pressure and the installation of a biofilter odors can be reduced or prevented. Normal housekeeping, improved operation, and the provision of a maintenance design procedures will further reduce or prevent odor emissions.

The primary mitigation measure for odor control remains the proper site selection of the facility. The facility should be located at a site where prevailing winds mostly blow away from nearby residential areas. In this case, the proposed facility site is approximately 1Km from the village center and 400m from the nearest and only household. These distances along with the odor control measures suggested should be sufficient in control odor dispersion.

Where odor emissions could lead to complaints, the provision of covers to the odor sources should be considered, especially for compost storage and leachate collection tanks. Proper landscaping around the facility may serve as a natural windbreaker and minimize potential odor dispersions. When odor becomes an evident public nuisance, synthetic windbreakers (e.g. walls) should be employed to maintain odor nuisance within the site.

7.2.4 Mitigating Impact on Biodiversity

Recommended mitigation measures to minimize or eliminate the impacts on the biodiversity at proposed location\s, include:

- Avoid deforestation activities: plan the building sites and roads on areas void of trees.
- Design a landscape plan that enhances the landscape aesthetic value using local and native population flora.
- When detected, sensitive species or habitats should be conserved.
- All waste resulting from construction works, land reclamation, or any other activity should be collected and disposed properly in an allocated disposal site. Littering in the project area and surrounding areas should be prevented.

Table 7-1 presents additional mitigation measures specific to locations.

Table 7-1. Additional Mitigation of Impacts on Biodiversity Specific to the Location

Location	**Mitigation Measures (specific)**
Ain Baal	Building the plant on the selected site would not lead to significant environmental impacts on the present biodiversity Design a landscape plan that introduces tree and plant communities surrounding the site that will act as a windbreak leading reducing dispersion of noise and odors. Carefully design the plant and access road rehabilitation to minimize removal of trees, especially old trees. Avoid alteration of abiotic factors

7.2.5 Mitigating Impacts on Receiving Soils

The STWF construction works may lead to erosion of soil, however with proper resurfacing of exposed areas, and the induction of vegetation, significant reduction of erosion can be observed. In addition, impacts may also occur from accidental leakage of used chemicals, fuel, or oil products used in equipment maintenance operations that should be strictly prohibited. Utmost precautions and workmanship performance should be adopted for the proper disposal of hazardous product. Education of workers on environmental protection will improve those practices and it is the responsibility of the supervision engineers and SWTF operators to ensure such practices.

On the other hand, compost quality and application may significantly impact the receiving soil quality. Compost quality should be regularly monitored as described in Section 8.2, in accordance to MoE standards. In order to achieve compost of superior quality, the sorting of MSW should be performed carefully to ensure the removal of impurities. In addition, regular maintenance of the aeration bays and the computerized monitoring system should be performed. Compost maturity is another parameter of quality and therefore, it is recommended to allow for proximal maturation of compost before soil application. It is the responsibility of the SWTF operators to ensure compost quality and process maintenance.

In the situation the compost of inferior quality is produced, 'Grade C' or 'Grade D', its application to food production systems should be strictly prohibited. It is also recommended that farmers be educated on methods of compost application for each compost quality grade. In addition, if compost is to be packaged, clear labeling and application advice should be declared.

7.2.6 Mitigating Degradation of Water Resources

With no river, streams or springs surrounding the site and no underlying aquifers; no impacts are anticipated. However, the application of compost containing impurities, either mineral or bacterial, will lead to significant impacts on surface and ground water resources. This is especially important since the application of the compost is not restricted to the SWTF area but to the region. Therefore, the provision of proper monitoring of compost quality and the application of the compost according standards set by the MoE will reduce the possibility of toxic infiltration to groundwater. In addition, proper labels declaring compost quality grade and mode of application will indicate application method appropriate to farmers. Classification of quality, recommended use and application of compost are available in Appendix E.

7.2.7 Mitigating Impacts from MSW Collection, Storage and Handling, Composting Process, Compost Curing, and Compost Utilization

The impacts caused by the MSW storage and handling activities, composting process., compost storage and utilization involve mainly the Tipping Floor, Sorting, IPS In Vessel Composting System, the Curing Area and the final compost utilization. To reduce potential impacts the following strategies should be adopted.

Waste collection: The waste collection from the municipalities included in this project have been identified as inadequate in capacity and number. Therefore, it is essential to increase the waste collection fleet to avoid the accumulation of MSW at the collection bins for several days.

Tipping Floor: This zone is designed to handle a two-day storage capacity in case of MSW overflow. Therefore, it is crucial to keep this area clean, and to provide a front end loader ensuring the continuous turning of waste material. Cleanliness of this area will also minimize the problem of pests, and will limit the odor problem.

Sorting: The removal of non- organic material from the waste stream is essential to ensure compost quality. Shredding of the organic portion should be avoided to enable the removal of impurities at the refining stage of the process.

Recyclable Material Pit: Once the non-organic material have been separated from the waste stream, the recyclables will be stored in a separate Recyclables pit. In order to reduce their volume, the project design has incorporated a shredder, however, it is recommended to avoid the shredding of recyclables to ensure their acceptance by the recycling industries. On the other hand, the non-organic rejects destined for landfilling may be shredded to reduce their volume and increase their storage capacity.

IPS In Vessel Composting System: Maintenance operations of the IPS Agitator and the Computer Control system are essential to ensure the operational efficiency of the SWTF. Failure to the system will incur additional costs for maintenance and/ or the replacement of parts of the machinery. Once the equipment is fixed, the process will have to work on a double shift to compensate for the accumulated MSW during the failure period.

Biofilter: The Biofilter is designed in three segments to ensure that maintenance operations can be done without upsetting the whole odor control system. It is essential to perform these operations as scheduled to avoid public complaints.

Curing: The quality of compost is directly related to its maturity. Therefore, the compost must be left for a minimum of 21 days as in the design specification with regular turning by the front-end loader. Failure to do so, will lower the quality of compost, and thus limit the final use of the produced compost.

Compost Utilization: The compost must only be used according to its quality grade, as set by the MoE. Only compost of 'Grade A' and 'Grade B' can be applied to agricultural lands. Failure to do so will lead to negative impacts on the receiving soils, the food production systems and water resources. It is advised to ensure proper labeling of the compost to assist the consumer in proper utilization. Table 7-2 lists parameters for declaration to consumer. In the absence of an adequate markets for the produced compost, alternative environmentally sound strategies should be considered. This may be its use as landfill cover material or land rehabilitation.

Table 7-2. Parameters of Compost for Declaration to Consumer

Parameters for declaration to utilizer	Quality Grade Maturity Grade Producer Mode of Application Grain size and Bulk density C / N ratio Salt content pH value Plant nutrient total (N, P_2O_5, K_2O, MgO, CaO

7.2.8 Mitigating Adverse Aesthetic Impacts

To avoid possible visual impacts resulting from the existence of SWTF to the local community especially the single household present 400m North of the facility, the following steps are to be implemented:

- Maintaining cleanliness within the treatment facility,

- Appropriate landscaping of the plant grounds with planting of suitable trees (such as Junipers), grass, and flowers.
- Fencing and screening the site with appropriate trees to obstruct the plant components from onlookers and area inhabitants. (All along with some noise reduction).

7.2.9 Mitigating Public and Occupational Health Hazards

The likelihood of impacts on public and occupational safety can be significantly suppressed by the following mitigation measures:

- Restricting unattended public access to the SWTF by proper fencing and guarding.
- Surrounding excavated locations with proper safety barriers and signs.
- Controlling movement of equipment and vehicles to and from the site, especially in the construction phase.
- Emphasizing safety education and training for system staff. Enforcing adherence to safety procedures.
- Providing appropriate safety equipment, fire protection measures, and monitoring instruments.
- Providing hand railing around all open treatment units, except where sidewalls extend ≥1.1 meters above ground level.
- Properly rating electrical installations and equipment and, where applicable, protecting them for use in flammable atmosphere.
- Providing sufficient lighting that should comply with zoning requirements.

As a conclusion, proper supervision, high workmanship performance, and provision of adequate safety measures will alleviate public and occupational risks.

Table 7-3. 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	-
	Disturbance to biodiversity	• Conservation of present trees and used as wind brakes and aesthetic cover for the facility. • Inducing vegetation growth	Supervision engineers	-
Dumping of excavated and construction material into the environment	Groundwater pollution	• Prohibition of uncontrolled dumping. Disposal at appropriate locations • Education of workers on environmental protection	Supervision engineers	-
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	-
Storage of hazardous material, traffic deviation, deep excavation, movement of heavy vehicles, 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	-

Table 7-3. Mitigation Measures, Monitoring, and Estimated Costs for Actions Affecting Environmental Resources and Human Amenity (Continued)

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 • Storage of MSW and compost in enclosed areas • Provision of covers where possible • Landscaping a proper natural windbreaker around the facility • Installation of biofilter • Provision of internal negative pressure of building • Maintenance of leachate collection ponds	Design engineers	Required in tender/ Included within contract
		• Maintaining proper cleanliness and housekeeping • Transportation of odorous byproducts in enclosed container trucks	SWTF administration and operating staff	
	Impaired aesthetics	• Maintaining cleanliness around and within the plant • Proper fencing and landscaping	SWTF administration and operating staff	-
	Noise generation	• Limit waste collection and delivery to daytime hours • Incorporating low-noise equipment • Locating mechanical equipment in proper acoustically-lined enclosures • Proper fencing and landscaping	Design engineers	-
	Traffic generation	• Proper routing of waste delivery trucks • Limiting waste collection and delivery to daytime hours	Design engineers	-
	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	SWTF administration and operating staff	-

Table 7-3. Mitigation Measures, Monitoring, and Estimated Costs for Actions Affecting Environmental Resources and Human Amenity (Continued)

Action	*Potential impact*	*Mitigation measures*	*Monitoring of mitigation measures / responsibility*	*Estimated cost of mitigation (USD)*
B. During Design & Operation (CONT'D)				
Inappropriate compost management practices	Contamination of water resources	• Monitoring of compost quality in accordance with MoE standards • Appropriate compost application method	SWTF administration and operating staff, Municipality Union, MoE and MoA	N/A
		• Storage of MSW and compost on appropriately lined surfaced • Provision of leachate collection pond	Design engineers	N/A
	Contamination of crops and vegetables	• Monitoring of compost quality in accordance with MoE standards • Appropriate compost application method	SWTF administration and operating staff, Municipality Union, MoE and MoA	N/A
	Contamination of receiving soils	• Proper design and operation of SWTF • Provision of adequate separation of waste • Monitoring of compost quality in accordance with MoE standards • Training farmers for the proper handling and use of compost at the agricultural sites	Design engineers, SWTF administration and operational staff, Municipality Union, MoE and MoA	N/A
Inappropriate handling of non-organic waste	Disposal of recyclable non-organic material in landfill	• Prohibition of shredding of non-organic recyclable wastes.	SWTF administration and operating staff	-
Inappropriate waste collection	Accumulation of waste at waste collection bins	• Increasing the capacity and number of collection vehicles	Municipality Union	N/A
Inappropriate equipment maintenance operations	Odor emissions	• Maintaining cleanliness of storage areas • Maintenance of IPS Agitator machine • Provision of biofilter	SWTF administration and operational staff	N/A
	Incurred additional cost by machinery replacement	• Maintenance of operation equipment	SWTF administration and operational staff	N/A

8. ENVIRONMENTAL MANAGEMENT PLAN

The proper implementation of a comprehensive environmental management plan (EMP) will ensure that the proposed SWTF meet regulatory and operational performance (technical) criteria.

8.1. OBJECTIVES OF THE ENVIRONMENTAL MANAGEMENT PLAN

Environmental management/monitoring is essential for ensuring that identified impacts are maintained within the allowable levels, unanticipated impacts are mitigated at an early stage (before they become a problem), and the expected project benefits are realized. Thus, the aim of an EMP is to assist in the systematic and prompt recognition of problems and the effective actions to correct them, and ultimately good environmental performance is achieved. A good understanding of environmental priorities and policies, proper management of the facility (at the municipality and the Union levels), knowledge of regulatory requirements and keeping up-to-date operational information are basic to good environmental performance.

8.2. MONITORING SCHEMES

Two monitoring activities have to be initiated for the proposed SWTF to ensure the environmental soundness of the project. The first is *compliance monitoring*, and the second is *process control monitoring*. Compliance monitoring provides for the control and categorization of compost quality, while process monitoring relates to detecting the impact of the operational activities. Together, the objective is to improve the quality and availability of data on the effectiveness of operation, equipment, and design measures and eventually on the protection of the environment.

8.2.1 Compliance Monitoring

In this context, compliance to the regulations set by the Ministry of Environment to limit air, water, and soil pollution shall be observed. Compliance monitoring requirements include compost quality testing. Compliance monitoring shall be the responsibility of the treatment facility administration, thus monitoring activities shall be budgeted for accordingly.

