Republic of Yemen
Ministry of Electricity and Water
Urban Water and Sanitation Project

Taiz Water Supply and Sanitation Project
Rehabilitation of Water and Sewerage Networks

Contract for Consultants Services I, Addendum 1

Environmental Impact Assessment
(Al-Qaida)

December 2001
( Final Draft )
Joint Venture DORSCH/GITEC

DORSCH CONSULT
Ingenieurgesellschaft mbH

GITEC CONSULT GmbH

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List of Abbreviations

BOD5  Biochemical Oxygen Demand within five days
C    Clay
CBO  Chemical Oxygen Demand
CCF  Country Cooperation Framework
DCI  Ductile Cast Iron
DN  Diameter Nominal
DS  Dry Substance
EA  Environmental Assessment
EC  Electrical Conductivity
EPC  Environment Protection Council
GEF  General Environment Facility
GPs  Good Practices statements
GST  Galvanized Steel
ITN  Insecticide Treated Nets
ITCZ  Intertropical Convergence Zone
L  Loam
masl  meters above sea level
ME  Multi-Effect
MSF  Multi-Stage Flash
NGO  Non Governmental Organizations
NWRA  National Water Resources Authority
NWSA  National Water and Sanitation Authority
O&M  Operation and Maintenance
OPs  Operational Policies
PDRY  People’s Democratic Republic of Yemen
PVC  Polyvinyl Chloride
RO  Reverse Osmosis
RoY  Republic of Yemen
RSCZ  Red Sea Convergence Zone
SAI  Supreme Audit Institution
Si  Silt
St  Steel
ToR  Terms of Reference
TWSSL Ce Taiz Water Supply & Sanitation Corporation
UFW Unaccounted for Water
UNDP United Nations Development Program
WHO World Health Organization
WWTP Wastewater Treatment Plant
YR Yemeni Rial (Yemeni currency)
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Appendix D: Draft Inspection Checklist

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Appendix F: Provisional World Bank Guide for Insecticide Treated Nets

Appendix G: Provisional WHO Guide on Pesticides for Vector Control

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Appendix J: Process Calculations for the WWTP

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1. Executive Summary

1.1 The Project Scope and Introduction

1.01 This document summarizes the environmental impact assessment, environmental management plan and environmental mitigation program for selected water and sewer investments planned for the City of Al Qaida. Since further studies are required at this point to extend the Initial Development Plan (IDP) beyond 2005, this EA only covers Phase 1 of the Al Qaida Water and Sanitation Project. The EA and its associated Environmental Management Plan will need to be extended at a later date, in order to accommodate for works to be completed under subsequent phases. The Phase 1 portion of these investments, to be financed by IDA, under the proposed Al Qaida Water Supply & Sanitation Project, have been proposed as a Category “B” project for the purposes of this assessment.

1.2 The Project Description and Setting

1.02 The GoY has a comprehensive strategy for the development of water and wastewater services in the City of Al Qaida. These are specified in the “Taiz Water Supply & Sanitation Project: Development Program, Rehabilitation of Water and Sewerage Networks For Al Qaida, Initial Development Plan, August 2001”. The most immediate of the planned investments under the Development Program is generally referred to as “Phase 1” and include the items discussed below. Investments that will follow Phase 1 will be referred to as the “Long-Term Program”.

1.03 The Initial Development Program covers a period through 2021 for which the following objectives have been established for the provision of satisfactory water supply and wastewater services:

For Water Supply

- To increase water production to enable continuous and adequate water supplies;

To develop a zoning system to facilitate an efficient and equitable distribution of available water supplies;

- To introduce bulk and consumer water metering to enable an adequate control of water supplied and consumed; and

- To control unaccounted for water within feasible limits.

In this context, Table E1 summarizes the proposed Water Supply investments:

<table>
<thead>
<tr>
<th>Total new Pipe* DN100-DN150 (m)</th>
<th>Total new Pipe* DN50-DN100 (m)</th>
<th>Increase of Supplied Area* (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>453</td>
<td>1,057</td>
<td>18</td>
</tr>
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</table>

*Phase 1 works
For Wastewater Collection and Disposal

- To install wastewater collection in high population density areas;
- To ensure that for non-connected households satisfactory on-site facilities will be provided and maintained;
- To provide wastewater treatment capacity commensurate with increasing flows and to provide for and maintain established requirements on effluent quality; and
- To enable effluent reuse for irrigation purposes.

In this context, Table E2 summarizes the proposed Wastewater System investments:

**Table E2: Wastewater System Investments**

<table>
<thead>
<tr>
<th>Increase in Served Area* (ha)</th>
<th>Service Connections*</th>
<th>Percentage of Population Served*</th>
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<tr>
<td>50</td>
<td>2,500</td>
<td>74%</td>
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</table>

*Phase 1 works

1.04 The NWSA Al Qaida branch office will concurrently be developed to cope with its enhanced responsibilities and for its operation on commercial basis. Water and wastewater tariffs and charges will be adjusted to ensure long-term financial self-sufficiency.

1.05 The Initial Development Plan (IDP) reflects a proposed extension in phases of water supply and wastewater facilities, with each phase covering a 5-year period. The IDP also provides for an estimate of immediate and long-term investment costs.

1.06 The improvement of the water supply situation in Al Qaida depends upon both the reduction of drinking water losses and an increase in drinking water production. Although the development of new potable water sources to satisfy the demands of the increasing population is not part of first phase works for Taiz, it is considered feasible to meet the lower demands of Al Qaida by the end of this initial 5-year period. The specifics of further extensions of additional water resources cannot be addressed in the current version of the development plan, since further studies will be required for exploring potential groundwater and surface water availability. Broad assumptions have therefore been made on the availability of additional water supplies during subsequent phases of the project, and also on relevant costs. Because of uncertainties in background data, the development plan will need to be updated at regular intervals in order to benefit from further knowledge to be gained.

1.3 The Environmental Review and Assessment

A. Introduction

1.07 Phase 1 of the proposed IDA project has been proposed for Category B, consistent with the provisions of the World Bank Group's Operational Directive 4.01, Annex E, "Environmental Assessment". There are no major environmental issues involved. Further, there are no involuntary resettlement, indigenous people or cultural heritage issues. The Project has no effect on international waterways. The Environmental
Impact Assessment (EIA) and Management Plan was prepared by the Government of Yemen with the assistance of international consultants and comprises three elements:

- Project Description and Statement of Baseline Conditions
- Impact Statement
- Environmental Management Plan

B. Major Environmental Issues and Mitigation Measures

1.08 The project has three main environmental issues, none of which are considered major or which will cause irreparable harm to the environment after the application of the proposed mitigation measure. These issues are: (i) Malaria; (ii) Dried Sewage Sludge and Wastewater Effluent Reuse; and (iii) the handling of chemicals used to flush rehabilitated or new water lines.

i) Malaria:

1.09 Description: There were some 23,288 reported cases of malaria in Taiz Governorate and some 150,000 in Ibb Governorate in 1998 (WHO, 2001), with over 7,000 of these in Taiz City alone, although the actual number of cases was likely much higher. Figures received for Al Qaida put the number of cases for 1998 at almost 9,000, although these numbers, too, should be taken with precaution. Malaria cases in the last two years declined drastically in Al Qaida, partly due to the immunization campaign initiated under the national strategy, and partly due to the shortage of rainfall in the last two years and the resulting reduction of ponding areas. Figures for 1999 put the number of reported cases at 4,196 and numbers for 2000 show a marked decrease to 845 reported cases.

1.10 The wastewater lagoons located some nine kilometers to the north of Taiz City and 16 kilometers southwest of Al Qaida are considered to be a major source of the malaria (Anopheles ssp) problem in the region, which especially appears during the summer months. Raw sewage ponds and rivulets caused by the poor sanitary conditions in many sections of Al Qaida are also likely breeding sites for the mosquitoes. Due to a project-induced increase in the volume of water within city limits, this situation is expected to worsen again following the implementation of this project.

1.11 Mitigation: It has been decided to include in the EIA for the Taiz Pilot Project a malaria abatement program. This program will be designed as a part of the Taiz Environmental Management Program and the EMP will contain money to carry out whatever measures are appropriate and sustainable. Given the proximity of Al Qaida to Taiz and the Taiz WWTP, Al Qaida is also expected to benefit from this program.

1.12 The aim of this program is to supplement the health sector’s national malaria program, primarily through vector control strategies. These strategies will be targeted at reducing or controlling mosquito breeding areas that are associated with Taiz’s water sector infrastructure, including Taiz project components and the ongoing municipal development project. The program will also assist the health sector’s efforts to provide Insecticide Treated Bednets (ITB) to residents living in project areas that are known to suffer from high incidence rates of malaria. In order to achieve this, a malaria expert will be hired under the project. This expert will design a malaria abatement program for Taiz,
which will then be implemented by an ESO, in cooperation with the MENA Health Sector's support for the National Malaria Control Program.

1.13 The Bank's Pesticide Safeguard will apply to this project if the project is involved in any kind of pesticide purchase, or program that employs pesticides (i.e. if the final plan includes spraying or the re-treatment of ITNs). If the resulting abatement program utilizes pesticides in any way, therefore, a Chemical Management Plan (CMP) will be designed and implemented in the context of the EMP.

ii) Wastewater and Sludge Reuse:

1.14 Description: The provision of wastewater treatment will, for financial reasons, be extended in stages with the first stage to include primary treatment only. Secondary treatment will follow, with the timing to be decided based on experience to be gained from first stage treatment, actual pace of sewer connections, and the availability of funds. The environmental impact from the discharge of primary treated effluents will be closely monitored, including its potential use for irrigation.

1.15 In this context, an interim Phase 1 arrangement has been proposed, consisting of pre-treatment and a septic tank, to be designed for a BOD5 load of 1,500 kg/day with the effluent to be discharged to the wadi after aeration through cascading. It is estimated that the treatment efficiency of this system will be about 50% of what would be provided through the use of a trickling filter. Therefore, the use of effluents for irrigation should, at least initially, be restricted. During the dry season most of the effluent could be expected to infiltrate into the ground. Proposed arrangements provide for a significant improvement of existing conditions.

1.16 An extension of these interim arrangements is expected to be implemented during Phase 2. Pre-treatment with an anaerobic sedimentation pond, in combination with a trickling filter using the natural slope of the hill, followed by a final sedimentation pond, has been proposed.

1.17 The government currently has no policy on the use of dried sludge and has not identified a final dumping site or other disposition measures.

1.18 Mitigation: In order to deal with the large amount of dried sludge that will be generated from the rehabilitation of the lagoons, and to develop a long-term solution for sludge and treated wastewater, a formal wastewater and sludge reuse policy will be developed as part of the EMP for Taiz. This policy will also be applicable to the situation in Al Qaida.

iii) Disposal of Hazardous Chemicals:

1.19 Description: The use of small amounts of hazardous chemicals (one of Calcium or Sodium Hypochlorite, or Chlorine Gas) will be used as part of the normal cleaning procedure during the final stages of the water system construction and rehabilitation components. The amount of chemicals necessary for flushing is expected to be modest.

1.20 Mitigation: The contractor will be responsible for training workers on the handling of such chemicals, and providing suitable safety gear. Spill prevention and counter-control

---

1 Environment and Safety Officer, to be appointed as part of the Environmental Management Plan
measures for hazardous chemicals will be specified in a contingency plan (included in the EIA Appendix). Spills of hazardous materials will be promptly cleaned up and chemically treated. Workers handling these spills will wear overalls and gloves in addition to any other protective equipment that may be needed. Wastewater containing hazardous chemicals will be routed to the new wastewater treatment plant and the feed rate of hazardous chemicals limited to levels that can be handled by the plant. Compliance with the proposed provisions will be monitored by an ESO in the PMU.

C. Secondary Environmental Issues and Mitigation Measures

i) Employee Health and Safety:

1.21 Soil in project areas will be sampled to test for contamination. In the case of minimal risk, simple mitigation measures will consist of wearing appropriate clothing, and education of workers. In the case of more severe contamination, waste material will be excavated and taken to an appropriate NWSA and EPC approved site.

ii) Public Safety:

1.22 A number of public health and safety measures are addressed to limit risk of an accident involving the public. These would include erecting appropriate fences and walkways to permit safe passage of pedestrian and vehicular traffic in and around the site. On-site inspectors will supervise heavy equipment use.

iii) Public Health:

1.23 As part of the public information campaign, the population shall be advised as to the nature and extent of the works proposed. Capacities of local hospitals and clinics will be assessed and, if deemed necessary, a project clinic will be established in project areas without easy access to existing facilities.

iv) Collection, Storage and Disposal of Household Wastewater:

1.24 The contractor will establish a special unit to specifically handle this task. This unit will dispose of the wastewater in a manner that prevents spillage of wastewater. All such wastes will be transported to the inlet sump of the WWTP, and will not be handled by any workers outside of the designated unit.

v) Abatement of Noise and Air Pollution:

1.25 A detailed plan for the control of noise pollution is included in the EA. The measures to be undertaken will include proper maintenance of equipment, erection of screens, use of muffling devices to minimize both dust and noise pollution, and strict monitoring of vehicular traffic used in project works. Noise and dust levels will be kept within recommended World Bank and Yemeni standards.

vi) Public Consultation Process:

1.26 Despite the fact that this type of category "B" environmental project does not require a public consultation program, the Government of Yemen has nevertheless implemented a program of public awareness and consultation. This program comprises three
components: (i) public meetings; (ii) newspaper and television articles and programs; and (iii) household surveys.

1.4 Overall Cost of the Project's Environmental Program

1.27 A summary of the Project's environmental issues, mitigation program, and associated costs is summarized in Table E3. For Phase 1, the cost is expected to be around $23,010. This consists primarily of monitoring costs. Major items such as the salary of the ESO, the malaria abatement program and the sludge & wastewater reuse study are covered under the Taiz EMP.

1.5 Conclusions

1.28 The overall impact of the Project is to significantly improve environmental conditions at every phase of the project cycle. The environmental review concludes that the proposed project will generate overwhelmingly positive environmental, social and economic impacts. With its mitigation measures, the project does not present negative environmental consequences. Detailed discussion of all items, including the complete mitigation plan and item-by-item costs, are included in the EIA.
## Table E3: Summary Matrix of Mitigation Measures and Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Potential Negative Impact</th>
<th>Mitigation Measure</th>
<th>Implementation Responsibility</th>
<th>Monitoring Responsibility</th>
<th>Total Phase 1 Cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewage from destroyed cesspits and households</td>
<td>Contamination resulting from improper disposal of sewage</td>
<td>Controlled transport to Taiz WWTP. Temporary disposal measures and waste dilution if necessary. Cesspit Sampling.</td>
<td>Contractor</td>
<td>PIU ESO</td>
<td>1,400</td>
</tr>
<tr>
<td>Improved living conditions for Anopheles</td>
<td>Increase in incidence of malaria</td>
<td>A Malaria Abatement Program will be designed and implemented under the Project.</td>
<td>ESO in conjunction with local malaria and health officials</td>
<td>PIU, ESO</td>
<td>0</td>
</tr>
<tr>
<td>Dried wastewater sludge.</td>
<td>Improper use and lack of storage space.</td>
<td>Sludge re-use policy study to be performed and financed under the Project.</td>
<td>PIU</td>
<td>ESO, with assistance from IDA Resident Mission</td>
<td>0</td>
</tr>
<tr>
<td>Effluent and Influent monitoring at WWTP.</td>
<td>Low quality wastewater.</td>
<td>Regular sampling will be included in the mitigation measures.</td>
<td>Independent sampling contractor</td>
<td>PIU ESO</td>
<td>1,900</td>
</tr>
<tr>
<td>Soil &amp; Groundwater.</td>
<td>Contaminated soil and groundwater in construction areas and downstream of WWTP.</td>
<td>Proper clothing and worker education. Proper disposal if warranted. Soil and groundwater downstream of the WWTP and in the project area will be monitored to determine if contamination has occurred</td>
<td>Contractor, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>4,950</td>
</tr>
<tr>
<td>Noise</td>
<td>Disturbances during construction.</td>
<td>Use of heavy equipment restricted from 7 p.m. to 6 a.m. Proper noise muffling devises, traffic routing and monitoring.</td>
<td>Contractor, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>180</td>
</tr>
<tr>
<td>Dust</td>
<td>Disturbances during construction.</td>
<td>Use of dust suppression measures such as wetting, dust covers and speed restrictions. Monitoring will be carried out.</td>
<td>Contractor, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>180</td>
</tr>
</tbody>
</table>
## Rehabilitation of the Water and Sanitation Network Taiz

### Environmental Assessment

<table>
<thead>
<tr>
<th>Water Use: On and Off Site</th>
<th>Water contamination. Reduced public water levels.</th>
<th>Contractors will be required to bring all water on site in tankers and only be allowed to fill their tankers at approved sites. Water storage provisions must be made.</th>
<th>Contractor, PIU, NWSA</th>
<th>ESO</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Chemicals</td>
<td>Improper disposal of chemicals used to flush water lines.</td>
<td>Supply of proper training and safety gear. Spill contingency plans.</td>
<td>Contractor</td>
<td>PIU ESO</td>
<td>0</td>
</tr>
<tr>
<td>Medical Clinic</td>
<td>Construction site related injuries.</td>
<td>A temporary clinic will be established in project areas that do not have easy access to local facilities.</td>
<td>ESO</td>
<td>Contractor, ESO</td>
<td>8,600</td>
</tr>
<tr>
<td>Public Consultation</td>
<td>Unnecessary disruption of affected communities.</td>
<td>An extensive public consultation program will continue to be undertaken, including the use of radio, TV, town meetings, and household surveys.</td>
<td>PIU</td>
<td>ESO</td>
<td>2,600</td>
</tr>
<tr>
<td>ESO &amp; Information Campaign</td>
<td>Non-compliance with Management Plan.</td>
<td>An Environmental Safety Officer (ESO) will be hired to monitor mitigation measures and disseminate relevant information to public.</td>
<td>PIU, TWSSLIC</td>
<td>IDA</td>
<td>3,000</td>
</tr>
<tr>
<td>Environmental Reviews</td>
<td>Non-compliance with Mitigation Plan.</td>
<td>Semi-annual reviews performed to examine compliance with mitigation plan, regulatory requirements, and to identify potential environmental problems.</td>
<td>ESO, with assistance from WB Environmental Specialist as part of IDA supervision missions</td>
<td>IDA</td>
<td>300</td>
</tr>
</tbody>
</table>

**Total Cost**
23,010

For Detailed Tables, see Annex 9.1
2. Introduction

2.1 Project Background and Objectives

2.01 The very poor technical condition of the existing water supply and sewerage systems of Al Qaida, in connection with increasing pollution levels of the shrinking water resources and the increasing water demand of the rapid growing population call for immediate actions to improve this already critical situation.

