Environmental and Social Impact Assessment

Upgrade of Ain Baal Solid Waste Treatment Facility

Council for Development and Reconstruction

Plot No. /765/, Ain Baal, Tyre, South Lebanon

December 2017

EXECUTIVE SUMMARY

Introduction

The objective of the Environmental and Social Impact Assessment (ESIA) study is to identify and assess the potential environmental and social impacts of the proposed development and consult relevant stakeholders to prepare an Environmental and Social Management Plan (ESMP) including mitigation measures, monitoring plans, as well as institutional roles and responsibilities for the operationalization of the ESMP.

The Ain Baal SWTF was established in 2004 to treat around 150 tons of waste per day. However, due to different operational challenges, it is currently treating around 70-80 tons/day. The proposed project comprises of upgrading the existing Solid Waste Management Facility (SWMF), located on plot /765/ at Ain Baal, to be able to treat 150 tons/day of municipal solid waste. This project is part of the Lebanese Municipal Services Emergency Project (LMSEP) project funded by the World Bank. The upgrade of the facility will increase the capacity and treatment efficiency of the composting facility and thus decrease the amount of waste that is sent to the landfills and open dumps.

According to Decree No. 8633/2012 “Fundamentals of Environmental Impact Assessment (EIA)”, such a project category requires an Environmental Impact Assessment study (EIA). In particular, the proposed project requires an ESIA as there is a need to assess, monitor and manage its intended and unintended environmental and social impacts of the development.

Administrative and Legal Framework

The administrative and legal framework assessment of this study discusses the related applicable legal provisions. The aim is to provide a review of relevant national legal instruments as well as legislation and regulations, and policy documents, which are applicable to the proposed project.

The main authorities involved in the Lebanese solid waste management sector are the Council for Development and Reconstruction (CDR), Ministry of Environment (MoE), Ministry of Interior and Municipalities (MoIM), the Office of the Minister of State for Administrative Reform (OMSAR) and concerned municipal unions and municipalities (the Union of Municipalities of Danniyeh for the case of the planned Danniyeh sorting and composting facility). Other institutions that are indirectly involved, mainly the Ministry of Finance (MoF), Ministry of Agriculture (MoA), and Ministry of Public Health (Having several institutions and authorities involved in the SWM sector results in several uncertainties regarding the roles and responsibilities and the levels of authority.

Public Participation

Public participation is a major requirement in the EIA study, which combines the concept of transparency with the rights of public awareness, and the involvement in any activity that may cause a change in existing conditions and environment. Public participation improves the quality of the information brought to the decision makers, and assists in identifying priorities and mobilizing local support.

For this purpose Geoflint organized two public hearing sessions at the Union of Tyre Municipalities for both the scoping phase and for the ESIA phase. An invitation letter to attend the public hearing session was sent to several stakeholders (MoE, municipalities, local residents…) and a public hearing invitation letter was also posted on the wall of the Union of Tyre Municipalities. The announcement described the project and expressed the readiness of the involved parties to receive feedback, complaints and suggestions, and to respond to any questions. In addition, the invitation was published in two official newspapers (Al Diyar and Al Akhbar), 15 days prior to the public consultation meeting.

Description of Proposed Project

The proposed project comprises of the upgrade of the existing facility to be able to efficiently treat 150 tons of municipal solid waste per day. A new design is being prepared for the Ain Baal SWMF which will upgrade the different sections of the facility. The modifications/enhancements in the treatment process are listed below:

- An additional sorting line and mechanical sorting technologies will be added to increase the efficiency of separation between the compostable materials and the inorganic wastes (recyclables and rejects).
- The composting area will be increased, the blowers will be maintained, and the compost turning machines will be added.
- The curing area will be increased where an additional metallic hangar will be installed and covered.
- A refining screen will be included for the final screening of cured compost.
- The existing biofilter will be demolished and replaced by a more efficient biofilter system. Also, an additional bio filter system will be installed near the composting zone.
- A wastewater treatment unit will be installed in order to treat generated leachate and condensate as a result of the process reactions.

Baseline Environmental Conditions

The environmental and social assessment recorded the existing conditions of the project area including physical, biological and socioeconomic conditions prior the project implementation and operation. Baseline data and field survey were conducted to describe the status of the following environmental receptors: air quality, water quality, soil quality, geological conditions, climate and meteorology, natural habitats and biodiversity, land-use/land-cover, acoustic environment, cultural resources, and socio-economic conditions.

Climate and meteorology

Ain Baal falls in the sub-humid bioclimatic zone, characterized by an annual average rainfall of 800mm/year which is considered as a medium range for Lebanon. Climatological data was obtained from the closest meteorological monitoring station which has been collecting data for the past years. The two stations have data recorded between years 1944 and 1970. The hottest months in the area are July and August and the coldest months are January and February

On the other hand, the mean monthly relative humidity is highest during January (73%) and December (72%) and lowest during September (63%) and June (64%). Annual precipitation in the coastal area of South Lebanon ranges from 620 to 800mm. Concerning the wind records, according to "Service Météorologique du Liban", the dominant wind direction is in the South and South West orientation.

Geology

The study area does not include major faults but some local fractures. Some minor faults pass from East to west at a distance of about 2000m to the South and 1500m to the East of the project site. These faults are trending NE-SW and had displaced the depositions in the area, but do not subject the project site for tectonic threats.

Hydrogeology

With respect to hydrogeology, no water resources are found within a 2000m diameter from the project site, except for the Ain Baal seasonal spring that is located at e2 geological formation. This spring is not likely to be affected by the project, since it is separated by the project terrain with a valley and the rock bedding with dips towards NW at the two locations, while the project is located at the North East direction.

Seismology

Areas of high earthquake activity should be avoided based on a geological investigation. The integrity the structural components in an unstable geological area should be well demonstrated. The structural geology field investigation and the seismic categorization map of Lebanon indicated that the selected area is considered a low seismic zone. Therefore, the integrity of the structure components along the site might not be expected to get exposed to the risk of active earthquake hazard.

Air Quality

Air quality is an essential component in assessing social wellbeing and health status of a community. Air pollutants come from various sources such as traffic, commercial, industrial and manufacturing facilities. According to the UNDP, MoE project Air quality assessment in an East Mediterranean country: the case of Lebanon, the project site lies in zone 5 with the following baseline ambient air quality.

Table I Annual background average concentrations in µg.m3

	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	CO
Concentration (µg.m3)	20.22	82.46	20.40	17.29	13.54	400.27

Acoustic Environment

The major source of noise pollution site is believed to be the roads network in the area. Noise from transport sector (cars and trucks) can impair people's ability to work, learn in school and sleep, and consequently results in lowered property values in affected areas. As number of cars is increases, noise is becoming even more of a concern. Noise levels in the project area are considered as moderate. Noise levels were recorded by Geoflint team during the site visit (09/08/2016). The average noise levels recorded was around 76dB.

Wastewater Management Infrastructure

In the South Governorate, the rate of connections to the sewage network is estimated to be around 42.1%. Three treatment stations and their associated wastewater discharge networks have been constructed in Yohmor, Kfar Sir and Zoutor (South of Lebanon), at an estimated cost of around US$ 12.5 million, funded by the European Commission. The non-connected areas drain wastewater in wells or use septic tanks (MoE/LEDO/ECODIT, 2001; Makdisi et al., 2007). The uncontrolled discharge of wastewater is leading to the contamination of surface water. El-Fadel et al. (2000), state that the coastal waters from Tyre to Akkar are contaminated by industrial wastewater discharges.

Solid Waste Management Infrastructure

Municipal solid waste management practices vary in the different regions in Lebanon. Tyre caza is producing around 220 t/d of solid waste. The caza depends on open dumps and the Ain Baal solid waste treatment facility to manage its generated wastes. The Caza includes about 51 uncontrolled dumps (ELARD, 2011). There are 7 non-operational dumps and all the remaining were operational until the date of the survey. The oldest dump was in Bedias village at the year of 1984 and many new dumps were started at the year of 2010. The largest dump is Deir Qanoun / Ras El Ain dump that has an area of about 12,230m^2 and an estimated volume of about 183,450m^3. This dump was totally closed last year 2015 to be rehabilitated later.

Biodiversity and Natural Habitat

Given that the main impacts on biodiversity takes place during the construction phase, and given that the facility is already constructed, no biological assessment was undertaken to assess the flora and fauna of the project settlement. Also, given the limited time given to conduct the EIA study, the biodiversity team couldn't assess the ecological value of the project surroundings that could be of some significance. A proper management of the operational activities would be crucial in order to avoid irreparable damages to remaining natural habitats near the project site.

Socio-economic conditions

Ain Baal, where the SWMF is present, is situated in the central region of the Caza of Tyre. The caza constitutes of 26 municipalities and has a total population of 282,768 registered residents, among which only 4410 are residents (80% of the total population). The village Ain Baal is dominated by the young and middle aged (between 20 and 50 years old), which are considered active members of the society. Moreover, according to UNHCR database, the total number of Syrian refugees in the Union of Tyre Municipalities was 28,062 in 2016. The labor force of Ain Baal constitutes 30% of the village's residents. The majority of the labor works in agriculture (40%) and trade (20%), as well as the other income generating activities, such as crafts, governmental jobs, and the construction industry. The facility itself is approximately 500 meters from the nearest inhabited structure. The closest structure to the facility is 650m using the road that leads to the site. This minimizes the impacts of the facility on permanent residents of the area.

There are 45 workers that live on or near the project area. These workers are from Syria. Forty of the workers live on a worker camp on site, and five live in a nearby plot. 42 of the workers are men and three are women. The living conditions of the workers on the site are poor, as they live in small rooms (approximately 7 men per room) and they have 5 shared toilets and 5 shared shower facilities. The remaining five workers live in tents in a plot next to the settlement.

In addition to growing crops, Ain Baal's farmers engage in animal husbandry. On average, the production of milk is around 400 kg/day and produce of eggs and chicken meat is enough to meet the village's needs.

According to the land use/land cover map, a high percentage of land use in the project area is designated as agricultural, the total area of Ain Baal is 6950 dunam, among which 5500 dunam are arable, 1450 are non-arable, constituting around 79% and 21% of the total area respectively.

The agricultural soil of Ain Baal is of two types: white and black with percentages of 60 and 40 respectively.

The sector relies mainly on five major crops, namely: Olives, citrus fruits, vegetables, fruits trees and tobacco.

Historic and archaeological heritage

Tyre was a Phoenician island city founded around the third millennium BC. Tyre is currently famous for its two UNESCO sites, al-Mina and al-Bass, which are home to Roman and Byzantine remains of the city's flourishing period (Living Lebanon, 2017).

Impacts Evaluation

The report identifies all potential environmental and social implications that the construction and operation of such a facility would result in, proposing all needed mitigation measures along with a monitoring plan. Mainly, the facility will have potential negative implications on air and soil quality if not well maintained and operated; whereas, it provides composting management solutions of the municipal solid waste, with an ultimate purpose of alleviating the severe impacts of uncontrolled waste disposals.

Analysis of Alternatives

The ESIA guidelines require analysis of practicable alternatives to the various elements of the proposed project. The purpose of this analysis is to identify the most environmentally sound, cost-effective and practical means of accomplishing the broader project objectives. The analysis of alternatives for the proposed project includes: (1) assessing the "Do Nothing" scenario, (2) site selection, (3) the selection of composting method, and (4) the selection of the odor management technology.

The study showed that without the project development, the area would continue to be impacted by chaotic waste disposal. The project aims to sustainably manage generated wastes, eliminate the negative effects of open dumping. The proposed upgrade of the facility will thus serve as an environmentally safe solution to the solid waste problem in Tyre. Without the installation of the facility, the local environment (natural environment and biodiversity) will continue to be impacted. Moreover, from a socio-economic perspective the 'no action" alternative may not be the best alternative as the benefits to be gained from the development would not be realized. The facility will ensure the proper sorting of generated waste, produce usable compost, and create income generating activity (revenue to Union of Tyre Municipalities from waste management and marketing of compost and recyclable materials) and create job opportunities.

The study showed that in tunnel composting is an effective method for handling reasonable volumes of wastes with low investment, operation and maintenance costs compared to the other discussed composting techniques. Finally, the favored biofilter to be implemented is an open-bed biofilter due to its low capital cost requirement and efficiency.

Environmental and Social Management Plan

An Environmental and Social Management Plan is required in order to ensure the efficient and environmentally sound operation of the plant. As such, the report provides a detailed ESMP that requires avid and precise application by all involved personnel (i.e. workers, administration, contractors, etc.). Considering the nature of the activities taking place in such a facility, it is essential to provide all involved personnel and administrative staff with the essential capacity building programs that ensure they receive the needed amount of training and knowledge over the following topics: firefighting and prevention, technical training, water and energy conservation, first aid…etc. As such, incident occurrences are minimized and emergency preparedness is optimized, promoting the protection of the environment and the public health.

The ESMP provides for further actions in the case that plant workers are affected by temporary plant closure due to project activities. The ESMP describes a mechanism for compensating such workers in the short term, ensuring their continued source of livelihood. The plan also provides for minor upgrading of the facilities where workers live.

A proper management plan was provided including measures and equipment to control exhaust emissions, dust and odor emissions during both phases, and the installation of a wastewater treatment unit to avoid impacts on water and soil. Moreover, proper measures and guidelines on the use of chemical substances were provided to prevent soil contamination. Recommendations were provided to guide the project developers in reducing the negative impacts on natural habitats. The aim is to fulfill the management plan with as minimal impact on the environment.

Conclusion

The study showed that the proposed project has potential implications, both adverse and beneficial, on the existing environment during both construction and operational phases.

In this context, the project proponents shall be committed to putting in place several measures to mitigate the negative environmental, safety, health and social impacts associated with the development cycle of the project. The project proponents shall focus on implementing the measures outlined in the ESMP, as well as; adhering to all relevant national and international environmental, standards, policies and regulations that govern the establishment and operation of solid waste management project. Moreover, the identified positive impacts that emanate from such project shall be maximized as much as possible.

In conclusion, if the developed ESMP is properly implemented and all monitoring means are followed, the project will operate in an environmentally sustainable manner, and will comply with all environmental standards and legislation

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LIST OF ABBREVIATIONS

CDR	Council for Development and Reconstruction
CER	Contractor's Environmental Representative
CFM	Cubic Feet per Minute
CMP	Construction Management Plan
COD	Chemical Oxygen Demand
CS	Carbon Disulfide
DMDS	Dimethyl Disulfide
DPF	Diesel Particulate Filters
ECC	Environmental Compliance Certificate
EDL	Electricite du Liban
EIA	Environmental Impact Assessment
ELV	Environmental Limit Values
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
ESMP	Environmental and Social Management Plan
GAS	General Awareness Seminars
GBA	Greater Beirut Area
GHG	Greenhouse Gases
HGVs	Heavy Goods Vehicles
IMF	Independent Municipal Fund
ISWM	Integrated Solid Waste Management
LMSEP	Lebanese Municipal Services Emergency Project
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoF	Ministry of Finance
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
MSL	Mean Sea Level
MSW	Municipal Solid Waste
MSWTF	Municipal Solid Waste Treatment Facility
NGO	Non-Governmental Organization
NIMBY	Not In My Back Yard
OMSAR	Office of the Minister of State for Administrative Reform
pH	Acidic and Basic Scale
PIC	Person In Charge
PM	Particulate Matter
PPE	Personal Protective Equipment
RA	Risk Assessment
RH	Relative Humidity
RHBIA	Beirut-Rafic Hariri International Airport
RRR	Reduce – Reuse & Recycle
SWEMP	Solid Waste Environmental Management Plan
SWM	Solid Waste Management
SWMF	Solid Waste Management Facility
SWT	Solid Waste Treatment
TSS	Total Suspended Solids

TT	Technical Training
UNDP	United Nations Development Program
UoTM	Union of Tyre Municipalities
VOC	Volatile Organic Compounds
WWTP	Wastewater Treatment Plant

1. INTRODUCTION

1.1. ESIA Objectives

The objective of the Environmental and Social Impact Assessment (ESIA) study is to identify and assess the potential environmental and social impacts of the proposed development and consult relevant stakeholders to prepare an Environmental and Social Management Plan (ESMP) including mitigation measures, monitoring plans, as well as institutional roles and responsibilities for the operationalization of the ESMP.

The specific objectives of the study are:

- Identify and assess environmental and social impacts of the proposed development
- Identify the existing legal framework and the relevant environmental regulations and standards related to the proposed project
- Consult relevant stakeholders, including potential project-affected population, and receive feedback, complaints and suggestions regarding the environmental and social impacts of the proposed development project. The results of the public hearing meetings and consultations will be reflected in the ESIA report and will be considered and incorporated (if relevant) into the project design and planning
- Develop an Environmental and Social Management Plan (ESMP) detailing mitigation measures, monitoring plans, as well as institutional roles and responsibilities in the operationalization of the ESMP
- Cost the mitigation and monitoring measures in the ESMP
- Conduct baseline assessments and establish the existing state of the environment with its correspondent sensitive components within the project area and area of potential project effect
- Assist and improve the proposed project design by studying the aspects of location, construction and operations, which may cause adverse environmental, social, health and economic effects
- Propose an environmental management and monitoring program including compliance, monitoring, auditing, contingency, and risk management planning
- Establish a basis for co-operation and consultation between the project developers and operators and the regulatory, non- regulatory authorities, and the public.

1.2. Background and Rationale

The rapid increase in volume and types of solid waste due to the continuous economic growth, urbanization and industrialization, is becoming a burgeoning problem for national governments to ensure effective and sustainable management of waste (UNEP, 2009). Since July 2015, Lebanon is suffering from a solid waste management crisis with embedded disastrous health and environmental consequences (Hilal, Fadlallah,et al. 2015). The causes of the improper solid waste management practices include the absence of long term vision, political favouritism, limited environmental awareness, increased consumption rates, rapid urbanization…etc.

By the year 2009, the Office of the Minister of State for Administration Reform (OMSAR) constructed Ain Baal SWTF, which was financed by the European Union (EU). Initially, the SWMF was planned to serve 63 municipalities under the Union of Tyre Municipalities (UoTM) (150 t/d). However, due to operational difficulties, the facility is currently operating at below 100 t/d and is serving only 35 municipalities. During August 2016, the facility was publicly opposed due to the odor emissions, which lead to the temporary closure of the facility.

The Council of Development and Reconstruction, funded by the World Bank LMSEP project, plans to upgrade the existing facility in Ain Baal. The LMSEP project aims to address urgent community priorities in select municipal services, targeting areas most affected by the influx of Syrian refugees. The project’s interventions would focus on priority areas such as solid waste management, drainage, road maintenance and rehabilitation, water, wastewater and sanitation, street lighting, etc., with the objective of improving sanitary conditions, improving mobility and safety, and strengthening social cohesion in the context of the crisis.

In the above-mentioned context, the Union of Tyre Municipalities, commissioned Geoflint to conduct the Environmental and Social Impact Assessment.

1.3. Project Type, Size and Location

The proposed project comprises of upgrading the existing Solid Waste Management Facility which is located on plot no. /765/, Ain Baal cadastral area, Tyre Caza, South Lebanon Governorate. The plot is classified as an (NI) based on Decree 608 dated 2007, which authorizes the use of plot no. /765/ for a SWMF.

The site was selected by the project proponents for its general suitability for such projects being accessible and distant from residential areas.

Table 1-1Property location in stereographic geographical coordinates

Area	**Geographical Coordinates**	
	X	**Y**
Ain Baal	-360 075	-99 675

1.4. Scope of Work

The ESIA study assessed the components of the proposed project during all its phases. In the course of executing the ESIA, a preliminary literature review was conducted to initiate the screening process and determine the baseline data available from various studies previously conducted on air, meteorology, geology, socio-economics, infrastructure, sensitive areas (nature reserves, archaeological, historical)…etc. No field work was carried out for this

A thorough analysis was conducted to evaluate all elements of the proposed project. The study also identified the potential impacts on both the environment and society. Accordingly, mitigation and monitoring measures were analyzed to alleviate adverse impacts. An Environmental and Social Management Plan (ESMP) with measures to prevent and mitigate against impacts was developed. The ESMP also included a monitoring plan, which is needed to ensure the compliance of the project with environmental regulations. Finally, a contingency plan was established in this study which included a Risk Assessment (RA) and Emergency Response Plan (ERP) describing the probable risks and preventive and precautionary measures to be followed in the case of emergency situations such as accidents, fire incidents, oil spills…etc.

2. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

This chapter is to provide a comprehensive review of the Lebanese legal and institutional framework that is of particular relevance to the project. The main aim is to ensure the compliance of the project with the national environmental legislation as well as international conventions, treaties and guidelines, and to adopt the Best Available Techniques and Best Environmental Practices.

2.1. Administrative and Institutional Framework

The main authorities involved in the Lebanese solid waste management sector are the Council for Development and Reconstruction (CDR), Ministry of Environment (MoE), Ministry of Interior and Municipalities (MoIM) and concerned municipalities (Municipalities of UoTM. Other institutions are indirectly involved, mainly the Ministry of Finance (MoF), Ministry of Agriculture (MoA), Ministry of Public Health (MoPH) and the Office of the Minister of State for Administrative Reform (OMSAR). Having several institutions and authorities involved in the SWM sector results in several uncertainties regarding the roles and responsibilities and the levels of authority.

Although the legal framework for the SWM in Lebanon is oftentimes outdated or incomplete, the MoE incorporated SWM as one of 10 priority themes into its Work Program, working in partnership with relevant ministries (MoIM, MoF, MoPWT, MoPH, MoA, and OMSAR) and CDR. The Work Program also aims to promote Integrated Solid Waste Management (ISWM) and to manage uncontrolled dumpsites and define guidelines for the treatment of special waste (MOE/UNDP/ECODIT, 2011).

The correspondent administrative and institutional roles and duties with respect to the proposed project are specified below.

2.1.1. Ministry of Interior and the Municipalities (MoIM) and Municipalities

The Ministry of Interior and Municipalities (MoIM) is involved in SWM, as it represents the municipalities who are legally responsible for waste collection, disposal and management operations. According to Decree 8735 dated 23/9/1974 on the preservation of public cleanliness, the UoTM are responsible for the collection and disposal of household wastes, and the location of waste disposal sites should be approved by the health council of the Mohafaza. Moreover, the Municipal Act of 1977 (Decree-Law 118, Article 49) authorizes municipal councils to establish solid waste disposal facilities. Municipalities report to the local governor and the MOIM, which manages the allocation and distribution of funds from the Independent Municipal Fund (IMF), under the control of the Ministry of Finance (MoF) (MOE/UNDP/ECODIT, 2011).

2.1.2. Ministry of Environment (MoE)

The MoE, established in 1981 and reinstated in 1993, is responsible for environmental management in terms of protection and sustainable conservation of natural resources. It also plays a role in introducing strategic environmental planning into all aspects of national and sectorial decision making process. The general and specific duties assigned to the MoE as stipulated in Article 2 of law No. 216 dated 02/04/1993.

In the context of SWM, the Service of Urban Environment-Department of Urban Environmental Pollution Control- is responsible for solid waste issues, according to MOE's new organizational structure (Decree No. 2275, dated 15 June 2009). The Department of Urban Environmental Pollution Control is responsible for reviewing all studies and tender documents related to solid waste, preparing Master plans for the management of MSW, participating in committees for the reception of works linked to SWT facilities and landfills, and defining environmental limit values for the disposal of non-hazardous solid waste (and liquid waste) in water bodies and on soil (MOE/UNDP/ECODIT, 2011). Moreover, the MoE has prepared environmental guidelines for the construction and operation of sorting and composting plants, and sanitary landfills, as well as compost ordinance on the quality assurance and utilization of compost in agriculture, horticulture and landscaping.

2.1.3. The Council for Development and Reconstruction

The Council for Development and Reconstruction was established through Decree No. 5 dated 31st January 1977. The responsibilities of the CDR were specified to three main tasks: complying a plan and a time schedule for the resumption of reconstruction and of development, guaranteeing the funding of projects presented, supervising their execution and utilization by contributing to the process of rehabilitation of public institutions, thus enabling it to assume responsibility for the execution of a number of projects under the supervision of the Council of Ministers.

Law 501 dated 6/6/1996 charged CDR with the implementation of the World Bank-funded Solid Waste Environmental Management Program (SWEMP). This program was later terminated and the fund was withdrawn after extensive delays and public opposition to proposed landfill sites (MOE/UNDP/ECODIT, 2011). However, the CDR is still responsible for the implementation of the Emergency Plan for SWM in GBA and has also developed proposals for improving SWM services in other cities (i.e. Tripoli and Zahleh).

Moreover, and in the context of this project, CDR is responsible for supervising the LMSEP project which aims to address urgent community priorities in select municipal services.

2.1.4. Other Institutions with Responsibilities for SWM

In addition to the stakeholders mentioned above, it is important to include the Ministry of Finance (MoF), which allocates budgets to municipalities through the independent municipal fund, the Office of the Minister of State for Administrative Reform (OMSAR), which launched a municipal SWM program to improve the provision of solid waste services in rural areas, and the Ministry of Public Health (MoPH), which is empowered to propose technical specifications and terms that should be implemented in solid waste collection and disposal projects. Finally, national and local NGOs play an important role in raising funds for Solid Waste Management projects and in undertaking awareness campaigns.

The table below summarizes the major role and responsibilities of the concerned players in the solid waste sector.

Table 2-1Roles and responsibilities of the major players in the solid waste sector

Institutional Bodies	Roles and Responsibilities Related to SWM
MoE	▪ Reviewing all studies and tender documents related to solid waste Preparing Master plans for the management of MSW ▪ Participating in committees for the reception of works linked to SWT facilities and landfills ▪ Defining environmental limit values for the disposal of non-hazardous solid waste (and liquid waste) in water bodies and on soil ▪ Preparing environmental guidelines
CDR	▪ Implementing the Emergency Plan for SWM in GBA ▪ Preparing and Implementing SWM Master plan ▪ Preparing tenders for SWM projects…etc.
MoIM	▪ Supervising municipalities and municipal unions ▪ Managing the allocation and distribution of funds from the Independent Municipal Fund (under the control of the MoF)
MoF	▪ Assigning resources to municipalities through the Independent Municipal Fund.
MoPH	▪ Indirectly responsible (through health councils) for health care waste treatment facilities.
OMSAR	▪ Developing the institutional and technical capacities of ministries, other government and public agencies, and municipalities. ▪ Improving the provision of solid waste services in rural areas. ▪ Implementing an EU-funded program (to build and equip SWM facilities) and related investments from the national treasury (to operate and maintain the facilities).
National and Local NGOs	▪ Collecting funds ▪ Undertaking awareness campaigns ▪ Implementing Solid Waste projects at the national level.
International Donors and Organizations	▪ Sponsoring solid waste projects for the treatment of waste in Lebanon

2.2. Legal Framework

This section accounts for the presentation of all national applied legislations in relation with the upgrade project of the Ain Baal SWMF.

There are no specific legislative texts addressing solid waste management, apart from some fragments and general guidelines that tackle solid waste management in Lebanon. Moreover, the distribution of roles and responsibilities in the implementation of the existing legislation is unclear, making implementation and enforcement practically challenging (Massoud, Merhbi, 2016).

This Environmental Impact Assessment was prepared in respect to MoE Decree 8633/2012 “Fundamentals of Environmental Impact Assessment” (Annex I, Section 4) and MoE Decision 261/1 dated 25/06/2015 which identifies the reviewing procedures of Environmental Impact Assessment reports. The ESIA process is dictated in the mentioned decision are illustrated in Figure 2-1.

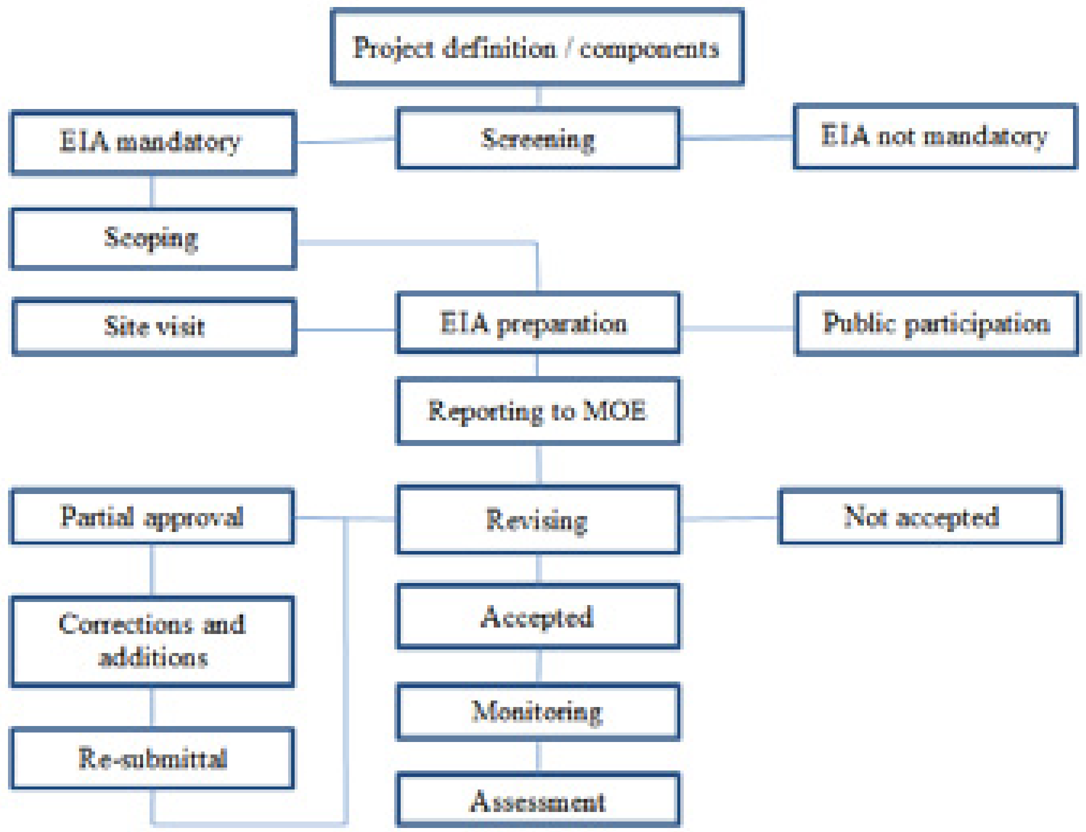


Figure 2-1 General framework of EIA process in Lebanon

The specified time span and stages for reviewing and commenting on EIA's reports are illustrated in the table below (refer to Table 2-2).

Table 2-2Steps and duration of the EIA review process

Department		**Activity**	**Duration (days)**
MoE registrar		Information verification	2
Environmental technology service		Preliminary review	2
		1. Identify the related services in the MoE 2. Prepare the draft decision of the reviewing committee	2
A- Reviewing committee		Report reviewing	30
B- Head of committee		Prepare the comments letter and send to the	10
C- The Minister	Option 1	Notify the concerned of any required addendum to the EIA*	5
	Option 2	Notify the concerned with the approval or rejection study	5
Total			**51**
*In this case, activities A, B and C are applied again.			

Table 2-3 Lebanese legal structure hierarchy

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.

The main legislations related to the proposed project are listed in the table below (Table 2-4).

Table 2-4 Summary of legislation related to the project

Legislation	Date	Official Gazette	Issue No.	Brief Description	Relevance to the Project
Decree 2775	1928	-		Dumping of pollutants into public water courses is prohibited.	The project will provide a solution for the management of organic wastes. This decision will be respected during the execution of the project.
Decree 7975	5/5/1931	-		Waste should not be dumped around houses, but be buried or removed by the municipality.	The project will provide a solution for the management of solid waste for some municipalities in Tyre caza.
Decree 2761	19/12/1933	-	-	Regulations for disposal of sewage and contaminated substances that lists the penalties involved in illegal disposal of municipal and industrial waste.	The proposed upgrade will decrease illegal and uncontrolled MSW dumping practices and thus will eliminate their negative impacts on the environment.
Decision 425/1	8/9/1971	-	78	Refuse must be placed in plastic bags for disposal. Waste must not be dumped on the street or other public places.	The proposed upgrade will decrease illegal and uncontrolled MSW dumping practices and thus will eliminate their negative impacts on the environment.
Decree 8735	23/8/1974	9/9/1974	72	Preservation of public cleanliness. Municipalities are responsible for collection and disposal of domestic wastes. Household and Construction wastes may not be dumped in public places or private land adjacent to roads and residential districts.	The project will decrease illegal and uncontrolled MSW dumping practices and thus will eliminate their negative impacts on the environment.
Law 118	1977	1977	20	Municipalities have the authority to manage solid waste within their cadastral limits.	The proposed facility will treat solid waste in certain municipalities in Tyre caza.
Law 216	2/4/1993	8/4/1993	14	Creation of the Ministry of Environment (MoE). MoE responsible for environmental management and supervision.	MoE is responsible for reviewing all studies related to solid waste, preparing master plans for the management of MSW, participating in committees, defining environmental limit values and guidelines…etc.
Decision 52/1	29/06/1996	12/09/1996	45	Environment quality standards and criteria for air, water and soil pollution. Revised standards for water, air and soil pollution (partly updated in Decision 8/1 dated 30/1/2001).	Decision 52/1 was referenced in this EIA to specify the National Standards for Environmental Quality and the Environmental Limit Values for Air and Water. The decision will be used for monitoring air emissions noise pollution at the project site.
Law 197	18/2/1993	18/2/1993		Creation of the Ministry of Municipal and Rural Affairs (MoMRA). It is charged with	The Ministry of Interior and Municipalities (MoIM) is involved indirectly in SWM as it is a competent authority responsible for

Legislation	Date	Official Gazette	Issue No.	Brief Description	Relevance to the Project
				the of the development municipal sector in areas such as strategic planning, budgeting, and programming, as well as auditing the functions of the various municipalities in Lebanon. Law 247 of 9/8/2000 (Issue 35 dated 14/8/93) cancels the MoMRA and merges its departments into the Ministry of Interior, thus creating the Ministry of Interior and Municipalities (MoIM).	supervising the activities of municipalities.
Law No. 667	29/12/1997	30/12/1996	59	Amends Law 216, the creation of MoE.	MoE is responsible for reviewing this study and for monitoring all environmental related components of any project.
Decision 8/1	30/1/2001	-	10	Amendment to part of MoE Decision 52/1 dated 29/6/1996. Revised standards for air emissions, liquid effluents and wastewater treatment plants.	The project operations will abide with the ELVs defined in this Decision. The leachate collection and treatment system will abide by this decision.
Decree 9093	15/11/2002	21/11/2002	63	Amends MoIM Decree 1917 dated 6/4/1979. States that any municipality that constructs a sanitary landfill or a waste treatment facility on its lands will get 5 times its allotted share of municipal funds from the Independent Municipal Fund, and if this municipality accepts wastes from 10 other municipalities its share will be 10 fold its allotted share.	This decree provides financial incentives for municipalities for hosting SWM facilities. However, this decree has never been implemented to date.
Law 444	29/7/2002	8/9/2002	44	Environment Protection Law: Fundamental principles and public rules, Organization of environmental protection, Environmental information system and participation in the management and protection of the environment, Environmental Impact Assessment, Protection of environmental media, Responsibilities and fines, other regulations (miscellaneous, institutional).	The project will abide by the general framework for environmental management activities provided in this Law.
Decree 690/2005	2005	-	37	Law defining the functions of the Ministry of Environment and its structure.	MoE is responsible for reviewing all studies related to solid waste, preparing master plans for the management of MSW, participating in committees, defining environmental limit values

Legislation	Date	Official Gazette	Issue No.	Brief Description	Relevance to the Project
					and guidelines…etc.
Decree 608	04/08/2007	09/08/2007	48	The Ministry of Public Work and Transport (MoPWT) authorizes the use of the project plot for the construction and operation of a solid waste management facility.	The project plot can be used for the operation of Ain Baal SWMF.
Decree 8471	04/07/2012	19/07/2012	30	Environmental compliance for establishments	The plant will be subject to apply for the Environmental Compliance Certificate (ECC) every three year. Applying for this certificate includes preparing an Environmental Audit with an Environmental Management Plan. Once environmental compliance is proven, the facility will be awarded with an Environmental Compliance decree.
Decree 8633	07/08/2012	16/08/2012	35	"Fundamentals of Environmental Impact Assessment" states in Article 5 (Project Classification) that "If the proposed project falls in the domain of Annex 2, it will be subjected to an "EIA" study according to information contained in Annex 6".	Used as a legal reference to conduct this ESIA study. An ESIA will be developed for this project according to mutually agreed terms between MoE and the project proponents.
Decision 261/1	25/06/2015	29/11/2012	26	Minister of Environment: Decision for reviewing procedures of submitted Environmental Impact Assessment reports.	The reviewing procedure of this EIA needs to be adopted throughout the completion of the EIA report.
Circulation note 8/1	16/11/2015	19/11/2005	47	Guidelines for Municipal Solid Waste Management including procedures and recommendations for waste sorting, recycling and composting.	Highly correlated, as the facility is a solid waste management facility and the proposed guidelines are relevant to its operation.

2.3. World Bank Safeguard Policies

This section will comprise of the World Bank's environmental and social safeguard policies which are part of the bank's support to the sustainable reduction of poverty. The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process.