For effective compliance monitoring, the following shall be assured:

- Trained staff (facility operator, laboratory staff, maintenance team, etc.) and defined responsibilities
- Adequate analytical facility (ies), equipment, and materials,
- Authorized Standard Operating Protocols (SOPs) for representative sampling, laboratory analysis, and data analysis,
- Maintenance and calibration of monitoring equipment,
- Provision of safe storage and retention of records.

In the proposed SWTF, qualified plant operators and laboratory staff should carry out compost quality testing. The technical staff that would run the plant shall attend training programs to improve their qualifications and update their information. Both Contractors and Consultants would be involved in knowledge transfer to operators and management through regular assistance and specialized technical workshops.

Table 8-1 provides a comprehensive list of monitoring parameters as set by the MoE. It is noteworthy to mention that the SWTF proprietor or operator should cooperate with the technology provider for a better approach in process control. As will be mentioned later, an understanding of the treatment process and technology will lead to better compost quality production.

Suggested frequency for compliance monitoring is listed in Table 8-2. Given that the facility capacity at the start of operation is less that 2,000 tons/ year, it is recommended that compliance monitoring occurs once every 3 months. However, in the case of facility expansion, the frequency of monitoring should be increased accordingly.

It is noteworthy to mention that initial comprehensive characterization of the solid waste to be treated is necessary for proper facility design, operation, and future monitoring. The frequency of monitoring should not be reduced, even after the necessary constant recorded compliant values are obtained over a long period normal operation.

However, in case of any sudden change in the trend of any parameter, it is imperative to locate and correct the cause of change, and to adopt a more frequent monitoring scheme until a regular trend is re-established.

Table 8-1. Compost Quality Parameters set by the MoE

Analytical Parameter	*Standard Determination*	*Sample Type* [1]
Water content	% water: ISO 11465	C
Man - made impurities	% weight in dry mass	C
Stone content	% weight in dry mass	C
Maturity grade	By DEWAR self- heating test Grade I &II: Immature compost Grade III: semi mature compost Grade IV & V: mature compost	C
Plant compatibility	% germination in compost > % germination in standardized soil	C
Organic mater content	% weight in dry mass	C
Heavy metal content	ISO 11047	C
Nutrient and salt content	By 86/ 278/ EEC method	C
pH	N/A	In situ
Hygiene	Salmonellae Fecal coliforms	C

[1] C: composite sample; 12 single samples (5 – 10 per sample) should be taken at 12 different spots of the compost heap to be examined. After thorough mixing of those samples the material is then reduced by dividing it repeatedly into quarters until the remaining representative sample has a volume of around 4 l. This sample, it is then again divided into 4 separate samples. One sample is used for the determination of the water content. The other samples are dried in an oven at a temperature of 105°C until no further loss of water is detectable. They are then filled into airtight plastic bottles and conserved at a temperature level of a few degrees Celsius.

Table 8-2. Frequency of Monitoring Procedure According to SWTF Capacity

Plant input (tons/year)	*Number of analysis per year*
Up to 2,000	4
2,001 to 5,000	5
5,001 to 10,000	10
More than 10,001	12

Within the framework of the quality monitoring procedure, sample taking and analyses must be carried out by external monitoring laboratories that should be licensed by the MoE. Licensing of the independent outside monitors is subject to verifying certain preconditions of the recognized laboratories (for example taking part in an inter-laboratory test).

Further in-house analyses can be carried out on a voluntary basis. The determination of characteristics important for the application of compost, which can be ascertained using simple techniques, such as water content, weight by volume, salt content, pH value, plant compatibility and extraneous matter in the end product, is recommended.

Appendix E thoroughly details the analysis methods and the compost quality categorization as set by the MoE. All test result should be recorded and the compost of different quality should be stored separately. It is imperative to declare the compost quality to the consumer. Table 8-3 lists the parameters for declaration.

Table 8-3. Declaration Parameters to Consumer

Parameters for declaration to utilizer	Quality Grade Maturity Grade Producer Mode of Application Grain size and Bulk density C / N ratio Salt content pH value Plant nutrient total (N, P_2O_5, K_2O, MgO, CaO

8.3. PROCESS CONTROL MONITORING

This course of action is needed since a precise and adapted process control strategy translates into a better process performance, and thus compost quality compliance. Process control monitoring also includes occupational health and safety monitoring. Table 8-4 presents the recommended process performance monitoring parameters.

Occupational health and safety is crucial for the proper performance of the SWTF. The main access roads connecting to the facility must remain in good condition to avoid vehicles accidents. In addition, the SWTF supervisor must continuously observe the occupational safety standards of labor.

The SWTF supervisor must also regularly check for outdoor odor levels. This is performed weekly by a field visit to the area surrounding the facility, especially in the predominant wind direction and close to the residential area. Monitoring for pest is essential to maintain hygienic standards within the facility. This is an ongoing process. All labor should be instructed to report unusual pest rises to the SWTF supervisor. Pest infestations are expected to arise in waste storage area (tipping floor), the compost processing units and curing area.

The quality of compost will be monitored for by certified laboratories as described in the compliance monitoring scheme. However, the SWTF operators must perform in house monitoring to ensure the safe hygiene status of the decomposition process by documenting accurately the temperatures achieved during the first intense decomposition phase. Within the framework of the monitoring procedures carried out by external laboratories the correct measuring and documentation of those temperature protocols is examined in irregular intervals but at least once a month. In addition, the moisture content of compost will be monitored for in the composting bays.

Table 8-4. Process performance Monitoring Parameters

Domain	*Parameter*	*Frequency*
Health and Safety	Main access roads	Quarterly
	Occupational safety	Ongoing
Odor	Off site odor levels	Weekly
Pests	Waste storage, compost processing and curing areas	Ongoing
Composting process	Temperature rises in bay	Weekly
	Moisture of compost in bays	Ongoing

8.4. RECORD KEEPING AND REPORTING

Monitoring efforts would be in vain in the absence of an organized record keeping practice. It is the responsibility of the SWTF administration to ensure the development of a database that includes a systematic tabulation of process indicators, performed computations, maintenance schedules, logbook, and compliance and process performance monitoring outcomes. Such a historical database benefits both the facility operator and design engineers. The treatment facility should submit a periodic Compliance Monitoring Report to the assigned regional authority, namely the Municipality Union and subsequently to the MoE. Such record keeping shall be requested and assured by the Municipality.

8.5. CONTINGENCY PLAN

The contingency plan in case of emergency was tackled in the design consideration of the facility. Primarily, the actual population served is 217,711 people, however the design population is 300,000. This extra capacity is beneficial in case of waste delivery overflow occurs.

In the situation of IPS Agitator failure, either due to improper operation and maintenance procedures then several options can be adopted to handle the daily incoming MSW. Each composting bay have a 4m wide loading zone that can store up to 1 day of incoming waste. This zone can be equipped with a blower to ensure proper aeration. In the case that the IPS agitator was not fixed by the next day, then the MSW can be stocked in the Tipping floor zone that is designed to handle a 2-day waste storage, and turned using the front end loader. Once the turner is fixed, a double working shift will be adopted for the next couple of days, thus operating the IPS agitator for 16 hours/ day. Another emergency situation may occur in case of electric power failure. However, the facility has a buck-up generator that will power the main panel board.

Furthermore, in case of Computer Control System failure, a manual override system is in place to operate the aeration blowers. Handheld temperature probes are provided for manual temperature readings as well.

According to the requirement set in the tender document, the awarded contractor will have to perform regular and frequent maintenance check ups of the facility since he will be responsible for the operation of the plan. These preventive measures and design considerations will ensure a continuous and uninterrupted operation of the facility.

8.6. CAPACITY BUILDING

Considered as corner stone of the EMP the capacity-building program consists of two major parts: On the Job Training (OJT) and a General Awareness Seminars (GAS).

8.6.1 On the Job Training (OJT)

The majority of the Operation and Maintenance training of the SWTF will commence within 60 days of substantial completion of construction. The most significant training, especially as it relates to the processing equipment, will occur during the general equipment shake down period and continue during facility start up and performance testing. In addition, formal classroom lecture for process familiarization for the staff will take place. A highly technical training manual should be distributed to the participants to serve as a basis for future reference and application of proper environmental guidelines.

8.6.2 General Awareness Seminars (GAS)

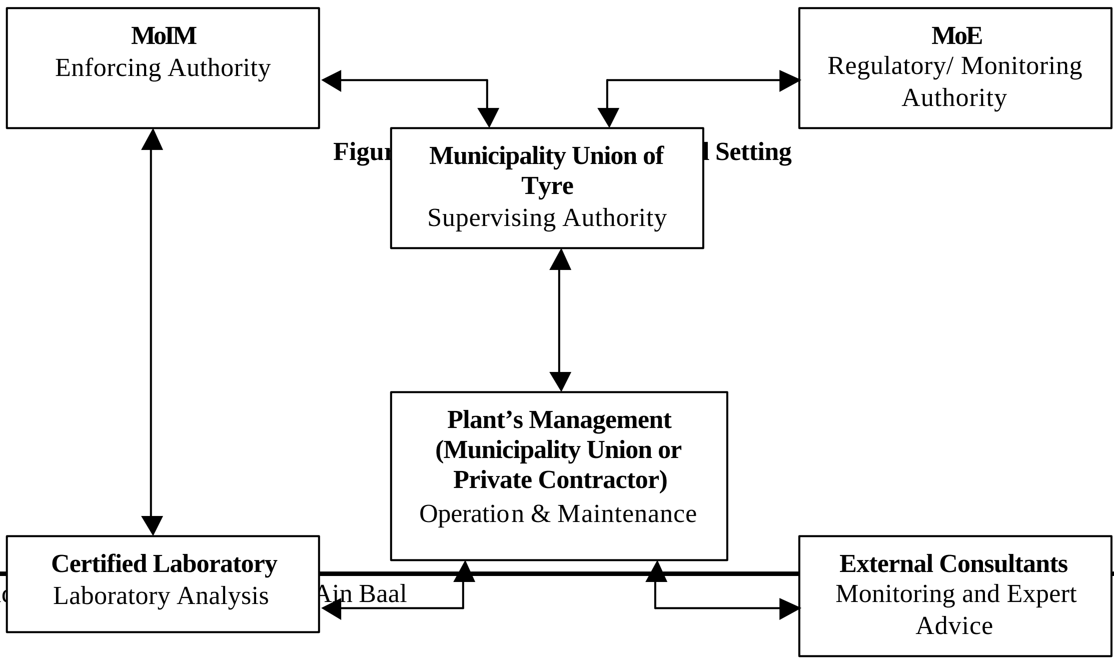
General awareness seminars targeted to the local community in general is recommended. Issues addressed in a General Awareness Seminar are less technical than those in OJT, and aim at raising awareness and improve environmental practices of the local population. It would be however rather difficult and expensive to provide these seminars to a very large portion of the local communities during the duration of the project. It is believed to be a more sustainable approach to train the trainers who will subsequently train and raise awareness in the community. These trainers include municipality officials, primarily school professors and NGO's that could take over this educational role. Topics to be included in these seminars could be environmental impacts from poor disposal practices, role of the local community in improving the environment and other general topics aimed to increase environmental awareness. Awareness lectures on the importance and method of home/ source separation should also be included emphasizing its benefit on the final compost quality. Awareness lectures to farmers on the proper application of compost is also essential in reducing the risk of impacts caused by inappropriate compost application.

Awareness manuals and ready-made presentations will be prepared and provided to these trainers as tools to be used in raising awareness. Trainers would attend awareness seminars provided in schools and other public locations in order to be acquainted with the principle. Several General Awareness Seminars would be conducted in order to initiate the environmental awareness in the rural communities.

8.7. INSTITUTIONAL ARRANGEMENTS

No matter how meticulously an environmental management scheme has been prepared, it will fail in the absence of predefined responsibilities and strong technical bodies. Compliance monitoring shall be the responsibility of the treatment facility administration (municipalities or a contracted operator) and thus its activities shall be budgeted for accordingly. However, it is recommended that a private sector be contracted for the operation of the SWTF.

In accordance with the requirements of the regulatory authority (MoE), the treatment facility should submit a periodic Compliance Monitoring Report to the assigned enforcement authority (Municipality Union/ MoIM/ MoA). The assigned authority will be responsible for drawing conclusions based on the monitoring data, and deciding on specific actions to alleviate pollution impacts. The coordination with the MoE and MoA is also important since they are responsible for compost compliance standards and compost application practices. Figure 8-1 is an illustration of such institutional arrangement.



