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مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

E608

**DRAFT ENVIRONMENTAL IMPACT ASSESSMENT**
**CULTURAL HERITAGE AND URBAN DEVELOPMENT PROJECT**
**LEBANON**


Republic of Lebanon
Office of the Minister of State for Administrative Reform
Center for Public Sector Projects and Studies
(C.P.S.P.S.)

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## ACKNOWL EDGEMENTS

## EXECUTIVE SUMMARY

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## 1. INTRODUCTION

Cultural heritage represents a set of unique assets that Lebanon can leverage to promote national and international cultural tourism. Its cultural heritage assets, as well as good climate and hospitality, are the hallmarks of a land of history and culture. Since the early 1990s, many Lebanese institutions, often in partnership with international organizations, have undertaken significant initiatives to protect, rehabilitate, restore, and revitalize the cultural heritage that suffered from neglect and damage during 16 years of war. In this context, the magnitude and importance of Lebanon's cultural heritage and its diversity and presence throughout the country surpass the currently available management capacity and resources. The law that regulates the sector dates back to 1933, human resources are scarce, and budgetary constraints and administrative red tape limit funding for much-needed investments. Some important archaeological sites are currently endangered due to insufficient protection of ancient artifacts within the sites, unreliable boundary enclosures, encroachment of illegal housing, the intrusion of public roads and of buildings, and by urban redevelopment plans. These intrusive developments are encouraged by the fact that local residents derive no economic benefit from the sites. As a result, Lebanon's main archeological sites and historic urban cores are generally surrounded by modern constructions. Developers often view this heritage as a hindrance; as a consequence, the urban areas surrounding the sites are often fringe and derelict spaces, lacking basic infrastructure.

In recognition of the tourism potential gowth and the interest in capturing its revenue streams for the local economy, Lebanese cities will have to make the investments needed to provide visitors with comfortable access, parking facilities, pedestrian routes, and a visually improved environment surrounding heritage or natural sites. In areas around archeological sites and old town centers, there is a need to ensure a framework and process for spatial planning and development that will:

- Maintain the integrity of the sites themselves, with provision for their future extension or reintegration where this is feasible;
- Provide for the needs of the tourist industry and urban regeneration in areas adjacent to sites, particularly with regard to facilities and redevelopment of the immediate environment, such as by preserving pedestrian zones, tourist circuits, etc.;
- Respond to the socio-economic characteristics and development needs of residents;
- Designate an appropriate location for other developments that may be inconsistent with the first three objectives.

As such, the Government of Lebanon represented by the Council of Development and Reconstruction (CDR) is preparing a Cultural Heritage and Urban Development Project (CHUD) for World Bank financing. The four main components of the proposed project are:

- Archeological sites preservation and management, to conserve and develop works priority world-class archaeological sites; and to develop sites and environs so as to enhance visitor experience at the selected sites;
- Rehabilitation of historic city centers, to rehabilitate public spaces in these areas so as to complement ongoing public and private conservation initiatives;
- Urban infrastructure improvements, to improve urban areas surrounding the selected archaeological sites to attract and service tourists and benefit the local community;
- Institutional strengthening to assist the specified agencies in playing their respective roles in preserving cultural heritage and deriving economic benefits for the country and the residents of the municipalities concerned.

### 1.1 EIA objectives

The objectives of the EIA are to provide a sound basis for decision-making about the design of project components that takes environmental considerations including social and economic impacts into account, insure that the project is implemented with full awareness of environmental factors, inform the public when and how the project implementation may affect their environment, and facilitate public participation in the decision-making process

### 1.2 Scope of work

The scope of work implemented in the preparation of the EIA report includes the following:

- Definition of existing legal and administrative framework (Chapter 2)
- Description of the proposed project (Chapter 3)
- Definition of baseline environmental conditions (Chapter 4)
- Identification and analysis of potential environmental impacts (Chapter 5)
- Analysis of potential alternatives (Chapter 6)
- Development of an environmental mitigation plan (Chapter 7)
- Development of an environmental monitoring plan (Chapter 8)
- Development of an environmental management plan (Chapter 9)
- Soliciting public participation (Chapter 10)

## 2. LEGAL AND ADMINISTRATIVE FRAMEWORK

The law regulating the cultural heritage sector in Lebanon dates back to 1933. This sector is characterized by the scarcity of human resources, budgetary constraints and administrative red tape that limit funding for much needed investments. Some important Lebanese archaeological sites are currently endangered due to insufficient protection of ancient artifacts within the sites, unreliable boundary enclosures, encroachment of illegal housing, the intrusion of public roads and buildings, and by urban redevelopment plans. These intrusive developments are encouraged by the fact that local residents derive no economic benefit from the archaeological sites.

The proposed CHUD project is multi-sectoral in nature involving several institutions at various levels. While the Council for Development and Reconstruction (CDR) is coordinating the preparatory work of all concerned agencies, and facilitating project preparation, the institutions that are closely involved in the project include the Directorate General of Antiquities (DGA), the Directorate General of Urban Planning (DGU), and the Municipalities of the concerned cities. Although not as closely involved, other institutions that will be concerned in the project include the Ministry of Environment (MoE), the Ministry of Interior and Municipal Affairs (MdMA), and the Ministry of Transport and Public Works (MoTPW). A brief statement of the mission/responsibilities of these institutions is summarized in Table 2 1. It is anticipated that the CDR will continue to be the project's implementing agency. In implementing the project CDR will closely coordinate with the Ministry of Culture, the Directorate General of Archaeology (DGA), the Directorate General of Urban Planning (DGU), and the municipalities and local communities of the five target cities.

Table 2-1 Summary of functional responsibilities of transport/traffic involved agencies

| Agency | Mission |
|---|---|
| Council for Development & Reconstruction (CDR) | • Plan and arrange for financing of projects including relations with donors and loan management<br>• Executing projects in all sectors<br>• Manages contracts in all sectors, including the transportation sector, which involve planning, design, construction, and supervision of construction |
| Ministry of Culture (MOC) –*Department of Antiquities* | • Manage archeological finds<br>• Review and approve project specific "Archaeological Chance Find" procedures which would be used by construction contractors, consulting engineer and archaeological consultants to address actions to be taken if unrecorded archaeological materials are encountered during the course of project implementation |
| Ministry of Public Works (MPW)[1] *Directorate of Roads* *Directorate General of Urbanism* | • Collect and analyze relative data and statistics and operate a road materials lab<br>• Perform and oversee road design<br>• Perform and supervise road studies and execution<br>• Perform road maintenance<br>• Take care of traffic safety in cooperation with other ministries / government agencies<br>• Develop master plans for cities and villages, and establishing land use regulations<br>• Develop road and street plans within cities and villages |
| Ministry of Transportation (MOT)[1] | • Organize and supervise land, maritime and air transport<br>• Construct, equip, manage and exploit publicly owned transport modes and facilities and develop them in harmony with the social and economic development and according to the needs of the country<br>• Supervise the safety of transport means and facilities, its maintenance, modernization, and development<br>• Prepare plans and conduct techno-economic studies aiming at operating transport means and facilities<br>• Enforce laws and regulations related to the transport and public maritime property<br>• Exercise tutelage authority over the autonomous authorities and public enterprises in the public transport sector<br>• Exercise control over transport concessions<br>• Control and periodically update transport tariffs |

| Agency | Mission |
|---|---|
| Ministry of Municipal and Rural Affairs (MOMRA)[2] | • Contribute to strengthening decentralization and activation of local government<br>• Supervise municipal government units and ensure conformity with administrative and financial regulations<br>• Coordinate among municipal units<br>• Provide technical assistance and support to municipal governments<br>• Cooperate and coordinate with other administrations on issues related to municipal and rural affairs |
| Ministry of Interior (MOI)[2] | • Manage vehicle registration and inspection, and driver licensing<br>• Enforce law, including that of the Traffic Code<br>• Organize and manage civil defense activities and traffic related functions |
| Ministry of the Environment (MOE) | • Monitor and control of environmental protection, preservation of natural sites and amenities<br>• Prevent pollution, protect wildlife, and preserve environmental balance<br>• Set environmental standards, specifications and guidelines<br>• Manage natural resources and amenities<br>• Coordinate and encourage environmental awareness programs |

[1] MOT and MPW have recently been combined into a single ministry
[2] MOI and MOMRA have recently been combined into a single ministry

Note that a separate study is on-going with respect to the institutional and financial structure of the Directorate General of Antiquities, being the main institution with overall jurisdiction over cultural heritage and archaeological sites in Lebanon. The outcome of this study will be examined in the final EIA report.

## 2.1 EIA requirements

A Lebanese Environmental Code has reportedly been drafted and submitted for governmental approval several years ago. To date, no action has been taken in this regard. Within this code, provisions are proposed to conduct an environmental impact assessment (EIA) for developmental projects. Furthermore, while there are currently no approved EIA procedures in Lebanon, efforts are underway at the Ministry of Environment (MoE) to pass an EIA draft decree that defines such procedures. Within the draft decree, these procedures follow to a great extent the guidelines and safeguards recommended by the World Bank Operations Directives and sourcebooks[1]. The EIA draft decree provides a list of project types that require an EIA. Included in this list are projects that involve cultural heritage rehabilitation. The decree outlines the elements to be examined in an EIA report, which are consistent with the scope of work described above.

World Bank Operational Directive 4.01, "Environmental Assessment",
World Bank Operational Directive 4.12, "Involuntary Resettlement"
World Bank Environmental Assessment Sourcebook (3 Volumes),
World Bank Environmental Assessment Sourcebook Update No 7, "Coastal Zone Management in Environmental Assessment",
World Bank Environmental Assessment Sourcebook Update No 8, "Cultural Heritage in Environmental Assessment",
World Bank Environmental Assessment Sourcebook Update No 19, "Assessing the Environmental Impact of Urban Development",
World Bank , "Roads and the Environment A Handbook"

## 3. PROJECT DESCRIPTION

The magnitude and importance of Lebanon's cultural heritage and its diversity and presence throughout the country surpass the currently available management capacity and resources. The proposed CHUD project which encompasses five Lebanese secondary cities: Tripoli, Byblos (Jbail), Saida, Tyre and Baalbeck (Figure 3-1), is an essential milestone in providing these much needed capacity and resources. The objective of the CHUD project is to promote national and international cultural tourism in order to boost the local economy in these five old cities. Lebanese cities will have to make the investments needed to provide tourists with comfortable access, parking facilities, pedestrian routes, a visually improved environment surrounding heritage and natural sites, and maintain the integrity of the sites themselves. The strategic rationale for the proposed CHUD Project lies in its focus on the area of overlap between the three major essential stakeholder interests: Antiquities, Tourism, and the municipalities and local communities of the secondary cities that are rich in cultural heritage. Effective management of cultural assets, urban regeneration and enhanced cultural tourism are at the core of the proposed project. Well functioning cities with an enabling environment for private sector investment, enhanced cultural assets and tourism as a basis of their sustainable development are the overarching objectives of a longer term development program for the selected cities.

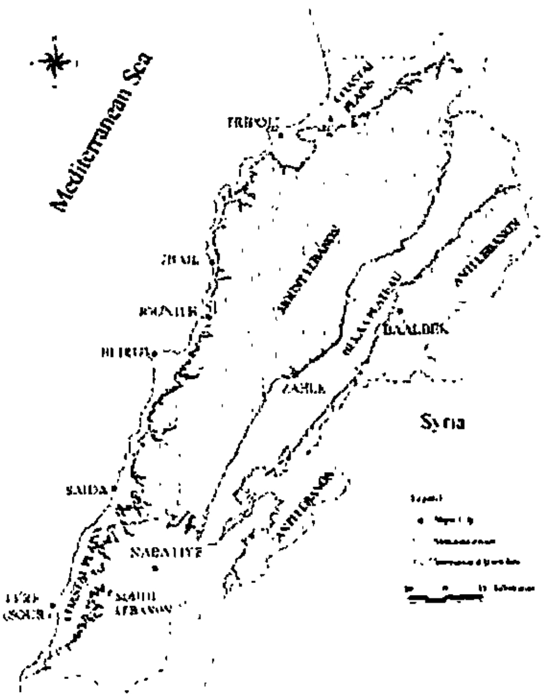


Figure 3-1 Physiography of Lebanon showing the general location of the Project cities

### 3.1 Project need

In Lebanon, areas around archaeological sites and old town centers are in much need to ensure a framework and process for spatial planning and development that will maintain the integrity of the sites with the provision for their future extension, provide for the needs of the tourist industry and urban regeneration in areas adjacent to archaeological sites such as preserving pedestrian zones and creation of tourist circuits, respond to the socio-economic characteristics and development needs of residents, and designate an appropriate location for other developments that may be incompatible with these objectives.

The proposed project would primarily address the most pressing needs of the five secondary cities in terms of cultural heritage preservation, urban regeneration and tourism site operation, and support necessary institutional development activities. In this context, The project will assist the Ministry of Culture and the Directorate-General of Antiquities in the preservation, rehabilitation and presentation of sites of key attraction. It will support the Ministry of Tourism insofar as cultural heritage tourism promotion is concerned. It will also support participating municipalities and local communities in developing and implementing urban development plans based on the role of unique major cultural heritage sites and resources, and ensuring that the local populations draw economic benefits from these investments.

### 3.2 Project components

The proposed project consists of four main components listed below with the elements of the first three being outlined in Table 3-1 and the elements of the fourth one outlined in Table 3-2.

1. *Archaeological sites conservation and management*, which includes the conservation of surfaces and structures of archaeological sites, and the development of sites and environs so as to enhance visitor experience at the selected sites.
2. *Rehabilitation of historic city centers*, which includes the improvement and the upgrading of public spaces, conservation and reuse of monuments and historic buildings, creation of tourist circuits so as to complement ongoing public and private conservation initiatives.
3. *Urban infrastructure improvement*, which includes the management of vehicular access to historic centers, municipal parking and commercial facilities, the protection and landscaping of coastal and green areas, and improvement of the water and wastewater infrastructure.
4. *Institutional strengthening*, which includes the provision of technical assistance and capacity building to the involved stakeholders.

Table 3-1 Details of the activities of the first three components of the CHUD project

| *City* | *Archaeological sites conservation and management* | *Rehabilitation of historic city centers* | *Urban infrastructure improvements* |
|---|---|---|---|
| *Tripoli* | | • Rehabilitation of public spaces and squares along the souks (Bazerkan, Haraj, El Kendarjieh, El-Attarine, El-Khodar, El-Kameh)<br>• Rehabilitation of Khan el Aaskar and its adaptive reuse for cultural and social activities<br>• Rehabilitation of several Khans (Al-Khayyatine, Al Masriyyin, Al Saboun, Al Aarsat) and Hammams (Ezzeddine and Al Nouri)<br>• Rehabilitation of main node entry points to the old city<br>• Rehabilitation of some housing clusters and creation of tourism circuits | • Improvement of the banks of the Abou Ali river and the traffic system around the historical city center and reorganization of street parking<br>• Construction of a building complex that will include a parking, commercial facilities and needed infrastructure for the development of temporary housing units<br>• Creation of a public park at the foot of the St Gilles Citadel and a pedestrian path<br>• Improvement of the various access nodes to the historic city including management of street parking, treatment and landscaping of the vehicular access streets |
| *Byblos* | | • Rehabilitation of the access to the old town and creation of a pedestrian promenade through the Via Romana<br>• Rehabilitation of the city old center including Ottoman souk, public squares and spaces<br>• Historical buildings and planning their adaptive use for cultural activities<br>• Byblos harbor and treatment of the new pier | • Provision of an integrated parking system and pedestrian circuits from the exit of the national highway to the harbor<br>• Construction of a pedestrian circuit from the harbor to the archaeological site on the maritime border |
| *Saida* | | • Rehabilitation of the main squares within the old town (Bab El Saray square, Dahr al Meir))<br>• Rehabilitation of pedestrian visitor circuits to link and help promote various cultural activities within the old town<br>• Rehabilitation and conservation of existing building facades | • Upgrading the city's infrastructure (sewage and drainage systems)<br>• Providing of parking spaces to serve the old city and the waterfront (on street parking organization, underground and multi storey parking facilities)<br>• Reducing the traffic load from the sea boulevard through deviation of heavy vehicles away from the existing port which will be assigned for fishing and recreational activities<br>• Creating a green belt around the old city especially within the area confronting the boulevard |

| | | | |
|---|---|---|---|
| *Tyre* | Conservation and management of the archaeological sites of El-Mina and of El-Bass | • Rehabilitation of the harbor square and the Ottoman building, relocation of Fisherman Association, creation of the Fishing Museum<br>• Rehabilitation of the Hammam square, Menchieh square and the Hamra street<br>• Rehabilitation of Khan Al Rabou and its adaptive reuse into a cultural center<br>• Creation of a pedestrian path along the northern border of the El Mina archaeological site<br>• Rehabilitation of some housing clusters | • Reorganization of the El Bawaba square and the creation of a public space and a vegetable market and an integrated parking scheme<br>• Protection and landscaping of the coastal zone from the rest house to the Phoenician harbor including visitor platforms and public gardens |
| *Baalbeck* | Conservation and management of Al Qala'a and surrounding archaeological sites and monuments | • Sites surrounding al Qala'a<br>• Access and visitor circuits within the historical central district<br>• Development of pedestrian links | • Rehabilitation of access to the city central districts and the archaeological sites<br>• Development of visitor parking |

Table 3-2 Institutional strengthening component of the CHUD project

| | *Institutional strengthening* |
|---|---|
| Ministry of Culture | • Review current laws and proposals of new regulatory and legislative framework for the cultural heritage sector<br>• Detailed assessment of DGA's current status and design of administrative, technical and financial reform |
| Municipal management of historic centers | • Technical assistance to the 5 municipalities for the integration of Municipal Implementation Units in their permanent organization<br>• Tripoli City Development Strategy and assistance to other municipalities to promote their cultural and tourism potential<br>• Advisory services to the DGU for the formal adoption of special planning and building regulations for historic cities as part of their management tools |
| Ministry of Tourism | • To be determined |
| Council for Development and Reconstruction | • Staffing of the Project implementation Unit with technical, legal and administrative professionals |

## 4. DESCRIPTION OF THE ENVIRONMENT

This chapter presents background data and information collected to date regarding the environmental conditions in the five secondary cities involved in the proposed project, namely, Tripoli, Byblos, Saida, Tyre and Baalbeck. The chapter will be updated in the final EIA report as more data are being gathered. The data and information have been synthesized and are presented independently for each city, although coastal cities (Tripoli, Byblos, Saida, and Tyre) tend to exhibit many similar characteristics. Note that the proposed project areas in the five involved cities is mostly urbanized and often exceeding 90 percent development. Therefore, the data and information presented in this chapter focuses on the physical and socio-economic environment rather than on the biological environment that is practically absent in such highly urbanized and developed areas. Table 4-1 provides a brief summary of various physical and socio-economic indicators related to the five cities, which are further described in the following sections.

Table 4-1 Summary indicators of the five cities

| *Indicator* | *Tripoli* | *Byblos* | *Saida* | *Tyre* | | *Baalbeck* |
|---|---|---|---|---|---|---|
| Population (2002) | 588,200 | 16,910 | 75,615 | 61,000 | | 55,000 |
| Working population, % | | 38 | 27 | | | 70 |
| Occupation | Service sectors, commercial activities, employees, industry | Service sector, industry, agriculture, maritime | Vendors, daily workers, employees, fishermen, drivers | Fishing, public sector, commercial activities | | Agriculture<br>Industry<br>Services |
| Property and Tenure | Private, Waqf, & Public | Private, Waqf, & Public | Private, Waqf, & Public | Private, Waqf, & Publi | | Mainly home owners |
| Precipitation, mm | 1,015 | 1,015 | 660 | 750 | | 410 |
| Humidity, % | 70 | 70 | 71 | 72 | | 56 |
| Temperature, °C | 20 | 20 | 19 5 | 37 summer, 14 winter | | 15C |
| Wind | W & SW | W & SW | SW | W & SW | | NE & SW |
| Geology | karstic | | Karstic from Cenomanian age | Turonean, Cenomanian, Eocene formations | | Turonean formations |
| Water sources | Hab, Racheine, & aquifers | | Kfarwe spring and underground wells | Ras el Ain and Rashidiy springs, and private well | | Loujouj & Ain Bourdai springs and 7 boreholes |
| Water quality | Requires improvement | | Requires improvement due to contamination | Polluted in upper layer | | Ras el Ain spring is contaminated |
| Major rivers | Abou Ali | | Awwali and Saniq | Litani river | | None |
| Coastal areas status | Polluted, sewage discharge, Solid waste | Polluted due to sewage discharge | 9 sewage outlets discharge to the sea | Polluted by sewage disch sewage outlets | :, 6 | None |
| Wastewater collection systems | Inadequate, requires improvement | Not available, coastal collector | Inadequate, discharge to sea, require a costal collector | Old system, pumping st requires extensive maint development foreseen | ı ice, | Is being improved |
| Wastewater treatment | Secondary treatment serving the whole caza and parts of Zghata and Koura on mouth of Abou Ali River | Secondary treatment serving the caza of Jbeil (capacity 9,000 $m^3$/d) in Zoummar area | Secondary treatment serving the caza of Saida(capacity 33,600 $m^3$/d) on the Saniq river | Secondary treatment serv caza of Sour to the north city | the e | Secondary treatment serving the surrounding area, located in Iaat. Capacity 12,500 $m^3$/d and can be doubled. |
| Effluent discharge | Sea outfall | Sea outfall | Sea outfall | Sea outfall | | Outfall discharge *in an open ditch* |
| Stormwater drainage | Bad conditions, mixing with sewage, is being improved | Old system, mixing with sewage | Old system, mixing with sewage | Mixing with sewage | | |
| Solid waste | 382 t/d, in open dump on Abou Ali River | 13 t/d in open dump at Hbaline | 53 t/d disposed in open dump South of Saida | 49 t/d disposed in open | ps | 45 t/d disposed in open dump at Roman quarry |
| Solid waste plans | Rehabilitation of dump | Construction of a sanitary landfill and rehabilitation of the existing dump | Construction of a sanitary landfill, location is still unknown | Construction of a sanitar serving the region in He Zebqine area | ndfill o- | Construction of a sanitary landfill serving the region, location is still unknown |
| Air Quality | CO, $SO_2$, $NO_2$, TSP above WHO standards | NA | NA | NA | | NA |
| Noise levels | Exceed standards at all times | NA | NA | NA | | NA |

## 4.1 Tripoli

4.1.1 Physical environment

Figure 4-1 depicts a general orientation plan for Tripoli which is located some 80 kms north of Beirut along the Mediterranean coast in the Mohafaza of North Lebanon.