The triggered safeguard policies for the Lebanon Municipal Services Emergency Project are OP 4.01 and OP 4.12.

Environmental Assessment (OP/BP 4.01)

The World Bank's environmental assessment policy and recommended processing are described in Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment. Environmental Assessment is used in the World Bank to identify, avoid, and mitigate the potential negative environmental impacts of the project cycle. The policy states that Environment Assessment (EA) and mitigation plans are required for all projects having significant adverse environmental impacts or involuntary resettlement. Assessment should include analysis of alternative designs and sites, or consideration of “no option” and require public participation and information disclosure before the Bank approves the project.

The WBG EHS guidelines were adopted as the acceptable pollution prevention and abatement measures. The guidelines are deemed acceptable by the World Bank's regulations. Both the General EHS Guidelines and EHS Guidelines will be guiding the environmental management of the project.
The General EHS Guidelines include standards for air quality, water quality, energy conservation, waste management, hazardous waste management, land contamination, noise, Occupational Health and Safety, and community health and safety while the EHS Guidelines include standards for waste management facilities: industry specific impacts and mitigation measures and performance indicators and monitoring.
It is also to be noted that the standard CDR HSE guidelines and regulations adopted in all projects implemented through the CDR shall form an integral part of the Contractor's contract and shall accordingly be adopted and deemed to be enforced during project construction and operation.

Natural Habitats (OP/BP 4.04)

This policy ensures that the project takes into account biodiversity conservation and aims at protecting natural habitats, legally protected, officially proposed for protection, or unprotected but of known high conservation value. Appropriate mitigation measures should be adopted to ensure environmentally sustainable development.

Involuntary Resettlement (OP/BP 4.12)

This safeguard policy relates to the administration of resettlement issues in the event of project activities inducing displacement of people and disrupting their livelihoods. It aims at assisting displaced people to restore their living standards after displacement. Particular attention is given to vulnerable groups including the elderly, women and children and the infirm. Resettlement planning includes provision of compensation and/or any other assistance that may be required during and after resettlement. No involuntary resettlement as such has been and/or will be incurred due to plant designated activities.

2.4. International Conventions and Agreements

In order to meet the fulfillment of the sustainable development agenda Lebanon has signed several important regional and international agreements. These agreements are presented in the table below.

Table 2-5International conventions, treaties and protocols

Year	Conventions, Treaties and Protocols
1972	UNESCO Convention on the Protection of Cultural and Natural Heritage. *Adhesion: 30/10/1990 by Law No.19.*
1977	Barcelona Convention for the Protection of the Mediterranean Sea against Pollution (incl. Protocols). *Ratification: 30/6/1977 by Law No.126*
1983	London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. *Accession 28/5/1983 by Law No.13*
1985	Vienna Convention for the Protection of the Ozone Layer-Vienna. *Adhesion: 30/3/1993 by Law No.253.*
1989	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. *Ratification: 21/12/1994 by Law No.387*
1992	United Nations Framework Convention on Climate Change-Rio de Janeiro. *Ratification: 11/8/1994 by the Law No.359.*
1992	United Nations Framework Convention on Biological Diversity-Rio de Janeiro. Ratification: 11/8/1994 by the Law No.360.
1992	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer-Copenhagen. *Accession: 3/11/1999 by Law No.120.*
1994	Climate Change Convention by Lebanon. *Ratification: 11/8/1994 by Law No.359.*
2001	Stockholm Convention on Persistent Organic Pollutants for adoption by the conference of plenipotentiaries. *Signature: 22/5/2001 and Accession: 8/8/2002 by Law No.432.*
2006	Kyoto Protocol linked to the United Nations Framework Convention on Climate Change, aiming to fight the global warming. *Adhesion: 15/5/2006 by Law No.738.*
2008	Amendment to the Barcelona Convention. *Adhesion 16/10/2008 by Law No.34.*

Note:

Signature: the State expresses its interest to the treaty and its intention to become a Party. Treaty signature is not binding.

Accession: the State, which has not taken part in the negotiations, signed the treaty and is consent to be bound by its terms.

Ratification: the State expresses its definitive consent to be bound by the treaty. It must then respect the provisions of the treaty and implement it by a Law within the statutory allowed period. The date corresponds to the date of publication in the Official Gazette in Lebanon.

Adhesion: the State, which has not taken part in the negotiations and has not signed the treaty, adheres to the treaty by law and is consent to be bound by its terms.

3. PUBLIC PARTICIPATION

The public participation is a major requirement in the ESIA study, which combines the concept of transparency with the rights of public awareness, and the involvement in any activity that may cause a change in existing conditions and environment. Public participation improves the quality of the information brought to the decision makers, and assists in identifying priorities and mobilizing local support.

For this purpose Geoflint organized two public hearing sessions at the Union of Tyre Municipalities for both the scoping phase and for the ESIA phase. An invitation letter to attend the public hearing session was sent to several stakeholders (MoE, municipalities, local residents…) and a public hearing invitation letter was also posted on the wall of the Union of Tyre Municipalities. The announcement described the project and expressed the readiness of the involved parties to receive feedback, complaints and suggestions, and to respond to any questions. In addition, the invitation was published in two official newspapers (Al Diyar and Al Akhbar), 15 days prior to the public consultation meeting (attached in Appendix 2).

During the public participation sessions held on June 13, 2016 and April 20, 2017, Geoflint representative explained the concept of an EIA study including its requirement and execution, the supporting tasks and responsibilities of the project team and MOE, the importance of the public involvement, and the components of the proposed project. The presentation included a description of the current SWMF facility in order to notify the public with the current components, capacity, efficiency and deficiency of the facility. Moreover, Geoflint representative continued to explain the proposed improvements in the facility. Furthermore, the expected impacts along with their mitigation measures and alternatives to this project were addressed.

The presentation ended by leaving the floor for the participants to ask about any uncertainty regarding the proposed project. During the first public hearing session (June 13, 2016), the attendees were concerned about the increase of the facility's treatment capacity, as they are aware that the current operational practices are very poor. They shared their frustrations over the existing odor emissions and unsanitary conditions. The time lapse with the current operational difficulties and the hot summer weather conditions have led to the increase of the odors. The Geoflint team, World Bank and CDR representatives explained to the participants that the upgrade of the facility will enhance the operation practices and will enclose the SWMF hangars, as well as improve the biofilters design which will contribute to the reduction of odor emissions.

During the second public hearing session (April 20, 2017), the attendants were concerned about the proper management of the remaining residual/inert materials. Questions were raised on whether incineration is considered as a treatment technology for the residual waste in Ain Baal. Geoflint representative explained that the management technologies of inert waste are still under consideration where RDF or incineration can be adopted. However, a separate EIA study will be conducted for this matter and separate public hearing sessions will be held. Moreover, a discussion was made on the importance of sorting at source and waste reduction for the proper management of solid waste.

Finally the attendees were thanked for their active participation and they were noted that their role is highly important in monitoring the proper implementation of the environmental management plans.

Figure 3-1Public participation attendees (April 20, 2017)

Figure 3-2Public participation attendees (April 20, 2017)

Table 3-1Public participation attendees (April 20, 2017)

No.	Name	Position	Phone Number
1.	Fadel Saleh	Citizen	78/ 890 491
2.	Khouloud Mahdi	Citizen	70/ 902 227
3.	Abbas Safieddine	Wash Officer	70/ 996 607
4.	Salam Eid	Wash Sector Field Coordinator	70/ 996 624
5.	Berta Travieso	Chief of Field Office	76/ 774 420
6.	Zein Khatoun	Citizen	70/ 673 995

7.	Jihad Jradi	Citizen	70/ 665 906
8.	Marwan Rizkallah	P.M. / LEPAP - MoE	03/ 958 088
9.	Bechara Ghabi	Architect Union of Tire Municipalities	70/ 748 467
10.	Ahmad Shoobi	Surveying Engineer Union of Tire Municipalities	70/ 757 442
11.	Hussein Houbballah	IT- RTO Union of Tire Municipalities	03/ 158 767
12.	Nasser Sabbah	Civil Affairs Officer UNIFIL	71/ 500 767

Table 3-2Public participation attendees (June 13, 2016)

No.	Name	Position	Phone Number
13.	Abdel Mohsen al-Husseiny	Head of Union of Tyre Municipalities	-
14.	Hassan Mohsen	Head of Aaytit Municipality	03/ 668 941
15.	Jalal Abed Ali	Union of Tyre Municipalities	03/ 125 468
16.	Moustafa Bazoun	Vice President of Hanawey Municipality	03/ 775 129
17.	Anwar Watfa	Environmental Advisor-Union of Tyre Municipalities	-
18.	Nasser Sabbah	Citizen	71/ 500 767
19.	Hassan Hammoud	Mayor of Borj Rahel	03/ 793 227
20.	Abdel Karim Hassan	Mayor of Klayle	03/ 379 057
21.	Bahij al Hussein	Mayor of Bazourieh	03/ 067 101
22.	Fadi Riyachi	World Bank	-
23.	Youssef Saffouri	Citizen	03/ 936 588
24.	Miriam Caretta	Citizen	71/ 531 430
25.	Nabil Kraiten	Citizen	76/ 666 952
26.	Maha Ayyoubi	Shelter Wash Project Manager	70/ 775 574
27.	Adnan Kassir	Mayor of Deir Kanoun-Al Nahr	03/ 833 811
28.	Ali Aoun	Area Manager-Mercy Corps	70/ 996 639
29.	Ali Jaber	Yanouh Municipality	03/ 377 865
30.	Nidal Chehayeb	CDR	03/ 397 014
31.	Raji Maasri	Citizen	03/ 756 464
32.	Patil Mardigin	Coordinator at OMSAR	03/ 420 065
33.	Elie Chaaye	UNHCR	71/ 910 619
34.	Checrallah Abou Jaoude	UNDP	70/ 115 885
35.	Bachir Borkhach	IOM-Livelihood Project Assistant	03/ 036 811

36.	Doha Farrar	Citizen	03/ 402 103
37.	Yehia Diab	Citizen	03/ 637 655

Figure 3-3Public participation attendees (June 13, 2016)

Appendix 2 includes all the documentation regarding the public participation meeting, mainly the list of participants, the announcement letter as well as the ad published in the local newspapers.

4. DESCRIPTION OF PROJECT COMPONENTS

4.1. Type and Importance of the Project

The proposed project comprises of upgrading the existing Solid Waste Management Facility (SWMF), located on plot /765/ at Ain Baal, to be able to treat 150 tons/day of municipal solid waste. This project is part of the Lebanese Municipal Services Emergency Project (LMSEP) project funded by the World Bank.

The upgrade of the facility will increase the capacity and treatment efficiency of the solid waste treatment facility and thus decrease the amount of waste diverted to landfills and open dumps. Furthermore, the project will improve the operating conditions of the existing facility to effectively reduce the nuisance imposed on the surrounding communities. More importantly, this project will be contributing to the adoption of Integrated Solid Waste Management Strategy, where sorting and composting of organic waste are important components of the waste management hierarchy.

4.2. Project Overview

The proposed project comprises of the upgrade of the existing facility to be able to efficiently achieve the original design specifications of 150 tons of municipal solid waste per day. A new design is being prepared for the Ain Baal SWMF which will upgrade the different sections of the facility. The treatment process will continue to be in-tunnel composting. The modifications/enhancements in the treatment process are listed below:

- A full sorting line will be added to cater for both manual and mechanical sorting in view of significantly improving the sorting operation and hence increase the efficiency of separation between the compostable materials and the inorganic wastes (recyclables and rejects). The new sorting equipment shall consist mainly of a bag opener, a trammel, a ballistic separator, an eddy current and an optical sorter, in addition to the much needed increased length of conveyors commensurate with sorting requirements.
  The recyclables include paper and cardboard, plastics, metals, aluminum and glass. These recyclables are generally sold to known enterprises, NGOs or communities involved in the sector of sustainable development and industrial production from recyclable materials. While their price varies based on demand and market needs, the revenues generated therefrom constitute a reasonable source of income in addition to alleviating the environmental concerns related thereto. As for their quantity, it also depends on the quality of the incoming wastes as well as the implementation of the sorting at source that has started shyly and not proven to be very efficient as yet. Generally however, such quantity is in the range of 7-10% of the incoming waste.
- The composting area will be increased, the blowers will be maintained, and the compost turning machines will be added.
- The curing area will be increased where an additional metallic hangar will be installed and covered.
- A refining screen will also be included for the final screening of cured compost.
- The existing biofilter will be demolished and replaced by a more efficient biofilter system. Also, an additional biolfilter system will be installed near the composting zone.

- A leachate treatment plant will be installed in order to treat generated leachate and condensate as a result of the process reactions.

Further to the much improved sorting and composting operations that will undoubtedly lead to an improved quality of compost, the produced compost will accordingly be distributed to local farmers, after the completion of the required monitoring tests.

With respect to the residual, inorganic and non-recyclable waste, will be sent to Bourj El Chmel dumpsites that are currently used by the Union of Tyre Municipalities until a management strategy is adapted to reception the refuse waste. It is to be noted that no hazardous waste/materials/refuse are currently generated or anticipated to be generated from the Ain Baal plant since it is only dedicated to treat municipal solid waste, The main Hazardous waste/materials currently found in the municipal waste stream include cleaning agents, hair spray, tires, pharmaceutical products, ammunition, gun powder, paint, household batteries, lead acid (car) batteries, fluorescent light bulbs, other chemicals. Their estimated quantities do not exceed 0.5-1 ton/day and, in the absence of more evolved technologies and solutions, these are normally handled in the normal municipal waste landfills. In this respect, it is to be noted that Bourj El Chmel existing dumpsite is approved by the local authorities for both the non-recyclable waste and the hazardous waste/materials normally found in the municipal solid waste stream.
The handling of these wastes, including the hazardous waste, shall be done in accordance to WBG EHS standards.

Currently, a controlled air incinerator is proposed by the UOTM to be installed. Knowing that it is covered by the UoTM fund, and not the World Bank fund, a specific ESIA was prepared and submitted to MoE waiting for approval.

4.3. Description of the Existing Facility

The Ain Baal SWTF was established in 2004 to treat around 150 tons of waste per day. However, due to different operational challenges, it is currently treating around 70-80 tons/day. The existing SWMF in the village of Ain Baal comprises of three major treatment units: sorting, composting and managing non-organic waste.

Table 4-1Existing sections of Ain Baal SWTF

Section	Area (m^2)
Unloading bay	790
Tipping floor	812
Sorting area	247
Composting area	1745
Curing area	2700
Recyclable material pits	1014
Administrative areas	62
Personal facilities	150

The existing treatment process is thoroughly explained in the following sections.

- <u>Sorting Process</u>

The MSW is currently delivered to the facility by municipal trucks to the receiving area, whereby the material is deposited onto the tipping floor. The tipping floor has an area of 812 m^2 and was designed to uphold a two-day waste accumulation. The received solid wastes are mechanically opened by a bag opener (10ton/hr). Afterwards, the waste is conveyed through the two sorting lines, where manual waste sorting occurs. The existent sorting lines are 14m in length and 1m in width and are made of heavy-duty rubber with 10mm thickness. The line is equipped with a variable speed electrical motor to allow for more operational flexibility during waste stream variations.

Following the manual sorting, the waste then passes over a pulley type magnet, prior to being shredded and dumped in the tunnel loading bay. On the other hand, the recyclable wastes will be collected and stored to be later sent to local recyclers.

Figure 4-1Sorting lines

- <u>Composting Process</u>

The sorted organic waste is dropped from the conveyor belts onto the composting floor. The existent facility adopts in-tunnel aerobic composting scheme. The composting area (1,745m²) includes the loading area, ten compost bays and unloading area at the end of the bays. The system operates under controlled aerobic conditions, in open-topped concrete bays. The system is sheltered in a weatherproof building to allow year-round operation. Each of the ten 53m long, 2 m wide and 2.13 m deep concrete bays are considered separate composting units.

A front-end loader transports the sorted organic waste directly into the composting bay. An automated agitator/mixer machine with a movable, toothed drum and a conveyor mixes and moves the material down the bay at an average of 3.65 m per 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.

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 Programmable Logical Control (Siemens type) to activate blowers when temperature set points are exceeded. Temperature is monitored using sensors installed for each blower.

For the provision of continuous aeration during the composting process, each bay is independently aerated with four aeration zones each with independently controlled three blowers. 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 a 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.

For the existing SWTF, the compost remains in the composting bays for at least 14 days. This retention time is based on operating the agitator once a day 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. Afterwards, the compost will then be removed from the vessels to be cured and dried. The curing phase takes up to 30 days. Afterwards, the front-end loader deposits the composted material in a fine trommel screen where remaining fine particles (stones, plastic and glass) are removed. The screen removes the final rejects from the compost prior to distribution.

Figure 4-2Composting tunnels

Figure 4-3Cured compost

- <u>Management of Non-Organic Waste</u>

Once the non-organic waste portion has been separated, recyclables are stored separately in the recyclable materials specified areas. The recyclable materials pits are located below the sorting line, and may be stacked to a maximum height of up to 3 meters. With the incoming volumes of recyclables, it is expected that the pits are emptied once every month. The sorted recyclable materials will be then stored outside the facility, until it is sold to local recyclers (Figure 4-4).

Non-recyclable materials such as tires, cloth, shoes, can be stocked in one single bay where it is sent to open dumps, after the closure of the Ras El Ain Dumpsite on the 5th of September 2015.

Figure 4-4 Recyclable waste

4.2.1.<u>Existing Odor Control System</u>

Composting facilities are usually associated with odor emission. In general, the composting process air comprise a complex mixture of chemical components that included; hydrogen sulphide; ammonia; a wide range of odorous VOCs including aliphatic hydrocarbons, alcohols, ketones; and organic sulphur compounds; organic acids; esters and terpenes (Fletcher, Jones, et.al., 2014).

The ventilation, exhaust and odor control systems for the present SWTF are divided into two zones:

- Zone 1: the tipping floor, sorting area and bay loading area
- Zone 2: the composting bays

The ventilation of the sorting and composting facilities is kept under negative pressure. As for Zone 2, it is 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 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, to direct the air into the biofilter. A minimum of three air changes per hour are exhausted from the active composting area into the biofilter.
A biofilter odor control system, consisting of a 310 m^2 biofilter bed, has been used to mitigate odor generated within the composting zone of the facility.

The biofilter consists of a piping network covered with stones which was designed for uniform air distribution. The media, a thoroughly mixed combination of wood chips, wood bark, and other appropriate material, is placed over the stone to a depth of 5ft. The biofilter is equipped with four fans each 1,325 cubic feet per minute (CFM). The biofilter is constructed in three cells or sections in order to facilitate maintenance and periodic media replacement as deemed necessary. Each section is operated independently so that a cell can be taken out of operation without interrupting the service of the other two sections.

4.2.2.Existing Leachate Collection System

The generated wastewater in the existing facility is held in two 10 m^3 septic tanks. One tank accepts the generated domestic wastewater and the ancillary wastewater resulting from the locker rooms, bathrooms, floor washing…etc. The other septic tank collects wastewater from the compost bays and leachate from the biofilter and reuse to increase the piles moisture.

According to the project design consultant, the existing drainage system of the sorting hangar is clogged and/or plugged. The water is evacuated manually by the workers as much as it is possible for them to do it. The evacuated water is left to flow creating undesirable runoff on the road, with all its pollutants. In line with the rehabilitation works, the drainage/ grating system shall be repaired and replaced to regain its normal functionality inside and outside the hangar, thus ensuring a safe evacuation of the water towards existing sewer collection tanks.

Moreover, the leachate from the composting hangar and the stormwater at the hangar level are currently mixed together with little to no separation due to the malfunction of the leachate and drainage conveying systems (clogged pipes, seepage at manhole point...). In addition to that, no drainage is foreseen around the existing hangar where the compost is stocked. In line with the upgrading works, this hangar shall be removed and replaced by another one with a complete design storm water collection system, which shall ensure the evacuation of the water towards the existing sewer collection tanks too.

According to the current operators the quantities of wastewater generated are summarized in the table below:

Table 4-2 Quantities of generated wastewater

Source	Quantities (m^3/month)
Staff	25
Visitors	10
Building washdown	100
Equipment washdown	50
Biofilter	0
Total	**185 m^3/month**

4.2.3.Compost Quality at the Existing Facility

The existing facility produces around 20-25 tons of compost per day. All the compost produced was distributed, free of charge, to organizations and individuals, who pick it up themselves at the plant in bulk form. The compost was not of the best quality knowing that it is produced from municipal solid waste. Some of the sampling results are attached in Appendix 3.

Table 4-3 Compost quality of the existing facility (test date 30/11/2016)

Parameter	Concentration
Moisture	26.4%
Ash content	24.5%
Conductivity at 25ºC (3+50)	2.02 mS/cm
Organic matter	49.1%
Total nitrogen, as N	0.9%
Total carbon as C	17.0%
Phosphorus, as P	2.2 g/kg
Potassium, as K	0.6 g/kg
pH at 25ºC (10% aqueous suspension)	7.0
Lead, as Pb	Less than 0.1 mg/kg
Nickel, as Ni	1.4 mg/kg
Zinc, as Zn	27.8 mg/kg
Copper, as Cu	1.4 mg/kg
Mercury, as Hg	Less than 0.1 mg/kg
Chromium, as Cr	0.6 mg/kg
Thermotolerant coliforms (CFU/g)	1.0×10^1
E.coli (CFU/g)	1.0×10^1
Salmonella/ 25g	Not detected

4.4. Challenges Faced by the Existing Facility

The existent facility is currently facing challenges which are leading to the weak operation practices and low quality end products. These challenges include:

- The ineffective manual sorting where the organic waste stream being composted is still containing inorganic non-compostable waste. This is leading to the deterioration of the compost quality.

- The low capacity of the bag opener (10ton/hr). Due to its limited capacity compared to the treatment capacity of the facility, the waste is being held at the tipping floor, leading to formation of leachate and odors.
- The presence of large quantities of plastic bags (Nylon) in the waste stream and the facility is not capable of handling such waste (absence of plastic bag collection system)
- The inefficient design of biofilters
- The limited area for composting and curing
- The curing area is outdoors which makes the waste exposed to the different climate conditions (such as rain, wind…)
- The low quality of produced compost which is highly contaminated with glass. In addition the produced compost is not being nitrogen stable. The compost sampling results will be analyzed in the ESIA study.
- The inability to sell or market the produced compost due to its poor quality. Large quantities of compost are stored onsite.
- The absence of efficient leachate collection system and subsequent wastewater treatment unit. The collected leachate is being stored in septic tanks, leading to the generation of odors.
- The variability in the quantity of solid waste received, where in some cases the facility was receiving quantities of waste beyond its treatment capacity.
- The absence of recyclable waste management equipment such as shredders, balers…etc.
- The absence of operational expertise mainly to manage the composting procedure such as operating the aerators, agitating the compost windrows based on requirements, addition of enzymes…

4.5. Description of the Proposed Improvements

As mentioned previously, the proposed project comprises of the upgrade of the existing facility to be able to efficiently treat 150 tons of municipal solid waste per day.

A new design is being prepared for the Ain Baal SWMF which will upgrade the different sections of the facility. The modification/enhancement in the treatment process is briefly explained in the sections below.

4.4.1.Upgrade in the Sorting Process

To increase the efficiency of separation between the compostable materials and the inorganic wastes (recyclables and rejects), an additional sorting line and mechanical sorting technologies will be added. Although mechanical sorting technologies will be introduced to the sorting lines, the facility will still follow manual sorting procedures due to heterogeneous properties of the received waste. The additional sorting technologies include:

a. Grabber

Due to the limited area and for better maneuvering and efficiency, an electro-hydraulic grabber is recommended as a replacement of the wheel loader. The grabber shall be operated by a hydraulic motor installed at the top of the grabber to increase the ease and efficiency of operation.

Figure 4-5 Grabber

b. Bag Opener

The bag opener shall be installed integrated in the sorting line to open and empty the domestic solid waste plastic bags prior to sorting operations. It shall open the plastic bags and transfer material to subsequent sorting units.

The bag opener will consist of the bag opening unit and a moving floor system integrated into a single unit. The bag opener receives the collected commingled waste through a feeding conveyor after being unloaded by the grabber.

Figure 4-6 Bag opener

c. Plastic Bags Collection System

A plastic bag collection system will be installed for the removal of the opened bags at the beginning of the sorting line. This is recommended in order to increase the efficiency of the overall mechanical sorting.

d. Trommel Screen

The trommel screen consists of a large-diameter screen, formed into a cylinder and rotating on a horizontal axis. For the proposed facility, a trommel screen with a capacity of 15 tons/hour will be integrated in the municipal solid waste sorting line.

The trommel screen shall consist of a drum with normally 60 mm opening (screen hole) throughout the cylindrical body of the trommel. The recommended dimensions are a length of 5m and a diameter of 2m. The waste passing through the screen of the trommel screens mainly consists of organic materials to be conveyed to the fermentation zone.

Figure 4-7 Trommel screen

e. Ballistic separators

The ballistic separator will be integrated in the municipal solid waste sorting line to sort the waste material which was not retained in the trommel screen. The ballistic separator shall have 3 outlet chutes with necessary hoppers for the three different fractions (one for the 2D fraction, on for the 3D rolling fraction, and one for the screened fraction consisting mainly of organic material).

Figure 4-8 Ballistic separator

f. Magnetic Separators

For the proposed facility, a magnetic separator shall be for each sorting line. The separators will be of a permanent magnet, self-cleaning type and will be integrated in the municipal solid waste sorting line to collect all ferrous metals.

Figure 4-9 Magnetic separator

g. Eddy Current Separators

For the proposed facility, an Eddy current separation system will be installed in order to separate non-ferrous metals from ferrous metals. This technology works by using repulsive forces on electrically conductive materials. The external drum of the separator rotates at the speed of the belt, acting as the head pulley, while the internal rotor operates at a higher speed than the drum. These combined forces create a strong repelling force, inducting eddy currents. The system will be located after magnetic separation to minimize contamination by ferrous materials. Aluminum is the main metal recovered from the waste stream.

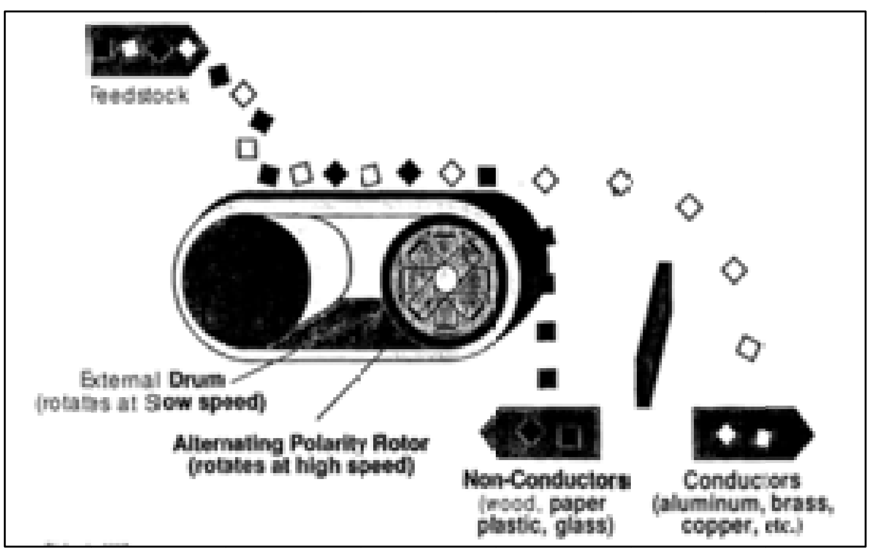


Figure 4-10 Eddy current separator

Figure 4-11Illustration of an eddy current separator

h. Optical separator

The optical sorting process is done using a photodetector camera with sophisticated programming technology, paired with accurate separation modules. The sorter will simply determine how much light is reflected off the object. It will accept or reject the item depending on how reflective it is. This system can be arranged in vertical or horizontal configurations to perform multiple sizing and specific material separations.

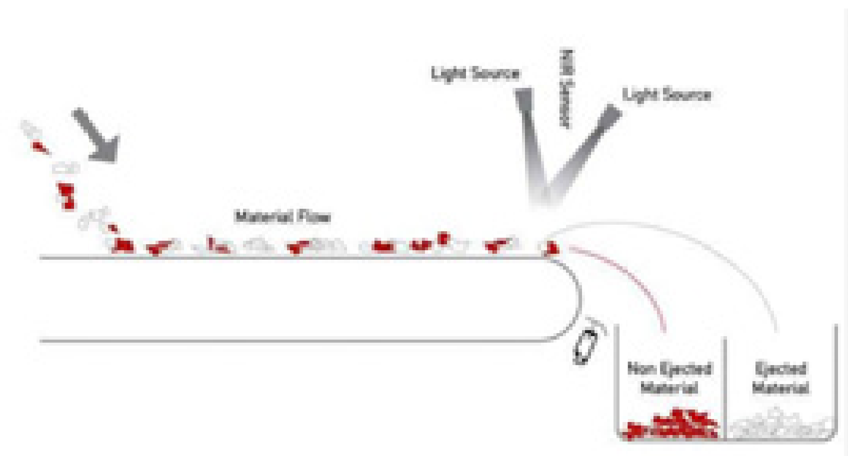


Figure 4-12Optical separator

4.4.2.Upgrade in the Composting Process

The composting process will be enhanced when enhancing the previous sorting process. Moreover, compost turning and compost refining machines will be added, a leachate collection system and wastewater treatment unit will be installed, the curing area will be increased where an additional hangar will be installed. The additional metallic hangar will be attached to the already existing curing hangar. The hangar's area will be increased from 1450 m^2 to 2250 m^2.

The produced compost will be distributed to local farmers, after the completion of the required monitoring tests.

Figure 4-13Proposed windrow turning machine

Figure 4-14Proposed compost refining screen

4.4.3.<u>Upgrade in the Inorganic Waste Management Process</u>

After primary size segregation and hand separation processes, all recyclable materials are stored separately in specified areas. The recyclable materials will be later baled, wrapped and stored in the specific storage area to be sent to local recyclers.

With respect to the residual, inorganic, non-recyclable waste, and hazardous waste/materials, will be sent to Bourj El Chmel dumpsites until a management strategy is adapted to treat the refuse waste. Currently, a controlled air incinerator is proposed by the UOTM to be installed. Knowing that it is covered by the UoTM fund, and not the World Bank fund, a specific ESIA was prepared and submitted to MoE waiting for approval.

4.4.4.Upgrade of the Odor Control System

Odor, gas and dust emissions from the proposed MSWTF may exceed ambient air quality standards and may result in complaints from nearest receptors. One odor control technology that has been shown to be both economical and effective is a biofilter.

In the present facility, the existing biofilter will be demolished and replaced with a more efficient biofilter system. Also, an additional biolfilter system will be installed near the composting zone. Accordingly, air from the loading zone will be transferred to the first biofilter, while air from the composting area will be directed into the newly installed biofilter.

The proposed biofilter system consists of suction fans, a piping system and a biofilter media of 1.6 m in depth. The suction fans are able to change the air in the hangar at a rate of two air changes per hour. In fact, the proposed system has a total airflow rate of 17 m^3/s. The biofilter media is made out of a combination of wood chips and coco husk which ensures a removal efficiency of 85-90%. Moreover, a sprinkling system is installed in order to ensure an optimal level of humidity in the biofilter media

4.4.5.Upgrade of the Leachate Collection and Treatment System

Leachate and storm water collection systems are separated as shown in the drawings in Appendix 8.

The leachate generated from the sorting and composting facility shall be conveyed to the existing leachate tank (labeled with the letter M on the drawing), further to which it will be pumped to the leachate treatment plant (labeled with the letter P on the drawing). Further to treatment, the treated effluent may, depending on the level of treatment, be either stored in tanks for re-use for domestic use or for irrigation of the green areas within the plant, or alternatively transported by means of special trucks towards the regional wastewater treatment plant of Tyre. It is to be noted that the alternative of releasing the treated water into receiving water bodies was not considered due to the absence of such nearby water bodies as well as the need to make sound use of the available water in view of its scarcity.

It is essential to point out that the wastewater generated from the biofilter shall be channeled towards the existing sewer tanks, which are periodically emptied by means of tankers for disposal in a dedicated sewer collection point ensuring its collection in the existing sewerage network servicing the neighboring area / village, or directly into the regional wastewater treatment plant. This practice shall remain in application until a proper sewerage system is implemented in the area.

On the other hand, storm water shall be collected at the entrance and periphery of the reception area and composting facility in order to prevent its mixing with fresh waste and compost. In the absence of nearby receiving water bodies, such drainage water generated from stormwater runoff may, depending upon its turbidity, be stored in a tank dedicated for domestic use or irrigation of green areas, similarly to the treated effluent for the leachate treatment (addressed here above), or alternatively be drained towards the existing sewer collection tanks (labeled with the letter N on the drawing), which, as stated here above, shall be disposed of into the nearby sewerage network or directly in the regional wastewater treatment plant.

Accordingly, the separation of leachate and storm water is ensured. The treated water shall be transported by means of special trucks towards the main sewer network of Ain Baal.

The proposed facility will install a leachate treatment unit to treat generated leachate and condensate as a result of the process reactions. A Disc Tube Reverse Osmosis (DT-RO) system with capacity of 50 m^3 /d or 3 m^3/ hr will be installed to treat leachate from the composting tunnels, tipping floor, floor pits and condensate from the biofilters. The expected influent characteristics are summarized in the table below.

Table 4-4Expected wastewater influent characteristics

Parameter	Concentration
pH	6.5-8.5
COD	6000 mg/L
BOD	3000 mg/L
Total Nitrogen	1600 mg/L
Potassium	1470 mg/L
Sodium	4800 mg/L
Lead	1.64 mg/L
Copper	0.1 mg/L
Zinc	0.3 mg/L
Nickel	0.1 mg/L
Cadimum	0.05 mg/L
Chrome	0.30 mg/L
Mercury	4.6 µg/L

First, the wastewater is collected in a raw water/leachate conditioning tank (capacity 5m^3) for leachate conditioning including a sieve strainer and a raw leachate supply pump. The holding tank will serve as an equalization/homogenization/conditioning tank prior to conveying the leachate for the treatment unit. In this basin, the pH of the leachate will be adjusted, using H_2SO_4, to 6.5-8.5 to avoid premature precipitation of water hardness ions. Then, the leachate will be first filtered in sand filters, followed by cartridge filters and finally the DT-RO units. The DT-RO units proved to have high removal rates of chemical oxygen demand (COD), total organic carbon (TOC), electrical conductivity (EC), ammonia nitrogen (NH3-N), and heavy metals (Liu, Y., Li, X., et.al. 2008).

The general wastewater treatment system design criteria are set out in the Terms of Reference, to be imposed on proposed WWTP designers (Appendix 4). The generated sludge will be collected twice per year and added to the composting piles for the biological treatment. The wastewater treatment plant effluent will be in compliance with Decision 8/1 dated 2001 (Table 4-5) and shall be compliant with the WBG EHS guidelines (whichever is more stringent).

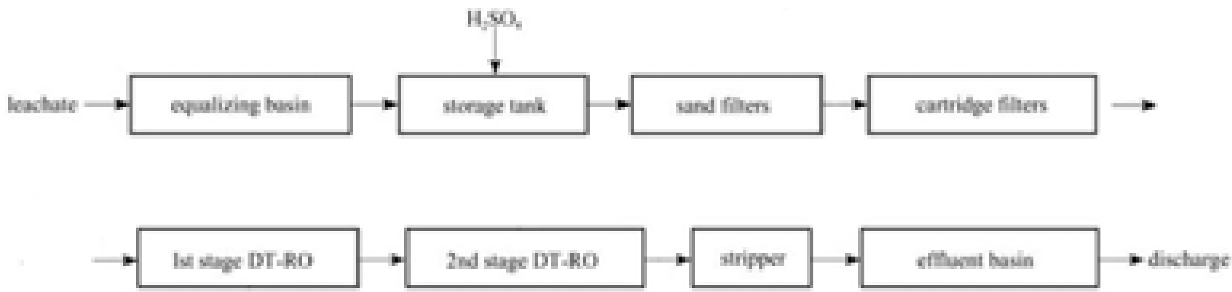


Figure 4-15Leachate treatment process flowchart

Table 4-5Environmental Limit Values for wastewater treatment unit effluent water

Parameter	**For discharge to surface watercourses Decision 8/1 dated 2001**
pH	6-9
Temperature ^{0}C	35
BOD mg O_2/l	25
COD mg O_2/l	125
Total Phosphorus mg/l	10
Total Nitrogen mg/l[1]	30
Suspended Solids mg/l	60
Detergents mg/l	3
Coliform Bacteria 37^{o}C in 100ml[2]	2000
Salmonellae	Absence
Oil and Grease mg/l	30
Total Organic Carbon mg/l	75
Nitrate mg/l	90
Phosphate mg/l	5
Sulphate mg/l	1000

4.6. Resources, Utilities and Infrastructure

4.5.1 Project Staff

During construction phase, an estimate of 35-50 workers will be present on-site to perform all required activities. During operation phase of the facility, 20 workers will be for all working shifts. Note that workers will not reside on site. Only a handful key skilled workers will come from outside the local community. All remaining workers will be recruited locally.