Figu… l Setting

9. PUBLIC INVOLVEMENT AND PARTICIPATION

Public involvement started early in the process when it became apparent that the foremost issue being requested from the municipalities was a SWTF. Since it was a publicly initiated and supported project, public involvement was assured.

During this EIA study, the consultant met numerous times with Council Members of Municipality Union of the Tyre Caza along with the assistance of YMCA representatives and GROSSIMEX designers, to present the findings regarding many aspects concerning the site location, network system, process design, most appropriate technologies and many other aspects required to finalize the study. Additional meetings were also set between MEEA and YMCA to set the Specifications, Requirements and Standards requested for compliance of contractors in the bidding process.

In the preliminary stages of the study, information was requested from the Municipality Union of Tyre Caza. The requested information related to the physical and biological environment, the socio-economic situation in the Caza of Tyre and particularly Ain Baal, and general requirements pertinent to the EIA process. Many other meetings, presentation, and workshops relevant for each specific project are yet to be implemented.

Also in conformity with EIA guidelines, a notice was posted in April 2005 for informing the public about the EIA study that is being conducted and the proposed treatment facility, and soliciting comments. A public hearing was held on May 13 2005, and was attended by 32 people including officials from the Municipality Union of Tyre Caza and people from the local community. GROSSIMEX gave a presentation where questions and comments were solicited. MEEA attended this meeting and took public concerns into consideration. A summary of the public hearing is presented in Appendix H. Photograph 9-1 presents the public hearing meeting for the proposed SWTF.

Photograph 9-1. Public Hearing Meeting

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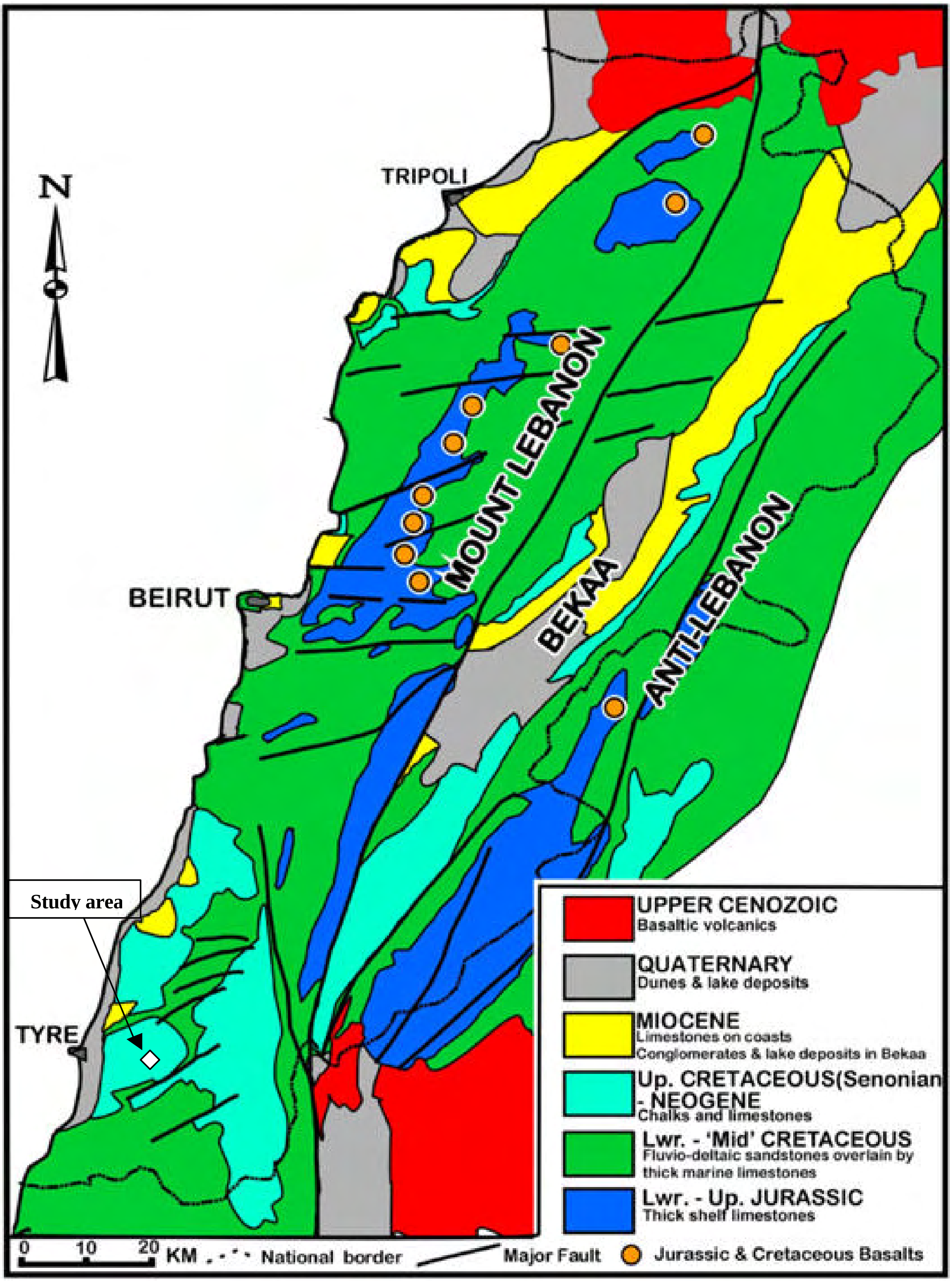
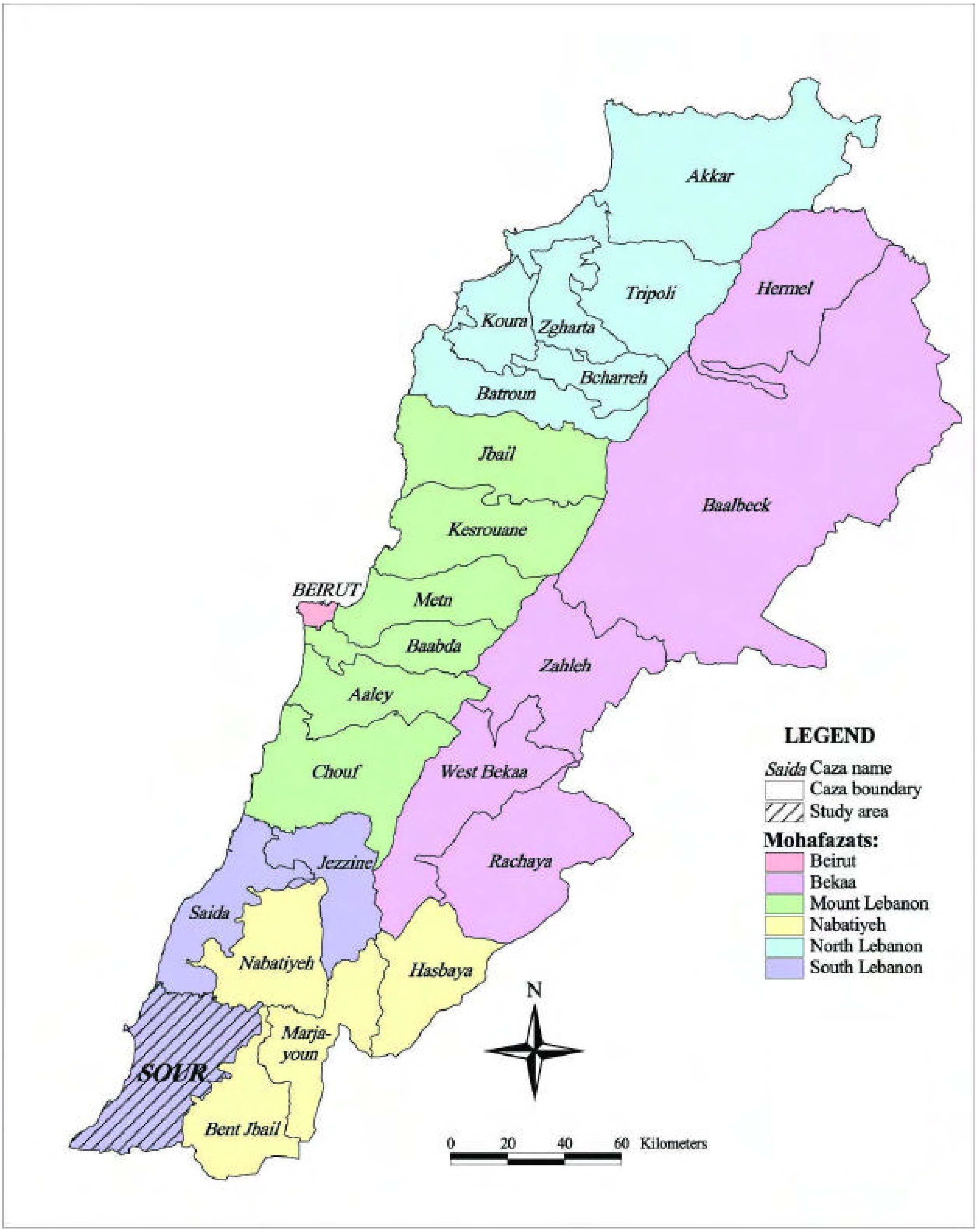
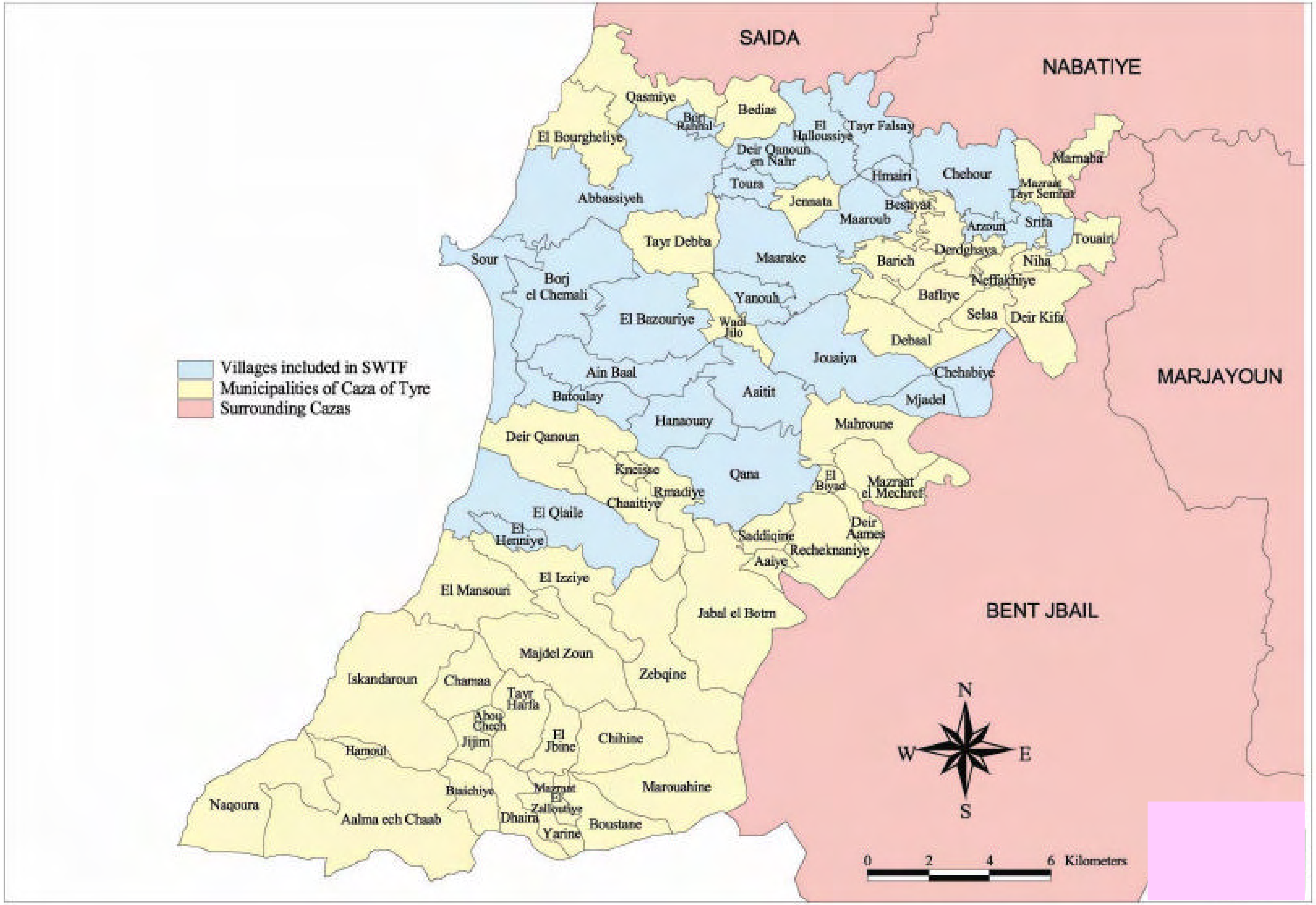
APPENDIX A
TECTONIC AND GEOLOGICAL MAP OF LEBANON AND STUDY AREA