2.02 Current water sources consist of three wells, two northeast of the town, and one near the eastern boundary of the town. Due to the lack of meters on two of these wells, total yields are estimated using the one available water meter, along with estimates based on pumping time for the other two. In this context, total combined yield for the three wells is estimated to be around 600 m³/d, or an annual water production of about 251,720 m³/a.

2.03 Some 60,000 m³ of this supply is utilized by several small villages to the northeast of the city, leaving Al Qaida with about 191,720 m³/a, or 20 l/c/d. Water losses in the distribution network are indicated to be about 30%. Therefore, theoretically an amount of only 14 liters of drinking water is available per capita and day. In practice the real consumption of water per capita depends on accessibility to the water resources, and on the financial status of the consumer. Members of the poorest social stratum survive with only a few liters of drinking water per capita and day or even use polluted water.

2.04 In this context, a project has been proposed by the World Bank to implement the technical rehabilitation of the drinking water distribution and wastewater collection systems of the city of Al Qaida, as part of a similar, yet much larger project in nearby Taiz. This project will serve as a very important and short-term feasible step to avoid further drinking water losses and to reduce the pollution of the scarce ground water resources.

2.05 The main Objectives of this water and sanitation Project are the:

- increase in water production needed to enable a continuous and adequate water supply,
- develop a zoning system to facilitate an efficient and equitable distribution of available water supplies,
- construction of a preliminary wastewater collection and treatment system,
- reduction of water losses and improvement of the reliability of the water supply services, and
- improvement of the living conditions of the poorest segments of the population.

2.2 Report Scope

2.06 According to international standards an Environmental Assessment (EA) is an integral part of any larger technical project. It is a formal document provided by the project sponsor and preferably prepared by an independent consultant. Since further studies are required at this point to extend the Initial Development Plan (IDP) beyond 2005, this EA only covers Phase 1 of the Al Qaida Water and Sanitation Project. The EA
and its associated Environmental Management Plan will need to be extended at a later date, in order to accommodate for works to be completed under subsequent phases.

2.07 The main task of this EA is to ensure that adverse environmental impacts will be avoided or mitigated as far as possible. For impacts that cannot be avoided, compensation measures will be proposed. This document will also provide a comprehensive information source for the decision-makers and project implementers, in order to ensure that the planned project is environmentally sound and sustainable.

2.08 The investigation factors of this EA include soil, water, climate & air, flora & fauna, human health and cultural heritage. Based on the present environmental situation within the investigation area, this EA will assess the potential impacts that are determined to be critical for the project's environmental soundness and sustainability. The time frame covered will extend from the initial planning stages through the construction period and until the end of the operation. This will encompass the forecast period under consideration of planning alternatives as well as mitigation and compensation measures.

2.09 According to the ToR, the potential impact of the Al Qaida Water Supply and Sanitation Project has to be assessed during the preparation of the Initial Development Plan for Water and Wastewater. In the early project stage only existing reports have been reviewed and general considerations on the future situation have been made concerning population projections, water demand projections, water supply projections, wastewater treatment capacities, and required measures. Thus, conclusions reached in this report will need to be reviewed on a regular basis, in order to ensure that any new project components or revisions are assessed in a similar manner.

2.3 Report structure

2.10 To meet the financing agency's requirements, this report has been prepared according to the "Generic Terms of Reference for the Preparation of Environmental Impact Assessment, Environmental Management Plan and Environmental Monitoring Plan", paragraph 10.09. This report is therefore organized according to the following outline:

- Executive Summary
- Policy, Legal and Administrative Framework
- Project Objectives and Description
- Baseline Studies and Data
- Environmental Impacts
- Analysis of Alternatives
- Environmental Management Plan
- Environmental Monitoring Plan

2.4 Project Location

2.11 Yemen is situated between the Red Sea in the west and the western part of the Indian Ocean, the Gulf of Aden to the south and southeast. It borders Saudi-Arabia in the north and Oman in the east.
2.12 The city of Al Qaida is located in the mountainous southwest of Yemen, and belongs to the drainage basin of the Red Sea and the Gulf of Aden. Major wadis drain this high and midland region of the country in a westerly direction towards the Red Sea and southerly direction to the Gulf of Aden.

2.13 Al Qaida is situated in the Province of Ibb, south of Sana’a, and about 90km inland from the Red Sea. The city is located some 30km to the north of the city of Taiz, and has an average annual rainfall of 600-700mm, with much of the precipitation characterized by significant rainfall events.
3. Policy, legal and administrative framework

3.1 Introduction

3.01 This section outlines the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, etc., at international, national, regional, and local levels. As the United Republic of Yemen is a very young state, the national and local institutions governing environmental regulations are also quite young, and still busy with their inner organization and the definition of their responsibilities.

3.2 Institutional framework

A. Governmental Organizations

3.02 Prior to 1995 primary responsibility for environmental matters in Yemen resided with the State Ministry of Environmental Affairs (now the Ministry of Tourism and Environment), although an Environmental Protection Council (EPC) was established in 1990 under Prime Ministerial decree 94. This council was reformed by the Prime Minister's decree (No. 28) of 1995, to perform the tasks outlined in Table 3.1.

Table 3.1: Functions of the EPC

- Propose the general policy to protect the environment and adopt environmental design research as the general framework for an adequate solution of pollution problems
- Co-ordination of concerned national agencies and follow up and assess their activities as well as co-ordination with regional and international organizations concerned with the protection of the environment
- Set up standards that are suitable for protecting the environment from pollution and make use of scientific principles in this respect to assure the abatement of pollution and the protection of the animal, plant and marine ecology etc.
- Prepare draft laws regulations and systems necessary to protect the environment and review regional and international agreements on environmental protection.
- Set up effective programs for international co-operation and environmental protection for implementation in accordance with general GoY policy
- Collect data, carry out assessments and prepare reports on the status of the environment, and establish capable monitoring systems
- Set up the general framework of environment education and awareness programs with the objective of enhancing awareness among the public and inducing them individually and collectively to participate in the protection of the environment.
- Record and evaluate changes in the condition of the environment and Natural Resources of Yemen and

2 Many of the functions defined in this Table are paraphrased and or summarized from the available documentation. It is therefore possible that some tasks / functions may have been lost.
inform the Cabinet of these changes by means of regular reports

- Prepare a national plan for training of a Yemeni cadre in the various environment fields
- Organize local seminars and deliver lectures concerning environment protection as well as represent the ROY at international conferences and seminars and conduct bilateral meetings regarding such issues.

Source: EPC 1997

3.03 After 1995, and as a result of the reforms brought about by the inaction of the Environmental Protection Law (Law No. 26 of 1995), (EPL), the EPC became the government agency with primary responsibility for environmental matters.

3.04 Under Article 5 of the EPL the EPC is required to:

"undertake the preparation of the general national policy for environment protection and its control and shall carry out in co-ordination with concerned bodies to execute such policy after approval of the cabinet. Each concerned body shall adhere and be obliged to implement the decisions, resolutions and recommendations that are issued by the council."

3.05 Accordingly, the EPC has, primarily, an oversight and management function with many responsibilities remaining with existing authorities. To facilitate this oversight role, the EPC is established as one of three entities under the direct control of the Cabinet and its annual budget is part of the budget of the Council of Ministers.

3.06 The Technical Secretariat of the EPC was formed in 1992 to undertake the tasks defined under the Prime Minister's decree, No. 34. In effect the administering of the EIA process and any other requirements and procedures included in the EIA legislation. This involves not only the drafting of EIA guidelines, standards and regulations but also the implementation of the EIA Process.

3.07 Notwithstanding, at this time, EPC is still in the early stages of capacity building in all areas, the development of human resources, the definition and establishment of standards and the development of EIA policies and guidelines. It is being supported in this by an assistance program sponsored by the Dutch Government.

3.08 There has been a UNDP mandate in Yemen since the 1960's, that has been agreed upon jointly with the government. Due in part to this cooperation between the government and the UNDP, decisions on the nature and content of the country program are made according to the priority needs for technical cooperation of the country. In addition to their core resources, the UNDP administers activities supported by a number of special funds.

3.09 As part of its ongoing relationship with the GoY, the UNDP provides for funding through one of its special funds, known as the General Environment Facility (GEF) for environmental management strengthening. Within the 1992-1996 country unification program to integrate the economic, political and administrative systems of the ex-PDRY and RoY a natural resources management program was developed by the GoY, with the help of UNDP. This program was concentrated in three main areas:

1. The strengthening of the Environment Protection Council (EPC) skills in the environment management,
2. supporting the establishment of an effective institutional framework for water management, and

3. implementing two concrete projects: protection of the Red Sea marine ecosystem and development of a liquid petroleum gas substitution program.

3.10 Within the new cycle that started in 1997 the following five programs were also developed:

1. Sustainable water resource management,

2. Sustainable environmental management,

3. Poverty eradication / Employment generation,

4. Promotion of good governance and assistance to decentralization, and

5. Rehabilitation and emergency preparedness.

3.11 Working Groups composed of EPC local teams, expatriate and local consultants, and other governmental organizations have been formed under this assistance program. With respect to environmental management, the activities of the Working Groups are the following:

- Planning and Co-ordination
- Environmental Legislation
- Data Information Management
- Environmental Awareness and Education
- Water Resources Protection
- Urban and Industrial Environment
- Land Resources Protection
- Natural Habitats.

B. Other Competent Authorities

3.12 Given the above and the nature of the EIA process, (especially in the setting of standards), it is inevitable, during this transitional phase, that many of the key environmental responsibilities in Yemen still reside with other 'competent authorities'. The situation with regard to water supply sanitation and public health is however perhaps more complicated than most as indicated in Table 3.2.

Table 3.2: Project Related Environmental Responsibilities in Yemen

<table>
<thead>
<tr>
<th>Agency</th>
<th>Area of Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Agriculture and</td>
<td>Irrigation project development and management;</td>
</tr>
<tr>
<td>Irrigation</td>
<td>agricultural extension (water use, cropping patterns etc.)</td>
</tr>
<tr>
<td>Ministry of Electricity and</td>
<td>Regulatory authority for the Public Electricity Corporation (PEC)^3, NWSA and GAREWS</td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
</tbody>
</table>

^3 PEC is also responsible for rural electricity
NWSA
Development and operation of water supply and sewerage systems in urban areas.

NWRA
National water resources investigation, development and monitoring

Ministry of Local Administration (MLC)
Water supply development in rural areas

Dept. of Environmental Health (MoCHUP)
Monitoring of water quality and other public health matters in respect of the existing public health legislation

Ministry of Public Health
Health care provision, disease prevention and management

Source: Consultants Review

3.13 In Al Qaida, the main tasks of the National Water and Sanitation Authority (NWSA) are the management of the water resources (drinking water supply, discharge of waste water, ground water extraction quantities), and the development of new water resources (test drillings, planning). In addition there are monitoring or controlling activities (taking samples, analysis of water quality, pollution levels, etc.) NWSA has, at this time, no dedicated environmental management or planning capacity at either their Head Office in Sana’a, the TWSSLC Office in Taiz, or the local NWSA office.

3.14 The National Water Resources Authority (NWRA) was established by the government and has been given full authority over water resources planning, management, and protection in order to achieve sustainable control of country’s water resources and to improve the living conditions for the population.

3.15 The Supreme Audit Institution (SAI) in Yemen is called The Central Organization for Control and Auditing. It is an independent authority of the country. With regard to environmental auditing, the mandate of the SAI gives access to:

- the national government,
- local, regional, provincial or federal state governments,
- state-owned enterprises, and
- non-governmental public bodies.

3.16 The SAI has the authority to carry out performance audits with regard to environmental issues.

3.17 The local hospital in Al Qaida treats residents affected by locally contracted water-borne diseases, and registers reported cases. The results of these reports have to be considered with caution, as only a small percentage of the population can afford to access medical treatment with established hospitals or doctors. Many people are using other means, such as home treatments, medicine without prescription, etc. Only cases treated by established hospitals or doctors are registered in the reports.
C. Research Institutions

3.18 The principal governmental structure is supported by a limited number of research organizations, primarily at the Universities of Sana'a and Aden.

3.19 The Dutch government is particularly active in this area providing support to the University of Sana'a in two key areas that are of direct relevance to this project:

- Support for the Center for Empirical Research and Women's Studies;
- Strengthening of the Department of Civil Engineering in the fields of sanitation, and water and environmental engineering.

3.20 The International Institute for Infrastructure, Hydraulic and Environmental Engineering (IHE), Delft has provided, since 1989, the technical and financial assistance to the strengthening of the latter program in the Department of Civil Engineering by providing capacity building measures in both the academic and applied fields. A water quality monitoring laboratory, equipped with latest and technically advanced apparatuses, has been established in Sana'a under this program.

3.21 Water samples from NWSA are analyzed at the laboratory in Taiz, or at the University of Sana'a. According to the consultant's information there are no local private research institutes or companies in Al Qaida or Taiz.

D. NGOs

3.22 The first country cooperation framework (CCF) for the Republic of Yemen outlines the focus of UNDP technical cooperation for the period 1997-2001. The CCF recognized the problems of the depleting water resources, exploitation and mismanagement. Therefore several programs have been developed in order to improve the present situation.

3.23 Increasing environmental problems have lead to the foundation of small, local environmental groups such as the "Society of the Friends of the Environment" in nearby Taiz. In Yemen there is still very little public awareness concerning environmental problems, mainly due to the very low level of education. Therefore this small group, mostly comprised of well-educated inhabitants of Taiz, mainly concerns itself with implementing education programs, trying to create public awareness for the natural environment, informing state or municipal authorities about environmental problems and discussing solutions.

3.24 In many places in the city of Taiz there are small trees, which have been planted recently, mostly due to an initiative of this NGO. These plantings are visible signs of the activities of this small group, which is almost overwhelmed by the multitude of environmental problems (lack of water, pollution of air, soil and water, uncontrolled waste deposition, poverty, diseases, etc.). There are no such groups in Al Qaida.

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4 NWSA's laboratory in Taiz is in very poor condition, such that more detailed or accurate analysis needs to be performed in Sana'a
3.3 Legislative framework

A. General Framework

3.25 The EPL is now the framework environmental legislation for Yemen. In general terms it provides for the controlling of actions or activities described as being 'unsafe to the environment'. Specific provisions in that act that may relate directly to this project are identified in Table 3.3.

3.26 Beyond these specific provisions of the EPL a plethora of other laws and regulations dealing with the environment exist. The principal pieces of legislation and their areas of jurisdiction are outlined in Table 3.4.

B. EA Legislation and Guidelines

3.27 The EPL contains provisions for the enacting of legislation on the requirement for an EIA in project development. The relevant bylaw has been drafted and approved by the EPC. It is understood from discussions with EPC officials that this draft legislation does not include any measures that vary significantly from the initial documentation prepared with the assistance of Euroconsult in 1996.