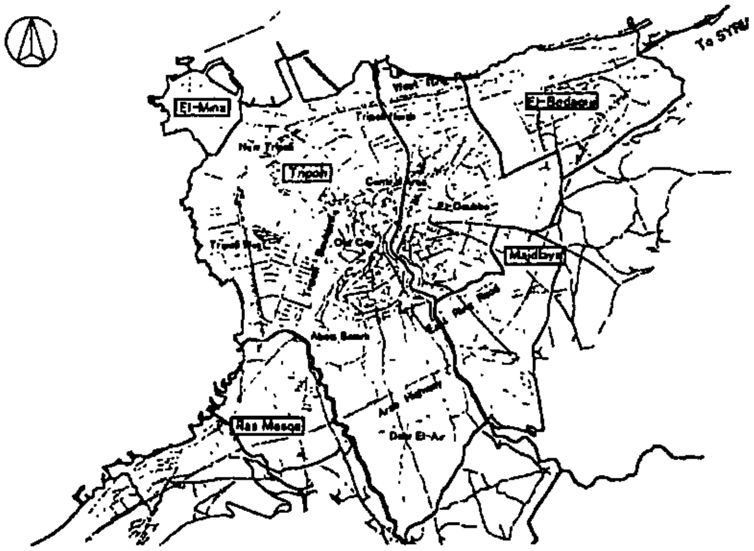


Figure 4-1 Orientation plan for Tnpolı

*Climate*

The climate in the region of Tnpoli is of the sub-tropical, Mediterranean type with warm and dry summer and fall (May to October), and moderately cold, windy, and wet winter (October to April). The average annual precipitation is 1,015 mm (Batroun station, altitude 20 m) while the average annual humidity is 70 percent.

*Temperature*

The average temperature in Tripoli is 28°C in summer, 10°C in winter, and the annual mean temperature is 20°C. The maximum daily-recorded temperature has been 39.6°C. Temperatures above 30°C occur for around 46 days per year. Days with temperature below 0°C are very seldom with less than 1 day in average per year. The difference between day and night temperatures is usually 7°C.

*Wind patterns*

The sea and mountains located by the Abou Ali River determine the breeze and wind conditions. Prevailing winds are from the West and Southwest, while winds from the East and Northeast occur with less frequency (85 percent vs 15 percent).

*Hydrogeology*

The region of Koura-Zgharta-Tripoli is a fragile underground environment. The Karst, which developed, without any impervious cover on synclines and faults, constitutes an environment vulnerable to environmental stress. Continuous aggression to the environment (sewage inflows, domestic solid wastes, industrial, agricultural and gas station effluents and discharges) contributes to the degradation of soils and groundwater quality. Thus it is of utmost importance to eliminate or reduce these aggressions to alleviate the pollution load on the subsurface.

The general pattern of groundwater flow is from the mountainous area to the sea. Groundwater layers at a depth of 150 m below ground surface serve as drinking water sources. The discharge from this source is currently not a limiting factor when compared to water pumped from a depth of 5 to 15 m, which appears to be contaminated by fecal coliform.

The quality of water in the Koura-Zgharta Miocene limestone aquifer was tested chemically (pH, Ca, Mg, Na, K, Cl, sulfate, bicarbonate, iron, nitrates, nitrites, ammonium, silica, TDS, hardness and phosphates) and bacteriologically (fecal coliforms) at 11 locations (Table 4-2). The quality of the water was found to vary with geographic location. Locations outside the Tripoli area are of good quality for domestic and agricultural uses. The Tripoli area has water acceptable for irrigation use but of poor quality for domestic use as all samples exhibited high levels of nitrite, ammonium and hardness when compared to the Lebanese and WHO standards.. The groundwater in the Tripoli area suffers from reportedly seawater intrusion and sewage contamination which is the most common problem in most coastal cities in Lebanon.

Table 4-2 Chemical and bacteriological analysis for samples from the Miocene limestone aquifer in the Tripoli area (Khayyat, 2001)

| *Analysis* | *Sankari* | *El Jisr* | *Kroum El Laouz* | *Manara* | *Casernne* | *Saadoun* | *Standards*[a] |
|---|---|---|---|---|---|---|---|
| pH | 7 52 | 7.21 | 7 49 | 7.38 | 7 62 | 6.62 | 6 5-8.5 |
| Calcium | 72 5 | 80.7 | 55.7 | 91.4 | 48 5 | 37 7 | 200 |
| Magnesium | 24.7 | 11 9 | 25.6 | 20 2 | 46 9 | 22.6 | 50 |
| Sodium | 31.8 | 17 7 | 20.1 | 17.8 | 30 1 | 16 5 | 150-200 |
| Potassium | 3.8 | 2.1 | 4.2 | 3 1 | 4.3 | 1.9 | 12 |
| Chloride | 58 9 | 36 9 | 41.3 | 36.9 | 56 8 | 30.9 | 200 |
| Sulfate | 17.4 | 12 6 | 47.3 | 81.3 | 183.5 | 25.2 | 250 |
| Bicarbonate | 255 | 228 | 190 | 220 | 120 | 155 | - |
| Iron | 0.04 | 1 2 | 0.02 | 0 07 | 0.12 | 0 22 | 0 3 |
| Nitrate | 0.18 | 0.16 | 0.28 | 0 48 | 0.72 | 0.09 | 45-50 |
| Nitrites | 0.13 | 0 01 | 0.08 | 0.05 | 0 08 | 0 01 | 0.05-3 |
| Ammonium | 0 23 | 0 27 | 0.17 | 0.08 | 0 33 | 0.05 | 0-1.5 |
| Silica | 0 42 | 0 58 | 0.94 | 0.52 | 3 54 | 1.25 | - |
| TDS | 414 | 353 | 398 | 498 | 669 | 302 | 500-1000 |
| Hardness | 280 | 248 | 242 | 309 | 310 | 185 | 500 |
| Phosphates | 0.03 | 0 03 | 0 | 0.06 | 0.03 | 0 | 1 |
| Total coliforms | 0 | 0 | present | 0 | present | 0 | 0 |

[a] based on Lebanese and WHO standards

*Water sources*

Water is supplied to the greater Tripoli area from three main sources that have a combined flow of 50,000 $m^3/d$:

- Hab spring source
- Racheine springs
- Aquifers

The Hab source supplies Tripoli with more than 40,000 $m^3/d$. Its water treatment works are currently not operational, and thus poor and uncontrolled quality water is supplied directly to the system which is not capable to meet current water demands. In addition, the major part of the network is very old, undersized and a high percentage of water is wasted through leaks and careless practices. It is estimated that overall losses due to leakage, illegal connections, and losses at households reach around 60 percent of the capacity of the water flowing into the system.

*Water Quality*

The water supply system in the greater Tripoli area is associated with major public health concerns for the local population and municipal authorities alike. Water quality is adversely impacted by uncontrolled discharges of industrial wastes, solid wastes, sewage, waste oils, wastewater infiltration and the absence of adequate water treatment. Inadequate water supply and sanitation have been major causes of health problems and water pollution.

*Surface Water*

Abou Ali River is an important landmark of the geomorphology and urban development of the city of Tripoli. The river has flooded twice, in 1942 and 1955, causing extensive property damage and loss of life. As a result, the banks of the Abou Ali River were built by the end of 1968. The proposed CHUD touches on a small potion of the western and eastern embankments of the river. Nearly all surface waters (rivers, streams, swampy areas) are more or less contaminated with pathogenic germs originating from uncontrolled discharge of wastewater and solid waste from the populations living in adjacent streets that use the flood channels as dumpsites.

*Coastal areas*

At present, the coast and the beaches around Tripoli suffer from the uncontrolled discharge of untreated wastewater and open dumping of solid waste. There is no doubt that this practice is affecting the quality of the coastal waters in a serious manner. Another problem is sand dredging from the seabed, which has a significant impact on marine ecology, coastal morphology, beaches, and fisheries. Furthermore, the seabed might have become a pollution sink as a result of long term contamination of coastal water and any major disturbance of the seabed such as dredging for sand, could release many contaminants into the marine environment.

*Wastewater collection systems*

Tripoli is generally served by a wastewater system and a separate storm water drainage system, although at some places the system is a combined one. Although plans to construct a treatment plant for the region have been completed, the plant is not expected to come into operation before 2005. At present, sewage is either directly discharged into the sea through pipelines and channels or indirectly via coastal streams. The existing wastewater collection system (some 130 km of pipelines) does not cover the entire city. An average of 70 percent of the population are connected to the system which was constructed in the 60's for a planning horizon up to the year 2000 and a population of 220,000 only. The system is consequently undersized and non functional due to the destruction of crucial facilities such as the El Mina pumping station and the sea outfall during the war and the clogging and silting of numerous sewer lines. In the absence of a proper collection system, several houses resorted to the discharge of their sewage to an old network of irrigation canals. As a result, raw sewage is directly discharged to land, rivers, and sea at more than thirty points in the city. Severe pollution and eutrophication all along the coastline constitute a serious threat to public health. The most polluted sections are near the temporary storage outlet at the tip of El Mina and the mouth of Wadi Bahsas at the southern side of Tripoli. In the old city center, the wastewater collection system is obsolete. Wastewater is directly discharged to the Abou Ali River or to an irrigation channel. In other cases, wastewater is discharged in septic tanks or indirectly to the soil through artificial wells. In some locations, the situation is extremely intolerable for hygienic reasons and the odors emanating to the vicinity are unbearable.

In order to alleviate this situation, a new secondary wastewater treatment plant (activated sludge) was proposed at the northern entrance of the city, at the outlet of the Abou Ali River. The effluent water will be discharged into the sea through a long sea outfall. The plant was designed to treat the wastewater collected from Tripoli and neighboring areas with an estimated population projection of 1,740,000 persons for the year 2040. Similarly, The situation of the sewage network has recently been improved by initiating the renovation of the entire network across the city and the neighboring region and designing a new system of main collectors and pipelines (Figure 4-2) (August 2002) to cope with the increasing flows and the need to change the direction of some of the flows as to reduce the environmental impact on land, coastal streams, the Mediterranean sea and the coastal beaches. This system will be installed along with the construction of the wastewater treatment plant. The design study indicates that around 155 km of main collectors and 130 km of secondary collectors must be installed before 2020.

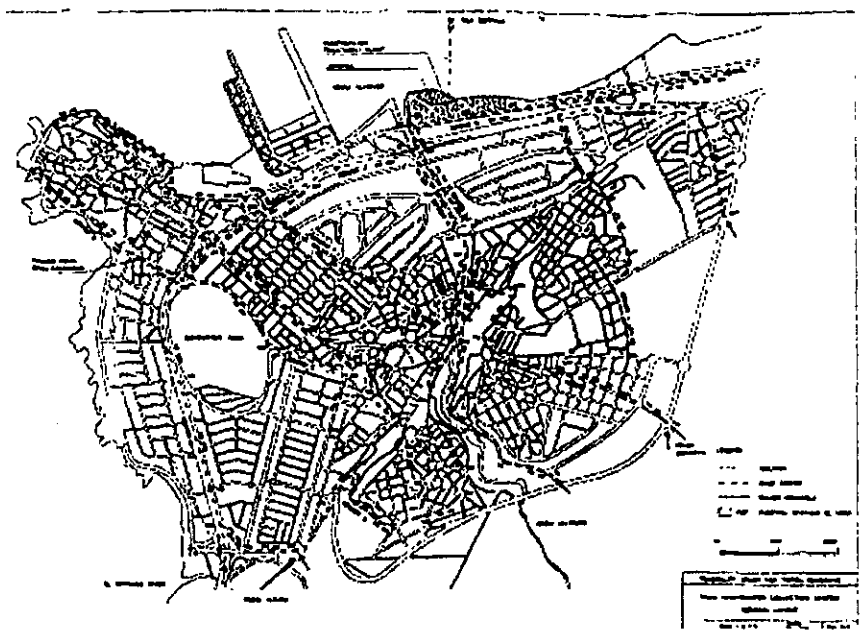

Figure 4-2 Main wastewater collection system – General layout - Tripoli

*Stormwater Drainage*

The stormwater drainage system consists of the three main components: the natural rivers of Nahr Abou Ali and Nahr el Bahsas, the storm water along the highways, and the existing urban stormwater drainage/irrigation facilities. Most of the existing drainage facilities consist of ditches and of short lengths of pipelines, all of which became undersized and in bad conditions after 20 years of negligence. Moreover, new roads have cut off a number of pipes and channels and interrupted flows in these areas. The system is in need for upgrade and extension to cope with the expansion of the city. The new sewage network design (BTD design) include 285 km of storm water drainage pipes ranging in size between 200 and 300mm and serving Tripoli, including the old city till the year 2020.

*Solid Waste*

The average generation rate of solid waste in Tripoli is about 0.65 kg/capita/day, thus resulting in a total of 382 t/d that have long been dumped in an open area on the exit of the Abou Ali River. The inefficiency of garbage collection has transformed the river and the streets of the old town into a dumping ground. Solid waste can also be seen dumped along the roadsides, in vacant lots, in rivers causing pollution problems, or directly burned in the streets. Industrial solid waste and medical waste are mixed with municipal waste. Waste lubricating oils is disposed of at waste dumps or directly into sewers. In 1997, Tripoli Municipal Union benefited from the SWEMP-World Bank project and received street cleaning and washing vehicles, as well as waste collection trucks and curbside containers. The project also aimed at the rehabilitation of the old dump and transforming it into a sanitary landfill.

*Air quality*

A recent field monitoring survey was conducted at a total of 10 stations representing different areas of Tripoli (Table 4-3). Measurements were made at several intersections inside the busy streets of Tripoli and inside the old city. Results showed that CO, $SO_2$ and $NO_2$ and TSP concentrations exceed WHO standards at most locations during daytime, due to vehicle-induced emissions and construction activities, and generally decrease during night-time. Consequently, air pollution is considered as a major environmental problem caused by traffic in the area.

Table 4-3 Average day and night time concentrations of CO, $SO_2$ and $NO_2$ and daily average concentration of TSP in Tripoli (JICA, 2001)

| *Sampling station* | *CO 1-hour WHO standard 9 ppm* | | *$SO_2$ 1-hour WHO standard 0 134 ppm* | | *$NO_2$ 1-hour WHO standard 0 21 ppm* | | *TSP WHO standard 150μg/m³* |
|---|---|---|---|---|---|---|---|
| | *Day* | *Night* | *Day* | *Night* | *Day* | *Night* | *Daily average* |
| S1 | 10.3 | 5.1 | 1.8 | 1.6 | 0.17 | 0.15 | 190 |
| S2 | 8 3 | 7.0 | 1.8 | 1.6 | 0.4 | 0.15 | 200 |
| S3 | 16.0 | 11.9 | 1.7 | 1 5 | 0 2 | 0.1 | 230 |
| S4 | 12.3 | 11.0 | 1.8 | 1.6 | 0.37 | 0.1 | 220 |
| S5 | 8 9 | 2.3 | 1.8 | 1.5 | 0.5 | 0.3 | 80 |
| S6 | 13.5 | 5.0 | 1.8 | 1.6 | 0.4 | 0.3 | 150 |
| S7 | 16 4 | 2 6 | 1.7 | 1 5 | 0.4 | 0.3 | 50 |
| S8 | 13.7 | 1.2 | 1.7 | 1.5 | 0 4 | 0.3 | 50 |
| S9 | 11.8 | 3 4 | 1 7 | 1.5 | 0 4 | 0 3 | 230 |
| S10 | 11.6 | 11.0 | 1.7 | 1.5 | 0.3 | 0.1 | 100 |

*Noise levels*

In the same air quality study, the noise level was measured inside the old city center during daytime and nighttime hours on an hourly basis. Most average noise values ($L_{eq}$) exceed the Federal Highway Administration (FYWA) noise abatement criteria of 72 dBA in developed and urbanized lands. The noise levels recorded during the night were similar to those measured during the day, highlighting the intensive nightlife activities in the city. Noise standards are as low as 55 dBA during the night and were exceeded in all measurements.

4.1.2 Socio-Economic environment

*General aspect*

Tripoli is considered Lebanon's second capital and the most important city in the Northern Mahafaza. Figure 4-3 depicts the general city layout with respect to its environs.

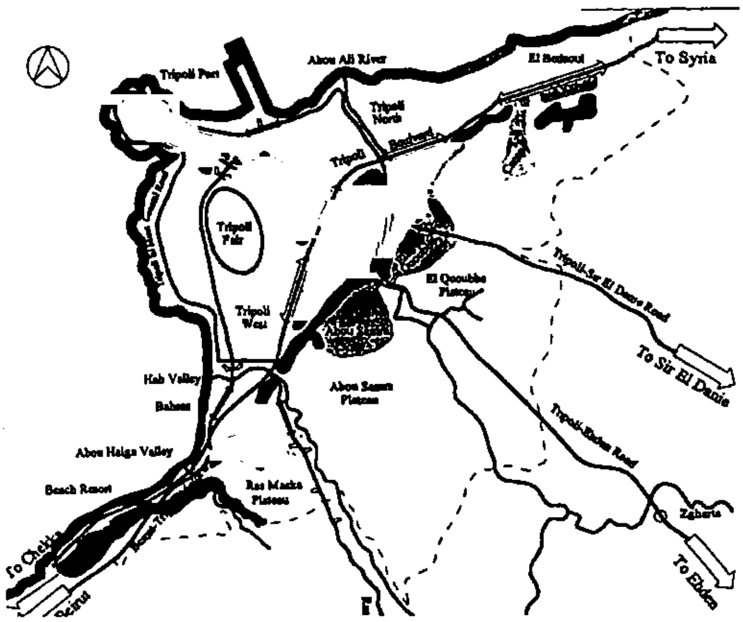


Figure 4-3 Tripoli and its environs

The city of Tripoli was more or less clustered on two hills (Abou Samra and El-Qoubbeh) around a central core or the old city. The area of Greater Tripoli is around 873 ha, of which 39 ha constitute the old city of Tripoli. Currently, the city itself comprises three municipalities, namely, Tripoli (includes Tripoli center, Qoubbeh and Abou Samra), El Mina (located in the west at the tip of a peninsula), and El Baddawi (in the north-east).

*Population*

The population in Tripoli and its immediate surroundings grew rapidly from 54,876 in 1932 (French Mandate Census) to around 500,000 in 1995 (used in various studies). This population growth took concrete form in the expansion of the old city. The population of Tripoli is expected to follow a linear declining growth rate starting at 2.3 percent and reaching 2.0 percent.

| Year | 1995 | 2005 | 2010 | 2020 | 2040 |
|---|---|---|---|---|---|
| Population | 500,000 | 626,000 | 698,000 | 865,000 | 1,302,000 |

The average population density in the old city center is 260 persons/ha, varying between 100 person/ha in Nouri to 500 persons/ha in Al Soueika and Haddadin.

*Industry*

Present industries include small industries scattered throughout greater Tripoli residential neighborhood and include car repair workshops, food processing establishments, furniture and wood crafts, soap making, and different commercial shops (selling clothes, cosmetics, books, leather goods, toys, spices, coppersmiths, food and household products). Most large industries in Bahsas area have closed down during the war (steel mill, compressed wood mill, seed oil and sugar refinery). In the same manner, the oil refinery in El Beddawi stopped operating and its future is uncertain.

*Socio-cultural activities*

Except for the Rabita al Thakafiah that organizes socio-cultural activities (conferences, art exhibitions, annual book fair), Tripoli suffers from insufficient cultural and recreational facilities such as theatres, public libraries, recreational areas and parks.

*Property and Tenure*

Like most other historic cores in Lebanon, land ownership in the ancient core of the city is subdivided into three general categories:

- Private ownership traditionally by the older families of Tripoli who lived at one point in the city center,
- Waqf ownership or land held in endowment for one of the religious groups, sects or families, and
- Public land owned by ministries or the municipalities.

## 4.2 Byblos

### 4.2.1 Physical environment

Byblos is located 38 Kms North of Beirut along the Mediterranean coast, and stands halfway between Tripoli and the capital. The city itself is part of the caza of Jbeil that includes 84 other villages grouped into 20 municipalities. The municipal boundaries of the city cover an area of 75 ha, of which 10 ha constitute the ancient core of the old city of Byblos, one of the oldest settlements of the cities of the East (Figure 4-4).


Figure 4-4 General location plan for the old city of Byblos

*Climate*

Similar to Tripoli, the climate in the region of Byblos is of the subtropical, Mediterranean type with warm and dry summer and fall (June to September), and moderately cold, windy, and wet winter (November to April). The average annual precipitation is 1,015 mm (Batroun station, altitude 20 m) while average annual humidity is 70 percent.

*Temperature*

The average temperature in summer in Byblos is 28°C, while in winter it is 10°C. The annual mean temperature is 20°C. Temperatures above 30°C occur in average on 46 days per year. Days with temperature below 0°C are very seldom with less than 1 day in average per year.

*Wind patterns*

Prevailing winds are from the West and Southwest, while winds from the East and Northeast occur with less frequency (85 percent vs 15 percent).

*Wastewater and stormwater drainage*

Byblos does not have a sewage network, neither in the old city nor in the modern settlements. All buildings rely on septic tanks for sewage discharge. In the old city, a section of the medieval sewage system is still operational. It is currently used for the drainage of rainwater. During the past two years, overflows from septic tanks were diverted to this channel. The contaminated rainwater is drained downhill through the medieval discharge pipe located next to the old harbor southern jetty. Consequently, a new wastewater and drainage systems are considered a priority and were integrated within the cultural heritage project (Figure 4-5).

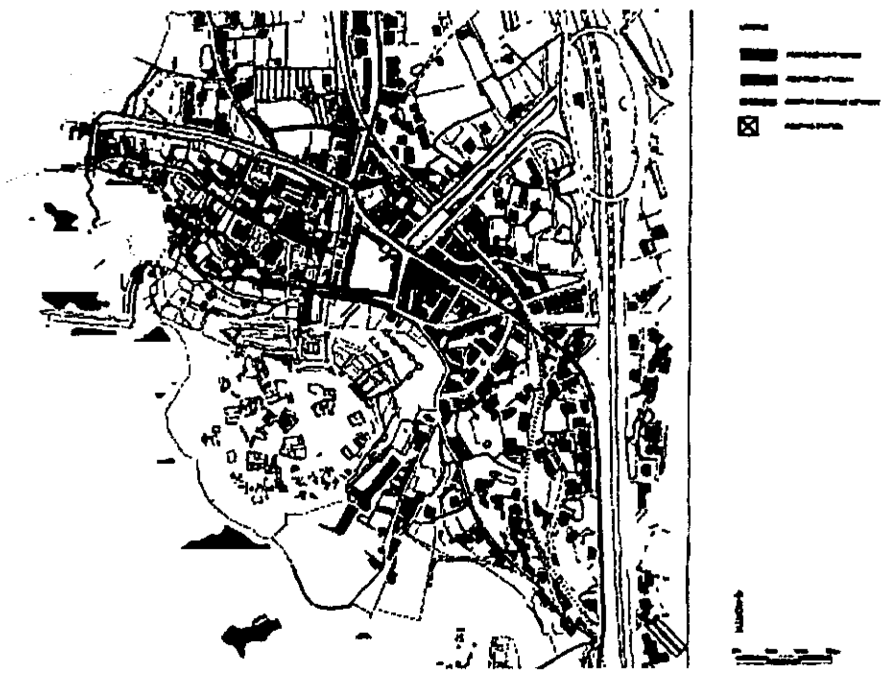

Figure 4-5 Proposed sewage network inside the old city of Byblos

A master plan for the collection, treatment and disposal of wastewater generated in the caza of Jbeil was prepared by Libanconsult and Cabinet Merlin in 1999. A new wastewater collection system covering most of the villages of the caza of Jbeil is envisaged. A main coastal collector will convey the wastewater to a sewage treatment plant located to the North of Byblos city (the exact location is still to be finalized in the Zoummar area-Figure 46). The system is designed to serve a total population of nearly 51,500 until the year 2040. The proposed wastewater plant will be receiving an average daily flow of 9,000 $m^3/d$ and will be either of the activated sludge system or the bio filtration system. The treated effluent will be discharged through a sea outfall that will extend some 600 m into the sea.

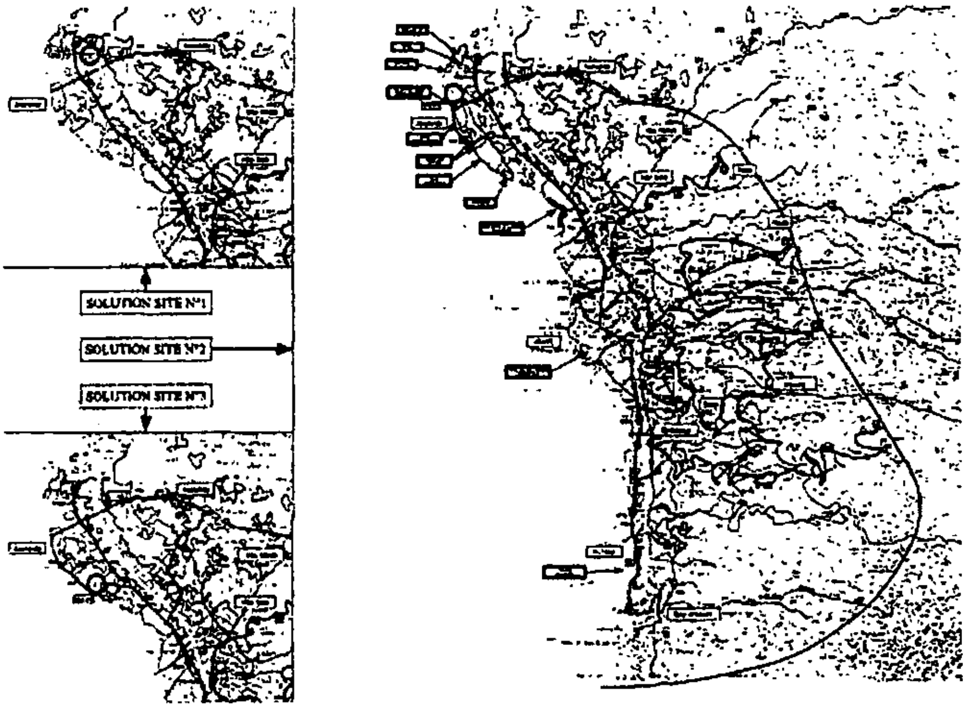


Figure 4-6 Alternative locations for the proposed wastewater treatment plant for Byblos

*Solid Waste*

The average waste generation rate in the city of Byblos is 0.75 kg/capita/day, resulting in a total of 13 t/d. The whole caza of Jbeil, comprising of 69,000 residents generates around 59 t/d. Solid waste generated from the city of Byblos and the caza of Jbeil are being disposed of, for more than 20 years, in the open dump of Hbaline, 5 km from the coastal zone of Jbeil (Figure 4-7). Waste management practices at this site were based on open dumping and burning to decrease the accumulated volume. These practices are environmentally unacceptable and were stopped two years ago by the municipalities of the area. However, burning of waste still occurs due to the generation of biogas in the dump. Currently, waste is being compacted and covered on a daily basis to prevent the emission of odors, while gases are discharged into the atmosphere through passive wells. Within the SWEMP-World Bank project, an EIA was recently completed on a close by site in Hbaline for the construction of a new sanitary landfill serving the whole caza of Jbeil. The site, with an area of 7 ha, is located in the vicinity of the existing dump in Hbaline.

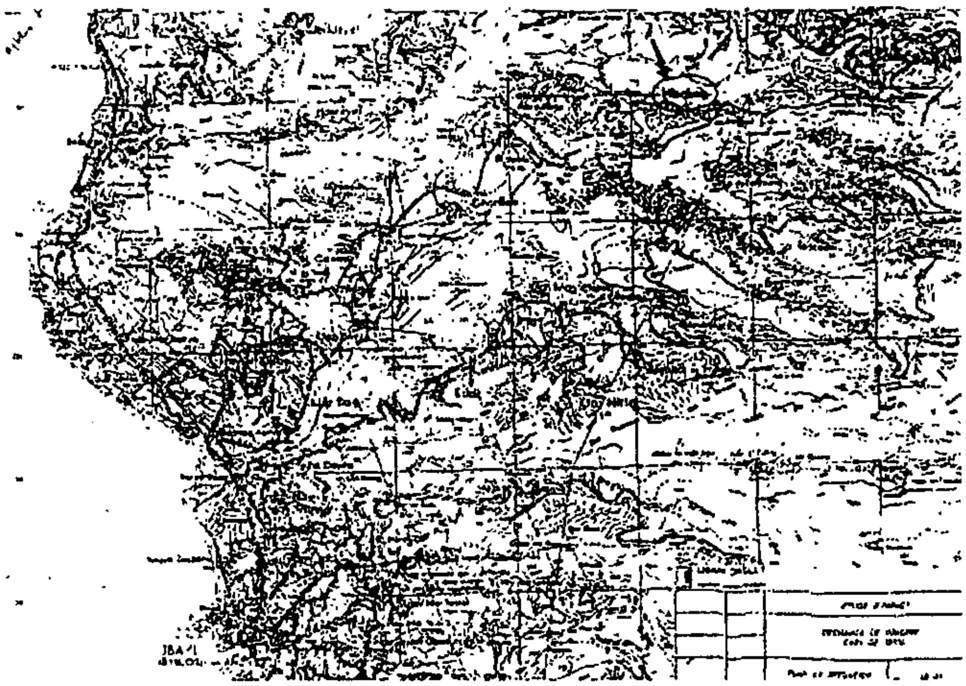

Figure 4-7 Hbaline landfill location plan

4.2.2 Socio-economic environment

*Population*

According to a 1999 survey conducted by the Research and Consultation Group for the Study of the Lebanese Coastline, the population of Byblos has more than doubled during the last twenty years. Population demographics are presented below:

| | |
|---|---|
| Number of residents during summer | 15,300 |
| Number of residents during winter | 17,000 |
| Number of households | 4,250 |
| Average family size | 4 |
| Gender distribution | 49.5% males, 50.5% females |
| Age group distribution | <20 years : 38 % |
| | 20-39 years: 34 % |
| | 40-59 years: 20 % |
| | >60 years : 8 % |

Population projections for Byblos city until the year 2040 and based on a population growth of 2.35 percent per year are as follows:

| Year | 1995 | 2005 | 2015 | 2025 | 2040 |
|---|---|---|---|---|---|
| Population | 14,296 | ·18,034 | 22,750 | 28,698 | 40,660 |

*Socio-cultural activities*

The working population in Byblos constitutes 38 percent of the total population. The majority of this workforce is in the services sector (65 percent), while others are distributed on industry, agriculture and maritime sectors at 15, 10, and 10 percent, respectively. Female employment constitutes 30 percent of the total workforce.

Byblos is benefiting from the development of industrial activities to the south and north of the city such as cables industry, paper and cardboard, tapestry, cosmetics, beer, metal works, as well as the development of greenhouses that has expanded he agricultural area. The old Souks of Jbeil constitute the historic commercial centers of the city. They are composed primarily of paved narrow alleyways with small commercial activities selling artisanal clothes and shoes, small gifts, coppersmiths, and local food. With the exception of few restaurants that can accommodate some 1,300 person, no entertainment or leisure activities exist in the historic core of the ancient city.

*Property and Tenure*

Similar to Tripoli, land ownership in Byblos is subdivided into three general categories:

- Private ownership traditionally by the older families who lived at one point in the city center (22.7 percent),
- Religious ownership or land held in endowment for one of the religious groups, sects or families (27.7 percent), and
- Public land owned by ministries or the municipalities (49.6 percent).

## 4.3 Saida

### 4.3.1 Physical environment

Saida is located 35 Km South of Beirut along the Mediterranean coast (Figure 4-8). It sits at the edge of now severely eroded agricultural plains, mainly citrus orchards. Saida is the administrative center for the Mohafaza of South Lebanon. The city is subdivided into three cadastral zones, the historic core, the Dekerman, and Wastani. The historic core accounts for a total area of 20 ha. In the last two decades, the city has witnessed significant growth and urbanization over its adjacent hillsides.

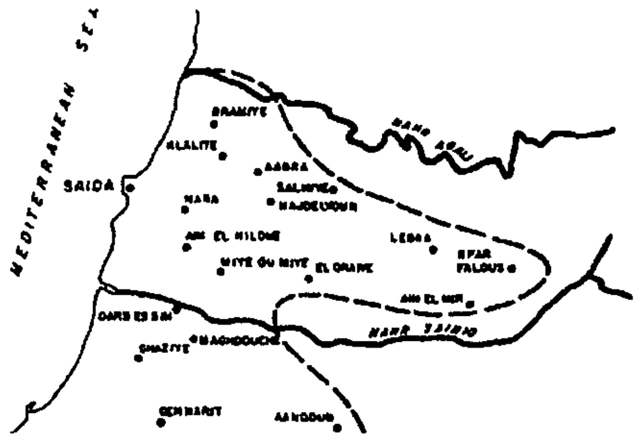


Figure 4-8 General Location plan for Saida

*Climate*

The climate in the region of Saida is Mediterranean characterized by mild wet winters and dry summers. The average annual precipitation over Saida is around 660 mm/yr (Saida station, altitude 5 m). On average, there are roughly some 60 days of rain per year with a monthly precipitation ranging between 170 mm in January to 0.5 mm in July and August. Humidity ranges from an average of 66 percent in winter to 75 percent in summer.

*Temperature*

The average yearly temperature in Saida is around 19.5°C, ranging between an average of 9°C in winter and 31°C in summer.

*Wind patterns*

The prevailing wind in the coastal region is mostly southwesterly bringing humid air masses and rainfall in winter. It also brings humidity in summer, which stays on the coast or rises on the slopes to turn into fog. The wind is relatively calm most year round. The average wind speed ranges between 3 and 5 m/s.

*Hydrogeology*

Saida falls within two watershed basins, namely Bisri-Awali and Sainiq. Bisri starts at an elevation of 1,921 m at the Barouk hills with a length of 48 km and an area of 302 $km^2$. Sainiq has a length of 20 km and an area of 111 $km^2$. The average monthly discharge of the Awwali and Sainiq rivers is 0.329 $m^3/s$ and 0.452 $m^3/s$, respectively. About 60 percent of the actual domestic water demand of Saida is extracted from 6 wells, of which 5 are located within Saida and one at Ain el Helwe (total yield of 27,100 $m^3$/day). The remaining 40 percent are withdrawn from the Kfarwe spring (yield 10,000 $m^3$/d in dry season and 20,000 $m^3$/d during wet season).

*Coastal front*

The coastal ecosystem is a flat strip with an average width of 1,200 m. The northern and central parts of the coastal plain are mostly built and heavily populated. Vegetation is moderate with very little agricultural activities. The seafront beaches are straight and mostly sandy to gravel in nature. There is little construction at the seafront except in the central area (touristic site and port facilities). Around 9 major outlets are discharging their effluents of domestic raw sewage and industrial wastewater directly or indirectly (through storm water culverts, and open stream channels) into the sea.

*Seawater Quality*

Untreated sewage discharge into the marine environment is contaminating seawater, sediment, and marine flora and fauna with fecal matter containing pathogen and heavy metals and causing health hazard to bathers or individuals consuming seafood next to sewage outlet areas. An increased level of organic and inorganic nutrients is leading to eutrophication of shallow protected areas near the shore and which is manifested by high degree of algal growth. Deterioration of seawater quality in terms of increased turbidity, coloration, odors, and other visual aesthetic criteria are affecting amenities of local residents and tourists.

*Wastewater and stormwater drainage systems*

The city of Saida is served by a sewerage network that discharge directly to the seashore, into a storm water culvert, which eventually discharges into the sea, or overland into natural stream channels of dry bed wadis. In the coastal region extending from Awali River to Zahrani River, 22 outlets that discharge to the sea were identified. These outlets have varying sewage loads depending on the population density of the served areas. Out of these 22 outlets, 9 are responsible for the discharge of the wastewater generated from the city of Saida. The proposed solution to alleviate this situation consists of the installation of a wastewater interceptor running along the coastline, starting to the North of Saida and reaching Sainiq river whereby a wastewater treatment plant and a sea outfall will be constructed to dispose of the treated effluent (Figure 4-9). The wastewater treatment plant, having an area of 4 ha, is sufficient to accommodate a secondary treatment system up to the year 2015. The plant is designed to serve a population of 234,000 up to year 2015 and an average daily flow of 33,600 $m^3/d$. Treated effluent will be discharged through an 800 mm diameter sea outfall extending for 1,700 m at a minimum depth of 31 meters. The primary treatment components of the wastewater treatment plant and the sea outfall are currently being installed through a fund from the Japanese government.

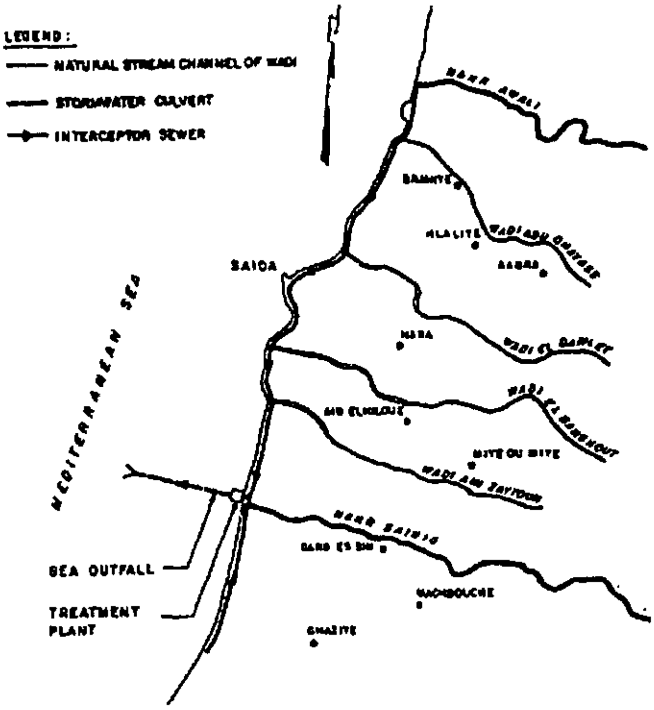


Figure 4-9 Proposed wastewater collection and disposal system for Saida caza

*Solid waste*

The average solid waste generation rate for Saida is 0.7 Kg/capita/day. Consequently, Saida generates around 53 t/d of solid waste that is being collected by the municipality and is currently being disposed of in an open dump at the Southern entrance of the city. The presence of this dump in this area is environmentally unacceptable. Solid waste must be disposed of in a properly designed sanitary landfill that should be identified by the Lebanese Government. The municipality has proposed an integrated solid waste management plan for Saida and its surroundings with the assistance of foreign investors but the plan has not been approved yet.

4.3.2 Socio-economic environment

*Population*

The city's urban development is evident in the encroachment of structures over Saida's surrounding hills and along its coastline. The population has increased from a low of 15,000 in 1946 to an actual more than 70,000 today. Population projections for Saida city until the year 2040 are as follows:

| Year | 1995 | 2000 | 2010 | 2020 | 2030 | 2040 |
|---|---|---|---|---|---|---|
| Population | 63,365 | 72,869 | 86,597 | 94,752 | 99,610 | 100,611 |

The population in the old city of Saida reaches 14,000 residents with a density exceeding 485 persons/ha. Families in the old City of Saida are relatively large with 57 percent consisting of more than five members. The population is marked by its relative youth whereby more than 60 percent is under the age of 25.

*Socio-cultural activities*

Around 27 percent of the old city's residents are employed with males constituting around 86.5 percent of the workforce and females the remaining 13.5 percent. The types of jobs include small-scale vendors, daily workers, construction workers, employees, fishermen, drivers, teachers, and traders. Major trade activities existing in the old city center include food, furniture, cloth and accessories, construction material, mechanical parts for boats, general services, and coffee houses. With the exception of few restaurants and coffee shops, no entertainment or leisure activities exist in the historic core of the ancient city.

*Property and Tenure*

Similar to the Tripoli and Byblos, land ownership in Saida is subdivided into three categories:

- Private ownership traditionally by older families who lived at one point in the center,
- Religious ownership or land held in endowment for one of the religious groups, sects or families, and
- Public land owned by ministries or the municipalities.

## 4.4 Tyre

### 4.4.1 Physical environment

Situated along the Mediterranean coast, around 80 km to the south of Beirut and 26 km north of the Lebanese southern borders (Figure 4-10), Tyre functions as the administrative and regional center of the Mohafaza of the South Lebanon. It is a small, rocky peninsula on one of the largest and richest plains of the Lebanese coastline. The seashore to the south of Sour has the longest and widest stretch of sand beaches. The fishing harbor surrounded by fishing installations and traditional living quarters constitute the heart of the ancient city.

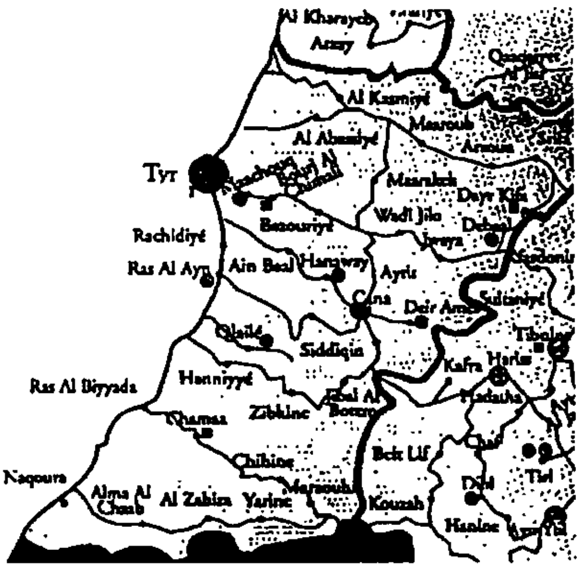


Figure 4-10 General location plan for the city of Tyre

*Climate*

A Mediterranean climate characterized by dry summers and wet winters prevail in the Tyre region. The coastal region receives an amount of 700 to 800 mm of rainfall per year with about 80 percent of the rainfall is concentrated in the winter during a period of four months from November to February.

*Temperature*

Temperatures vary with the seasons. The average values of the mean monthly temperature in summer and winter are 37 and 14 degrees Centigrade, respectively. The humidity is relatively constant being always high with a maximum of 80 percent during the month of August. The difference in temperature and relative humidity for winter and summer months usually ranges between 10 to 15 °C and 10 to 12 percent, respectively.

*Wind patterns*

The prevailing wind direction and speed vary with the season. During February to August, the Southwestern winds prevail. During the rest of the year, the western winds are strong enough to be easily detected. There are also local winds known as coastal winds, blowing from the coast in the afternoon, and shore winds blowing from the sea during daytime.

*Hydrogeology*

South Lebanon is known for the scarcity of its surface water in spite of its abundant rainfall. The geological layers dip towards the west and northwest, and the geographical slope also runs in approximately the same direction, at no more than 40 meters per kilometer. The geological formations are extremely fragmented with an impermeable layer often separating them. As a result of this combination, a large quantity of groundwater is available in the Tyre region. In fact, while devoid of perennial surface water sources, the Tyre region is sitting on a groundwater basin whose estimated flow might exceed 50 million cubic meters per year

*Water Quality*

The major groundwater source is the Cretaceous limestone layer. The water from this aquifer is of very good quality with no microbial pollution. The upper Eocene layer, which is also used as a source of water for private wells in the Tyre area, is very polluted as a result of the poor condition of the sewerage network and the presence of large numbers of septic tanks in nearby areas not yet served by a collection system. Seawater intrusion due to over pumping is also a remarked phenomenon along the coastline area. The Litani River, lying to the northern boundary of the study area is polluted due to wastewater and industrial wastes discharges. The seawater along the coast is polluted due to the discharge of wastewater into the sea, mainly in the harbor area, which is targeted for rehabilitation under the proposed CHUD project. Drinking water quality is variable. While the water is filtered and chlorinated before being distributed to users, damage and neglect to the distribution system give rise to irregular supply pressures and can pollute the network.

*Water supply system*

The city of Tyre is supplied by water from Ras El Ain and Rashidiyeh springs at an estimated volume of 10,000 to 15,000 $m^3$/day and 6,600 $m^3$/day, respectively. The water supply is regular and constant, although the city suffers from the inadequacy of supply during the summer months. As such, many private and community wells have been drilled to supply the region with drinking water, in addition to the Government's wells of Ouadi Jilo (15,000 to 20,000 $m^3$/day). The water distribution system inside the old city is connected to the main distribution line. Some pipes are installed in an inadequate manner on the ground surface, or are insufficiently backfilled, which makes them susceptible to pollution. No storage reservoir exists in the area. The water consumption is currently in the order of 100 l/c/d while the future daily water demands require 260 l/c/d (for the year 2040). Recent water supply studies kept the existing system and developed a design of a new network around the city to meet its future demands.

*Wastewater and storm water drainage systems*

The city of Tyre collects the wastewater coming from different villages in the Tyre caza. The wastewater is conveyed to a pumping station neighboring the fishing port that pumps the wastewater to an old sea outfall on the western side of the city. A new wastewater treatment plant with a sea outfall is foreseen in the Abbassiyeh area for the overall caza of Tyre. The present wastewater collection system consists mainly of pipe in principal venues, rectangular channels in internal streets serving both for wastewater and storm water drainage, and main pumping lines from the pumping station to the sea discharge point (two 500 mm pipes). The wastewater that is mixed with the storm water drainage system is also discharged into the sea through 5 main outlets to the north of the fishing port (Figure 4-11). The fishing port pumping station receives wastewater from several regions outside the study area, namely from El Raml, El Bass, and Abbassiyeh. The pumping station consists of three pumps with one of them is not operational and the others suffer from major maintenance problems causing wastewater overflows into the sea.

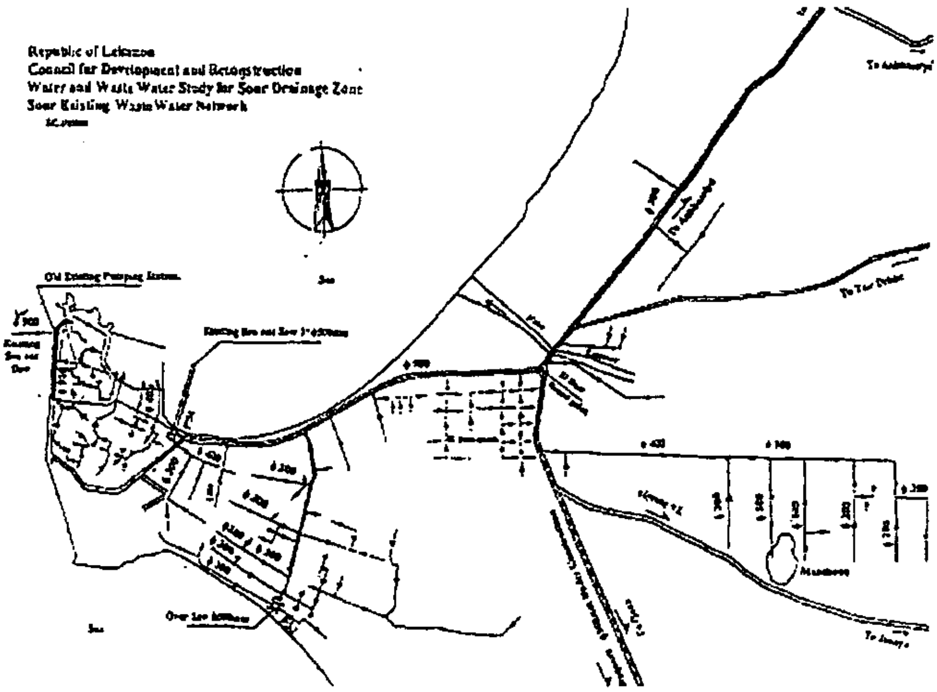

Figure 4-11 Existing sewer layout in the city of Tyre

New developments in the wastewater collection system are foreseen for the region of Sour with wastewater mains (400 mm diameter) to be constructed to separate the drainage system from the wastewater collection system. Wastewater will be pumped to a gravity sewer leading to the proposed wastewater treatment plant to the north of the city of Tyre (Figure 4-12) where it will be discharged to the sea through a submerged sea outfall after treatment.

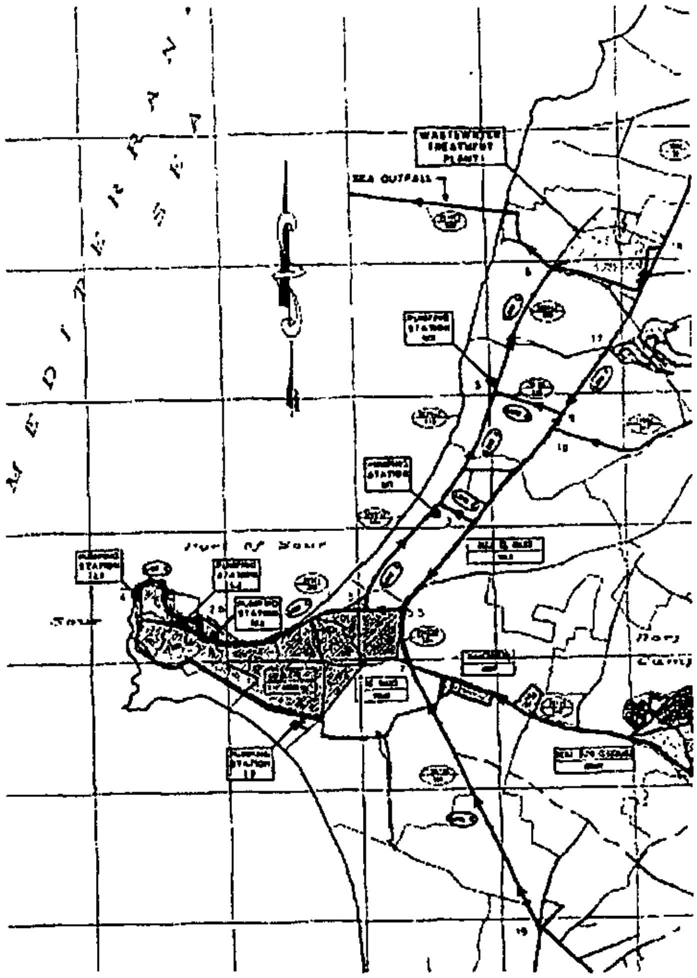

Figure 4-12 Proposed Wastewater collection and disposal system in Tyre

*Solid waste*

The average solid waste generation rate for Tyre is reported at 0.7 to 0.9 Kg/capita/day. Thus, Tyre generates around 49 t/d of solid waste that is being collected by the municipality and is currently disposed of in open dumps in the area surrounding the city. The presence of open dumps in this area is environmentally unacceptable and waste must ultimately be disposed of in a properly designed sanitary landfill. An EIA for the construction of a sanitary landfill for the disposal of the waste generated from the cazas of Sour, Saida, Jezzine, Nabatiye, Hasbaya and Bent Jbeil was prepared under the SWEMP-World Bank project. The proposed site is in the region of Zebqine-Henniye, approximately 12 kms south east of Tyre and 4.5 kms from the main coastal road at an elevation of 200 meters (Figure 4-13). The total lifespan of the landfill is expected to last for 20 years. About 203 t/d will be disposed of at the landfill as soon as operations start and will be able to receive 301 t/d of waste by the year 2020. The total area devoted to the landfill is 16-18 ha with an additional 20 ha available for further expansion.

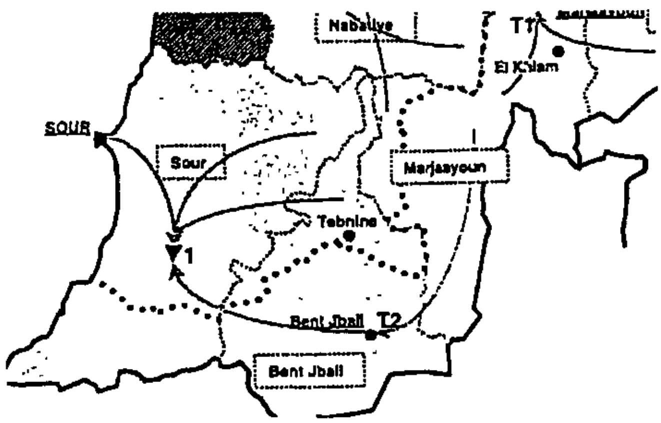


Figure 4-13 Location plan of the Henniyeh-Zebqin landfill

4.4.2 Socio-economic environment

*Population*

High population densities and haphazard growth characterize Tyre. Similar to the other Lebanese cities, it grew at an increasingly rapid pace during the second half of the twentieth century. It comprises five principal residential areas: the historic city, the Al-Raml quarter, the Palestinian camp of Al-Bass, Jal el Baher and al Rashidiyye area. In 1998, Tyre population accounted for some 58,000 residents (Mudun, 1998). Population densities vary between 250 to 500 persons per hectare. The population in Tyre is expected to grow at a decreasing annual rate starting at 2.2 percent until 2005, at a rate of 2 percent until the year 2015, and then at a rate of 1.8 percent until the year 2040 to reach a population size of 87,000. The age distribution of the population is 42.6 percent lower than 18 years, 51.5 percent are between 18 and 64 years, and 5.9 percent are above 64 years.

*Socio-cultural activities*

Tyre is surrounded by orchards and agricultural plains, which employ local population living in the city or its immediate environment. Nearly 77 percent of the areas in Tyre and its im mediate surrounding are uninhabited including agricultural plains, archaeological sites and beaches. Around 20 percent of families living in the old city of Tyre are involved in the fishing industry. The daily pattern of most of this community is marked by periodic trips to the sea, depending on the sea and weather. The fishing methods used in the region are primitive. Motorboats are used, with fishing rods, lamps and nets. The rest of the historic core residents are employed in the public sector, mainly in banks or they run small commercial enterprises consisting mainly of stores selling household appliances and products, groceries, furniture making, bakeries, meat, fish and vegetable markets. With the exception of few restaurants and coffee shops, no entertainment or leisure activities exist in the historic core of the ancient city.

*Property and Tenure*

Similar to the other cities, land ownership in Tyre is subdivided into three general categories; private, public, and Waqf. Private property is dominated by old families that are mostly Christian. Waqf property is primarily belonging to the Catholic Waqf who owns a couple of churches and large tracts of land around the historic core of the city. Public property in the ancient city is significantly high due to the presence of large archaeological sites that belong to the DGA.

## 4.5 Baalbeck

### 4.5.1 Physical environment

Baalbeck is located 86 km east of Beirut, at an altitude of 1,100 m, and is surrounded by vast agricultural plains of the North Bekaa regon. Baalbeck city, the administrative capital of the region, is located in a micro-region that includes the three adjacent villages of Younine, Douris, and Iaat. The major cultural heritage zone in Baalbeck includes the historic core of the city and the archaeological sites, namely the Roman temple of Jupiter, Venus and Bachus, located inside the Qala'a, as well as the adjacent site known as the Bouleuterion.

*Climate*

The climate in Baalbeck is dry and arid, with low precipitations due to its geographic location in the Bekaa plain between two mountain chains (East and West). Winters are cold while summers are hot and dry. Rain showers are scattered between October and May and accompanied with snowfall between December and February. The annual cumulative rainfall is about 410 mm. The mean annual humidity is 56 percent reaching 67 percent in winters and decreasing to 46 percent in summers.

*Temperature*

Temperatures vary with seasons from a low of -6.2 °C in February to as high as 40 °C in August with a mean monthly temperature of 15 °C.

*Wind patterns*

The prevailing winds are normally Northeast and southwest due to the geographical location of Baalbeck within the internal corridor between the two mountain chains. The northeast wind prevails normally during the winter while the southwest wind prevails for the remaining of the year.

*Hydrogeology*

The geological formations, notably the Turonian, form an exploited aquifer in the region with many springs.

*Water supply system*

The existing source of domestic water supply for Baalbeck consists of 2 springs (Loujouj and Ain Bordai) and seven wells providing 19,650 $m^3$/day (Figure 4-14). The Ras el Ain spring is not suitable for domestic water use. An additional seven were recently installed (Oumouchki and Al Moudawar area) whose yield is estimated at 23,700 $m^3$/day. The combined flow, after the completion of development activities, will be in the order of 44,790 $m^3$/day. The storage facilities consist of four main reservoirs with a capacity 10,750 $m^3$/d. The total storage capacity is about 50 percent of the water demand for the year 2017, considering that each household has a one-day storage capacity. Baalbeck water demands are estimated at 100 l/c/d in 1995 and are expected to reach 110 to 122 l/c/d in 2007 and 2017, respectively. The water distribution system is generally old and in poor conditions. It does not extend to the new areas of the city and has not been renovated since the 1970s. The Baalbeck authority continues to distribute water through gauges that are not calibrated. In addition, many service connections were damaged by infrastructure works. The water losses are very high and exceed 30 percent. Pipe connections between the main water distribution facility and many households are non-existent. People depend largely on polluted wells or resort to buying water in cisterns for their daily water supply.

The water quality analysis of newly drilled water wells and existing springs(Table 4-4) indicate that the water quality is good chemically with chemical indicators (conductivity, dry residues, pH, Ca, Mg, Na, K, Cl, sulfates, nitrates, bicarbonates, and iron) exhibiting levels below the maximum allowable standards set by the Lebanese Government, the WHO and the CEE. However, the bacteriological results show the presence of fecal coliforms and streptococcus, which indicates that the water is contaminated bacteriologically which is the major cause of contamination in the absence of an adequate wastewater collection network.

Table 4-4 Chemical and bacteriological analysis of the springs in Baalbeck (World Bank 2001)

| *Analysis* | *Ras El Ain* | *LoiyoiyA* | *in Jouzeh* | *Dardara* | *Delbe* | *Sbat* | *Sbah* | *Standards*[a] |
|---|---|---|---|---|---|---|---|---|
| Conductivity | 286 | 290 | 240 | 263 | 253 | 279 | 329 | 400 |
| Dry residue | 195 | 210 | 165 | 195 | 180 | 205 | 240 | 1000 |
| Total alkalinity | 120 | 115 | 105 | 100 | 105 | 125 | 150 | |
| pH | 7.99 | 7 64 | 7 61 | 7 68 | 7.89 | 7.51 | 7.65 | 6.5 – 8.5 |
| Calcium | 37 | 37 5 | 30 8 | 33.4 | 34 2 | 41.4 | 54.9 | 100 |
| Magnesium | 9.1 | 6 63 | 8.05 | 4.4 | 5.4 | 6.6 | 7.6 | 30 |
| Sodium | 10.6 | 12.2 | 6 8 | 8.4 | 4.5 | 4.7 | 10.7 | 200 |
| Potassium | 1.3 | 1 8 | 0.92 | 1 1 | 0 6 | 0 4 | 1.8 | 12 |
| Chlorides | 17 7 | 22.5 | 10.9 | 13.9 | 7.4 | 7.1 | 17.7 | 250 |
| Sulfates | 8.2 | 2 9 | 1.6 | 1 3 | 2.1 | 5 6 | 17 4 | 250 |
| Nitrates | 0 55 | 0.26 | 0 23 | 0.09 | 0.07 | 0 05 | 0.27 | 50 |
| Iron (µg/l) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 300 |
| Fecal coliforms/100ml | >80 | 12 | 24 | 7 | 3 | 0 | 5 | 0 |
| Fecal Streptococcus/100ml | >80 | 11 | 13 | 2 | 0 | 0 | 2 | 0 |

[a] WHO or CEE standards

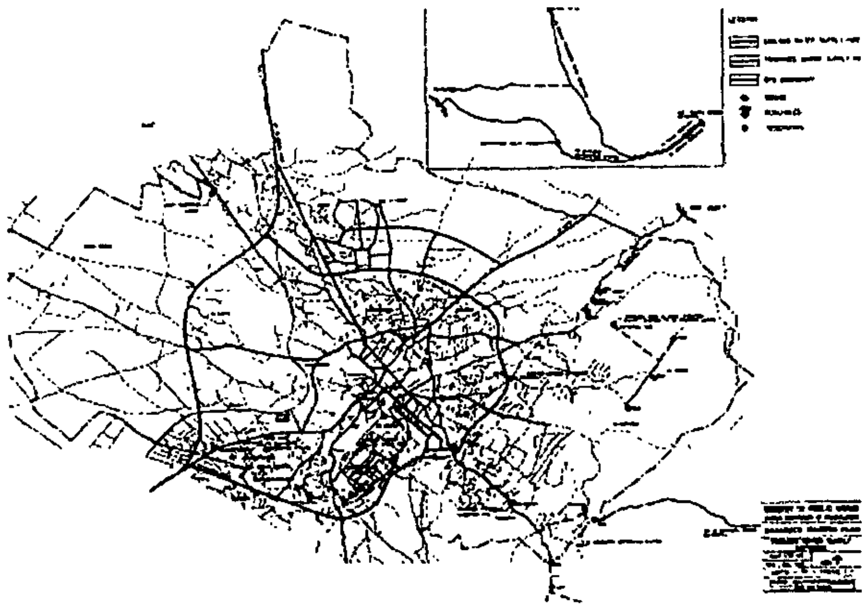

Figure 4-14 Primary water supply network for Baalbeck

*Wastewater collection system*

The survey conducted by Dar El Handassah in November 1997 indicated that 60.5 percent of the total population of Baalbeck is connected to a sewer network. In the year 2017, this would be equivalent to approximately 30 percent of the population if no further extension occurs. Nearly 75 percent of the existing trunk sewers (23 km of sewers in Baalbeck city ranging in size from 150 to 600 mm) were replaced under the Baalbeck/Nabi Chit construction contract and the remaining were upgraded. The constructed network reinforces and replaces the old network, however it does not cover all the urban areas. A secondary wastewater treatment plant (activated sludge) was constructed in the middle of Iaat plain at 2 kms from Baalbeck city (Figure 4-15). The capacity of the plant is 12,500 $m^3/d$ with the possibility of extension to 25,000 $m^3/day$ after 2008. The treatment plant is designed to discharge an effluent for agricultural use having a BOD of 35 mg/l and SS of 30 mg/l.

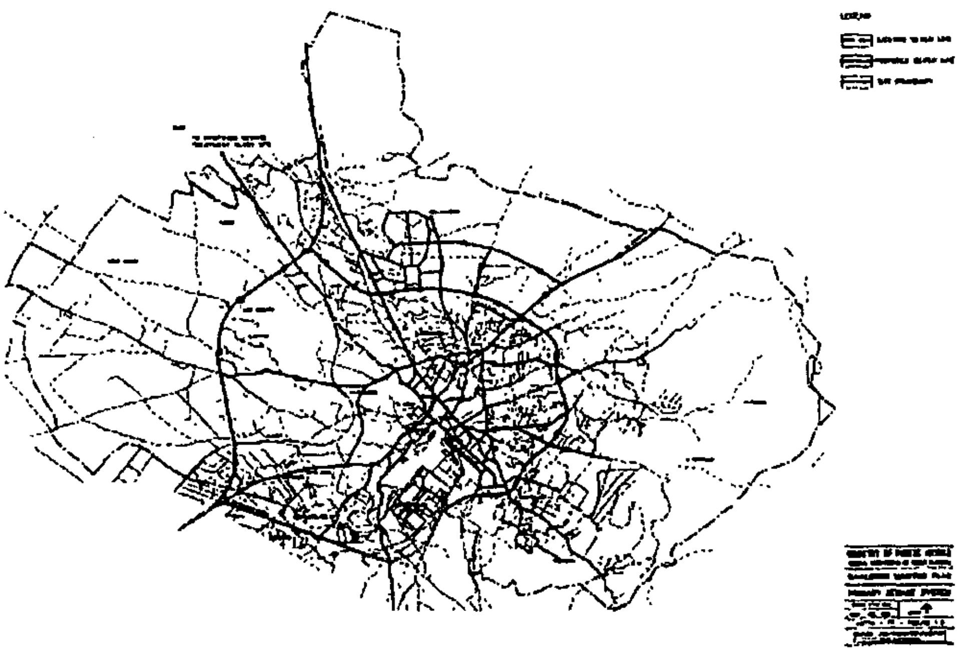

Figure 4-15 Primary sewage network for Baalbeck

*Solid waste*

Baalbeck currently generates around 45 tons per day of municipal solid waste. A private contractor undertakes collection and disposal of the waste for the Municipality who provides the facilities and equipment. Solid waste is currently being disposed of in an open dump at Al-Kayyal area, adjacent to the monolith Roman Quarry. Dumping is poorly controlled and open burning is practiced to decrease the waste volumes. The collection service is relatively poor due to the lack of adequate equipment, containers and personnel. Waste collection containers are distributed throughout the city on street corners but waste are often burned instead of being collected. The waste containers need to be regularly cleaned and maintained. An EIA for a new sanitary landfill for the disposal of solid waste generated in Baalbeck caza was prepared under the SWEMP-World Bank project. The landfill is located on a plot of land having a surface area of 92,000 $m^2$ in the industrial area, 3.3 km to the north of Baalbeck. The site is expected to receive between 70 and 80 t/d (between 25,000 to 29,000 t/yr) generated from the caza of Baalbeck. Local residents around the site did not allow the construction of the landfill in their premises and another site is being investigated in Taibeh area.

4.5.2 Socio-economic environment

*Population*

Baalbeck consists of dense residential fabric extending from the citadel and throughout the valley. Nearly one third of its population are non-residents, having migrated to other parts of the country or emigrated abroad. It is characterized by a young population whereby 52 percent are less than 24 years old. Its total population is estimated at 55,000 with a density of 234 residents per hectare. An additional 38,000 residents live in the adjacent villages of Douris, Younine and Iaat. Moreover, Baalbeck houses an additional 25,000 to 30,000 Palestinian refugees in the Wavel camp, south west of the city center. According to the Dar El Handassah Master plan study (December 98), the population of Baalbeck city is expected to grow to reach a size of 98,300 to 118,000 at growth rate of 2.5 and 3.5, respectively. Gender distribution in the city is almost balanced but literacy rates are low compared to other regions of the country with 13.6 percent of residents over the age of 10 being illiterate.

*Socio-cultural activities*

Most Baalbeck's households are characterized by a low income although its micro-region contains an important portion of economic activity found in the north Bekaa as a result of its proximity to the principle axis linking Beirut to Damascus. Despite being the main economic sector in the region, agriculture attracts only 21 percent of the population. Another 25 percent are absorbed by industrial production (local industries, construction, artisanal products). The remaining 54 percent are employed in services, which are subdivided into public services (administration, health, education, and army) and the private sector (medical services, banks, tourism and leisure activities). Professional and commercial activities are concentrated in the city center and include barbers, tailors, carpenters, private offices and institutions, government offices, clinics, dispensaries, and a hospital. Unemployment rate is estimated at 30 percent with only 5 percent of the total female population in the labor force. Employment rates reach 80 percent in the age range of 25 to 44 for males and 11.4 percent for females.

*Property and Tenure*

The average household size in Baalbeck is 5.5 residents per household which is slightly higher than the national average of 4.6. The city is marked by a significantly high portion of home owners (73.7 percet), although an increasing demand on house rentals is becoming available especially in the city center. Figure 4-16 provides the land use pattern in the city of Baalbeck.

## 5. IMPACT ANALYSIS

The environmental impact analysis focused on comparing the expected evolution of the five cities with and without the implementation of the proposed CHUD project components. The impacts are addressed in accordance to the different phases of the project namely, construction and operation. The magnitude of these impacts varies with time and site management. The environmental issues that are typically associated with the phases of the project are presented in Table 5-1.

Table 5-1 Classification of potential environmental impacts

| Category | Phase | Duration (yrs) | Potentially impacted parameter |
|---|---|---|---|
| Short term | Construction | < 2 - 5 | • Traffic<br>• Air quality<br>• Noise<br>• Landscape and visual intrusion<br>• Waste generation (construction/demolition)<br>• Water quality (surface, groundwater, seawater)<br>• Health and safety<br>• Archaeology and cultural heritage<br>• Socio-economics |
| Long term | Operation | > 2 | • Traffic<br>• Air quality<br>• Noise<br>• Landscape and visual intrusion<br>• Waste generation (solid waste and wastewater)<br>• Water supply (surface, groundwater, seawater)<br>• Health and safety<br>• Archaeology and cultural heritage<br>• Socio-economics |

While the impacts of some parameters can be assessed quantitatively using analytical and mathematical means (traffic, air, noise, water, economics), the impacts of other parameters can be described by relying on a qualitative approach. There are for instance, well-established methods for the measurement of traffic counts, air pollution, noise levels, water quality and economic benefits in the context of a cultural heritage rehabilitation project. For the other parameters however, a qualitative and comparative approach is adopted.

In the present EIA report, the major activities are related to rehabilitation and renovations of existing cultural heritage facilities and no major new facilities will be constructed. As such the impacts are addressed in general for such activities all while pointing out special cases that are characteristics of certain cities.

### 5.1 Traffic

It is expected that traffic circulation will be negatively impacted in all five cities during the construction phase particularly at and around a site under rehabilitation, Traffic problems will occur when traffic must be moved through or around construction areas. Construction zones present to motorists unexpected and unusual situations in their traffic movements, such as, abrupt changes in geometry, lane narrowing, lane transitioning and lane dropping. These situations will require motorists to perform rapid maneuvers and to reduce their speed thereby creating congestion and delays.

During the operation phase traffic circulation is likely to improve in some cities (Tripoli) or not be affected in others (Tyre, Byblos, and Baalbeck). Several streets in these cities will be converted for pedestrians only. Such an occurrence will naturally affect circulation patterns. The most significant intervention in this respect is in Tripoli where a main street in the heart of the old city will be closed. Such an intervention was tested a travel forecasting model to conduct a network analysis for the Tripoli area with and without the proposed closure and diversion of the traffic flow to an existing boulevard along Nahr Abou Ali. The analysis showed that while vehicles may travel longer distances, traffic circulation will not be affected. Indeed, today traffic congestion is a permanent occurrence along the street proposed for pedestrian and the conversion will have various benefits on air quality and noise levelsed below. In the other cities, the streets converted to pedestrians carry low side traffic and as such will not impact overall traffic circulation patterns. On the contrary, pedestrian safety as well as air quality and noise levels will improve.

### 5.2 Air Quality

Construction is a source of dust emissions that may have temporary impact on local air quality. Emissions during the construction phase in general are a function of land clearing, excavation schemes, cut and fill operations, and the machinery used on-site. Emissions will consist primarily of particulate dust matter released as a result of rehabilitation activities, and to a lesser extent of emissions from the on-site usage of construction equipment.

Dust emissions often vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. For this phase, it is expected that negative impacts on air quality will occur in and around the immediate locality of a site under construction. In order to quantify this impact, the total construction emissions and the corresponding ambient particulate matter concentration were estimated (Annex A).

It was found that the construction activity will indeed have a temporary negative impact on air quality in the immediate vicinity of site, in terms of dust emissions. However, such an impact will not be significant, given the relatively small construction areas at one time and the short duration of the construction phase, particularly if proper management measures are adopted as described below in the impact mitigation (Chapter 7).

During the operation phase, the air quality along streets converted to pedestrian only will certainly benefit from improved air quality as a result of the elimination of vehicle-induced emissions along these roads. However, air quality may be negatively impacted at a global and local scales depending on the city under consideration. At a global scale, one of the objectives of the proposed CHUD project is to attract more visitors/tourists who will invariably visit the various cities by car thus increasing total vehicle-induced emissions. Within the same city, the conversion of some streets, such is the case of Tripoli, will increase travel distances around the old city for drivers to reach their destination. Hence, overall emissions will increase as well. In both cases, the impact of increased emissions is typically much less than the potential gain from converting a highly frequented street into a pedestrian one. At a local scale, air quality impact can be significant under certain conditions. For instances, in most cities, proposed parking areas/facilities can bring a high number of cars into one single location. Atmospheric dispersion simulations conducted at proposed parking areas/facilities in various cities indicate that CO levels (used as an indicator for air quality) will increase in the vicinity of these areas (within less than 100 meters) and often exceed the WHO and Lebanese air quality standards. Note that within an underground parking facility, the concept of the box model can be applied to estimate indoor exposure levels and air ventilation requirements. In this case, pollutant concentration estimates are compared to maximum allowable contaminant exposure levels in an occupational setting to assess the extent of impacts from car exhaust emissions on workers and customers inside the parking facility. Occupational exposure is generally not considered within the scope of an EIA process.

## 5.3 Noise

Noise levels during the construction phase are a function of the rehabilitation scheme and the machinery used on-site. Table 5-2 shows typical energy-equivalent noise levels associated with various work phases at a building construction site, when all pertinent equipment is present.

Table 5-2 Typical noise levels at a building construction site (USEPA, 1972 *cited in* Canter, 1996)

| *Phase* | *Noise level (dBA)* |
|---|---|
| Ground clearing | 84 |
| Excavation | 89 |
| Foundations | 78 |
| Erection | 87 |
| Finishing | 89 |

Noise from construction operations is different from noise from other sources because it is caused by many types of equipment, and the resulting adverse effects are temporary since the operations are relatively short term. In order to assess the extent of potential noise impacts at a typical construction site, a noise model specific for construction operations was applied (Annex B).

The simulated noise levels at different radii away from the site are presented in Figure 5-1, which indicates that the daytime Lebanese noise standard for the Project Area will be exceeded. As such, residential units in the vicinity of the site will experience temporary periods of high noise levels, typical of any construction activity.

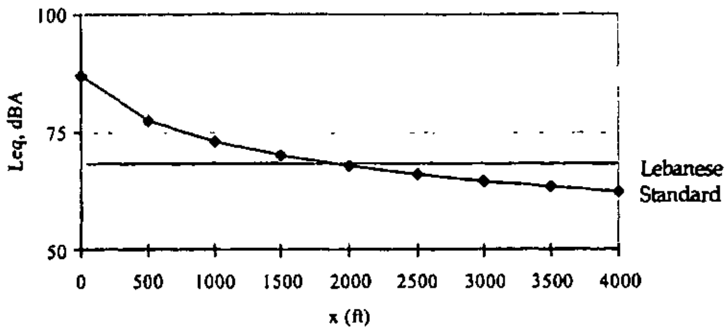


Figure 5-1 Noise levels at different radii around the site during construction

At the operational level, which represents the long-term phase of the proposed project, the impact is less significant. In fact, noise levels will decrease in the areas where pedestrian streets are created. While this indicates that no negative impacts will result from the proposed project as compared to base conditions, it sometimes does not preclude the need for mitigation measures to address the starting base condition. This will be particularly true at newly created parking areas/facilities. Note that within an underground parking facility, noise levels can be compared to allowable exposure levels in an occupational setting to assess the extent of impacts from vehicle noise emissions on workers and customers inside the parking facility or an underpass. Occupational exposure is generally not considered within the scope of an EIA process.

### 5.4 Landscape and Visual Intrusion

Negative impacts on existing landscape at very few locations and visual intrusion at the proposed sites for rehabilitation are inevitable during the construction phase. At the operational level however, these impacts will certainly be positive since this is indeed a rehabilitation project to improve the current conditions of various sites. Field surveys to collect information about the urban landscape at selected locations have been conducted. The survey consisted of a visual assessment and photography including the recording of existing vegetation, where it exists, and site usage. The survey indicates that the areas surrounding the most sites, are used primarily for a combination of residential and commercial activities. Hardly any location visited to date had any landscaping with the exception of the Nawfal Palace in Tripoli, which is located across a public garden. No major rehabilitation is occurring at that location. Hence, the impact on the landscape will be limited, if any.

### 5.5 Waste Generation

Construction activities are inherently associated with the generation of waste from building material. The extent of waste generation from the proposed CHUD project can be significant particularly at sites where complete rehabilitation may occur (such is the case in Tyre and Byblos) or an underground parking facility is planned (such is the case in Tripoli). The impact of the generated waste is dependent primarily on the waste management option that will be adopted during the construction phase.

At the operational level, construction waste generation from these facilities is minimal and does not present a significant impact. However, the project will result in increased quantities of solid waste and wastewater generation due to increased attraction of visitors/tourists. These increased quantities will add to an already existing problem in most of these cities as discussed above in Chapter 4. Baalbeck is of particular concern in this respect given that the current management of wastewater and solid waste is already impacting archaeological resources. The fishing port of Tyre is another location of major concern. As indicated in Chapter 4, current wastewater discharge from the old city occurs in the fishing port which is part of the rehabilitation project. Various alternatives for this specific location are examined within the mitigation measures (Chapter 7).

Fortunately, plans for better management of both solid waste (through sanitary landfills) and wastewater (through secondary wastewater treatment plants) near completion or are underway in all cities. When these plans materialize the projected increase in solid waste and wastewater generation rates will be within the handling capacity of the planned facilities. Note that if the attraction rates of visitors/tourists increase dramatically as what is observed in some coastal and cultural heritage cities in Europe or Turkey, the design capacity of most planned facilities will not be adequate and serious mitigation measures would be necessary in such an eventuality which is not expected in the near future.

### 5.6 Water Quality

Construction activities particularly rehabilitation work generates significant amounts of dirt and dust. In addition, lubricants and solvents are commonly used in similar construction projects. These may impact the surface water, groundwater, and seawater quality particularly following rainfall events. During such events, runoff will occur and carry the litter and pollutants to undesirable locations. This can be of particular concern for coastal work along the seashore in Byblos, Saida, and Tyre.

During the operation phase, the potential increase in vistors/tourists is likely to exert more water demand, which in turn is translated into more water exploitation that is often extracted from groundwater resources. Overexploitation of the latter can affect its water quality, which is already exhibiting seawater intrusion and bateriological contamination. Increased numbers of visitors/tourists tend to increase littering which can have a negative impact on seawater quality in coastal cities. The vehicle fleet and average daily trips will also increase thus increasing pollutants (i.e. oil, lubricants) from non-point sources. Compared to the amount of pollutants in industrial and domestic wastewater, the amount attributable to road transport is extremely small. Therefore, it is not expected that non-point sources related to transport activities will have any additional impact on water quality.

Similar to increased solid waste and wastewater generation rates, the projected increase in water demand and vehicle trips due to the attraction of visitors/tourists can be accommodated with existing resources. However, if attraction rates increase dramatically as what is observed in some coastal and cultural heritage cities in Europe or Turkey, the design capacity of most planned and existing facilities will not be adequate and serious planning and mitigation measures would be necessary in such an eventuality which is not expected in the near future.

## 5.7 Health and Safety

Health and safety are considered primarily in terms of potential exposure and accident occurrence (direct and indirect) to workers on-site, pedestrians, operators or visitors during both the construction and operation phases. In this respect, CDR has developed specific site health and safety guidelines for contractors involved in construction projects (Annex C). These guidelines will be adopted for the proposed project. In the context of archeological sites, the safety of visitors/tourists can become a major concern and proper management procedures must be adopted.

Note that, in the absence of accident data in Lebanon in general and the project cities in particulary, and the difficulty in obtaining unit costs for fatal, injury and property damage crashes in Lebanon, the changes in accident rates for the proposed project were not estimated. However, it is important to note that the project will result in increased long distance trips which may have negative impacts on traffic safety based on international experience. The potential additional impact accrued on road users due to the increase in fatal, injury, and property damage crashes will not be accounted for in the stream of impacts for a particular rehabilitation program, which could bias the socio-economic benefits described below.

## 5.8 Archaeology and Cultural Heritage

As indicated in the project description (Chapter 2), the main components of the proposed CHUD project consist of archaeological sites conservation and management (Tyre and Baalbeck) as well as the rehabilitation of historic city centers (Tripoli, Byblos, Saida, Tyre, and Baalbeck). The conservation/rehabilitation phase involve various construction activities that can impact the existing conditions negatively if they are not systematically planned and organized, carefully implemented, and well-managed. The construction phase can presumably be well-controlled however, the operational phase is projected to attract a larger number of visitors/tourists who will naturally be roaming or visiting archaeological sites and newly rehabilitated city centers and buildings. While this is a desired outcome of the proposed CHUD project, it can bring about negative impacts if proper management practices are not adopted and implemented with commitment and strict enforcement.

## 5.9 Socio-Economics

A stakeholder analysis and social assessment for the proposed CHUD project has been recently completed (Information International, 2002). The implementation of the project components will result in various socio-economic impacts, which are summarized below.

5.9.1 Potential positive impacts

- *Increase in the number of tourists and increase in their expenditures.* Baalbeck attracts an estimated 89,000 visitors yearly (highest annual turnover in the country) due to its internationally renowned archaeological sites and its International summer festivals. This number is expected to grow rapidly upon the implementation of the project. Moreover, there will be the potential to integrate Baalbeck into a wider network of tourist itineraries including eco-tourism. Similarly, Byblos, the second most visited city after Baalbeck, Tripoli and Saida are expected to benefit from an increase in the number of tourists. Quantitaively, the expected growth in the number of tourists in Tripoli and Tyre will vary from 6 to 17 percent (Table 5-3).

Table 5-3 Growth rate of tourists with corresponding expenditure (Information International, 2002)

| *Indicator* | *Tripoli* | *Tyre* |
|---|---|---|
| Number of tourist in 2001 | 17,487 | 19,000 |
| Expected growth rate, % | 6 to 10 | 10 to 17 |
| Expected number of tourist | 33,000 in 2008 | 45,000 in 2010 |
| Increase in the expenditure of a local tourist, USD/person/day | from 41 in 2001 to 52 in 2008 | from 32 in 2001 to 41 in 2010 |
| Increase in the expenditure of a foreign tourist, USD/person/day | from 57 in 2001 to 94 in 2008 | from 38 in 2001 to 52 in 2010 |

- *Creation of new employment opportunities.* Direct job creation will result from the employment of workers involved in the management of rehabilitated sites, execution of works (rehabilitation of facades, public spaces, infrastructure works, rehabilitation of monuments, commercial spaces, parking). Indirect employment will occur as a result of the increase in the expenditure of tourists, creation of new markets in the newly formed commercial spaces, hotels, and development of micro-credit activities.

- *Improve accessibility and connections to the old cities.* This would be the result of improvement to the existing circulation network and the creation of parking structure on the city's peripheries, and the reorganization of parking spaces. The construction and reorganization of vehicle and bus parking facilities, as well as shuttle services will add the benefits of availability of organized and shaded parking spaces outside the limit of the old city, the opportunity of how to approach the city, and a contribution to economic development through creation of income generating activities (employment through the operation and maintenance of the shuttle service, in commercial activities, and along access itineraries).
- *Improvement in the quality of life of inhabitants.* Upgrading of the physical infrastructure such as solid waste management, water and wastewater networks, electrical connections, and the improvement in the landscaping, creation of green areas and public places will improve the quality of life for inhabitants of the area and the city, as well as improve the value of land and the value of assets.
- *Revival of the urban core and facilitates and its functional re-integration into the city as a whole* through the upgrading and generation of new activities will help. This will result in drawing more residents as well as government and educational institutions to the core of the city.
- *Enhancement of functional and visitor diversity to the center* through the introduction of cultural and educational centers as well as thematic tourist itineraries This will result in an increase in the local productivity and insure survival of near extinct trades (handicrafts, artisanal works, specialized construction techniques). The rehabilitation of some of the old Souks and the restoration of monuments and transforming them to hotels or cultural centers will improve tourism (transformation of Khan el Askar to a cultural center, Khan el Rabou to an agro-industrial center, spice and home made or organic food products).
- *Improvement of the quality of the urban environment and life for inhabitants and visitors* through the potentail relocation of polluting industries to open available spaces for more varied economic functions. In Tyre, the relocation of the fish and meat market that exists within the old city to an outside area will result in a net environmental improvement. In Saida, the relocation of furniture making to an industrial area outside the old city, the regrouping of specific traditional activities to facilitate deliveries, the creation of public spaces to relieve the density of residential neighborhoods, reorganization of the meat, poultry and the fish markets will improve the quality of the urban environment.
- *Inform tourists about the historical importance of the cities* through the creation of pedestrian access in one of the most dramatic approaches to the old cities. The provision of sidewalks along roads helps in improving the safety of pedestrians.

- Improvement in the landscape and greeneries and creation of public spaces help in *eliminating the visual negative impact caused by the poor architectural aspect* of buildings boarding the roadsides.
- The treatment of the waterfront in Tyre through the upgrading of the fish market and fisherman association will *improve their economic status* as well as the *reviving of the fishing industry* with all its parallel activities including restaurants, boat building, and net making.
- *Reviving of certain agriculture-based products* such as jam and food processing and empowerment of the production of local women that are involved in handicrafts, sewing, and wood making (particularly in Baalbeck).
- The implementation of rehabilitation and renovation activities may help *prevent the degradation of archaeological remains* and the encroachment of unauthorized construction onto some of these sites as well as the haphazard restoration of individual structures.

5.9.2 Potential negative impacts

- Loss of income at exiting sites targeted for rehabilitation during the construction phase.
- Relocation of employment centers as a result of the potential relocation of some industries and warehouses outside the old city center.
- Marginalization of current inhabitants and their potential eventual relocation outside the historic quarter.
- Disturbances to residents during rehabilitation, renovation, and infrastructure works.
- Disruption of daily activities as a result of the rehabilitation works.
- Consolidation of dilapidated structures and the renovation of large monuments currently occupied by displaced populations such as Khan el Aaskar in Tripoli will entail the relocation of a small group of residents. Khan el Aaskar, which is currently owned by the municipality of Tripoli, is strategically situated in the Al Zahrieh district at the outskirts of historic core of Tripoli. The Khan was constructed in the late 13$^{th}$–early 14$^{th}$ century to house Mamlouk Troops. The Ottomans subsequently restored the Khan in the 18$^{th}$ century. As a result of the flood of the Abou Ali River in 1958, the municipality settled some residents as an emergency and temporary measure until securing an alternative permanent accommodation. Following the floods and to this date, all attempts to relocate the residents of the Khan to more suitable and healthy living environments have failed. The Khan is one of the largest covered spaces occupying around 5,200 $m^2$ and is surrounded by severely dilapidated privately owned structures. The Khan was never set up and or intended as a residential space. Current residents live in physically deplorable conditions lacking proper sanitary infrastructure, water and electric supplies. The Khan is characterized by high levels of overcrowding whereby the average family size of tenants is 7 persons per household occupying rooms that are 12$m^2$ in size

### 5.10 Summary of Impact Analysis

Environmental impacts analysis showed that the greatest environmental impacts will occur during the construction phase particularly with respect to dust and noise emissions, re-routing of traffic, visual intrusion, waste generation, water quality, safety concerns, potential damage to archaeological sites, and socio-economic impacts associated with loss of income and resettlement. Other potential impacts include temporary alterations in drainage patterns and expansion of existing quarries for construction materials. During the operation phase, the analysis showed that the proposed project will result mostly in positive environmental impacts when compared with the case of not implementing the project, all while recognizing that certain aspects associated with the project are in dire need for the adoption of proper management practices to ensure the sustainability of the project and its expected benefits (solid waste, wastewater, archaeological sites). Given the highly urbanized nature of the cities involved, the CHUD project is not anticipated to have significant environmental impacts from Project-induced growth or land use changes. Most lands in the vicinity of rehabilitated areas has been built and is largely occupied by low and medium-rise commercial and residential buildings. Relying on the quantitative analysis as well as judgment based on previous experience, Table 54 provides a qualitative summary of the significance of potential environmental impacts that are associated with both the construction and operation phases.

Table 5-4 Summary of potential environmental impacts

| *Potential Impact* | *Construction Phase* | *Operation Phase* |
|---|---|---|
| Traffic | - | 0/+ |
| Air quality | - | -/++ |
| Noise | - | 0/++ |
| Landscape and visual intrusion | - | +++ |
| Waste generation (solid waste and wastewater) | - | 0 |
| Water quality / supply (surface, groundwater, seawater) | - | -/0/++ |
| Health and Safety | - | + |
| Archaeology and cultural heritage | -/0 | -/+ |
| Socio-economics | - | +++ |

+++ High positive impact
++ Moderate positive impact
+ Low positive impact
0 Neutral impact
- - - High negative impact
- - Moderate negative impact
- Low negative impact

## 4. ANALYSIS OF ALTERNATIVES

The alternatives or options for intervention in every city were briefly described in the preliminary design studies of each project. The «do nothing» option is not favorable given the general consensus about the degrading quality of the urban fabric around valuable cultural heritage features and since desired urban conservation objectives would not be acheived. Concerning the siting of facilities, the proposed project offers limited opportunities for the analysis of alternatives given that the stress is put on certain specific sites whereby rehabilitation or renovation works are required. The remaining options aim at optimizing environmental quality in the urban areas of the various cities. While the various cities have similar rehabilitation elements that do not lend themselves into an analysis of alternatives, each city is characterized with peculiar features for which different options were considered and are outlined below by city.

### 6.1 Tripoli

In *Tripoli* the analysis of alternatives focused on four elements: Khan El Aaskar Resettlement, traffic circulation, parking, and rehabilitation.

#### 6.1.1 Resettlement - Khan El Aaskar

With the exception of Khan El-Askar, population resettlement in the entire CHUD project has been kept at a minimum. At Khan El Aaskar the resettlement is inevitable for the rehabilitation of the old city and the do nothing scenario would certainly not accomplish the much desired objectives of the project. One alternative that was considered by the municipality is to offer compensation through the expropriation committees. These tend to compensate tenants for expropriated properties according to the market price per square meter of occupied land for owners, and according to yearly income and rent for tenants. This option was also deemed inappropriate because the residents of the Khan have only informal tenure and as such do not fall within the compensation criteria of the expropriation committees. Consequently, a re-housing scheme proposed in the CHUD was the only viable alternative to be considered, although it was judged inappropriate at the beginning.

#### 6.1.2 Traffic Circulation

Two alternatives to divert the traffic from the old city center were considered. The objective of both alternatives was to limit the traffic flow towards the inside of the city center. These alternatives would relieve congestion and improve air quality along main streets inside the old city by practically converting them to pedestrian-only zones and alleviating the congestion problem along the western bank of Abou Ali River. With both alternatives however, the eastern bank of the Abou Ali River will become a relatively wide boulevard and will necessitate the relocation of the fruit and vegetable market to the northern entrance of the city as envisaged by the municipality. As a result, congestion and air quality problems may be transferred to the easter n bank of the Abou Ali River on the outskirts of the city.

#### 6.1.3 Parking

Several underground and open space parking facilities were proposed to resolve the parking problem around the old city center as a result of restricting most internal streets to pedestrian access only. Two potential underground parking garages were proposed at the base of the Citadel but were rejected by the DGA due to their proximity to the garden of a historic mosque. Alternatively, a large parking, bus and shuttle station was proposed on the northern entrance of the city in the neighborhood of Khan El Aaskar, on a plot of land owned by the municipality. This option was considered unnecessary at the present time given that it will result in the deterioration of the air quality and increase the noise levels as a result of increased traffic. While this parking has not been approved, it remains a potential option.

#### 6.1.4 Rehabilitation

Originally, the preliminary design considered two scenarios, a strategic large-scale scenario and a limited small-scale scenario. Both scenarios proposed several interventions in various zones of old Tripoli. A series of interventions were selected within the context of the small-scale scenario due primarily to financial limitations.

### 6.2 Byblos

In *Byblos*, several pilot projects for intervention regarding the cultural heritage and tourism development in the old city were proposed. Due to budget limitations, only some of these projects were selected for further development. Selection was based on the importance of the project, and priority to the municipality, the DGA, and the local residents. The analysis of alternatives focused on four components: the writing and books museum, the medieval wall promenade, the old harbor, and the pier extension.

#### 6.2.1 Writing and Books Museum

One major alternative to the final retained interventions in Byblos was the proposal to create the "Writing and Books Museum" as a symbolism to Byblos, the city of the alphabet. The external architecture of the museum was in the form of a huge reversed boat, symbolizing Byblos' maritime origins and importance. The museum will serve as a permanent exhibition center on the alphabet, writing, conference centers, libraries, book fair exhibitions and other cultural and art activities in order to promote the importance of the city. An underground parking serving some 600 cars and tourist buses will be built below the museum. The Beirut Tripoli highway will be passing through a 275 m long tunnel under the museum. This alternative, which was proposed to replace all the current interventions, was rejected for several reasons. The old city of Byblos is characterized by its typical historic souks, museums, and attractions that offer a cultural value and charm to its visitor. The introduction of the books and writing museum in its huge and remarkable architecture will concentrate tourists in one location outside the city rather than scattering them inside the old Souks to get a feel from its charm. In this context, the objectives of the CHUD project will not be achieved since instead of rehabilitating old historic monuments and preserving archaeological remains, a new modern project was proposed. In addition, with this alternative, pedestrians will make use of a rehabilitated Roman road to access the city's old center. Pedestrians would have to cross the gardens of a medieval cemetery, which was rejected by the Sunnite Waqf, the proprietor of the cemetery. Moreover, the resulting environmental impacts (traffic re-routing, congestions at the entrance of Byblos, traffic delays especially on the Beirut-Tripoli highway, air quality deterioration, noise problems, visual intrusion, etc.) during the extended construction phase and concentrated operation phase will be significant. Last but not least, at a cost of 25 MUSD financial limitations precluded the pursuit of this alternative. Naturally, the municipality of Byblos preferred to invest in the rehabilitation and improvement of the city center and preserve existing cultural heritage monuments rather than investing in the construction of a new museum.

#### 6.2.2 Medieval Wall Promenade

The medieval wall promenade, one of the most important cultural heritage components of the old city of Byblos, was amongst several minor alternatives that were considered. It consisted of the construction of wooden deck promenades along the wall surrounding the old city. The proposed alternative entails the digging and uncovering of the wall in some parts where it is completely hidden or partly built on (some houses were already constructed on the wall and uncovering it requires the demolition of parts or the whole of these houses). The alternative was rejected since it involves the relocation and resettlement of some people. As a compromise, it was agreed to create the wall promenade on the northern section of the wall only.

#### 6.2.3 The Old Harbor

Another proposal related to the improvement of the old harbor was the enlargement of the quay area by extending it by means of wooden decks. This enlargement would help reorganize traffic circulation and pedestrian access to the port. The fishermen rejected this alternative since the extension would reduce the available spaces for their fishing boats. The proposal was thus dismissed since one of the objectives of the project is to preserve the cultural habits on the fishing port and promote the fishing industry.

#### 6.2.4 Pier Extension

This alternative which was considered at the request of the Ministry of Transport (MoT), consisted of extending the current pier westward to provide protection for boats, to increase the anchorage capacity of the harbor, and to cater for ferry boats to reach Byblos. The municipality expressed its concern of using this pier as a commercial port area and anchoring commercial boats and convinced the MOT to adopt its own plan to only rehabilitate the existing pier by paving it which would exert less environmental stress on the marine environment and is cheaper, thus allowing the allocation of funds elsewhere in the old city.

## 6.3 Tyre

In *Tyre,* 26 pilot projects were identified at the early stages of the CHUD project. Of these, only six were retained. The other 20 were either repackaged into the retained projects or completely abandoned. Out of the 20 proposed pilot projects, 8 involve the conservation and management of archaeological sites that include the conservation of surfaces and structures of archaeological sites, and the development of sites and environs to enhance the visitor's experience. These proposals were integrated within an archaeological site conservation study that is being conducted by the Italian firm ARS Projetti. The reasons for abandoning the remaining projects were due to budget limitations, or to the undertaking of some of these projects by the municipality, or because they involve the relocation of housing/school or commercial units or land expropriation.

Wastewater in the old city surfaced out as a peculiar problem in this context of the proposed CHUD project. At present, wastewater from the old city is discharged directly into the fishing port, which is proposed to be rehabilitated through the project. The concern is related to the possibility that the project will be completed prior to the completion of a wastewater treatment facility planned for the city of Tyre and its surroundings in the nearby Abbasiyeh area. In the event such a scenario materializes, several alternatives were examined and the associated cost is accounted for within the mitigation plan (Chapter 7).

### 6.3.1 Wastewater collection and treatment

At present, wastewater from the old city is discharged in the fishing harbor through several short and submerged pipes. The proposed CHUD project includes the rehabilitation of the port which means that the old city's wastewater can no longer be discharged into the fishing port and must be diverted to a nearby pumping station. From this station, the wastewater is supposed to be pumped to a surface outfall located to the west of Tyre. In the event of the pumping capacity is exceeded which is what is currently happening because additional sources are linked to the station, the wastewater is discharged into the sea through a surface outfall on the eastside of Tyre not far from the fishing port. In order to resolve this situation, two alternatives were considered:

- Prevent further discharge in the port and through eastern outfall, ensure the capacity and operation of the pumping station, elongate the surface outfall, and continue to discharge until the planned Abbasiyeh facility is operational.
- Prevent further discharge in the port and through eastern outfall, ensure the capacity and operation of the pumping station, construct a temporary treatment plant near the station, treat the water and use the effluent for landscaping or discharge to the sea until the planned Abbasieh facility is operational

### 6.4 Saida and Baalbeck

In *Saida* and *Baalbeck* the analysis of alternatives is on-going and will be part of the final EIA report.

## 7. MITIGATION PLAN

The impact analysis found that the Project would result in an overall improvement in urban environmental quality as well as improvements to the quality of life of the residents in the five involved cities as a result of a) rehabilitation of degraded cultural sites and improving public accessibility to these sites; b) improving social life in and around the old city centers; c) improved traffic circulation in city centers; d) conversion of many streets to pedestrian only; and e) complementary improvements in parking management. The primary benefits would come from improved accessibility to quality cultural heritage sites, which is accompanied with socio-economic growth due to increased attraction rates of visitors/tourists, reduced noise and emissions from vehicles along streets converted to pedestrians only, and enhanced access to city centers with cultural heritage sites which is associated with improved social life in these centers. Another significant positive environmental impact relates to the elimination of wastewater discharge into enclosed ports (i.e. the city of Tyre).

The primary adverse environmental impacts that are associated with the construction and operation phases were discussed above in detail. These impacts can be minimized by careful planning of the staging used for construction and the adoption of proper management practices during operations and relying on environmental monitoring to support management decisions. Mitigation measures are typically recommended whenever the potential impact is significant with the ultimate purpose to eliminate or reduce the negative impacts of the proposed project. Mitigation measures are highly dependent on the significance of the predicted impact, the nature of the impact (permanent vs. temporary), or the phase of the project (construction vs. operation) and to the extent possible, they are presented below in this context

### 7.1 Mitigating Potential Traffic Impacts

The primary activities to mitigate traffic impacts during the construction phase include the proper dissemination of information regarding construction schedule and potential changes to the schedule, and providing alternate routes during all phases of construction. Proper planning and development of a traffic-control plan is essential to minimize the effects of the construction and its resulting inconvenience on traveling public and to insure safety of motorists, pedestrians and workers in the vicinity of construction zones. The basic principle in the development of traffic control plans is that motorists should be guided through construction zones in a clear and safe manner while approaching or crossing construction zones. This should be done through adequate warning, delineation and channelizing by proper marking, signing and other effective devices that will provide motorists positive guidance in advance of and through the work zone. Safety could be achieved in separating motorists and pedestrians for the work groups. Preliminary routing schemes covering the various construction phases must be developed and communicated early on to the public.

At the bidding stage, contractors must include a traffic re-routing plan during construction. The construction period should take into consideration the possibility of night construction, if it does not disturb neighboring activities. The tender documents will require contractors to present detailed plans for utility relocation, approved by the concerned utilities, before excavating the site. Without compromising safety of workers, pedestrians, or vehicles, traffic roads will be re-opened as early as possible, even before the final readiness of the site, in order to minimize the impact on traffic during the construction period. A summary of specific measures to be undertaken to control traffic impacts during construction follows:

*Supervising Consultant* ·

- Dissemination of information regarding construction schedule
- Planning and development of traffic control and re-routing plans during all phases of construction.
- Traffic monitoring and guiding of motorists outside the boundaries of the site.

*Contractor*

- Guiding motorists through construction zones.
- Installation of warning signs in and around the site.

### 7.2 Mitigating Potential Air Quality Impacts

During the construction phase, it is essential to adopt strategies to prevent or minimize dust emissions. The main control measures towards this purpose will be included within the construction contracts and be considered as requirements from contractors. These measures include proper site enclosure, on-site mixing and unloading operations; maintaining minimal traffic speed on-site; ensuring adequate maintenance and repair of construction machinery; and proper water spraying when necessary. The supervising consultant will have the responsibility of ensuring the implementation of these measures.

At the operational level, with the exception of parking facilities, the proposed project will not result in negative air quality impacts that can be mitigated at a local scale. At a global scale, long term mitigation plans are necessary to address existing air quality problems particularly that traffic-induced emissions constitute the major source of air pollutants in urban areas. In this regard, policy studies on urban air quality management are planned in the context of the Beirut Urban Transport Project and can ultimately benefit the cities of this project as well.

### 7.3 Mitigation of Potential Noise Impacts

The major mitigation measures required are during the construction phase. Construction activities are characterized by relatively short duration, the main area of activity may move around the site and the working hours may be long but variable and never continuous. The extent to which construction noise impacts may be mitigated is more limited than on fixed operational sites because of the mobile sources. Moreover, the fact that much of the work is performed in the open, overly restrictive working measures might unreasonably prolong the construction phase. Typical mitigation measures that should be enforced during the construction phase to minimize noise levels are:

- Choices of inherently quiet equipment
- Proper site logistics and planning
- Proper maintenance of equipment
- Limiting site working hours if possible
- Informing the local when noisy activities are planned
- Placing muffling devices that will reduce vibration
- Scheduling noisy activities during the morning hours
- Enforcing noise monitoring
- Keeping equipment speed as low as possible

The noise control measures will be included within the construction contracts and considered as requirements from contractors. The supervising consultant will have the responsibility of ensuring the implementation of these measures. At the operational level, the proposed project will not result in negative noise impacts.

### 7.4 Mitigating Landscape and Visual Intrusion Impacts

The main landscape impacts were limited in extent to public gardens. In this context, provisions must be made to re-vegetate to original status. During the operation phase, public gardens or additional landscaping introduced through the proposed project will be managed by the municipality where they are located as is the case today. Visual intrusion during the construction phase will be minimized by proper site fencing and housekeeping within the site proper. The final design will adopt provisions to minimize visual intrusion. Such provisions include blending color of paint, exterior construction material, and architectural features with the surrounding areas, and implementing appropriate landscaping with visual screens and greenbelts where necessary. The control measures for landscape impacts and visual intrusion will be included within the bid specifications and construction contracts. The supervising consultant will have the responsibility of ensuring the implementation of these measures.

### 7.5 Mitigating Waste Generation

During rehabilitation projects of this magnitude, there may be a tendency to dispose of the waste generated from the proposed project in along the seashore given that most of the cities are located on the coast. This method of waste management is not acceptable unless the waste is disposed of at a Government-permitted site. Construction waste should be disposed of appropriately at locations designed for this purpose. At present, the disposal facilities at all cities are not adequate. Excavated soils can be used as cover or support material at existing facilities, depending on capacity. While many landfills are being planned for construction in various parts of Lebanon and can be considered as a final repository for construction waste generated from the proposed project, many of these landfills will either have limited capacity or will not be completed by the time the project is initiated. Therefore, an agreement must be reached with the respective municipalities to designate an area in each city for construction wastes. Last but not least, consideration should be given whenever feasible for waste material recycling and re-use. Note that all existing landfills belong in principle to the Government and they are often operated by an independent contractor through the municipality. Specific routes should be designated by the supervising consultant to control and manage the movement of large amounts of waste through city streets to the final disposal sites. To the extent feasible, these routes will be selected in a way to minimize potential traffic congestion. Weight limits for trucks and measures to control potential dust emissions (by covering or water spraying) should be adopted by the contractor. The control measures for waste collection and disposal will be included within the bid specifications and construction contracts. The supervising consultant will have the responsibility of ensuring the implementation of these measures.

During the operation phase, since one of the main objectives of the CHUD project is the attraction of a larger number of visitors/tourists, it is expected that increased solid waste and wastewater generation rates will occur. While the additional rates are not significant to cause an environmental impact under normal conditions in a typical city, it should be noted that the existing solid waste and wastewater conditions in all involved cities require better management irrespective of the proposed CHUD project. In this context, various projects/programs are underway across Lebanon in general and in the cities involved in particular. The capacity of these projects/programs once completed will easily accommodate the projected increased rates associated with the implementation of the CHUD project. In this context, the situation in the old city of Tyre is of most concern since at present, wastewater from the old city is discharged directly into the fishing port which is proposed to be rehabilitated through the proposed CHUD project. As mentioned above, the concern is related to the possibility that the CHUD project will be completed prior to the completion of the wastewater treatment plant for the city of Tyre and its surroundings. In the event such a scenario materializes, two mitigation alternatives were considered in the analysis of alternatives and the associated cost is accounted for within the mitigation plan summary cost (Table 7-1). Once again, note that significant investments would be required if the attraction rates of visitors/tourists increase dramatically as what is observed in some coastal and cultural heritage cities in Europe or Turkey, the design capacity of most planned facilities will not be adequate and serious mitigation measures would be necessary in such an eventuality which is not expected in the near future.

### 7.6 Mitigating Water Quality / Supply Impacts

The most appropriate mitigation measures to ensure minimal water quality impacts include provisions for proper surface drainage during both the construction and operation phases, and the minimization of on-site water and chemical usage (oil, lubricants and fuel), and soil exposure time during the construction phase. Note that there are no provisions or regulations in Lebanon for the proper disposal of oil, lubricants and fuel used by the construction equipment. These wastes when mixed with other construction waste are typically disposed of in a landfill and as such they will be handled similar to what is described in Section 7.5.

### 7.7 Mitigating Health and Safety Impacts

Health and safety are considered primarily in terms of potential exposure to pollutants (particularly particulate matter) and accident occurrence (direct and indirect) to workers on-site, pedestrians, and operators or visitors/tourists during both the construction and operation phases. In this respect, the CDR has developed specific site health and safety guidelines for contractors involved in construction projects (Annex C). The guidelines will be included within the bid specifications and construction contracts. The supervising consultant will have the responsibility of ensuring the implementation of these guidelines. Note that a health-based economic valuation of air or water quality is beyond the scope of the present EIA.

### 7.8 Mitigating Archeological and Cultural Heritage Impacts

As indicated above, the impacts of the construction phase can be minimized through proper planning and careful implementation. The operational phase is associated with an increased number of visitors/tourists who will frequent archaeological sites and newly rehabilitated city centers and buildings. Visitor guidelines must be developed to ensue the protection of these sites. Provisions must be made to eliminate the effects of littering through the development and implementation of a waste collection and management plan at the sites.

### 7.9 Mitigating Socio-Economic Impacts

While the proposed CHUD project will bring about positive socio-economic impacts, it is not without negative impacts particularly during the construction phase. The most significant in this context include the resettlement of dwellers of Khan El-Askar in Tripoli and potential disturbance and loss of income at or around facilities or areas under construction.

*Resettlement Action Plan*

The implementation of the CHUD project involves, amongst its various tasks, the rehabilitation and renovation of Khan El Aaskar, and transforming it into a cultural and artisanal exhibition center for regional products and handicrafts. This component involves the resettlement of the current residents (64 families or 324 individuals) and relocation of 78 of the existing commercial activities. The objective of he resettlement plan for the Khan is to provide current residents with improved living conditions whilst allowing the municipality to recuperate its property and transform it into an economically viable enterprise on a citywide scale. The location of this project insures the continuation of existing community networks and trigger minimal disruption to the daily patterns of residents. More importantly, the housing project will insure a qualitative improvement in the physical environment of the inhabitants.

The project will be executed in three phases. The phasing of the project is designed to provide a smooth transition of the residents into their new homes. This will result in long-term impacts on the resident population by bringing about a dramatic improvement in the living conditions of the residents, minimizing the disruption of community links by limiting the resettlement option within the old city, and minimizing the disruption of the livelihood of commercial tenants by maintaining them in place. The three phases are:

- Phase 1 will be concerned with the renovation and rehabilitation of the Khan and the resettlement of part of its residents. This phase involves the re-housing of 26 families, and the relocation of 12 small business enterprises and 24 warehouses from their present location in the Northeastern block of the Khan to newly constructed social housing in the immediate vicinity in a way that largely maintains the social fabric and community relations. The plan would permit the rehabilitation of the Khan as a visitor's center and a regional artisanal hub, thus contributing to the economic regeneration of the city, whilst greatly improving the living conditions of some of the city's poorest inhabitants.
- Phase II of the project will be the re-housing of the residents of the other half of the Khan. This phase is not planned at this stage and is dependent on the availability of suitable alternative housing being located.
- Phase III involves the renovation of the commercial premises, which involve temporary displacement of businesses to allow undertaking of works.

*Eligibility and benefits*

The municipality, which owns the Khan, is committed to resettling all current residents and tenants in alternative housing. The basic principles of the resettling project are that each family will be given an apartment commensurate with family size, and that residents would be charged affordable rents in a fair and just manner that would ensure no hardships to the individual families. The municipality will retain ownership for these units.

As indicated above, Phase I will involve the relocation of 26 housing units. Residents will be allocated units in the complex proportionate to family size. The number of units needed from each size is presented in Table 7-1.

Table 7-1 Phase I housing units

| *Family size* | *Area of apartment* $m^2$ | *Units needed for phase I* |
|---|---|---|
| 1 person | 20 | 2 |
| 2 to 5 | 60 | 12 |
| 6 to 8 | 80 | 9 |
| 9 to 12 | 100 | 3 |
| > 13 | 120 | 0 |
| *Total units* | | *26* |

All commercial units to the exterior of the Khan will be kept in place while units on the interior will be relocated in the new complex. Eleven commercial occupants will be relocated on the ground floor of the new building with direct access to the street (stores ranging in size from 10 to 15 $m^2$) while 24 commercial non retail units (warehouses and storage areas) as well as environmentally polluting units (leather dying) will be relocated in the underground units of the complex.

The RAP is expected to take place in a smooth manner that will be insured by a committee that will be formed to handle the resettlement and to address any problem that might arise. Upon completion of the housing project, residents will be moved to their allotted units. Existing warehouses and stores will be moved to their allotted areas on the renovated premises. According to the RAP the works on phase I shall commence as of September 2003 after approval of the loan by the bank, ratification by the Lebanese council of Ministers and Parliament, preparation of bidding and tender documents. The World Bank will finance the project at 80 percent while the municipality will contribute to 20 percent of the total budget.

### 7.10 Summary of Impact Mitigation

Table 7-2 presents a summary of the proposed elements of the Mitigation Plan that will be considered in the various phases of the project. Implementation responsibility and cost allocation for the mitigation plan are also included. The elements of the Mitigation Plan are subdivided into the three phases of the project namely: design, construction and operation. With the exception of the wastewater management in Tyre, the cost of all other elements during the design and construction phase will be part of the cost allocated for the corresponding phase. During the operation phase, the elements of the Mitigation Plan will become the responsibility of the DGA and/or the municipality where a certain project component is located. With the exception of the wastewater management in Tyre, these elements become part of the routine maintenance activities undertaken by the DGA or the municipalities. As such, the cost of the Mitigation Plan during the operation phase is not directly related to the proposed project (excluding the operation cost of the Tyre wastewater management and monitoring cost, which are addressed below).

Table 7-2 Summary of proposed elements of the mitigation plan

| *Impact* | *Mitigation measure* | *Responsibility* | *Cost* |
|---|---|---|---|
| **DESIGN PHASE (PREPARATORY AND FINAL)** | | | |
| Traffic | □ Public participation<br>□ Modification of design to reflect public consultation process<br>□ Development of re-routing schemes<br>□ Assessment of projected increase in traffic vs. congestion and change in circulation patterns | CDR / Consultant | Included in final design preparation |
| Air quality | □ Assessment of existing standards, regulations<br>□ Assessment of vehicle-induced emissions vs. traffic increase and change in circulation patterns<br>□ Maximizing the distance to adjacent buildings<br>□ Adequate ventilation in parking facilities | CDR / Consultant | Included in final design preparation |
| Noise level | □ Assessment of existing standards, regulations<br>□ Assessment of vehicle noise emissions vs. traffic increase and change in circulation patterns<br>□ Consideration for porous material, flexible joints and supports<br>□ Consideration for sound barriers<br>□ Protection of buildings and sensitive receptors | CDR / Consultant | Included in final design preparation |
| Landscape and visual intrusion | □ Documentation of existing conditions<br>□ Blending color(s) of paint<br>□ Blending exterior construction material<br>□ Blending architectural features<br>□ Provisions for visual screens or greenbelts | CDR / Consultant | Included in final design preparation |
| Waste generation | □ Locate nearby disposal sites and secure permit for waste disposal<br>□ Explore waste material recycling or re-use<br>□ Assessment of projected increase in solid waste generation<br>□ Assessment of projected increase in wastewater generation<br>□ Development of solid waste management system at archaeological sites<br>□ Tyre: special case temporary management of wastewater from the old city | CDR / Consultant<br><br><br><br>CDR / DGA / Consult | Included in final design preparation<br><br><br><br><br>10,000 USD |
| Water quality | □ Provisions for proper surface and ground water drainage<br>□ Assessment of projected increase in water demand | CDR / Consultant | Included in final design preparation |
| Health and safety | □ Develop and/or review and update general health and safety plans | CDR / Consultant | Included in final design preparation |
| Archaeological and cultural heritage | □ Develop rehabilitation/construction monitoring plans<br>□ Develop Archeological Chance Find Procedures | CDR / DGA / Munici y /<br>Consultant | Included in final design preparation |
| Socio-economics | □ Eliminate or minimize land acquisition and population resettlement<br>□ Ensure community participation<br>□ Develop proper compensation and resettlement plans | CDR / Consultant | Included in final design preparation |

Table 7-2 Summary of Proposed Elements of the Mitigation Plan *(Continued)*

| *Impact* | *Mitigation measure* | *Responsibility* | *Cost* |
|---|---|---|---|
| | **CONSTRUCTION PHASE** | | |
| Traffic | ☐ Public communication<br>☐ Re-routing schemes<br>☐ Extended construction hours | CDR / Consultant / C actor | Included in construction |
| Air quality | ☐ Site and stock pile enclosure<br>☐ Spraying of long term stockpiles with chemical bonding agents<br>☐ On-site mixing in enclosed or shielded areas<br>☐ Proper unloading operations<br>☐ Water damping of stockpiles when necessary (dry conditions)<br>☐ Sealing of completed earthworks and<br>☐ Re-vegetation as soon as possible<br>☐ Medium and heavily used haul routes permanently surfaced<br>☐ Damping unsurfaced haul routes<br>☐ Keep hauling routes free of dust and regularly cleaned<br>☐ Minimal traffic speed on-site with proper enforcement<br>☐ Maintenance and repair of construction machinery | CDR / Consultant / C actor | Included in construction |
| Noise level | ☐ Construction of site enclosure<br>☐ Control of timing of noise emissions<br>☐ Proper road maintenance<br>☐ Enforcement of speed limits<br>☐ Employ low noise machinery, or machinery with noise shileding and/or sound absorption materials (e.g. on-site power generator enclosure)<br>☐ Proper maintenance of equipment and machinery | CDR / Consultant / C ctor | Included in construction |
| Landscape and visual intrusion | ☐ Preserve existing vegetation when feasible<br>☐ Blending color(s) of paint<br>☐ Blending exterior construction material<br>☐ Blending architectural features<br>☐ Provisions of visual screens or greenbelts<br>☐ Implementing appropriate landscaping | CDR / Consultant / Co ctor | Included in construction |
| Waste generation | ☐ Waste transport and disposal at designated disposal sites<br>☐ Development of solid waste management system at archaeological sites<br>☐ Tyre: special case temporary management of wastewater from the old city | CDR / Consultant / Co ctor<br>CDR / DGA / Municip / | Included in construction<br>Included in construction<br>290,000 USD |
| Water quality | ☐ Proper surface and ground drainage<br>☐ Decrease water usage during the construction phase<br>☐ Minimize soil exposure time during the construction phase<br>☐ Minimize chemical usage (lubricants, solvents, petroleum products) | CDR / Consultant / Co ctor | Included in construction |

Table 7-2 Summary of Proposed Elements of the Mitigation Plan *(Continued)*

| *Impact* | *Mitigation measure* | *Responsibility* | *Cost* |
|---|---|---|---|
| | **CONSTRUCTION PH ASE** | | |
| Health and safety | ❑ Provide pedestrian walk wa<br>❑ Install proper warning sign<br>❑ Provide protective clothing l equipment<br>❑ Create buffer zones<br>❑ Follow CDR's written proc res | CDR / Consultant / Contractor | Included in construction |
| Archaeological and cultural heritage | ❑ Documentation of Buried S and Conservation of Materials<br>❑ Construction Monitoring b rchaeological Consultants<br>❑ Implementation of Archaeo cal Chance Find Procedures, if needed | CDR / DGA<br>Consultant/contractor | Variable to be defined on a case-by-case basis. It is recommended to set a fund aside. |
| Socio-economics | ❑ Ensure community particip n<br>❑ Implementation of Resettle nt Plan | CDR / Consultant / Contractor | Included in construction |

Table 7-2 Summary of Proposed Elements of the Mitigation Plan *(Continued)*

| *Impact* | *Mitigation measure* | *Responsibility* | *Cost* |
|---|---|---|---|
| **OPERATION PHASE** | | | |
| Traffic | ❑ Maintenance and operation of traffic management organization | Government | Not directly part of this project |
| Air quality | ❑ Maintenance of ventilation in parking facilities<br>❑ Implementation of long term strategies | Municipalities<br>Government | Not directly part of this project |
| Noise level | ❑ Sound insulation and pavement maintenance<br>❑ Limiting vehicle speed<br>❑ Implementation of long term strategies | Municipalities<br>Traffic police<br>Government | Not directly part of this project |
| Landscape and visual intrusion | ❑ Maintenance of exterior material, visual screens or greenbelts | Municipalities | Not directly part of this project |
| Water quality | ❑ Maintenance of surface water drainage | Municipalities | Not directly part of this project |
| Waste generation | ❑ Maintenance of waste management system at archaeological sites<br>❑ Tyre special case temporary management of wastewater from the old city | DGA / Municipality<br>CDR / DGA / Municipality | Not directly part of this project<br>30,000 USD / year |
| Health and Safety | ❑ Maintenance of signs and warnings | Municipalities | Not directly part of this project |
| Archaeological and cultural heritage | ❑ Routine monitoring and maintenance | DGA / municipality | Not directly part of this project |

## 8. ENVIRONMENTAL MONITORING

Environmental monitoring will be undertaken during the construction and operation phases in each of the five cities within the proposed CHUD project with the aim to:

- Verify the environmental impacts predicted in the EIA study
- Monitor the performance of the project and the effectiveness of mitigation measures
- Determine project compliance with national and international requirements and standards
- Take remedial action if unexpected problems and unanticipated impacts arise
- Improve cultural heritage site management and environmental control.

The Government of Lebanon (through the CDR) will be responsible for funding and undertaking the environmental monitoring activities. During the construction phase, the CDR supported by consultants would undertake the monitoring. The collected data will be provided to the MoE. During the course of the operational phase, depending on its capabilities and resources, the MoE can become responsible for implementing the monitoring, with the support of Consultants as appropriate. At this time, it is assumed that CDR will continue to be responsible for the monitoring plan implementation. The following sections describe a general outline of the proposed monitoring programs that will be undertaken during the construction and operation phases in each of the five cities.

### 8.1 Monitoring during construction and rehabilitation phase

During the construction and rehabilitation phase, monitoring will be conducted at varying frequencies depending on the parameter monitored. Monitoring will take place at specific locations whereby the environmental impacts are thought to be most important. The frequency of monitoring is included below. The parameters that will be monitored include:

- Traffic counts at identified monitoring stations
- Air quality using selected indicators at selected locations
- Noise level using selected indicators at selected locations
- Seawater quality at selected locations using selected indicators
- Runoff water quality at selected locations using selected indicators
- Landscape visual inspection and photographic documentation
- Waste generation through visual inspection and photographic documentation
- Archaeological deposits, when applicable
- Health and safety is to be monitored at the construction site throughout the construction period through inspection/supervision and photographic documentation in addition to the maintenance of a record of injuries and accidents, specifying their underlying cause and describing their location

## 8.2 Monitoring during the operation phase

During the operation phase, monitoring will be conducted for the following parameters. Detailed locations and frequencies of monitoring are detailed below.

- Traffic counts at identified monitoring stations
- Air quality using selected indicators at selected locations
- Noise level using selected indicators at selected locations
- Seawater quality at selected locations using selected indicators
- Landscape visual inspection and photographic documentation
- Waste generation through visual inspection and photographic documentation
- Maintenance of a record of injuries and accidents, specifying their underlying cause and describing their location
- Deterioration of archaeological sites by inspection and photographic documentation.

## 8.3 Monitoring plan implementation

The required equipment and technical skills for the implementation of a proper environmental monitoring plan are generally lacking at the professional level in Lebanon; particularly, with respect to the availability of analytical equipment to conduct air and water chemical analysis. Academic institutions are currently best equipped to assist in the implementation of the proposed plan. As such, the monitoring plan can be implemented in a collaborative effort between local consultants and academic institutions.

In order to ensure the proper implementation of the proposed environmental plan in each of the five cities, it is essential to maintain proper environmental monitoring particularly during the construction phase. For this purpose, qualified personnel must be designated. The detailed yearly staffing requirements for the implementation of the monitoring plan during the construction and rehabilitation phase, as well as the operation phase in each of the five cities including the definition of frequency, indicator, and sampling and monitoring locations are provided outlined in Tables 8-1a, to 8-5b.

## 8.4 Data reporting

Periodic environmental monitoring reports will be prepared to analyze the data collected, assess monitoring activities and provide recommendations to ensure the effectiveness of the overall environmental monitoring and management plan during the project life span. A yearly comprehensive report will be generated to present results of monitoring activities and evaluate the adequacy of environmental control measures in each of the involved cities. The contents of the report will include the original measurements, sampling locations, time of sampling, influencing factors (weather information, activities on site), environmental quality assessment and data analysis. The reports will be submitted to the CDR, DGA, MoE, and the World Bank. In case national standards for environmental quality that are issued by the MoE (Decision 8/1 dated January 2001 – Annex D) are exceeded, notifications will be issued to the contractor and site engineer to take immediate corrective actions.

Table 8.1a Summary of proposed monitoring plan for Tripoli

| Parameter | Location | Samples | Frequency | Phase | Responsibility |
|---|---|---|---|---|---|
| Traffic | At stations S1, S2, S3 | Continuous vehicle counts for 24 hours | Annually | Construct / Operation | CDR / Consultant |
| Air quality (TSP, CO) | At stations S1, S2, S3 | Four samples / location | Annually | Construct / Operation | CDR / Consultant |
| Noise ($L_{eq}$, $L_{min}$, $L_{max}$) | At stations S1, S2, S3 | Four samples / location | Annually | Construct / Operation | CDR / Consultant |
| Landscape[1] | At intersections and along the Abou Ali River | Visual inspection / photographic documentation | Annually | Construct / Operation | CDR / Consultant |
| Water Quality (pH, COD, Pb, Cu, Cr, Zn, TC, FC) | Upstream and downstream locations of line supplying old city center | Two samples / location | Annually | Construct / Operation | CDR / Consultant |
| Archaeology | At excavation sites<br>At archaeological sites | Visual inspection / photographic documentation | Continuous<br>Annually | Construct<br>Operation | / CDR / Consultant |
| Accidents (cars / pedestrians) | In the old city and at entrances | Police / newspaper records | Annually | Construct / Operation | CDR / Consultant |
| Health and safety / Hygiene | Within project boundaries | Visual inspection / photographic documentation | Continuous | Construct / Operation | CDR / Consultant |

S1 (at the entrance of the proposed parking facility), S2 (at the bridge crossing Abou Ali River after the Bortassiah mosque), S3 (At one point along the Souk)

Table 8.1b Estimated requirements for the implementation of the Environmental Monitoring Plan in Tripoli

| Parameter/Activity | Staff category | Number | Schedule | Cost (USD) |
|---|---|---|---|---|
| CONSTRUCTION & REHABILITATION PHASE | | | | |
| Traffic / Accidents | Traffic engineer | 1 | rt-time | 18,000 |
| Landscape | Landscape architect | 1 | rt-time | |
| Archaeology | Urban archaeologist* | 1 | ill-time | |
| Air / Noise / Water | Environmental specialist | 1 | rt-time | |
| Equipment and laboratory analysis fees | - | - | | |
| Health and safety | Health & Safety officer (Construction engineer)* | 1 | ill time | |
| Training | Environmental specialist | 1 | rt-time | |
| Reporting | Environmental specialist | 1 | rt-time | |
| Total annual monitoring cost during the construction and rehabilitation phase | | | | |
| OPERATION PHASE | | | | |
| Traffic / Accidents / Landscape | Traffic engineer | 1 | rt-time | 6,000 |
| Archaeology | Urban archaeologist | 1 | rt-time | |
| Air / Noise / Water | Environmental specialist | 1 | rt-time | |
| Equipment and laboratory analysis fees | - | - | | |
| Training | Environmental specialist | 1 | rt-time | |
| Reporting | Environmental specialist | 1 | rt-time | |
| Total annual monitoring cost during the operation phase | | | | |

*The archaeologist and the Health & Safety officers will be among the teams of the contractors executing the works

Table 8.2a Summary of proposed monitoring plan for Byblos

| Parameter | Location | Samples | Frequency | Phase | | Responsibility |
|---|---|---|---|---|---|---|
| Traffic | At stations S1, S2, S3 | Continuous vehicle counts for 24 hours | Annually | Constructio | Operation | CDR / Consultant |
| Air quality (TSP, CO) | At stations S1, S2, S3 | Four samples / location | Annually | Constructio | Operation | CDR / Consultant |
| Noise ($L_{eq}$, $L_{min}$, $L_{max}$) | At stations S1, S2, S3 | Four samples / location | Annually | Constructio | Operation | CDR / Consultant |
| Landscape[1] | At intersections | Visual inspection / photographic documentation | Annually | Constructio | Operation | CDR / Consultant |
| Seawater Quality (pH, BOD, TSS, TC, FC) | At stations S4, S5, S6 | Two samples / location | Annually | Constructio | Operation | CDR / Consultant |
| Water Quality (pH, COD, Pb, Cu, Cr, Zn, TC, FC) | Upstream and downstream locations of line supplying old city center | Two samples / location | Annually | Constructio | Operation | CDR / Consultant |
| Archaeology | At excavation sites<br>At archaeological sites | Visual inspection / photographic documentation | Continuous<br>Annually | Constructio<br>Operation | | CDR / Consultant |
| Accidents (cars / pedestrians) | In the old city and at entrances | Police / newspaper records | Annually | Constructio | Operation | CDR / Consultant |
| Health and safety / Hygiene | Within project boundaries | Visual inspection / photographic documentation | Continuous | Constructio | Operation | CDR / Consultant |

S1 (facing entrance of parking on highway ellipse), S2 (lower end of Decumanus Maximus road), S3 (facing the municipality parking)
S4 (at 10 m offshore, 1 m deep), S5 (at 20 m offshore, 1 m deep), S6 (at 100 m offshore, 1 m deep)

Table 8.2b Estimated requirements for the implementation of the Environmental Monitoring Plan in Byblos

| Parameter/Activity | Staff category | Number | edule | Cost (USD) |
|---|---|---|---|---|
| CONSTRUCTION & REHABILITATION PHASE | | | | |
| Traffic / Accidents | Traffic engineer | 1 | -time | |
| Landscape | Landscape architect | 1 | -time | |
| Archaeology | Urban archaeologist* | 1 | -time | |
| Air / Noise / Water | Environmental specialist | 1 | -time | |
| Equipment and laboratory analysis fees | - | - | | 15,000 |
| Health and safety | Health & Safety officer (Construction engineer)* | 1 | l time | |
| Training | Environmental specialist | 1 | -time | |
| Reporting | Environmental specialist | 1 | -time | |
| Total annual monitoring cost during the construction and rehabilitation phase | | | | |
| OPERATION PHASE | | | | |
| Traffic / Accidents / Landscape | Traffic engineer | 1 | -time | |
| Archaeology | Urban archaeologist | 1 | -time | |
| Air / Noise / Water / Archaeology | Environmental specialist | 1 | -time | |
| Equipment and laboratory analysis fees | - | - | | 5,000 |
| Training | Environmental specialist | 1 | -time | |
| Reporting | Environmental specialist | 1 | -time | |
| Total annual monitoring cost during the operation phase | | | | |

*The archaeologist and the Health & Safety officers will be among the teams of the contractors executing the works.

Table 8-3a Summary of proposed monitoring plan for Saida

| *Parameter* | *Location* | *Samples* | *Frequency* | *Phase* | *Responsibility* |
|---|---|---|---|---|---|
| Traffic | At stations S1, S2, S3 | Continuous vehicle counts for 24 hours | Annually | Construction / Operation | CDR / Consultant |
| Air quality (TSP, CO) | At stations S1, S2, S3 | Four samples / location | Annually | Construction / Operation | CDR / Consultant |
| Noise ($L_{eq}$, $L_{max}$, $L_{min}$) | At stations S1, S2, S3 | Four samples / location | Annually | Construction / Operation | CDR / Consultant |
| Landscape[2] | At intersections | Visual inspection / photographic documentation | Annually | Construction / Operation | CDR / Consultant |
| Seawater Quality (pH, BOD, TSS, TC, FC) | At stations S4, S5, S6 | Two samples / location | Annually | Construction / Operation | CDR / Consultant |
| Water Quality (pH, COD, Pb, Cu, Cr, Zn, TC, FC) | Upstream and downstream locations of line supplying old city center | Two samples / location | Annually | Construction / Operation | CDR / Consultant |
| Archaeology | At excavation sites<br>At archaeological sites | Visual inspection / photographic documentation | Continuous<br>Annually | Construction / Operation | CDR / Consultant |
| Accidents (cars/pedestrians) | In the old city and at entrances | Police / newspaper records | Annually | Construction / Operation | CDR / Consultant |
| Health and safety/Hygiene | Within project boundaries | Visual inspection / photographic documentation | Continuous | Construction / Operation | CDR / Consultant |

S1 (on the road along the seafront facing the sea castle) and at station S2 (at the entrance of the multi-storey parking outside the eastern perimeter of the old city), S3 (along rehabilitation activities)
S4 (at 10 m offshore, 1 m deep), S5 (at 20 m offshore, 1 m deep), S6 (at 100 m offshore, 1 m deep)

Table 8-3b Estimated requirements for the implementation of the Environmental Monitoring Plan in Saida

| *Parameter/Activity* | *Staff category* | *Number* | *Schedule* | *Cost (USD)* |
|---|---|---|---|---|
| **CONSTRUCTION & REHABILITATION PHASE** | | | | |
| Traffic / Accidents | Traffic engineer | 1 | Part-time | |
| Landscape | Landscape architect | 1 | Part-time | |
| Archaeology | Urban archaeologist* | 1 | Full-time | |
| Air /Noise / Water | Environmental specialist | 1 | Part-time | |
| Equipment and laboratory analysis fees | - | - | - | 7,000 |
| Health and safety | Health & Safety officer (Construction engineer)* | 1 | Full time | |
| Training | Environmental specialist | 1 | Part-time | |
| Reporting | Environmental specialist | 1 | Part-time | |
| Total annual monitoring cost during the construction and rehabilitation phase | | | | |
| **OPERATION PHASE** | | | | |
| Traffic / Accidents / Landscape | Traffic engineer | 1 | Part-time | |
| Archaeology | Urban archaeologist | 1 | Part-time | |
| Air /Noise/ Water / Archaeology | Environmental specialist | 1 | Part-time | |
| Equipment and laboratory analysis fees | - | - | - | 2,333 |
| Training | Environmental specialist | 1 | Part-time | |
| Reporting | Environmental specialist | 1 | Part-time | |
| Total annual monitoring cost during the operation phase | | | | |

*The archaeologist and the Health & Safety officers will be among the teams of the contractors executing the works.

Table 8-4a Summary of proposed monitoring plan for Tyre

| Parameter | Location | Samples | Frequency | Phase | | Responsibility |
|---|---|---|---|---|---|---|
| Traffic | At stations S1, S2 | Continuous vehicle counts for 24 hours | Annually | Constructi | Operation | CDR / Consultant |
| Air quality (TSP, CO) | At stations S1, S2 | Four samples / location | Annually | Constructi | Operation | CDR / Consultant |
| Noise ($L_{eq}$, $L_{max}$, $L_{min}$) | At stations S1, S2 | Four samples / location | Annually | Constructi | Operation | CDR / Consultant |
| Landscape[2] | At intersections | Visual inspection / photographic documentation | Annually | Constructi | Operation | CDR / Consultant |
| Seawater Quality (pH, BOD, TSS, TC, FC) | At stations S4, S5, S6 | Two samples / location | Annually | Constructi | Operation | CDR / Consultant |
| Water Quality (pH, COD, Pb, Cu, Cr, Zn, TC, FC) | Upstream and downstream locations of line supplying old city center | Two samples / location | Annually | Constructi | Operation | CDR / Consultant |
| Archaeology | At excavation sites<br>At archaeological sites | Visual inspection / photographic documentation | Continuous<br>Annually | Constructi<br>Operation | | CDR / Consultant |
| Accidents (cars/pedestrians) | In the old city and at entrances | Police / newspaper records | Annually | Constructi | Operation | CDR / Consultant |
| Health and safety/Hygiene | Within project boundaries | Visual inspection / photographic documentation | Continuous | Constructi | Operation | CDR / Consultant |

S1 (facing the parking area towards the intersection of Rue Hamra), S2 (along rehabilitation activities)
S4 (at 10 m offshore, 1 m deep), S5 (at 20 m offshore, 1 m deep), S6 (at 100 m offshore, 1 m deep)

Table 8-4b Estimated requirements for the implementation of the Environmental Monitoring Plan in Tyre

| Parameter/Activity | Staff category | Number | edule | Cost (USD) |
|---|---|---|---|---|
| **CONSTRUCTION & REHABILITATION PHASE** | | | | |
| Traffic / Accidents | Traffic engineer | 1 | l-time | 20,000 |
| Landscape | Landscape architect | 1 | l-time | |
| Archaeology | Urban archaeologist* | 1 | l-time | |
| Air /Noise / Water | Environmental specialist | 1 | l-time | |
| Equipment and laboratory analysis fees | - | - | | |
| Health and safety | Health & Safety officer (Construction engineer)* | 1 | ll time | |
| Training | Environmental specialist | 1 | l-time | |
| Reporting | Environmental specialist | 1 | l-time | |
| Total annual monitoring cost during the construction and rehabilitation phase | | | | |
| **OPERATION PHASE** | | | | |
| Traffic / Accidents / Landscape | Traffic engineer | 1 | -time | 6,667 |
| Archaeology | Urban archaeologist | 1 | -time | |
| Air /Noise/ Water / Archaeology | Environmental specialist | 1 | -time | |
| Equipment and laboratory analysis fees | - | - | | |
| Training | Environmental specialist | 1 | -time | |
| Reporting | Environmental specialist | 1 | -time | |
| Total annual monitoring cost during the operation phase | | | | |

*The archaeologist and the Health & Safety officers will be among the teams of the contractors executing the works.

Table 8-5a Summary of proposed monitoring plan for Baalbeck

| *Parameter* | *Location* | *Samples* | *Frequency* | *Phase* | *Responsibility* |
|---|---|---|---|---|---|
| Traffic | At stations S1, S2, S3 | Continuous vehicle counts for 24 hours | Annually | Construction / Operation | CDR / Consultant |
| Air quality (TSP, CO) | At stations S1, S2, S3 | Four samples / location | Annually | Construction / Operation | CDR / Consultant |
| Noise ($L_{eq}$, $L_{max}$, $L_{min}$) | At stations S1, S2, S3 | Four samples / location | Annually | Construction / Operation | CDR / Consultant |
| Landscape[2] | At intersections | Visual inspection / photographic documentation | Annually | Construction / Operation | CDR / Consultant |
| Water Quality (pH, COD, Pb, Cu, Cr, Zn, TC, FC) | Upstream and downstream locations of line supplying old city center | Two samples / location | Annually | Construction / Operation | CDR / Consultant |
| Archaeology | At excavation sites<br>At archaeological sites | Visual inspection / photographic documentation | Continuous<br>Annually | Construction / Operation | CDR / Consultant |
| Accidents (cars / pedestrians) | In the old city and at entrances | Police / newspaper records | Annually | Construction / Operation | CDR / Consultant |
| Health and safety / Hygiene | Within project boundaries | Visual inspection / photographic documentation | Continuous | Construction / Operation | CDR / Consultant |

S1 (on the road facing the parking area towards the southern entrance of Baalbeck), S2 (along the main road facing the entrance to the parking in Moutran Square), S3 (along the main road facing the entrance of the northern parking along Hermel-Baalbeck road)

Table 8-5b Estimated requirements for the implementation of the Environmental Monitoring Plan in Baalbeck

| *Parameter/Activity* | *Staff category* | *Number* | *Schedule* | *Cost (USD)* |
|---|---|---|---|---|
| **CONSTRUCTION & REHABILITATION PHASE** | | | | |
| Traffic / Accidents | Traffic engineer | 1 | Part-time | |
| Landscape | Landscape architect | 1 | Part-time | |
| Archaeology | Urban archaeologist* | 1 | Full-time | |
| Air / Noise / Water | Environmental specialist | 1 | Part-time | |
| Equipment and laboratory analysis fees | | - | - | 20,000 |
| Health and safety | Health & Safety officer (Construction engineer)* | 1 | Full time | |
| Training | Environmental specialist | 1 | Part-time | |
| Reporting | Environmental specialist | 1 | Part-time | |
| Total annual monitoring cost during the construction and rehabilitation phase | | | | |
| **OPERATION PHASE** | | | | |
| Traffic / Accidents / Landscape | Traffic engineer | 1 | Part-time | |
| Archaeology | Urban archaeologist | 1 | Part-time | |
| Air / Noise / Water / Archaeology | Environmental specialist | 1 | Part-time | |
| Equipment and laboratory analysis fees | - | - | - | 6,667 |
| Training | Environmental specialist | 1 | Part-time | |
| Reporting | Environmental specialist | 1 | Part-time | |
| Total annual monitoring cost during the operation phase | | | | |

*The archaeologist and the Health & Safety officers will be among the teams of the contractors executing the works.

Table 8-6 Summary of the annual environmental monitoring costs

| Phase | Tripoli (USD) | Byblos (USD) | Saida (USD) | Tyre (USD) | Baalbeck (USD) | Annual Cost (USD) | Project Duration (years) | Program Cost (USD) |
|---|---|---|---|---|---|---|---|---|
| Construction (USD) | 18,000 | 15,000 | 7,000 | 20,000 | 20,000 | 80,000 | 5 | 400,000 |
| Operation (USD) | 6,000 | 5,000 | 2,333 | 6,667 | 6,667 | 26,667 | 3 | 80,000 |
| | | | | | | | | 480,000 |

## 9. ENVIRONMENTAL MANAGEMENT

Institutional capacity for environmental management in Lebanon is weak, which constrains the potential range and effectiveness of policy options for environmental management. Lebanon has a large body of environmental related laws, but there is a need to update and consolidate them. Law enforcement is generally weak due to the lack of clarity in responsibilities and coordination as well as insufficient deterrent value. The creation of the MoE has contributed to strengthening the institutional framework for the design and implementation of environmental policy. While measures are being taken to establish an integrated environmental management system under the MoE, the institutional framework for environmental management remains fragmented because the MoE's broad mandate overlaps with those of a number of other ministries or governmental agencies (Agriculture, Energey and Water, Industry and Petroleum, Public Health, Transport and Public Works, as well as CDR). This constrains the ability of the MoE to have a real impact on the coordination of various sector initiatives and on facilitating the integration of environmental policy into general development initiatives. In addition, the resources and staffing levels provided are such that the ministry's capacity for environmental management (including monitoring and enforcement) is limited. There is considerable potential for increasing involvement of the private sector and NGOs in environmental management (ERM, 1995b; World Bank, 1996). While the MoE has by law a broad mandate over environmental issues, it not only overlaps with other agencies but lack provisions for a unit or body to carry out its tasks as well. For instance, monitoring functions have been accorded to the MoE however, enforcement lies within the prerogatives of the Ministry of Interior. In conclusion, there is a considerable need in general to strengthen the existing institutions with responsibilities for environmental management. This effort should be focused on the MoE with encouragement to private sector participation in providing environmental services and NGOs for monitoring and enforcement. Strengthening and enhancing cross-sectoral coordination and planning control mechanisms are also needed. Once again, such an effort should also be led and coordinated through the MoE in conjunction with other ministries such as the ministries of transport, industry, and public health.

In the context of the proposed CHUD project, the needs in environmental management fall within several sectors ranging from archaeology and cultural heritage to waste management, and water quality. While Lebanon in general and the CHUD project cities in particular, suffer from problems associated with the lack of proper management of basic sectors (water, wastewater, solid waste) that may be impacted by such a project, in recent years, plans have been developed and often are being implemented to initiate proper environmental management. These plans provide the project with the infrastructure for managing basic urban environmental services adequately. On the other hand, appropriate environmental management dictate that construction and operation be implemented in accordance to the current state of the art and knowledge regarding environmental protection. This can be accomplished by hiring competent personnel with the appropriate educational and professional background and instituting periodic training programs and site specific plans that are adequate for protecting the general public and the environment as well as contributing to the mitigation of potential environmental impacts.

For this purpose, contractors who will be involved in the construction and operation of the various components of the proposed project as well as personnel who will be involved in monitoring activities, will be required to attend an environmental training course prior to the initiation of project activities. The objective of this training course is to ensure appropriate environmental awareness, knowledge and skills for the implementation of environmental mitigation measures. Environmental training sessions will be conducted annually for a period of two days during the construction phase and three years thereafter. The training program will emphasize on pollution prevention measures during both phases. The cost and schedule of this training program are included with environmental monitoring.

In an effort to strengthen institutional capacity and environmental awareness, training sessions on the proposed CHUD project shoul be opened for individuals from the MoE as well as concerned ministries and agencies such as the MoTPW, MoIM, CDR, NGOs, etc. In addition, the scope of the training sessions may not be limited to just issues related to the CHUD. Other environmental management topics can also be addressed in these sessions. Public education in itself creates a valuable positive feedback in environmental management. For example, if people are aware of the connections between respiratory diseases and particulate matter emitted from badly maintained vehicles, they may be more receptive to regulations requiring regular vehicle maintenance.

A maximum of 30 participants will participate in a training session, which will address various topics including:

- Environmental laws, regulations, and standards
- Pollution health impacts
- Pollution prevention measures
- Sampling techniques and environmental monitoring guidelines (air, noise, water)
- Protection of archaeological and cultural heritage sites
- Air quality management
- Solid waste management
- Wastewater management
- Traffic and pedestrians safety measures

## 10. PUBLIC PARTICIPATION

In initial consultation meetings, the municipal councils in selected cities that have significant cultural heritage enthusiastically supported the idea of restoring active and productive urban life, conserving heritage, rehabilitating the degraded urban fabric, capitalizing on the tourism potential, and improving the standard of living of local community. They appear committed to ensuring that municipal development strategy and initiatives have to be well coordinated with the needs of cultural heritage preservation. They welcomed the proposed project as having significant potential to contribute to national and local economic development, bringing improvements to the quality of life of the residents of the municipalities concerned. A second round of town meetings has been initiated to further discuss environmental aspects of the project components. One such meeting was completed in the City of Tyre with other meetings scheduled in late June in other cities. Such meetings are providing feedback concerning the overall scope of the project and the EIA process and this feedback will be taken into consideration in the final design phase. A full record of these meetings including a list of people who attended, their feedback, and the results of questionnaire (Annex E) that is being administered during the meetings will be included in the final EIA report.

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## ANNEXES

**Annex A**
**Calculation of impact of construction activities on air quality**

**Annex B**
**Calculation of impact of construction activities on air quality**

**Annex C**
**Safety, Health, and Environmental Regulations**

**Annex D**
**National standards for environmental quality, Decision 8/1 dated January 2001**
**Ministry of Environment, Antelias, Lebanon**

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**Annex A**
**Calculation of impact of construction activities on air quality**

**Step 1:** Estimation of the total construction emissions using the area wide method.

In this method, the quantity of particulate matter emissions from construction operations is considered proportional to the area being worked and to the level of construction activity. Emissions from heavy construction operations are positively correlated with the silt content of the soil (particles with a diameter <75 micrometers [μm]), as well as with the speed and weight of the average vehicle, and negatively correlated with the soil moisture content. An approximate aerial emission factor (EF) for the construction activities that is used in the estimation of total emissions (USEPA, 1995) is:

$$EF = 0.3\ Kg/m^2/month\ of\ activity^2$$

Hence, the temporal emission factor for the total construction area of 200 m² and a duration of 6 months of activity, considering 30 days/month and 8 hours/day of work is:

$S = 0.3 \times 200 / (30 \times 8 \times 3600)$
$S = 0.07$ g/s

Note that a better method is to estimate construction emissions for a particular construction site, the construction process be broken down into component operations, each involving traffic and material movement

$$Rate\ of\ PM\ emission\ (mass/time) = \sum_{activity} {}_{activity}\ [EF(mass/volume\ of\ material\ handled) \times volume\ of\ material\ handled/time)]$$

However, due to the random nature of construction activities, and lack of design data, the extent of PM impact cannot be quantified using this method.

**Step 2** Summary of key meteorological parameters with regard to air pollution dispersion namely, mixing height, inversion height, and mean annual wind speed (Table A1).

Table A1. Summary of key meteorological parameters

| *Parameter* | *Typical scenario* | *Worst case scenario* |
|---|---|---|
| Mixing height | 1000[a] m | 1 m |
| Average wind speed | 4[b] m/sec | 1 m/sec |
| Wind direction | west [c] | west |

[a] De Nevers, 1995
[b] Average monthly wind speed for the years 1995-1999 recorded by the AUB weather monitoring station
[c] Predominant wind direction as recorded by the AUB weather monitoring station

**Step 3:** Application of the Fixed Box Model to calculate ground-level concentration of PM (De Nevers, 1995)

To compute the air pollutant concentration using this model, the site was represented by a parallelepiped (Figure A1) and the following simplifying assumptions were made (DeNevers, 1995)

[2] The value is most applicable to construction operations with (1) medium activity level, (2) moderate silt contents, and (3) semiarid climate.

- Mixing of pollutants occurs within a layer of height H, confined from above by a layer of stable air
- The concentration of pollutant in the entire city is constant and uniform, and equals to c
- The wind velocity is constant and independent of time, elevation, and height above the ground
- The concentration of pollutant entering the city (at x = 0) is constant, and equals to the base line measured PM concentration, b
- No pollutant enters or leaves the top of the box, nor the sides that are parallel to the wind direction.
- The destruction rate inside the box is zero

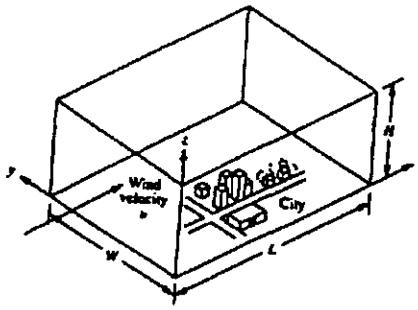


Figure A1. Rectangular city in a fixed box model

$$c = b + \frac{SL}{WLuH} \qquad (1)$$

Where,

| | | |
|---|---|---|
| c | = | Concentration of PM in the entire site ($\mu g/m^3$) |
| b | = | Background PM concentration ($\mu g/m^3$) |
| S | = | Emission rate of PM ($\mu g/s$) |
| L | = | Site length (m) |
| W | = | Site width (m) |
| H | = | Mixing height (m) |
| u | = | Wind speed (m/s) |

The input data for the site under study are summarized in Table A2, taking into consideration two scenarios: the typical scenario and the worst-case scenario.

Table A2. Input data for the box model

| *Parameter* | *Typical scenario* | *Worst case scenario* |
|---|---|---|
| W | 14 m | 14 m |
| L | 14 m | 14 m |
| H | 1000 m | 1 m |
| b[1] | 116 $\mu g/m^3$ | 116 $\mu g/m^3$ |
| u | 4 m/s | 1 m/s |
| S | 70,000 $\mu g/s$ | 70,000 $\mu g/s$ |

[1] Average TSP concentration in Beirut (El Fadel M. and Massoud M., 2000)

By direct substitution of the values in Equation 1, the predicted total PM concentration at the OSR site is expected to range between 117.25 $\mu g/m^3$ under typical conditions, and 5,116 $\mu g/m^3$ under worst-case conditions. For typical conditions, the expected PM emissions are below the proposed Lebanese 24-hr standard (120 $\mu g/m^3$. However, under worst-case conditions, which typically occur during the summer, the expected PM emissions markedly exceed the Lebanese standard.

**Annex B**
**Calculation of impact of construction activities on air quality**

The first step in the noise quantification was the determination of the total site $L_{eq}$ from the different operations listed in Table 5-2 using Equation I.

$$L_{eq} = 10 \log \frac{1}{T} \sum_{i=1}^{N} T_i (10)^{L_i/10} \qquad (I)$$

Where
$L_i$ = $L_{eq}$ for the ith phase (Table 5-2)
$T_i$ = Total time duration for the ith phase
T = Total time of operation from the beginning of the initial phase (i=1) to the end of the final phase (i=N)
N = Number of phases

Taking into consideration the five construction phases listed in Table 5-2, with each having an estimated average duration of 1 month, the total $L_{eq}$ for the site was estimated at 86.8 dBA. This noise level exceeds the Lebanese guidelines (Table B1) for a zone with the characteristics of the Project Area (65 dBA) However, this value was lower than the OSHA standard for an 8hr exposure (90 dBA). In this case, the exposure of workers to noise during their work shift is acceptable.

Table B1 Lebanese noise guidelines in different zones (Ministry of Environment, 1996)

| *Area classification* | *Maximum accepted noise level dBA* | | |
|---|---|---|---|
| | Day[1] | Evening[2] | Night[3] |
| Business district | 55 – 65 | 50 – 60 | 45 – 55 |
| Residential area with few construction sites, commercial activities or on 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.

To determine the propagation of noise levels at various radial distances from the construction site, $L_{eq}$ was corrected using Equation II:

$$L_{eq}\ adjusted = -20 \log(x + 250) + 48 \qquad (II)$$

## Annex C
## Safety, Health, and Environmental Regulations

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