TRIPOLI
BEIRUT
TYRE
Study area
MOUNT LEBANON
BEKAA
ANTI-LEBANON
N
UPPER CENOZOIC
Basaltic volcanics
QUATERNARY
Dunes & lake deposits
MIOCENE
Limestones on coasts
Conglomerates & lake deposits in Bekaa
Up. CRETACEOUS(Senonian
- NEOGENE
Chalks and limestones
Lwr. - 'Mid' CRETACEOUS
Fluvio-deltaic sandstones overlain by thick marine limestones
Lwr. - Up. JURASSIC
Thick shelf limestones
0 10 20 KM
National border
Major Fault
Jurassic & Cretaceous Basalts

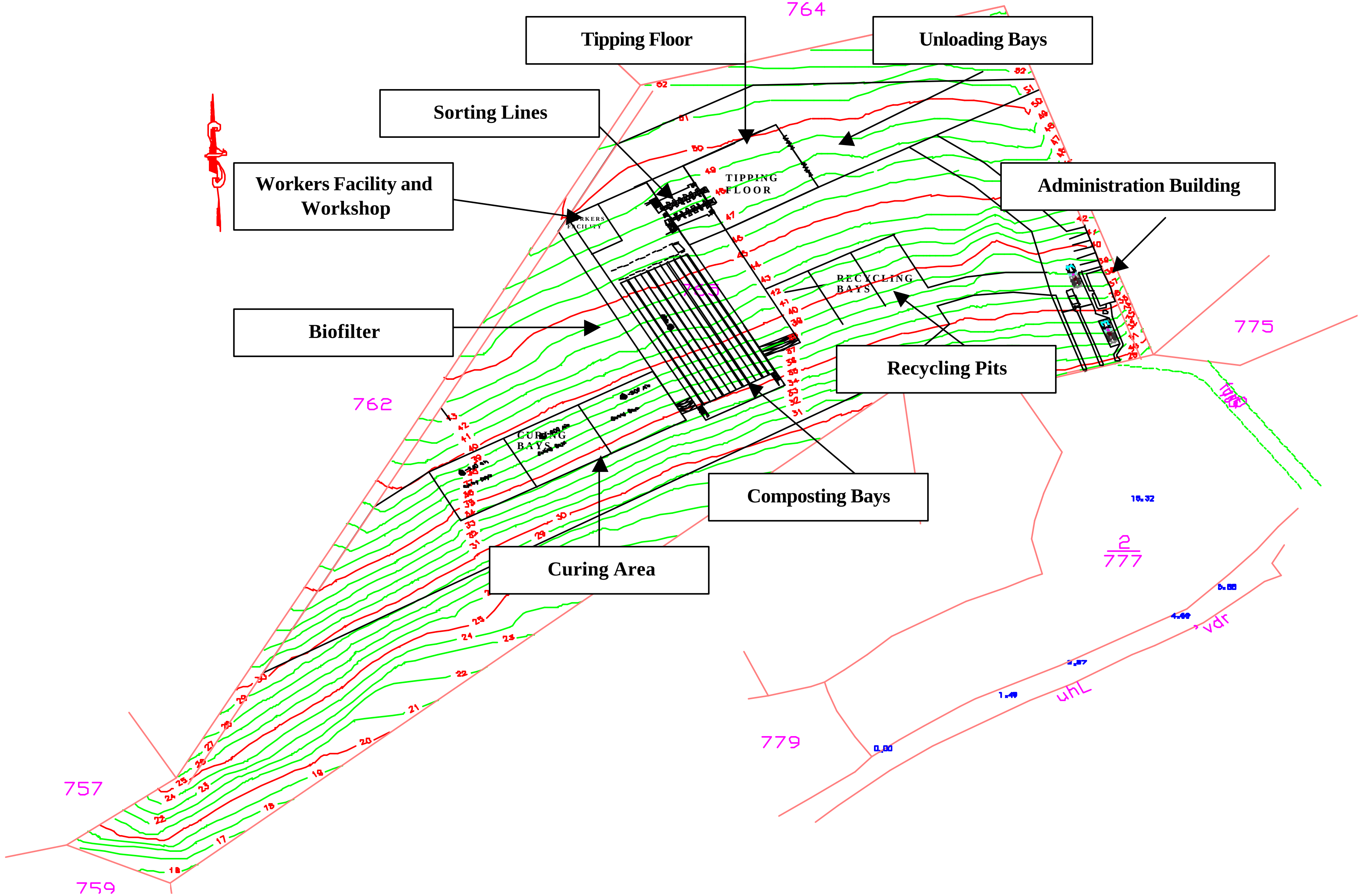
APPENDIX B
TOPOGRAPHIC MAP OF LEBANON AND STUDY AREA; CAZA BOUNDARIES OF LEBANON; MUNICIPALITIES OF TYRE CAZA IN PROPOSED PROJECT

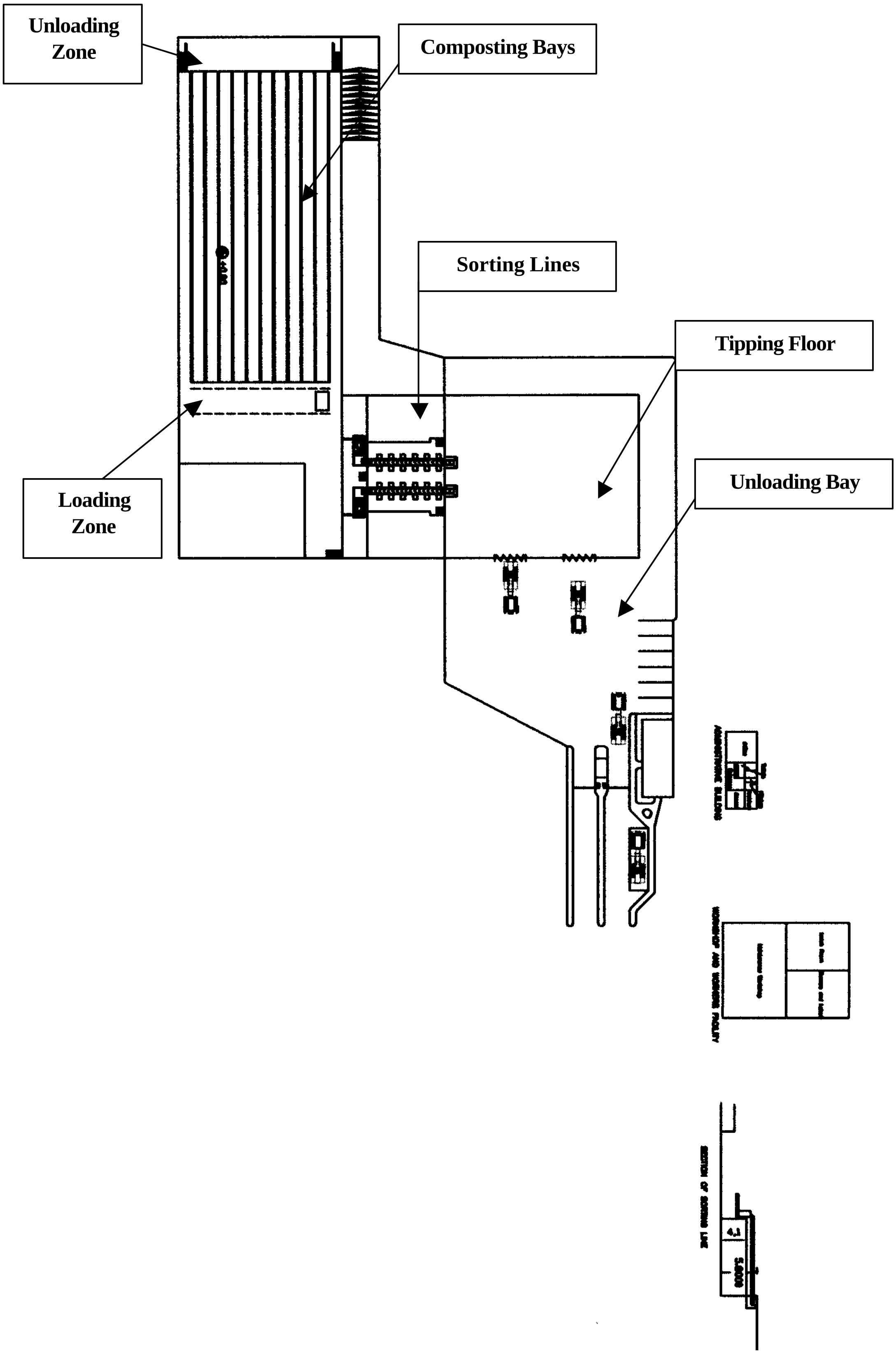

Lebanon
International boundary
Governorate (mohafazat) boundary
National capital
Governorate (mohafazat) capital
Expressway
Railroad
Road
15 Kilometers
15 Miles
Boundary representation is not necessarily authoritative.
Study Area
SYRIA
Mediterranean
Sea
ECH CHIMÂL
EL BEKAA
JABAL LOUBNANE
BEYROUTH
EJ JNOUB
Beirut
Tripoli
El Mina
Chekka
Batroûn
Jbail
Joûnié
Baabda
Aley
Damour
Sidon
Tyre
Naqoura
Nahariyya
ISRAEL
Zahlé
Chtaura
Rayak
Baalbeck
Hermel
Qaa
Halba
Al 'Abdah
Bcharré
Aynata
Al Labwah
Al Qusayr
Damascus
Qatana
Al Kiswah
Baniyas
Qiryat Shemona
Al Qunaytirah
GOLAN HEIGHTS
(Israeli occupied)
UNDOF Zone
Marjayoûn
Jazzîn
Rachaiya
Qaraoun
Joub Jannine
Beit ed Dîne
Dûma
Aş Sanamayn
Aş Şawarah aş Şughrá
Burrâq
Al Quţayfah
Sa'sa'
Ad Dimâs
Gadot
Bint Jbail
Rmaich
1949 Armistice Line
Al Hamidiyah
Tall Kalakh
Qoubaiyat
Amioun
Doûma
Bikfaiya
Barja
Arqâr
An Nabaţiyah at Taḩta
Ḩimş
Base 802709AI (C00059) 6-00

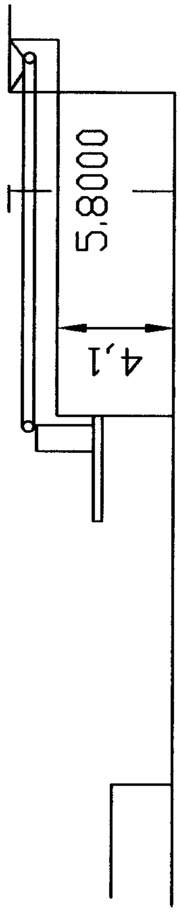

Akkar
Hermel
Tripoli
Koura
Zgharta
Bcharreh
Batroun
Jbail
Baalbeck
Kesrouane
BEIRUT
Metn
Baabda
Zahleh
Aaley
Chouf
West Bekaa
Jezzine
Rachaya
Saida
Nabatiyeh
Hasbaya
Marja-
youn
SOUR
Bent Jbail
N
0 20 40 60 Kilometers
LEGEND
Saida Caza name
Caza boundary
Study area
Mohafazats:
Beirut
Bekaa
Mount Lebanon
Nabatiyeh
North Lebanon
South Lebanon


SAIDA
NABATIYE
MARJAYOUN
BENT JBAIL
Villages included in SWTF
Municipalities of Caza of Tyre
Surrounding Cazas
Qasmiye
Bedias
El Bourgheliye
Deir Qanoun en Nahr
Toura
Tayr Falsay
Hmairi
Chehour
Marnaba
Abbassiyeh
Jennata
Maaroub
Srifa
Touairi
Sour
Borj el Chemali
Tayr Debba
Maarake
Barich
Niha
Yanouh
Bafliye
Selaa
Deir Kifa
El Bazouriye
Debaal
Jouaiya
Ain Baal
Chehabiye
Mjadel
Aaitit
Batoulay
Hanaouay
Mahroune
Deir Qanoun
Qana
Rmadiye
Chaaitiye
El Qlaile
Mazraat el Mechref
Deir Aames
Saddiqine
Recheknaniye
Aaiye
El Izziye
El Mansouri
Jabal el Botm
Majdel Zoun
Iskandaroun
Chamaa
Zebqine
Tayr Harfa
Jijim
Chihine
Hamoul
Marouahine
Naqoura
Aalma ech Chaab
Dhaira
Boustane
Yarine
N
W
E
S
0 2 4 6 Kilometers