4.5.2 Water Consumption

During the construction phase, water will be used for domestic purposes (sanitary, housing...etc.), for construction activities and for cleaning and dust suppression. The total daily or monthly water consumption cannot be estimated accurately as it highly depends on worker's behavior, constructional activities and other factors.

During the operation phase, the facility will depend on public water for its operation. Water is used mainly for domestic purposes, facility and equipment cleaning, biofilter application and compost piles watering. The expected water consumption is presented in the table below.

It is important to mention that water consumption records of the existing facility were not available.

Table 4-6Estimated water consumption during the operation phase

Usage	Water Consumption (m^3/day)
Domestic consumption	3
Composting bays spraying	4
Biofilter application	8
Facility cleaning	4
Equipment cleaning	2
Total	**21**

4.5.3 Power Consumption

The estimated total power consumption of the upgraded facility is around 530,000 kWh/year (Table 4-6). The list of machines used and the corresponding power consumption are shown in the table below. The plant uses two diesel generators of 550 kVA capacity each and one additional 300 kVA generator. The generators are enclosed within a designated room onsite. One diesel storage tanks of 20,000L capacity is present onsite.

Table 4-7Estimated power consumption (after the upgrade)

Equipment	Total Consumption (kWh/year)
Bag Opener	45,864
Plastic bags	50,960
Trommel Screen	28,028
Ballistic Seperator with Vibro feeder	30,576
Magnetic Seperator	12,740
Eddy Current with Vibro feeder	17,836
Optical Sorter with Vibro feeder	63,700
Conveyor Belts	152,880
Bailing Press	127,400
Total	**529,984**

4.5.4 Total Cost of the Project

According to the designer, the project is estimated to cost an estimated amount of 2,700,000 Euro (EUR).

5. DESCRIPTION OF THE ENVIRONMENT SURROUNDING THE PROJECT

The environmental and social baseline assessment is a key component in any ESIA study. This assessment will basically record the existing conditions of the area including physical, biological and socioeconomic conditions before the project implementation and operation. The aim of this section is to identify key environmental issues that need to be monitored during the implementation of the project.

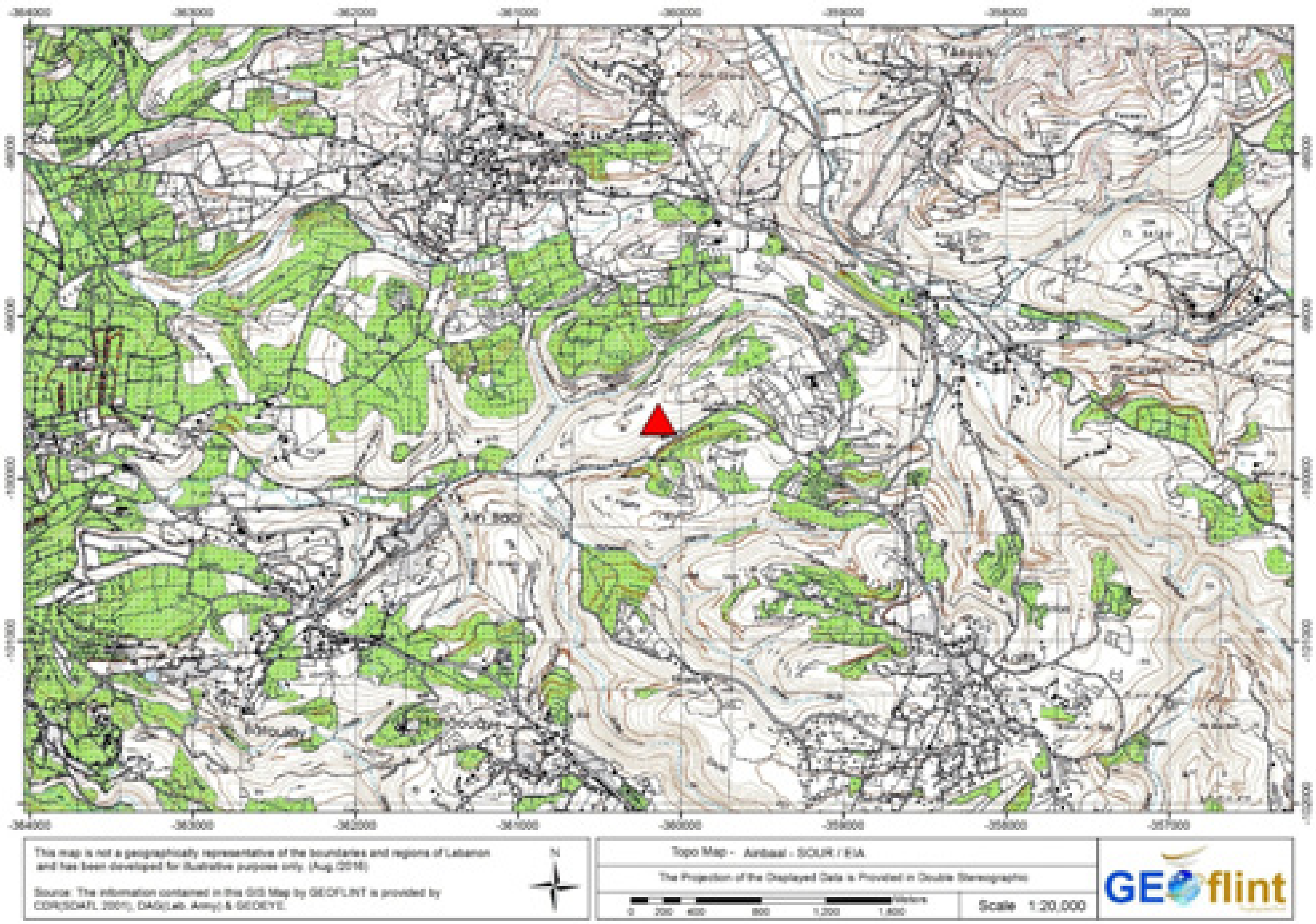
5.1.Physical Environment

5.1.1. Project Location

The project is located within Ain Baal cadastral area, Tyre Caza, South Lebanon Mouhafaza.
Tyre lies on the Eastern slopes of South Lebanon and includes the coastal city of Tyre and other villages with land elevations ranging between 0 m and 1500 m above sea level. The village of Ain Baal is situated 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. The road network in the region is generally in good conditions connecting the villages to each other. However, rehabilitation is needed for the road connecting the facility to the main road. The location of the proposed facility is shown in the map below (Map 5-1).

Figure 5-1Ain Baal existing SWMF

Figure 5-2 Satellite image



Map 5-1 Topography map

*5.1.2.**Climate and Meteorology***

The climate and meteorological parameters play a vital role in transport and dispersion of pollutants in the atmosphere (air and water). Thus, the collection and analysis of meteorological information, including primarily precipitation, ambient temperature, wind direction and speed, are essential data for adequately assessing environmental impacts. The most significant meteorological parameters that influence the direct environmental impacts at the proposed project are: wind due of its ability to carry odors and gas to nearby communities; and precipitation due to its ability to enhance the infiltration of chemical and toxic material within the facility land depending on site operation procedures. Unfortunately, meteorological records are seldom available except for few locations in the country where stations are operating. Climatologically (long-term) data is obtained from the closest meteorological monitoring station or from any other nearby station which has been collecting meteorological data for the past years. Climatic parameters have not been monitored at the site; however, data from nearby weather monitoring stations El Qasmiye and Naquora meteorological stations are the closest stations.

As for Ain Baal, it is characterized by a wide fluctuation between the absolute highest and lowest temperatures, high evaporation rate, low air humidity, and violent winds.
Furthermore, the proposed site falls in the sub-humid bioclimatic zone, characterized by an annual average rainfall of 800mm/year which is considered as a medium range for Lebanon. Due to the unavailability of recently published national data, climatic parameters have not been monitored at the site; however, data from nearby weather monitoring stations have been used to conduct a preliminary evaluation of the site’s climatic conditions. Thus, climatological data was obtained from the closest meteorological monitoring station which has been collecting data for the past years.

5.1.2.1. Temperature

The two meteorological stations that acquire temperature data, and are nearest to Ain Baal area are El Qasmiye and El Douair stations. The two stations have data recorded between years 1944 and 1970. The hottest months in the area are July and August and the coldest months are January and February (Figure 5-3). The average maximum recorded mean temperatures are 27 ^{o}C and 23 ^{o}C for El Qasmiye and El Douair stations respectively, while the minimum recorded mean temperatures are 13.7 ^{o}C and 11 ^{o}C respectively. Fluctuations between day and night temperatures are generally significant Figure 5-4, where minimum and maximum monthly temperatures are recorded at El Qasmiye station.

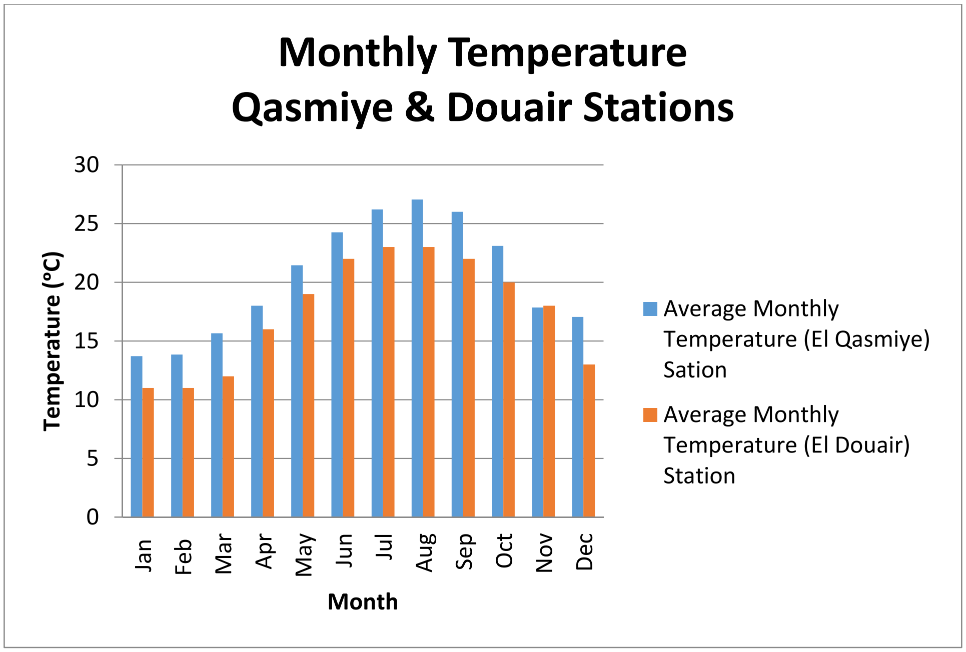


Figure 5-3 Average monthly temperatures at El Qasmiye and El Douair station during the years 1944 and 1970

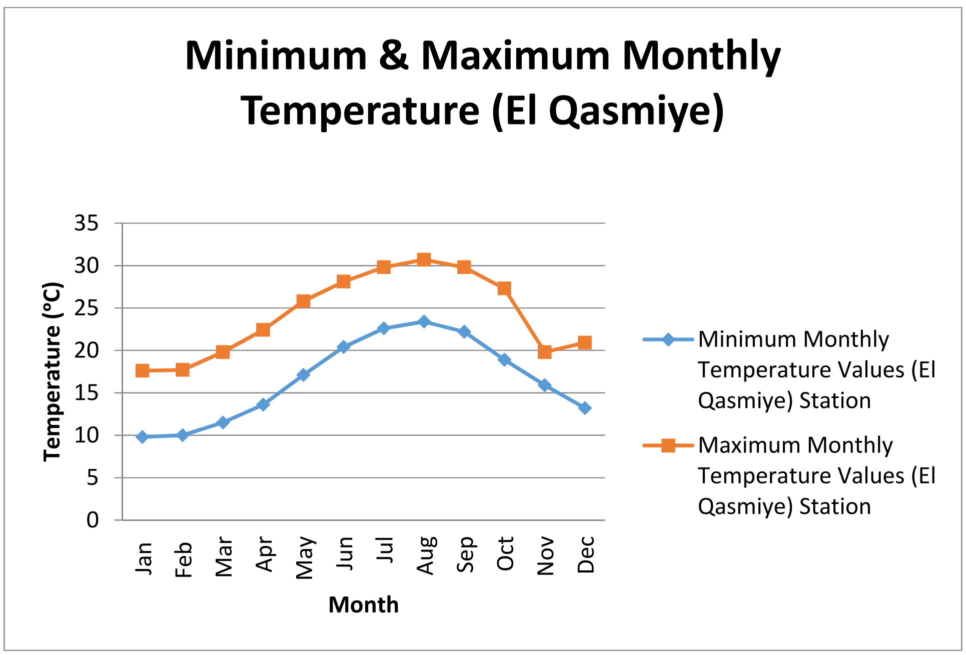


Figure 5-4 Minimum and Maximum monthly temperatures at El Qasmiye station during the years 1944 and 1970

Since there are no meteorological stations installed in Ain Baal specifically, other sources can be used. Climate-data.org has been collecting climate data from the year 1982 until 2012. The site uses a climate model that has more than 220 million data points and a resolution of 30 arc seconds. Climate data for Ain Baal is not available, but El Bazourye; a village 1.8 km away from Ain Baal has available data and can be representative of Ain Baal climate.

Table 5-1 Temperature data for El Bazourye (Climate-data.org)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Avg. Temp (°C)	13.4	13	14.9	18	21.2	23.7	25	26.5	25	23	19.1	15.2
Min. Temp (°C)	9.6	8.9	10.2	13	16.1	18.8	21	21.9	21	18	14.5	11.4
Max. Temp (°C)	17.2	17	19.6	23	26.3	28.7	30	31.1	30	27	23.8	19.1
Precipitation (mm)	199	135	80	39	10	0	0	0	4	28	86	156

5.1.2.2. Precipitation rates

Annual precipitation in the coastal area of South Lebanon ranges from 620 to 800mm (Figure 5-5).

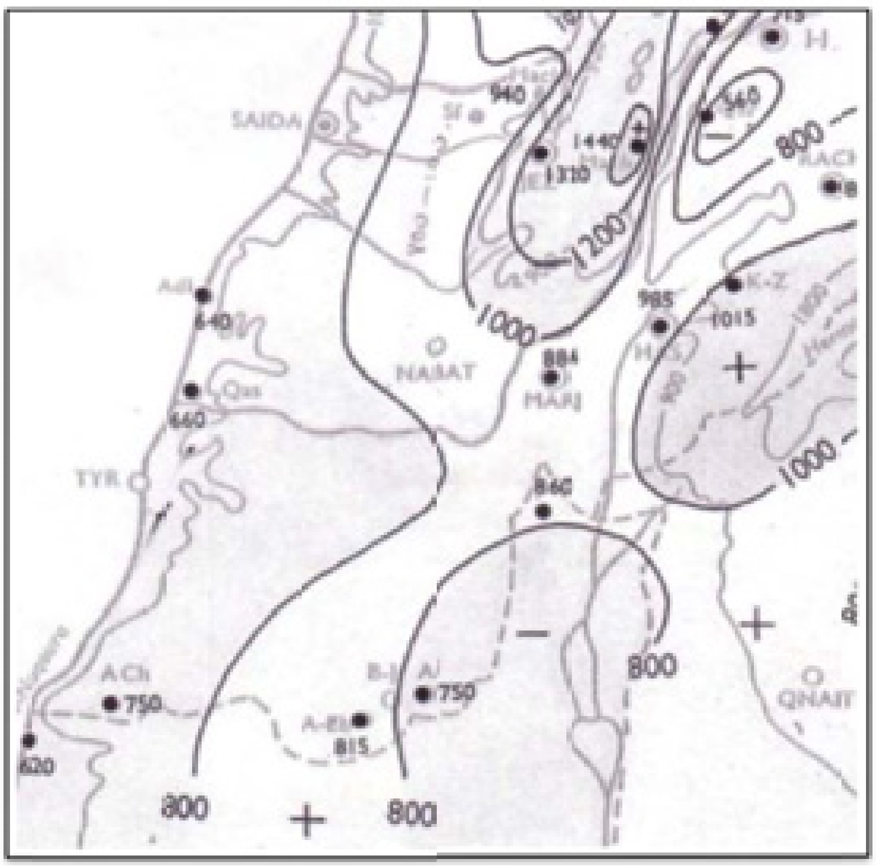


Figure 5-5 Contour lines representing annual precipitation values in South of Lebanon

El Quasmiye and El Naquora stations are the closest available coastal stations to Ain Baal. They are located at elevations of approximately 30 and 50m respectively, and Ain Baal is between them on an average elevation of 180m. Climatic conditions taking place at the stations are very likely to be similar to the ones reaching Ain Baal, thus this study will consider the data representative for the study. In addition, it is important to mention that even though the recorded data is between years 1944 and 1970, it can still be used. According to (MoE; UNPD, 2005), measurements taken after year 1975 were averaged and compared to the ones of the (1944-1970) period, this comparison showed no significant difference in the climatic trend and showed that past data can be used.

During the 27 years period between 1944 and 1970, El Qasmiye station received an average annual precipitation of 654 mm and that of El Naquora received 609 mm. Both stations received the maximum rainfall in the month of January, having an average value of 162mm (Figure 5-6). July and August didn't receive any rain, and the minimal average monthly rain occurred in June and September (1 to 4 mm). In addition, El Qasmiye stations witnessed 49 rainy days and El Naquora station witnessed 50 days (according to Atlas Climatique Du Liban).

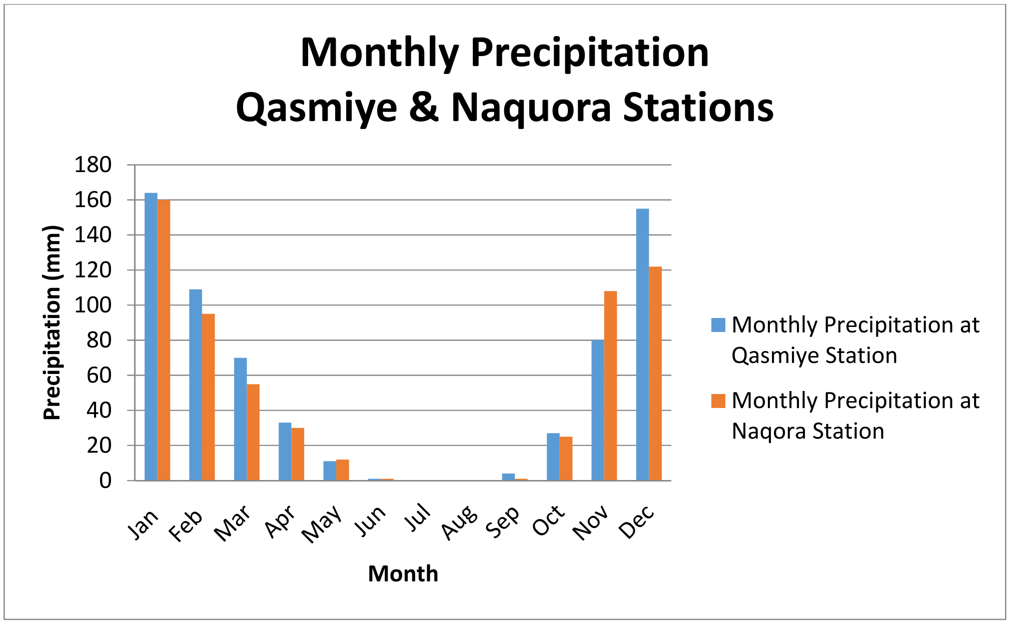


Figure 5-6 Average Monthly precipitation values in mm recorded at El Qasmiye and El Naquora stations during the 1944 – 1970 period

Precipitation data for Ain Baal is not available, but El Bazourye; a village 1.8 km away from Ain Baal has available data and can be representative of Ain Baal climate. The precipitation data from the year 1982 until 2012, collected from Climate-data.org, are presented in the table below.

Table 5-2 Precipitation data for Ain Baal

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Precipitation (mm)	199	135	80	39	10	0	0	0	4	28	86	156

5.1.2.3. Wind records

The closest wind data station to the study area is located in Saida. According to (Service Météorologique du Liban), wind direction is dominant in the South and South West orientation (Figure 5-7). Stronger winds are more frequent in the summer months, and relatively weaker winds are prevalent in the winter season.

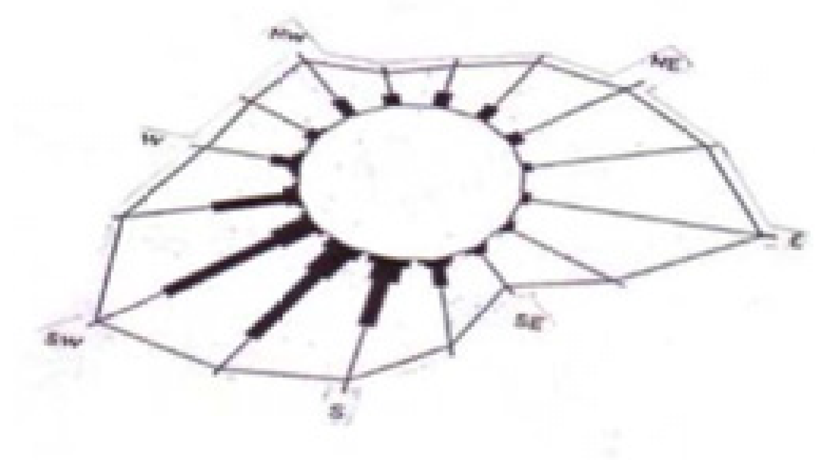


Figure 5-7 Wind Rose in the station of Saida (Atlas Climatique du Liban)

5.1.2.4. Relative Humidity

The relative humidity (RH) data obtained from El Douair meteorological station are listed in Figure 5-8. Data shows that the area has a medium to high relative humidity which is averaged about 68 percent yearly with an average relative humidity reaching 63% during the winter and 73% during the summer. Mean monthly RH is highest during January (73%) and December (72%) and lowest during September (63%) and June (64%).

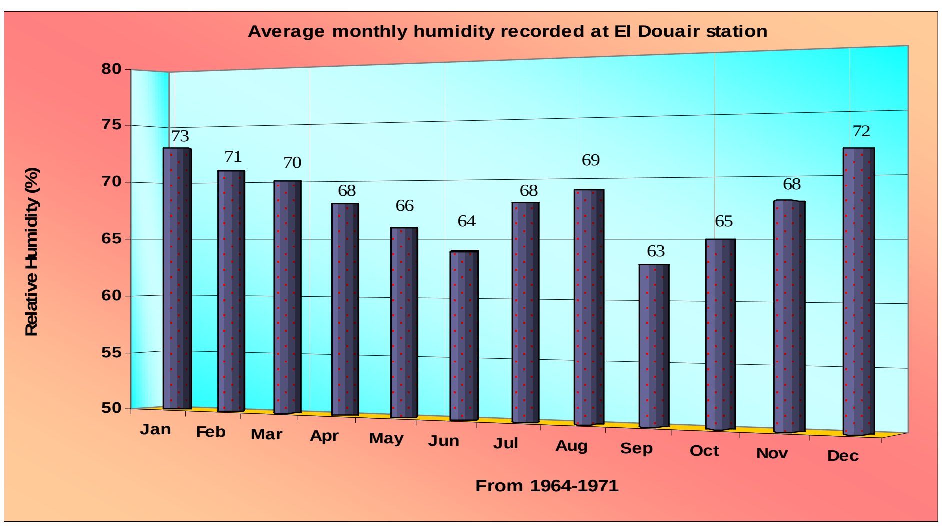


Figure 5-8 Average monthly relative humidity record at El Douair station from 1964 till 1971

5.1.3. Geological Setting

The geology of the studied area, including outcropping formations, subsurface stratigraphy, structure (faults, folds, seismic…etc), hydrogeology and surface water was developed based on office work (review of available maps and literature and analysis of aerial photographs and topographical maps) and site works (geological surveys and site visits).

Geological Stratigraphy and structural condition of the area

The outcropping lithological formation in and around the study areas belongs to Chekka Marl (C_6) of the Cretaceous and lower Tertiary geological unit. It is comprised of sediments indistinguishable lithology; stiff bluish plastic Marl with glauconite, interbedded with chalky marly limestone and nodules of black chert. This formation has a thickness varies from 400 m to 150 m. the formation bedding is dipping towards NW with N60^{o}E / 30^o NW.

The site under study is located on hilly terrain area surrounded by two natural water drainage channels passing at Northwest and Southeast direction and intersects at the Southwest point of hill. The soil cover is a medium layer of creamish and reddish to light brownish clayey silty plastic sand full with gravel.

Lebanon is cut by various faults, where the longest fault in is the Yammouneh Fault that runs along the western margin of the Bekaa and links the major fault of the Jordan Valley to the Ghab Valley Fault of Northern Syria. This is a lateral (or transform) fault and makes up the Lebanese segment of the Dead Sea Transform Fault. The other major fault in Lebanon is the Roum Fault, which runs from Marjayoun towards Awali River. This fault is probably witnessing most of the plate tectonic motion and may be the present plate boundary between the Arabian and the African Plate. The other major fault in Lebanon is the Serghaya Fault that bands the eastern side of Bekaa. Other faults are present with displacements ranging from a few centimeters to several kilometers.

The study area does not include major faults but some local fractures. Some minor faults pass from East to west at a distance of about 2000m to the South and 1500m to the East of the project site. These faults are trending NE-SW and had displaced the depositions in the area, but do not subject the project site for tectonic threats.

5.1.4. Hydrogeology

The groundwater flow is but one part of the complex dynamic hydrologic cycle, where the occurrence and movement of groundwater are related to physical forces acting in the subsurface and the geological environment in which they occur. Saturated formations below the surface act as mediums for the storage of water, and the water infiltrates to these formations from the surface is transmitted slowly for varying distances until it returns to the surface by action of natural flow, vegetation, or man.

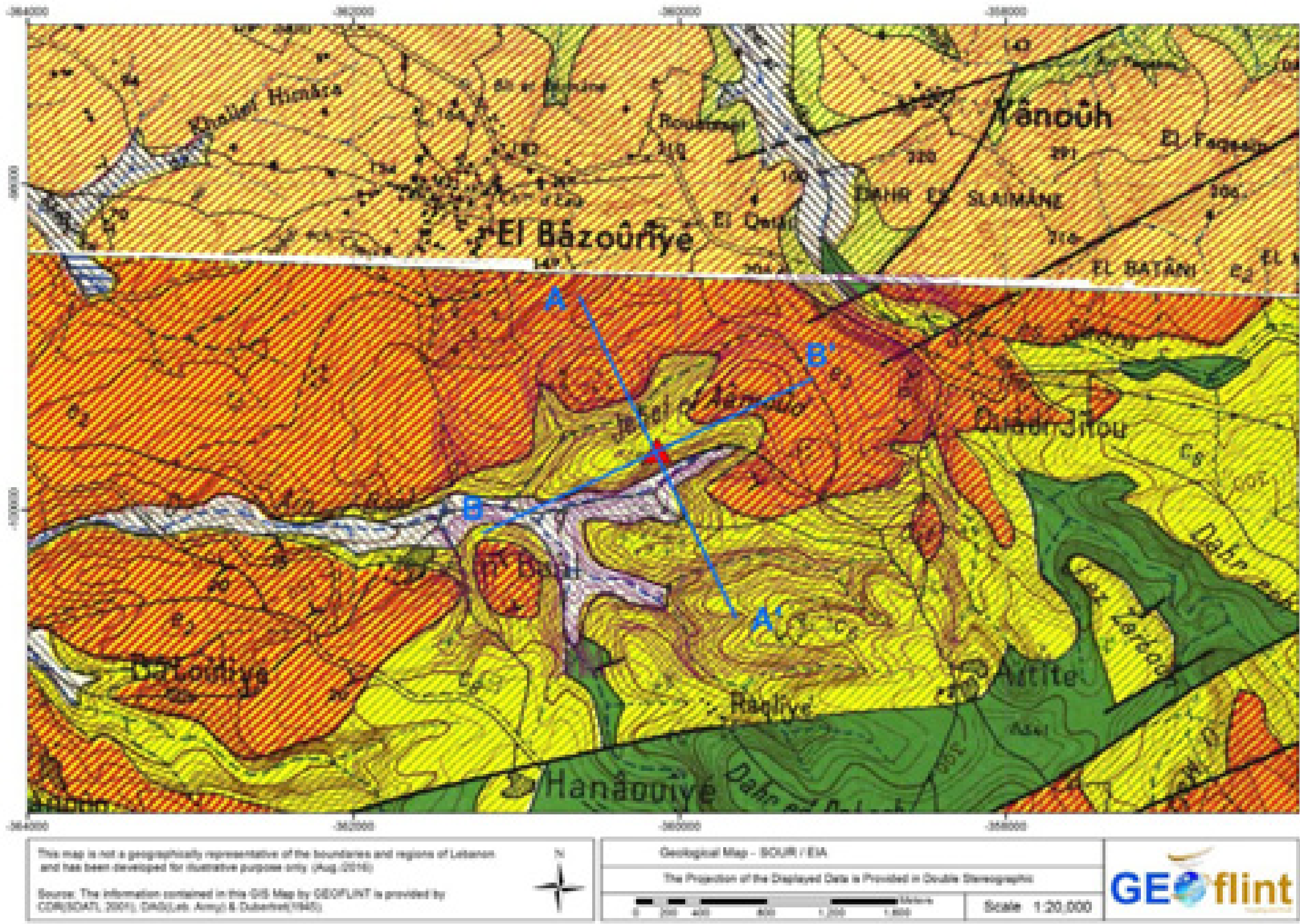
The proposed site is located at the Aquiclude of marl formation (C6) characterized by poor hydraulic properties because of the low hydraulic conductivity of marls. This fact will help in preventing any seepage, in case it has happened, from reaching the water aquifer in the underlying limestone formation. As detailed in section 4.4.5 here above, the stormwater, wastewater and leachate generated from the existing facility shall be separately collected and directed to the respective storage and treatment units as appropriate (as detailed in section 4.4.5 and shown in the drawings - Appendix 8). This, in addition to the low permeability of the marly soil, shall ensure that no contamination of the groundwater be induced.

General hydrologic patterns in the area are driven by patterns of rainfall and groundwater inflow. High flows occur in December, January, and February in response to abundant rainfall and high amounts of runoff as soils become saturated through the rainy season. Summer shows no flows in July, August and September. Through the area, the ground water level varies due to topography, sedimentation and rock beds inclination.

With respect to hydrogeology, no water resources are found within a 2000m diameter from the project site, except for the Ain Baal seasonal spring that is located at e2 geological formation. This spring is not likely to be affected by the project, since it is separated by the project terrain with a Wadi and the rock bedding with dips towards NW at the two locations; whereas, the project is located at the North East direction. Accordingly, any possible seepage will be directed to a different direction from the spring.

5.1.5. Seismology

Areas of high earthquake activity should be avoided based on a geological investigation. The integrity of the structural components in an unstable geological area should be well demonstrated. The structural geology field investigation and the seismic categorization map of Lebanon indicated that the selected area is considered a low seismic zone. (Refer to seismic map of the area, Map 5-3). Therefore, the integrity of the structure components along the site might not be expected to get exposed to the risk of active earthquake hazard. Some anti-earthquake measure should be considered in the design of the structures to prevent any possible risk even if seismic activities are mainly low.



Map 5-2 Geological map

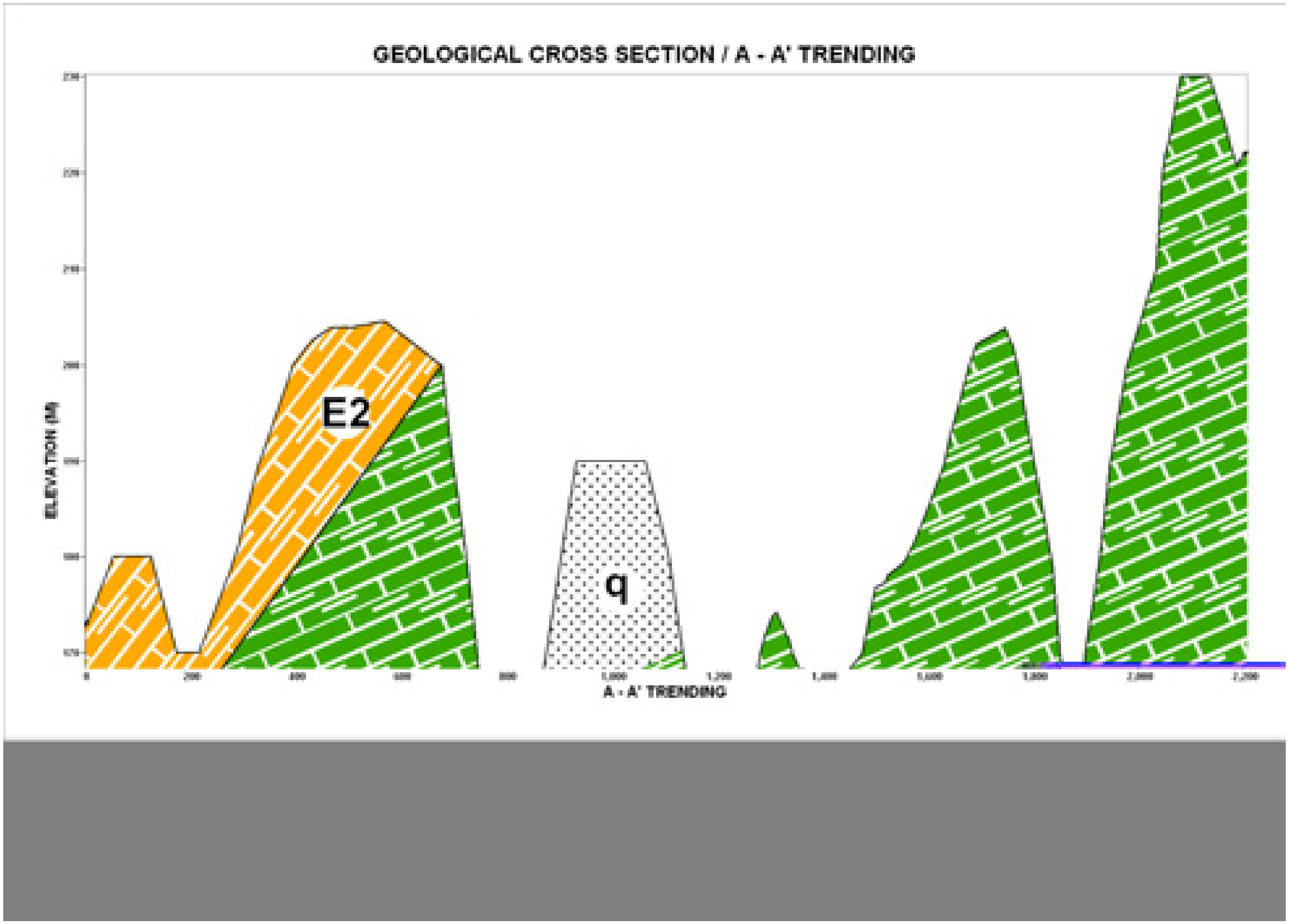


Figure 5-9 Geological cross section (A-A')