Table 3.3: Key Articles of EPL Relating to the Project

<table>
<thead>
<tr>
<th>Article</th>
<th>Issue</th>
<th>EPL Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Protection of Water Resources</td>
<td>The concerned body shall protect the surface and groundwater and to undertake the development of water resources, and limitations of the issuance of licenses for drilling of groundwater wells and impose strict regulations and restrictions to prevent the misuse and overuse of water resources or contaminating it.</td>
</tr>
<tr>
<td>7</td>
<td>Water Resource Development</td>
<td>The concerned body shall prepare the necessary policies and plans in relation to the construction of dams, canal, water catchment and storage to develop such resources and to support and encourage the local community initiative towards such projects in accordance with the studies and specifications which shall be prepared by the concerned body or approved by it.</td>
</tr>
<tr>
<td>30, 33 and 37.1</td>
<td>Definition of Standards and Development of EIA guidelines</td>
<td>Define the process for the establishment of standards and their establishment by the Cabinet.</td>
</tr>
<tr>
<td>56</td>
<td>Environmental Protection and Economic Development</td>
<td>All competent bodies especially those concerned with development and economic planning shall adhere to include the considerations of the protection of the environment and control of pollution and the rational consumption and utilization of natural resources of the projects and national economic development plans.</td>
</tr>
</tbody>
</table>

Source: EPL, 1995

Table 3.4: Principal Relevant Environmental Legislation (excl. EPL)

<table>
<thead>
<tr>
<th>Law/ Decree</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law No. 5 of 1973 regarding mines and quarries</td>
<td>4/8/73</td>
</tr>
</tbody>
</table>
3.28 A similar situation prevails with respect to standards and guidelines. The EPC has released draft standards for Wastewater Quality and Air Quality, but a comprehensive set of standards is not yet available. In their place international standards, primarily those of the World Health Organization (WHO), are used.

3.29 Yemen has signed several international environmental agreements that also serve as guidelines, including: Biodiversity, Climate Change, Desertification, Environmental Modification, Hazardous Wastes, Law of the Sea, Nuclear Test Ban, Ozone Layer Protection, and Traffic in Endangered Species.

3.4 Policy framework

3.30 The National Environmental Action Plan (NEAP)\(^5\) has been prepared with the support of the UNDP and World Bank and was published in 1996. The principal elements of the NEAP as they affect the Water Supply and Sanitation Sectors are summarized in Table 3.4.

3.31 While the NEAP does not have any legal status, it provides the policy framework for the actions of the EPC. As such, it provides guidance on the application or otherwise of the available legislation though, in Yemen, as in most countries, the existing body of legislation (prior to the EPL) was probably sufficient to provide adequate protection to the environment had there been an effective policy framework for its application.

Table 3.5: Principal Elements of the NEAP Affecting the Water and Sanitation Sectors

<table>
<thead>
<tr>
<th>Sector / Issue Concern</th>
<th>Over extraction of groundwater</th>
</tr>
</thead>
</table>

\(^5\) The EPL Article 5 (2) requires the EPC to prepare a National Environmental Action Plan; the official organ of the state and shall undertake the preparation of the general national policy for environment protection and its control.

The NEAP is thus considered to be an established element of the Environmental Framework.
<table>
<thead>
<tr>
<th>Land Degradation</th>
<th>Lack of water allocation and conservation systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Pollution</td>
</tr>
<tr>
<td></td>
<td>Inadequate Water supply Services</td>
</tr>
<tr>
<td>Waste Management</td>
<td>Soil Erosion</td>
</tr>
<tr>
<td></td>
<td>Wastewater management</td>
</tr>
<tr>
<td></td>
<td>Solid Waste Management</td>
</tr>
<tr>
<td></td>
<td>Hazardous Waste management</td>
</tr>
<tr>
<td></td>
<td>Pesticide Management</td>
</tr>
</tbody>
</table>

Source: NEAP, 1996

3.32 The tasks and responsibilities of the water authorities mentioned in chapter 3.2.1 (NWRA, NWSA, SAI) overlap with the responsibilities of several other governmental organizations, e.g. the authorities for Agriculture or Economy. The contradicting interests of the authorities often cause delays or even prevent vital decisions.

3.5 **Financing Framework**

3.33 Article 92 of the EPL (1995) stipulates that an Environmental Protection Fund (YEP) is established to receive all moneys allocated by the GoY to protect the environment. This fund has now been established and is managed on a day to day basis by the Chairman of the EPC, or more usually his delegated authority.
4. Project Objectives and Description

4.1 Introduction

4.01 This section contains summary descriptions of the project, according to the Initial Development Plan (IDP), which covers a period through 2020. According to the IDP, the main objectives of the Al Qaida component of the Urban Water Supply and Sanitation Project are:

4.02 For Water Supply:
- To increase water production to enable continuous and adequate water supplies;
- To develop a zoning system to facilitate an efficient and equitable distribution of available water supplies;
- To introduce bulk and consumer water metering to enable an adequate control of water supplied and consumed; and
- To control unaccounted for water within feasible limits.

4.03 For Wastewater Collection and Disposal:
- To gradually extend wastewater collection in high population density areas;
- To ensure that for non-connected households satisfactory on-site facilities will be provided and maintained;
- To provide wastewater treatment capacity commensurate with increasing flows and to provide for and maintain established requirements on effluent quality; and
- To enable effluent reuse for irrigation purposes.

4.04 The NWSA Al Qaida branch office will concurrently be developed to cope with its enhanced responsibilities and for its operation on commercial basis. Water and wastewater tariffs and charges will be adjusted to ensure long-term financial self-sufficiency.

4.05 The Initial Development Plan (IDP) reflects a proposed extension in phases of water supply and wastewater facilities, with each phase covering a 5-year period. The IDP also provides for an estimate of immediate and long-term investment costs.

4.06 The improvement of the water supply situation in Al Qaida depends upon both the reduction of drinking water losses and an increase in drinking water production. Although the development of new potable water sources to satisfy the demands of the increasing population is not part of first phase works for Taiz, it is considered feasible to meet the lower demands of Al Qaida by the end of this initial 5-year period. The specifics of further extensions of additional water resources cannot be addressed in the current version of the development plan, since further studies will be required for exploring potential groundwater and surface water availability. Broad assumptions have therefore been made on the availability of additional water supplies during subsequent phases of the project, and also on relevant costs. Because of uncertainties in background data, the development plan will need to be updated at regular intervals in order to benefit from further knowledge to be gained.
4.07 The first phase investments address urgently required works and represent minimum requirements. The investment requirements during subsequent phases are expected to be significantly higher in view of the need to rehabilitate the water distribution system, to provide for an increasing standard in water availability, and to extend wastewater treatment to a level enabling unrestricted use of treated effluents for irrigation.

4.08 Water and wastewater quantities were estimated based on population projections, and a preliminary hydraulic design determined the layout of pressure zones. Industrial zones do not exist in Al Qaida, while commercial activities are scattered throughout the town center.

4.2 Water Supply

A. Project need

4.09 In 1967, a private water supply system was introduced in Al Qaida, but was subsequently handed over to NWSA in 1994, because of the need to secure the development of additional water resources. This system included wells with depths up to 550 m, located to the northern and eastern directions of the city, transmission mains, four storage reservoirs and a distribution network covering the inner town. Because of further population growth and increasing water demand, the city presently faces serious water supply shortages. Deficient city water sources are supplemented either by bottled water, or through independent suppliers using water taken from local springs or treated using small reverse osmosis facilities.

4.10 Current water sources consist of groundwater wells in the northeastern and eastern directions from the town. One well (maximum yield of 6 l/s) is located to the east, adjacent to the town boundary, and two other wells (combined maximum yield of 12 l/s) are located 2.5 km to the northeast. The yields from the wells seem to be sustainable, and no significant variation to the groundwater table has been recorded since the commencement of operations.

4.11 One of the northeastern wells is currently metered, and thus its production can be measured, while the yields of the other two wells are estimated according to pumping time. Due to the lack of metering for these two wells, the estimated average production of about 690 m$^3$/d should be taken with precaution. This figure corresponds to an annual water production of about 251,720 m$^3$ for 1999.

4.12 The northeastern wells also serve several small villages before the pipeline reaches Al Qaida. The total population of these villages is estimated at 4,795, with an estimated per capita water consumption of 35 l/day. This approximates an annual consumption of 60,000 m$^3$ for these villages, implying that the water production available for Al Qaida is reduced to about 191,720 m$^3$/a.

4.13 The water from the three existing wells is considered to be of good quality and suitable for potable water supply. However, there is a need for chlorinating to prevent any contamination that might occur in the distribution system. Due to the northwest to southeast groundwater flow, the well fields are not considered to be at risk of being polluted by wastewater infiltration taking place in the town. However, the well fields may need to be protected from adjacent sources of pollution emanating from agricultural land use. The drilling of wells for irrigation would need to be restricted by the government in
order to protect the sustainability of the wells being used for domestic and non-domestic water supplies.

4.14 Starting in 1999, NWSA Al Qaida, with the cooperation from NWRA Taiz, succeeded in drilling three production wells in Al Kudaira, Dabah, and Eblal. At present they have six wells, three already in operation and the three new ones will be evaluated before introducing them into operation. Preliminary tests on the first three wells indicate that at least two of the wells have low draw down levels, but the third has a higher flow potential (see Section 5 for details).

4.15 The water is pumped from the wells through the town to the western and southern storage reservoirs. The total length of the transmission mains (sizes between DN 50 and 100, installed in 1967) is about 13 km (Appendix B, Layout of the existing System).

4.16 There are four existing storage reservoirs in Al Qaida. The largest of these (Nawbat Al-Ghazal) is made of concrete, and has a capacity of 200 m$^3$. This reservoir was built in 1997 on the western hills and is still considered to be in good condition. It currently receives water from the two eastern wells. The other three reservoirs vary in size between 10 to 30 m$^3$ and were built in 1967 and 1978. From each reservoir the water is distributed by gravity to respective supply areas. The storage capacities of these three reservoirs are considered to be too small to be integrated into the new system, given the anticipated increase in water demand. Equipment and pipework for these reservoirs are considered to be obsolete and in a state of deterioration.

4.17 The pipework in the water distribution system is made of galvanized steel (GSt) and mainly constructed in 1967. Over the years this system has been extended and repaired, first by the private operator and then by NWSA. The total pipe-length is about 24 km, with pipe diameters varying from DN 25 to 100. According to records on frequency of repair works available from NWSA, the networks are in poor condition and are further deteriorating.

4.18 Unaccounted for (UfW) water is presently estimated at about 30% of water production. This includes:

- Physical losses such as transmission and distribution systems leakage, including service connections; and

- Administrative losses due primarily to a lack or absence of adequate metering, and to illegal connections.

4.19 Administrative losses represent water used although not paid for, and will be reduced through actions to be taken in institutional strengthening, and through a gradual extension of water metering. It is estimated that at least 50% of UfW refer to visible leaks, mostly (up to 90%) at house connections. In Al Qaida, the pipework is primarily laid above ground, and it therefore could be assumed that only a very small percentage of UfW consists of invisible leaks.

B. Project components

<table>
<thead>
<tr>
<th>Total new Pipe*</th>
<th>Total new Pipe*</th>
<th>Increase of Supplied Area* (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN100-DN150 (m)</td>
<td>DN250-DN300 (m)</td>
<td></td>
</tr>
<tr>
<td>4,000</td>
<td>3,760</td>
<td>18</td>
</tr>
</tbody>
</table>

*Phase 1 works
4.20 The emphasis on the development of infrastructure to exploit the increase in water production brought about by the development of another three wells will have first priority, as this will rather significantly increase the per capita water availability. Due to financial constraints, this will defer until Phase 2 a needed rehabilitation of much of the distribution systems and further extensions to connect additional population as the city grows. This would imply a decrease in the connection rate from 97% to 85% by 2005, but during subsequent Phase 2, this should be corrected with a 100% connection rate to be reached by 2010. This would also imply an estimated increase in unaccounted for water from 30% to 35% by 2005.

4.21 The development of the three wells will also include the provision of transmission mains and storage tanks. This deferment will not, however, exclude normal reparation and replacement works to be done by NWSA, as well as minor distribution extensions.

4.22 The development plans covered by this EIA concern Phase 1 works, which are expected to be completed in 2005. The final development plan will cover the period through 2020, with works in subsequent phases designed at appropriate time periods, taking into account least cost solutions.

4.23 In this context, the following works are proposed to be included in the first phase:

- Pumping plants and piping for the three wells and equipment for chlorinating, which possibly could be combined for all wells;
- Extension of transmission mains in sizes of about DN 150, and replacement of existing transmission mains in sizes of about DN 200 (5.7 km in total); and
- Replacement of 50 m³ storage tank.

4.24 Despite the focus on increasing production during Phase 1 works, it is expected that long term targets of 70 l/cap/day by 2010 and 90 l/cap/day will be achieved under the project.

4.25 If there are difficulties in the development of additional groundwater resources, or if issues arise concerning the sharing of water between urban and rural areas, standpost water supplies might have to be accepted on temporary basis in subsequent phases. Nevertheless, the water transmission and distribution systems for all scenarios will be designed for 100% service connections.

4.26 The topography of Al Qaida provides for an elevation difference of only about 200m, which necessitates a division of the service area into supply zones to control service pressures. This division can be achieved by taking into account acceptable service pressures, the creation of zones of feasible size, and the utilization of existing service reservoirs and pipeline systems, wherever possible.

4.27 Figures 4.1 through 4.5 illustrate how the zoning system will be developed over the four phases of the project, which will also determine pertinent operational patterns for water supply distribution. These figures, found in Appendix B are described as follows:

- The current zoning system is shown in Figure 4.1 and illustrated on the schematic Figure 4.2;
- The zoning system has been designed for the year 2020 as shown on Figure 4.3 and illustrated on the schematic Figure 4.4. This system covers two pressure zones;
• The zoning systems for intermediate years (2005, 2010 and 2015) are shown on Figure 4.5.

4.28 The following basic assumptions have been made for the zoning system:

• The water pressure should not be less than two bar and not higher than six bar;

• Each zone should be provided with a storage tank, representing about 24 hours of average daily water demand. The transmission main that runs from the pumping station to the storage tank could either be connected to the distribution system or become a designated pipeline, as is presently done. In the latter case, a separate pipeline will be laid from the storage tank to feed the distribution system. In each case, this final decision will be made using a least cost analysis, with due regard to operational considerations; and

• Each zone will be provided with bulk water meters, in order to enable monitoring and control of water being supplied and consumed.

4.29 Following Phase 1 works, a new main reservoir will be located on the western hillside in order to supply zones III and IV, together with the existing Nawbat Al-Ghazal reservoir. A new reservoir will also be provided to serve zones I and II, and will be located in the eastern and southern sections of the town.

4.30 Table 4.1 shows the length of pipes (for transmission and distribution) that would need to be installed during the various phases of the project. The existing supply network consists mainly of obsolete GST pipes, which are proposed to be replaced by DCI pipes. It is proposed that the house connections be completed using HDPE pipes.

4.31 Detailed technical descriptions are given in the Final Design Report (DORSCH/GITEC, September 2001).

4.3 Wastewater

A. Project need

4.32 Cesspits and latrines are the predominant wastewater disposal systems currently used in Al Qaida. Supernatant infiltrates into the ground with the potential to pollute groundwater sources. Until now, however, groundwater flows in the southern direction have meant no risk for pollution of the eastern well-field area. This situation might change if town development continues to the east, which in the long term has the potential to affect the groundwater quality.

4.33 Stormwater collection and discharge facilities do not currently exist. Currently, stormwater drains along the natural slope of streets and walkways, ending up in roadside ditches and wadis. The general surface flow direction within the city is towards the east and the south.

4.34 In the center of the town, where because of rocky soil formations the possibilities for wastewater infiltration are limited, the wastewater overflows into the streets creating unsatisfactory sanitary conditions. Raw sewage can be seen pooling in city streets and wadis, often forcing residents to navigate pedestrian ways through unsanitary conditions. Children are often seen playing near raw sewage pools or flows.
B. **Project components**

<table>
<thead>
<tr>
<th>Increase in Served Area* (ha)</th>
<th>Service Connections*</th>
<th>Percentage of Population Served*</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>2,500</td>
<td>74%</td>
</tr>
</tbody>
</table>

*Phase 1 works

4.35 The construction of a new sewer network is an important part of this project. The wastewater generation rate is estimated at 85% of the supplied water amount at connections, while households with standpost water supply are assumed to have on-site wastewater disposals. The stormwater allowance has been estimated at 1.5 times average wastewater flow. Because of dry weather conditions and a low groundwater table, infiltration has not been taken into account. According to the Priority Measures mentioned in DORSCH/GITEC (August 2001), the following lengths of new sewer trunk main lines will be installed:

**Table 4.2: New sewer trunk main lines**

<table>
<thead>
<tr>
<th>Diameter [mm]</th>
<th>DN 250-DN400</th>
<th>DN 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length [m]</td>
<td>6,000</td>
<td>18,000</td>
</tr>
</tbody>
</table>

4.36 Although water availability will increase under Phase 1 to about 50 l/c/d, it is still considered to be rather low and is therefore expected to be partially accommodated through the use of existing or improved on-site disposal systems.