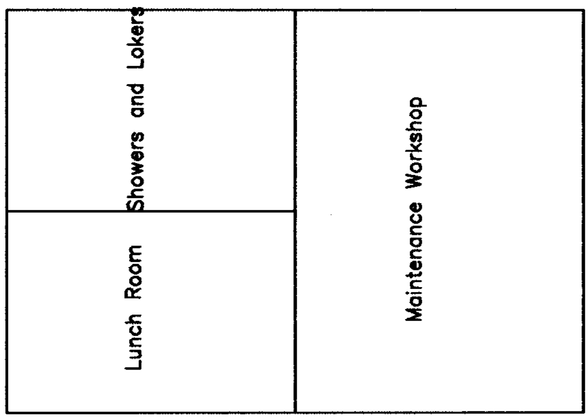
APPENDIX C
ARCHITECTURAL DRAWING FOR THE COMPOST FACILITY AT AIN BAAL, ACCESS ROAD NETWORK, AND LABORATORY TEST


Tipping Floor
Unloading Bays
Sorting Lines
Workers Facility and Workshop
Administration Building
Biofilter
Recycling Pits
Composting Bays
Curing Area
TIPPING FLOOR
RECYCLING BAYS
CURING BAYS
764
762
775
757
759
779
2
777

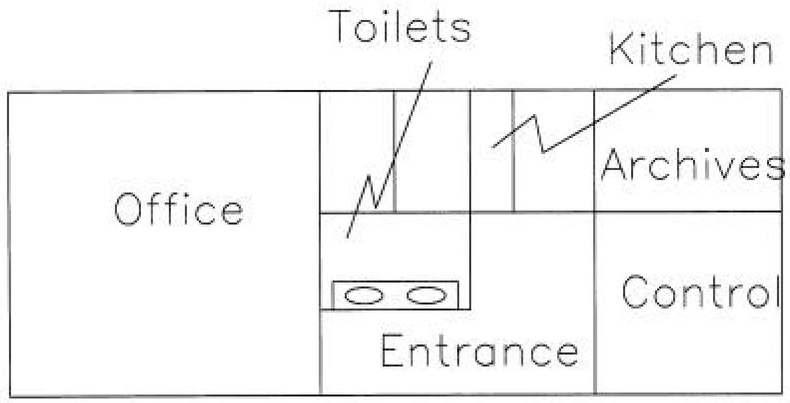

Unloading Zone
Composting Bays
Sorting Lines
Tipping Floor
Unloading Bay
Loading Zone



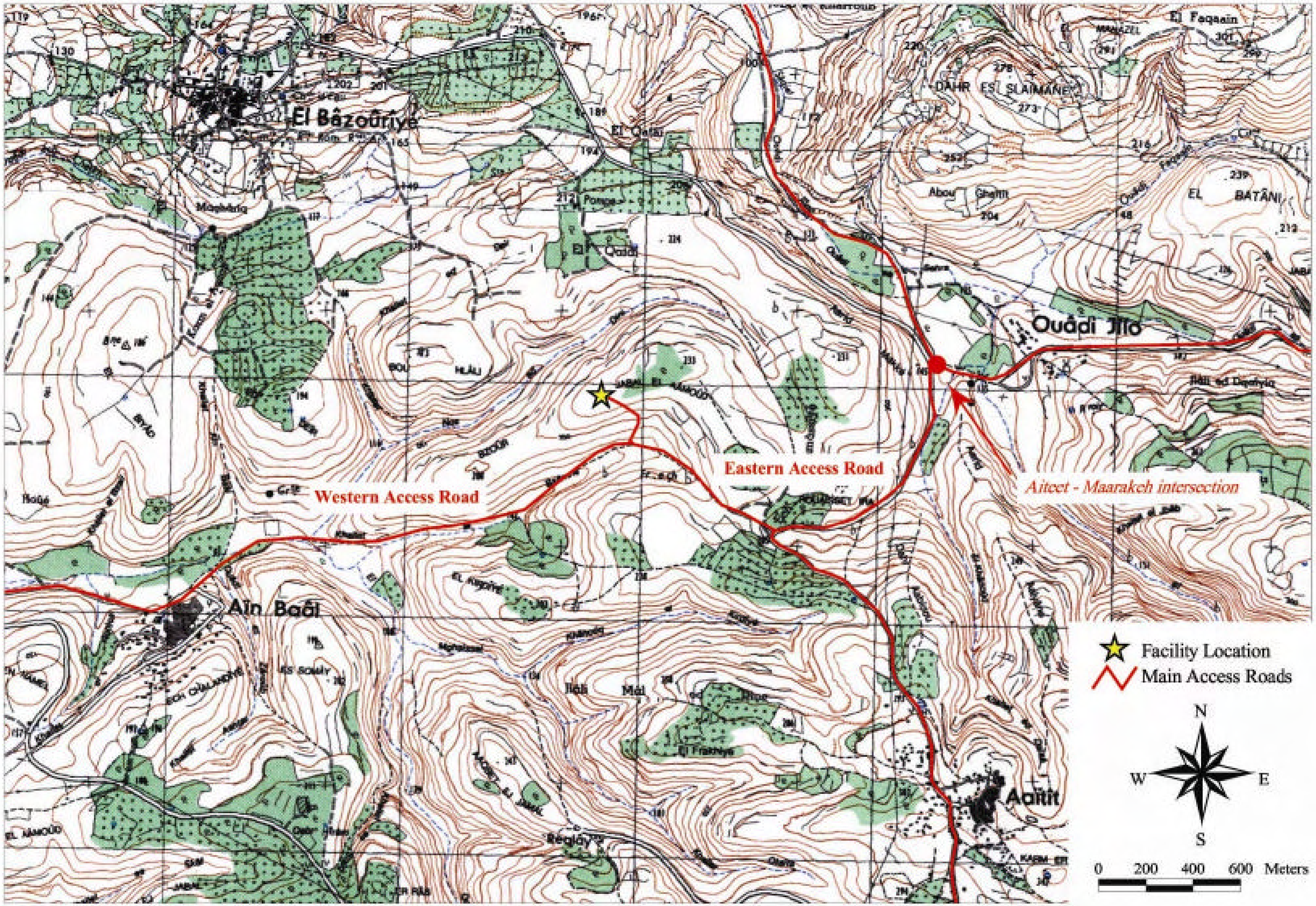
SECTION OF SORTING LINE

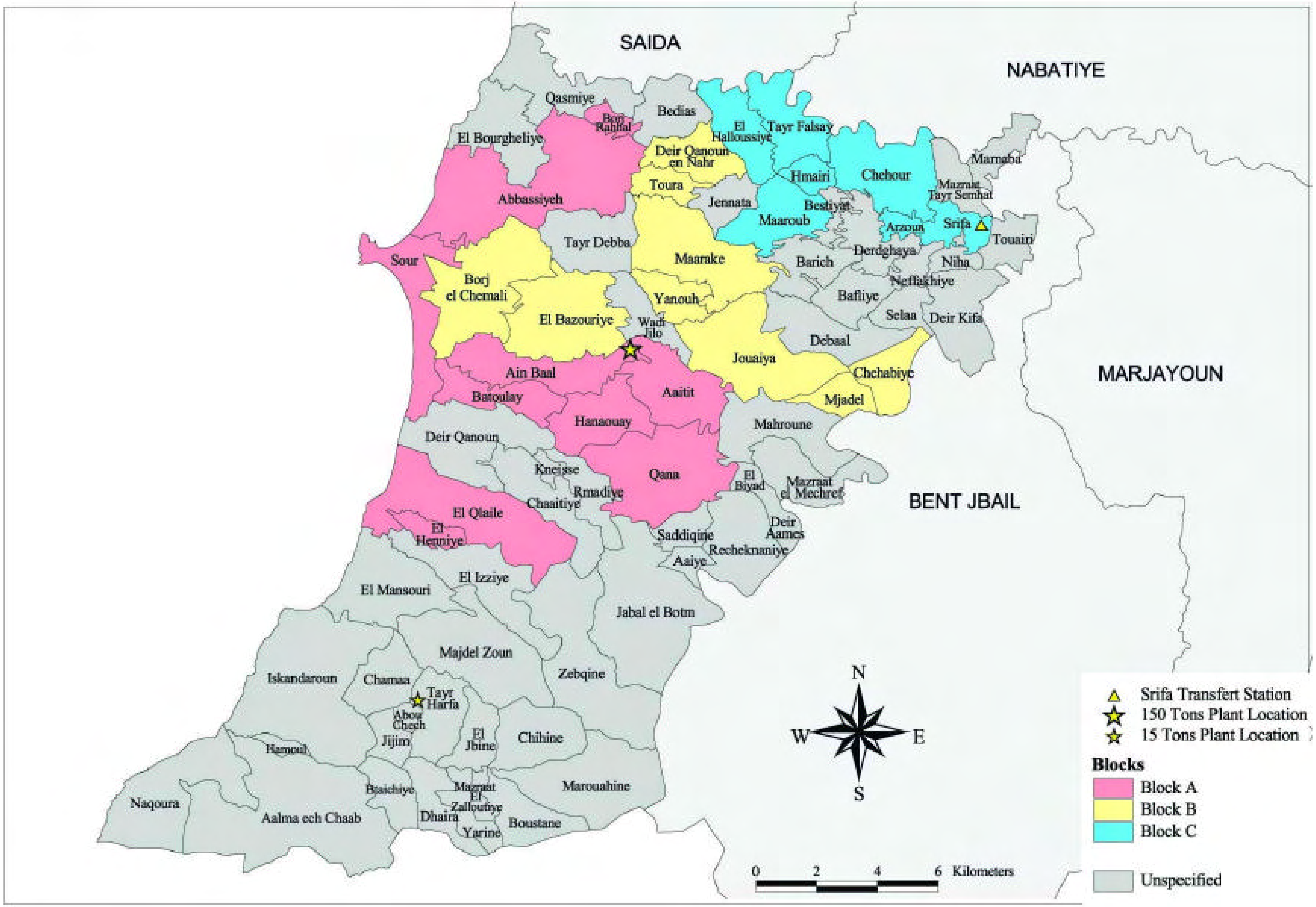


VORKSHOP AND WORKERS FACILITY



ADMINISTRATIVE BUILDING


El Bâzoûrîye
Ouâdi Jilo
Aïn Baâl
Aaïtit
El Faqaain
DAHR ES SLAIMANE
EL BATÂNI
Western Access Road
Eastern Access Road
Aiteet - Maarakeh intersection
Facility Location
Main Access Roads
N
S
E
W
0 200 400 600 Meters


SAIDA
NABATIYE
MARJAYOUN
BENT JBAIL
Qasmiye
Bedias
El Bourgheliye
Abbassiyeh
Tayr Debba
Sour
Borj el Chemali
El Bazouriye
Wadi Jilo
Ain Baal
Batoulay
Aaitit
Hanaouay
Deir Qanoun
Kneisse
Rmadiye
Chaaitiye
Qana
El Qlaile
El Henniye
El Izziye
El Mansouri
Saddiqine
Aaiye
Recheknaniye
Deir Aames
El Biyad
Mazraat el Mechref
Mahroune
Jabal el Botm
Majdel Zoun
Zebqine
Iskandaroun
Chamaa
Tayr Harfa
Abou Chech
Jijim
El Jbine
Chihine
Hamoul
Btaichiye
Marouahine
Naqoura
Aalma ech Chaab
Dhaira
Yarine
Boustane
Deir Qanoun en Nahr
Toura
Jennata
Maarake
Yanouh
Jouaiya
Chehabiye
Mjadel
Debaal
Barich
Bafliye
Selaa
Deir Kifa
Nefiakhiye
Niha
Derdghaya
Touairi
Srifa
Arzoun
Mazraat Tayr Semhat
Marnaba
Chehour
Hmairi
Bestiyat
Maaroub
El Halloussiye
Tayr Falsay
N
S
W
E
0 2 4 6 Kilometers
Srifa Transfert Station
150 Tons Plant Location
15 Tons Plant Location
Blocks
Block A
Block B
Block C
Unspecified

Laboratory Tests Not Available

APPENDIX D
CONFIRMATION OF LAND OWNERSHIP; LAND PARCELLATION; AND OTHER LEGAL DOCUMENTS

APPENDIX E
ORDINANCE ON THE QUALITY ASSURANCE AND UTILIZATION OF COMPOST IN AGRICULTURE, HORTICULTURE AND LANDSCAPING.

Ordinance on the quality assurance and utilization of compost in agriculture, horticulture and landscaping

OBJECTIVES

The main objective of this ordinance is to create a legal framework for the production and utilization of compost and to improve at long term the recycling quota of organic material from waste. Therefore the Compost Ordinance regulates the application of treated and untreated bio-wastes and mixtures on land which is used in agriculture, horticulture, viticulture or forestry and it treats as well the use of compost, having a low quality, in landscaping and in landfill operation. It also covers suitable raw materials, quality and hygiene requirements, and treatment and investigations of such bio-wastes and mixtures. The Compost Ordinance regulates – from a precautionary perspective – the waste side (e.g. heavy metals) of the application.

AREAS OF APPLICATION

All treated and untreated biodegradable wastes from animals or plants, and all mixtures under the collective name of 'biowastes' applied to soils through agriculture, forestry or horticulture, landscaping and landfill operations are subject to the requirements of the compost ordinance.

DEFINITIONS

Additives: Materials to improve structure and to form clay-humus-complexes of compost (e.g. basalt meal, calcium bentonite, clay granulate, bone meal, horn meal, lime etc.), are added to raw compost materials for their nutrient or bulk qualities.

Bio-waste: Term used to describe the composting of separately collected organic domestic waste. It is collected separately from households in so-called 'bio bins', which are sometimes also known as compost bins or 'green' bins. Biowaste normally contains a certain amount of garden or green waste (up to 40%).

Bulk density: Density of loosely heaped material per volume unit in t/m³.

C/N-ratio: Ratio of carbon to nitrogen (total content); used to describe nutrient or decomposing ability of organic waste.

Compost: Product of decomposition process resulting from the aerobic treatment of organic material.

Compost windrows: Stacking of organic matter intended for composting in regular piles of triangular or trapezoid cross-section.

Contaminants / pollutants: Organic and inorganic materials in concentrations harmful to health and environment.

Degree of maturation: Identification of the current status of the decomposition process to characterise the progress of maturation. Scale ranges from I(compost raw material) to V (mature compost).

DEWAR Self-Heating Test: used to determine maturation stage of compost by investigating temperature rise of compost under standardized conditions;

Dry substance: Amount of substance after removal of water; measurement after drying at 105°C until constant weight is reached.

Impurities: Unwanted substances which are disturbance factor either technically or optically and which lower the quality of compost (e.g. stones, glass, metal, plastics).

Fertilizers: Substances intended to be added directly or indirectly to plants to promote growth, increase harvests or increase quality of crops.

Food waste: Waste from restaurants and large kitchens (larger than a normal household) which is normally collected in addition to the regular bio-bin system, in special containers. (Those wastes have to undergo extra treatment (70 °C for one hour) to guarantee sanitation which has to be done before they are treated in composting or digestion plants.)

Green waste: Pure organic residues from gardens and parks.

Heavy metals: Lead, Chromium, Nickel, Zinc, Cadmium, Copper and Mercury.

Horticulture: Capital and/or labour intensive form of agricultural cultivation often carried out in relatively small areas; often close to houses.

Household waste: Waste from households and similar waste from small businesses which are regularly collected, transported, treated and disposed.

Humus: The end product of aerobic biological decomposition processes such as composting.

Immature Compost: Compost in an early stage of decomposition which is characterized by maturation stages I and II

Mature Compost: Compost in an advanced stage of decomposition which is characterized by maturation stages IV and V (i.e. temperature rise smaller than 10°C at DEWAR-self-heating test.)

Native organic waste: Organic waste consisting of materials in their natural state.

Pathogen: Causing diseases.

Quality criteria: Description of certain quality characteristics and contents for compost.

Sanitizing: Process stage with the aim to disinfect material.

Organic fraction of household waste: Fraction of household waste containing predominantly organic matter as result of previous sieving and sorting process.

Semi-mature Compost: Compost in an incomplete stage of decomposition which is characterized by maturation stages III (i.e. temperature rise between 10°C and 20°C at DEWAR-self-heating test.)

SUITABLE RAW COMPOST MATERIAL

Suitable raw material is listed in the enclosed Annex of this Ordinance and includes the following groups of organic waste materials:

- Source separated organic municipal waste
- Organic fraction of household waste
- Green waste
- Residues from the food and animal feed industry
- Mineral composting additives.

A detailed list of waste types suitable for composting either as organic matter or as additive is given in the enclosed annex. If the operator of the composting plant intends the composting of wastes not listed in annex than he requires a specific authorization by the Ministry of Environment.

TYPES AND QUALITY STANDARDS FOR COMPOST

4 different types of compost are defined by quality criteria presented in table 1 (overview) to table 5 are valid. The range goes from Grade A compost, being a high quality compost and most appropriate for any agricultural utilization, to Grade D compost which must only be used on controlled landfills as intermediate cover or as landscaping material. The product of a composting process which does not correspond to the specifications of Grade D compost cannot be considered as an organic recycling-product and must be categorized as waste.

Table 1: Definition of compost types (overview)

Type of compost	Characteristics	Main Fields of Utilisation
Grade A	Main characteristics are: Native organic raw material, generated by source-separation; Mature compost (maturation degree V); hygienised, biologically stable; Corresponds to European Eco-label for composts	Food production in Agriculture Horticulture Viticulture
Grade B	Main characteristics are: 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 Viticulture
Grade C	Main characteristics are: 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 soil can be excluded; e.g. in Landscaping Recultivation of abandoned quarries Soil for green space along traffic roads
Grade D	Main characteristics are: 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 recultivation material on controlled landfills and as intermediate layer of deposited waste. No to be utilized as top layer of recultivated landfill sites in order to prevent contamination of humans, fauna and flora as well as spreading of pollutants.

Table 2: Quality standard for compost, Grade A

Quality characteristics	Quality requirements			
Origin of raw material	Source-separated organic material from households or agriculture; Mechanical sorting of impurities prior to composting process			
Hygiene	Exposure of entire material to temperatures > 65°C for at least 7 days during thermophilic decomposition phase (sanitizing phase). Extensive exclusion of germinable seeds and sprouting plant parts (less than 1 germinable weed-seed in 2 liters of compost). Exclusion of Salmonellae Faecal coliforms must be < 1,000 MPN/g of total solids calculated on a dry weight basis			
Man-made impurities2	Maximum of 0.5 weight-% in dm; plastic less than 0.1 weight-% in dm (selection of impurities in compost fraction > 2 mm)			
Stones	Maximum of 5.0 weight-% in dm (selection of stones in compost fraction > 5 mm)			
Plant compatibility	50% compost with 50 % standard soil media; germination rate of barley seeds must pass > 90 % after 5 days			
Decomposition degree	Maturation degree V			
Water content	Loose material: maximum 45% weight Bagged material: maximum 35 % weight Higher contents of water are admissible for composts with more than 40% organic matter			
Organic matter	at least 15 % weight-% in dm, measured as volatile solids			
Plant nutrients and salt content	max. 2.5 g/l Salt content <300 mg/l Minimum nitrogen (sum NO3/NH4-N) <1.200 mg/l Soluble phosphate P2O5 <2.000 mg/l Soluble potassium K2O <500 mg/l Soluble chloride <250 mg/l Soluble sodium			
Contents of heavy metals	Guide values3 (mg/kg dm)			
	Lead	< 150	Cadmium	< 1.5
	Chromium	< 100	Copper	< 100
	Nickel	< 50	Mercury	< 1.0
	Zinc	< 400		
Parameter for declaration to utilizer	Mature compost from source – separated organic waste Producer Grain size and bulk density (volume weight) C/N-ratio pH value Salt content Plant nutrients total (N, P2O5, K2O, MgO, CaO) Plant nutrients soluble (N, P2O5, K2O) Organic matter Net weight or volume Information for a suitable application (method and application rate)			

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 3: Quality standard for compost, Grade B

Quality characteristics	Quality requirements			
Origin of raw material	Organic raw material, generated by mechanical treatment of mixed household waste; minimum standard of treatment: sieving, hand-sorting, magnetic separation of impurities by drum-magnets or equivalent equipment			
Hygiene	Exposure of entire material to temperatures > 65°C for at least 7 days during thermophilic decomposition phase (sanitizing phase). Extensive exclusion of germinable seeds and sprouting plant parts (less than 1 germinable weed-seeds in 2 liters of compost). Exclusion of Salmonellae Faecal coliforms must be < 1,000 MPN/g of total solids calculated on a dry weight basis			
Man-made impurities2	Maximum of 0.5 weight-% in dm; plastic less than 0.1 weight-% in dm (selection of impurities in compost fraction > 2 mm)			
Stones	Maximum of 5.0 weight-% in dm (selection of stones in compost fraction > 5 mm)			
Plant compatibility	25% compost with 75 % standard soil media; germination rate of barley seeds must pass > 90 % after 5 days			
Decomposition degree	Maturation degree IV or V			
Water content	Loose material: maximum 45% weight Bagged material: maximum 35 % weight Higher contents of water are admissible for composts with more than 30% organic matter			
Organic matter	at least 15 % weight-% in dm, measured as volatile solids			
Plant nutrients and salt content (only required if compost is used as substrate for production of potting soil)	max. 2.5 g/l Salt content <300 mg/l Minimum nitrogen (sum NO3/NH4-N) <1.200 mg/l Soluble phosphate P2O5 <2.000 mg/l Soluble potassium K2O <500 mg/l Soluble chloride <250 mg/l Soluble sodium			
Contents of heavy metals	Guide values3 (mg/kg dm)			
	Lead	< 150	Cadmium	< 1.5
	Chromium	< 100	Copper	< 100
	Nickel	< 50	Mercury	< 1.0
	Zinc	< 400		
Parameter for declaration to utilizer	Mature compost from mixed waste Producer Grain size and bulk density (volume weight) C/N-ratio pH value Salt content Plant nutrients total (N, P2O5, K2O, MgO, CaO) Plant nutrients soluble (N, P2O5, K2O) Organic matter Net weight or volume Information for a suitable application (method and application rate)			

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 4: Quality standard for compost, Grade C

Quality characteristics	Quality requirements
Origin of raw material	Organic raw material, generated by mechanical treatment of household waste; minimum standard of mechanical treatment: sieving, hand-sorting, magnetic separation of impurities by drum-magnets or equivalent equipment; Appropriate organic waste from industrial sources (e.g. residues from the food and animal feed industry) after proper treatment
Hygiene	Exposure of entire material to temperatures > 60°C for at least 7 days during thermophilic decomposition phase (sanitizing phase). Exclusion of germinable seeds and sprouting plant parts to a large extend (less than 5 germinable weed-seeds in 2 liters of compost). Exclusion of Salmonellae Faecal coliforms must be < 2,000 MPN/g of total solids calculated on a dry weight basis
Man-made impurities[2]	Maximum of 1.0 weight-% in dm; plastic less than 0.5 weight-% in dm (selection of impurities in compost fraction > 2 mm)
Stones	Maximum of 10.0 weight-% in dm (selection of stones in compost fraction > 5 mm)
Plant compatibility	25% compost with 75 % standard soil media; germination rate of barley seeds must pass > 75 % after 5 days
Decomposition degree	Minimum maturation degree III
Water content	Loose material: maximum 40% weight Bagged material: maximum 30% weight Higher contents of water are admissible for loose composts with more than 30% organic matter
Organic matter	at least 20% weight-% in dm, measured as volatile solids
Contents of heavy metals	Guide values[3] (mg/kg dm) Lead < 300 Cadmium < 3 Chromium < 200 Copper < 200 Nickel < 100 Mercury < 2.0 Zinc < 1000
Parameter for declaration to utilizer	Semi-mature compost; only to be used for landscaping, rehabilitation of abandoned quarries and green space along traffic roads Producer Grain size and bulk density (volume weight) C/N-ratio pH value Salt content Plant nutrients total (N, P2O5, K2O, MgO, CaO) Organic matter Net weight or volume Information for a suitable application (method and application rate)

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 5: Quality standard for compost, Grade D

Quality characteristics	Quality requirements
Origin of raw material	Organic raw material, generated by mechanical treatment of household waste; minimum standard of mechanical treatment: sieving, hand-sorting, magnetic separation of impurities by drum-magnets Appropriate organic waste from industrial sources (e.g. residues from the food and animal feed industry) Food waste after sanitation at 70°C for 1 hour or more
Hygiene	Exclusion of Salmonellae Faecal coliforms must be < 2,000 MPN/g of total solids calculated on a dry weight basis
Man-made impurities2	No specific requirements
Stones	No specific requirements
Plant compatibility	No specific requirements
Decomposition degree	Minimum maturation degree II
Water content	Loose material: maximum 40% weight Not to be bagged
Organic matter	No specific requirements
Contents of heavy metals	Guide values3 (mg/kg dm) Lead < 750; Cadmium < 7.5 Chromium < 500; Copper < 500 Nickel < 250; Mercury < 5.0 Zinc < 2000
Parameter for declaration to utilizer (here: landfill)	Immature compost; only to be used on landfills as intermediate cover and as rehabilitation material; not to be used as top layer Producer Grain size and bulk density (volume weight) Net weight or volume Information for a suitable application (method and application rate)

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

UTILIZATION OF COMPOST GRADE A AND GRADE B

Nutrients

Application rates, given for one year, shall specify that the amount of compost spreaded per year should not exceed the following limits:

- 17g/m2 total nitrogen
- 6g/m2 phosphate
- 12g/m2 potassium oxide

In addition to those limits the following figures and comments presented in table 6 and 7 should be used as an orientation for the specific use of compost from organic waste. Table 6 refers to subtropical climate as it can be found along the coastline of Lebanon, while the values presented in table 7 are to be applied for agricultural land in irrigated arid zones with a high rate of mineralization.

MONITORING PROCEDURE

Bill of Delivery

In order to document a properly executed process, the compost plant has to give a bill of delivery to the person responsible for application to the soil and to send every 3 months a report on the utilization of compost to the following authorities:

- Ministry of Environment,
- Ministry of Agriculture,
- Ministry of Health,
- CDR.

The report should outline the absolute amounts of utilized compost, the specific type of agricultural or other utilization and the specific amount of utilized compost per costumer.

Table 6: Recommended use for compost from organic waste (coastal zones)

Area of use	Vegetation	Purpose	Amount1 kg FS/m²	Frequ-ency	Method
Horti-culture	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
Viticulture	Fertilizing of existing vineyard	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 cultivation	Supply of humus, fertilizing	3 – 4	Every 2 years	Spread or work 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, supply of humus, soil improvement	3 – 6	Annually	Work in superficially
	Cereals	Fertilizing, supply of humus, soil improvement	2 – 4	Every 2 years	Work in superficially
	Pasture	Fertilizing, supply of humus, soil improvement	3 – 6	Every 2 years	Work in superficially

[1]: The amounts refer to fresh compost, with a dry substance content of 60 %. The formula for t/ha is achieved by multiplying by the factor 10 (e.g.: 4 kg/m² = 40 t/ha). The formula for with a volume weight of e.g. 700 kg/m³ is achieved with the reciprocal value (e.g. 1/0.7= around 1.42). Example: 4 kg/m² = 5.7 l/m² = 57 m³/ha.
[2]:FS = fresh substance

Table 7: Recommended use for compost from organic waste (interior parts of Lebanon)

Plant culture	Amount (kg FS/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

[1]: (see table 5)

Frequency of investigations

The frequency of the investigations during the first year of a composting plant and the subsequent on-going monitoring procedure depends on the plant input capacity (see Table 8). At least four inspections should be carried out during the first year of operation – one for every season – to assess the essential quality characteristics over the course of the year. At least one sample should be taken every three months.

Table 8: Frequency of investigations within the monitoring procedure (per year)

Plant input (tons/year)	Number of analysis during first year	Number of analysis after first year
Up to 2,000	4	4 analyses/year
2,001 to 5,000	5	4 analyses/year
5,001 to 10,000	10	8 analyses/year
More than 10,001	12	12 analyses/year

External monitoring

Within the framework of the quality monitoring procedure, sample-taking and analyses must be carried out by external monitoring laboratories that should be licensed by the Ministry of Environment. Licensing of the independent outside monitors is subject to verifying certain preconditions of the recognized laboratories (for example taking part in an interlaboratory ring test).

In-house analysis

The compost producer also does its own analyses. He is obliged to verify the safe hygiene status of the decomposition or the digestion process by documenting accurately the temperatures achieved during the first intense decomposition phase. Within the framework of the monitoring procedures carried out by external laboratories the correct measuring and documentation of those temperature protocols is examined in irregular intervals but at least once a month. The laboratory should produce a quarterly report on the results of their examinations. This report should be presented to the Ministry of Environment at the latest in the third week of the following month.

Further in-house analyses can be carried out on a voluntary basis. The determination of characteristics important for the application of compost and digestion residues which can be ascertained using simple techniques, such as water content, weight by volume, salt content, pH value, plant compatibility and extraneous matter in the end product, is recommended.

TEST METHODS

In the following the procedures to be applied can only be outlined in a few sentences.

Sampling procedure

In order to produce a representative sample 12 single samples (5 – 10l per sample) should be taken at 12 different spots of the compost heap to be examined. After thorough mixing of those samples the material is then reduced by dividing it repeatedly into quarters until the remaining representative sample has a volume of around 4 l. This sample, it is then again divided into 4 separate samples. One sample is used for the determination of the water content. The other samples are dried in an oven at a temperature of 105°C until no further loss of water is detectable. They are then filled into airtight plastic bottles and conserved at a temperature level of a few degrees Celsius.

Determination of water content

The water content is determined according to the international standard ISO 11465 by drying 2 samples each having a quantity of around 100 g under an infrared-light and measuring permanently the weight. As soon as there is no further loss in weight the drying-process is stopped. The weight determined before and after the drying procedure is then used for the determination of the water content.

Determination of man-made impurities

The content of man-made impurities is determined by sieving a dried sample of around 200 g at a screen size of 2 mm. Then man-made impurities such as glass, metal an plastic are separately sorted by using tweezers. The plastic fraction is then weighed apart from the other fractions.

Determination of stones

The content of stones is determined by sieving the dried sample of around 200 g at screen size of 5 mm. Stones are then sorted by using tweezers.

Determination of maturity grade

The maturity of compost is determined by carrying out the DEWAR self-heating test. This test uses a standardized steel container that holds approximately 1 litre of compost. As with any test, the compost sample moisture content may need to be adjusted prior to incubation. A maximum-minimum thermometer is then inserted to about 5 cm of the bottom of the container which is left to stand at room temperature (20 °C) for a period of at least 5 days and no more than 10. The highest temperature of the compost sample is recorded daily. The results are calculated as maximum temperature rise during the test period. The maturity is then expressed as number ranging between I (fresh compost) and V (mature compost).

Determination of plant compatibility

In order to determine the plant compatibility of compost the germination of barley seeds in a mixture of compost and standard soil must be greater than the germination rate of barley in a control sample (standardized soil) and the growth rate of plants grown in a mixture of compost and soil must not differ more than 50 percent in comparison with the control sample.

Determination of organic matter

In order to determine the content in organic matter three samples of dried compost with 10 g /each are filled into temperature resistant ceramic vessels. The vessels are then set into a laboratory oven and exposed to a temperature of 750°C. After 3 hours all the organic material is burnt up and the amount of organic matter can be then calculated by weighing the totally mineralized residue in the vessels.

Determination of heavy metals

The determination of the heavy metal content is determined according to the international standard ISO 11047.

Determination of nutrients, pH and salt content

The determination of nutrient content is carried out according to test methods 86/

278/EEC.

Annex: Suitable organic waste and mineral additives

Name of waste type	Key according to EWC1	Examples
	I Waste with a high percentage of organic material	
Waste from plant tissue	02 01 03	Wheat dust Fodder waste
Animal faeces, urine and dung (including spoilt straw)	02 01 06	Chicken droppings Liquid manure from cows Dung Used straw
Forestry waste	02 01 07	Bark Wood, wood chippings
Waste unsuitable for consumption or processing (Food processing)	02 03 04	Spoilt foodstuff Residues from preserving factories Residue from oil seeds
Undefined waste	02 03 99	Sludge from consumable oil production Residues from spices Residue from potatoe, corn or other starch production
Materials unsuitable for consumption	02 05 01	Spoilt foodstuff
Undefined waste	02 05 99	Whey
Materials unsuitable for consumption or processing	02 06 01	Spoilt foodstuff Dough remains
Waste from wshing, cleaning of mechanical grinding of raw material	02 07 01	Used filters and adsorption masses, active and siliceous earth
Waste from distilling spirits	02 07 02	Fruit, wheat and potato pulp Sludge from distillery
Undefined waste	02 07 99	Malt Hops Liquid residue and sludge from breweries Sludge from wine making Wine remains Yeast and similar residues
Bark and cork waste	03 01 01 03 03 01	Bark
Sawdust	03 01 02	Sawdust and wood shavings
Shaving, chippings, ends of planks, pressed wood and veneer	03 01 03	Sawdust and wood shavings
Waste from untreated textile fibers and other natural fibers, primarily from plant origin	04 02 01	Cellulose fiber waste Plant fiber waste

[1] EWC: European Waste Catalogue

Name of waste type	Key according to EWC1	Examples
Waste from untreated textile fibers, primarily of animal origin	04 02 02	Wool waste
Undefined waste	07 05 99	Marc from medicinal plants Myceliums Remains from fungus remains
Solid waste from first filtration and sievings	19 09 01	Fishing, mowing and raking remains Protein waste
Paper and cardboard	20 01 01	Used paper
Organic, compostable kitchen waste, fractions collected separately	20 01 08	Kitchen and canteen waste
Compostable waste	20 02 01	Garden and park waste waste from landscaping and forest clearances plant remains
Mixed settlement waste	20 03 01	household waste
Market waste	20 03 01	source separated biodegradable fraction suitable for utilization
II Mineral additives		
Calcium carbonate sludge which does not conform to specifications	02 04 02	Carbonisation sludge
Sludge from decarbonisation	19 09 03	Sludge from water softening
(no waste)	---	Lime Bentonite Rock dust Sand Clay

APPENDIX F
COMPOST RELATED INFORMATION

Compost Essential for Soil:

The organic material in household waste is a resource that should be returned to nature to maintain soil structure and productivity. This is an important step towards a sustainable society in harmony with the eco-cycle.

Humus and organic fertilizers are essential components of sustainable agriculture and forestry. They build the fertility of soils. Humus is the basis for all plant life.

Good quality compost and organic fertilizers are extremely valuable soil amendments, which improve a broad range of soil properties. Increased fertility and resistance to plant disease are achieved by improving the soil's porosity, structural and thermal stability, water retention and resistance to wind and water erosion, and by stimulation of the soil biology.

Humus forms the basis for all life

It is the humus which incorporates all of the prerequisites for the establishment of natural life. Usually the humus layer forms approximately 4% of the topsoil. When the humus layer falls below approximately 1%, erosion will commence and the soil is unable to retain its moisture or nutrients. A seed that falls on soil that lacks humus has much greater difficulty in establishing itself.

To increase our understanding of the importance of humus, it may help to examine a greatly enlarged picture of the mycorrhizae, or fungal mycelium, that is established around the roots of a young pine seedling. These mycorrhizae can only develop in the soft, moisture-containing humus. Via a complex interaction with the mycorrhizae, nutrients are transported to the root system and the plant grows stronger. Without this root system, the plant finds it harder to absorb nutrients and water and will perhaps not survive.

Energy

Think of leaves under a tree in the autumn. Everybody knows that if you gather up these leaves and make a fire, they will flare up and burn. Energy is released in the form of heat. If these leaves are not burnt, what happens to this energy? By the time the spring arrives, most of the leaves are gone. So is the energy also gone? Has the energy disappeared?

Nature strives to use as little energy as possible. These leaves are decomposed by micro-organisms to form compost and thus nourishment for the soil. An exceedingly small amount of heat is emitted when the micro-organisms decompose the leaf. The majority of the energy is left behind in the nutrients and in the humus and is transferred to new plants. The energy that was generated when the leaves were burned is now, instead, "growing power" and, together with the Sun, provides new energy.

APPENDIX G
ALTERNATIVE COMPOSTING TECHNOLOGIES (ADENSYS & BEDMINSTER)

1- The Process of Bedminster Corp of USA:

The Bedminster Bioconversion Corp provides communities with a cost-effective patented technology that transforms the organic fraction of waste stream from an environmental liability into an asset of significant value. This valuable organic material will rebuild the soil by introducing rich sources of the most fundamental building blocks of fertility.
The Six Steps of the Bedminster Process are the following:

Step 1 - Take In The garbage trucks or pickups deposit their load at the tipping floor of the facility.

Step 2 - Waste Preparation & Digester Loading
The solid waste is examined, and unacceptable items (bulky appliances, plastic bottles, tin cans, etc.) are manually removed from the waste stream. The mixed waste is then loaded into the first compartment of the digester, a rotating drum with three consecutive compartments.

Step 3 - Processing of Garbage
The mixed waste spends one day in each of three compartments in the digesters. Air is continuously pumped counter-current to the mix. Within the digesters, an accelerated, natural process of pathogen reduction and waste breakdown is accomplished.

Step 4 - Digester Unloading & Product Separation
The processed materials are unloaded from the digester at the end of three days and are taken to a trommel screen which separates rough compost from the non-compostable materials. The non-compostable materials are removed from the compost process and are separated into the different recyclable and non-recyclable components.

Step 5 - Compost Curing
The compost is taken from the trommel screen to the curing floor where large piles of the compost are cured for 30 or more days. During this period the piles are aerated and turned to ensure maximum composting effectiveness.

Step 6 - Final Screening
The cured compost is taken from the curing floor and undergoes a final screening process which removes glass and other fine debris from the desired compost. After this final screening, the compost is taken to a waiting floor and is ready for the public as an EPA certified unrestricted commodity.

The Process in Details:

The incoming waste

The domestic refuse from the truck is emptied on the floor.
No domestic refuse is stored at the plant, but instead it is loaded into the drum on the same day as it arrives. Loading into the drum is carried out using a conveyer.

Feeding of domestic refuse and other organic material into the drum is carried out manually in accordance with tried and tested formulas in order to create the ideal environment for the microbes as regards moisture content and the carbon/nitrogen ratio.

Design of the drum

The composting drum is divided into three compartments, and the interior walls within the drum are constructed in such a way as to keep the batches apart. The drum is provided with transfer boxes for moving the material inside the drum and with controlled doors for emptying the material into the output plate.

During loading, transfer of the material inside the drum and while the material is being emptied, the composting drum rotates continuously at a variable speed of 0.4-1.2 revolutions per minute.

Pre-sorting

The incoming materials are pre-sorted. Plastic bags are opened, and metals, plastics and other undesired material are conveyed to different containers for reuse or recovery. Magnets and eddy-current generators can be used in this separation process.

Inside the drum

Composting is an aerobic process and requires a continuous supply of air.
The mixing of waste, any other solid material (such as sawdust) and water in the drum is carried out according to tried and tested formulas in order to create the ideal environment for the microbes as regards the moisture content and carbon/nitrogen ratio.

Inside the drum, the micro-organisms break the organic material down to crude compost in three days. Temperature, humidity, carbon dioxide content and acidity (pH) are measured. The process can be controlled so that the breakdown of the material occurs in the desired manner by varying the drum rotation speed and controlling the air and moisture conditions. No chemicals or heat are added to the drum.

The material spends 24 hours in each compartment. Heat is generated in the drum as a result of the microbial activity and the usual temperatures are 60° C, 70° C and 50° C in the first, second and third compartments, respectively. Temperature and time guarantee that any infectious agents are killed, which means that any bacteria that may be harmful to humans will die during the process - i.e. the material is sanitized.

Sorting and screening of the crude compost after three days in the drum

The crude compost is sorted and screened so that any remaining inorganic materials are segregated before the curing stage. Magnetic materials and materials with particles that are larger or denser than the compost grains are segregated using such devices as trommel screens, (de-stoners and magnetic separators- optional).
The compost is then moved to the curing hall.

The sorted inorganic material

The inorganic material that is segregated before and after the composting drum is used in different ways, depending on which waste management systems are available locally. Aluminium and other metal cans, for example, can be sent for metal recovery. Recovered plastic can be sent for material recovery or energy recovery. Only a small part of the incoming material (less than 15%) usually needs to be landfilled.

The material that is reclaimed does not create any problems with regard to gas emissions, leachate or vermin.

Quality assurance programme

The entire process is continuously monitored to check incoming and outgoing materials. The ongoing analysis and testing of the materials throughout the entire process ensures the quality of the compost.

Curing stage

The curing stage takes place in open air where the compost is stored in windrows approximately 1.5 to 2 metres high. The compost continues to mature for around six weeks, during which time it is regularly turned, aerated and watered in order to optimise the maturation process.

During the curing phase a surplus of heat energy and carbon dioxide is produced. This can be used in various ways. Heat and carbon dioxide can be used in an adjacent greenhouse.

Storage and transport

The final compost will either be bagged or stored as bulk goods. Transportation of the finished products may be done by trucks.

Organic fertilizer

The finished compost will have a dry matter content (DMC) of around 65%. It is screened (e.g. to 4 mm) and the coarser fraction may be transported back to the composting drum. The portion of the compost that is smaller than 4 mm is cleansed of glass and heavier materials prior to distribution.
The compost can be nutrient-enriched if requested by the customers.

Properties of organic fertilizer

- they require less energy to produce than chemical fertilizers
- they are better than chemical fertilizers from an environmental point of view
- they are associated with less leaching of nutrients into the groundwater than chemical fertilizers
- they are long-acting (about 7 years)
- they provide the plant with nutrition according to its own specific growth requirements, and release nutrients in a way that is tailored to the plants' absorption capabilities
- they enrich and build up soil structure
- they are economical to transport and can be stored
- they can be nutrient-enriched according to the needs of different soils and plants
- they can be spread using existing machinery
- they are competitively priced

2- ADENSYS Inc. Composting Process in Stationery In-Vessels

The Stationary In-Vessel Composting technology is a controlled process of biologic decomposition of organic material under aerobic conditions. In other words, the decomposition will take place in the tightly closed vessels and no vermin will have access to the waste material. The process will produce compost and some inert material.

The basic steps of the ADENSYS Process are the following:

1- In the first place, garbage truck empties its load on the concrete floor of SWTP. Laborers first remove bulky recyclable material, such as large tin cans, home appliances, large plastic bottles and glass jars and various large metallic items.

2- Next the solid waste bags are put on a conveyor belt and the workers manually remove the recyclable material and place them in separate containers. The materials removed are plastic bottles, glassware, aluminum cans, shoes, textile and scrap rubber in addition to nylon bags and sheets. These recyclables are stored properly in separate cells and periodically sold or given away for recycling.

3- The bulk of solid waste left is a mixture of organic matter, paper and cardboard, and some inert material. They are pushed into the shredder, and after grinding pushed into the mixer, where bulking material is mixed with shredded biowastes.

4- Then with a front loader (a Bobcat) the mixture is taken into the composting vessel or chamber, where it undergoes aerobic degradation for 21 days. Air blown through the mixture to keep it in the aerobic state. In here aerobic microorganisms generate heat and a temperature of higher than 65 0C is maintained for more than 7 days; for destroying the pathogens and weed seeds that are available in waste material.

5- After this time, the fresh compost is screened with a Trommel screen and piled in open cells for curing for 15 to 20 days, before given out for agricultural use. Screening can be done also after curing, which is safer.

6- The separated non-degradable inert material can be returned back to the composting vessels or taken to the landfill.

The size and composition of the microbial population and prevailing ambient conditions (temperature, humidity, oxygen, C/N ratio) inside the vessel determine the rate and extent of the decomposition activity. The microbial population produces a large part of the heat released in the composting mass, the high temperature attained in the compost pile is the result of internal processes and not of external sources. Temperatures as high as 75 0C can be reached in the vessel when the ingredients and the composting parameters (air, humidity, C/N ratio) are in an ideal proportion. The success of the reaction is dependent on the careful control of the pH and temperature. The composting vessels are equipped with temperature sensors for monitoring the temperature fluctuations at all times, via a computer. Temperature, humidity and biodiversity of microorganisms are the most decisive factor in pathogen destruction, which is one of the objectives of the composting operation in addition to degradation and digestion of organic matter and reduction of organic waste volume and weight. The humidity in the waste stream is usually above 80%, which is held well within the organic structure of the compost mass, avoiding excessive leachate production. The aerobic fermentation of the waste inside the vessel prevents the formation of smelly emissions. No gaseous emissions are released from the composting process.

The produced leachate is channeled in a multiple pond, where it receives biologic treatment and then re-used in the curing process of the compost. Therefore, no pollutant goes out of the SWTP.

The cured compost can be further screened out with the trommel screen and sorted into two or three grades according to the particle size (less than 10mm, 10-15mm and 15-20mm). The 15-20 mm size compost can be used as initial bedding for reclaiming rocky land and used in forestation programs. The compost of particle size less than 10-15 mm can be used as soil builders and mild fertilizers for agricultural purposes. From every ton of fresh solid waste, about 300 kg of mature compost can be obtained. The matured compost will be a neutral matter and after its application on farmlands it will bring benefits to local farmers by boosting crop production. It will become a natural fertilizer and it will not create environmental impacts, such as contamination of soil or water resources.

The produced compost comply with the EPA standards, which are presented here below:

Regulatory maximums for Class 1 Compost, in ppm , Dry Weight:

Heavy metal	EPA 503
Cadmium	85
Selenium	100
Copper	4300
Lead	840
Mercury	57
Nickel	420
Arsenic	75

On the other hand, the reclaimed recyclable material from the upfront end of the treatment Process is sold to material recycling plants.

Environmental Pollution Issue:

The process does not generate effluents and any harmful gaseous emissions. Therefore, it does not create water and air pollution problems. This implies that the project does not have an impact on the surface and ground water resources. Compost leachate from the concrete surfaces of the maturation cells and from the composting vessels is collected by a drainage system into a watertight storage tank. Biologic treatment is given to the leachate and then it is sprinkled on the curing compost piles, for enhancing its humidity and quality. The odor problem of the plant is solved by installing a bio-filter. The final inert residues, which are less than 15% of the incoming waste, are bailed and landfilled. This will not create any harmful effect on the environment.

Advantages of the Stationary In-Vessel Composting Technology

- It is not land intensive.
- It maintains high temperature of 65 ^{o}C for more than 7 days.
- Pathogenic bacteria and weed seeds are killed effectively.
- Easily operated at rural level with semi skilled labor.
- The equipment is simple and low cost. It can be maintained locally. No special skills needed to operate the equipment.
- Less waste material to be landfilled, corresponding to 10-15% of the initial wastes.
- No surface or ground water pollution takes place because no leachate is discharged.
- No air pollution results because no gaseous emissions are produced.
- The composting process is a dependable biological digestion, replicating the natural phenomena of aerobic fermentation.
- Organic wastes are recycled into high quality compost, which is utilized in agriculture. This compost will boost crop production in the project area and all of it will be given to local farmers. There are enough lands in the project area to utilize all of the compost produced at the plant
- It accepts unsorted and unshredded waste.
- No severe odor and fly problems are experienced at the plant.
- This technology is modular. It is applicable to the needs of any size community, large or small. When the need arises the plant's capacity can be increased by adding a new composting chamber (a vessel).
- It is of particular interest in rural areas where open dumping and burning are the common solid waste disposal practice applied all over Lebanon.

The following Flow Chart presents the overall operation at in a Solid Waste Treatment Plant (SWTP) of ADENSYS Inc.

APPENDIX H
PUBLIC HEARING

APPENDIX I
CONSULTING FIRM DETAILS

List of Individuals and Institutions Involved in the Preparation of the EIA Report

The Environment Impact Assessment study of the project and the preparation of the EIA Report have been carried out by the Middle East Engineers and Architects (MEEA) Ltd., Consulting Environmental Engineers, based in Beirut since 1979.

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Experience of MEEA Ltd. in EIA Process

MEEA Ltd. - Consulting Environmental Engineers- has long experience in a wide range of environmental issues. The specific Experience that pertains to the EIA process are summarized here below:

- Conduction of the first *EIA Training Workshop*, for Ministry of Environment Lebanon (Capacity 21 Project), in June 1995. This was the first EIA workshop ever held in Lebanon, implemented jointly with Grontmij Consulting Engineers, our Dutch partners.
- Participation in the presentations of the *EIA Training Workshop II*, organized by the Capacity 21 Project of Ministry of Environment and implemented by CEMP of UK, in February 1996.
- MEEA prepared for the Ministry of Environment the *EIA Manual: Basic Procedures for EIA in Lebanon* in 1997, which describes the EIA Process in Lebanon.
- Since 1995, MEEA Ltd. has evaluated some EIA reports prepared by other consultants.
- Since 1996, MEEA experts have participated in several consultations on EIA process organized by Ministry of Environment.
- Representatives of MEEA Ltd. participated in three EIA Training Workshops on specific topics organized by UPP/MOE, sponsored by UN-METAP project and conducted by AUB professors, December 2000 – January 2001.
- During 2000-2005, MEEA Ltd. conducted 7 EIA studies and prepared the EIA Reports for solid waste treatment plants. Five of these were done for YMCA, for SW treatment plants in Akkar El-Attika, Mais El-Jabal, Bint Jbail, Nabatiyeh Al-Faouka, Maarakeh, Arab Saleem and Rashaya. Another EIA Repo The densified material will be used as raw material for producing poles, park benches, etc rt was prepared for the Municipality of Tourza, related to establishing a solid waste material recycling facility.
- During March-June 2004, MEEA prepared 4 EIA reports on wastewater treatment plants projects for YMCA.

Since 1997, MEEA Ltd. is pre-qualified with Council for Development and Reconstruction (CDR) for doing environmental studies.

MEEA team that conducted the EIA study

1- **Boghos Ghougassian:** MS in Environmental Science Engineering. Columbia University, NY, 1976.
2- **Lama Abdul Samad:** MS in Ecosystem Management, Environmental Sciences. American University of Beirut, Lebanon, 2001.
3- **Janine Maalouf:** BS in Geology. American University of Beirut, Lebanon, 2004.