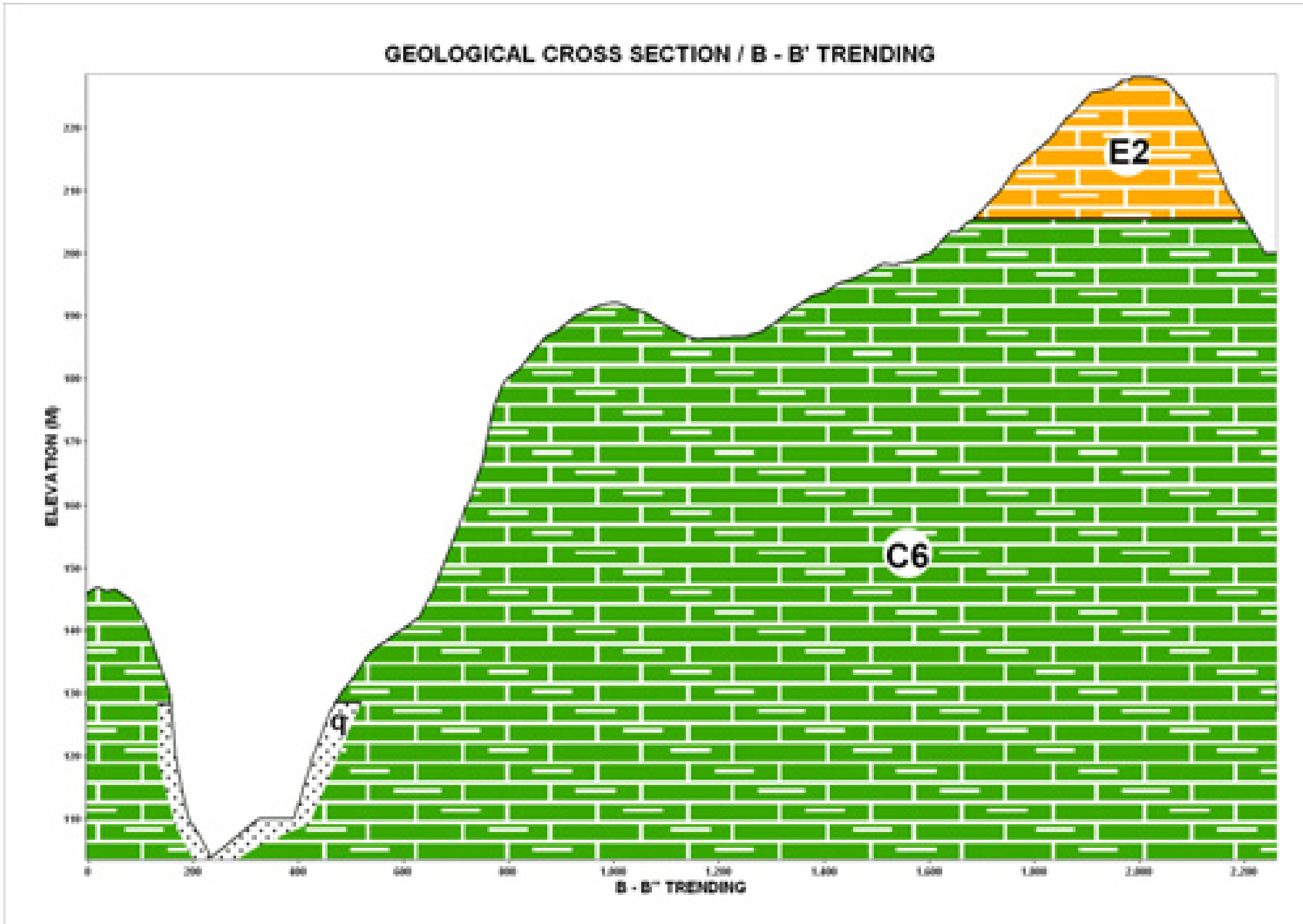
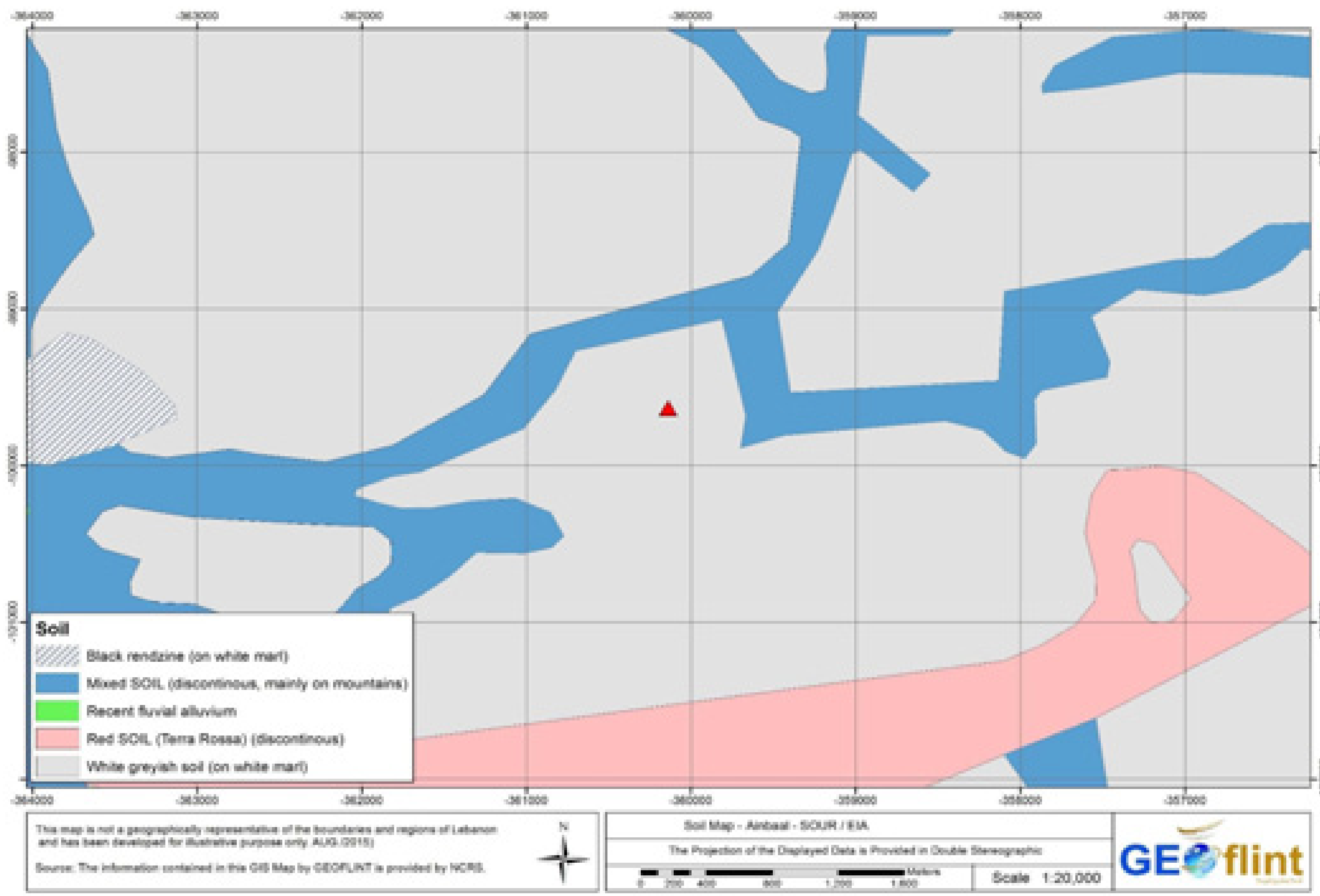
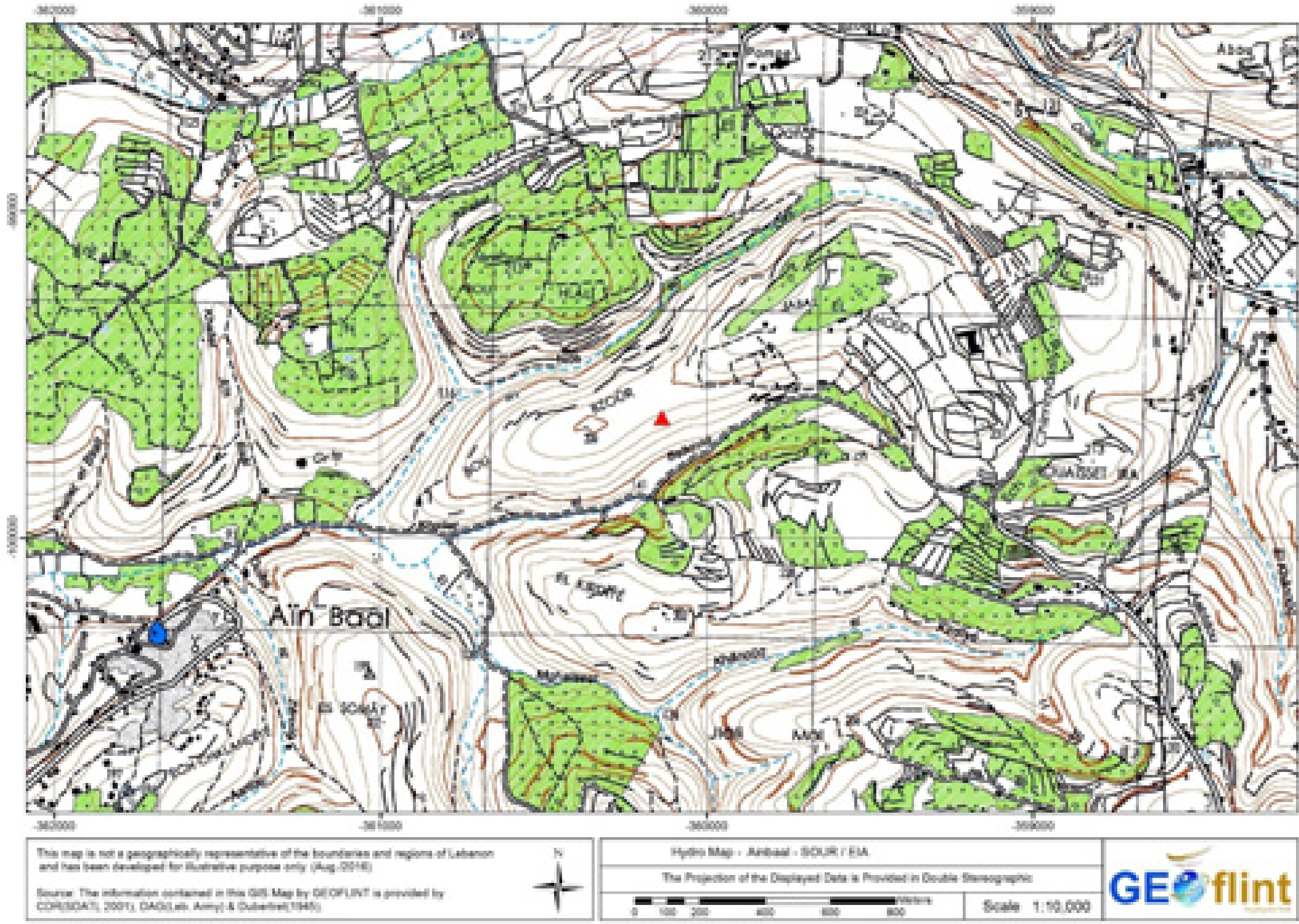


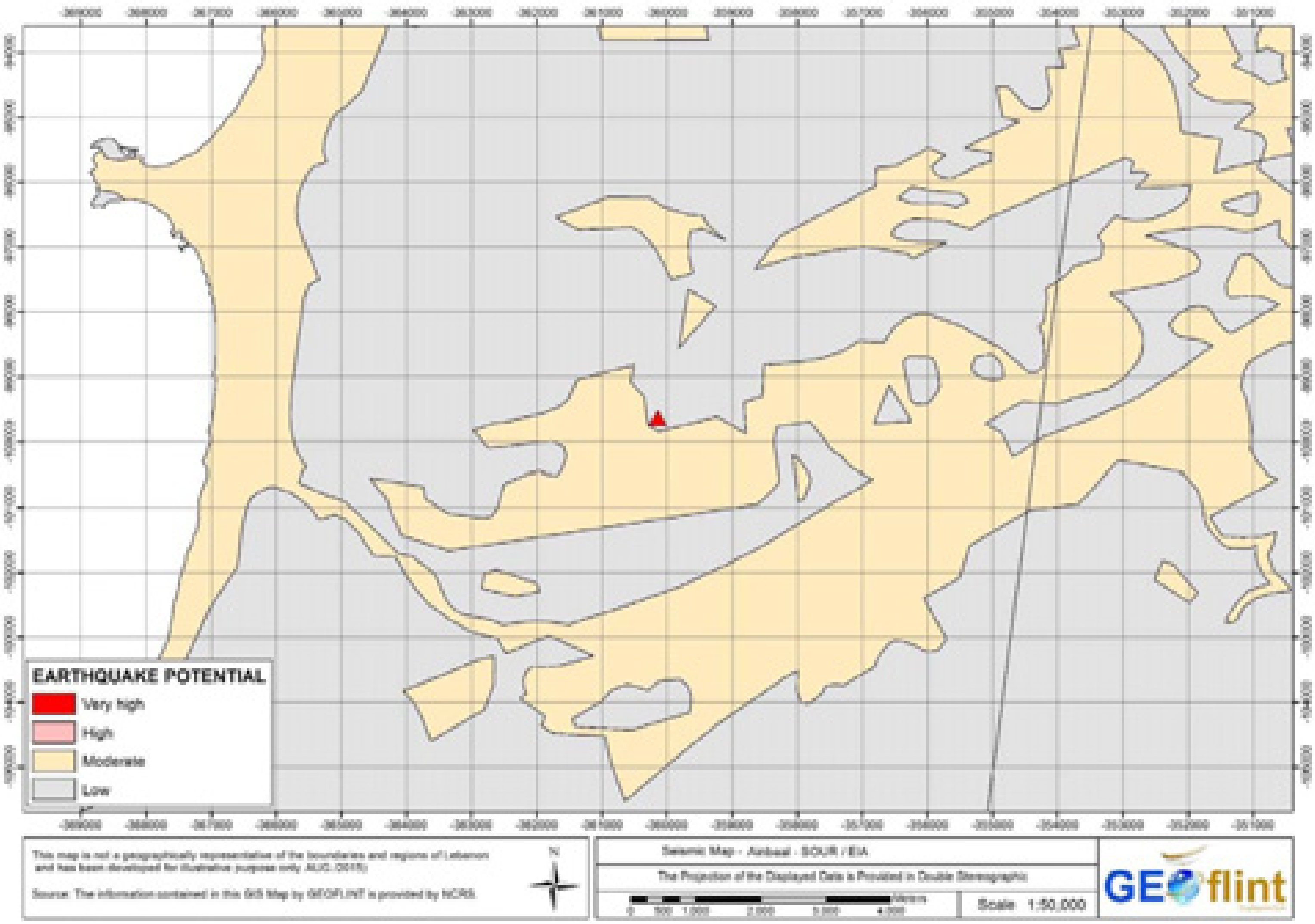
Figure 5-10 Geological cross section (B-B')



Map 5-3 Soil map



Map 5-4 Hydrogeological map of project site



Map 5-5 Seismic map

5.1.6. Air Quality

Air quality is an essential component in assessing social wellbeing and health status of a community. Air pollutants come from various sources such as traffic, commercial, industrial and manufacturing facilities. According to the UNDP, MoE project Air quality assessment in an East Mediterranean country: the case of Lebanon, the project site lies in zone 5 with the following baseline ambient air quality.
It is to be noted that the poor operation of the existing facility has impacted odor in the surrounding areas to levels that have generally been rather significant because of specific concerns in the lack of functioning of the biofilter due to potential shortages in electricity supply, or in the malfunctioning of the biofilter due essentially to (i) lack of proper operation and maintenance of the bofilter media that require regular watering of the media and timely replacement of the media upon specified usage, (ii) lack of regular maintenance of the air extraction turbines. It is essential to point out that the absence of leachate collection and treatment is a significant factor affecting the generation of odors.

Table 5-3Annual background average concentrations in µg.m3

Cell	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	CO
1	37.74	69.11	25.14	21.01	26.40	635.80
2	22.25	80.52	21.27	18.09	14.37	397.96
3	17.69	93.97	20.45	17.44	12.39	346.92
4	22.28	80.94	20.78	17.03	13.59	470.99
5	20.22	82.46	20.40	17.29	13.54	400.27
6	19.08	83.43	20.28	17.27	12.95	377.25
7	19.06	82.87	19.76	16.24	11.87	440.33
8	15.54	86.30	19.42	16.34	11.23	328.32
9	13.70	88.17	19.23	16.31	10.80	297.07

Figure 5-11 Cells distribution for annual ambient air quality analysis

5.1.7. Acoustic Environment

The definition of noise as unwanted sound implies that it has an adverse effect on human beings and their environment. Noise can also disturb natural wildlife and ecological system.

The major source of noise pollution site is believed to be the roads network in the area. Noise from transport sector (cars and trucks) can impair people's ability to work, learn in school and sleep, and consequently results in lowered property values in affected areas. As number of cars is increases, noise is becoming even more of a concern.

Noise levels in the project area are considered as moderate. Noise levels were recorded by Geoflint team during the site visit (09/08/2016).

Table 5-4Noise level measurements

Area	Location	Time (am)	Average Noise level dB(A)
Inside the facility	Operational	10:36	88.59
Inside the facility	Non- operational	11:45	64.60
Outside the facility	Operational	10:58	75.38

5.1.8. Wastewater Management Infrastructure

In the South Governorate, the rate of connections to the sewage network is estimated to be around 42.1%. The non-connected areas drain wastewater in wells or use septic tanks

(MoE/LEDO/ECODIT, 2001; Makdisi et al., 2007). The uncontrolled discharge of wastewater is leading to the contamination of surface water. El-Fadel et al. (2000), state that the coastal waters from Tyre to Akkar are contaminated by industrial wastewater discharges. In fact, high concentration of Ni (max 41 μg/L), Cu (max 33 μg/L), Cr (max 160 μg/L) and As (max 48 μg/L) were recorded at several locations.

Moreover, three treatment stations and their associated wastewater discharge networks have been constructed in Yohmor, Kfar Sir and Zoutor (South of Lebanon), at an estimated cost of around US$ 12.5 million, funded by the European Commission.

Figure 5-12 Tyre wastewater treatment plant

5.1.9. Solid Waste Management Infrastructure

Municipal solid waste management practices vary in the different regions in Lebanon. Illegal dumping and open burning of MSW are common where most towns or cities operate open dumps within their jurisdictions. Currently, waste is being treated using the existing SWMF in Ain Baal, where it depends on composting as a method for treatment. However, the efficiency of treatment is weak and requires major modifications. The Union of Tyre Municipalities is composed of 63 villages with a population of around 490,000 inhabitants. The increase in the population, due to the Syrian displaced influx in addition to the Palestinian camps, estimated around 83,000, raised financial burdens to the Municipalities in the Tyre area mainly in the collection of solid waste. The whole caza is producing around 220 t/d of solid waste, while the Ain Baal solid waste treatment facility financed from the EU has a capacity of 150 t/d but is currently operating at below 100 t/d and is now only serving 35 municipalities out of the 63 initially intended for.

Tyre Caza includes about 51 uncontrolled dumps (ELARD, 2011). There are 7 non-operational dumps and all the remaining were operational until the date of the survey. The oldest dump was in Bedias village at the year of 1984 and many new dumps were started at the year of 2010. The largest dump is Deir Qanoun / Ras El Ain dump that has an area of about 12,230m^2 and am estimated volume of about 183,450m^3. This dump was totally closed last year 2015 to be rehabilitated later. The closest uncontrolled dump sites to Ain Baal facility are as such:

Table 5-5Surrounding uncontrolled dump sites

Name	Direction	Distance (m)	Start Year	Condition
Wadi Jillo	NW	1,575	2008	Operational
Jouaya	W	2,765	2009	Operational
Aaytit	SW	3,680	1993	Operational

The proposed upgrade of the treatment facility will be helping divert the generated solid waste from the existing dumpsite. However, the rehabilitation of the dumpsites will not be within the scope of this project.

5.2. Biodiversity and Natural Habitat

This section of the ESIA is supposed to discuss the biological conditions pertaining within the project area and its surrounds. As all planning applications will require an assessment of ecological effects, preliminary ecological assessment that includes an evaluation of the relative ecological importance of the area would be helpful in notifying developers of the key ecological constrains/threats, design options, and management requirements.

However, assessing the ecological value of a damaged site where construction activities (land leveling and excavation) were carried out, and the natural conditions of the site were drastically changed, is very challenging.

Specifically, given that the main impacts on biodiversity takes place during the construction phase, and given that the facility is already constructed, no biological assessment was undertaken to assess the flora and fauna of the project settlement. Also, given the limited time given to conduct the EIA study, the biodiversity team couldn't assess the ecological value of the project surroundings that could be of some significance.

It can however be generally quantitatively stated that the village is distinguished by both its white and black soil suitable for the cultivation of all types of crops. Different types of rain-fed and irrigated open-cultivated vegetables exist in Ain Baal. The most common cultivated products within this area are citrus fruits, olives, tobacco and fruit trees. No specifically significant flora and fauna (forest, migrating birds' route, etc.) exists in the village besides the mentioned agricultural types.

Despite the absence of any sensitive fauna and flora within the site and surrounding area, a proper management of the operational activities (e.g., leachate collection and treatment, etc.) is essential in order to avoid any potential negative impacts to the remaining natural habitats near the project site.

5.3. Socio-Economic Conditions

5.3.1. <u>Socio-Economics Status</u>

5.3.1.1. Demographic Profile

The village of Ain Baal is situated in the central region of the Caza of Tyre, approximately 8 Km from the city of Tyre. In the caza, 282,768 residents are registered. The population count of the 26 villages in Tyre, in 2010, is presented in Table 5-6.

As stated by Ain Baal's municipality, the total population of the village in 2016 was 5510 people, among which only 4410 are residents (80% of the total population). Referring to 2014 elections, the number of registered voters is 4698, and only 2526 of them actually voted (Municipality Website, 2016). During the summer, the village inhabitants' number rises to 1600 people, while 1100 inhabitants exist all year long (In addition to the inhabitants of Housh Basma). The village Ain Baal is dominated by the young and middle age (between 20 and 50 years old), which are considered active members of the society.

It is important to mention that the people in Tyre Caza are known to migrate. The migrants are scattered in Africa, Europe & United States, and Arab countries with the following percentages respectively: (80, 10, and 10). The largest number of Ain Baal immigrants is found in Sierra Leone, Africa (Municipality Website, 2016). According to GETI's feasibility study, 600 villagers were displaced to other parts of the country and they constitute around 10.9% of the total population. Additionally, around 500 migrated to other countries and constitute about 9.1% of the total population.

In Ain Baal, people with an age less than or equal to 21 years are 2610 in number, and they make around 47% of the whole population. People with an age between 21 and 65 included are 2735 in number, and they constitute around 49% of the total population. People older than 65 years old are 165 in number, and constitute only about 3% of the total population in the village. In this context, it can be said that the village of Ain Baal is dominated by the young and middle age, which are considered active members of the society (GETI, 2016).

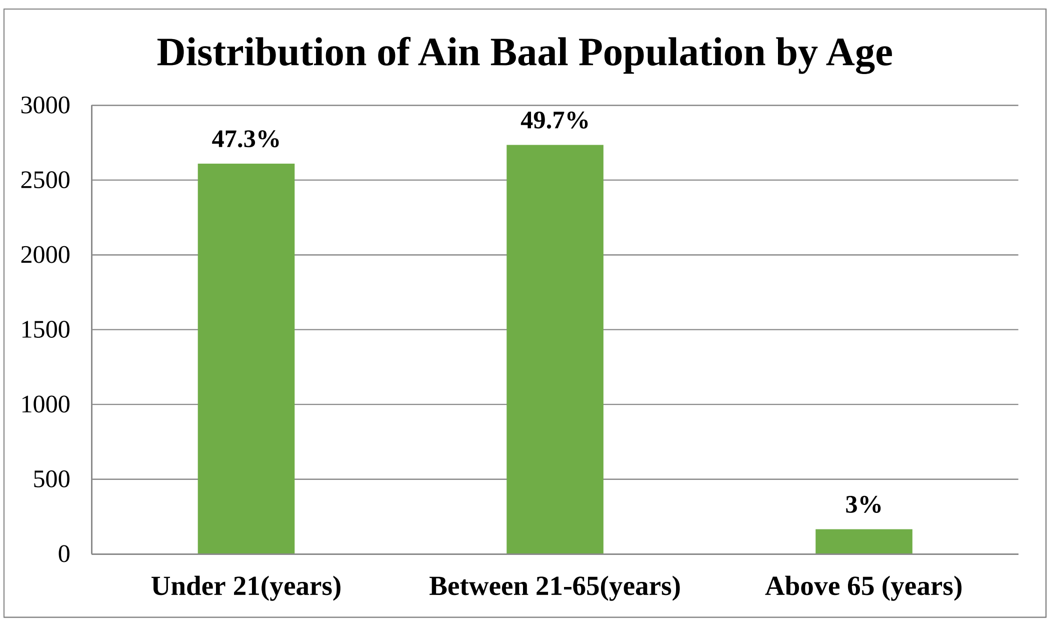


Figure 5-13Distribution of Ain Baal population by age

Table 5-6 Population of Tyre villages

Name of Union	Nb of municipality	Name of municipality	Nb of Registered	Nb of Residents	Nb of Refugees	Refugee % within the Union
Union of Tyre Municipalities	1	صور Tyre	48,777	65,000	7,469	26.6%
	2	برج الشمالي Borj Al-chimali	7,635	45,000	2,603	9.2%
	3	صديقين Seddikeen	4,707	6,000	1,557	5.5%
	4	Arzoun أرزون	780	1,200	100	0.3%
	5	Batoulieh باتولية	2,348	850	200	0.7%
	6	Barish باريش	4,173	5,000	120	0.4%
	7	البازورية Bazourieh	7,344	16,000	1,125	4.0%
	8	Baflieh بافلية	3,048	3,300	100	0.3%
	9	Badias بدياس	1,785	2,000	200	0.7%
	10	Bourj Rahal برج رحال	4,694	5,500	1,800	6.4%
	11	البرغلية Bourgalieh	4,127	3,500	530	1.8%
	12	El Boustan البستان	2,291	900	0	0.0%
	13	El Beyad البياض	1,228	1,000	70	0.2%
	14	Jebal El Boutem جبال البطم	2,300	2,300	200	0.7%
	15	El Jebbine الجبين	2,485	1,500	80	0.2%
	16	Jennata جناتا	810	400	70	0.2%
	17	Jouya جويا	17,625	9,000	950	3.3%
	18	El Hallousieh الحلوسية	3,209	2,800	55	0.1%
	19	El Hmeireh الحميري	1,050	1,000	76	0.2%
	20	حناويه Henaouyeh	3,196	1,100	250	0.8%
	21	El Heneyeh الحنية	947	1,000	200	0.7%
	22	Debaal دبعال	2,780	2,750	400	1.4%
	23	Derdagya دردغيا	1,240	1,200	350	1.2%
	24	Deir Ammes دير عامص	2,816	2,600	150	0.5%
	25	دير قانون النهر Deir Kanoun El Naher	5,587	9,500	400	1.4%
	26	دير قانون رأس العين Deir Kanoun Ras El Ein	3,754	2,300	314	1.1%
	27	Deir Kifa دير كيفا	3,472	3,500	125	0.4%
	28	El Ramadieh الرمادية	2,515	2,500	500	1.7%
	29	رشكنانية Rechkanieh	1,484	1,600	30	0.1%
	30	Zebkine زبقين	2,352	3,000	400	1.4%
	31	Selaa سلعا	2,932	3,000	260	0.9%
	32	Chahrour شحرور	7,290	5,000	100	0.3%
	33	El Chaatatieh الشعيتية	3,292	3,000	30	0.1%
	34	Chamea شمع	1,779	3,000	60	0.2%
	35	El Chahabieh الشهابية	8,640	15,000	390	1.3%
	36	Chihine شيحين	1,886	750	50	0.2%
	37	Sreifa صريفا	7,600	9,000	750	2.7%
	38	Toura طورا	4,662	5,500	300	1.1%
	39	Teir Harfa طير حرفا	3,368	1,200	30	0.1%
	40	Tair Debba طيردبا	5,635	5,500	650	2.3%
	41	طيرفلسيه Tayrfalseyeh	4,284	3,000	318	1.1%
	42	El Zaheira الظهيرة	1,307	2,500	0	0.0%
	43	El Abasieh العباسية	7,548	30,000	1,909	6.8%
	44	Alma El Chaab علما الشعب	3,085	700	100	0.4%
	45	Ayteet عيتيت	4,128	6,000	450	1.6%
	46	Ain Beal عين بعال	5,158	15,000	688	2.5%
	47	Kana قانا	11,667	10,000	1,239	4.4%
	48	El Kaleile القليلة	5,150	5,300	220	0.8%
	49	El Kaniseh الكنيسة	726	1,500	20	0.1%
	50	El Majedel المجادل	4,315	3,000	300	1.1%
	51	Majed El Zoun مجدل زون	4,481	4,500	215	0.8%
	52	محرونة	1,845	1,000	0	0.0%

		Mahrouneh				
	53	مروحين Marwhein	2,161	2,500	150	0.5%
	54	مزرعة مشرف Mazraet Mechref	1,635	400	100	0.4%
	55	معركة Maaraqueh	10,240	10,000	1,047	3.7%
	56	Maaroub معروب	4,192	6,000	537	1.9%
	57	El Mansoureh المنصوري	3,689	700	330	1.2%
	58	El Naqourah الناقورة	3,896	2,800	200	0.7%
	59	Yareen يارين	3,883	1,500	100	0.4%
	60	Yanouh يانوح	1,735	1,200	30	0.1%
	Total		282,768	361,850	28,062	

Refugees in Ain Baal

One of the primary destinations of Syrian refugees in Lebanon is Tyre, which is located in the South governorate. According to UNHCR, during the year 2015, the total number of female and male refugees in the South is 64813 and 60819 respectively, for a total of 125,632. As for the village of Tyre, the total number of Lebanese residents is 361,850. According to UNHCR database, the total number of Syrian refugees in the Union of Tyre Municipalities was 28,062 in 2016 (Table 5-6). From these values it can be said that the Syrian refugees located only in Tyre are 22.3% of all the refugees located in the South. In addition to Syrian refugees, one Palestinian camp also exists in Tyre, with approximately 80,000 refugees recorded.

5.3.1.2.Economic Profile of Ain Baal

In general, for Tyre caza, the socio-economic data for the 26 villages is presented in Table 5-7.

Socio-economic conditions of the project site.

The facility itself is approximately 500 meters from the nearest inhabited structure. The closest structure to the facility is 650m using the road that leads to the site. This minimizes the impacts of the facility on permanent residents of the area. As these residents stated during consultations, the impacts on them are mostly related to odors coming from the facility, which will be reduced further to the implementation of the mitigation measures.

There are 45 workers that live on or near the project area. These workers are from Syria. 42 of the workers are men and three are women. In addition to these 45 day laborers, 10 Lebanese workers work on in the facility as managers and operators.

The 45 workers live in the solid waste facility. The workers live in two areas.

- The first is on the solid waste site itself. In this area, the operator has provided 40 male workers 2 rooms and 4 containers to live in. The area includes 5 showers and toilets for the workers. The workers have no furniture and have improvised cooking facilities.
- The second is a plot next to the solid waste site. This area accommodates 3 men and 2 women who are brothers and sisters.

The living conditions of the workers on the site are poor, as they live in small rooms (approximately 7 men per room) and they have 5 shared toilets and 5 shared shower facilities. The remaining five workers live in tents in a plot next to the settlement.

Table 5-7 Socio-economic data in 26 villages served by the facility (GETI, 2016)

Village	Residential Units	School	Hospitals	Clinics	Slaughter house	Butchers	Workshops	Commercial institutions	Restaurants
Abbasieh	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

The empty cells are missing data

Specifically in Ain Baal, according to GETI's report which analyzed the socioeconomic profile to determine the solid waste composition and generation rates, the labor force of Ain Baal constitutes 30% of the village's residents. The distribution of labor force among sectors is as follows:

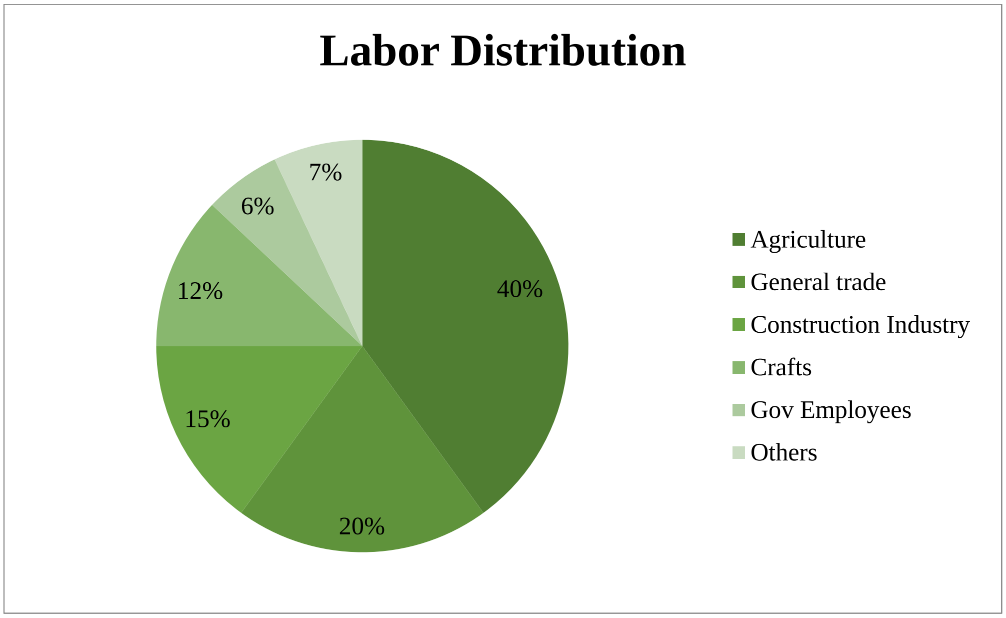


Figure 5-14 Labor force distribution in Ain Baal

<u>Animal Husbandry</u>

In addition to growing crops, Ain Baal's farmers engage in animal husbandry. Farmers breed domestic animals such as cows, goats, chickens, and bees. In Ain Baal you can find 150 beehives, 20 cows, 2 chicken farms, and 800 goats. On average, the production of milk is around 400 kg/day and produce of eggs and chicken meat is enough to meet the village's needs. Any surplus of produce is transported and sold in the market of Tyre.

<u>Trades, Construction, and Crafts</u>

Although there is a shortage of trained labor in the trades market, Ain Baal houses different craft and trade activities, and contains factories for the production of mainly cement blocks, steel, aluminum, stones, and tiles.

Table 5-8Workers in each profession

Profession	Workers Number	Profession	Workers Number
Concrete Carpentry	40	**Barber**	3
Construction	20	**Aluminum**	2
Painting	15	**Car Electrician**	2
General Carpentry	13	**Industrial Smith**	5
Sanitation	10	**Car Mechanic**	4
Tiling	10	**Butchering**	3

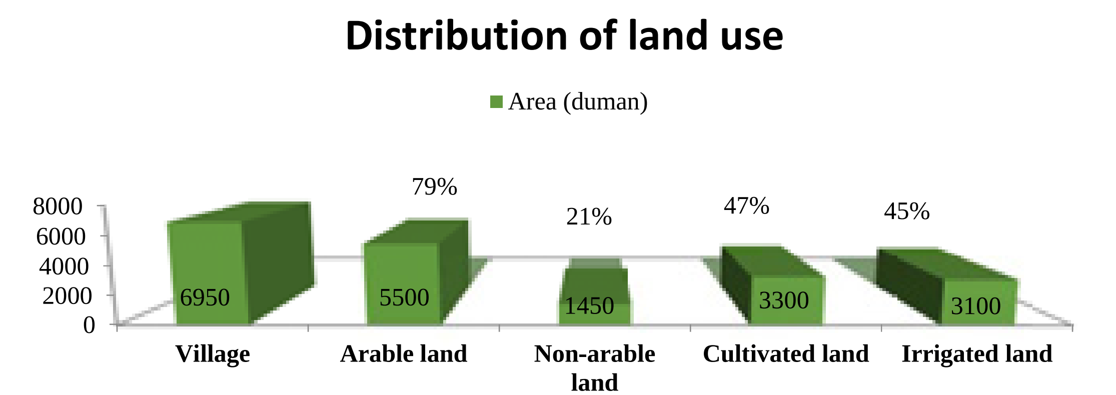
Electrician	10	**Baking**	3
Furniture Painting	8		

Real Estate Market

Housh Basma is a neighboring village to Ain Baal. After adjusting Housh Basma into a residential use area, Ain Baal villagers working in Tyr and that own land in Housh Basma started focusing on real estate in that area and this became a new rising sector in the economy of Ain Baal. Other than real estate, Ain Baal has a public market that opens every Thursday of the week and attracts users from Tyr and surrounding villages.

5.3.2. Land use / Land cover

According to the land use/land cover map, a high percentage of land use in the project area is designated as agricultural, the total area of Ain Baal is 6950 dunam, among which 5500 dunam are arable, 1450 are non-arable, constituting around 79% and 21% of the total area respectively. Furthermore, the cultivated land is slightly larger than the irrigated land. Moreover, cultivated land cover 47% with 3300 dunam, lastly the irrigated land cover 45% which forms 3100 duman of the village (GETI, 2016).



	Village	Arable land	Non-arable land	Cultivated land	Irrigated land
Area (duman)	6950	5500	1450	3300	3100
Area (in Percentage)		79%	21%	47%	45%

Figure 5-15 Distribution of landuse

The agricultural soil of Ain Baal is of two types: white and black with percentages of 60 and 40 respectively.

The sector relies mainly on five major crops, namely: Olives, citrus fruits, vegetables, fruits trees and tobacco. The distribution of agriculture area by type of crop is as follow:

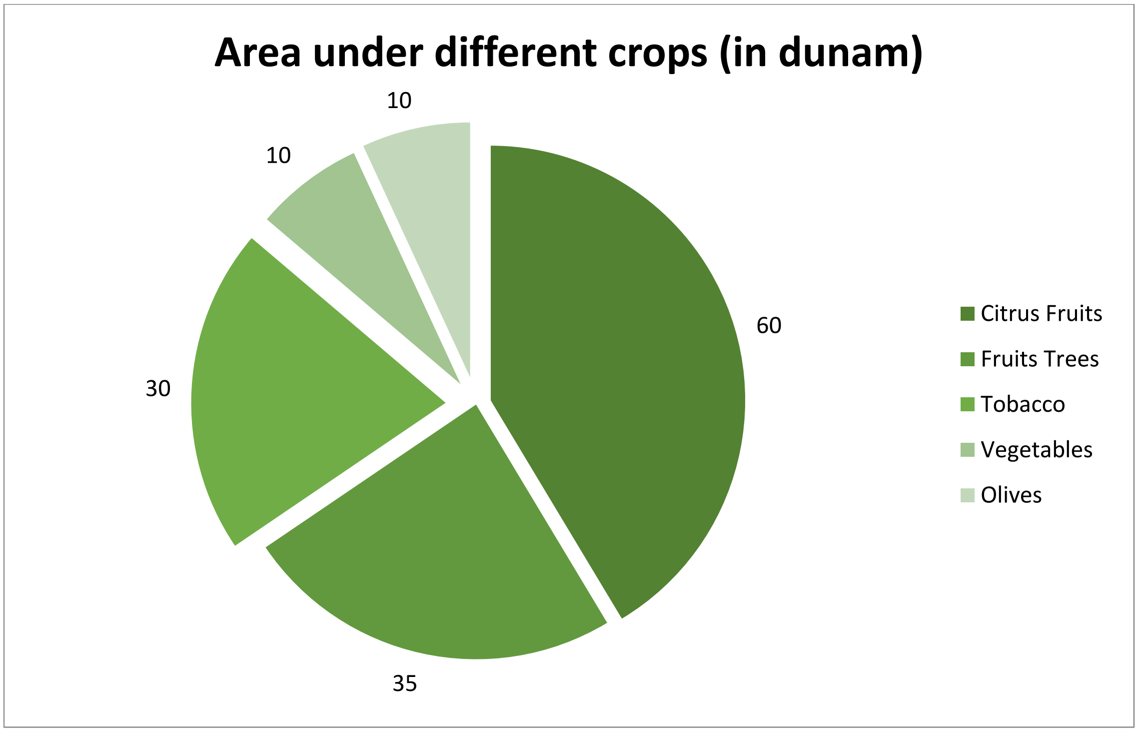
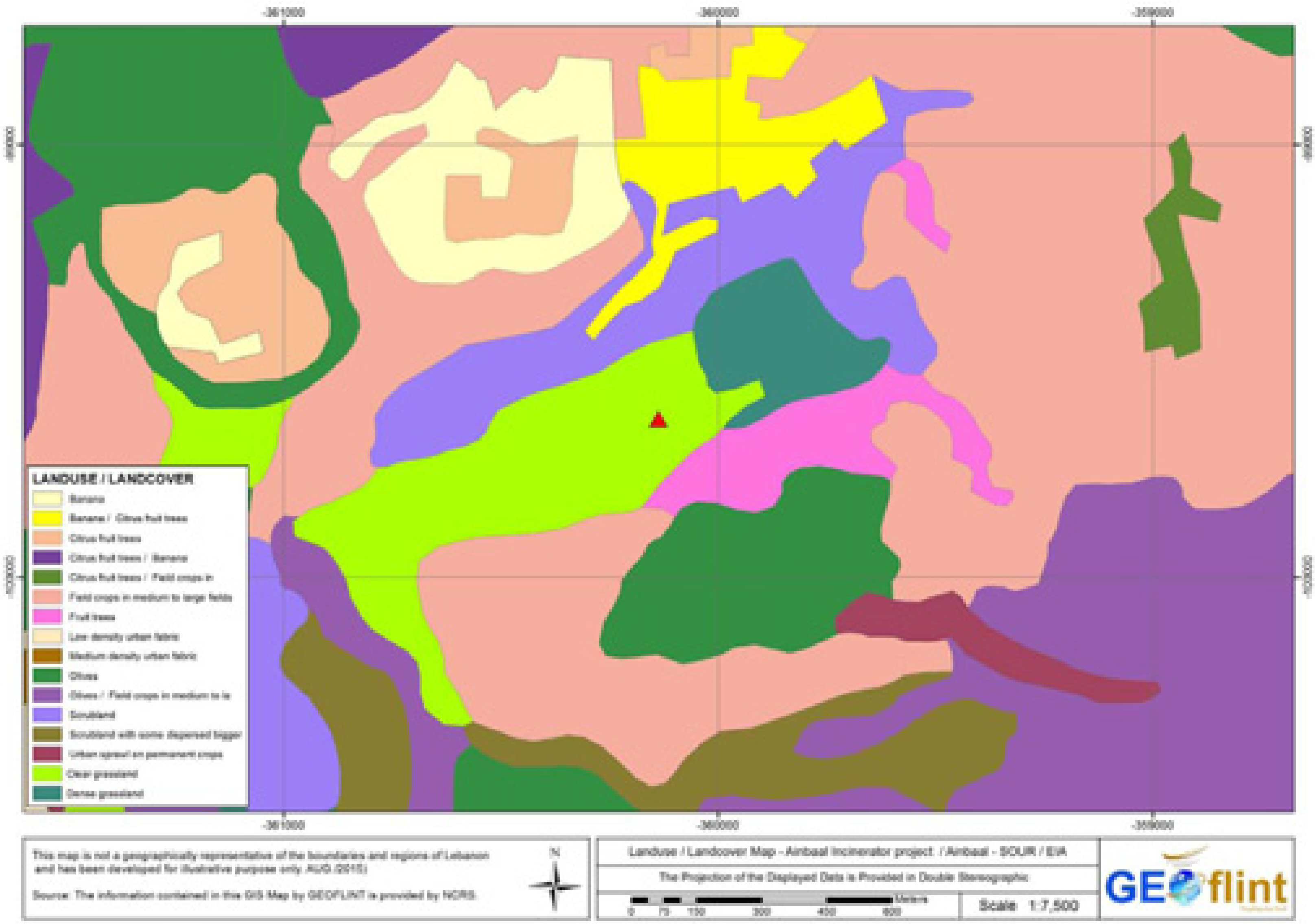


Figure 5-16Type of crops and respective area

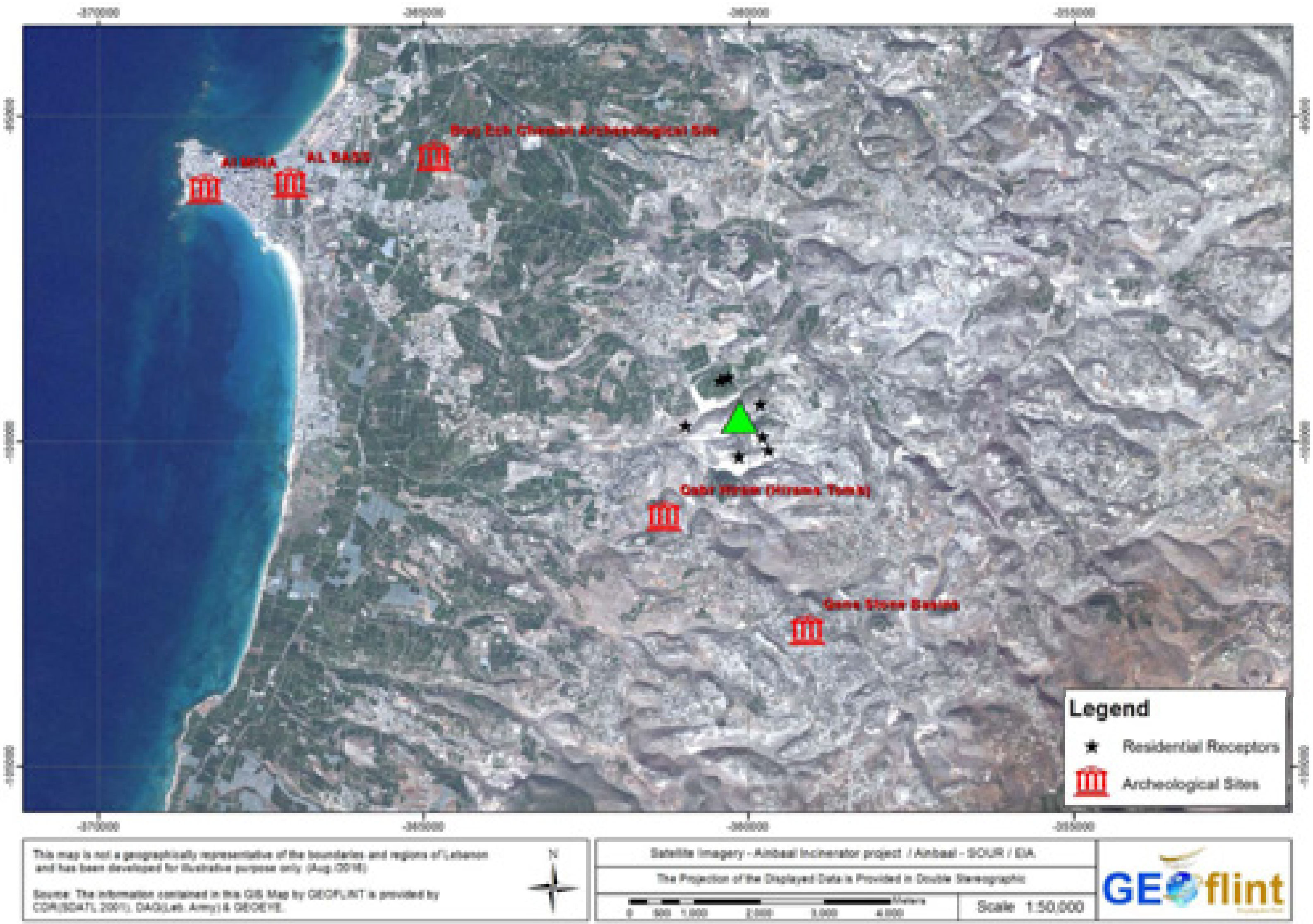
Citrus and bananas trees are planted on the coast. Moreover, bananas trees are being increasingly planted. In addition, agriculture production mostly comprises of citrus orchards and olive.

There are around 500 people working in agricultural sector, most of them own the cultivated land and employ latest machinery and skills.

It is important to mention that the woman and youth also cultivate tobacco and vegetables besides working in the educational sector.



Map 5-6 Land use/Land cover map



Map 5-7 Site surrounding map

5.3.3. Historic and Archaeological Heritage

Tyre was a Phoenician island city founded around the third millennium BC. Tyre is currently famous for its two UNESCO sites, al-Mina and al-Bass, which are home to Roman and Byzantine remains of the city's flourishing period (Living Lebanon, 2017).

Al-Mina Site

Dating to the 3rd millennium BC, the ruins are spread cover a vast area leading down to an ancient submerged harbor. It houses a street paved with geometrical Roman and Byzantine mosaics, on each side of which are rows of large columns. It also entails the unusually large public Roman bathhouse from the 2nd or 3rd century AD and a 4th-century rectangular arena that would have held up to 2000 spectators (Lonely Plant, 2017). Ainbaal SWMF is 9km away from Al-Mina site.

Al-Bass Site

This site lies 2km east of the Al-Mina site. It houses a vast funerary complex, with hundreds of ornate stone and marble sarcophagi. It entails also a preserved Roman road that stretches from an impressive 20m-high monumental archway which possibly dates from the time of Emperor Hadrian (2nd century AD). Following the archway is a large and preserved Roman hippodrome built in the 2nd century AD, and once held more than 20,000 spectators (Lonely Plant, 2017). Ainbaal SWMF is 7.8 km away from Al-Bass site.

6. IMPACTS EVALUATION

The proposed project aims to upgrade the existing solid waste treatment facility by increasing the capacity and treatment efficiency and thus decreasing the amount of waste that is diverted to landfills and open dumps.

The planned construction, renovation, equipping and commissioning project activities will extend for a period of six to seven months. The rehabilitation works are expected to end by December 31, 2017. It is important to note that there will be no disruption (or minimal) of management of incoming waste. Construction works will first take place in the newly proposed hangar. Certainly, there will be minor disruptions while dismantling and reinstalling the sorting line. These minor interruptions will be catered for in the coordination between the proposed contractor and the current operators.

6.1.Impact Evaluation

As per the decree 261/1, addendum to the decree 230/1 for reviewing procedures of submitted Environmental Impact Assessment reports, the following impact grading methodology shall be used.

This approach was adopted in order to address the several sources of impacts from the project's construction and operation phases. The stages of the evaluation process are the following:

- Identification of project-related activities (sources) and environmental aspects.
- Identification of potential impacts to the environment (physical, biological, human, cultural).
- Evaluation and assessment of the related unmitigated impact significance.

Classification of Impacts:

Impacts are first classified as shown the table below (refer to Table 6-1):

Table 6-1Classification of impacts

Matrix	Classification	Criteria
N (Nature)	**P** (Positive)	• The proposed activity offers benefits for the overall project
	N (Negative)	• Impacts having minimal to major negative influence
	D (Direct)	• Impact arising directly from the project activities
	I (Indirect)	• Impacts arising from activities not directly related to the project development
M (Magnitude)	**L** (Low)	• High potential to mitigate negative impacts on the physical, biological or human environment to the level of insignificant effects. • Disturbance of degraded areas with little conservation value. Minor changes in species occurrence or variety. • Simple mitigation measures may be needed to minimize impacts
	M	• Medium range (beyond site boundary but restricted to local

Matrix	Classification	Criteria
	(Moderate)	area). • Medium-term (reversible over time, duration of operational phase). • Potential to mitigate negative impacts on physical, biological or human environment. However, the implementation of mitigation measures may still not prevent some negative effects. • Destruction/Disturbance of areas with potential conservation value. Complete changes in species occurrence or variety. • Mitigation measures will help minimize impacts
	H (High)	• Disturbance to areas of high conservation value. Destruction of rare or endangered species. • Mitigation is required. • Largely irreversible impacts on the physical, biological or human environment. • Has a massive impact on the surrounding livelihood. • Potentially irreparable damage to a site of social and/or cultural importance
E (Extent)	**L** (Local)	• Limited to the project area • Locally occurring impact within the locality of the proposed project
	G (Global)	• Extend beyond the local area • National impact affecting resources on a national scale
T (Timing)	**S** (Short-term)	• Activities and their related impacts are characterized by a short duration of effect
	M (Medium-term)	• Activities and their related impacts are characterized by a medium duration of effect
	L (Long-term)	• Activities and their related impacts are characterized by a long duration of effect
D (Duration)	**C** (Construction)	• Impacts arise during the construction phase of the proposed project
	O (Operation)	• Impacts arise during the operational phase of the project
R (Reversibility)	**R** (Reversible)	• Impacts may be reversible, or able to be rehabilitated upon the decommissioning of the proposed project
	I (Irreversible)	• Impacts may not be reversible, or able to be rehabilitated upon the decommissioning of the proposed project
L (Likelihood of occurrence)	**L** (Low)	• The classified impact is unlikely to occur under normal operating conditions
	M (Medium)	• The classified impact may possibly occur
	H (High)	• The classified impact is likely to occur under normal operating conditions

Matrix	Classification	Criteria
S (Significance)	**L** (Low)	• Results in no substantial adverse change to existing environmental conditions
	M (Medium)	• Substantial adverse change to existing environmental conditions • Can be mitigated to less-than-significant levels by implementation of proposed potentially feasible mitigation measures or by the selection of an environmentally superior project alternative
	H (High)	• Substantial adverse change to existing environmental conditions • Cannot be fully mitigated by implementation of all feasible mitigation measures

6.2. Impacts during Construction

6.2.1. ***<u>Impacts on Water Quality</u>***

Although the project area is not rich in surface water resources, the construction activities shall be conducted safely to prevent any impact on water quality, particularly ground water resources.

<u>Accidental spillage</u>

Surface water pollution and eutrophication can be caused by accidental spills or leaks of chemicals, oil or fuel, stored on site for maintenance activities and electricity generation. In the event of a direct or indirect major spill to the environment, even small volumes can significantly degrade water quality within the study area for a long period of time.

<u>Domestic wastewater</u>

Domestic wastewater is generated by the daily activities of workers and administrators onsite. Domestic wastewater may cause pollution to nearby surface water bodies, soils or underground aquifers.

The project will involve 35-50 workers during the construction phase. The State of Environment Report (MOE/UNDP/ECODIT, 2011) dictates a wastewater generation of 120L/person/day. Thus 4.2 m^3 to 6 m^3 of wastewater shall be generated daily during the construction phase. The generated wastewater is discharged into the sewerage network of the facility.

<u>Construction wastewater</u>

In regards to construction wastewater, the main sources of contaminants might include:

- Contact cooling water for certain machinery
- Fuel and oils from machinery maintenance
- Machinery and vehicle wash down water
- General debris from the construction site

Moreover, the preparation and construction of the facility increase the compaction and impermeability of soils which results in surface water runoff and higher sediment loads in nearby streams. Wastewater generated during the construction phase of the project is difficult to estimate due to the wide range of constructional activities.

Storm water point discharge

Storm water runoff or a direct point source discharge can transport the contaminants as well as eroded materials from the site into the receiving environment. Storm water may carry with it:

- Spilled fuels
- Suspended particles, such as sand and silt, bentonite, cements
- Solid waste, such as plastic, paper, bottles, wood

All of the aforementioned discharges can significantly impact water quality in the area. Proper management modalities would be crucial.

Generation of solid waste

The quality of water within the local environment of the project might be altered if solid wastes are mismanaged. Solid wastes generated throughout the construction phase of the project consist mainly of domestic wastes and construction wastes.

- Domestic wastes:

Domestic wastes are comprised of papers, plastics, glass, textiles, organic matter, and ferrous/non-ferrous metals. These wastes can be subject to best available practices of recycling and furthermore can be dumped with no prior treatment to a municipal approved dumpsite.

The State of Environment Report (MOE/UNDP/ECODIT, 2011) estimates that domestic wastes in urban areas are generated at 1.1 kg/person/day. With a number of workers ranging between 35-50, an average 47 kg of domestic wastes are expected to be generated daily during the construction phase.

- Construction wastes:

In general, the construction phase will result in the production of various sorts of construction wastes. Construction wastes typically consist of concrete, asphalt, plaster, nylon and wood products.

The construction wastes generated from abortive works will include structural steelwork, steel sheeting and other metal material, reinforced concrete, concrete, electrical and mechanical services and other miscellaneous building materials.

Where possible, materials generated from abortive works will be saved, and materials in an acceptable condition will be returned to the appropriate authority. Excavated materials will be disposed of on-site and the remaining materials will be taken to a municipality approved disposal sites. As such, solid wastes generated throughout the construction phase of the project would most likely negatively impact the environment if not well managed and disposed.

Accordingly, the impacts on water quality are assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of high significance.

6.2.2. Impacts on Soil Quality

Construction activities

The construction activities may increase soil compaction and erosion, accumulating sediment loads in nearby water surfaces.

Disposal of solid wastes and liquid effluents

The disposal of solid wastes on land, as well as the discharge of sewage and other liquid effluents can all potentially cause soil contamination, impacting the quality of the soil on the longer run. Solid wastes generated throughout the construction phase of the project consist mainly of domestic wastes and construction wastes.

Accidental spills and leaks

Considering the quantities of diesel oil and chemicals that could be stored onsite during this phase, there is the potential for soil contamination due to accidental spills and leakages, particularly during the loading, unloading and storage of these materials.

Accordingly, the impacts on soil quality are assessed as: direct, moderate, local, long-term, reversible, of medium likelihood of occurrence and of high significance.

6.2.3. Impact on Air Quality

Exhaust gases

Emissions into the atmosphere during the construction phase are mainly caused by the combustion of fossil fuel in generators and the increased levels of traffic that will be introduced into the area. Such vehicles may include, but are not limited to:

- Heavy construction vehicles such as trucks
- Vehicles transporting workers to/from site (i.e. buses, mini-vans, cars)
- Delivery vehicles (i.e. concrete delivery trucks and light delivery vehicles)
- Personal vehicles

Emissions from the combustion of fossil fuel are considered as extremely difficult to quantify due to the unpredicted operational needs throughout the construction process.

Combustion and vehicle exhaust gases (petrol and diesel) constitute a complex mixture of organic and inorganic substances such as: PM_{10}, NO_2, SO_2, CO, Benzene, Toluene, Xylenes, and Ozone.

Dust emissions

Local air quality may decline as a result of dust generated during the construction phase. The main activities that may lead to the generation of dust are:

- Material loading/dropping into stockpiles or heavy goods vehicles (HGVs)

- Vehicle Movements on paved and unpaved surfaces
- Disturbances to material stockpiles by local winds and material handling

The generation of dust is affected by the wind conditions in the area. Receptors in proximity to construction activities area are more susceptible to fugitive dust impacts, as well as on-site construction workers.

Odors

During the construction phase, the main sources of odors are the emissions of diesel fuels, the improper storage or disposal of solid wastes and the improper discharge of wastewater. Moreover, loading of waste is another major source of offensive odors that may decline the local air quality and may extend beyond the boundary of the premises.

Accordingly, the impacts on air quality can be assessed as: direct, moderate, local, medium-term, irreversible, of medium likelihood of occurrence and of moderate significance.

6.2.4. Impact on the Acoustic Environment

Noise can be caused by various sources on the construction site. However, construction noise is temporary and cannot be assessed in the same way as more permanent operational impacts. Environmental noise limit values are not always appropriate for assessing the impact of construction noise due to the fluctuations in construction noise levels, its temporary nature and the fact that construction activities are noisy by their very nature.

The major noise sources during construction works may be:

- Engine noise
- Generators
- Opening and closing gates
- Reverse warning devices

The University of Washington’s Department of Environmental and Occupational Health and Services (2005) identified the generated noise levels of construction equipment. These are summarized in the following table:

Table 6-2 Construction equipment – generated noise levels

Equipment	Noise levels at operator's ear (dB)
Back hoe	85
Bulldozer	87
Chop saw	92
Grader / scraper	107
Front end loader	90
Jackhammer	102
Nail-gun	97
Router	90
Welding equipment	92

The potential impact of this vibration generated by construction equipment depends on the magnitude and duration of construction-related activities.

Accordingly, the impacts on the acoustic environment are assessed as: direct, moderate, local, short-term, reversible, of high likelihood of occurrence and of low significance.

6.2.5. Impact on Biodiversity and Natural Habitat

The main construction elements that are capable of having a detrimental effect on biodiversity are considered earth-moving activities, handling/disposal of construction waste materials, improper wastewater management discharge and construction activities noise / vibrations.

Potential negative impacts affecting biodiversity during project construction are summarized in the following table:

Table 6-3 Potential negative impacts on biodiversity during construction operations

Impact	Cause
Habitat loss or destruction	Construction works
Altered site factors	Soil compaction, erosion
Mortality of individuals	Destruction of vegetation
Habitat fragmentation	Habitat removal and/or introduction of barriers e.g. roads
Disturbance	Due to construction noise, traffic, or presence of people
Altered species composition	Changes in biotic conditions, habitats

However, the project site is already degraded and is not designated as an area of national or international importance (e.g. world heritages, wetlands, biosphere reserve, or protected areas). Therefore, the construction phase will not affect endangered and endemic species, critical ecosystems, or habitats.

Accordingly, impacts on biodiversity are assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance.

6.2.6. Impacts on Land-use / Land cover

The development of solid waste management facilities affects significantly the physical characteristics and land use of the site. However, the proposed project is an upgrade for the existing facility. Thus, the impacts on land use/land cover caused by the construction activities are not expected to be significant.

Accordingly, impacts on land-use and land cover are assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance.

6.2.7. Impact on Visual Intrusion

Visual impacts that need to be addressed during the construction phase are mainly related to converted land use and the effect of those visual changes on people, as important features may be removed. Some construction activities, such as earthworks, vegetation clearing, structures construction and vehicle movements, may create visual impacts and detract from the aesthetic value of the area.

Accordingly, the impacts on visual intrusion are assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance.

6.2.8. Impacts on Water and Energy Resources Consumption

Freshwater Demand

During the construction phase, the following activities will require significant volumes of water:

- Ready mix concrete
- General construction activities.
- Vehicle wash-down.
- Dust suppression.

The potable water needed for construction will be obtained from a public source. The estimation of water consumption for construction activities is not applicable. However the domestic water consumption can be estimated as 5.2 to 7.5 m3/day (35-50 workers x 150L/capita/day). Although construction activities will consume moderate volumes of water, it will only be for a relatively short finite period.

Energy Demand

During the construction phase, some of the activities that will result in significant energy use include:

- Concrete mixing activities
- Piling rigs and construction cranes
- Construction vehicles
- Generators

The energy used during construction will contribute to the depletion of fossil fuel resources. However, the construction phase will be relatively short-term when compared to the long-term nature of the operational phase.

Accordingly, the impacts on water and energy resources are assessed as: direct, moderate, local, short-term, irreversible, of moderate likelihood of occurrence and of moderate significance.

6.2.9. Impacts on Health and Safety

Due to the limited scale of the construction activities, construction labours are expected to be the most affected people. Health impacts can be caused by onsite or offsite accidents.

On-site Accidents

Silica dust: Workers are constantly exposed to silica, a component in most of construction related materials such as natural stone, bricks and concrete. With the manipulation, breaking, crushing or grinding of such materials, silica dust is generated and affects the workers in multitude of ways such as silicosis (a lung fibrosis disease that reduces lung capacity).

Lead dust: Many construction activities involve the use and manipulation of many lead based materials. Lead is a compound found in paints, pipes and several construction equipment. With the hot cutting, dismantling and handling of lead based materials, lead dust is emitted and has adverse impacts on the worker's health such as acute chronic effects on the nervous system.

Gas vapours and fumes: A multitude of construction processes involving welding, flame cutting, Liquid Petroleum Gas burners, waste burning, painting and use of adhesive thinners may release many types of vapours that differ in their constitution depending on the activity undertaken. These gases have potential negative impacts on workers' health depending on the constitution of the released vapours as well as the duration of exposure.

Other chemicals: A complex matrix of chemicals is used in any construction site. These include: mineral oils and/or pitch that are carcinogenic. Disinfectants, bleaches, solvents, oils and acids cause irritation. Epoxy, resins, acrylic, formaldehyde, nickel, cobalt, chrome may lead to adverse allergic reactions.

Entry into confined spaces: During construction, the need to enter within confined spaces is required. Workers entering tight places are to respect all precautionary measures taken noting the fact that the workers will be subject to a pallet of adverse health effects such as oxygen deficiency and inhalation of toxic/flammable gases.

Noise: All construction activities have the potential to generate a significant amount of noise, affecting the workers within a relatively high duration of exposure. Exposure to high levels of noise leads to concentration distraction, communication difficulties, increase risk of accidents and hearing damage.

Vibrations**:** Earthwork activities and material loading / unloading activities generate levels of vibrations. Exposure to high level of vibrations for a significant duration will affect workers' health such as carpal tunnel syndrome and permanent damage to the nerves.

Heat: Working under direct sunlight or in proximity to heat generating equipment will cause workers to suffer heat exhaustion, heat rashes, heat strokes and heat cramps.

Manual handling**:** Handling material and equipment is often thought the major cause of injury in the workplace such as minor injuries to permanent lifetime pain and disabilities.

Off-site accidents

Off-site accidents could occur along the roads accessed by delivery trucks. Accidents risk is also increased when dust and dirt is allowed to accumulate on the external roads making them slippery after rain events.

As the project labours will be mostly concentrated and self-contained within the site boundaries, and due to the absence of residential/commercial areas within the buffer zone of the project, the effect on the general public should be limited.

Accordingly, impacts on health and safety are assessed as: negative, moderate, local, medium-term, irreversible, of moderate likelihood of occurrence and of high significance.

6.2.10. <u>Social Impacts</u>

5.3. Project Affected Population

According to World Bank OP 4.12, Project-Affected Persons refers to all the people who would be directly impacted by the project, which will affect their:

- Standard of living
- Right and Interest in any removable asset acquired or possessed (land, house, etc.)
- Access to occupation, work, or place of residence

Moreover, Project-Displaced Persons are those who will have to change their place of business or residence, as a direct result of the project implementation. In the case of the upgrade of Ain Baal solid waste treatment facility, the project activities will not cause any permanent displacement of population. Refer to Map 5-7 for the nearest residential settlements.

Although there is no permanent physical or economic displacement, the project could lead to temporary economic displacement of the 45 workers of the solid waste facility. These 45 workers are day laborers from Syria who do not have formal contracts and get paid on a monthly basis based on a rate of 27,000 Lebanese pounds per day. The same laborers have worked on the site for an average of X months. It is estimated that the plant may need to shut down for two weeks during which the existing sorting line will be dismantled and replaced by the new one.

The 45 Syrian day laborers live on-site or in an adjacent plot. The project will in no way restrict the workers ability to continue living in these facilities.

Broader community impacts

The broader community, including the plant workers, are expected to largely benefit from the project. The safe disposal of solid waste is critical for public health and the communities of Ain Baal are suffering from the haphazard dumping of solid waste. The project upgrade will enhance the aesthetic conditions of the area, diverting the generated wastes from open dumps. Hence, living conditions in the area will improve and property values in the area might increase.

The upgrade project will create job opportunities during its construction phase. The surrounding communities' business and commercial activities are expected to be minimally affected by construction activities.

The project contractor will need to hire approximately 40 people (15 skilled and 25 unskilled) to complete this project. The contractor has 20 workers that are specialized and will not come from nearby communities. An additional 20 workers will be hired from nearby areas. None of these workers will live on or near the site. Because of the small number of workers needed to complete the works, and the fact that they come from social groups that are well represented in nearby communities, there is no significant risks related to labor influx. The current plant workers shall be displaced for a short period (approx. 2 months), thus no significant economic risks are to be mentioned.

Because the site is not adjacent to permanent housing, working, or recreational areas, the project will not have any other negative social impact. The project will not have any impacts on relations between social groups, and will not increase any kind of tensions. The project could in fact have positive indirect impacts on fragility and conflict in Lebanon, as better solid waste management can increase citizen satisfaction with and trust in their government.

Accordingly, the impacts on the socio-economic conditions are assessed as: positive, moderate, local, medium-term, reversible, of medium likelihood of occurrence and of medium significance.

6.3. Impacts during Operation

The MSW is delivered to the facility by municipal trucks to the facility receiving area, whereby the material is sorted, the organic material is composted and the recycling materials are recycled. The conduct of composting activities has the potential to generate environmental impacts such as noise, air emissions and odors, leachate and contaminated runoff...etc. The purpose of this project, the upgrade of the facility, is to reduce the residual impacts and to identify the source of the current challenges faced by the existing facility.

6.3.1. Impacts on Water Quality

Although the project area is not rich in surface water resources, the operation activities shall be conducted safely to prevent any impact on water quality, particularly ground water resources.

Wastewater generated from composting facilities is reasonably expected to contain elevated organics, nutrients, and to a lesser degree salts, metals and microbiological organisms which need to be appropriately managed to prevent impacts to the surface and groundwater. The major sources of potential adverse impacts on water resources can be either leachate from feedstock loading and composting areas, contaminated runoff from compost operation, or contaminated storm water runoff.

Leachate is formed only when the moisture content of the solid waste is higher than the optimum for composting. Thus, when the waste’s moisture content exceeds its field capacity, which is the maximum moisture that is retained in a porous medium without percolating downward, leachate is generated (El Fadel, et. al., 2002). The leachate generation rate is affected by several factors such as waste moisture content, rate of decomposition, exposure to weather conditions (i.e. rainwater…). In general, leachate is a liquid potentially contaminated by nutrients, metals, salts and other soluble or suspended components and products of decomposition of the waste. Although solid waste composting significantly reduces the concentration of pollutant, leachate from properly matured compost mass can also impact the quality of ground and surface water (Diaz, 1977; Cooper et al., 1974).

According to the project design consultant, the existing drainage system of the sorting hangar is clogged and/or plugged. The contaminated runoff is left to flow creating undesirable runoff on the road, with all its pollutants. In line with the rehabilitation works, the drainage/ grating system shall be repaired and replaced to regain its normal functionality inside and outside the hangar, thus ensuring a safe evacuation of the water towards existing sewer collection tanks.

Moreover, the leachate from the composting hangar and the stormwater at the hangar level are currently mixed together with little to no separation due to the malfunction of the leachate and drainage conveying systems (clogged pipes, seepage at manhole point...). In addition to that, no drainage was initially foreseen around the existing hangar where the compost is stocked. In line with the upgrading works, this hangar shall be removed and replaced by another one with a complete design storm water collection system, which shall ensure the evacuation of the water towards the existing sewer collection tanks too.

In line with the upgrading works, and as detailed in section 4.4.5 here above, the leachate generated from project operation shall be adequately collected and conveyed towards the dedicated leachate treatment plant, further to which the treated effluent may, depending on the level of treatment, be either stored in tanks for re-use for domestic use or for irrigation of the green areas within the plant, or alternatively transported by means of special trucks towards the regional wastewater treatment plant of Tyre. Similarly, the wastewater generated from the biofilter shall be channeled towards the existing sewer tanks, which are periodically emptied by means of tankers for disposal in a dedicated sewer collection point (until such time as the project area and surroundings are serviced by a sewerage network) ensuring its collection in the existing sewerage network servicing the neighboring area / village, or directly into the regional wastewater treatment plant.

On the other hand, storm water shall be collected at the entrance and periphery of the reception area and composting facility in order to prevent its mixing with fresh waste and compost. In the absence of nearby receiving water bodies, such drainage water generated from stormwater runoff may, depending upon its turbidity, be stored in a tank dedicated for domestic use or irrigation of green areas, similarly to the treated effluent for the leachate treatment (addressed here above), or alternatively be drained towards the existing sewer collection tanks, which, as stated here above, shall be disposed of into the nearby sewerage network or directly in the regional wastewater treatment plant.

Accordingly, the separation of leachate and storm water is ensured. The treated water shall be transported by means of special trucks towards the main sewer network of Ain Baal.

Moreover, a leachate treatment unit (reverse osmosis, capacity of 50 m3 /d) will be installed (refer to section 4.4.5.). The wastewater treatment unit should be properly operated, maintained and managed to prevent any contamination of water quality with improperly treated effluent water. The wastewater treatment plant effluent should be in compliance with Decision 8/1 dated 2001 (Table 4-5) and with WBG EHS guidelines (whichever is more stringent).

Furthermore, inferior compost quality could have a negative impact on surface and groundwater quality. Regular compost examination would eliminate such negative effect. In addition, any improper management of domestic wastewater, generated by the labor onsite, could impact the water resources.

Accordingly, the impacts on water quality are assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of medium significance

6.3.2. Impacts on Soil Quality

In operational phase, the impacts of this project can pose a threat on soil quality if the facility is not properly managed and if the produced compost does not meet the predefined set of standards (MoE National Compost Ordinance).

Accidental spills and leaks

The soil can be significantly affected in the case of continued leaching from composting waste piles. In fact, soils situated near poorly managed composting facilities may become contaminated with natural phenolic compounds and nitrates. Potential contamination of soil quality could also arise via accidental leakage of oil products during loading, unloading or storage of these materials or during maintenance activities.

Compost product quality

Potential threats can arise when the sorting process is poorly practiced. It is very challenging to completely eliminate chemical, biological and physical pollutants in composts made from mixed waste. Screening and sorting technologies can help sufficiently remove physical impurities (i.e. stones, glass, metal, plastics). However, chemical contaminants which include toxic organic chemicals and heavy metals (i.e. lead, chromium, nickel, zinc, cadmium, copper and mercury) have more adverse effects on the environment. The main threats to human and animal health from heavy metals are mainly caused by exposure to arsenic, mercury, cadmium and lead.

Several measures can be introduced to minimize the previously mentioned adverse environmental impacts. For example, efficient sorting before and after composting can assure that the compost product complies with the national type and quality standards, means of utilization (MoE National Compost Ordinance) and disposal of undesirable compost products.

Accordingly, the impacts on soil quality are assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of medium significance

6.3.3. Impact on Air Quality

The main operation process, composting, is associated with the generation of by-products including heat, carbon dioxide, water vapor, and odorous compounds. Odors have been one of the major operation challenges for Ain Baal SWMF. The existing facility is accused of odors as well as other significant odor generating activities around the facility (slaughterhouse, surface water pollution…).

Malodorous compounds emitted are volatile emissions generated from chemical and microbiological decomposition of the organic matter. Various locations within the composting site can be a potential odor source, namely raw feedstock piles, composting piles, windrows, finished compost product, biofilters, blowers' exhaust, and runoff ponds. Several compounds are commonly associated with odors at composting facilities: Hydrogen sulfide (H_2S), Thiols, Dimethyl Disulfide (DMDS), Carbon disulfide (CS), Ammonia (NH_3), Amine, Indoles, Volatile fatty acids, Terpenes, Ketones, Aldehydes, and Alcohols. The type of feedstock handled determines the type of odors generated. For example, waste rich in protein are considered sources of volatile nitrogen compounds (ammonia, amines and indoles) and possibly volatile sulfur compounds (organic sulfides, mercaptans and hydrogen sulfides). Other factors may also affect the formation of odorous compounds namely, the amount of surface area of stacked organic materials exposed to the external environment, oxygen level, aeration, turning frequency, moisture level, bulk density and porosity, temperature, pH… (Integrated Waste Management Board, 2007).

The fate of odorous compounds in the environment depends on the atmospheric conditions. In fact, atmospheric instability is more favorable for composting facilities. Also, the wind plays an important role in the dispersion of odors. Moreover, wind has a dual effect, it can carry odors from the facility to the neighbors, but it can also dilute the odors within the atmosphere (Integrated Waste Management Board, 2007). According to Service Météorologique du Liban, wind direction is dominant in the S and SW orientation. Stronger winds are more frequent in the summer months, and relatively weaker winds are prevalent in the winter season (RHIA Station).

However, a proper odor control system (ventilation system and bag filters) is able to treat the contaminated air flow. In the absence of an air pollution control system, the facility would pose a potential source of odor emissions to the surrounding facility.