4.37 Due to unfavorable soil permeability in the center of the city, an alternative to on-site disposal systems is recommended. It is expected that water consumption will remain low even after Phase 1, implying that some on-site disposal systems are likely to continue to be utilized in these sections of the city in subsequent phases, leading to the potential for very low flow in some areas. The design of the network, therefore, will take the low flow into account in order to reduce the risk and frequency of clogging.

4.38 Where feasible, highly populated areas in the city will be connected to the sewerage system. Therefore, new sewers will be installed at a length of approximately 2.4 km under Phase 1 works. The connected area, which does not exist at present, will be extended to 50 ha. In this context, house connections for some 74% of the population will also be installed.

4.39 For the wastewater collection network a minimum diameter of DN 200 is recommended. The minimum diameter for house connections is, according to required slope, proposed to be either DN 100 or DN 150. Network density is expected to increase from 100 m/ha in 2005 to 200 m/ha in 2020. The required pipe length for different pipe diameters has been estimated according to the ratio 1:4 (DN 250 to DN 400:DN 200).

4.40 Pipes to be selected are proposed to be made of ductile iron or vitrified clay (steep slopes) and PVC or concrete (normal slopes). House connections are proposed to be made of PVC. The minimum cover above any sewer pipe will not be less than 1 m. Otherwise, special encasement is necessary and shall be constructed around that portion of the pipe that has less than 1 m cover. Any manholes that are located in wadis shall be raised at least 2 m above ground level.
ii) **Catchment Areas**

4.41 Figure 4.6 shows the city boundary, relevant catchment areas and the location of the proposed wastewater treatment plant (WWTP).

4.42 The highly populated zones in the town center, catchment area A, will have priority for wastewater collection system coverage. It is in these zones, representing 40% of the area of the town, where the sanitary conditions are currently most severe. The zones in the north and west are proposed to be connected during subsequent phases. The lower areas of the southern zone are not currently proposed to be connected, since this would involve pumping for discharge to the WWTP. Such pumping would not presently be justified for the small number of houses in this area.

iii) **Industrial Wastewater Collection**

4.43 The amount of industrial/commercial wastewater is currently considered to be of secondary importance for the public sewerage system, as there are currently no plans for the establishment of any major industries within the city. If the need arises, however, appropriate arrangements will have to be made for effluent disposals. The status of such needs will be reviewed under subsequent phases.

iv) **Wastewater treatment**

4.44 The provision of wastewater treatment will, for financial reasons, be extended in stages with the first stage to include primary treatment only. Secondary treatment will follow, with the timing of investments to be decided based on experience to be gained from first stage treatment, actual pace of sewer connections, and the availability of funds. The environmental impact from the discharge of primary treated effluents will be closely monitored, including its potential use for irrigation.

4.45 In this context, an interim Phase 1 arrangement has been proposed. This arrangement will consist of pre-treatment and a septic tank, to be designed for a $\text{BOD}_5$ load of 1,500 kg/day with the effluent to be discharged to the wadi after aeration through cascading. It is estimated that the treatment efficiency of this system will be about 50% of what would be provided through the use of a trickling filter. Therefore, the use of effluents for irrigation should, at least initially, be restricted. During the dry season most of the effluent could be expected to infiltrate into the ground. Proposed arrangements provide for a significant improvement of existing conditions.

4.46 An extension of these interim arrangements is expected to be implemented during Phase 2. Pre-treatment with an anaerobic sedimentation pond, in combination with a trickling filter using the natural slope of the hill, followed by a final sedimentation pond, has been proposed. For details of the alternatives considered, refer Section 7 (Analysis of Alternatives), and Appendix J (Process Calculations for WWTP).

4.47 In order to enable unrestricted use for irrigation in subsequent phases, effluent quality should eventually satisfy the following criteria:

- $\text{BOD}_5 <$20mg/l;
- $\text{SS} <$20mg/l; and
- Total Coliforms $<$1000/100ml.
v) **Disposal of residues**

4.48 The residues to be removed from the different stages of wastewater treatment are screenings, grit, and sludge, with sludge being the major component. This sludge can feasibly be used as a soil conditioner for agriculture or reforestation.

vi) **On-site facilities**

4.49 Disposal of faecal sludge from latrines, septic tanks and cesspits is presently done uncontrolled, without regard to environmental and health considerations. Applicable low cost solutions for on-site disposal of waste and wastewater are described in Appendix K. These low cost solutions have in common that only about 50% of discharged pollution load will be retained in various treatment units (such as cesspits). Highly polluted supernatant will drain underground and could, depending on the flow direction, contaminate existing or potential well fields.

4.50 It is proposed that unsewered areas use septic tanks with cesspits. For single households not using water (flushing) closets, ventilated improved double pit latrines would be applicable. The tanks have to be emptied regularly with the content to be conveyed by vacuum trucks to the treatment works for disposal. The sludge from pit latrines will be stabilized after two years of storage and can likely be used directly in agriculture as fertilizer.

4.51 The costs for the installation of septic tanks, cesspits, soakpits or latrine-systems will have to be paid for by individual households, with technical assistance given by NWSA. Once a year they should be emptied and the sewage should be treated in the Wastewater Treatment Plant (WWTP) in Taiz, until the treatment facility in Al Qaida can handle such concentrated waste.

4.52 NWSA funding would be made available for collection networks and treatment units only in cases where the construction of a neighborhood system is indicated. Such a treatment unit will typically function as a larger septic tank/cesspit system. The effectiveness of such systems is considered to be about 50%, which in more densely populated areas cannot be considered sufficient for needed groundwater protection.

4.4 **Implementation Schedule**

4.53 The following table outlines the proposed implementation schedule for the project.

**Table 4.3: Implementation Schedule (Al Qaida)**

<table>
<thead>
<tr>
<th>Construction period</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor's mobilization</td>
<td>May 2002 – June 2002</td>
</tr>
<tr>
<td>Preparatory works</td>
<td>May 2002 – Aug 2002</td>
</tr>
<tr>
<td>Supply of imported materials</td>
<td>July 2002 – Dec 2002</td>
</tr>
<tr>
<td>Supply of local equipment</td>
<td>June 2002 – Aug 2003</td>
</tr>
<tr>
<td><strong>Networks</strong></td>
<td></td>
</tr>
<tr>
<td>Rehabilitation of water network</td>
<td>Jan 2003 – July 2003</td>
</tr>
<tr>
<td>Rehabilitation of sewer network</td>
<td>Jan 2003 – July 2003</td>
</tr>
<tr>
<td>Rehabilitation of the Water and Sanitation Network Taiz</td>
<td>Environmental Assessment</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Extension of sewer network</td>
<td>Jan 2003 – July 2005</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>Sep 2003 – Nov 2004</td>
</tr>
<tr>
<td><strong>WWTP</strong></td>
<td></td>
</tr>
<tr>
<td>Rehabilitation of lagoons (desludging, etc.)</td>
<td>Jan 2003 – Dec 2003</td>
</tr>
<tr>
<td>Fencing</td>
<td>Mar 2003 – May 2003</td>
</tr>
<tr>
<td>Commissioning</td>
<td>Apr 2003 – Feb 2004</td>
</tr>
</tbody>
</table>
BOUNDARY OF THE AREA SERVED BY THE EXISTING WATER SYSTEM

TRANSMISSION PIPE LINE FROM THE WELLS TO THE RESERVOIRS

Reservoir

Neighborhood Unit No. 14

NORTH

FIGURE 4.1
AL-QAIDA
EXISTING SUPPLY ZONE
FIGURE 4.3
AL-QAIDA LAYOUT WATER PIPES

LEGEND:
○ EXISTING WELL
□ ZONE No. I
TO BE SUPPLIED FROM RES. 1
□ ZONE No. II
TO BE SUPPLIED FROM RES. 2
FIGURE 4.4
AL-Qaida
Schematic new system
FIGURE 4.5
AL-QAIDA WATER DISTRIBUTION SYSTEM
FOR YEAR 2005 / 2010 / 2015

LEGEND:
○ EXISTING WELL

YEAR 2005

YEAR 2010

YEAR 2015

YEAR 2020

TO DOSUPAL

TO SANA'A

PRESENT

TO HABERER

YEAR 2005

YEAR 2015

YEAR 2020

TO TAIZ

NORTH
FIGURE 4.6
CATCHMENT AREAS FOR WASTEWATER COLLECTION SYSTEM
AL-QAIDA

LEGEND:
SEWAGED AREA
NOT SEWAGED AREA

NORTH
5. Baseline Studies and Data

5.1 Introduction

5.01 Baseline data in the following section is based on previous studies; literature research and information collected during visits in the Taiz and Al Qaida regions at various points during 1999 and 2000. During site visits NWSA and the World Bank PIU provided additional information.

5.02 The following studies were used as the primary sources of information for this section:

- "Water Resources Management Action Plan for the Taiz Region" (Draft), Republic of Yemen, NWRA, Policy and Programming Sector,
- "Hydrogeological and Land-Use Studies in the Taiz Region (Upper Wadi Rasyan Catchment)", Volumes 1 and 2, TCD-Contract No. YEM/93/010-3, Republic of Yemen,

5.03 The photographs in Appendix A of this report were taken made during site visits in Taiz and Al Qaida in July 2000.

5.04 The descriptions of the local environment include a generalized description of the Upper Wadi Rasyan Region (Drawing No 1), as well as a more specific description of the area in and around the planned construction sites in Al Qaida (Drawing No 2).

5.05 Insufficient water supply and water quality is one of the most severe problems of the region. Therefore the main emphasis of this section will discuss the hydrogeological and human aspects of the project areas.


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6 geology & soil, climate & air, surface & groundwater, biotopes, flora & fauna, population & cultural heritage
5.2 Physical Context

A. Geology

5.07 The Arabian Peninsula is part of the East African Shield, an extended region of Precambrian basement that has undergone different metamorphisms. This Precambrian rock was largely leveled to a peneplain in the Paleozoic era and subsequently covered by sediments in the Jurassic and Cretaceous Ages. Intensive volcanic and intrusive activity began at the end of the Cretaceous, caused by the fact that the western part of the Arabian Peninsula and the adjacent East African Table were pressed upwards and started to break into separate blocks.7

5.08 Lava streams were mainly extruded through fractures, followed by volcanic tuff. These materials covered the Precambrian basement and the overlying Mesozoic sediments and are known as Tertiary Volcanic with a thickness of layer up to 2000 m. The Quaternary is represented by plane deposits that may derive from the weathering of Tertiary Volcanic tuffs and ashes. This volcanic material has been deposited as loess, which can be found especially in the Qaida and Al Janad plateau.

5.09 The Sabir Mountain is a post-Tertiary granite stock cutting across the Tertiary Volcanic. Tertiary basalt flows and Quaternary wadi terraces, alluvial fans and wind deposits make up the present day landscape of the investigation area.

B. Geomorphology

5.10 Al Qaida is located in the Ibb province, about 90 km inland from the Red Sea and some 24 km north-west of the city of Taiz. The elevation of the town varies between 1,500 and 1,700 m above sea level and the average annual rainfall is in the range of 600 - 700 mm. Al Qaida is located to the north of the Jabal Sabir Mountains. The Jabal Sabir, representing the southern boundary of the east-west faulted central graben, is the dominant morphological feature of the area and rises up to more than 3000 m. Within the area around Taiz and Al Qaida there are five major morphological units that have to be distinguished:

1. Mountains,
2. hills and escarpments,
3. undulating eroded lands with major wadis,
4. major wadis and plains, and
5. loess covered plateau

5.11 As the high plateaus above 2,500 m receive significant rainfall, man-made terraces with dense vegetation are concentrated on the upper parts, which are often densely populated. Terracing occurs on the slopes up to 45°. On the lower foothills the mountains are deeply cut by narrow valleys.8

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7 Final Report of the Swiss Airphoto Interpretation Team, 1978
5.12 The wadis that cut through the undulating lowlands vary especially in their width. Major wadis and plains are filled with deep alluvium layers, forming the major water resources.

5.13 The so called Al Janad plateau in the south of Al Qaida is located along the major water shed between the Red Sea and the Gulf of Aden Drainage Basin. It can be seen as a cliff covered with buildings.

C. Soil

5.14 There is very little available information concerning the soils of the Upper Wadi Rasyan. A soil study, produced by NWRA in 1997, was the primary information source used in this section. In this study thirty profiles have been made in a district that covers approximately 929 km². None of these profiles, however, are directly located within the investigation area of this Project. On the basis of information regarding adjacent areas, only general statements about soils can therefore be made.

5.15 The soils typically found in the area are Ustorthents, Ustifluvents and Ustropepts. These classifications do not correspond correctly to the classifications that are used in the card of the world soils, so only the main characteristics of these soils are mentioned.

5.16 Most of the soils are silts mixed with alluvial and/or colluvial materials from the weathering of local rocks. Their thickness varies from 1 m in the mountains to 3 m in the wadis. Under these soils there is a thick layer of loess and/or alluvial deposits, which varies from 2 to 40 m.

Some profiles with the appropriate soil properties are listed in table 5.1.

Table 5.1: Soil properties (NWRA, 1997)

<table>
<thead>
<tr>
<th>Sub-area/ Location</th>
<th>Observ. profile No.</th>
<th>Physiography</th>
<th>Soil depth [cm]</th>
<th>Surface and sub-surface texture</th>
<th>Surface texture [%]</th>
<th>E.C. [mS/cm]</th>
<th>pH</th>
<th>Organic matter [%]</th>
<th>infiltration rate after 3 hrs [cm/h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhi Sufal- Haimah Sub-area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al-Haimah 23</td>
<td>middle wadi</td>
<td>20</td>
<td>CL, SiCL</td>
<td>28 32 30</td>
<td>1.4</td>
<td>8.4</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al-Janad Sub-area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al-Janad Plateau 29</td>
<td>plain (terraces)</td>
<td>300</td>
<td>SiCL, SiCL</td>
<td>32 52 16</td>
<td>0.6</td>
<td>8.0</td>
<td>0.7</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Al-Hawban Sub-area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al-Hawban 32</td>
<td>plain flat</td>
<td>200</td>
<td>C, SiC</td>
<td>56 36 8</td>
<td>3.5</td>
<td>9.5</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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5.17 In principle, soils in urban areas are often very different from natural soils, due to mechanical and chemical changes, and caused by human activities (construction works, pollution, agriculture, etc.). One typical characteristic of urban soils is the high concentration of Nitrate, for example.

5.18 One of the most important characteristics of the soil is the soil reaction (pH) because it has a decisive influence on the biological decomposition and on the pollutant fixing capacity of materials such as heavy metals etc. All of the investigated soils showed alkaline reaction (pH > 7). This is positive, because it increases the pollutant fixing and the soils' buffer capacity.

5.19 Generally soil texture is the product of weathered rocks, the influence of the local vegetation and the climate. Due to the dry climate and the meager vegetation cover in the region, the share of organic components is very low. Clay minerals dominate in areas of basic volcanic while sand and silt dominate in areas of acidic volcanic, granite and sandstone.

5.20 The soil salinity (electrical conductivity) measured by NWRA varies between less than 1 mS/cm in Al Haimah and Dabab to more than 1.5 mS/cm in Al Hawban and the area in the northwest of Taiz. Some erratic measurements (23 mS/cm in a depression on the Al Janad plateau, 12 mS/cm in alluvial areas in Dabab and 26 mS/cm on a water clogged soil in Ukaysh) even exceed the landfill values that amount to 10 mS/cm. The high salinity is probably caused by irregular waste water flows (leakage, field watering) or waste water overflows of the few existing ponds in short periods of heavy rainfall, when the amount of waste water exceeds the ponds capacity. Compared with the permitted limits in Germany (1 mS/cm for soil deposits), for example, the measured values exceed this limit by far.\(^\text{10}\)

5.21 The concentrations of organic components are generally low to very low (up to max. 1-2% humus). This is typical for an arid climate, because there is only a meager vegetation cover and organic material is quickly decomposed. Higher shares of organic materials (about 3%) are found in polluted areas, mainly due to the influence of waste water/waste.

5.22 The soil infiltration rates, which are of great importance for the water balance, the agriculture and the groundwater level, are high in the central sub-area and medium in the other areas.\(^\text{11}\) The infiltration rates in one half to one third of the observation points are high enough to seep away 30 minutes of heavy rain (5-10 cm/h, NWRA, 1997); the main rainfall events are characterized by high intensity and short duration.

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\(^{10}\) LANDESAMT FÜR WASSER UND ABFALL NRW, 1989

\(^{11}\) classification of Burghardt et al. 1998
D. Climate and Air

5.23 The climate of Yemen is determined by the country’s geographic location and by the articulated relief, which rises from sea level to an elevation of 3,700 masl within a distance of only 100km\(^2\).

5.24 The country is located in the border-area of two systems of atmospheric circulation:

a) from May to September the climate is mainly influenced by moist air masses of the monsoon circulation system which flows from the southwest against the Yemen highlands and cause heavy precipitation on the mountain slopes exposed to the west, mainly above 1,500 masl. The rainfall events are characterized by high intensity, short duration and limited extent.

b) from October to February dry air masses originating from the Central Asian Anticyclone are the main reason for the clear and rainless winter season.

5.25 During the rainy season Taiz and Al Qaida will often receive high amounts of rainfall, periodically causing flooding throughout the two cities. In Al Qaida, these floodwaters tend to run in wadi beds and alongside roadways, sometimes washing them out, or making them impassable.

5.26 These rainfall events are based on three different meteorological mechanisms:

1. the Red Sea Convergence Zone (RSCZ): Caused by the daily rapid and intensive heating up of the land surface, inland winds lead to convection effects along the western escarpment. Humid air masses are lifted, carried eastward and lead to the typical short-term rainfall events with high intensity, especially in the afternoon. At night the conditions are vice versa. The cool air masses of the highlands descend during the night towards the coastal plain. This is a typical system of land-sea wind.

2. the monsoon Intertropical Convergence Zone (ITCZ): This mechanism causes the main rainfalls between July and September. As the ITCZ moves gradually northward and then southward again, the southern part of Yemen benefits much longer from this effect than the northern part north of Sana‘a. Compared to the RSCZ rains single rain cells from the ITCZ have a potentially larger extent.

3. the Mediterranean effect: Appearing only once every few years, this effect causes occasional light rainfalls in December/January. It is based on an influx of polar air following a cyclone.

5.27 The average yearly rainfall in the investigation areas of Taiz and Al Qaida (temperate highland zone) is between about 500 and 600 mm. The distribution of the annual rainfall is bimodal with peaks in April/May and August/September. During the months June and July there is less rainfall (Figure 5.1). The dry season begins in mid October and ends in mid March.

5.28 Although accurate figures for precipitation are not available for Al Qaida itself, figures for the Taiz Airport, located 6km to the south of Al Qaida, are considered representative.

\(^{12}\) Final Report of the Swiss Airphoto Interpretation Team (1978)
5.29 Typical for the summer rains are the high intensity, the very localized appearance and convective storms. These storms are associated with spring inland winds in the first rainy season and with the presence of the ITCZ in the second rainy season.

5.30 The rain falls in combination with the storms that take place in limited areas, so there is a great difference in the amount of every single rain event over short distances. Average values of single stations must therefore be interpreted with caution. The awareness of the possible mistakes and the dependence of the investigation data on the monitoring station are very important.

5.31 The average annual temperature is around 24 °C. About six months per year (October to March) the average temperature is lower (minimum in December around 14 °C), from April to September it is higher (maximum in July around 33 °C). The distribution of temperature over the course of the year is shown in Figure 5.2, which shows the data that were collected at the meteorological station in Ossaifrah. This station, with an elevation of 1200 masl, is in the vicinity of Taiz.

5.32 With 8 to 9 sunshine hours per day, and an evapotranspiration rate of about 1790mm per year, the climate is hot and arid. The typical daily evapotranspiration rates are between 4 and 6 mm; in summer 6 mm is a typical value\textsuperscript{13}.

E. Water

i) General situation

5.33 The cities of Taiz and Al Qaida are located in the Red Sea drainage basin. Seven major wadis drain this high and midland region of the country in a westerly direction towards the Red Sea. These Highlands receive some of the largest quantities of rainfall in the Arabian Peninsula. The average rainfall in the region is 534 mm per year.

5.34 Although the total amount of the annual precipitation seems to be quite high, there are large differences from one year to the next, and most of the rain falls during only a few and intensive rain events.

5.35 Most of the mountain surfaces in the area are only covered with bare rocks with a low or even missing vegetation cover, giving them a low water retention ability. The water quickly runs down the mountains and fills the wadis, which then transport enormous volumes of water and sediments for periods of only a few hours.

5.36 A part of this water then infiltrates the spacious lower wadi areas, and replenishes the groundwater layers there. In those regions major wells for the exploitation of drinking water are located (Photograph No. 4, Drawing No. 1).

5.37 However, the amount of water that is exploited from the aquifers in many areas exceeds the re-infiltration rate, resulting in a constant lowering of the groundwater level.

ii) Groundwater

5.38 Although much of the rainwater is lost to the atmosphere through evaporation, it also partly recharges the aquifers. The volume of water stored in a typical aquifer is

\textsuperscript{13} NWRA, 1997
much greater than the annual recharge rate as the recharge is a process that takes place over a very long time period. The process of ground water accumulation in the aquifers of arid climates often takes hundreds, or even thousands, of years. In order to ensure a sustainable exploitation of groundwater resources it is essential that the groundwater extraction rate does not exceed the annual recharge rate. Unfortunately this is not the case in the investigation area.

5.39 The region has three main aquifer systems:

1. alluvial aquifers from the Quatemary
2. volcanic aquifers from the Tertiary
3. tawilah sandstone aquifers from the Cretaceous

5.40 The alluvial aquifers are located in the uppermost layers. These consist of sediments with varying sizes, ranging from boulders to silt, and they are found along the wadi beds and filled up depressions. With a thickness of about 30 to 40 meters (locally up to 70 meters) the alluvial aquifers are quite shallow. They mostly occur in a depth of 11 to 13 meters; generally they are found in a depth of less than 20 meters. This shallow depth allows for the easy exploitation of this aquifer. According to NWRA (1997), the significant quantity of groundwater resources is estimated at 200 Mm$^3$.

5.41 The most important priority of the alluvium aquifer in the context of this study is the fact that the alluvial aquifers are very vulnerable to man-made pollution. This is particularly true in the central area of the Upper Wadi Rasyan catchment, where the Hougala and the Houban well fields near Taiz are located.

5.42 The second aquifer layer is a volcanic one, and is found within fractures of the volcanic rocks, with an estimated thickness of 600 to 700 meters. The volcanic aquifers, with an estimated groundwater storage of 300 Million m$^3$ (NWRA, 1997), are not a very productive source, as yields of these wells are low. Caused by fractures that are connected to overlying alluvial aquifers in the polluted zones, the extracted water is of poor quality, similar to the alluvial aquifer. The high salinity of this layer, a further negative influence, is a natural one.

5.43 According to NWRA (1997) there is some evidence that the volcanic aquifer receives upward flow from deeply seated aquifers, but the extent and the significance of these aquifers is still unknown. This information is based on a hydrochemical study and on water temperature observations.

5.44 In summary, these two aquifers are of little significance for drinking water supply because of their poor quality. This water, however, is likely quite important for irrigation purposes.

5.45 The deep-seated Tawilah sandstone layer, with an estimated volume of 1,500 Mm$^3$ (NWRA, 1997) for all of Yemen, appears to be the only layer where unpolluted water is found$^{14}$, and it is the most productive layer in Yemen.

5.46 In the area surrounding Al Qaida, the sandstone occurs predominantly at depths between 400 and 600 meters; it is deeper than 600 meters in the Al Janad area and not as deep in the Dabab area (150 to 200 meters). This aquifer is the focus of exploratory

$^{14}$ More recent drillings would seem to partly contradict this, indicating the need for further exploration in the area.
efforts in the region\textsuperscript{15}. The sandstone aquifer is not fully exploited except for the Dhi Sufal area\textsuperscript{16}, where NWSA and private wells extract water.

5.47 The groundwater flow direction, which is very important in terms of the distribution of polluted water, is different in the two research areas. In Al Qaida the groundwater generally flows in a southeastern direction and therefore does not pollute the eastern well-field area.

\textit{iii)} \textit{Surface water}\textsuperscript{17}

5.48 The Taiz-Al Qaida region does not have any river or brook with a lasting flow because of the arid climate. The major wadis that drain the high and midland regions carry water during a very short period of time per year. During this period, the effluent is enormous, while during the rest of the year the wadis are dry or just carry wastewater. The surface water flowing into the wadis is partly used for irrigation via the so-called "Sawaaqi"\textsuperscript{17}, which are excavated channels on both sides of the wadi that irrigate the adjacent fields.

\textit{iv)} \textit{Wells and Well-fields}\textsuperscript{18}

5.49 Drawing No 1 shows the biggest well-field in the area between Taiz and Al Qaida. Here, water is pumped out of the aquifer, in most cases the Toil sandstone aquifer. To the northwest of Al Qaida there is the Habra and the As Shah well-fields. To the southwest of Al Qaida there are two well-fields, Makita and Al Hialeah. Two more well-fields are in the north of Taiz, the so-called Houban and the Hougalala well-fields.

5.50 The branch of the National Water and Sanitation Authority (NWSA) for Al Qaida and the surrounding villages has, until recently, three main wells in operation. One in Dabah to the east of Al Qaida and two in Manzial Khanwah to the north east of Al Qaida. See Drawing #3 in the appendix. The three wells combined are producing an estimated 18 l/s. The water of the well in Manzial Khanwah has a temperature exceeding 60\textdegree{} C.

5.51 Starting in 1999, NWSA Al Qaida, with the cooperation from NWRA Taiz, has succeeded in drilling three additional production wells in Al Kudaira, Dabah, and Eblal. At present they have six wells, three already in operation, with the remaining three yet to be evaluated before introducing them into operation.

5.52 The three new wells in operation, Al Kudaira (well # 1), Dabah (well # 2) and Eblal (well # 3), are drilled in the upper layer of the alluvium and reach to the volcanic layer therein. The depth of the wells is mainly restricted by financial problems, with the total contracted (max. allowable) depth having been 1,000 m. The water-bearing zone of the three wells is the fractured volcanic layer.

5.53 The proximity between the new wells and local farmer’s wells causes interference in the drawdown water level, particularly for wells #1 and #2.

5.54 A no-flow natural boundary can be seen at the ground level as a natural dyke that goes from east to west, especially near to the Al Kudaira well (well # 1). The effect of this boundary appears as a sharp continuous drawdown of the water table in the well. It has

\textsuperscript{15} Known as “The Delta Drilling Program”\textsuperscript{16}

\textsuperscript{16} REPUBLIC OF YEMEN, 2000

\textsuperscript{17} REPUBLIC OF YEMEN, 2000

\textsuperscript{18} aq_eia_textS.doc
therefore been recommended that well #1 should be pumped with a rate of 5.0 l/s for a few hours per day, not exceeding eight hours per day.

5.55 Surface and groundwater drainage for Al Qaida is towards the Dabah area. Well #2 is located at the downstream side of the upper part of the wadis Nakhlan and Al Hawre. Therefore the potential for contamination of the aquifer has to be monitored.

5.56 Well #3 is located in the upper part of the wadi Al Hawre at the bed of the wadi. A few hundred meters upstream there is a spring. This spring has a substantial discharge (base flow) during the whole year, including the dry season, giving this well a higher potential than the other two.

5.57 Preliminary chemical analysis of the three new wells show the water from wells #1 and #2 is quite hard, with elevated levels of calcium. The water quality from well #3 is much better, and within required WHO levels. Still, further analysis needs to be done on these wells to determine the suitability of this water for domestic purposes. It is expected that NWRA and NWSA will be responsible for such analysis.

5.58 Most of the other wells in the region are private wells, operated without state control. Most of these are uncovered and only a few meters deep. They are typically hand dug (=dugwell), and have a quite poor water quality.

v) Irrigation Water

5.59 Almost half of the population in the Taiz/Al Qaida area lives in rural areas. Agriculture is their primary source of income, practiced usually in the main wadis and in the highlands, depending on the availability of water. Because of meager clean water resources, polluted water (dugwells, wells, surface water) or even sewage itself is used for irrigation. Livestock also use the wadis downstream of the populated or industrial areas. This usage happens without any control or guidelines. Farmers note that using the polluted water for irrigation results in blighted crops, such that only hardier species such as millet are growing. If polluted groundwater is used for irrigation for several years, farmers notice increasing salinity and a decline of soil fertility. In most cases they are neither aware of the pollution sources, nor the risks to human health nor agricultural production.

5.60 Much of the groundwater used in agriculture is used in the areas where qat is cultivated, a crop that requires a lot of water. The increasing cultivation of qat is one of the reasons for an increasing demand for water by the agricultural sector.

5.61 Another reason for the high water consumption of agriculture is the fact that water saving technologies such as drip and sprinkler systems are not used in the research area. Most farmers use basin irrigation and furrow watering is not used at all.

vi) Main Water and Wastewater Problems

5.62 The lack of a wastewater collection and treatment system, along with poorly maintained cesspits, represents one of the village’s most critical environmental problems. Pooling of raw sewage is common in the village’s wadis and roadways, exposing Al Qaida’s residents to risk of disease. Periodic downpours exacerbate this situation, resulting in overflowing cesspits and causing raw sewage to flow unabated through the town’s streets and wadis. The lack of a stormwater drainage system periodically causes these inundations to wash out roadways, causing hazardous street conditions and impeding traffic.
5.63 Disposal of faecal sludge from latrines, tanks and cesspits is presently done uncontrolled without regard to environmental and health considerations. Highly polluted supernatant has the potential to drain underground and could, depending on the flow direction, contaminate existing or potential well-fields.

5.64 Due to a currently low water supply of 14 l/cap/day, along with an increasing population, Al Qaida faces an urgent water supply problem. Deteriorating water supply networks and a limited available water supply further exacerbate this problem.

5.65 In summary, the main water and wastewater problems are as follows:
- water demand is increasing with an increasing population
- over-exploitation of the aquifers
- decreasing groundwater levels
- large areas of the town have no orderly water supply
- no areas of the village have access to a wastewater network and disposal system (housing and industry)
- wastewater from overflowing cesspits and raw sewage flowing directly from some households ponds and runs through city streets and aquifers

F. Flora

5.66 There are indications that the country was once covered with rich forests of *Acacia*, *Juniperus*, *Tamarix* trees etc. It is likely that the indigenous population destroyed the forests, because they needed timber for house construction and for domestic fuel. Today intensive erosion occurs where the slopes are deforested, similar to the situation in the Mediterranean area, which was also once covered by forests, and now only substituted plant communities are growing.

5.67 Today the territory of Yemen does not have extended forests or large regions of abundant natural vegetation as is found in areas to the west of the Red Sea. Natural vegetation elements such as *Acacia*, *Ficus*, *Juniperus*, *Acanthus*, *Aloe*, *Euphorbia* and structures are still common in the mountains and on steep hillsides. The density of the vegetation cover depends on the availability of water.

5.68 In the direct vicinity of Al Qaida, most of the natural vegetation cover has disappeared. Occasionally there are some larger bushes or trees in open areas, and especially along the main roads and streets. There is also a high percentage of neophytes (e.g. *Opuntia ficus-indica*, *Eucalyptus*, *Delonix*). Due to their high water consumption, *Eucalyptus* trees in the area cause problems, such that other plants cannot survive in their vicinity.

5.69 In the large plains between Al Qaida and Taiz, the vegetation cover is relatively dense, with a high percentage of bushes and small trees. According to NWRA (1997), there are three vegetation types in the Al Janad plateau. The dominant type is the *Acacia mellifera – Euphorbia cactus* type. The main plant species are as follows: *Euphorbia cactus*, *Acacia mellifera*, *Cissus rotundifolius*, *Euphorbia inarticulata*, *Kleinia adora*, *Eragrostes papposa*, *Anisotes trisulcus*, *Grewia erythrea*, *Indigofera spinosa*, *Ruellia patula*, *Euphorbia schimperi*, *Cadia purpurea* and *Cissus quadrangularis*. 
5.70 The Acacia gerrardii – Eragrostes papposa type is confined to the plateau and consists of the following main species: *Eragrostes papposa*, *Acacia etbaica*, *Fagona indica*, *Euphorbia inarticulata* and *Blepharis ciliaris*.

5.71 In high salinity sites, the Sporobolus spicatus – *Suaeda aegyptiaca* type is found. The main plant species within this type are *Sporobolus spicatus*, *Suaeda aegyptiaca*, *Tamarix spec.* and *Flaveria trinervia*.

5.72 Along the roads the two Acacia- species *Acacia seyal* and *Acacia gerrardii* together with *Eucalyptus* are the dominating trees.

5.73 The lower parts of the plains, wadis or terraced parts of the hillsides are used for agricultural production (mainly sorghum, maize, qat).

5.74 Great parts of the flatland and the terraces are now fallow land, mainly due to the fact that there is not enough water to irrigate all agricultural areas, but also because of the rural exodus to the city.

5.75 With only a few years of studies (NWRA, 1997), it is difficult to estimate a trend with respect to the development of the flora in the investigation area, particularly as parts of this area have recently almost completely lost their vegetation cover due to falling groundwater levels. The long-term trend, however, is more clearly foreseeable, as the increasing population will demand increasingly more space, and pressure on the few remaining natural biotopes and plants will increase.

G. Fauna

5.76 Little information exists concerning local wildlife that might be effected by project components. While this is unlikely to be an issue in the urban areas where most of the works will take place, an improvement in hygienic conditions and an improvement of the water supply is also likely to improve the living conditions of local livestock.

5.3 Demography

A. Existing Population and Population Forecasts

5.77 Figure 5.3 shows present status on population and town development. According to the 1994 census, the combined population of Al Qaida (including nearby Al Mansura) was 27,183 and the number of domestic households was 4,059. The total number of houses was 4,293, including offices and stores. The average household contains 6.75 persons. By using an annual growth rate of 3.5%, the population in 2000 would amount to 33,415 and increase to 66,496 by 2020.

5.78 Maps and drawings showing future infrastructure development have been prepared. Population numbers in various zones are determined according to urban development land use data, and the number of subscribers, as recorded by the NWSA branch office. Population growth (Figure 5.3) in various zones provides the basis for network extensions during the planning period.

5.79 Industrial zones do not exist in Al Qaida, while commercial activities are scattered throughout the town center.
5.4 Urban Development

A. Urban Planning Framework and Urban Growth Pattern

5.81 Residential land use occupies the majority of land in Al Qaida. Within the commercial center stores and workshops often occupy the ground floors. The cliff located in the south of Al Qaida acts as natural barrier for future development in this direction. This cliff, however, is already covered with buildings, despite the emphasis of the urban planning department to develop the downhill areas.

5.82 The Consultant recommends concentrating town development to the north to enable better utilization of future wastewater disposal and other infrastructure works, which are proposed to be located uphill on the eastern side of the town.

B. Service Provision

5.83 According to NWSA, in 2000 32,413 of the 33,415 residents in Al Qaida, or 97% of the total, are connected to the water supply network.

5.84 Sewerage system coverage is currently zero, increasing the risk of water borne diseases as raw sewage runs close to many households.

C. Physical Environment

5.85 Today, the quality of the urban environment of Al Qaida is very poor and under pressure from a range of factors is continuing to deteriorate. Of principal concern are the raw sewage pools that occur throughout the city, collecting in both natural depressions and man made low points. The sewage originates from three sources:

(i) Overflow: Percolation pit overflow is a significant factor in this regard.

(ii) Direct discharge: In specific locations the existing sewage network discharges into open wadis and storm drains. In some cases infiltration / seepage (with resultant sub surface and soil contamination) and natural grades will combine to prevent surface lakes forming. Elsewhere where natural channel beds have been modified large and small retention ponds have been created.

5.86 This brief review is not to say that other factors can be ignored. They must not. Factors such as the Air pollution, from diesel pumps and generators, cars and construction materials, Noise pollution, from diesel pumps and generators, cars, and Water Wastage, all contribute to the production of a very heavily degraded urban environment, especially in public areas.

D. Education

5.87 Education levels in Yemen are generally low, with national adult illiteracy rates among the highest in the Region, and well above the MENA average. There is a large gap between the education level of males (47% are illiterate) and females (74% are illiterate). Most people have an extremely low income, such that many families simply...
cannot afford to send their children to school. The low education rate of females is also a religious and cultural one, as most women are still homemakers.

E. Gender Issues

5.88 At a general level and highly simplistic level, Yemeni society draws clear distinctions between the responsibilities of men and women:

Women: Are the dominant force in the home, and within the house. They are traditionally responsible for cleaning the house, preparing the food and educating children. Some of the work, washing, (cleaning, helping prepare food) may be delegated to the children, primarily daughters. Women may be also be restricted in their movement, being allowed to leave the house only in the afternoon and then only to visit relatives or female friends.

Men: Are traditionally expected to represent the family outside the house. He is responsible for obtaining the family income and usually will do the shopping. In circumstances, where some conflict in roles may be perceived to apply, such as carrying solid waste to rubbish containers or collecting water, children are usually delegated the task. Where no conflict is felt to exist, women will be responsible.

5.89 The right of women to work and participate in the development process without hindrance or discrimination was established in legislation in the constitutions of the YAR and the former People's Democratic Republic of Yemen (PDRY) and since unification in the Constitution of the ROY. Despite this, it is clear from the available data (Table 5.2) that women have either been unable, or have not desired, (or both) to participate fully in the workplace and that there has been little change in the last 10-15 years.

Table 5.2: Economic Participation Rates %: (10 years and over)

<table>
<thead>
<tr>
<th></th>
<th>1988</th>
<th>1994</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>51.64</td>
<td>54.46</td>
<td>54.68</td>
<td>54.37</td>
</tr>
<tr>
<td>Females</td>
<td>12.80</td>
<td>14.80</td>
<td>6.62</td>
<td>17.28</td>
</tr>
</tbody>
</table>

18 YAR clause 36: “Every citizen has the right to practice the career he or she chooses within the limits of the law”

clause 10: “Yemeni citizens are equal in the right of labor”

clause 34: “All texts organizing the employment of both sexes are applicable to working women without distinction......”

PDRY clause 27: “Labor is the right and duty of every capable citizen, corresponding with his or her ability, qualification and rights without distinction based on age, sex, blood, color, religion or language”

ROY: Labor is a right and honor: it is deemed inevitable in developing the society. Every citizen has the right to practice the job he chooses for himself within the limits of the law. It is unlawful to impose through compulsory means jobs on any citizen, except as stated by the law to carry out a public service without fair wages in return
Factors that are still perceived to restrict this participation include:

- Society perceives of woman’s primary role as being in the home, to the extent that that this is where the woman will inevitably end up. Accordingly, education is not a necessity for women, many of whom may suffer restricted access to basic education. This is strongly reflected in the variable literacy rates for men and women (Table 5.2 above) and in particular, at later stages, in access to a scientific and technical education. Laws requiring compulsory universal primary education have been in existence of laws for many years they are rarely if ever enforced and in some cases especially in rural areas no girl only facilities are available because of a shortage of female teachers.

- Even when educated initially, strongly perceived pre-eminence of role in the home associated with very young first marriage and very high total fertility rates combine (Table 5.3) to reduce secondary and further education opportunities and limit female skill development opportunities.

- Conflict with the traditional view that the man is the income earner, exacerbated by both, the potential social stigma that may be attached to a man whose wife is either the sole or part income, and the potential competition for some between men and women jobs.

### Table 5.3: Female Age of First Marriage and Fertility Rates

<table>
<thead>
<tr>
<th></th>
<th>Age of First Marriage</th>
<th>Total Fertility Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>National All</td>
<td>20.72</td>
<td>-</td>
</tr>
<tr>
<td>PDRY</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OTHER COUNTRIES</td>
<td>1987</td>
<td>2000 est.</td>
</tr>
<tr>
<td>Syria</td>
<td>21.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Egypt</td>
<td>21.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Morocco</td>
<td>21.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Jordan</td>
<td>21.6</td>
<td>4.7</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>n/a</td>
<td>5.9</td>
</tr>
<tr>
<td>Tunisia</td>
<td>23.9</td>
<td>3.3</td>
</tr>
</tbody>
</table>

19 National values for 1986 are for YAR only and are appreciably lower than the overall 1994 value. The potentially strong moderating influence of the PDRY must therefore be recognized.
5.91 Surveys undertaken in 1985, 1991 and more recently in 1994 do indicate positive
trends suggesting for example that the overwhelming majority of urban Heads of
Household approve of women being allowed to work.

5.92 In addition to the general constraints imposed on participation in the labor market,
women also appear to be disadvantaged in that where they do participate they are not
fully utilized. In general terms women tend to be employed in the public sector, often in
'reserved occupations' where they have little opportunity to develop a professional career
and or where their potential is rarely fully realized.

5.93 Women have been successful in the broader development process only in those
areas that are culturally allocated to them, maternity care, child nutrition, illiteracy
programs etc. Nevertheless, the successes in these areas, and especially those
promoted and supported by the General Union of Yemeni Women should not be
underestimated or undervalued.

5.94 In project specific terms the following conclusions are drawn:

- Given that no land acquisition and resettlement is proposed, there will be no
circumstances in which women are deprived of their due compensation rights.
- There will be no significant loss of employment and as such no particular
disadvantage to women through employment loss.
- Similarly, women are unlikely to benefit directly from reductions in workload. These
  benefits are most likely to fall to children who are charged with carrying out most
domestic duties outside of the home; fetching water, disposing of waste, etc.

5.95 The primary area of benefit will be in the reduction of time and other resources
spent in crisis management as the family manager; fewer occurrences of disease, fewer
sick children, reduced health costs and greater productive time with children.

5.5 Income and expenditure

A. Income

5.96 Data on household and per capita income in Al Qaida, and for Yemen as a whole,
is scarce, although the level of household income is generally very low. A 1995
household budget survey for Yemen gave an average household income of 11,300 YR.
According to available income indicators the lowest 20% of the households in Al Qaida
would have a monthly income of about 8,000 YR (DORSCH/GITEC, Initial Development
Plan).

B. Expenditure

5.97 Data on expenditure patterns is even more difficult to obtain and reconcile with
income. According to NWSA, reported monthly water bills range from 45 to 50 YR/m³,
with an average use of 3.1 m³ per household and month. This rate would correspond to
about 2% of income for the lowest income group.
5.98 Due to the low amount of water supplied by NWSA, deficient city water sources are supplemented either by the use of bottled water, or through independent suppliers using water taken from local springs or treated using small purification facilities. Households are primarily complementing their water supplies by buying from tankers (150 - 180 YR/m³). In comparison, and depending on the quality, one liter of bottled water costs between 2 and 30 YR/l. This is equivalent to between 2,000 to 30,000 YR/m³. As a result, the exploitation of wells is an important source of income for private well owners.

5.6 Public health

A. General

5.99 Figures for malaria and diarrhea, by age group, provided by the local hospital are shown below. Both of these maladies are frequently caused, directly or indirectly, by polluted water in the urban environment:

<table>
<thead>
<tr>
<th>Disease</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria, o/w…</td>
<td>8,962</td>
<td>4,196</td>
<td>845</td>
</tr>
<tr>
<td>Age &lt;5</td>
<td>2,440</td>
<td>1,175</td>
<td>152</td>
</tr>
<tr>
<td>Age &gt;=5</td>
<td>6,522</td>
<td>3,021</td>
<td>693</td>
</tr>
<tr>
<td>Diarrhea, o/w…</td>
<td>4,843</td>
<td>4,580</td>
<td>3,001</td>
</tr>
<tr>
<td>Age &lt;5</td>
<td>2,705</td>
<td>2,351</td>
<td>1,508</td>
</tr>
<tr>
<td>Age &gt;=5</td>
<td>2,138</td>
<td>2,229</td>
<td>1,493</td>
</tr>
</tbody>
</table>

Al Qaida Hospital (2000)

5.100 The real infection rate is probably much higher than that indicated by the existing data, as a large portion of the population does not have access to relatively expensive medical treatment, and therefore is not included in the statistics. These people will often self-medicate or seek treatment elsewhere. Because of this, the local hospital estimates that only about 1/3 of the population are recorded by official statistics.

5.101 The rate of diarrheal infections for children is particularly high, and may, in part, be caused by pooling sewage throughout the city. Children can frequently be seen playing in and these pools, and may thus expose themselves to risk of infection.

B. Malaria

1) Introduction

5.102 Malaria represents a serious public health problem in Yemen. About 60% of the total estimated population of 17.7 million live under the risk of malaria. The estimated number of cases of malaria is 0.5 million per year, out of which about 90% are due to \textit{P. falciparum}. Endemicity varies from high to low and many areas are regularly affected by epidemics. The malaria situation has deteriorated over the last decade due to reduction in malaria control activities and, possibly, to climatic change, aggravated by the spread of chloroquine resistant \textit{P. falciparum}. 
5.103 Malaria in Yemen, with the exception of Socotra Island, belongs to the Afrotropical type, with *Anopheles arabiensis* as the main vector. Malaria is hyper- or mesoendemic in the foothills and meso- and hypoendemic in the coastal plain. Arid and semi-arid hypo- and mesoendemic areas are particularly prone to outbreaks of malaria following heavy or prolonged rainfall.

### ii) National Programs and Participation

5.104 The National Malaria Control Program (the structure that is responsible for controlling malaria) has suffered from a long history of instability. The program has moved from a place to place, according to the magnitude of prevalence of disease in different geographic areas. It began in Taiz in the 1960s, moved to Hodeidah in 1970s until the end of 1980s where it faced a period of inactivity. In 1992, the program was located in Sana'a, the capital, where it resided until 1997, when it was transferred again to the Ebian Governorate. A center was established there, where it was supplied with all equipment. In the beginning of 1999, a decree was issued to transfer the program to Sana'a again. Due to administrative procedures the decision was not effective for six months. A new director was appointed to the program in the middle of June, 2000. The Director currently oversees four main units:

- Training and Research
- Malaria Epidemiology
- Operations
- Administration & Finance

5.105 The National Malaria Control Program presently covers 8 governorates with a view to expand in the future.

5.106 Malaria control activities in Yemen are currently in a state of rapid evolution. At the Ministry of Public Health in Sana'a, the Focal Point for malaria activities falls administratively within the Communicable Disease Control Unit, within the General Directorate for Primary Health Care. Surveillance and epidemiologic studies lie within the General Directorate for Epidemiology and Disease Surveillance. Both of these General Directorates are under the authority of the Deputy Minister for Medical and Health Services, who reports directly to the Minister. There are two additional Deputy Ministers, one for Health Development—with responsibility for the health statistics unit and the new NHMIS—and another for Drugs and Supplies—with authority over the essential drugs program and quality control laboratory.

5.107 Yemen was represented at the Nairobi consensus and inception meeting for Roll Back Malaria (RBM) in April 1999. A statement of intent for the introduction of RBM has been developed in January 2000 and is currently being supported. A national inception meeting, chaired by the Minister of Public Health, for over 53 participants from various sectors was held February 14, 2000. Yemen further participated in the 2nd Global Partners' meeting in Harare, (June 30 – July 1), 1999 where consensus on key RBM concepts, issues and solutions was reached.

5.108 The Roll Back Malaria movement builds on efforts being undertaken in many countries to Roll Back Malaria. WHO country and regional offices, WHO headquarter departments, other UN system organizations, bilateral agencies, research groups (particularly the co-sponsored Tropical Disease Research Program, and more recently,
the Multi-lateral initiative on Malaria) and non-governmental organizations have been supporting country efforts. The WHO Africa and Eastern Mediterranean regional offices helped to accelerate malaria control action in response to the expressed concerns of African Heads of State. This led to the Africa Initiative on Malaria, launched in 1997, and established as "Roll Back Malaria in Africa" in 1998. The initiative aims to halve the numbers of malaria deaths by the year 2010.

5.109 Four elements of the Roll Back Malaria (RBM) strategy point to a solution:

1. People at risk can prevent malaria if they sleep under insecticide treated mosquito nets.

2. Pregnant women, especially those who are pregnant for the first time (a group particularly at risk), can take medicines to prevent and treat malaria.

3. People can treat malaria with a wide variety of effective medicines, and they can cure malaria if they seek and receive treatment early, with effective medication, within - or close to - their homes, and finally,

4. Families and communities can be empowered to predict and prevent a malaria epidemic and contain it within one week of its being confirmed.

5.110 The new approaches will help the world reduce its reliance on DDT, which is generally considered to be environmentally unsound.

5.111 Malaria control experts at a recent WHO conference said that a number of strategies will be used for increasing the availability of bednets under the RBM, including:

1. increasing local production and demand;

2. using public/private partnerships to bring down the cost of bednets, and improving the market for them;

3. encouraging the governments of endemic countries to remove all tariffs on bednets and insecticides;

4. encouraging private and public donors to subsidize the provision of bednets for those who cannot afford them; and

5. promoting the need to regularly re-treat bednets with safe insecticides.

iii) Laboratory Diagnosis

5.112 Microscopic diagnosis is available at a small number of health units, most health centers, and the hospitals in the Taiz and Al Qaida area. In addition, malaria laboratories are supported by the malaria control programs in Sana’a and in the capital cities of endemic governorates, including Taiz. The laboratory in Taiz provides free diagnostic and treatment services for a few thousand self-referred clients each month, but does not provide any supervision of the hospital and health center laboratories within its jurisdiction. In the past the laboratory reviewed a select number of positive blood films from peripheral laboratories and provided training, but these activities have been dormant for at least three years. In addition, this malaria control laboratory occasionally undertakes active case detection activities in response to requests from political and community leaders.
iv) Vector Control

5.114 There appears to have been a strong infrastructure for vector control activities in both the northern and southern governorates prior to unification, but these activities have long since lapsed. The malaria control staff at the national and some of the governorate levels still include sanitarians and entomology technicians, and small quantities of insecticide are available for residual spraying, fogging and larviciding. However, currently no comprehensive program of vector control activities appears to be evident at any level. Programs commonly lack vehicles, insecticide and equipment to carry out routine vector control activities, and most are inactive except under extreme circumstances.

5.115 In Taiz, malaria control and public health officials reported conducting a very active ULV fogging campaign on the periphery of Taiz city in late 1998. Although this activity appears to have involved considerable effort and substantial resources no evaluation of its impact appears to have been conducted. Prone areas of malaria epidemics are not yet properly defined, and forecasting indicators have not yet been defined.

5.116 There is great enthusiasm by malaria control and public health officials to reestablish vector control activities in the area, and most consider this the key to malaria control in the area, often neglecting to consider improved case management. This risks the expenditure of large sums of money on interventions that may have little or no impact on the vectors that transmit malaria. For instance, larviciding and outdoor fogging would probably have little effect on vector species that breed in small temporary water collections or those that bite and rest indoors.

v) Current Situation

5.117 There were some 23,288 reported cases of malaria in Taiz Governorate and some 150,000 in Ibb Governorate in 1998 (WHO, 2001), with over 7,000 of these in Taiz City alone, although the actual number of cases was likely much higher. Figures received for Al Qaida put the number of cases for 1998 at almost 9,000, although these numbers, too, should be taken with precaution. Many residents utilize home treatments or obtain medicine without prescriptions. The director of the local hospital in Al Qaida estimates that as many as 2/3 of malaria cases may go unreported.

5.118 Malaria cases in the last two years declined drastically in Al Qaida, partly due to the immunization campaign initiated under the national strategy, and partly due to the shortage of rainfall in the last two years and the resulting reduction of ponding areas. Preliminary estimates show a sharp drop in reported cases of malaria in Al Qaida. In 1999 the number of reported cases dropped to 4,196 and in 2000 there were only 845 recorded cases. Early figures for 2001 show a continuation of this trend. Due to a project-induced increase in the volume of water within city limits, however, this situation is expected to worsen again following the implementation of this project.
5.119 The wastewater lagoons located some nine kilometers to the north of Taiz City and 16 kilometers southwest of Al Qaida are considered to be a major source of the malaria (Anopheles ssp) problem in the region, which especially appears during the summer months. A malaria abatement program implemented under the Taiz component of this project will improve this situation. Other likely breeding sites for the mosquitoes include:

- Raw sewage ponds and rivulets caused by the poor sanitary conditions in many sections of the city.
- Periodic ponding attributed to the periodic floods that wash through the city.
- Ponding caused by ruptures in water supply lines.
- Rooftop water storage tanks, which are used by residents to store water during periods of intermittent water supply.

5.7 Data Weaknesses

5.120 The principal areas of data weakness encountered in preparing this report are as follows:

- **Air quality and Noise**

  5.121 No monitoring data for the above was found. Any future assessment of impacts will therefore have to be based on one off stochastic assessments of baseline conditions

- **Income and expenditure**

  5.122 Although the preceding data might provide some insight into existing income and expenditure levels, there will be a need in the future to assess the benefits and costs accruing to various sector development programs much more precisely. In particular the degree of impact on the poorer, disadvantaged sections of the community will need to be more closely defined. To be able to do this using a consistent data set, potentially over an extended period of time, will require a far better data set than is at present available from one off project related surveys.

- **Public Health and Economic Costs and Benefits**

  5.123 Health data and medical statistics must be interpreted with caution, as a relatively small proportion of the population actually has access to the expensive medical treatment and only this group appears in the statistics. Data on malaria incidence rates, for example, show inconsistencies between local and governorate level statistics.

  5.124 Consistent data on other water-borne diseases was difficult to find during the investigation period, so efforts should be made to establish baseline data for the purpose of establishing benchmarks.

  5.125 The comment above on income and expenditure profiles applies in a wider context to the data required to estimate the potential costs and benefits of this project. Of perhaps most significance here is the inability to relate medical record data to a place of residence and work/school attendance. While there will always be extreme difficulty from a practical and theoretical perspective to establish causal linkages between incidence of ill health and geographic areas, such data is often of prime importance in quantifying the potential benefits of a project.
• Mosquitoes

5.126 No detailed studies on the lifecycles of Anopheles were found to have been performed in the Al Qaida area. Most reports of disease concentrations have been anecdotal, leading to a poor understanding of the sources of malaria and seemingly ad-hoc approaches to vector control.

• Demography

5.127 One main data weakness is in the field of demography. While it is expected that the rate of population growth is high, a more detailed survey is needed to determine the exact number of inhabitants and a corresponding growth rate.

• Hydrology

5.128 The scientific databases regarding hydrological conditions are quite poor, and it turned out that most estimates, particularly estimates concerning the resources of the different aquifers, have been too optimistic in past years.

5.129 The soil descriptions only refer to the soil profiles represented in Drawing No.1. As much of the bedrock is acidic, and the soil of the wadis is predominantly sand, an alkaline soil reaction would not be expected. It is very likely, however, that the measured soil reactions within the wadis and cultivated terraces are caused by the influence of wastewater.
Figure 5.1

Average monthly rainfall

- Ta'izz Airport 1976-1989
Figure 5.2

Temperature and Sunshine in Ossaifrah (1979-1995)
FIGURE 5.3
AL-QAIDA
CITY LAYOUT, POPULATION DEVELOPMENT, COMMERCIAL ZONES
6. Environmental Impacts

6.1 Introduction

6.01 The implementation of a water and sanitation project causes a variety of impacts on the environment. At the same time, it improves the environmental situation by providing a regulated water supply and wastewater disposal, and prevents further pollution of existing water resources. These improvements reduce the distribution of water-dependent diseases.

6.02 Many of the impacts of this project have already been mitigated through choices made during the drafting of the Initial Development Plan. Input from this consultant, as well as from IDA personnel, impacted project decisions during an iterative planning process. Still, some impacts can only be mitigated during project implementation, while others may appear as the project progresses. This Section provides an overview of defined project impacts. These are assessed as:

6.03 Typical Impacts: i.e. impacts that may be attributable to a greater or lesser extent to both project types. These are outlined in Section 6.2. Since the water supply and wastewater collection systems share many of the same trenches (around 10%) or at least the same type of trenches in the same areas, project impacts are mostly grouped together.

6.04 Sections 6.3 and 6.4 identify the impacts that are either related only to Sanitation or Water Supply Projects or which are of particular significance in either context. In all cases impacts are defined under one of three categories:

- Pre construction
- Construction Impacts; (temporary, off site and resource consumption)
- Operational Impacts

6.05 Induced, or indirect impacts are relatively minor and are considered under operational impacts.

6.06 Section 6.5 will outline potential permanent impacts from the project, and Section 6.6 will list expected project benefits.

6.07 Section 6.7 summarizes the impacts in each section, and indicates their significance.

6.2 Typical Impacts

6.08 The rehabilitation and extension works of the drinking water network, and the creation of sewage networks only take place in densely populated areas in or along streets where urban development has led to an almost complete loss of the previous natural conditions.

6.09 The creation of an interim treatment facility takes place in an area that is uninhabited and where the surface is comprised mainly of rocks and soil, with little or no flora. Areas immediately downstream of the facility are also uninhabited, such that construction works are not expected to have any significant impacts.
6.10 Still, there are expected to be other construction related impacts, most of which can be mitigated, either in advance, or during the construction activities.

A. Pre-Construction Impacts

6.11 There are two main aspects of project preparation to be taken under consideration:

- confirmation of the right to access lands for survey purposes, (topographic and subsoil),
- subsoil investigation pits.

6.12 Neither is considered likely to be a source of major impacts, provided reasonable health and safety measures are taken in the digging of the pits (which are not likely to exceed 6.5m).

6.13 Additionally, and through environmentally sound planning, it will be possible to minimize negative impacts before the construction works begin. In this context, careful attention will be paid to avoiding environmentally sensitive areas or locations such as tree groupings or single large trees.

6.14 Potential environmental nuisances attributable to construction activities can be minimized through the choice of suitable construction equipment and methods. These will be elaborated upon separately as their relevance is discussed.

B. Construction Impacts (temporary)

i) Public Safety

6.15 During the construction phase, there may be an increased risk of accidents involving local populations, especially children. These may result from one or a combination of the following:

- unauthorized access to a construction site.
- an absence of control over access to construction sites,
- conflict with construction vehicles,
- poor site safety,
- inadequate site management.

6.16 By their very nature, construction activities generate elevated levels of accident risk. However, three factors suggest that the impacts from these projects may be further increased:

- it is evident that a number of construction sites in Yemen lack proper management and in some cases are clearly dangerous and equally importantly that off site activities, such as construction traffic, are as poorly controlled.
- widespread construction within the urban area. Extensive linear construction sites along urban streets will expose large sections of the population, especially children who use streets as play areas, to risk.
the nature of the urban development is such that access routes for construction traffic will be poor; often comprising relatively narrow streets and lanes with no pedestrian facilities, blind corners etc.

**ii) **Noise and Construction Disturbance

6.17 During site preparation and construction, noise will be generated from a number of sources including: jack hammers, excavators, payloaders, generators, etc. and in many instances these will be operating in immediate proximity to residential areas.

6.18 Certain levels of noise disturbance are unavoidable. In excess, however, they can be a nuisance to neighboring residents and, in extreme cases, can become a health hazard to workers and residents. Typically, operational noise will be broadband but intermittent, and is in a wide range from 50dB(A) (non-operation) to 90+dB(A) as indicated in Table 6.1.

<table>
<thead>
<tr>
<th></th>
<th>Distance</th>
<th>Typical International Standard</th>
<th>Exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5m 20m 50m</td>
<td>Day</td>
<td>Night</td>
</tr>
<tr>
<td>Loader</td>
<td>90 78 70</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Vibration Roller</td>
<td>86 74 66</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Sprayer</td>
<td>87 75 67</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Generator</td>
<td>98 86 78</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Impact Drill</td>
<td>87 75 67</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Concrete Mixer</td>
<td>91 79 71</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Pneumatic Hammer</td>
<td>84 86 78</td>
<td>75</td>
<td>55</td>
</tr>
</tbody>
</table>

Note: "Distance" refers to the distance between observer and machinery

6.19 From Table 6.1 it is clear that without exception night operations will exceed standards and day operations are uniformly excessive up to 20m. It is therefore inevitable, without mitigation, that significant disturbance will be experienced by a substantial element of the population.

**iii) **Air Quality

6.20 Unmanaged air pollution, especially of particulate and gaseous emissions from construction machinery may create nuisance and in extreme cases direct adverse health impacts or damage to property. However while some impacts can be expected throughout Project areas, the quantity and nature of the machinery to be used is such that these impacts need not be severe.

6.21 Construction traffic may potentially generate substantial quantities of dust in and around active construction areas and on some of the unpaved access roads. This issue is linked to that of heavy traffic use and access and safety on minor roads within the city.
6.22 It is also possible that off site facilities, in particular aggregate processing plants, may generate sufficient dust to be of nuisance.

iv) Waste Material

6.23 The alluviums in which the greater majority of the project works will be constructed will contain materials that are unsuited for use either as selected pipe bedding (contains material of > 100 mm diameter) or backfill (plasticity index greater than 6%).

6.24 These materials will need to be carted away and disposed of appropriately and suitable replacement materials brought in.

v) Hydrogeology, Geology and Topology

6.25 The necessary earthworks for the installation of the supply and the wastewater network disturb the natural series of soil horizons. Within the city, where most of the pipeline network will be installed within or along existing roads, this impact is negligible. This impact will be more significant at the construction site for the interim treatment facility and the new water reservoirs. These impacts, however, are unlikely to represent any significant detrimental environmental impact.

6.26 A further effect on the natural balance will involves the discharge effluent from the treatment facility, as well as the removal of the sludge. Any temporary negative impacts in this context are expected to be more than offset by the increase in the quality of wastewater that enters into the system.

6.27 The groundwater of the area may be affected by:

- Contamination of groundwater from minor spillage at contractor camps (septic tank and leachate from trash and solid waste) or construction materials on site.
- Disturbances in soil physical properties may temporarily increase chances of seepages of fecal material and other contaminants into groundwater.
- Increased potential mixing of contaminated surface flows with those of the shallow aquifer/ water table

6.28 These impacts are however not expected to be significant. The construction sites will not be deep enough to reach the groundwater. Dewatering is therefore unlikely to be required and mixing of waters precluded. The risk of release of hazardous materials is minimal and the additional load negligible in the context of that released by cesspits.

vi) Fauna, Flora and Ecology

6.29 The mostly urban context of the projects is expected to ensure that the threat of destruction of habitats and associated displacement of fauna will be negligible. There are therefore considered to be no direct impacts on the region's ecology from project works and almost certainly no loss of biodiversity.

6.30 Where project works take place in non-urban areas, these areas are either already designated for this use, or take place in areas where little negative impact is expected.

6.31 The temporary use of land for the purpose of storing materials and equipment can be neglected within the city, as most of these areas are already sealed. Soil densification or losses of natural vegetation are also of minor relevance outside the city due to the soil.
vi) Archaeology/Cultural Heritage

6.32 The principal heritage and cultural values of the study area lie in occasional isolated examples of traditional architecture. However, no sites of specific scientific, cultural or heritage significance were identified that may be directly affected by Project works. The rich cultural and archaeological heritage of the old city will be entirely unaffected by project works.

6.33 Moreover, virtually all project activities will occur within existing rights of way that have already been subject to development. It is considered very unlikely therefore that any buried site will be encountered in construction.

viii) Off Site Works

6.34 Five types of off site facility may be developed to support the project:

(i) Project offices

6.35 Project offices may be located anywhere within Al Qaida, in any number of available existing buildings, and will generate no adverse impacts. Temporary site offices may be established, but these will not be large and can be easily established and provided with necessary facilities at little or no local impact.

(ii) Materials Stockpiles

6.36 The Bid Documents will indicate that the Client will provide a site for materials stockpiles. This site is not yet identified, but may be at the client’s headquarters site. The materials for stockpile at this (or any other defined) site will be exclusively non-hazardous and should not require application of any exceptional handling and storage measures.

(iii) Pre-Fabrication Yard

6.37 Elements for manholes will need to be pre cast off site. A yard will therefore be required to store cement, chemicals (primarily oils) for the moulds, moulds and for pre fabrication. It will require access to adequate water supplies and immediate access to suitable (for heavy traffic) roads.

6.38 It is possible that a sub-contractor (or the contractor) will undertake these works at an existing facility. It is, however, equally likely that they will be carried out at a new site.

6.39 Possible adverse impacts may include: soil contamination, increased accident risk from heavy truck movements and possible modification to local water resource availability. The quantity of water required is not excessive, but given the severe constraints on available local supplies the actual location of the yard may interfere with water availability to surrounding properties.

(iv) Equipment Maintenance and Cleaning

6.40 As with the prefabrication yard, it is possible that contractor will utilize locally available suppliers for equipment and lease equipment as required. In such cases there will be no need for the creation of a new maintenance yard.

6.41 However, should the contractor wish to establish a new facility, the major threat would be the pollution of groundwater resources from the industrial waste that will be generated by the maintenance and cleaning activities. Of particular concern is the disposal of wastewater from the cleaning of equipment since such water will contain pollutants; at a minimum, industrial strength detergents and oil cleaning solvents.
6.42 There will, in addition, be a potential risk of pollution from the accidental spillage of, and/or leakage from, industrial materials stored on site. The nature and significance of the threat to water resources cannot be determined at this stage, without full knowledge of the materials to be stored.

(v) Borrow Material and Aggregate Washing and Screening

6.43 Substantial quantities of borrow material and aggregates will need to be obtained and made suitable for use on site.

6.44 At all off site facilities it will be important that contractors maintain and manage sites to high standards, that health and safety regulations are in force, that appropriate means for waste control and disposal are applied and that all temporary project sites are cleaned up and made good. Possible residual wastes of concern at each facility are as follows:

Table 6.2: Residual Wastes of Concern

<table>
<thead>
<tr>
<th>Waste Material</th>
<th>Sources</th>
<th>Impact Type / Environment Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spent oils</td>
<td>Maintenance yard</td>
<td>Immediate temporary contamination: Shallow aquifer, Soil</td>
</tr>
<tr>
<td>Batteries</td>
<td>Various</td>
<td>Long term persistent contamination: Soil and water</td>
</tr>
<tr>
<td>Scrap metals</td>
<td>Various</td>
<td>Long term persistent: Soil and water</td>
</tr>
<tr>
<td>Waste pipes</td>
<td>Stockpile site</td>
<td>Negligible/Unsightly</td>
</tr>
<tr>
<td>Surplus fill</td>
<td>Construction Site(s)</td>
<td>Variable / Unsightly, Safety concern, esp. children. Urban.</td>
</tr>
<tr>
<td>Spent oils</td>
<td>Maintenance Yard</td>
<td>Immediate temporary contamination: Shallow aquifer, Soil</td>
</tr>
</tbody>
</table>

ix) Access and Construction Traffic

6.45 All points of contact between heavy construction traffic and existing traffic will be a potential source of accidents. Three factors will contribute to this:

- the increased number of turning movements of heavy construction traffic gaining access to, and exiting from, the primary road
- the relatively low speed of the construction traffic, and the mixing of traffic types and speed
- the possibility of damage to the road surface from the increased level of heavy traffic and, more likely, modification of road surface conditions by mud, chippings, surface oil and other foreign matter.

6.46 Access to the construction sites, which may require the use of local access roads that would generally not be considered suitable for use by heavy vehicles, will also be a potential source of concern. Use by construction traffic of such roads may cause damage to the road surface or in other cases to structures, delays to non-construction traffic and increased risk of accidents.
6.47 For off site facilities where some choice in siting is available, direct access to the primary network should be a major criterion in location.

C. Operational Impacts

6.48 There are a few adverse or positive operational impacts common to both projects, and those that do occur are of sufficient significance to warrant detailed attention in each Project Case.

6.3 SANITATION PROJECTS

A. Pre Construction

6.49 There are no pre construction impacts additional to those defined in Section 6.2 above.

B. Construction Impacts (Temporary)

6.50 Four areas of activity that may generate potentially significant impacts are reviewed below.

i) Cesspit Removal

6.51 Phase 1 proposes to lay some 24km of sewer lines in currently unsewered areas. In this context, Phase 1 components will require the closure, excavation, fill and stabilization of cesspits in a 221 ha area. These actions will bring with them a number of potentially significant impacts:

- The general threat to public health from the opening of a pit

6.52 Some of these pits lie within public rights of way. Each individual pit, when opened, will therefore be a source of potential hazard to all uses of that right of way.

6.53 It is also common in Yemen for children to be seen playing around recent construction areas. The mounds associated with cesspit removal are both unstable and unsanitary. The specific nature of any materials to be excavated from around active pits is unknown but they will undoubtedly pose a much greater health hazard than that excavated for new sites, with children in particular at risk.

- Nuisance (and potential health effects) from the extreme odor of the open pits.

6.54 The nature of the works suggest that nuisance values, especially from odor (and potentially health concerns), will be high and will be experienced by residents, land users and road users alike.

- The removal and disposal of waste materials from cesspits.

6.55 All (non-solid) materials in existing cesspits will need to be removed and carted away to a point of safe disposal. Operators of desludgers and other workers in the immediate environs of the operation will be at some risk from contact with the material and thus at some health risk.

6.56 Although the total quantity of material involved is not expected to be very significant, much of this material will be extremely aggressive. It will be anaerobic and potentially
very acidic. It may therefore have a strong adverse impact if disposed of directly to existing, main or interceptor sewers, or directly to the environment.

6.57 Any excessive amounts of this material should therefore be released directly into the input sump of the interim treatment facility, or taken to the Taiz WWTP during off-peak hours (i.e. at night), when the plant is not operating at full capacity.

ii) The collection, handling and disposal of waste generated by households disconnected from their disposal system.

6.58 This is another potentially problematic issue even though it is anticipated that no more than three trenches will be open at any one time and that each trench will be open for a maximum of one hundred meters (assumed maximum distance between manholes).

6.59 Nevertheless, assuming a plot/structure frontage of 25 m and 4 households per frontage, a system of temporary sewage collection and disposal will be required to be in place for up to 16 families throughout the construction period.

6.60 The volumes dealt with are quite small, at a minimum (approx. 4.5 m³/day, with a maximum of 9.7 m³/day), but the systems must be in place and it is in the maintenance and management of operation of those systems that the problems may lie. It will be unacceptable for any raw domestic sewage to be discharged (or escape) in the public domain.

iii) Inappropriate Disposal of Waste Materials

6.61 Associated with elements of (i) and (ii) is the problem of fly dumping. Much of the above discussion has highlighted the scale of the wastewater, slurry and sludge evacuation program required and indirectly the costs (fleet operations) of that operation. Under these circumstances there is a potential (official and unofficial) for materials to dumped at sites other than those defined.

6.62 Such dumping, (especially of slurry and sludge) will have the potential to cause extensive damage to virtually any environment to which it is discharged, particularly if it is permitted for an extended period. In all cases such dumping will pose a serious health hazard.

6.63 Strict controls will therefore be required to ensure that this does not occur.

iv) Access and Traffic Disruption

• Property Access

6.64 Access to all properties in areas to be served by the project will be adversely affected at some point in the construction period. In most cases these impacts will be minor, restricted both in their severity and duration by the narrowness of the trenches required for the relatively small diameter of the pipes being laid.

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20 Fly dumping is the illegal disposal of waste materials at a site other than that designated or approved as suitable for receiving that material. In effect, it is the casual disposal of materials at a site of convenience rather than an approved site.
6.65 However, in cases where construction work is slated to take place in the immediate vicinity of special sites, (schools mosques and such like,) or other Public Buildings specific access issues will be raised.

- **Traffic Disruption**

6.66 For larger pipes (>500mm) these impacts will be far greater, magnified by the potential depth of the construction works and their duration. These pipes by their nature, also tend to be laid in main roads or secondary roads of functional importance to local and urban wide road networks.

6.67 In these cases, potentially severe impacts on traffic circulation (delays etc.), local access and plot access, can be expected with impacts resulting not only from a loss of road space as a direct result of the construction site but also to construction traffic, loading and unloading, parking etc.

**C. Operations Phase**

**Wastewater Treatment Facility**

6.68 The porosity of the soil directly downstream of the treatment facility is considered to be moderate to low. Given the projected low effluent flow during Phase 1, the effluent is expected to mostly subside into the soil, such that the filtering of pathogens and contaminants is expected to be good during at least the first three years of operation. Very little is currently known about the subsoil environment, although there are no known shallow aquifers in the area. Thus, during the rain season it is highly unlikely that untreated effluent will be carried into unwanted areas.

6.69 The land usage downstream is almost exclusively agricultural, and rain fed. The topography of this area slopes from north to south, ending in a low slope terminal area close to the Taiz airport. It is therefore likely that contamination would result if untreated effluent were discharged by the sewage system. Therefore, a reasonably high level of treatment will be needed in subsequent phases of the project. Few residential areas exist nearby, the majority of which are located upstream of the proposed facility.

6.70 During subsequent phases of the project a higher treatment efficiency is expected to be achieved, such that it is envisaged that the effluent from the treatment facility will eventually be used for irrigation. Corn, Maize and Sorghum are currently planted in the area downstream of the proposed facility.

**Social Impacts**

- **Migration and Social Organization**

6.71 The preparation, construction and operation of the projects are unlikely to generate adverse impacts from in-migration to Al Qaida or, specifically, to the project areas as:

- there will be little or no requirement to import labor for the project.

- though improved sanitary conditions may increase the attractiveness of the areas for development, these are unlikely encourage large-scale relocation of populations either within or to the Al Qaida urban area.

**Development Constraints**

6.72 The project is unlikely to significantly alter existing patterns of development directly though it is conceivable that modifications to land values (see Housing and Urban
Development in 6.6 below), and potential future pressures on the available quantity of serviced land will stimulate a change in the land use pattern of the improved areas.21

6.4 Water Supply

A. Pre Construction

6.73 There are no pre construction impacts defined additional to those in Section 6.2 above.

B. Construction Phase

6.74 In general, the impacts of construction activities for the water supply project will be less severe than those for the sewage projects. Trenches are shallower and narrower, and pipes smaller. Impacts on road users will also be less severe with the greater majority of works confined to local neighborhoods. Therefore, in addition to having less overall effect, adverse impacts will be more keenly felt by those directly benefiting from the project and will be made the more tolerable for being so.

6.75 Perhaps most significantly there will be no requirement for cesspit clearance. There is nonetheless one area of potential concern: system flushing and disinfection.

Flushing and Disinfection

6.76 The contract documents will likely require that the contractor flush and disinfect pipe systems. They should specify:

- Use of one of: Calcium or Sodium Hypochlorite, or Chlorine Gas
- Dosage rates
- Residual concentrations of after first flush
- Maximum residual after second flush

6.77 These requirements introduce a number of possible areas of concern.

i) Storage and Use of Materials

6.78 All three materials are potentially hazardous. They can

- cause very severe external damage to all who come into contact with them
- cause death if ingested (or inhaled)
- cause substantial damage to all component elements of physical environments, plant life, fauna, and especially micro-organisms

6.79 The potential threat posed by the use of these materials is summarized in Table 6.3 for each of the stages of the use process.

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21 Depending on the eventual Sector Development Plan adopted it is possible that there will be differential levels of service provided by the public water supply system. This will clearly modify relative land values and reduce the available quantum of fully serviced land in the future. By definition, under these policies sewered areas will therefore be among the most attractive development areas of the city.
6.80 A further factor that would apply to all aspects of Table 6.3 (except fly dumping) is the speed and the adequacy of the response to an event. Prompt effective action would in most cases effectively eliminate adverse impacts and in the few remaining instances would minimize the severity of the impacts.

ii) Disposal of Wastewater

6.81 The waters utilized in this process would contain significant quantities of residual chlorine, in concentrations of not less than 5ppm after the first flushing, and not more than 1ppm on the final flush. While these waters will not pose a significant threat to human health, they will not be suitable for consumption, and as such will need to be disposed of in a manner that precludes local populations accessing even residual quantities.

6.82 The wastes will however be toxic to a wide variety of organisms and highly destructive to many micro-environments, a factor that should be considered in their disposal.

iii) Resource Use

6.83 In addition to the above flushing and disinfection (and pressure testing) would impose very short and highly localized, but nonetheless potentially significant, water resource demands on local networks.
<table>
<thead>
<tr>
<th>Stage of Process</th>
<th>Risk</th>
<th>Source</th>
<th>Possible Impact</th>
<th>Affected Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unloading</td>
<td>High</td>
<td>Damaged containers / leakage</td>
<td>Contact with skin especially eyes</td>
<td>Contractor staff. Assumes unloading undertaken at closed (to public) facility.</td>
</tr>
<tr>
<td>Storage</td>
<td>High / Moderate</td>
<td>Inadequate storage facility may lead to damage.</td>
<td>Inhalation</td>
<td>Contractor staff. Assumes adequate security. Potential localized damage to physical environment.</td>
</tr>
<tr>
<td>Handling</td>
<td>High</td>
<td>Damaged containers. Complexity of the mixing process. Nature of the process utilized. Condition of the equipment utilized. Level of training of operator</td>
<td>Contact with skin especially eyes and inhalation</td>
<td>Depending on location of mixing. On site: contractor staff and public. Off site: contractor staff only.</td>
</tr>
<tr>
<td>Disposal of Surplus</td>
<td>High</td>
<td>Assumes material stored over extended period. Container may be damaged Fly dumping may be seen as a cheap disposal option.</td>
<td>Pollution of local environment</td>
<td>Physical environment. All populations using that environment, productively or casually.</td>
</tr>
</tbody>
</table>
C. Operations Phase

i) Existing System

6.84 The existing networks, both official and unofficial, in place across much of the project area will potentially generate a number of concerns.

- Firstly, wherever possible normal\(^{22}\) supplies to existing users will have to be maintained, throughout the construction period.

Water supply provision from the public system in Al Qaida is already poor and the cost of alternative supply sources high (at least for guaranteed clean water). Accordingly, extended periods of supply loss may impose substantial costs on affected households, financially, physically and socially.

There are, however, no compelling reasons for such impacts to occur. Contract documents will require existing supply provision to be maintained and there is nothing in the nature of the existing system or the development proposals that should make such it difficult for any contractor to meet this obligation.

- Secondly, although there is a requirement for existing systems and new systems to be isolated and although existing cesspits have been removed there is a slight risk of (cross) contamination. Accordingly, care must be taken that elements of the existing system are not left around after completion of the works or that some households or blocks of houses are left unconnected.

- Thirdly, all existing consumers must be guaranteed connection to the new network. No reduction in existing access to piped water, (whether legal or illegal) would be an acceptable impact.

- Finally, while it is expected that the ad hoc systems will be isolated from supply, every effort should be made to ensure that these do not simply reappear. It may be, for example, that while many people welcome the project and the improved service it will bring, there will be a number who do not want to pay for water.

ii) Cross Contamination

6.85 The recent sewering of the area will ensure that the expected rise in the level of wastewater generation will not cause problems of cesspit overflow as is common throughout many areas of the city at present. Accordingly, the risk of cross contamination will be markedly reduced from present levels even under conditions of relatively poor maintenance assuming that the design requirements for separation are maintained in construction.

6.5 Permanent Impacts

6.86 All the project components are noteworthy for having:

- No involuntary resettlement: the construction of the water supply and sanitation system will take place within existing settlement areas\(^{23}\).

\(^{22}\) Normal in this context implies that the areas in question should receive their theoretical typical supply pattern of the last few years, during construction. They should not be further disadvantaged.
• No impact on cultural properties such as ancient housings, mosques or ancient city walls.

i) Flora and Fauna

6.87 Perhaps one of the more significant potential permanent negative impact concerns the potential loss of trees, in areas where it is either impossible to lay the pipeline within the street or to bypass the trees. In a city like Al Qaida, where during summer months any shade is very valuable for residents, the loss of trees constitutes an impairment of the urban microclimate. Trees also provide scarce habitat for a variety of fauna that live within the urban environment. Such losses can be mitigated through the replanting of existing trees, or the planting of replacement trees. Depending on the age of the lost tree one, two or even three trees should be planted as compensation.

6.88 Sensitive or protected habitats with endangered plants and animal species, however, will not be touched by the project within or outside of the city. A small survey of flora or fauna native to the area downstream of the proposed treatment plant was performed in the context of this assessment, and it was found that this area is relatively sparsely vegetated or populated with fauna, so the impact will likely be minimal.

ii) Malaria

6.89 The construction of an interim treatment facility in Al Qaida may lead to an improvement of the living conditions of Anopheles ssp. and may thus increase the malaria risk in the vicinity. A general increase in water in the city might also aggravate this situation. However, the associated decrease in ponding within city limits is expected to offset this effect somewhat. The malaria abatement program being implemented under the Taiz portion of this project is also expected to decrease the incidence rate of malaria in Al Qaida.

iii) Dried Sludge

6.90 The first phase of the project calls for the construction of an interim treatment facility for Al Qaida. The residues to be removed from the different stages of wastewater treatment are screenings, grit, and sludge, with sludge being the major part. By 2020, under scenario 1, annually produced sludge could amount to 14,600 m³ (at 3.5% solid content). The sludge can feasibly be used as a soil conditioner for agriculture or reforestation.

6.91 The government currently has no policy on the use of dried sludge and has not identified a final dumping site or other disposition measures. A sludge reuse study performed under the Taiz portion of this project will also examine the case for Al Qaida.

6.6 Benefits

6.92 The planned project is expected to fully stabilize the current water supply losses caused by the obsolete and broken supply network, while contributing to the reduction of water pollution and water-related diseases.

6.93 The water quality of the treatment facility effluents will be an enormous advantage, especially for the irrigation of agricultural areas.

23 within Phase 1. Later phases may require land for storage reservoirs.
In this context, a target of 90 l/c/d by the year 2020 is anticipated for Al Qaida under the project. The city’s population will gain a number of directly related benefits, as follows:

A. Public Health Improvements
6.95 Although the water quality in Al Qaida is considered to be quite good, it would seem that the reduction of soil contamination, through the decrease in raw sewerage entering the subsoil environment, is certain to have some positive impact on water quality. This will most certainly result in improvements in public health.

6.96 Similarly, a more obvious and immediate public health improvement will be realized through the elimination of raw sewage that currently flows and accumulates on the surface throughout Al Qaida. This sewage, which is the result of overflowing cesspits, broken sewerage lines and households that directly discharge to the surface, will be mostly eliminated as a result of the project.

6.97 As a result of the above, it is expected that there will be an improvement in overall public health, in particular in:

- reducing the incidence of gastrointestinal disease,
- reducing levels of infant mortality,
- reducing the potential threat of a major outbreak of communicable disease,
- reducing the presence of airborne diseases within the city limits

B. