BEKAA WATER SUPPLY REHABILITATION AND MODERNIZATION PROJECT

ENVIRONMENTAL ASSESSMENT

CONTRACT No. 8646

FINAL REPORT (draft)

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1. INTRODUCTION

1.1 Background

The drinking water situation in the Western Bekaa area is alarming in terms of water quantity and quality, which has been further aggravated by the destruction of some existing infrastructure during the war. Available resources are limited to 20 000 cubic per day which represent only 70% of the present water demand. In addition to the fact that available resources cannot meet the required demand most of the water facilities are undersized and inefficiently operated. The Government has not been able to rehabilitate and expand the water supply system in this region. Consequently the Beqaa Water Establishment is obliged to limit service delivery by rationing water. Residents rely on buying water tankers that are of poor quality and extremely expensive for a population, which is relatively poor.

Water quality studies indicate that the water does not meet WHO standards nor the Lebanese drinking water standards. Laboratory analyses of the water extracted from the existing wells show the presence of nitrate from agricultural practices and wastewater seepage[1]. Analyses also show that in several parts of the network the water is not safe in terms of biological quality due to wastewater seepage and poor performance of the disinfection system. As a result of the degraded water quantity and quality a number of water born diseases are reported in the project area especially among children[2].

The major development objective of the proposed "Bekaa Water Supply Rehabilitation and Moderrnization Project" (the project) is to improve the access of the population to satisfactory water supply services.

The project area encompasses 44 villages with a present population of 203,000 inhabitants and is projected to reach 335,000 by the year 2030. The total water demand of the project area is 28,000 cubic meters per day and is expected to reach 46,000 cubic meters per day by the year 2030. At present the project area is fed from Chamsine spring and Lousi water wells which are located within the drainage zone of agricultural areas.

[1] Bekaa Water Supply Rehabilitation and Modernization Project, Present Conditions Report, March 2006, BTD
[2] Lebanon State of the Environment Report, 2001, ECODIT

1.2 Objectives

The main objective of the present environmental review is to ensure that the project is environmentally and socially sound and sustainable. This report has been prepared to assess potential negative impacts that might arise from the construction and rehabilitation works and to identify possible mitigation measures and monitoring plans. For this purpose the following activities were undertaken:

- Identification of all project components/activities;
- Identification of project components that would require an environmental review;
- Assessment of potential long term environmental impacts;
- Identification of possible mitigation measures and monitoring plans; and
- Development of Environmental Management Plan (EMP).

1.3 Project Components

The proposed project includes:

i) Improving the delivery of adequate water quantity and quality to the project area through the rehabilitation and extension of the water supply system; and

ii) Institutional development and technical support to the Beqaa Water Establishment.

As part of the proposed project, the following civil works will be executed for a total amount of about 52 million US dollars:

- Installation of 40,000 house connections and water meters to serve the population up to the year 2010;
- Replacement and extension of water distribution network by replacing and laying about 300 km of water pipelines having 40 to 350 mm diameters;
- Construction of 38 ground reservoirs with capacities varying between 50 and 6000 cubic meters;
- Construction of about 143 km of transmission lines having 80 to 600 mm diameters;
- Provision of 13 pumping stations;

- Drilling of 17 wells and rehabilitating the catchment works of Chamsine and El Abd springs.

1.4 Project Environmental Category

The proposed project has been reviewed and environmentally screened. The project has been classified as Category B, consistent with the provision of the World Bank Operational Policy 4.01, Annex C on Environmental Assessment (January 1999). The project focuses on the rehabilitation and extension of the water supply and distribution systems. Potential adverse environmental impacts during both construction and operation are restricted in magnitude and severity.

The proposed project is expected to have major beneficial impacts on the environment, as it would provide controlled water supply to the households and will reduce overdraft of the aquifer as residents will have sufficient water and will no longer need individual wells. On the other hand extracted groundwater will conducted by the Bekaa Water Establishment who will ensure that the quantities that will be pumped from the wells do not exceed the safe yield of the aquifer. The project will also improve health conditions of the population by providing them with good quality domestic water from storage facilities. These potential benefits should outweigh the magnitude of the adverse environmental impacts arising from the construction of the water supply and distribution networks.

2. LEGAL AND REGULATORY FRAMEWORK

2.1 Regulatory Framework for Environmental Impact Assessment:

The environmental framework of Lebanon is managed and supervised by the Ministry of Environment (MOE) that was created by law 216 of April 2nd, 1993 to be the government institution responsible for the development of a national strategy for sustainable development. The MOE is undergoing several review procedures to up-date the country's environmental policies and regulations including the preparation of a code de l'Environnement, an Environmental Assessment (EA) decree, as well as norms and standards for environmental protection.

A number of laws, decrees and ministerial decisions govern environmental management in Lebanon. Among these are the laws and decrees establishing the Ministry of Environment and defining its mandate and organizing the ministry. The latest legal environmental instrument was

the enactment of the environment code number 444 of August 2002 which requires that EA should be prepared for projects and MOE approval should be obtained. In parallel, MOE has prepared a draft EA decree that defines EA procedures in Lebanon and efforts are underway at the Ministry to pass this decree. The Environmental Assessment (EA) decree will require that an EA be initiated during the planning process of both public and private development projects in Lebanon. Procedures developed in the decree comply with the World Bank EA requirements. As part of the EA decree, two annexes have been prepared: Annex 1 lists projects that would require a full environmental assessment study (equivalent to World Bank Category A), while Annex 2 lists the projects that would require a limited environmental assessment (equivalent to World Bank Category B projects). According to the draft EA decree the construction, rehabilitation, and extension of a water supply system would require a limited environment assessment.

2.2 Existing Environmental Legislation

Existing laws and regulations for environmental protection in Lebanon date as back as 1925. Ground and surface water resources have been protected since the introduction of Order No. 144 dated June 1925, which covered the major springs that supply the country's potable and irrigation needs. Protection against pollution was first addressed by Decree No. 8735 of October 1974 that prohibited the digging of wells for the disposal of raw sewage, banned infiltration from cesspits, and the use of sewage for the irrigation of vegetables and some fruits. A list of the most significant existing environmental legislation is given in Attachment A1.

Decision No. 52/1 of July 1996 introduced measures to deal with the pollution of the air, water and soil, including national standards for drinking water, bathing waters and wastewater quality. Details of available standards for drinking water are given respectively in Attachment A2. Comparing the drinking water standards used by the Government of Lebanon with the ones adopted by WHO, no important differences could be noted.

3. ANALYSIS OF THE ENVIRONMENTAL ISSUES

The project will extend and rehabilitate the water system to ensure 100% water supply coverage, to provide good quality water on a continuous basis, to cater for population growth and to reduce unaccounted for water. Thus, the project will provide controlled water supply to the households and will reduce overdraft of the aquifer. It will improve health conditions of the population by providing them with adequate water quantity and quality from sustainable

sources. The execution of the project will have long term positive environmental impacts especially on the social environment.

Once operational, most of the impacts of the Project will be positive. The project will lead to better services to the population and an improved environment as a result of the water supply. This will lead to considerable public health benefits for the residents of the area. In particular it is expected to result in a reduction in the incidences of water born diseases.

3.1 Water Quantity

The provision of adequate water supply quantities is one of the main objectives of the project. To this end, adequate water supply quantities have been addressed at the planning level, wherein the water supply components to be developed under the project will meet the water demand up to the year 2030. In fact the feasibility study projects that the water supply will exceed the demand by 15,000 cum/day at year 2030. Furthermore, the water supply facilities will include adequate storage facilities that are capable of meeting seasonal, daily, and peak hourly demand. The supply network will be sized to provide the peak hourly rate required by various consumers.

The water balance for the study area was prepared on the basis of the population figures (203,000 for the year 2005 and 335,000 for the year 2030), the water demand 28,000 cum/d and 46,000 cum/d for the years 2005 and 2030 respectively) and the yield of springs and wells (ref. Attachments A3). The water balance indicates that the total available resources (springs and wells) exceed the water supply demand of the project area for the year 2030.

A number of studies have been conducted to assess the water reserves of the aquifers in the West Beqaa region including geological and hydrogeological studies, geophysical logging, and test pumping of the various water sources. Based on these studies, it was possible to identify the water resources for the project study areas. These sources consist of two water springs: Chamsine (56%) and El Abed (4%) and 16 wells (40%) in the same aquifer that feeds the springs without affecting the flows of the springs. In accordance with the feasibility study, these studies confirm that the current ground water resources have a safe yield capacity of 95,900 m^3/day. Under the current plan adopted by the project, the maximum water supply rate from these resources is 61,583 m^3/day in the target year of the project. Therefore the maximum supply rate from the water resources is lower than their safe yield capacity; hence the project would not

diminish the resources capacities[3]. Details of the aquifer capacities and pumping requirements for the project are provided in Attachment A3.

3.2 Water Quality

The water quality analyses of Chamsine Spring are summarized in Attachment A4[4]. The analyses indicate that the water quality is chemically good. The concentrations of all chemical parameters are below the maximum allowable standards set by the Lebanese Government. However, the bacteriological results show the presence of fecal coliforms, which indicates that the spring is contaminated bacteriologicaly. Among the major causes of contamination is the absence of proper wastewater collection network. The project area is not presently sewered but 60% of its area will be covered by a wastewater collection and treatment system as a wastewater collection system and two wastewater treatment plants presently under construction through an Islamic Bank Fund. The remaining 40% of the area has its sewers already designed and efforts are underway to secure the required funds for constructing the wastewater system.

On the other hand, the provision of chlorination at the water supply head works will certainly improve water quality by eliminating its bacteriological contamination. Chlorination units will be installed under the present proposed project. In addition, the proposed project will build capacities of the Beqaa Water Establishment to operate and maintain the water supply system including the regular monitoring of the water quality and the protection of the springs.

3.3 Other Impacts

Adverse environmental impacts during construction might not be negligible yet they are only temporary. Typical impacts for pipe laying and construction of water headworks are dust, noise, traffic congestion, and disturbance to the residents of the area but these are expected to be within acceptable limits.

On the other hand, incidents can arise during operation and could involve accidental chlorine emissions, pipe bursts, tank leakages, and occupational hazards, all of which can lead to serious health risks if not addressed and dealt with in an appropriate manner.

[3] Bekaa Water Supply Rehabilitation and Modernization Project, Feasibility Study, July 2006, BTD
[4] Bekaa Water Supply Rehabilitation and Modernization Project, Feasibility Study, July 2006, BTD

4. ANALYSIS OF ALTERNATIVES

The option of continuing with the current water supply system as well as alternative water supply schemes have been explored and compared in terms of capital costs, operational costs, land requirements, consumed energy, environmental impacts, management needs, and reliability.

The "do nothing" option which means continuing with current methods of water supply would avoid the temporary environmental impacts of installing pipelines, constructing reservoirs and drilling boreholes; however, this option is rejected on the ground of economic cost and adverse long-term environmental, social and health impacts. The "do nothing" option would mean 44 villages with extremely low water quantity and degraded water quality. Under such conditions adverse environmental impacts such as poor health conditions would increase and the prevailing environmental conditions will further deteriorate.

Moreover, the economic benefits of the proposed project are greater than the cost of not implementing it; taking into account revenues from charges for water supply; the cost of the degradation of water resources; the cost of supplying additional water quantities to compensate for the high unaccounted for water, the high maintenance cost of the aged water supply system; lost working days due to water related diseases; and the cost of medical treatment.

With respect to the selection of the water resources to serve the project area with adequate water quality and quantity, three alternatives have been considered including:

(i) Alternative 1: potable water is supplied from the following sources: Chamsine Spring, Ain Ez Zarqa Spring, Abed Spring and Seven wells,
(ii) Alternative 2: potable water is supplied from the following sources: Chamsine Spring, Loussi wells, Abed Spring and Seven wells. The use of the Loussi wells will necessitate their chemical treatment to eliminate nitrate, and
(iii) Alternative 3: potable water is supplied from the following sources: Chamsine Spring, Abed Spring and Seven wells, and the drilling of sixteen water wells in the same good quality aquifer that feeds the two springs without affecting the flows of the latter.

The three alternatives considered for the project were compared to each other in terms of capital costs, operational costs, land requirements, transmission lines, pumping stations, consumed energy, environmental impacts, management needs, and reliability of the process.

Alternative 1 entails the consumption of excessive energy for pumping the water from Ain Zarqa spring to the project area which is 900 m higher than the spring. Hence, this option was rejected based on high energy consumption and high operation and maintenance requirement. The alternative of treating the nitrate in the polluted wells (Alternative 2) was also rejected based on cost, system reliability and potential adverse environmental and health impacts which might occur in case of poor system performance or emergency shut down of the treatment plant. Under these conditions the residents would either experience water shortage or would receive water polluted by nitrates. The proposed option (Alternative 3) of using the two springs located in the project area (Chamsine and El Abed) and the drilling of new water wells in the same good quality aquifer as the one of the springs ranked first in terms of reliability to supply compliant water quantity and quality, least operation and maintenance cost and least energy consumption. Therefore this option was considered to be the most environmentally sound option and thus it was the selected alternative.

5. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

5.1 Objectives and Structure of the EMP

The objectives of the EMP are to identify feasible, cost effective measures that may be used to mitigate any adverse environmental impacts that might occur during the construction and operation of the project. The EMP will consist of three kinds of activities:

- Implementation of mitigation measures;
- Monitoring and evaluation of mitigation measures; and
- Institutional strengthening for effective implementation.

The EMP will be carefully coordinated with the construction programme of the project, to ensure that each relevant activity is implemented at the most appropriate time and that resources are efficiently allocated.

5.2 Implementation of Mitigation Measures

Mitigation measures have been identified to ensure that the defined objectives of the project are achieved whilst preventing and reducing any adverse environmental impacts. The mitigation measures are to be executed by the Construction Contractor and the Beqaa Water Establishment.

The final design process will detail and finalize construction drawings and tender documents of the project components. This process will incorporate final review of the designs by environmental specialists to ensure that all required environmental issues are properly addressed and tender documents include specific provisions concerning environment, health, and safety. Furthermore, pre-tender conferences will be held to brief pre-qualified contractors and supervising engineers on the effective implementation and monitoring of mitigation measures. All pre-qualified contractors and supervising engineers will be called to a pre-tender conference at which environmental, health and safety issues will be outlined.

5.2.1 Construction Phase

During the construction of the water supply network, the potential for causing disruption to public activities is the greatest. Monitoring during this stage will need to be continuous and will cover traffic impacts, noise and dust nuisances, disposal of spoil, and safety.

Construction mitigation measures will be required to minimize inconveniences to the public. Such mitigation measures are standard and widely used in construction practices properly supervised for achievement of international standards of quality. Table 5.1 summarizes the major adverse environmental impacts during construction and their mitigation measures.

The general disruption during construction will be mitigated by coordinated planning of construction activities. This will include coordination with all concerned authorities prior to the start of the construction activities. Other adverse construction activities will be mitigated through the adoption of Good Practice Environmental Procedures. For instance noisy construction activities can be limited to normal working hours and providing muffler to minimize noise nuisance. Dust emissions can be avoided by using dust suppression measures such as periodically sprinkling water in certain areas, providing appropriate covers and removal of excess material from the site. Dangerous activities in public areas will be controlled to reduce risk to the public, traffic and warning signs will be placed at construction sites, trenches will be provided by fences, or railings.

The contract with the contractor will incorporate all requirements to minimize disturbance from construction activities and will be monitored by the Supervision Engineer and the Beqaa Water Establishment to ensure compliance with the contract. The conditions of the contracts will include requirements for the work to be performed as per international

specifications. If the contracts are properly prepared and supervised, then disturbance will be minimized.

Monthly reports will be submitted by the Supervision Engineer to the Beqaa Water Establishment on the environmental impacts of construction with recommendations for dealing with any problems including corrective actions that should be taken.

The cost of the mitigation measures during construction will be incorporated in the contract cost of the contractor. Moreover, the Client and the financing agency will review all civil works contracts to ensure that the required mitigation measures have been incorporated in the tender documents.

Table 5.1: Potential Environmental Impacts During Construction and Proposed Mitigation Measures

Potential Impacts	Mitigation Measures	Responsibility
Noise generation	Restrict work to normal working hours; Use equipment with appropriate silencers; Only run equipment when required.	Contractor monitored by Supervision Engineer
Generation of dust	Employ dust suppression measures such as wetting and dust enclosures.	Contractor monitored by Supervision Engineer
Traffic congestion	Restrict movement of construction vehicles to and from the sites to normal working hours; Diversion of traffic through suitable roads to the expected traffic loading; Provision of adequate diversion signs; Minimizing lengths of open trench; Expeditious completion of backfill and reinstatement.	Contractor monitored by Supervision Engineer
Damage to access roads and streets	Site access roads will be inspected regularly and repairs made where necessary; All roads and streets used for laying pipes will be covered and paved.	Contractor monitored by Supervision Engineer
Water pollution	Collect and dispose wastes, demolition and excavated materials at appropriate locations; Restrict surface runoff from the site.	Contractor monitored by Supervision Engineer
Public safety and site security	Control access of unauthorized personnel; Provide pedestrian access; Provide safety barriers and signs.	Contractor monitored by Supervision Engineer
Damage to archeological remains	Cease construction on discovery of objects of cultural value and notify relevant authorities. Use chance finding procedures	Contractor monitored by Supervision Engineer and General Directorate of Antiquities
Air pollution	Do not burn wastes on site; Routine maintenance of construction equipment and vehicles to minimize exhaust emissions	Contractor monitored by Supervision Engineer
Generation of wastes	Minimize wastes generated during construction and reuse construction wastes where practicable; Use appropriate methods for the storage of waste materials; Dispose of wastes to an appropriate site.	Contractor monitored by Supervision Engineer

5.2.2 Operation Phase

The operation of the water network can create adverse impacts, which need to be avoided through the implementation of mitigation measures. Table 5.2 summarizes the potential impacts and the proposed mitigation measures. Responsibility for undertaking mitigation measures during the operation will reside with the water facilities operator under the supervision of the Beqaa water Establishment.

Table 5.2: Potential Environmental Impacts during Operation and Proposed Mitigation Measures

Potential Environmental Impacts	Mitigation Measures	Responsibility
Degradation of water quality	• Continuous monitoring of water quality at various locations within the water supply system; • Avoid cross contamination with sewage; control extraction of underground water.	• Water operator supervised by Bekaa Water Establishment
Reduction in available water supply	• Prohibit illegal connections to the network; avoid leakage in the network; ensure proper maintenance of the network including pumping stations, pipelines and house connections.	• Water operator supervised by Bekaa Water Establishment
Health and Safety of the employees	• Maintain hygiene and have medical surveillance; maintain showers and sanitary facilities; provide first aid and have an emergency response plan. • Capacity building and training in occupational health, safety and in operation and maintenance of chlorination unit.	• Water operator supervised by Bekaa Water Establishment

Water quality

Water quality should meet allowable drinking water standards set by the Lebanese Government and WHO. Among the parameters of concern are the bacteriological contamination of the water, the concentration level of nitrate, the presence of nitrite and the concentration of heavy metals. In order to safeguard public health, it is imperative that regular monitoring of the water at the sources, storage reservoirs and in the distribution network be implemented to ensure that drinking water quality limits are not exceeded.

Water Quantity

Mitigation measures during the operational phase will include:

- Responding to emergency leakage situations through an established procedure.
- Reducing unaccounted for losses through a comprehensive monitoring plan. The monitoring program will prohibit illegal connections to the water supply network and prevent system leakages.
- The operator of the water sources, chlorination units, and pumping facilities will adhere to the operation and maintenance procedures and manuals, and will conduct regular maintenance and monitoring to ensure that adequate output is maintained from these facilities. The Beqaa Water Establishment will check the plant's records and verify that proper O&M operations are being undertaken

In all instances, the Beqaa Water Establishment will establish an emergency response program to address citizens' complaints in the shortest possible time. These complaints shall be attended, and appropriate mitigation action will be taken to restore water quantity. A report will be generated to document such incidents, and will be forwarded to the management for review and evaluation of future required action.

Incidents and Emergency Cases

To ensure incidents and emergency cases are dealt with efficiently the following mitigation measures will be implemented:

- Training of professional staff in the fields of health and safety will take place before they commence work or operations. This would minimize the effects of health and safety incidents.
- Public accessibility to the water supply facilities should be restricted. For this purpose, water supply facilities especially storage reservoirs will be under the supervision of the guards of Beqaa Water Establishment.
- Both the operator and Beqaa Water Establishment shall ensure that training in basic operational procedures is fulfilled by the concerned staff. Training will be conducted on an on-going basis so as to ensure that staff is aware of best practice procedures, changes to technology and emergency procedures that may occur throughout the lifetime of the project.

- All staff shall be provided with basic training in first aid procedures.
- Formal procedures on how to respond to emergency cases for facilities should be prepared in the case of incidents. Summaries of these procedures should be displayed in key locations and near telephones so that immediate actions are targeted for obtaining correct assistance in a timely manner. Co-ordination with fire services and hospital services should take place so that the information is kept up to date.

5.3 Environmental Monitoring

To ensure the performance, efficiency, and effectiveness of environmental mitigation measures programs, it is necessary that these activities be monitored. Monitoring programs will be necessary for noise, air quality, and dust during the construction phase. During the operation water quality monitoring will include chemical and bacteriological data.

Compliance monitoring during construction will be the responsibility of the contractor who will be supervised by an Engineer on behalf of Beqaa Water Establishment. Environmental monitoring of significant impacts during the operation of the project will be among the responsibilities of the water operator. A strategic monitoring plan will be developed by the operator and periodic review reports will be produced and submitted to Beqaa Water Establishment.

The Beqaa Water Establishment will have the overall responsibility to ensure that the adverse impacts from the project are maintained to acceptable levels and corrective measures are undertaken when required. The Beqaa Water Establishment will also conduct periodic monitoring by visiting the project site at least twice a year. Beqaa Water Establishment will produce periodic review reports for the Ministry of Water and Energy.

Monitoring of construction activities will have to ensure that mitigation measures of construction impacts are being implemented properly, while the monitoring of operation is to ensure that no unforeseen negative impacts are arising. Tables 5.3 and 5.4 give the proposed monitoring requirements during the operational phase.

Table 5.3: Environmental Monitoring Program for the Construction Phase

Environmental Parameter to be monitored	Monitoring Location	Frequency	Standard
Noise	At construction Sites	Every day	70 dB (A)
Air Quality and Dust	At construction Sites	Every day	150 µg/m^3

Table 5.4: Monitoring Program during the Operation of the Water Supply System

Location of Monitoring Points	Parameters to be monitored	Frequency	Standard
Water Sources (wells and springs)	PH Salinity Alkalinity Conductivity Ammonium Nitrates Nitrites Chlorides Phosphates Calcium Magnesium Sodium Potassium Sulfates Iron Herbicide and Pesticides Coliforms	Every Month	6.5 – 8.5 400 µS/cm 0.05 – 0.5 mg/l 25 - 50 mg/l 0 mg/l 25 – 200 mg/l 100 mg/l 30 – 50 mg/l 20 – 150 mg/l 10 –12 mg/l 250 mg/l 50 – 200 mg/l 0.1 µg/l 0/100 ml
Water Sources (wells and springs)	Total coliforms Fecal coliforms Fecal streptocoques	Every day	0/100 ml 0/100 ml 0/100 ml
Water Reservoirs	Ammonium Phosphates Nitrites Chlorides Residual chlorine Total coliforms Fecal coliforms Fecal streptocoques	Every day	0.05 – 0.5 mg/l 0 mg/l 25 – 200 mg/l 0/100 ml 0/100 ml 0/100 ml
Distribution network	Total coliforms Fecal coliforms Fecal streptocoques Residual chlorine	Every day	0/100 ml 0/100 ml 0/100 ml

5.4 Institutional Strengthening

The Beqaa Water Establishment is to be responsible for the implementation of the Beqaa Water Supply Rehabilitation and Modernization Project, which includes the supervision of contractors' operation and ensuring that measures to mitigate adverse environmental impacts will be carried out. Following the implementation of the project, the Bekaa Water Establishment will be in charge of the operation and maintenance of the system, the collection of water tariffs and the continuous monitoring of the water quality and quantity. It is to establish a Technical Support Unit (TSU) to implement the project and might use the services of the private sector to operate and maintain the system.

The institutional arrangement and capacities of the organizations in-charge with the implementation and management of the proposed project were reviewed with the intention of providing technical assistance and reinforcement.

A capacity building program is defined in order to increase capability of staff to carry out the Beqaa Water Supply Rehabilitation and Modernization Project's mitigation measures. It should be noted that many water supply systems do not operate to their full capacity or to prevailing environmental standards due to poor maintenance and lack of suitably qualified staff. Capacity building is thus vital if this project is to achieve its environmental and social development aims.

Environmental expertise will be strengthened through: (i) the provision of an environmental expert to assist the Beqaa Water Establishment in supervising the implementation of the EMP; (ii) the development of a manual on occupational health, safety, and emergency response procedures; (iii) the development of base line on the quantity and quality of water resources in the project area; (iv) the development of baseline data on the occurrence of water born diseases and the preparation of a monitoring program for the occurrence of water borne diseases; (v) the provision of an expert to monitor and evaluate the implementation of the EMP especialy at mid-term review and at the completion of the project; and (vi) the provision of training programs that will be designed and implemented with the assistance of a local or international expert and will include:

(i) Beqaa Water Establishment, Ministry of Water and Energy, Ministry of Environment, and Municipalities: At the initiation of the project, a training workshop will be provided to the staff of the Beqaa Water Establishment, Ministry of Water and Energy, Ministry of

Environment, and Municipalities to raise environmental awareness and to clarify the specific environmental requirements related to the project.

A two days workshop will then be provided to the Beqaa Water Establishment, Ministry of Water and Energy, Ministry of Environment, and Municipalities and will cover the following topics:

- Effective implementation of mitigation measures
- Project supervision
- Sampling and analysis
- Monitoring and evaluation

(ii) Staff at Beqaa Water Establishment: A one day training workshop on occupational health, safety, and emergency response procedures will be provided.

In addition, the proposed project will fund some basic laboratory equipments to enable the Beqaa Water Establishment to conduct daily water analyses. The Establishment will either buy the remaining equipments that are required for weekly and monthly tests or will contract such analyses to the private sector.

5.5 Cost Estimates

The cost of the Environmental Management Plan (mitigation measures and monitoring) will be borne mostly by the contractor and the supervision engineer (construction phase) who will make the necessary provision as part of their contracts. These have been included in the project costs as part of the construction and supervision costs.

The cost of the institutional strengthening requirements and the required measures to avoid the degradation of the springs' water quality are detailed in Table 5.6. As indicated, an estimated amount of US$ 400,000 will be allocated for meeting the environmental requirements of the proposed project. As mentioned earlier, the total cost does not include the cost of mitigating negative construction impacts as these are included in the cost of the construction contract with the contractor.

Following the fund raising campaign conducted by the Lebanese Government, it was agreed that the World Bank will provide fifteen million dollars for funding part of the project

while the Kuwait Fund will cover the remaining financial requirements of the project. As part of the fifteen million dollars grant of the World Bank, hundred thousands dollars will be allocated to implement the associated environmental requirements. Table 5.7 details the environmental activities that will be funded under the World Bank Grant.

Table 5.6: Cost Estimates for the EMP of the whole Project

Component	Quantity	Unit Rate US$	Total Cost in Thousands US$
Beqaa Water Establishment			
Short term environmental specialist	12 MM	5000/month	60
Laboratory Equipment (priority will be given to the purchase of the laboratory equipments that are needed for conducting the tests that are required on a daily basis, specifically the bacteriological tests)[5]			150
Subtotal			**210**
Studies, Training and Workshops:			
Laboratory testing and preparation of baseline data on water quality and quantity in the project area			60
Development of a manual on occupational health, safety, and emergency response procedure and provision of one day training workshop to staff of Beqaa water establishment			20
Development of baseline data on the occurrence of water born diseases and preparation of a monitoring program on the occurrence of water borne diseases			40
Three days training workshop for water establishment, ministries and municipalities on environmental monitoring, sampling and analysis	2 workshops	10000/workshop	20
Subtotal			**140**
Protection of Chamsine and El Abd springs Preparation of necessary files and draft decree			**20**
Subtotal			
Monitoring and evaluation at the project level	2. 5 MM	8000/month	**20**
Operation materials and supplies			**10**
TOTAL			**400**

[5] Typical equipment required for microbiological laboratory testing include: Incubator, Hot-Air sterilizing oven, Autoclave, Gas sterilizer, Optical counting equipment, pH meter, Balances, Media preparation utensils, Pipet containers, Refrigerator, Temperature monitoring devices, Dilution bottles and Tubes, Petri dishes, Membrane filtration equipment, Fermentation tubes and vials, Inoculating equipment, Sample bottles. For residual chlorine measurement, an end point detection apparatus and an agitator will be required.

Table 5.7: Cost Estimates for the Part Covered by the World Bank Grant

Component	Quantity	Unit Rate US$	Total Cost in Thousands US$
Beqaa Water Establishment			
Short term environmental specialist	4 MM	5000/month	20
Portable kits for testing major water quality parameters			20
Subtotal			**40**
Studies, Training and Workshops:			
Laboratory testing and preparation of baseline data on water quality and quantity in Shamsine Spring			20
Three days training workshop for water establishment, ministries and municipalities on environmental monitoring, sampling and analysis	1 workshop	10000/workshop	10
Development of a manual on occupational health, safety, and emergency response procedure			10
Subtotal			**40**
Protection of Chamsine spring			
Preparation of necessary files and draft decree			**10**
Subtotal			**90**
Monitoring and evaluation at the project level	1.0 MM	8000/month	**8**
Operation materials and supplies			**2**
TOTAL			**100**

ATTACHMENT A1:

Existing Environmental Protection Legislation in Lebanon

Pollution and Protection of Water Resources

Document	Date	Subject	Responsible Ministry
Order No. 144	10.06.1925	Protection of Surface and Ground Water Resources	Energy and Water
Order No. 320/26	26.05.1926	Protection of Catchment Areas	Energy and Water
Decree No. 639	26.03.1942	Protection of Nabaa Al Assal Spring, Faraya	Energy and Water
Decree No. 10276	07.10.1962	Protection Zones for Water Sources and Recharge Areas	Energy and Water
Decree No. 14438	02.05.1970	Restrictions on the Depth of Unlicensed Boreholes	Energy and Water
Decree No. 8735	23.08.1974	Pollution from Solid and Liquid Wastes	Industry/Environment
Law No. 64	18.08.1988	Pollution from Hazardous Wastes	Industry/Environment
Decision No. 2528/C	28.05.1996	Protection of Ground Water at El Kneisse	Energy and Water
Decree No. 680	15.09.1998	The Preservation and Protection of Boreholes	Energy and Water

Protection Through Planning, Land Use and General Exploitation

Document	Date	Subject	Responsible Ministry
Decree No. 113	09.08.1933	Mining Exploitation	Interior
Decree No. 253	08.11.1935	Quarry Exploitation	Interior
Law No.	07.01.1949	Forest Protection	Agriculture/Environment
Law No.	09.11.1951	Soil Preservation	Agriculture
Law No. 60	09.09.1983	Excavation in Public Streets	Public Works
Order No. 69	09.09.1983	Urban Development	Public Works
Order No. 2/89	05.01.1989	Urban Development	Public Works
Law No. 98	09.09.1989	Excavation in Public Streets	Public Works
Law No. 58	29.05.1991	Land Expropriation	Public Works
Law No. 85	07.09/1991	Flora and Fauna Protection	Agriculture/Environment
Decree No. 10121	1992	Excavation of Sand from the Foreshore	Interior
Decision No. 1/42	01.03.1993	Tree Cutting and Felling	Agriculture/Environment
Decree No. 2/93	20.06.1993	Quarries, Sand Pits and Coating Plants	Environment
Law No. 360	01.08.1994	International Convention on Biodiversity	Environment
Decree No. 5616	06.09.1994	Quarry Exploitation	Interior/Environment
PMO Circular 6/95	13.03.1995	Excavation in Public Streets	Public Works
Law No. 558	24.07.1996	Forest Protection	Agriculture/Environment
Decision No. 185/1	07.11.1997	Marble Quarries and Concrete Block Works	Interior

Protection from Pollution

Document	Date	Subject	Responsible Ministry
Decree No. 8735	23.08.1974	Pollution from Solid and Liquid Wastes	Industry/Environment
Law No. 64	18.08.1988	Pollution from Hazardous Wastes	Industry/Environment
Decision No. 52/1	29.07.1996	Air, Water and Soil Pollution	Energy and Water/Environment

ATTACHMENT A2

Standards for Drinking Water – Lebanese Ministry of Environment - Decision 52/1, 1996

ORGANOLEPTIC, PHYSICAL AND CHEMICAL PARAMETERS

PARAMETER	GUIDELINE VALUE	MAXIMUM ADMISSIBLE CONCENTRATION	UNIT
Color	1	15	ALPHA
Turbidity	0.4	4	JTU
Taste	0 @ 12°C 0 @ 25°C	2 @ 12°C 3 @ 25°C	
Odor	0 @ 12°C 0 @ 25°C	2 @ 12°C 3 @ 25°C	
Temperature	12	25	°C
Electrical Conductivity (@20°C)	400	-	µS/cm
Hydrogen Ion Activity	6.5 - 8.5	9	pH units
Calcium	100	-	mg/l
Magnesium	30	50	mg/l
Sodium	20	150	mg/l
Potassium	10	12	mg/l
Chloride	25	200	mg/l
Nitrate (NO_3)	25	50	mg/l
Nitrite (NO_2)	-	0	mg/l
Iron	50	200	µg/l
Ammonium (NH_4)	0.05	0.5	mg/l
Kjeldahl Nitrogen	-	1	mg/l
Total Solids (@180°C)	-	1500	mg/l
Oxidability	2	5	mg/l
Fluoride	-	1.5 @ 8-12°C 0.7 @ 25-30°C	mg/l

HEAVY METALS AND TRACE ELEMENTS

PARAMETER	GUIDELINE VALUE	MAXIMUM ADMISSIBLE CONCENTRATION	UNIT
Aluminum	0.05	0.2	mg/l
Arsenic	-	50	µg/l
Barium	1	-	µg/l
Cadmium	-	5	µg/l
Chromium	-	50	µg/l
Copper	0.1	1	mg/l
Cyanide	-	50	µg/l
Lead	-	50	µg/l
Manganese	20	50	µg/l
Mercury	-	1	µg/l
Nickel	-	50	µg/l
Phosphorous (as P_2O_5)	0.4	5	mg/l
Selenium	-	10	µg/l
Silver	-	10	µg/l

Antimony	-	10	µg/l
Zinc	0.1	5	mg/l

HYDROCARBONS AND PESTICIDES

Parameter	Guideline Value	Maximum Admissible Concentration	Unit
Chlorinated Organic Pesticides		0.1	µg/l
Other Chlorinated Organic Compounds	1	-	µg/l
Phosphated Organic Pesticide	-	0.1	µg/l
Carbamides	-	0.1	µg/l
Herbicides	-	0.1	µg/l
Fungicides	-	0.1	µg/l
PCB	-	0.1	µg/l
PCT	-	0.1	µg/l
Phenols	-	0.5	µg/l
Surface Agents	-	0.2	µg/l
Dissolved Hydrocarbons	-	10	µg/l
Aldrin	-	0.03	µg/l
Dieldrin	-	0.03	µg/l
Hexachloro-Benzene	-	0.1	µg/l
3,4 Benzopyrene	-	0.01	µg/l
11,12 Benzofluoranthene	-	0.2	µg/l
3,4 Benzopyrene	-	0.01	µg/l
Total Measured Substances	-	0.5	µg/l

BACTERIOLOGICAL PARAMETERS

Parameter	Guideline Value	Maximum Admissible Concentration	Sample Volume
Total Coliforms	0	0	100 ml
Faecal Streptococcus	0	0	100 ml
Sporlutaed Sulphite-Reducing Bacteria	0	1	20 ml
Faecal Coliforms	0	0	100 ml
Salmonella	0	0	5 litres
Thermotolerant Coliforms	0	0	100 ml
Pathogenic Staphylococcus	0	0	100 ml
Faecal Bacteriophagus	0	0	50 ml
Intestinal Virus	0	0	10 litres

ATTACHMENT A3

Table A3.1: Present and Future Population of the Project Area

Locality	Population 2005	Population 2010	Population 2015	Population 2020	Population 2025	Population 2030
Region 1						
Barr Elias	25,298	27,959	30,899	34,149	37,740	41,710
Ed Dakoue	422	467	516	570	630	696
El Khiara	1,571	1,737	1,919	2,121	2,344	2,591
El Marj	14,118	15,603	17,244	19,057	21,062	23,277
Er Rachidiye	298	329	364	402	445	492
Er Raouda	1,733	1,915	2,117	2,339	2,585	2,857
Es Salamiye	298	329	364	402	445	492
Haouch El Harime	6,224	6,878	7,602	8,401	9,285	10,261
Majdel Aanjar	23,988	26,510	29,298	32,380	35,785	39,549
Manara	4,901	5,416	5,986	6,615	7,311	8,080
Saouiri/Mazraat Saouiri	13,857	15,315	16,925	18,705	20,672	22,847
Soultan Yaacoub El	1,236	1,366	1,510	1,668	1,844	2,038
Soultane Yaacoub Et Tahta	3,534	3,906	4,317	4,771	5,272	5,827
Tel Ez Zaazeaa	205	227	250	277	306	338
Sub-Total Region 1	**97,683**	**107,957**	**119,311**	**131,859**	**145,726**	**161,052**
Region 2						
Aazzi	3,640	4,023	4,446	4,913	5,430	6,001
Ain Aarab	1,118	1,236	1,366	1,509	1,668	1,843
Aita El Foukhar	3,689	4,077	4,506	4,980	5,504	6,083
Dahr El Ahmar	3,006	3,322	3,672	4,058	4,485	4,956
El Bire	1,801	1,991	2,200	2,431	2,687	2,970
El Mhaidthe	3,043	3,364	3,717	4,108	4,540	5,018
Er Rafid	5,963	6,590	7,283	8,049	8,895	9,831
Ghazze	10,012	11,065	12,229	13,515	14,937	16,508
Joubb Jannine	14,938	16,509	18,245	20,164	22,285	24,628
Kamed El Loz	9,745	10,770	11,903	13,155	14,538	16,067
Kfardenis	3,422	3,782	4,180	4,620	5,106	5,643
Khirbet Rouha	3,640	4,023	4,446	4,913	5,430	6,001
Mansoura	3,255	3,597	3,975	4,393	4,855	5,366
Mdoukha	3,161	3,494	3,861	4,268	4,716	5,212
Sub-Total Region 2	**70,435**	**77,842**	**86,029**	**95,077**	**105,076**	**116,127**
Region 3						
Aammik	1,081	1,194	1,320	1,459	1,612	1,782
Aana	3,199	3,535	3,907	4,318	4,772	5,274
Deir Tahnich	168	185	205	226	250	276
Kefraya	2,671	2,952	3,262	3,605	3,984	4,403
Tell Znoub	205	227	250	277	306	338
Tell Znoub Ej Jdideh	696	769	850	939	1,038	1,147
Sub-Total Region 3	**8,019**	**8,862**	**9,794**	**10,824**	**11,962**	**13,220**
Region 4						
Ain Kfar Zabad	7,193	7,949	8,785	9,709	10,730	11,859
Deir El Ghazaal	2,099	2,320	2,564	2,834	3,132	3,461
El Faaour	4,484	4,956	5,477	6,053	6,690	7,394

Kfar Zabad	4,292	4,743	5,242	5,793	6,403	7,076
Massa	3,062	3,384	3,740	4,133	4,568	5,049
Qoussaya	2,578	2,849	3,148	3,479	3,845	4,250
Raite	3,155	3,487	3,854	4,259	4,707	5,202
Sub-Total Region 4	**26,863**	**29,689**	**32,811**	**36,262**	**40,075**	**44,290**
Total Regions 1/2/3/4	**203,000**	**224,350**	**247,945**	**274,021**	**302,840**	**334,690**

Table A3.2: Present and Projected Future Water Demands (m^3/day)

Locality	Demand 2005	Demand 2010	Demand 2015	Demand 2020	Demand 2025	Demand 2030
Region 1						
Barr Elias	3,491	3,858	4,264	4,713	5,208	5,756
Ed Dakoue	58	64	71	79	87	96
El Khiara	217	240	265	293	324	358
El Marj	1,948	2,153	2,380	2,630	2,907	3,212
Er Rachidiye	41	45	50	56	61	68
Er Raouda	239	264	292	323	357	394
Es Salamiye	41	45	50	56	61	68
Haouch El Harime	859	949	1,049	1,159	1,281	1,416
Majdel Aanjar	3,310	3,658	4,043	4,468	4,938	5,458
Manara	676	747	826	913	1,009	1,115
Saouiri/Mazraat Saouiri	1,912	2,113	2,336	2,581	2,853	3,153
Soultan Yaacoub El Faouqa	171	189	208	230	254	281
Soultane Yaacoub Et Tahta	488	539	596	658	728	804
Tel Ez Zaazeaa	28	31	35	38	42	47
Sub-Total Region 1	**13,480**	**14,898**	**16,465**	**18,196**	**20,110**	**22,225**
Region 2						
Aazzi	502	555	613	678	749	828
Ain Aarab	154	171	188	208	230	254
Aita El Foukhar	509	563	622	687	760	839
Dahr El Ahmar	415	458	507	560	619	684
El Bire	249	275	304	336	371	410
El Mhaidthe	420	464	513	567	627	692
Er Rafid	823	909	1,005	1,111	1,228	1,357
Ghazze	1,382	1,527	1,688	1,865	2,061	2,278
Joubb Jannine	2,061	2,278	2,518	2,783	3,075	3,399
Kamed El Loz	1,345	1,486	1,643	1,815	2,006	2,217
Kfardenis	472	522	577	638	705	779
Khirbet Rouha	502	555	613	678	749	828
Mansoura	449	496	549	606	670	741
Mdoukha	436	482	533	589	651	719
Sub-Total Region 2	**9,720**	**10,742**	**11,872**	**13,121**	**14,501**	**16,026**
Region 3						
Aammik	149	165	182	201	222	246
Aana	441	488	539	596	659	728
Deir Tahnich	23	26	28	31	35	38
Kefraya	369	407	450	498	550	608
Tell Znoub	28	31	35	38	42	47
Tell Znoub Ej Jdideh	96	106	117	130	143	158
Sub-Total Region 3	**1,107**	**1,223**	**1,352**	**1,494**	**1,651**	**1,824**
Region 4						
Ain Kfar Zabad	993	1,097	1,212	1,340	1,481	1,636
Deir El Ghazaal	290	320	354	391	432	478
El Faaour	619	684	756	835	923	1,020
Kfar Zabad	592	655	723	800	884	977
Massa	423	467	516	570	630	697
Qoussaya	356	393	434	480	531	586

Locality	Demand 2005	Demand 2010	Demand 2015	Demand 2020	Demand 2025	Demand 2030
Raite	435	481	532	588	650	718
Sub-Total Region 4	**3,707**	**4,097**	**4,528**	**5,004**	**5,530**	**6,112**
Total Regions 1/2/3/4	**28,014**	**30,960**	**34,216**	**37,815**	**41,792**	**46,187**

Table A3.3: Present and Projected Future Required Water Supply Rates (m^3/day)

Locality	Supply 2005	Supply 2010	Supply 2015	Supply 2020	Supply 2025	Supply 2030
Region 1						
Barr Elias	4,655	5,144	5,685	6,283	6,944	7,675
Ed Dakoue	78	86	95	105	116	128
El Khiara	289	320	353	390	431	477
El Marj	2,598	2,871	3,173	3,507	3,875	4,283
Er Rachidiye	55	61	67	74	82	90
Er Raouda	319	352	389	430	476	526
Es Salamiye	55	61	67	74	82	90
Haouch El Harime	1,145	1,266	1,399	1,546	1,708	1,888
Majdel Aanjar	4,414	4,878	5,391	5,958	6,584	7,277
Manara	902	997	1,101	1,217	1,345	1,487
Saouiri/Mazraat Saouiri	2,550	2,818	3,114	3,442	3,804	4,204
Soultan Yaacoub El Faouqa	227	251	278	307	339	375
Soultane Yaacoub Et Tahta	650	719	794	878	970	1,072
Tel Ez Zaazeaa	38	42	46	51	56	62
Sub-Total Region 1	**17,974**	**19,864**	**21,953**	**24,262**	**26,814**	**29,634**
Region 2						
Aazzi	670	740	818	904	999	1,104
Ain Aarab	206	227	251	278	307	339
Aita El Foukhar	679	750	829	916	1,013	1,119
Dahr El Ahmar	553	611	676	747	825	912
El Bire	331	366	405	447	494	546
El Mhaidthe	560	619	684	756	835	923
Er Rafid	1,097	1,213	1,340	1,481	1,637	1,809
Ghazze	1,842	2,036	2,250	2,487	2,748	3,037
Joubb Jannine	2,749	3,038	3,357	3,710	4,100	4,532
Kamed El Loz	1,793	1,982	2,190	2,420	2,675	2,956
Kfardenis	630	696	769	850	939	1,038
Khirbet Rouha	670	740	818	904	999	1,104
Mansoura	599	662	731	808	893	987
Mdoukha	582	643	711	785	868	959
Sub-Total Region 2	**12,960**	**14,323**	**15,829**	**17,494**	**19,334**	**21,367**
Region 3						
Aammik	199	220	243	268	297	328
Aana	589	650	719	794	878	970
Deir Tahnich	31	34	38	42	46	51
Kefraya	491	543	600	663	733	810
Tell Znoub	38	42	46	51	56	62
Tell Znoub Ej Jdideh	128	141	156	173	191	211
Sub-Total Region 3	**1,475**	**1,631**	**1,802**	**1,992**	**2,201**	**2,433**
Region 4						
Ain Kfar Zabad	1,323	1,463	1,616	1,786	1,974	2,182
Deir El Ghazaal	386	427	472	521	576	637
El Faaour	825	912	1,008	1,114	1,231	1,360
Kfar Zabad	790	873	965	1,066	1,178	1,302
Massa	563	623	688	761	841	929
Qoussaya	474	524	579	640	708	782

Locality	Supply 2005	Supply 2010	Supply 2015	Supply 2020	Supply 2025	Supply 2030
Raite	581	642	709	784	866	957
Sub-Total Region 4	**4,943**	**5,463**	**6,037**	**6,672**	**7,374**	**8,149**
Total Regions 1/2/3/4	**37,352**	**41,280**	**45,622**	**50,420**	**55,723**	**61,583**

Table A3.4: Water Balance for the Project Area

Region No.	Locality	Population			Water Needs				Water Balance between needs & potential resources			Water Balance between needs & exploited resources	
		2005 (capita)	2010 (capita)	2030 (capita)	2005 (l/s)	2010 (l/s)	2030 (l/s)	Estimated Water Quantity Resources Potential	2010 (l/s)	2030 (l/s)	Estimated Water Quantity Exploited Resources	2010 (l/s)	2030 (l/s)
CHAMSINE SPRING													
1	Barr Elias	25,298	27,959	41,710	53.88	59.54	88.83	230 l/s from Chamsine spring + 220 l/s by drilling 6 new boreholes near the spring + 70 l/s from Manara,Saouiri & Aita El Foukhar wells after rehabilitation = 520 l/s			**403 l/s** from Chamsine spring by drilling 6 new boreholes near the spring & [70 l/s from Manara,Saouiri & Aita El Foukhar wells after rehabilitation] will be used as standby		
1	Ed Dakoue	422	467	696	0.90	0.99	1.48						
1	El Khiara	1,571	1,737	2,591	3.35	3.70	5.52						
1	El Marj	14,118	15,603	23,277	30.07	33.23	49.57						
1	Er Rachidiye	298	329	492	0.63	0.70	1.05						
1	Er Raouda	1,733	1,915	2,857	3.69	4.08	6.08						
1	Es Salamiye	298	329	492	0.63	0.70	1.05						
1	Haouch El Harime	6,224	6,878	10,261	13.25	14.65	21.85						
1	Majdel Aanjar	23,988	26,510	39,549	51.08	56.46	84.22						
2	Mansoura	3,255	3,597	5,366	6.93	7.66	11.43						
2	Ghazze	10,012	11,065	16,508	21.32	23.57	35.16						
1	Soultan Yaacoub El Faouqa	1,236	1,366	2,038	2.63	2.91	4.34						
1	Soultane Yaacoub Et Tahta	3,534	3,906	5,827	7.53	8.32	12.41						
1	Tel Ez Zaazeaa	205	227	338	0.44	0.48	0.72						
1	Saouiri/Mazraat Saouiri	13,857	15,315	22,847	29.51	32.61	48.65						
1	Manara	4,901	5,416	8,080	10.44	11.53	17.21						
2	Aita El Foukhar	3,689	4,077	6,083	7.86	8.68	12.95						
Sub-Total for the supply from Chamsine Spring		**114,640**	**126,697**	**189,009**	**244.14**	**269.82**	**402.52**	**520**	**250**	**117**	**403**	**133**	**0**
Sypply From Nine New Wells													
2	Aazzi	3,640	4,023	6,001	7.75	8.57	12.78	50 l/s from 2 boreholes in Mdoukha&Khirbet Rouha after rehabilitation + 25 l/s from one new borehole in El Bire + 32 l/s from one new borehole in Er Rafid + 25 l/s from one new borehole in Kfardenis + 120 l/s from 4 new boreholes in Kamed El Loz = 252 l/s			32 l/s from 2 boreholes in Mdoukha&Khirbet Rouha after rehabilitation + 8 l/s from one new borehole in El Bire + 32 l/s from one new borehole in Er Rafid + 23 l/s from one new borehole in Kfardenis + 100 l/s from 4 new boreholes in Kamed El Loz = 195 l/s		
2	Ain Aarab	1,118	1,236	1,843	2.38	2.63	3.93						
2	Dahr El Ahmar	3,006	3,322	4,956	6.40	7.08	10.56						
2	El Bire	1,801	1,991	2,970	3.84	4.24	6.32						
2	El Mhaidthe	3,043	3,364	5,018	6.48	7.16	10.69						
2	Er Rafid	5,963	6,590	9,831	12.70	14.03	20.94						
2	Joubb Jannine	14,938	16,509	24,628	31.81	35.16	52.45						
2	Kamed El Loz	9,745	10,770	16,067	20.75	22.94	34.22						
2	Kfardenis	3,422	3,782	5,643	7.29	8.05	12.02						
2	Khirbet Rouha	3,640	4,023	6,001	7.75	8.57	12.78						
2	Mdoukha	3,161	3,494	5,212	6.73	7.44	11.10						
Sub-Total for the supply from Nine New Wells		**53,478**	**59,103**	**88,171**	**113.89**	**125.87**	**187.77**	**252**	**126**	**64**	**195**	**69**	**7**
Supply From Aabed Spring													
3	Aammik	1,081	1,194	1,782	2.30	2.54	3.79	29 l/s from Aabed spring + 35 l/s from Kefraya existing well + 25 l/s from Ain Ej Jaouze = 89 l/s			28 l/s from Aabed spring		
3	Aana	3,199	3,535	5,274	6.81	7.53	11.23						
3	Deir Tahnich	168	185	276	0.36	0.39	0.59						
3	Kefraya	2,671	2,952	4,403	5.69	6.29	9.38						
3	Tell Znoub	205	227	338	0.44	0.48	0.72						
3	Tell Znoub Ej Jdideh	696	769	1,147	1.48	1.64	2.44						
Sub-Total for the supply from Aabed Spring		**8,019**	**8,862**	**13,220**	**17.08**	**18.87**	**28.15**	**89**	**70**	**61**	**28**	**9**	**0**
Sypply From Four New Wells													
4	Ain Kfar Zabad	7,193	7,949	11,859	15.32	16.93	25.25	60 l/s from 2 new boreholes in Kfarzabad + 60 l/s from 2 new boreholes in Qoussaya =120 l/s			56 l/s from 2 new boreholes in Kfarzabad + 40 l/s from 2 new boreholes in Qoussaya =96 l/s		
4	Deir El Ghazaal	2,099	2,320	3,461	4.47	4.94	7.37						
4	El Faaour	4,484	4,956	7,394	9.55	10.55	15.75						
4	Kfar Zabad	4,292	4,743	7,076	9.14	10.10	15.07						
4	Massa	3,062	3,384	5,049	6.52	7.21	10.75						
4	Qoussaya	2,578	2,849	4,250	5.49	6.07	9.05						
4	Raite	3,155	3,487	5,202	6.72	7.43	11.08						
Sub-Total for the supply from Four New Wells		**26,863**	**29,689**	**44,290**	**57.21**	**63.23**	**94.32**	**120**	**57**	**26**	**96**	**33**	**2**
	Total Regions	**203,000**	**224,350**	**334,690**	**432**	**478**	**713**	**981**	**503**	**268**	**722**	**244**	**9**

Table A3.5: Acquifer Capacities and Pumping Requirements for the Project

Chamsine Aquifer

The Chamsine spring aquifer has a recharge area of 320.000.000 m².
The amount of rain over that recharge area is about: 660 mm.
The part of water that infiltrates underground is about 44% that is:
V = 320.000.000 m² x 0,660 x 44% = 92,9 x 10^6 m^3.
Other inputs recharge that aquifer and are estimated at about 25 x 10^6 m^3. (20 millions from yahfoufa aquifer and from surface runoff and 5 millions from Jurassic aquifer).
The total is therefore about: 118 x 10^6 m^3.

Chamsine springs yield per year: 76 x 10^6 m^3
Public and private water wells yield per year: 23 x 10^6 m^3
Remaining volume not used per year: 118 x 10^6 m^3 - 99 x 10^6 m^3= 19 x 10^6 m^3

The project intends to extract an additional volume of 12,5 x 10^6 m^3 through water wells (6 around Chamsine spring and 2 for Kfarzabad).

The remaining volume in 2030 will be: 19 x 10^6 m^3 – 12,5 x 10^6 m^3 = 6,5 x 10^6 m^3

Southern Aquifer

The Southern area will be fed from the aquifer which outlets are the springs of Hasbani.
The spring has an average yearly flow 1.000.000 m^3.
The overall surface of this aquifer is: 119.000.000 m².
Assuming an average precipitations of 900 mm and an infiltration rate of 44% the volume of water that could be stored is: 119.000.000 x 0,9 x 0,44 = 47.124.000 m^3
The spring gives: 31.000.000 m^3
The remaining amount is 16.000.000 m^3
The project intends to extract: 6.000.000 m^3 up to year 2030.
The remaining amount is 10.000.000 m^3.

ATTACHMENT A4

Chemical and Bacteriological Analysis of Chamsine Spring

Parameter		1-Mar-72	4-May-72	6-Jun-72	11-Jul-72	14-Aug-72	22-Sep-72	7-Mar-02	8-Jun-02	23-May-03	20-Jun-03	22-Jul-03	29-Sep-03	16-Oct-03	28-Nov-03	23-Dec-03	29-Jan-04	20-Feb-04	27-Mar-04	28-Apr-04	6-Apr-05	24-June-05	13-Feb-06	US EPA MAC	LB MOE GV	LB MOE MAC
Temperature	°C	15.2	15.9	16	16	16.1	16.5	-	-	15.8	15.8	15.6	15.6	15.6	15.6	-	-	15.6	15.8	15.7	15.0	18.5	-	-	12	25
pH	-	7.22	8.38	7.53	7.6	7.5	7.5	-	-	7.43	7.59	7.65	7.57	-	-	7.35	7.42	7.44	7.44	7.27	7.05	7.03	-	7.5	7.5	9
Conductivity	□S/cm	305	315	335	370	320	375	-	-	402	407	401	404	400	403	-	-	-	420	-	-	-	321	-	400	-
Total Solids	mg/l	250	253	254	290		298	-	-	-	-	-	-	-	-	-	-	-	-	-	186	174	-	500	-	-
Turbidity	NTU	0.29	0.5	1.7	0.13	0.42	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.4	4
Total Hardness	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235	-	-	-
Chlorides	mg/l	10	15	10	8	10	10	-	-	9.8	10.8	5.6	6.6	6.5	6.9	6.8	10.5	10.5	10.5	10.5	-	-	51	250	25	200
Sulfates	mg/l	2.5	3	3	3	3	2	-	-	8.2	9	7.7	9.4	9.4	9.2	9.3	7.2	7	6.8	7	7	14	5.64	250	25	250
Phosphates	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	0.06	1.41	-	-	-
Ammonium	mg/l	0.9	0.6	0.59	0.7	-	0.77	-	0	-	-	-	-	-	-	-	-	-	-	-	0.01	0.02	0	-	0.05	0.5
Nitrates	mg/l	4.3	4.31	4.14	1.33	-	4.53	15	22	14	14.3	9.8	10.1	9.2	9.8	9.6	14.8	13.8	11.7	8.6	8.1	13.2	0.96	10	25	50
Nitrites	mg/l	0.02	0	0	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1.0	-	0
Calcium	mg/l	74	76	72	60	68	68	-	-	65.9	70	66.8	67.4	67.2	67.4	67.9	69.3	68	65	67	-	-	-	-	100	-
Magnesium	mg/l	7.2	7.2	9.6	13.2	12	13.2	-	-	15.4	15.9	13.7	14	13.6	14.1	14.2	12.4	12.3	14.5	12.9	-	-	-	-	30	50
Iron	mg/l	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.05	0.2
Fluoride	mg/l	0.28	0.25	0.23	0.28	0.26	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-	1.5
Dissolved Oxygen	mg/l	8.5	9.7	7.4	8.5	-	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	9.54	6.12	-	-	-	-
Total Coliforms	#/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32	52	0	0	0	0
Feacal Coliforms	#/250 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	31	0	0	0	0
Feacal Strepto.	#/250 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
Pseudomonas	#/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-