Moreover, another concern is airborne particles or bioaerosols (i.e. bacteria, fungi, viruses, allergens, bacterial endotoxins, antigens, toxins, mycotoxins, glucans, pollen, plant fibers, etc.). Bioaerosols, also known as “organic dust” can cause a wide range of adverse effects on human health (Taha et al., 2006).

Generation of Exhaust Emissions

The USEPA define fugitive dust as “any solid particulate matter that becomes airborne by natural or man-made activities, excluding particulate matter emitted from an exhaust stack”.

Increases in traffic levels to and from the facility will also increase dust and gaseous emissions. Currently, with the 300 tons/day treatment capacity, a range of 17 to 20 trucks per day access the facility. This number of trucks is expected to double after upgrading the facility. This will cause an increase in generated GHG emissions and dust. Moreover, power generators are also expected to introduce exhaust emissions to the atmosphere.

Accordingly, the impacts on air quality are assessed as: direct, moderate, local, long-term, irreversible, of high likelihood of occurrence and of high significance.

6.3.4. Impact on Acoustic Environment

During operation, noise is mainly generated from heavy machinery, power generators and loading and unloading of trucks. Peak noise level (recorded at 5 meter distance) from similar treatment processes is estimated to vary between 75dBto 85dB (NVC, 2012). However, the composting facility is closed and the generated noise is reduced to a minimal level. Moreover, the facility is located in an industrialized area, reasonably distant from residential areas, which imply that the adverse effect on the acoustic environment is minimal.

The impacts result from noise pollution is: direct, low magnitude, local, medium-term, during operation, reversible, of high likelihood of occurrence and of low significance.

6.3.5. Impact on Biodiversity and Natural Habitat

Assessing the ecological value of a deteriorated site where construction works were carried out, and the natural conditions of the site were majorly changed, is challenging.

During the operational phases of the compost facility, disturbances to local wildlife from the use of heavy machinery can occur. However, the habitats at the site are devoid of any outstanding or unique landscape features. The plant may attract opportunistic species to the area surrounding it, such as insects and rodents, which may cause the exclusion of other species, hence reduction in biodiversity. Other potential effects on biodiversity due to the operation of the plant include noise pollution caused by truck traffic and heavy machinery, and littering of the surrounding area.

Indirect operation impacts on biodiversity are associated with potential soil contamination and phytotoxicity of exciting plants due to inadequate application of compost. In fact, the use of immature compost can damage plants because of excessive levels of C:N ratio, ammonium and volatile organic compounds. Proper management of composting process, in addition to monitoring and labeling of compost, can be the remedy to biodiversity reduction. Moreover, the projects tends to reduce uncontrolled dumping and the amount of landfilled material which will consequently eliminate the negative effects on biodiversity.

Accordingly, impacts on biodiversity are assessed as: indirect, low, local, long-term, reversible, of low likelihood of occurrence and of medium significance.

6.3.6. Impacts on Land-use / Land cover

Similar to the land use and land cover impact during construction, no major impact is expected to be generated due to the operation of the plant. This is due to the fact that the exciting land use pattern remains unchanged knowing that the project only comprises of upgrading the operational capacity of the existing facility.

The impacts on land-use and land cover are indirect, low, local, long-term and irreversible, of low likelihood of occurrence and of low significance

6.3.7. Impact on Visual Intrusion

Visual impact that commonly needs to be addressed is the aesthetic impact of the converted land use and any additional buildings or other structures associated with it. In this case, the location is classified as an industrial area and does not include important or sensitive habitats.

Accordingly, the impacts on visual intrusion are assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance.

6.3.8. Impacts on Water and Energy Resources Consumption

Increase in fresh water demand

The facility will mainly use fresh water for washing, biofilter and domestic purposes. Water will be received from a public source and will be stored in water tanks. Moreover, leachate will be treated in an onsite wastewater treatment unit to be reused.

Increase in energy use

Energy will be continuously demanded in such a treatment facility. The expected total energy consumption is estimated to increase with the increase in the automation of the process. The increased energy demand will contribute to the depletion of fossil fuel resources. In addition the use of fossil fuel, contributes to global warming and climate change, and therefore should be minimized wherever practical.

Accordingly, the impacts of the operation of the project on land-use are: direct, moderate, local, long-term, irreversible, of high likelihood of occurrence and of moderate significance.

6.3.9. Impacts on Health and Safety

During the operational phase of the plant, the most critical factor is the occupational health and safety hazards due to onsite accidents. Such accidents are mostly related to practices that involve machinery handling. Implementation of adequate safety measures will limit the accidents occurrence.

Fire can pose a risk to the local air quality and human health, the facility and surrounding residential and industrial uses. The risk of fire can arise from a number of sources such as:

- Spontaneous combustion occurring as a result of piles overheating (occurring when the airflow is restricted or the piles are made too high).
- Fragments and shards of glass acting like a magnifying lens.
- A spark igniting the piles from cigarettes, lightning strikes and bushfires.

Moreover, a health concern in the operation of composting facilities is the presence of bioaerosols, organisms that can act as toxicants, pathogens, and allergens when inhaled in sufficient quantities. Bioaerosols include bacteria, fungi, actinobacteria, arthropods, endotoxins, microbial enzymes, glucans, and mycotoxins. Bioaerosols are in the highest concentrations during dust producing activities such as shredding, screening and turning. A simple, yet effective safety protection is to wear a respirator that can filter out particles as small as 1 micron.

Public safety risks are mainly posed by the increased traffic caused by the waste collection vehicles and transfer of compost and recyclables to specific contractors. Attention to traffic routing and timing should considerably reduce this impact.

Accordingly, impacts on health and safety are assessed as: direct, moderate, local, long-term, irreversible, of moderate likelihood of occurrence and of medium significance

6.3.10. Social Impacts

The potential socio-economic impacts arising from solid waste management facilities can generate concerns regarding property values in the vicinity of the compost plant. However, such operations usually create jobs for local people, hence may have a positive effect on local socio-economic issues. Concerning facility’s employment rate, although sorting procedures will be upgraded from manual to mechanical, workers retrenchment will not be considered. The number of workers working on the sorting lines will stay the same. Moreover, the upgrade of the facility will not lead to any resettlement of citizens or workers.

Furthermore, waste management is an income generating activity as produced compost will be sold. However, the operating plant might introduce additional traffic load onto the exciting roads, hence, transport of material should be adequately managed to avoid any undesirable traffic congestion.

Accordingly, impacts on the socio-economic profile are assessed as: positive, moderate, local, long-term, reversible, of moderate likelihood of occurrence and of moderate significance.

6.4. Impacts during Facility Decommissioning

Although the decommissioning of Ain Baal solid waste management facility is not currently considered by the UoTM or CDR, it is essential to include it in the impact assessment and the Environmental Management Plan (EMP). The decommissioning of the facility should be conducted in an environmentally safe manner, where waste is handled, treated, stored, and/or disposed. The purpose is to prevent and mitigate undue harm to people and their environment in the decommissioning process.

Specific closure procedures should focus on the preservation of the long-term integrity and security of the site. Typical activities during the facility decommissioning and site reclamation phase include facility removal, dismantling of equipment and machinery, breaking up of concrete pads and foundations, removal of steel structures, removal of access roads that are not maintained for other uses, re-contouring the surface, and re-vegetation.

Potential impacts from these activities are presented below, by the type of affected resource.

6.4.1. Impacts on Water Quality

Although the project area is not rich in surface water resources, the decommissioning activities shall be conducted safely to prevent any impact on water quality, particularly ground water resources.

Water Use

Water is likely to be used for dust control for road traffic, dismantling of buildings, and for consumptive use by the workers. Upon completion of decommissioning, water consumption associated with the facility operations and related impacts would end.

Water Quality

Water quality could be affected by activities that cause soil erosion, weathering of newly exposed soils leading to leaching and oxidation that could release chemicals into the water, discharges of waste or sanitary water, presence of dissolved salts from dust suppression wastewater, and pesticide applications. Upon completion of decommissioning, disturbed areas would be contoured and revegetated to minimize the potential for soil erosion and water-quality-related impacts.

6.4.2. Impacts on Soil Quality

Activities during the decommissioning phase that would impact soils and geologic resources include removal hangars and other structures; and heavy vehicle traffic. Soil erosion can be caused by the disturbance of the surface that alters surface runoff patterns. Impacts of soil erosion include soil nutrient loss.

Upon completion of decommissioning, disturbed areas would be contoured and revegetated to minimize the potential for soil erosion.

6.4.3. Impacts on Air Quality

Emissions from decommissioning activities are also similar to construction ones and include vehicle exhaust emissions; diesel emissions from heavy equipment (i.e. bulldozers, graders, backhoes, excavators, and dump trucks) and onsite backup generators; and fugitive dust resulting from many activities such as land clearing, structure removal, backfilling, dumping, restoration of disturbed areas (grading, seeding, and planting), and truck and equipment traffic. Air quality standards might be exceeded if specific mitigation measures are not followed.

6.4.4. Impacts on Acoustic Environment

The main sources of noise during decommissioning activities are very similar to the ones during the construction phase and consist of heavy equipment such as: bulldozers, graders, backhoes, excavators, and dump trucks. Other sources of noise include vehicular traffic. Several factors influence noise magnitude such as the type of activity, noise levels generated by each equipment, duration, the distance to sensitive receptors, and if there are any protective sound barriers. Decommissioning activities and specifically demolition activities can exceed the national noise limit values, but the latter would be irregular and occurs for a limited amount of time.

6.4.5. Impacts on Biodiversity

Impacts on biological resources from decommissioning activities are similar to construction impacts, but of a less magnitude. Removal of the sorting and composting hangars would temporary increase noise levels and disturb the surrounding environment. Removal of the facility would eliminate impacts associated with habitat fragmentation. Depending on what would be the end use of the decommissioned and reclaimed area, biological resources could return to pre-project conditions, and wildlife species will get attracted after regrowth of natural habitats.

6.4.6. Impacts on Land-Use/Land Cover

Upon decommissioning, land use impacts resulting from construction and operation of Ain Baal facility would be largely reversed. No permanent land use impacts would occur during this phase.

6.4.7. Impacts on Visual Intrusion

During decommissioning, visual resource impacts would be similar to those from construction. Road redevelopment, removal of equipment, demolition of foundations, phased activity over long durations, and the presence of temporary dismantled equipment can intrude the visual plain.

Restoration of a decommissioned site requires recontouring, planting, and perhaps stabilizing disturbed surfaces. Newly disturbed soils would create visual contrasts that would persist at least several seasons before revegetation would begin to cover the decommissioned site.

6.4.8. Impacts of Increased Solid Waste Generation Rates

Hazardous Materials and Waste Management

Substantial amounts of solid and industrial waste would be generated during the decommissioning and dismantling of the facility. Much of the solid material (e.g., concrete and masonry, steel, pipes, and pumps) could be recycled and sold as scrap. Any remaining nonhazardous waste would be sent to operating landfills.

In addition, other solid wastes specific to the sorting and composting process, such as finished compost, plastic, glass, cardboards…etc. should be transported to other treatment sites or disposed of in permitted landfill locations to avoid environmental pollution.

Of a main concern is the location of where to divert the generated solid waste and its treatment after the decommissioning of the facility. This would produce temporary stress on the solid waste management in the area until another suitable location or treatment option is adopted.

Industrial wastes (hydraulic fluids, heat transfer fluids, dielectric fluids, coolants, solvents, and cleaning agents) would be put in containers, characterized and labeled, possibly stored briefly, and transported by a licensed contractor to licensed landfill sites. If these wastes were not properly handled, they would pollute environmental resources.

6.4.9. Impacts on Health and Safety

Potential impacts to worker and public health and safety during decommissioning would be similar to those expected for any construction-type project with earthmoving, large equipment, and transportation of overweight and oversized materials. Most accidents in the construction industry result from overexertion, falls, or being struck by equipment. Construction-related illnesses could also result from exposure to chemical substances from spills. This is also true for the activities involved in decommissioning. In addition, health and safety issues include working in potential weather extremes and possible contact with natural hazards, such as uneven terrain and dangerous plants, or insects.

All personnel involved with the construction would utilize appropriate safety equipment and would be properly trained.

6.4.10. Social Impacts

Decommissioning activities would create new jobs for the hired workers and workers that were previously operating the facility will lose their jobs. Indirect impacts would occur from associated economic development and would include jobs at businesses that support the decommissioning workforce or that provide project materials, and associated income and taxes. Property values in the area might increase. In the long term, the loss of jobs and revenue after decommissioning is completed could adversely impact the local and regional economies.

7. ANALYSIS OF ALTERNATIVES

The ESIA guidelines require analysis of practicable alternatives to the various elements of the proposed project. The purpose of this analysis is to identify the most environmentally sound, cost-effective and practical means of accomplishing the broader project objectives.

The analysis of alternatives for the proposed project includes: (1) assessing the "Do Nothing" scenario, (2) site selection (3) the selection of composting method, and (4) the selection of the odor management technology. These alternatives will be discussed in detail in the sections below.

7.1. Do-Nothing Scenario

The Do-Nothing Scenario suggests that the current waste management used by the Unio of Tyre Municipalities will remain the same. The current waste management facility can handle 300tons of municipal waste and the remaining quantity will be sent to landfills, thus increasing the burden on landfills and open dumps.

On the other hand, upgrading the facility will increase the facility's capacity to treat more quantities of organic solid waste and to serve more municipalities in the union. The upgrade of the Ain Baal SWMF will contribute to the national implementation of the solid waste management hierarchy, where organic waste is recommended to be effectively composted.

7.2. Site Selection

Location of the MSWTF is mainly controlled by the availability of land in the area. Still, environmental, geological and social settings are important criterion when selecting an appropriate site for the project. However, since the facility is already existing and the project aims to upgrade it, alternative site for composting will not be considered.

In addition, selecting a new location that is related to solid waste treatment industry was a difficult mission due to the local communities' oppositions. This fact was proved by the failure of the previous efforts of finding new locations to treat the municipal waste. Therefore, upgrading such existing location would be a favorable option until a national plan proposes better alternatives.

7.3. Composting Technology Selection

The choice of the composting facility type and design depends on the financial capability of the local communities and the availability of operational expertise. Advanced systems require high capital and skilled labor for their operation and maintenance. Considering its nature, the proposed project will require thorough planning, designing and consulting with designated experts in order to assess the most suitable option to upgrade the existing composting facility. This will be done in accordance with waste generation rates, waste composition, space availability, socio-economic conditions, and other factors. Accordingly, the following alternatives of composting designs were considered for the proposed project.

7.3.1. Windrow composting

A windrow is a pile with a length exceeding its width and height. The optimal pile height should be large enough to allow an efficient heat generation, and small enough to allow the diffusion of oxygen. For most practices, the ideal height ranges between 1.25 and 2.75 meters, with a width of 4.75 to 5.25 meters (Sasikumar et al., 2009).

Turning allows a sufficient passive aeration of the pile. It is important to note that windrows must be placed on a firm surface so that the pile can be frequently turned (once per week). Moreover, turning allows the surface materials to move to the core of the pile and undergo composting. However, if inner sections of piles are not well aerated, odors may result when these portions are exposed to the atmosphere.

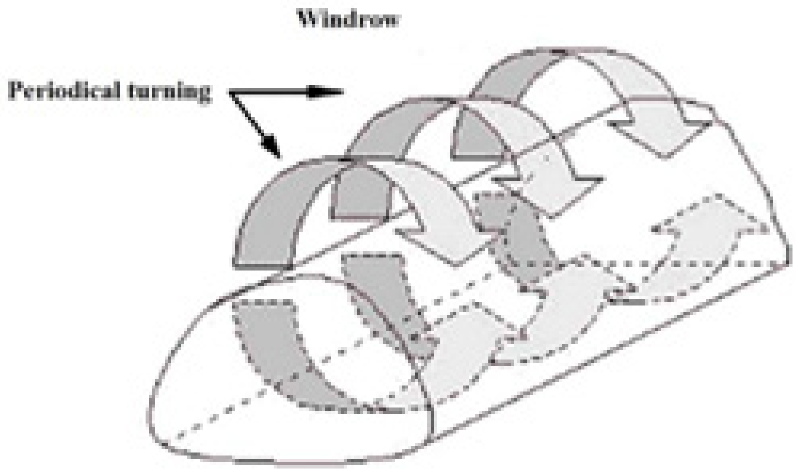


Figure 7-1 Periodical turning in windrow technology

There are several advantages for this technology (Environment Canada, 2013), namely:

- Ability to handle feedstocks with lower C:N ratios or porosity relative to other technologies
- Relatively low capital costs and technology requirements
- Relatively low operating costs
- Low electric power needed
- Extensive practical experience exists in the industry

This technology also presents some disadvantages including:

- Large area required
- More labor-intensive relative to other technologies such as static piles
- Less odor control, which may require larger buffer area between site and surrounding receptors
- More challenges to overcome if food wastes are included (Environment Canada, 2013)

7.3.2 Aerated static piles

Aerated static pile composting technology is an improved form of the conventional windrow composting technology. Aerated static pile technology requires the composting mixture to be placed in piles that are mechanically aerated. Piles can be connected to blowers supplying air (under positive or negative pressure) for composting. This technology has been used successfully for municipal solid waste treatment and industrial composting. The fact that it requires less land than windrow composting makes it more appealing. The production of compost using this technology usually takes between 6 to 12 weeks.

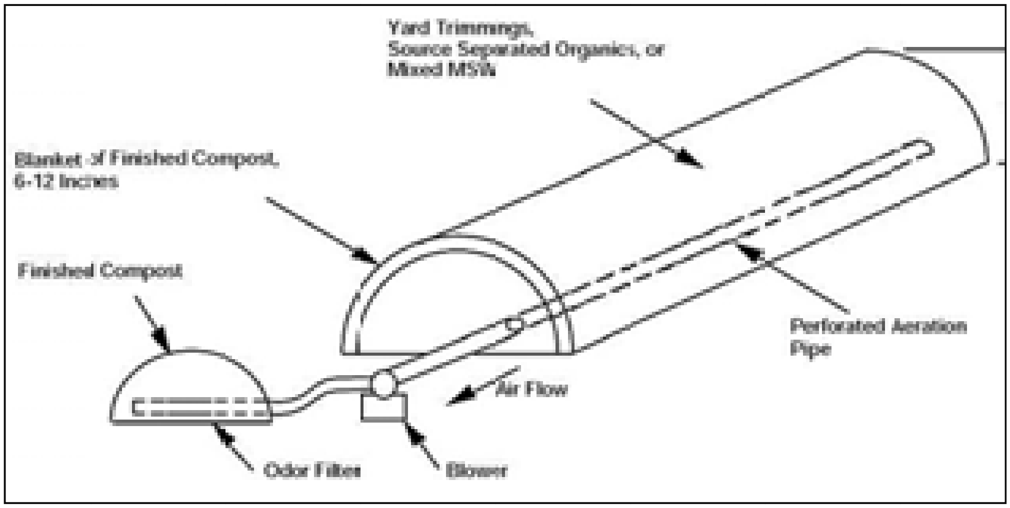


Figure 7-2 Aerated static pile composting technology

This composting technology is known to be an advantageous composting method due to the following characteristics (Environment Canada, 2013; Nema, 2010; The Composting Council of Canada, 2016):

- Relatively easy installations.
- Manual or mechanical turning of piles is not required, hence decreasing operational costs.
- The lack of turning within this system saves water consumption by 60-75% during the first 30 days, since when piles are turned considerable amount of moisture is lost.
- Aerates static pile system allows a full control over intensity and duration of aeration, enabling enhanced control of temperature of composting mass.
- The uniform sustained heating of waste leads to destruction of plant pathogens and weed seeds.
- The continuous and controlled oxygen supply eliminates formation of anaerobic conditions and thereby potential odor problems.
- The controlled system of aerated static piles accelerates the decaying process, resulting in significantly shorter active composting times than passively aerated systems.
- The control of pile configurations and height result in reduced area requirement.

On the other hand, some disadvantages associated with this composting method are (Environment Canada, 2013; The Composting Council of Canada, 2016):

- The lack of mechanical agitation is expected to slow down the breakdown process.
- Aerated static piles might not be able to fully treat materials that requires physical breakdown. Hence, they are usually used for the second phase of composting, as a final cuing.
- Feedstock preprocessing necessitates special care, as it must be well mixed and properly moistened.
- The risk of fires might arise in case of large piles.
- Over-aeration can remove moisture.
- Aeration systems need high energy requirements.

7.3.3. In-vessel composting

In-vessel composting systems enclose the feedstock in a vessel (chamber) in which adequate mixing, aeration and moisture is kept. This method involves feeding organic materials into a drum, silo or concrete-lined trench which is commonly known as tunnel-composting. In-vessel composters are generally more automated than windrow or static pile systems, and can produce a top quality finished product on a consistent basis.

There are several configurations of in-vessel composting systems namely: Plug flow vertical reactor, rotating horizontal drum, open horizontal rectangular tank, vertical mixed reactor and plug flow horizontal tank. It is crucial to provide the best environmental conditions in the reactor, particularly temperature, moisture level and aeration. Most in-vessel systems use forced aeration along with stirring and tumbling. Also, in-vessel composting requires an efficient odor control infrastructure. Modern in-vessel compost systems are a combination of windrow composting and in-vessel composting, where the latter system is reserved for the active stage, while the other system is used for curing and maturation of the compost product.

There are several advantages for this technology, namely:

- Shortening of the mesophilic and thermophilic stages of decomposition of organic waste.
- Achievement of higher process efficiency, which minimizes space requirements.
- Decrease of number of pathogens in the end product.
- Easier control of odours and emissions.
- Easier control of contact of animals (birds, rodents, etc.) with the decomposing material.
- Process and materials handling control.
- Better public acceptance due to the aesthetics/appearance of the composting site.
- More consistent product quality.

This technology also presents some disadvantages including:

- High capital and operational costs due to the use of computerized equipment and skilled labor.
- Less manpower requirements (where an increase employment policy is a priority).

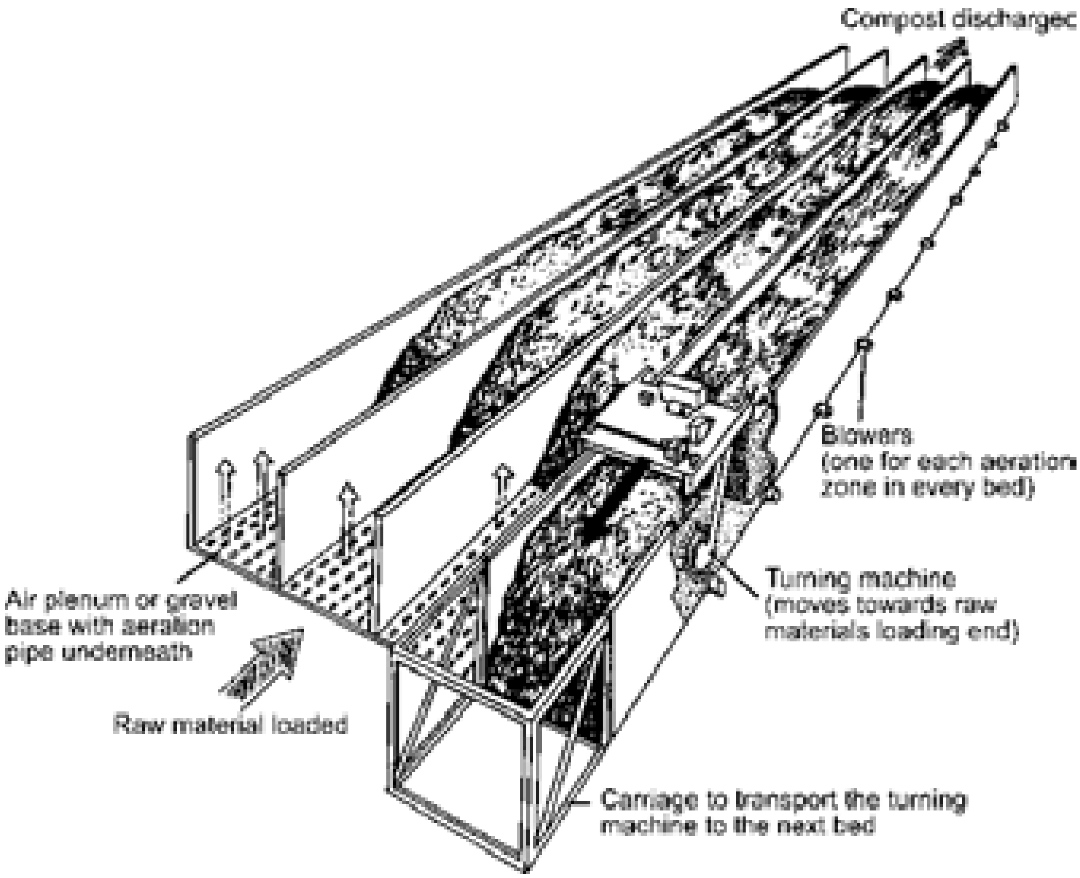


Figure 7-3 In-tunnel composting

7.3.4. Analysis of composting technology alternatives

The table below shows the comparison of the various composting technologies mentioned previously in this section.

Table 7-1Requirements and comparison of composting methods (AUB-NCC, 2016)

Parameters	Windrow	Aerated static pile	Tunnel
Active composting time	8 to 24 weeks	2 to 10 weeks	3-4week
Curing time	3 to 6 weeks	3 to 6 weeks	3 to 6 weeks
Odor production	High	Medium to low	Medium
Electrical consumption	Low	Medium	Medium
Leachate production	High	Medium	Medium
Land requirements	High	Medium	Low
Labor requirements	Site manager	Site manager	Site manager
	Machinery drivers	Machinery drivers	Machinery drivers
	Laborers	Laborers	Laborers

Parameters	**Windrow**	**Aerated static pile**	**Tunnel**
	Maintenance personnel	Maintenance personnel	Maintenance personnel
	Specialized operators	Specialized operators	Specialized operators
Investment cost	Low to Medium	Medium	Medium to High
Operation and maintenance costs	Low	Low to Medium	Medium to High
Machinery and required materials	Shredder	Shredder	Shredder
	Windrow turner	Aeration system (blowers, piping)	Aeration system (blowers, piping)
	Screen	Screen	Screen
	Electrical Generator	Electrical Generator	Electrical Generator
	Biofilter	Biofilter	Biofilter
	Leachate Treatment System	Leachate treatment system	Leachate treatment system
	Skid-steer/Front End loader	Skid-steer/Front End loader	Skid-steer/Front End loader

After assessing the different composting methods, in-vessel/tunnel is the selected technology for this project. This technology will allow for the good control of the environmental conditions such as temperature, moisture, and airflow. In tunnel composting can uphold a greater amount of waste without taking up as much space as the windrow method. In addition, it can accommodate virtually any type of organic waste (such as meat, animal manure, food scraps…). Moreover, other advantages of tunnel composting over the other composting technologies involve shortened mesophilic and thermophilic stages, higher process efficiency resulting in a decreased number of pathogenic microorganisms, and thus better compost quality (Cekmecelioglu, Demirci, et. al., 2005), and easier control of contact of animals (birds, rodents, …etc.)

7.4. Odor Control Using Biofiltration

Odor and air pollution control is one of the primary concerns of composting plants. Management of waste requires a high level of engineered odor controls since process management (such as control of pH, temperature…) alone is not sufficient to effectively minimize risks of odor impact. There are several options for odor and gas emissions management such as chemical stripping, thermal destruction and biofiltration. The latter, being both the least expensive and the most effective, is one of the most widely used treatment technology in the composting industry nowadays (Leson et al., 2012).

Biofiltration uses biologically active organic material with high moisture content to adsorb odorous compounds and biologically degrade them. The compost process air is cooled and humidified to be injected through perforated pipes into the filter media. Several materials can be used for biofilter media such as finished compost, soil, wood chips and biologically inert material such as gravel. The filtration bed height is typically 1 m high (Leson et al., 2012) for optimal gas flow and uniform moisture distribution.

7.4.1.Open biofilter

A basic design of an open biofilters is shown in Figure 7-4. The generated gas is vented from the emitting source through the filter. Contaminated air diffuses through the wet filter media where biological degradation occurs. The complete biodegradation of air contaminants generates CO_2, water, and microbial biomass. The degradation of sulfur compounds and chlorinated organic compounds also generates inorganic acids. Sometimes, heat exchangers are used to cool the hot off-gas emissions before being introduced into the biofilter. Radial blowers are typically used to overcome the back pressure caused by the filter. The off-gas must also have significant moisture content, since it would otherwise remove water from the filter material, resulting in drying of the bed, the death of most microorganisms and a total loss of control efficiency. Spray nozzles usually provide the required humidity to the inlet air. Finally, contaminated air is vented, through slotted distribution canals and air nozzles into the bottom of the filter bed. Down-flow systems have also been adopted in several recent installations. In open filters, the filter material is typically turned over after two years in order to increase its porosity and prevent compaction of the filter media. After another one to two years it is replaced by fresh material. To date, the most widely used biofilters are open single-bed systems (Leson et al., 2012).

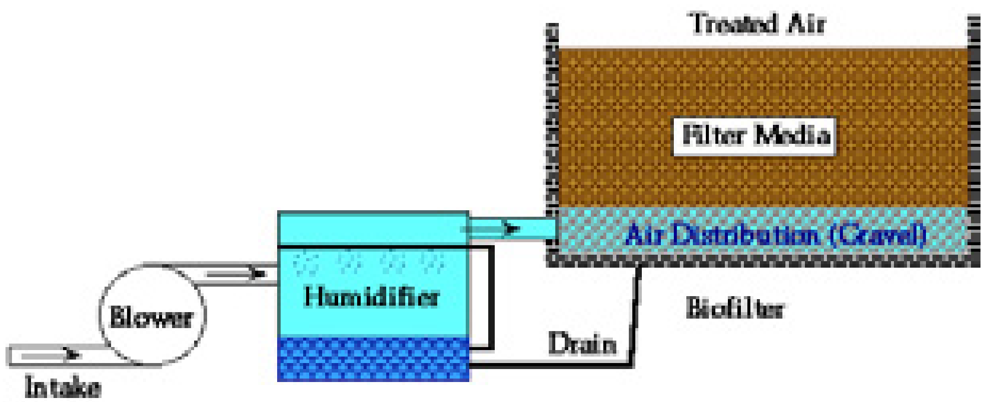


Figure 7-4 Schematic of an open single-bed biofilter system

7.4.2.Enclosed biofilter

Some facilities (i.e. in Europe) have built enclosed systems, usually with stacked beds. Although these systems are more costly, the use of enclosed multiple story systems can be efficient, in applications where minimum maintenance is required, and where there is no available space. Moreover, fully enclosed systems present other advantages including a lower susceptibility to changing climatic conditions and a higher possibility of continuous off-gas emissions monitoring. Maintaining the porosity of the filter media, especially the compost based media, by turning it over or eventually replacing it are the two major maintenance steps required for biofilters.

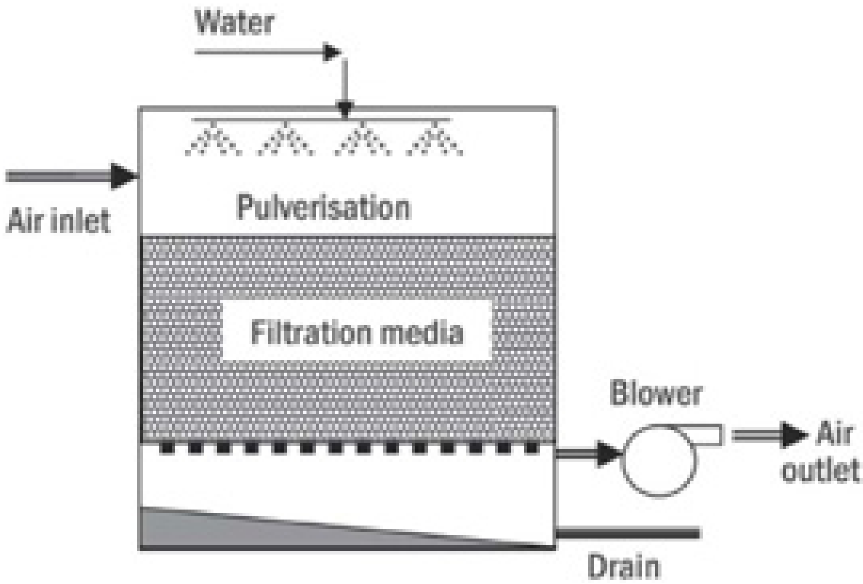


Figure 7-5 Schematic of an enclosed biofilter system

7.4.3.Analysis of Odor Management Technologies

Table 7-2 Comparison of biofilter technologies

	Open Biofilter	**Enclosed Biofilter**
Investment cost	Low	High
Maintenance requirement	Moderate	Low
Space requirement	Moderate	Low
Removal efficiency	High	High
Vulnerability to changing weather conditions	High	Low

The biofilter implemented is an open-bed biofilter due to its low capital cost requirement and efficiency, especially since the changing weather conditions (i.e. rain and sun...etc.) do not pose a threat to the biofilter media health.

8. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1. Objectives of the ESMP

Environmental management is essential for ensuring that all identified impacts are controlled within acceptable levels and unforeseen implications are mitigated as early as possible. Thus, the aim of an EMP is to assist in the systematic and prompt recognition of problems, ensuring effective and fast action responses to achieving good environmental and social performances.

In order to optimize operation conditions and ensure an effective and satisfactory environmental and social performances, a sound understanding of all applicable environmental and social priorities and policies is needed, along with knowledge of regulatory and operational standards and proper plant management (at the level of the administration).

The ESMP endeavors to set mitigation and monitoring measures, so minimizing and, if possible, eliminating the potential negative impacts of the proposed project. Furthermore, the ESMP provides the main capacity building and institutional strengthening requirements to ensure proper management and implementation of the plan.

8.2. Mitigation Measures (during construction)

As part of the ESMP, mitigation refers to the set of measures taken to eliminate, reduce, or remedy potential undesirable effects resulting from the construction and operation of the proposed project. The objective of the mitigation plan is to identify the possible actions to minimize the significance of the impacts presented in the impact assessment section. An environmental manager at the site in cooperation with the site operator should ensure that the proposed mitigation measures are implemented hence minimizing the negative effects of the activities on the surrounding environment.

Site preparation and the construction phase of the proposed upgrade project has the potential to affect many environmental receptors. Accordingly, mitigation measures relevant to the construction and upgrade of organic waste composting facilities are proposed below:

8.2.1. Water and Soil Quality

Knowing that any contamination or pollution that is to result from the construction phase of the project will affect both water and soil quality simultaneously, the assessed mitigation measures are provided for both, below.

Impacts on water quality were assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of high significance.

On another hand, impacts on soil quality were assessed as: direct, moderate, local, long-term, reversible, of medium likelihood of occurrence and of high significance. Thus, the proposed mitigation measures for both, water and soil quality are:

Control of accidental spills of construction materials

- Storage of diesel and construction materials in specific tanks in order to avoid soil or water contamination.
- It is recommended to store diesel and construction materials tanks near the construction site on an elevated concrete base so as to minimize soil and water pollution in case of accidental spill.
- Each receptacle shall be marked with the correct technical name of the substance it contains.
- Incompatible materials shall not be placed in common containment.
- All refueling operations shall take place off-site.
- Refueling nozzles shall be kept within the isolated area when not in use and shall also be padlocked.
- Develop a spill response plan and train all workers on its implementation.
- Used or waste fuel or other waste chemicals shall be stored in an isolated area until collected for off-site disposal by an approved waste contractor.
- Waste material or water containing waste chemicals such as thinners, oil, and mineral spirits shall not be pumped or disposed of into storm water drains, sanitary sewers or into the ground.

Domestic and construction wastewater management

- Temporary settlement ponds should be installed to treat all generated construction wastewater
- Wastewater shall not be discharged onto the open ground or into any water body.
- A collection system shall be provided under any machinery or equipment that may leak hydrocarbons (e.g. generator and pumps).
- The ground beneath servicing areas shall be constructed of an impervious material and isolated as necessary.
- Vehicle and equipment wash-down shall only be undertaken at designated areas. The ground under the wash-down area shall be impervious and designed to collect wash water. Wash water should be re-used where possible and excess water shall be collected and disposed of by an approved location.
- The contractor must ensure that all operations involving the use of concrete are carefully controlled.
- All dust suppression generated wastewater shall be collected and recycled
- Dry cleaning should be applied for dust removal before using water spraying.
- Contaminated storm water runoff should be diverted and cleaned, if possible.
- Construction materials should be properly stored to reduce any leakages or accidental spills and to reduce contact with storm water runoffs.

Control of soil manipulation activities

- All areas of the facility should be sealed. It is recommend to use stable, low-permeability and strong construction material to handle the weight of composting material, trucks and machinery. Concrete is considered the most appropriate material to use, as well as clay if it is compliant with the required standards. (EPA VICTORIA, 2015).

- Use of protective boarding and low ground pressure machinery in order to minimize soil compaction.
- The use of the excavated material as backfill on-site will require careful quality control in order to ensure that it is placed in the correct gradation, moisture, and layer thickness.
- Any excavated material to be removed from site, must be disposed to specified legal dumping sites.
- All natural and subsurface water-flow shall not be re-directed or concentrated to adjoining properties. Water flows shall follow the original flow direction without increased velocity.

Management of solid waste

- Effective practices for the disposal of solid wastes generated on-site should be developed by an approved personnel, such as a site manager.
- All personnel shall be trained to properly manage waste and handle chemicals.
- Sufficient waste disposal points must be provided and regular collection for disposal must take place.
- Appropriate measures should be employed to minimize windblown dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers.
- Overfilling of the waste containers should not be allowed.
- Applying the principals of waste reduction / re-use and recycling (RRR – reduce, reuse & recycle) wherever possible.

8.2.2. Air Quality

Impacts on air quality were assessed as: direct, moderate, local, medium-term, irreversible, of medium likelihood of occurrence and of moderate significance. Thus, the proposed mitigation measures are:

Control of exhaust emissions

- Uncontrolled fires should be prohibited onsite.
- Vehicles, equipment and power generators shall be regularly maintained.
- Catalytic converters and/or installation of the Diesel Particulate Filters (DPF) and/or catalytic silencers are necessary to control automotive and power generation pollution to significantly reduce vehicle emissions (A catalytic converter is a device used to convert toxic exhaust emissions from an internal combustion engine into non-toxic substances).
- All contained mechanical and technical areas should be provided with proper ventilation system. Such action will help to avoid excess humidity that contributes to damp musty air, odors, mold and mildew.

Control of dust emissions

- Driving surfaces should be paved to eliminate fugitive particulates. Facilities with paved surfaces may additionally employ sweeping or vacuuming as measures to reduce PM emissions.
- Stockpiles of fine material such as topsoil material, aggregates etc. shall be protected from wind.
- Adequate water supply shall be provided for dust suppression.
- Apply dust control measures.
- Dust generating activities shall be ceased during excessively windy periods.
- Contractors shall regularly inspect stockpiles, exposed work areas and construction work practices.
- Excessive vehicular movement shall be avoided.
- Vehicle speeds shall be restricted on unpaved roads and tracks.
- Trucks hauling raw materials should be covered and maintained to prevent spillages.

Control of odours

- Establish an inventory of all odour sources.
- Install adequate ventilation systems for all confined areas.
- Periodic checks to prevent any leakages of fuel or wastewater.

8.2.3. Acoustic Environment

Impacts on the acoustic environment were assessed as: direct, moderate, local, short-term, reversible, of high likelihood of occurrence and of low significance. Thus, the proposed mitigation measures are:

- Tailor construction activities schedule to avoid sensitive time and/or sensitive locations where possible.
- Control noise generating activities during working and off-working hours.
- Replace noisy equipment with less noisy alternatives, or designed with noise inhibitors such as generators and compressors with silencers and muffled jack-hammers.
- Use equipment in accordance with manufacturer's specifications.
- Orientate machinery away from noise sensitive residential areas.
- Cover engine shields of machineries.
- Maintain stationary and mobile equipment regularly and effectively.
- Ensure the noisiest construction activities are only carried out during day time hours.
- Initiate temporary noise barriers at the most sensitive areas.
- Locate stationary noise machinery such as generators away from sensitive receptors and in an enclosed structure for noise control.

8.2.4. Biodiversity and Natural Habitat

The impacts on biodiversity were assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance. Thus, the proposed mitigation measures are:

- Minimize disturbance to wildlife by phasing construction activities according to sensitive times of the year (e.g. breeding season)
- Conserve the present vegetation as much as possible to minimize disturbance to the surrounding biodiversity.
- Secure fencing of areas not required for land-take prior to start of work.
- Avoid any destruction action to the nearby environment.
- Reduce construction works in during any sensitive periods.
- Minimize unnecessary clearing of vegetation.
- Full site protection through project components.
- Education of workers on environmental protection.
- Plant trees around the site to protect the quality of underground water

8.2.5. Waste Generation Management

The impacts of waste generation are assessed as: direct, moderate, local, medium-term, reversible, of medium likelihood of occurrence and medium significance. Thus, the proposed mitigation measures are:

Waste reduction management

Good management and control can prevent the generation of significant amounts of waste. Waste reduction is best achieved at the planning and design stage, as well as by ensuring the implementation of good site practices.

- Applying the principals of waste reduction / re-use and recycling (RRR – reduce, reuse & recycle) wherever possible
- Nomination of an approved personnel, such as a site manager, to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility, of all wastes generated at the site
- Training of personnel in proper waste management and chemical handling procedures
- Provision of sufficient waste disposal points and regular collection for disposal
- Appropriate measures should be employed to minimize windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers
- Where applicable recycle waste concrete and use suitable excavated materials as backfilling
- No waste shall be disposed of or buried or burned on site.
- Segregate and store the different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials as well as their proper disposal.
- Collect and segregate aluminum cans.
- Recycle unused chemicals or those with remaining functional capacity.
- Maximize the use of reusable steel formwork and metal site hoarding.
- Plan and stock construction materials carefully to minimize amount of waste generated and avoid unnecessary generation of waste.
- Implement a recording system for wastes generated, recycled and disposed.
- Minimize resource depletion by selecting environmentally sustainable building materials in the public domain and providing on site recycling facilities.

- Wastes should be stored in a covered area to prevent storm water runoff and protect the containers from weather exposure.
- Overfilling of the waste containers should not be allowed.

Maintenance waste

Waste produced from the construction activities should be handled according to legislation on waste management, and disposed of by a licensed contractor at an appropriate disposal facility.

8.2.6. Land-use / land cover

The impacts on land-use and land cover were assessed as: direct, low, local, long-term, irreversible, of low-likelihood of occurrence and low significance. As such, no relevant mitigation measures for land use/land cover are proposed in this case.

8.2.7. Visual Intrusion

The impacts on visual intrusion were assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance. Thus, the proposed mitigation measures are:

- The height of all buildings on site should be kept as low as possible.
- The site should be fenced to minimize visual impacts.
- Existent vegetation clearing must be minimized when feasible.
- Buffer zones should be landscaped to prevent light pollution.
- Lights should be turned off by timer or manually when they are not needed.
- The type of light should be chosen wisely to less likely cause light pollution.

8.2.8. Water and Energy Resources Consumption

Impacts on water and energy resources consumption were assessed as: direct, moderate, local, short-term, irreversible, of moderate likelihood of occurrence and of moderate significance. Thus, the proposed mitigation measures are:

Freshwater demand control

- Dry clean-up methods should replace wet cleaning methods whenever practical (sweeping, dust collection vacuum, wiping…etc.).
- Signs or stickers near water-using appliances should be installed to encourage water conservation.
- Appropriate plastic sheeting or waterproof building paper should be used to cover the concrete after water curing to preserve moisture and reduce the evaporation that leads to decrease water quantities used

Energy management

- Turning off non-used equipment should be done.
- Machinery and generators shall be regularly maintained and operated in an efficient manner.

- Vehicles should not be allowed to remain idle for long periods.
- Temporary site offices shall be well insulated to retain heat or cool, utilize energy efficient bulbs and energy efficient cooling systems.
- Electrical power should be disconnected from the site offices after the working hours to reduce the energy consumption.

8.2.9. Occupational Health and Safety

Impacts on health and safety were assessed as: negative, moderate, local, medium-term, irreversible, of moderate likelihood of occurrence and of high significance. The proposed mitigation measures include:

Management of on-site accidents

Site layout and planning:

- Comply with the local Health and Safety Requirements, especially the Decree No. 7964/2012 related to the general conditions of public safety in buildings.
- Provide sufficient potable water for drinking and personal hygiene purposes.
- Designing carefully the construction site in order to avoid or reduce accidents due to tripping, slipping and collisions.
- Marking pavement properly and designing spacious loading and unloading ramps.
- Improving the access to the site by widening of entrance and exit points and providing lanes for turning movement.
- Providing adequate parking arrangements to reduce accumulation of vehicles at access points.
- Providing roads within the project site with speed limits signs of 25 km/hr to decrease risks of collisions and accidents and providing adequate loading and off-loading space.
- Restricting access to the construction site by proper fencing and provide guards to control entrances and exits.
- Install warning signs at the entrance of the site to prohibit public access and stress on utilizing the appropriate personal protective equipment.
- Provide personal ID cards for all employees.
- Provide appropriate lighting during night-time works.
- Proper labeling and storing chemicals, oils, and fuel to be used on-site.
- Provide all contained locations such as mechanical and technical areas with proper ventilation system.

Personal Protective Equipment and first aid:

- Providing appropriate Personal Protective Equipment (PPE) (e.g. hard hats, steel toe boots, respirators, dust masks) to workers and workers should be trained in proper use of the PPE
- Providing a properly equipped first aid room on site where at least one person on every shift must be trained in first aid.
- Keeping an accident register book on-site (all type of injuries must be recorded).

Health and safety warning signs:

- Installing safety signs and signals including illuminated signs and acoustic signals (fire alarms)

- Installing signboards such as prohibition and warning signs and signs for fire exits. Signboards must be large, clear and durable (securely fasten) to be certainly seen.
- Marking pipework containing dangerous substances

Safety policy:

- Developing a health and safety plan (including a fire control measure plan) and implementing it prior to starting construction work.
- Fire control equipment should always be available at the premises.
- Providing occupational health and safety training to workers. Training must include instruction in hazard recognition and control measures, learning safe work practices and proper use of the PPE.
- Developing appropriate procedure for storage (including proper labeling) and transportation of critical equipment and materials must be implemented.
- Providing good welfare facilities i.e. drinking and washing water, sanitary, changing rooms, rest rooms, amenities for preparing and eating meals.
- Developing an emergency response plan.
- Ensure that contact details of the local medical services are available to the relevant construction personnel prior to commencing work.

Management of off-site accidents

- Transportation-related traffic and accidents must be controlled.
- Truck drivers should be provided with an adequate traffic plan.
- Trucks should comply with speed limits.
- Construction vehicles movement should be undertaken during non-peak hours.

8.2.10. Management of Social Impacts

The impact assessment has identified that the overall impact of the construction of the proposed project on the socioeconomic profile of the region is expected to be positive. This section describes mitigation measures for traffic, for potential negative impacts on plant workers, and for any concern raised by citizens during the construction phase.

Traffic

The impacts of traffic on the local communities could be negative. Construction activities would result in some traffic disruption (closure and detours) and contribute to localize blocking from time to time. Accordingly, the mitigation measures are the following:

- Routing strategies should be developed for construction traffic that seeks to avoid sensitive receptors.
- Non-peak traffic times should be used or alternate routes should be provided when needed or when feasible.
- Adequate warning, signing, delineation and channeling at least 500 m down and up-gradient from the construction site must be provided by the project proponents.
- Movement of delivery vehicles outside the site should be restricted to off-peak traffic hours and during night-time.
- Traffic management plan should be followed by installing proper distributed road signage and monitoring devices.
- Speed limitation signs should be installed at the access points.

- Adequate parking areas should be provided.
- Continuous roads and pavements maintenance should be applied.
- The trays of all trucks entering or leaving the site should be covered to prevent spillage of any material from the truck onto the road.
- All vehicles being loaded or unloaded shall stand entirely within the property.
- Free all vehicles leaving the premises from dirt, aggregate or other materials such that materials are not transported onto public roads.
- Maintain all trafficable areas and vehicle maneuvering areas on the site in a condition that minimizes the generation of emissions or traffic generated dust from the site at all times.

Impacts on Plant Workers

While the proposed project and related facility's activities are not expected to induce any involuntary resettlement of Ain Baal village residents, a short-term economic displacement of the plant workers shall be induced during the construction / rehabilitation period, which is anticipated to last for a maximum of 5 months pending Operator contract renewal. This displacement has been assessed and livelihood restoration and compensation options are the responsibility of the Union of Tyre Municipalities. The Union of Municipalities will ensure that workers are compensated for temporary costs of relocation and short-term work disruption.

Livelihood restoration options are as follows:

- The Contractor in charge of the construction works will employ as many of the workers as possible, according to their skills.
- The remaining workers will continue to be employed and paid by the Plant Operator, under their existing contract.

All workers, whether employed by the Contractor or Plant Operator will receive at minimum the same daily rate during construction works as they were paid during the operation of the plant. For unskilled workers, this is 27,000 LBP per day.

Once construction is completed, workers who were formerly employed by the Plant Operator will have priority to receive training to work on the new facility and will continue working with the Plant Operator with the same contractual arrangements as before project implementation.

If that is the case, (Plant shut down due to operator selection process) measures will be put in place so that workers having worked in the plant for over three months would continue to be paid despite the plant being closed. The project will record the date the plant stopped working and the date the plant operations restarted to establish the amount of compensation for each worker. CDR will retain documentation verifying the payment of contractors for every day during the construction phase, as well as documentation that verifies that workers continue to be employed during the operation phase.

In addition to these 45 day laborers, 10 Lebanese workers work on in the facility as managers and operators. These 10 Lebanese workers will also be compensated for their time in the case the facility needs to close because of project activities.

The 45 workers live in the solid waste facility. The workers live in two areas. The project will in no way restrict the workers ability to continue living in these facilities. If, by any chance, workers are forced to leave these living facilities, they will be provided with alternative housing accommodations by the operator, depends on work location. Whilst operator contract tendering process by both the Union and OMSAR is underway, the current operator has dispatched workers to another work site location, where housing accommodations and other enmities have been provided as per conditional practice accord by the operation company and its work force body.

In addition, the project, during its construction phase, will also carry out small improvements to worker living facilities. Showers, toilets, and cooking facilities will be improved.

Addressing citizen concerns arising during construction
Consultations shall be held during project implementation with the purpose of gathering any feedback on the potential negative impacts of the project. This will take the place of a formal grievance redress mechanism, which would take longer to put in place and disseminate. The feedback gathered in these consultations will be used to minimize negative impacts on nearby populations. CDR will keep records of all consultations held during construction (at least 1 every 8 weeks.)

8.3. Mitigation Measures (during operation)

8.3.1. Air Quality

The impacts of the project on air quality were assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of medium significance. Thus, the proposed mitigation measures are:

Generation of dust

- Excessive vehicular movement shall be avoided to mitigate the footprint associated with transportation
- Vehicle speeds shall be restricted on un-surfaced roads and tracks.
- Driving surfaces should be paved to eliminate fugitive particulates. Facilities with paved surfaces may additionally employ sweeping or vacuuming as maintenance measures to reduce PM emissions.
- Housing floor cleaning operations must be undertaken in respect to low wind speeds
- Monitor dust emissions from shredded wastes

Release of combustion and exhaust gases

- The use of bio-filters and water scrubbers to control the air emissions and odors.
- Control composting operation in a closed system hangar
- Vehicles, equipment and power generator shall be regularly maintained.
- The used power generators must be either equipped with a cyclone filter or a stack of appropriate height in respect to the related national legislations.

Odors

Effective operational management, such as processing incoming waste as soon as possible, managing the process properly, following good housekeeping practices, can help to control the formation of odors. Moreover, several management practices can be adopted as part of a mitigation strategy:

- Blanketing with bulking agents, carbon amendments or finished compost
- Keep pH of pile below 7.5 (pH adjustments with lime or wood ash)
- Increase daily operation shift
- Maintain proper moisture and aeration to avoid anaerobic compounds (e.g. hydrogen sulfide, dimethyl sulfide, volatile fatty acids, etc.)
- Combine material to achieve high C:N ratio. To avoid ammonia odors, it is important to set the C:N ratio well above 10:1 (25-30:1 is ideal)

- In case ammonia odors are released, mix carbon-rich materials to reduce the excess of nitrogen.
- If a putrid odor is released, reduce the water content of the mixture.
- Reduce mixing/turning during unfavorable air conditions
- Reduce mixing/turning when wind is in the direction of receptors
- Treat exhaust gases in biofilters
- Check the proper functioning of biofilters (refer to biofilter media monitoring practices in section 8.4.2)
- All composting activities should be conducted in an enclosed area, connected to odor abatement systems.
- Adopt adequate ventilation systems and install biofilters in all the buildings
- Monitor periodically effluent of wastewater treatment unit
- Avoid percolation of leachate and contaminated runoff
- Storage and receiving areas should be controlled to reduce the dispersion of odors.
- Optimum hygiene practices should be applied on a daily basis

8.3.2. __Water Quality__

Impacts on water quality were assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of high significance.

Water at a composting facility must be carefully managed, particularly in the areas used for feedstock storage and processing. Preventive infrastructure can include:

- Intercepting drains should be used around the perimeter of the process and storage areas.
- Constructed ponds can be used to receive site runoff and reduce the impact of runoff and leachate on nearby water courses.
- The facility should store and process incoming feedstock on a low permeability liner with a 2% minimum drainage gradient that directs wastewater to a leachate collection system (EPA, compost guideline, 2013).
- Finished compost product should be stored on a designated area that has a minimum 2% drainage gradient to direct the potentially harmful runoff into a wastewater management system capable of removing contaminants (EPA, compost guideline, 2013).
- It is prohibited to discharge sewage onto the open ground. It is prohibited to discharge untreated wastewater into any water body.
- It is prohibited to use open ground for sanitary purposes including bathing, defecating, urination, cooking, washing (dishes or clothing).
- A collection system shall be provided under any machinery or equipment that may leak hydrocarbons (e.g. generator and pumps).
- The ground under the servicing areas shall be constructed of an impervious material and isolated as necessary.
- Vehicle and equipment wash-down shall only be undertaken at designated areas. The ground under the wash-down area shall be impervious and designed to collect wash water. Wash water will be re-used where possible and excess water collected and disposed of by an approved location.
- It is prohibited to allow wash water to cause pollution of the ground or groundwater.
- The contractor must ensure that all operations involving the use of concrete are carefully controlled.
- All dust suppression generated wastewater will be collected and recycled.
- Dry cleaning should be applied for dust removal before using water spraying to reduce dust emissions.

- Contaminated storm water runoff should be diverted and cleaned, if possible.
- It is prohibited to store any construction material in areas subjected to contact with storm water runoffs.

8.3.3. Soil Quality

Impacts on soil quality were assessed as: direct, moderate, local, long-term, irreversible, of medium likelihood of occurrence and of high significance.

Accidental spills and leaks and Process Wastewater discharge

Leachate generation during composting and landfilling must be controlled. A proper plan to collect and treat the generated leachate is important to reduce the negative impact of infiltration to the proximal soil. In this facility, the collected leachate is recycled back onto the windrows on a regular basis to reduce potential for overflow and soil contamination. Special care should be applied to the wastewater treatment unit in order to avoid leakage and contamination of the surface and underground water. Accordingly, periodic monitoring of the wastewater pipes must be undertaken in order to identify any potential leakages.

Also, the surface run-off must be prevented from being contaminated with the in-process compost, by using air permeable geotextile sheets to cover the windrows during the composting process.

Heavy machineries and generators should be regularly inspected for any potential leakages or improper storage of fuel and lubricants. Also, oil wastes should be handled and stored in a manner which ensures that they are held securely without leakage. In addition, diesel should be stored in designated tanks and placed on an elevated concrete base to prevent soil pollution in case of accidental spills.

Compost product quality

The plant should also efficiently control sorting and composting processes in order to avoid the production of undesirable compost that will contaminate the receiving soil. Magnetic separation takes place prior to composting in order to remove heavy metals. Moreover, compost quality and maturity grade should be regularly examined according to the methods outlined in the National Compost Ordinance. It is recommended to allow for proximal maturation of compost before soil application. In this context, it is the responsibility of the composting facility operators to ensure the production of a safe and healthy compost product and declare its application specifications to the utilizer. Finally, if the facilities produced compost of inferior quality, less than 'Grade D', its application should be strictly prohibited. It is, hence, recommended that the compost be packed and clearly labeled.

Sludge from the wastewater treatment unit

The generated sludge will be collected twice per year and added to the composting piles for the biological treatment. The handling of sludge should be properly done to avoid any contamination of soil quality.

Domestic solid waste management

All generated domestic waste will be treated in the facility similarly to municipal waste collected from outside the plant. The other types of waste, such as metal spare parts, oil containers and grease drum, which could be generated from periodical maintenance activities, will be assigned to specific contractors.

8.3.4. Acoustic Environment

The impacts on the acoustic environment were assessed as: direct, low magnitude, local, medium-term, during operation, reversible, of high likelihood of occurrence and of low significance

Noise pollution is mainly generated from unloading, sorting and composting activities in the facility. Selecting machines that are less noisy or equipped with noise suppression devices can help minimize noise. In addition, heavy machineries and generators should be regularly maintained to prevent any potential malfunctions and subsequently any unpleasant noise generation. Also, all trucks used for transport should be equipped with proper mufflers for noise reduction. Moreover, it is important to note that sorting activities are conducted within a closed system hangar and the noise is reduced to the minimal level.

The mitigation measures for noise pollution should conform to the Lebanese noise guidelines shown in Table 8-1. The collection of waste should be scheduled in the early morning or late in the afternoon to prevent traffic congestion and public disturbance. In addition, the occupational noise exposure should not exceed 90 dB for an average of 8-hour working day, and the maximum accepted level of noise for an industrial area (in terms of overall noise generation on site) is between 60-70 dB. Therefore, an adequate monitoring plan, where several noise measurements are recorded at diverse locations, is necessary in order to guarantee a good control of the noise generation on site.

In addition, a natural or artificial barrier of tall thick vegetation can be created on the sides facing the composting to serve as a visual barrier and also to help minimize the transmission of noise to the neighbors. Also, plant workers are to be provided with protective wear in plant areas with high noise levels.

Table 8-1Lebanese noise guidelines in different zones (MoE,52/1, 1996)

Area classification	Maximum accepted noise level dB(A)		
	Day[1]	Evening[2]	Night[3]
Business district	55 – 65	50 – 60	45 – 55
Residential area with few construction sites, commercial activities or on a highway	50 – 60	45 – 55	40 – 50
Urban residential area	45 – 55	40 – 50	35 – 45
Residential suburb	40 – 50	35 – 45	30 – 40
Rural residential, hospital, public garden	35 – 45	30 – 40	25 – 35
Industrial zone	60 - 70	55 - 65	50 - 60
(1) 7 a.m. to 6 p.m. (2) 6 p.m. to 10 p.m. (3) 10 p.m. to 7 a.m.			

8.3.5. Biodiversity and Natural Habitat

The impacts on biodiversity were assessed as indirect, low, local, long-term, and reversible, of low likelihood of occurrence and of medium significance. As such, mitigation measures given for the construction phase are applicable for this stage (refer to section 8.2.4).

In addition to the mitigation measures listed in section 8.2.4, the plant must prevent the contamination of the surrounding area during its operation. Receiving and storage areas should be closed and an appropriate fencing around the facility is crucial. It is important to note that the facility uses a pest control strategy where 5 types of rodenticides and insecticides (bait pesticides, Alpha-cypermethrin, beta-cypermethrin, or any pesticide of the -methrin family) are applied every 3 months.

The plant must control as well the quality of produced compost before it reaches the end user. In order to avoid the usage of contaminated compost, the phytotoxicity of plants, and the contamination of soil, the plant has to give a bill of delivery to the customer and provide him with a specific description of the compost product for a suitable application. In fact, compost should be applied in proper quantities relevant to the crop and soil type (refer to Appendix 5).

8.3.6. Waste Generation Management

The impacts of leakages, improper disposal and management of generated solid waste were assessed as direct, moderate, local, long-term, during operation, reversible, of medium likelihood of occurrence and of moderate significance. Thus, the proposed mitigation measures are:

Domestic solid waste management

All generated domestic waste will be treated in the facility similarly to municipal waste collected from outside the plant. While the other type of wastes such as metal spare parts, oil containers and grease drum that could be generated from periodical maintenance activities will be assigned to specific contractors.

Sludge Management

- Sludge must be emptied regularly from the leachate treatment unit
- Sludge must not be permitted to build up in the holding tank
- Sludge must be stored in a closed area with a concrete base in order to prevent seepage
- Sludge shall be emptied by means of tankers and hauled to the regional wastewater treatment plant where it will be mixed with the sludge generated by the WWTP and treated in the dedicated sludge treatment facility.
- At all times, the handling of sludge shall be undertaken in a way to reduce odor emissions.

8.3.7. Land-use / land cover

The impacts on land-use and land cover were assessed as: indirect, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance. There are no land use practices conflicting with existing activities, as such, there is no need for mitigation measures.

8.3.8. Visual Intrusion

The impacts on visual intrusion were assessed as: direct, low, local, long-term, irreversible, of low likelihood of occurrence and of low significance. Thus, the proposed mitigation measures are:

- The height of all buildings on site should be kept as low as possible to reduce visual impact.

- Enclose site with non-transparent fencing to minimize visual impacts or plantation of trees
- Preserve existing floral cover when feasible.
- Create a natural or artificial barrier of tall thick vegetation on the sides facing the composting to serve as a visual barrier.
- Where access restrictions result, arrangements for alternative access should be made with the provision of gates, bridges or stiles.
- Create a buffer zone consisting in part of finished compost to serve as visual barrier.
- Ensure that the used light source is the minimum intensity for the required purpose.
- Ensure that lights are turned off by timer or manually when they are not needed.
- Ensure that fittings are chosen that direct light accurately to where it is needed.
- Ensure that the type of light chosen is the least likely to cause light pollution.

8.3.9. Water and Energy Resources Consumption

Impacts on water and energy resources were assessed as: direct, moderate, local, long-term, irreversible, of high-likelihood of occurrence and of medium significance. The mitigation measures include:

Water conservation measures:

- Use dry cleanup methods whenever practical (sweeping, dust collection vacuum, wiping, etc.).
- Install signs or stickers near water-using appliances that encourage water conservation.
- Water arising from truck wash-down will be treated to remove silt and re-used where possible
- Reclaim and reuse effluent of wastewater treatment unit to reduce on fresh water consumption

Energy conservation measures:

- Ensure the turning off non-used equipment when not in use
- Machinery and generators shall be regularly maintained and operated in an efficient manner.
- Vehicles should not be allowed to remain idle for long periods.
- Temporary site offices shall be well insulated to retain heat or cool, utilize energy efficient bulbs and energy efficient cooling systems
- Ensure that electrical power is disconnected from the site offices after the working hours to reduce the energy consumption.

8.3.10. Health and Safety

Impacts on health and safety were assessed as direct, moderate, local, long-term, and irreversible, of moderate likelihood of occurrence and of medium significance.

Proposed mitigation measures for the Impacts on Health and Safety during construction are also to be respected and implemented during the operation of the proposed project. Additional mitigation measures include:

- Healthy and safety regulations should be imposed on all workers.
- Workers should not be allowed to exceed working hours
- Ensure the use of personal protective equipment (PPE) among the workers.
- Provide sufficient potable water for drinking, cooking and personal hygiene purposes.

- Train vehicles drivers on safety measures and vehicle maintenance issues.
- Adequately cover vehicles delivering and transporting material.
- Provide roads inside the site starting from the entrance with speed limits signs of 25 km/hr to decrease risks of collisions and accidents.
- Ensure that all employees are aware of the location of safety and rescue equipment available at the site.
- Ensure that contact details of the local medical services are available to the relevant construction personnel prior to commencing work; and,
- Provide adequate loading and off-loading space
- Develop an emergency response plan
- Provide environmental friendly fire-fighting equipment such as dry powder extinguishers within the premises of the plant
- Conduct annual fire-fighting and leak checks training drills for the operating staff
- Prohibit smoking as well as litter or weed build-up in the area as these may pose fire risk
- Ensure effective pest and rodent control measures
- A properly selected and worn respirator must be provided to operators to protect them from dust and mold spores
- Proper fencing at a minimal height of 3 meters around the whole site should be ensured to prevent trespass and vandalism.

8.3.11. Social Impacts

The impacts on the socio-economic profile were assessed as positive, moderate, local, long-term, and reversible, of moderate likelihood of occurrence and of moderate significance.
The operational and maintenance phases of the project will provide long term working opportunities for locals. The project is income generating with financial revenues resulting from compost sales.
Moreover, the facility will allow the closure of uncontrolled dumpsites and consequently will allow the rehabilitation of these sites.

However, the project might introduce additional traffic load onto the existing routes. Collection and transport of waste to the facility must be performed properly in order to prevent traffic congestion. A planned schedule must be followed and all drivers must respect highway speed restrictions. Traffic mitigation measures fall into two categories namely, those designed to control traffic entering and leaving the facility and those designed to mitigate impacts outside the facility.

Onsite traffic control measures

- Entrance and exit signs should be provided so as to provide maximum turning space and sight lines
- Adequate delivery and loading space
- Adequate off-street parking for employees
- One-way traffic within the site to prevent obstruction to vehicles entering and leaving
- Speed restrictions on vehicles entering and leaving the site

Offsite traffic control measures

- Routing of traffic to avoid residential areas

- Scheduling of deliveries and departures
- Ensuring that vehicles and containers are appropriate to the waste transported and that they are adequately maintained and checked
- Use of locally designated traffic routes management

Additional measures can be considered in order to reduce the socio-economic impact of this project, namely:

- Operations should aim to minimize disturbance to adjacent residential and recreational uses through the creation of a buffer zone between site activities and neighboring areas.
- Where access restrictions result, arrangements for alternative access should be made.

8.4. Mitigation Measures (during decommissioning)

Specific closure procedures should focus on the preservation of the long-term integrity and security of the site. The main mitigation measures that should be applied during the decommissioning activities are very similar to the ones during the construction phase. Refer to previous section 8.2 for the mitigation measures during the decommissioning phase.

Table 8-2 Environmental and social management plan

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
Construction	**Emissions**													
	Air Emissions / Odors	Generation of dusts, exhaust gases, and odors	D	M	L	M	C	I	M	M	• Driving surfaces should be paved to eliminate fugitive particulates • Stockpiles of fine material shall be covered • Dust generating activities shall cease during excessively windy periods • Vehicles, equipment and power generator shall be regularly maintained • Establish an inventory of all odor sources. • Install adequate ventilation systems for all confined areas. • Periodic checks to prevent any leakages of fuel or wastewater.	• Potential health-related problems • Air quality deterioration	Project owner/developers	**5,000**
	Acoustic Environment	Construction equipment noise and vibrations, earth manipulating activities	D	M	L	S	C	R	H	L	• Locate stationary noise machinery such as generators away from sensitive receptors and in an enclosed structure for noise control. • Tailor construction activities‟ schedule to avoid sensitive time and/or sensitive locations • Replace noisy equipment with less noisy alternatives • Public billboards should be erected at the construction site • Temporary noise barriers may be erected • Engine covers of machineries should always be kept closed	• Health-related problems (i.e. hearing loss, stress, high blood pressure, sleep loss, distraction...) • Wildlife disturbance	Project owner/developers	**10,000**
	Wastewater Generation	Construction wastewater generation; and Domestic wastewater	D	M	L	L	C	I	M	H	• Temporary settlement ponds should be installed to treat all generated construction wastewater • It is recommended to store diesel and construction materials tanks near the construction site on an elevated concrete base so as to minimize soil and water pollution in case of accidental spill. • Wastewater shall not be discharged onto the open ground or into any water body. • A collection system shall be provided under any machinery or equipment that may leak hydrocarbons (e.g. generator and pumps). • The ground under the servicing areas shall be constructed of an impervious material	• Potential contamination of water (surface and ground) • Potential degradation of soil quality	Project owner/developers	**5,000**

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
											and isolated as necessary. • Use of protective boarding and low ground pressure machinery in order to minimize soil compaction.			
	- **Solid Waste Generation**	Generation of construction wastes and domestic wastes from construction workers	**D**	**M**	**L**	**L**	**C**	**I**	**M**	**H**	• Effective practices for the disposal of solid wastes generated on-site should be developed by an approved personnel, such as a site manager. • All personnel shall be trained to properly manage waste and handle chemicals. • Appropriate measures should be employed to minimize windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers • Where applicable recycle waste concrete and use suitable excavated materials as backfilling • No waste shall be disposed of or buried or burned on site • Segregate and store the different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials as well as their proper disposal. • Implement a recording system for wastes generated, recycled and disposed.	• Potential contamination of natural resources	Project owner/developers	**In House**
	- **Accidental Releases**	Accidental spills of construction materials, wastewater generation, and storm water runoff	**D**	**M**	**L**	**L**	**C**	**R**	**M**	**H**	• Wastewater shall not be discharged onto the open ground or into any water body. • Avoid excavation work during rainy days • Create erosion control barriers (ex. Sand bags) • Prevent concrete mixers from washing at site or surrounding • Install adequate sanitary facilities for construction team • Apply a good storage and handling plan of chemical materials and fuels. • All refueling operations shall take place off-site • A spill response plan should be developed • A collection system shall be provided under any machinery or equipment that may leak hydrocarbons (e.g. generator and pumps).	• Potential contamination of water (surface and ground) • Potential degradation of soil quality	Project owner/developers	**20,000**

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
	Depletion of Natural Resources													
	- **Water and Energy Resources**	Increase in water and energy demand (Construction and domestic water consumption)	**D**	**M**	**L**	**S**	**C**	**I**	**M**	**M**	• Dry clean-up methods should replace wet cleaning methods whenever practical (sweeping, dust collection vacuum, wiping…etc.). • Install signs or stickers near water-using appliances that encourage water conservation. • Insure the turning off of non-used equipment when at night or during weekends. • The use of solar powered instruments/machines.	• Potential water shortages • Indirect increase in emissions	Project owner/developers	**10,000**
	- **Biological Resources**	Direct loss of habitat and fauna	**D**	**L**	**L**	**L**	**C**	**I**	**L**	**L**	▪ Minimize disturbance to wildlife by phasing construction activities according to sensitive times of the year (e.g. breeding season). ▪ Conserve the present vegetation as much as possible to minimize disturbance to the surrounding biodiversity. ▪ Secure fencing of areas not required for land-take prior to start of work. ▪ Avoid any destruction action to the nearby environment. ▪ Reduce construction works during any sensitive periods.	• Loss of species (fauna or Flora) • Potential implications on migratory species	Project owner/developers	**In House**
	Other Impacts													
	- **Visual intrusion**	Day time and night time construction works	**D**	**L**	**L**	**L**	**C**	**I**	**L**	**L**	▪ Enclose site with non-transparent fencing to minimize visual impacts ▪ Incorporate a maximum of green areas and greenbelt on site ▪ Preserve existing floral cover when feasible. ▪ Minimize the internal and external light pollution, especially that during nighttime.	• Disrupt the surrounding ecosystem	Project owner/developers	**In House**
	- **Socio-Economic**	Employment opportunities, some traffic disruption.	**P**	**M**	**L**	**M**	**C**	**R**	**M**	**M**	▪ Routing strategies should be developed for construction traffic that seeks to avoid sensitive receptors. ▪ Movement of delivery vehicles outside the site should be restricted to off-peak traffic hours and during night-time. ▪ Adequate parking areas should be provided. ▪ Continuous roads and pavements	-	Project owner/developers	-

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
											maintenance should be applied. ▪ The trays of all trucks entering or leaving the site should be covered to prevent spillage of any material from the truck onto the road.			
	- **Archeological/ Cultural**	-	-	-	-	-	-	-	-	-	-	-	-	-
	- **Health and Safety Hazards**	Construction Activities such as welding, cutting chemical handlings, loading, etc. + Off-site accidents	N	M	L	M	C	I	M	H	• Provide sufficient potable water for drinking, cooking and personal hygiene purposes. • Adhere to all applicable speed limits and implement speed limits for trucks entering and exiting the site. • Comply with the local Health and Safety Requirements; especially the Decree No. 7964/2012 related to the general conditions of public safety in buildings. • Ensure that all employees utilize appropriate personal protective equipment (e.g. hard hats, steel toe boots, respirators) and are trained on these as required. • Restrict access to the construction site by proper fencing and provide guards on entrances and exits to the site. • Provide training to a dedicated staff • Develop an emergency response plan.	▪ Injuries or other health related problems	Project owner/developers	**10,000**
Operation	**Emissions**													
	Air Emissions (and odors)	Feedstock, Competing odor sources, Changes in processing methods, Increase in volume processed, Weather impact/Weather patterns, Trucks and vehicles, Generators, Heavy machinery	D	M	L	L	O	I	H	H	▪ Make smaller piles of organic material ▪ Blanketing with bulking agents, carbon amendments or finished compost ▪ pH adjustments with lime or wood ash ▪ Increase daily operation shift ▪ Maintain sufficient moisture ▪ Combine material to achieve high C:N ratio ▪ Reduce mixing/turning during unfavorable air conditions ▪ Reduce mixing/turning when wind is in the direction of receptors ▪ Treat exhaust gases in biofilters ▪ Eliminate puddles where water collects ▪ Vehicles, equipment and power generator shall be regularly maintained.	• Health hazards • Fire hazards • Air quality deterioration	Project owner/developers	**50,000**
	Acoustic pollution	Daily operational activities; Trucks and vehicles; and	D	L	L	M	O	R	H	L	▪ Select equipment that are less noisy and equipped with noise suppression devices	• Health-related problems (i.e. hearing loss, stress,	Project owner/developers	**10,000**

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
		Generators									▪ Composting must take place in a closed hangar ▪ Control noise-generating activities during working and off-working hours. ▪ Replace noisy equipment with less noisy alternatives ▪ Orientate machinery away from noise sensitive residential areas. ▪ Engine covers of machineries should always be kept closed. ▪ Maintain stationary and mobile equipment regularly and effectively. ▪ Noise barriers may be erected at the most sensitive areas.	high blood pressure, sleep loss, distraction...) • Wildlife disturbance		
	Wastewater Generation	Accidental spills or leakages ; Domestic Wastewater discharge; and Process wastewater discharge	**D**	**M**	**L**	**L**	**O**	**I**	**M**	**M**	▪ Intercepting drains should be used around the perimeter of the process and storage areas. ▪ Constructed ponds can be used to receive site runoff and reduce the impact of runoff and leachate on nearby water courses. ▪ The facility should store and process incoming feedstock on a low permeability liner with a 2% minimum drainage gradient that directs wastewater to a leachate collection system (EPA, compost guideline, 2013). ▪ Finished compost product should be stored on a designated area that has a minimum 2% drainage gradient to direct the potentially harmful runoff into a wastewater management system capable of removing contaminants (EPA, compost guideline, 2013). ▪ A collection system shall be provided under any machinery or equipment that may leak hydrocarbons (e.g. generator and pumps). ▪ The ground under the servicing areas shall be constructed of an impervious material and isolated as necessary.	• Degradation of water and soil quality • Negative implications on public health	Project owner/developers	**70,000**
	Solid Waste Generation	Domestic wastes management; and sludge management	**D**	**M**	**L**	**L**	**O**	**R**	**M**	**M**	▪ Nomination of an approved personnel to be responsible for good site practices, arrangements for collection, of all wastes generated at the site. ▪ Segregate and store the different types of	• Potential contamination of natural resources • Health-related problems • Wildlife disturbance	Project owner/developers	**In House**

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
											waste in different containers – waste will be treated by the facility similarly to waste received from municipalities. ▪ Sludge must be emptied regularly from the wastewater treatment tank			
	▪ Depletion of Natural Resources:													
	Water and Energy Resources	Energy Resources (Operation of the facility); and Water resources (mainly domestic consumption)	**D**	**M**	**L**	**L**	**O**	**I**	**H**	**M**	▪ Abide to best available practices on energy saving in houses. ▪ Insure the turning off non-used equipment when not in use ▪ Machinery and generators shall be regularly maintained and operated in an efficient manner. ▪ Temporary site offices shall be well insulated to retain heat or cool, utilize energy efficient bulbs and energy efficient cooling systems ▪ Ensure that electrical power is disconnected from the site offices after the working hours to reduce the energy consumption. ▪ Install faucets, toilets and urinals with low-volume models. ▪ Install signs or stickers near water-using appliances that encourage water conservation	• Excessive consumption of energy and water	Project owner/developers	**50,000**
	Biological Resources	Potential water and soil contamination during operation of the facility – negative effect on biodiversity (fauna and flora)	**I**	**L**	**L**	**L**	**O**	**R**	**L**	**M**	▪ Prevent the contamination of the surrounding area by fraction of waste transported by wind: storage area should be closed and an appropriate fencing around the facility is needed ▪ Control the quality of produced compost before it reaches the end user (to avoid phytotoxicity of plant and soil contamination)	• Disturbance of the surrounding environment	Project owner/developers	-
	Other Impacts													
	Visual intrusion	The establishment of the facility and its operation	**D**	**L**	**L**	**L**	**O**	**I**	**L**	**L**	▪ The height of all buildings on site should be kept as low as possible to reduce visual impact. ▪ Enclose site with non-transparent fencing to minimize visual impacts or plantation of trees ▪ Preserve existing floral cover when feasible. ▪ Create a natural or artificial barrier of tall	• Disturbance of natural scenes • Disturbance of the regular area commuters.	Project owner/developers	**In House**

Phase	Sources of Impact	Project Activities	Evaluation of Impact								Mitigation measures	Residual impacts	Institutional responsibility	Cost estimation ($)
			N	M	E	T	D	R	L	S				
											thick vegetation on the sides facing the composting to serve as a visual barrier.			
	Socio-Economic	Work opportunities; Income generating activity; Trucks and vehicles	**P**	**M**	**L**	**L**	**O**	**R**	**M**	**M**	▪ Routing of traffic to avoid residential areas ▪ Ensuring that vehicles and containers are appropriate to the waste transported and that they are adequately maintained and checked	-	Project owner/developers	-
	Archeological/ Cultural	-	-	-	-	-	-	-	-	-		-	-	-
	Health and Safety Hazards	On-site accidents including Fires, risks of collision and accidents, risk of inhalation of PM and exhaust gases during operation activities, off-site accidents- vehicle accidents	**D**	**M**	**L**	**L**	**O**	**I**	**M**	**M**	▪ Healthy and safety regulations should be imposed on all workers. ▪ Workers should not be allowed to exceed working hours ▪ Ensure the use of personal protective equipment (PPE) among the workers. ▪ Provide sufficient potable water for drinking, cooking and personal hygiene purposes. ▪ Train vehicles drivers on safety measures and vehicle maintenance issues. ▪ Adequately cover vehicles delivering and transporting material. ▪ Provide roads inside the site starting from the entrance with speed limits signs of 25 km/hr to decrease risks of collisions and accidents. ▪ Ensure that all employees are aware of the location of safety and rescue equipment available at the site.	• Injuries or other health related problems	Project owner/developers	**50,000**

N (Nature): P (Positive), N (Negative), D (Direct), I (Indirect);

T (Timing): S (Short-term), M (Medium-term), L (Long-term);

L (Likelihood of occurrence): L (Low), M (moderate), H (high);

M (Magnitude): L (Low), M (Moderate), H (High)

D (Duration): C (during construction), O (during operation);

S (Significance): L (low), M (moderate), H (high)

E (Extent): L (Local); G (global);

R (Reversibility): R (reversible); I (irreversible);

8.5. Monitoring Plan

Environmental monitoring is one of the most important parts of an efficient and compatible operation of a project. All environmental requirements and restrictions from authorities, project owners and local communities are interlinked. Implementation of environmental techniques and modalities became a common ground for all involved parties as it commonly serves in the execution and operation of the project. It is important to note that the assessment of all proposed measures is imperative to ensure their proper implementation and the optimal operation of the project. Monitoring aims at optimizing the process design and provides quantitative and qualitative data that help in accurately communicating the performance of the project with regulators, the public or other stakeholders. Monitoring is ideally performed along the execution of the project: before, during and after construction.

The overall objective of environmental monitoring is to ensure that mitigation measures are implemented and that they are effective. Monitoring involves the observation, review, and assessment of onsite activities (including parameters) to ensure adherence to regulatory standards and the suggestions made to lessen negative impacts.

In this context, contractors shall employ qualified environmental and health officers/inspectors responsible for ensuring that the proposed mitigation measures are properly implemented during both construction and operation phases.

The Key Performance Indicators and Standards for the project are listed in the table below.

Table 8-3 Key performance indicators for the monitoring plan

<table>
<tr><th>Parameter</th><th>Standard/Indicator</th><th>Phase</th></tr>
<tr><td>Design confirmation</td><td>Minimal environmental impacts</td><td>Pre-construction</td></tr>
<tr><td>Air quality</td><td>Lebanese Stack Emission Standards
Lebanese Exhaust Emissions Standards for Vehicles</td><td rowspan="4">Construction</td></tr>
<tr><td>Occupational health and safety</td><td>Number of accidents and working days lost
Health and Safety Guidelines
Compliance with Lebanese Labor Law
Compliance with Lebanese Standards for the Discharge of wastewater to sewage network/ surface water</td></tr>
<tr><td>Public safety</td><td>Number of accidents involving public safety</td></tr>
<tr><td>Noise levels</td><td>Lebanese Noise Emission Limits for Outdoor Areas</td></tr>
<tr><td>Soil and water quality (of streams and lakes present onsite)</td><td>Odor, turbidity, type and quantities of fertilizers used (nutrient levels)</td><td>Post Construction (Operation phase)</td></tr>
</table>

Parameter	Standard/Indicator	Phase
Ecological state of existing ecosystems	Natural habitats and biodiversity state	Post Construction (Operation phase)
Volume and quality of water produced from the water treatment plants present onsite	Capacity of water treatment plant, and quality of effluent	Post Construction (Operation phase)

8.5.1.<u>Construction Phase Environmental Monitoring:</u>

Specific parameters need to be monitored during the construction phase of the project, in order to ensure optimal conditions for the construction of the proposed composting facility and minimize the generation of offensive emissions. The monitoring requirements are outlined in the table below.

Table 8-4 Monitoring requirements during construction

Monitoring Requirement	Frequency
Monitor on a regular basis the condition of areas affected by construction activities	Weekly
Inspect heavy vehicles before they leave the sites to ensure soil is not adhering to the undercarriage of vehicles.	Weekly
Monitor the extent of construction areas to ensure they do not extend beyond the defined construction zone.	Weekly
Inspect construction machinery to ensure it is in a good state of repair and is not leaking oil or fuel.	Monthly
Visually monitor dust generation from work zones to ensure that excessive dust is not being produced.	Daily
Check that dusty materials are well-covered in order to reduce dust emissions.	Daily
Conduct regular training for staff to prepare and use construction materials using best practices to reduce odour emissions.	Monthly
Conduct investigative noise monitoring in response to specific complaints	As required
Conduct noise monitoring in the vicinity of sensitive receiver locations	Monthly
Monitor construction activities that involve destroying existing ecosystems	As necessary
Report any archaeological sites discovered during construction activities	As necessary
Check that trucks are not overloaded, that they adhere to construction speed limits, that their trays are covered and that materials are loaded and unloaded carefully	Daily
Monitor any unauthorized waste disposal activity.	Weekly
Inspect the construction site to evaluate the effectiveness of waste storage and collection practices.	Weekly
Monitor waste recycling and disposal procedures	Weekly
Check that no fire sources are present at the construction site, including	Daily

Monitoring Requirement	Frequency
cigarettes, shards of glass, flammable chemical, etc.	
Plant workers are the responsibility of the operator that are contracted by both the union and OMSAR, due to plant shut down as contract is being tendered out, workers are dispatched to another site location where the operator has undertaken works.	Monthly

*8.5.2.**Operation Phase Environmental Monitoring***

Optimization of the composting process requires an understanding of the fundamentals of composting (Haug, 1993; Epstein, 1997). This section of the EIA presents an overview on all the operational parameters that should be controlled and monitored in order to implement a compatible and efficient environmental management plan.

Operation and performance parameters of the composting process

The rate at which the decomposition occurs is highly dependent on a variety of physical and chemical factors within the system. The most relevant performance and operation parameters that should be controlled are developed below (Lan, Bruce, et. al.1996):

Oxygen uptake

It indicates the oxygen consumption of the microbes, which reflects the rate of microbial activity. In fact the availability of oxygen is a prime environmental condition in the process of composting. Oxygen is essential for the metabolic functioning and respiration of the aerobic microorganisms as well as for the oxidation of various organic compounds present in the waste stream. The oxygen concentrations within the vessel will progressively drop due to the microbial decomposition, which could eventually result in anaerobic conditions. Oxygen uptake can be monitored through the olfactory sense, namely the detection of putrefactive odour, which is a positive manifestation of anaerobiosis. The stronger the intensity of odours, the higher is the extent of anaerobiosis. As such, maintaining aerobic conditions can be accomplished by various methods of aeration: drilling air holes, inclusion of aeration pipes, air pumping, and mechanical mixing or turning.

Temperature

Temperature is also an indicator of microbial activity. Compost heat is the by-product of the microbial breakdown of organic material and the occurring thermophilic microbial interactions within the vessel. A high temperature could inhibit microbial activity because most beneficial microorganism species cannot survive at temperatures above 60-65°C. Thus, the temperature of the composting site should be maintained through a proper ventilation system. Any deviation from the normal temperature shows that an environmental or operational deficiency has occurred.

Moisture

Moisture Content plays a major part in the progress of the decomposition. In fact, microbial decomposition occurs most rapidly in the thin liquid films found on the surfaces of the organic particles. A low moisture content is a common limiting factor in the composting process. It usually reflects a high paper content, thus water should be replaced in order to maintain an optimum moisture content, which ranges between 50 and 60% of the total waste volume. The lowest allowable moisture content is about 45%.

C:N ratio

It is a key parameter at determining the relative amounts of carbon and nitrogen present in a composting feedstock. A low C:N ratio indicates a higher proportion of nitrogen (i.e. food waste, green grass, etc.), while a high C:N ratio indicates a higher proportion of carbon (cardboard, woodchips, etc.) (Trautmann, Richard & Krasny, N.D). For example, if a pile's C:N ratio is less than 20:1, then the available carbon may be fully consumed before the nitrogen is totally stabilized, pushing the surplus nitrogen to convert to ammonia (i.e. gaseous emission). If the C:N ratio is higher, the composting process proceeds, but at a slower pace, since the microorganism's population size is limited by the lack of nitrogen.

pH

In general, pH level is not a major issue in the composting process, unless waste is unusually acidic. The optimum pH for bacteria ranges between 6 and 7.5. If pH level decreases to less than 4.5, some buffering should be added (e.g. addition of lime).

Color

The color of the composting mass progressively darkens, which is a crude parameter that the composting process is progressing.

Stability

A compost mass is considered stable when it has reached a stage where it can be stored without causing health or nuisance problems. There are many methods to determine the stability of compost. However, the most reliable method is the final drop in temperature.

Operation and performance parameters of the odor control system

Media moisture content

- 60% - 75%
- The maintenance of adequate moisture content within the filter bed is critical for optimum performance.
- Low moisture content results in reduced biological activity and the volatilization of adsorbed pollutants; and may cause compaction.
- Excessive moisture levels will lead to increased headloss and the formation of anaerobic zones which emit foul smelling compounds.
- Conducting simple laboratory dry solids analysis on sub samples of the media regularly.
- Moisture content sensors can be linked to irrigation systems so that the biofilter bed can be automatically maintained at the correct moisture content.

Media pH

- 6 to 8.5
- The pH of the media plays an important role in microbial activity, consequently it is a crucial parameter used to assess the effectiveness of the biofilter at removing contaminants.
- The pH of the media should be monitored at different depths and locations across the biofilter bed.
- Investigation should be undertaken if significant variation from the optimal pH of the biofilter bed is observed.

Ammonia and Hydrogen sulfide concentrations

- Inlet ammonia concentration <5mg/m^3
- Inlet hydrogen sulphide concentration <10 mg/m^3
- Measurements should be done at the inlet and outlet of the biofilter to determine the effectives of the biofilter for the removal of these contaminants of the process airstream.

Process air temperature

- Inlet air temperature 15 – 30°C
- Outlet air temperature <50^{o}C
- Airstream temperature is monitored upstream of the biofilter by periodic manual measurement or using a continuous inline monitor.
- Trends in the data should be monitored to provide early indication of temporal variations and seasonal effects.

Media Temperature

- Media temperature is monitored using a thermocouple inserted into the media.
- Trends in the data should be monitored to provide early indication of temporal variations and seasonal effects

Air distribution

- Air should be uniformly distributed through the media using a plenum chamber or distributed pipe work.
- Airflow distribution can be assessed by using a flow hood to measure the efflux velocity at a number of points across the bed. Where variations are observed, investigation should be undertaken to identify operational issues and resolve them.
- A smoke test provides a simple visual assessment of the airflow across the entire biofilter bed.

Odour concentration

- Inlet odour concentration 500 – 350,000 OU_E/m3
- Simultaneous measurement of the inlet and outlet air stream is crucial to provide an understanding the removal effectiveness.

Media health

Physiochemical properties of the biofilter media should be analyzed before and after the biofilteration process to determine:

- Moisture content
- Organic matter

- Respirometric index
- Nitrogen and Nitrate content
- C/N ratio
- Media pH
- Electrical conductivity

Summary of monitoring measures

The operational parameters to be monitored are illustrated in the table below.

Table 8-5 Monitoring requirements during operation

Parameters to be monitored	Monitoring Requirement	Frequency
Noise	Check that all machines and generators are mounted with noise suppressor devices and ensure regular maintenance of machine and generators.	Monthly
	Conduct investigative noise monitoring in response to specific complaints.	As required
	Noise measures near operation process must be conducted regularly.	Monthly
Odor	Monitor consistently the composting process by maintaining the following parameters within optimum ranges (pH, C/N ratio, aeration and moisture content in the windrows)	Daily
	Inspect monitoring tools such as thermometer, pH meter and others to ensure their proper operation and to detect when calibration is needed	Weekly
	Check the proper functioning of biofilters	Daily
	Make sure that are all waste delivery trucks are covered	Daily
Compost quality assurance-compliance with MoE's regulations	The compost should be tested for metal contamination, the presence of pathogens, and material composition. Compost sampling should be conducted following the MoE sampling procedure (Appendix 6). The parameters to be monitored are: • Moisture content • Heavy metals content (ISO 11047) • Bacteriological content • Nutrients, pH and salt content (test methods 86/278/EEC) • Maturity test- decomposition rate (DEWAR-self heating test)	Monthly
	The plant has to send a report on the utilization of compost to the following authorities MoE, MoA, MoPH, and CDR	Every 3 months
Solid Waste	Monitor the types and quantities of generated waste during operational phase - ensure proper treatment	Weekly

Parameters to be monitored	Monitoring Requirement	Frequency
Health and safety	Visual inspections to ensure that all labors are wearing their PPEs prior entering the processing units.	Daily
	Pest control programs	3 times per week
Wastewater treatment Unit	Monitor the sludge accumulation levels; if 2/3 full then sludge should be emptied.	Yearly
	Test effluent of water treatment unit (BOD, COD, TSS, TN, and other parameters necessary)	Quarterly
Biofilter media	Media moisture content: • Conducting simple laboratory dry solids analysis on sub samples of the media regularly. • 60% - 75% • The maintenance of adequate moisture content within the filter bed is critical for optimum performance.	Weekly
	Media pH: • 6 to 8.5 • The pH of the media plays an important role in microbial activity, consequently it is a crucial parameter used to assess the effectiveness of the biofilter at removing contaminants.	Weekly
	Amonia and Hydrogen sulfide concentrations: • Inlet ammonia concentration <5mg/m3 • Inlet hydrogen sulphide concentration <10 mg/m3 • Measurements should be done at the inlet and outlet of the biofilter to determine the effectiveness of the biofilter for the removal of these contaminants of the process airstream.	Weekly
	Process air temperature: • Inlet air temperature 15 – 30°C • Outlet air temperature <50^{o}C	Weekly
	Media temperature: Media temperature is monitored using a thermocouple inserted into the media.	Daily
	Air distribution: Air should be uniformly distributed through the media using a plenum chamber or distributed pipe work.	annual
	Odor concentration: Inlet odour concentration 500 – 350,000 OU_E/m3	Periodic
Generators	Test burning efficiency.	Weekly

Parameters to be monitored	Monitoring Requirement	Frequency
	Visual inspection of air emissions.	Daily
	Visual inspection to ensure absence of oil spill	Daily
Firefighting	Inspect all fire extinguishers to ensure their ease of operation, expiry date, appropriate location and availability.	Weekly

Table 8-6Monitoring plan

Phase	Impacts	Parameters to Monitor	Frequency	Monitoring Location	Number of Samples	Standard/Guidelines National/International**	Institutional Responsibility	MoE Ref.
Construction	**Emissions**							
	Air Emissions/GHG	Fugitive dust	Daily / Quarterly	Around PM generating activities	-	-	Ministry of Environment	Decision 52/1 dated 1996
		Criteria pollutants (SOx, NOx, CO,O3)	Biannually	At stack exit discharge of three power generators	One sample per stack	PM: 150 mg/m^3 SO_x: 3000 mg/m^3 CO: 1500 mg/m^3 NO_x: 3000 mg/m^3	Ministry of Environment	MoE Decision 8/1 dated 2001
	Noise	Noise levels	Weekly	Around the construction site	One sample per location	During morning hours: 60-70dB During evening hours: 55-65dB During night hours: 50-60dB	Ministry of Environment	Decision 52/1 dated 1996
	WW Generation	Effluent from construction activities (concrete curing, mixing, dust suppression…)	Biannually	Effluent of the construction settlement ponds	Two samples per location	BOD: 125 mg/L COD: 500 mg/L Total Suspended solids: 600 mg/L Total phosphorus: 10mg/L Total nitrogen: 60mg/L Oil and Grease: 50mg/L	Ministry of Environment	Decision 8/1 dated 2001
	SW Generation	Construction and demolition waste	Daily	At solid waste disposal and transportation points	-	N.A	Ministry of Environment	Law 444 dated 2002
	Accidental Releases	Chemicals, oils and fuel spills	Daily	Construction location	-	N.A	Ministry of Environment	-
	Depletion of Resources							
	Energy Resources	Fuel consumption rates	Monthly	Inventory (mainly invoices)	-	N.A	Ministry of Electricity and Water	-
	Other Impacts							
	Visual intrusion	Ensure the effective implementation of mitigation measures	Weekly	Around the construction site	Several photographs per location	N.A	Ministry of Interior and Municipalities	-
	Socio-Economic	Traffic records, complaints	Annually or upon complaint	Region of influence	-	N.A	Ministry of Interior and Municipalities	-

Phase	Impacts	Parameters to Monitor	Frequency	Monitoring Location	Number of Samples	Standard/Guidelines National/International**	Institutional Responsibility	MoE Ref.
	Health Safety Hazards	Medical records, documentation of injuries and accidents, Health and safety assessments	Monthly	Site and used roads	Adequate amount of health and safety surveys	N.A	Ministry of Labor	Labor law, Decree No. 11802 dated 2004
Operation	**Emissions**							
	Air Emissions	Criteria pollutants (SOx, NOx, CO,O3)	Annually	At stack exit discharge of three power generators	One sample per stack	PM: 150 mg/m^3 SO_x: 3000 mg/m^3 CO: 1500 mg/m^3 NO_x: 3000 mg/m^3	Ministry of Environment	MoE Decision 8/1 dated 2001
		Biofilter operation	Quarterly	Biofilter media	-	Refer to section 8.4.2 (table 8-5)	Ministry of Environment	-
	Odors	Composting operation parameters(pH, C/N ratio, temperature and moisture content)	Weekly	Monitoring control panels/ compost piles	-	Refer to section 8.4.2. for the optimum composting conditions	Ministry of Environment	MoE Compost Ordinance
	Noise	Excess noises	Quarterly	Entrance of the facility, generator rooms, leachate treatment units, polishing lines, near odor control system, inside composting hangars	One reading per location	During morning hours: 60-70dB During evening hours: 55-65dB During night hours:50-60dB	Ministry of Environment	MoE Decision 52/1 dated 1996
	WW Generation (Effluent from wastewater treatment unit)	BOD, COD, TSS, total nitrogen, total phosphorus, Salmonella, Ammonia or any other parameter found necessary	Biannually	Effluent from wastewater treatment unit	One sample	BOD: 125 mg/L COD: 500 mg/L Total Suspended solids: 600 mg/L Total phosphorus: 10mg/L Total nitrogen: 60mg/L Salmonella: Absent Ammonia: 10 mg/L And other parameters upon request	Ministry of Environment	MoE Decision 8/1 dated 2001
	Accidental Releases	Oil spills, sulfuric acid and ammonium sulfate spills, contaminated wastewater spills.	Daily	Power generator area, diesel storage tanks, sulfuric acid and ammonium sulfate storage tanks and wastewater treatment unit	Visual inspections	N.A.	Ministry of Environment	Decision 8/1 dated 2001
	Compost quality	Compost quality – parameters to be monitored (pH, C/N, moisture content, heavy metals,	Quarterly	Finished compost prior to distribution	12 single samples (5–10L per sample) at 12 different spots of the	MoE Compost Ordinance that includes compost compliance standards (including regulatory maximums for the four types of compost) and compost application	Ministry of Environment	MoE Compost Ordinance

Phase	Impacts	Parameters to Monitor	Frequency	Monitoring Location	Number of Samples	Standard/Guidelines National/International**	Institutional Responsibility	MoE Ref.
		bacteriological content, maturity level and grade)			compost pile; which should be then mixed and divided into 4 separate samples (4L each). Refer to section 8 in MoE compost ordinance attached in Appendix 6	practices. Regulatory Maximums for Grade A and Grade B: (mg/kg, dry matter) Cadmium <1.5, Chromium <100, Copper <100, Lead <150, Mercury <1.0, Nickel <50 Zinc <400		
	Depletion of Resources							
	Energy Resources	Electricity bill and fuel consumption rates	Monthly	Inventory (mainly invoices)	-	N.A	Ministry of Electricity and Water	-
	Water Resources	Water consumption rates, water expenses, etc.	Monthly	-	-	N.A	Ministry of Electricity and Water	-
	Other Impacts							
	Visual intrusion	Effective implementation of mitigation measures (fences around the facility)	Once a year or upon complaint	Around the project site and sensitive receptors	Several photographs per location (day time + night time)	N.A	Ministry of Interior and Municipalities	-
	Socio-Economic	Traffic records, complaints	Annually or upon complaint	Region of influence	-	N.A	Ministry of Interior and Municipalities	-
	Occupational health and safety	Medical records, documentation of injuries and accidents, Health and safety assessments	Monthly	Site and used roads	Adequate amount of health and safety surveys	N.A	Ministry of Labor	Labor law, Decree No. 11802 dated 2004

** The WBG EHS guidelines shall be applied. The more stringent standards (from national regulations or EHS guidelines) shall be respected.

8.6. Contingency Plan

Throughout the construction phase, the workforce are to be continuously informed of any hazardous issue that may materialize during the construction period, moreover, occupants of the project during the operational period should in turn be informed accordingly should a hazard persist. Stringent emergency procedures are to be assigned that will intercept any pollution that may occur as a result of structural damage due to any natural disaster occurrences.

A requirement should be set in the tender document that forces the awarded contractor to perform regular and frequent maintenance checkups of the equipment. These preventive measures and design considerations will ensure a continuous and uninterrupted operation of the facility activities.

Moreover, the contractor should also implement certain procedures at certain occasions, such as:

- All contractors shall develop a spill response plan for submission to the project proponent;
- In the event of a spill, immediate action shall be taken to contain or clean up the spill using sand or a suitable absorbent material;
- All contractors handling hazardous materials shall keep appropriate spill cleanup material adjacent to storage and maintenance areas;
- All spillages of hazardous materials shall be reported immediately to the Contractor's Environmental Representative (CER). The CER shall submit an incident report to the project proponent within 24 hours;
- Contaminated soil, rags and other clean up material shall be kept in appropriate containers before being disposed of to a municipality approved site;
- The contractor shall be responsible for training all staff in the procedures for handling spills and shall provide all staff with appropriate personal protective equipment; and,
- In the event of a spill, the area shall be inspected by the CER and the Project Manager and this shall form part of the incident report.

In the case of accident occurrence, three levels of emergency should be applied as such:

Level One

It is an emergency that would occur at the site but could be managed initially without external assistance. However, the person in charge (PIC) shall initiate an increase in status if:

- No information is forthcoming from the site of the incident;
- Situation is escalating or control has not been established immediately;
- If the incident requires additional resources;

Level Two

It is an emergency that may require external assistance initially but can be controlled via resources on site over time. The PIC shall initiate an increase in status if:

- Resources committed are insufficient;
- Situation is escalating or control has not been established immediately; or
- Possible impact to asset or customers.

Level Three

An emergency where the site's asset resources have been fully committed or the time to bring the incident under control is excessive or significant resources are required to control the incident. The PIC shall contact the appropriate emergency center. Other characteristics of the emergency include:

- Facility and/or asset and/or surrounding environment;
- Life, property and the environment.

Chemical and fuel spills

The facility should prepare an emergency response plan to deal with possible chemical spills, natural disasters, fires, vandalism or equipment problems. Containment of potential spills is undertaken as the following:

- Employees must be trained on the quick and efficient response to different kind of spills as well as the use of spill cleaning equipment
- Spill cleaning equipment must always be present and maintained
- Personal Protective Equipment must always be present and maintained
- Spill cleaning equipment include as pads, booms and absorbents such as oil dry, absorbent blankets, etc. as well as containers to hold spilled waste: drip-pans, pails and drums.

  Spill cleaning include:

- Placing the absorbent material directly on the spill
- The absorbent materials are then directly placed in a sealed container and disposed of properly
- Fire extinguishers must be present in close proximity
- Secondary containment of spill cleaning materials such as drums must be present in proximity
- Water must not be used to dilute the spills or wash the spill into drainage pipes
- Any spill of Hazardous materials must be directly reported to the adequate official authority
- In case of major untreatable spills, direct contact to the responsible authority must be undertaken
- Implement a recording system for all spills

Fires, flooding and storm damage

Where circumstances arise that threaten infrastructure, damage can be limited by using the following measures:

- Ensuring that hangar cladding is secure;
- Closing any hangar openings not essential to ventilation;
- Removing any loose or flammable materials near sheds;
- Maintaining a mobile water cart to put out spot fires;
- Irrigating hangar roofs, if practical, when fire threatens; and
- Ensuring essential equipment is available to repair or mitigate any after-effects with minimum delay.

Extended power failures

Power failures may disrupt the facility activities. Back-up procedures should be available to maintain essential services in the event of power failure. This may include access to portable generators.

8.7. Record Keeping and Reporting

Monitoring efforts would be in vain in the absence of an organized record keeping practice. It is normally the responsibility of the project administration, to ensure development of a database that includes a systematic tabulation of process indicators, performed computations, maintenance schedules and logbook and process control/performance monitoring outcomes. Such a historical database benefits both the project administrator and surrounding communities. The project administrator should submit a periodic report to the assigned regional authority, namely the Ministry of Environment (MoE).
During the construction and operation phase the contractor/operator shall produce a quarterly report containing details of inspections, non-conformances (major/minor), corrective actions taken, complaints received and monitoring results. Major and minor non-conformities are defined below:

1. Minor non-conformance – is typically a random or isolated incident. Minor Non-conformances involve discrepancies within an element of the construction management plan (CMP) that do not significantly affect the implementation of the environmental management plan and commitment to conform to the Code of Good Practice – a systemic problem is not indicated.

2. Major non-conformance – can occur when a contractor/operators has documented a process or procedure, but has not implemented it or cannot demonstrate effective implementation. A major non-conformance can also occur if a number of minor non-conformances in a given activity or against a given element point to a systemic failure. Major non-conformances also exist if an element is being disregarded sufficiently that it is having a noticeable effect on the contractor's environmental compliance, environmental impacts, or the quality of the structures being produced – there is a gap or problem that could lead to a systemic failure.

Monitoring reports including measurement records should be submitted to the Ministry of Environment (MoE) upon request, according to following:

1. Sampling Baseline data before project implementation.
2. Monitoring reports for construction and operational phase.

These reports should summarize monitoring data with full interpretation illustrating the environmental impacts and assessment of the implementation status of agreed-upon mitigation measures. The monitoring reports should include at least the following sections/information:

Environmental parameters:

- Implementation status of environmental mitigation measures as recommended in the EIA

- Monitoring locations
- Parameters monitored
- Monitoring results
- Monitoring date, time frequency, and duration

Operation process monitoring is essential to monitor the profitability and performance of the facility for the purpose of forecasting and improving.

The daily records should include:

- Waste quantities (per ton) received by the treatment facility
- Water quantities used during an operation day
- Number of trucks entering and leaving the facility
- Quantities of raw materials received per day
- Compost production per day
- End product (compost) specifications
- Quantities of materials sent to landfilling

Other parameters:

- Report of all non-compliance with or exceeding of the environmental standards
- Record of all complaints received including location, nature, actions and follow-up procedures

Records of health and safety accidents on-site

8.8. Capacity Building

Considered as a corner stone of the ESMP, the Union of Tyre municipalities, and concerned parties should provide the necessary trainings to plant operators and concerned parties. This allows overall sustainability and eventual transfer of technical expertise to the future appointed workers. The training program consists of two major parts: Technical Training (TT) and a General Awareness Seminars (GAS).

Technical Training (TT)

Technical trainings aim at improving the capacity of plant operators and concerned parties in the technical aspects of project implementation and operation. TTs generally include theoretical and technical sessions. In the context of the proposed project, theoretical sessions must focus on topics such as MSW management principles and environmental impacts from inadequate waste disposal. However, technical sessions must familiarize operators with operational processes and technologies that will be adopted during the operation of the planned MSWTF. Finally, 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.

8.9. Institutional Arrangements

It is essential to organize predefined responsibility and strong technical bodies to achieve a better environmental management plan. This organization of responsibility will allow every staff member to adhere to his duty and accordingly any mismanagement, to be easily detected.

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 (Union of Tyre Municipalities/ 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.

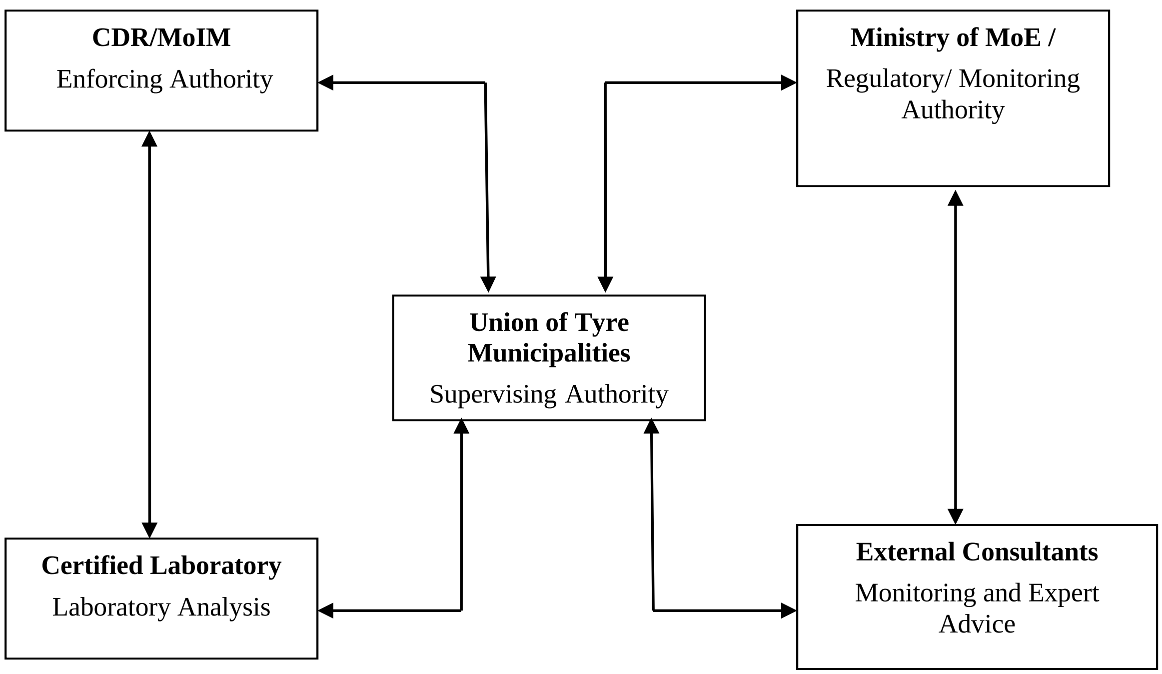


Figure 8-1Proposed Institutional Setting

8.8.1. ***<u>General Awareness Seminars (GAS)</u>***

Issues addressed in a General Awareness Seminar (GAS) are less technical than those addressed in the TT, and aim at raising awareness and improve environmental practices. It would be however rather difficult and expensive to provide these seminars to all the staff of the project. It is considered to be a more sustainable approach to train the trainers who will subsequently train and raise awareness in the staff.

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 in order to be acquainted with the principle. Several GASs would be conducted in order to initiate the environmental awareness.

8.8.2. ***Staff Training***

The Ain Baal SWTF staff should be encouraged to develop a commitment to protect the environment. They should be aware of any operations that may cause pollution, nuisance to wildlife and the local community or affect the operation process and take all practicable steps to minimize impacts. These initiatives aim to:

- Encourage environmental awareness and responsibility amongst staff
- Emphasize the importance of biosecurity in the facility

Increase adoption of measures to prevent environmental impacts; and provide advice on steps to follow when problems arise.

9. CONCLUSION

As the environmental concern grows, some communities found it difficult to comply with or embrace an Environmental Management System (EMS) that will improve the general environmental performance. This report identifies the important drivers for such an approach that goes beyond a system to comply with legal requirements into strategies to reduce degradation costs and living conditions. The required action is to develop a life trend that will divert the currently existing practices to a clean society lifestyle. This win – win situation is the desired value of similar projects that should alleviate the recent degradation of environment and replace it with sustainable development.

The report identified all positive and negative impacts and provided mitigation measures for the negative ones. In addition, monitoring measures and an Environmental Management Plan were developed. Monitoring measures include specific provisions and procedures for the preservation, protection, and enhancement of the environmental conditions during operation period of the facility. Such provisions and procedures are summarizes in the following factors:

- Trained staff and defined responsibilities.
- Adequate analytical equipment and materials, if possible.
- 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.

The operation of the proposed project will create a good chance for sustainable waste management and for the enhancement of the environmental condition in general, conditioned that the operators, JCC-SORIKO, MoE, MOIM, and the local municipal authorities are coordinating to successfully monitor and implement the proposed ESMP.

Accordingly, if the ESMP is properly implemented and all monitoring means are followed, the project will operate in a sustainable manner and will cause less harm to the environment.

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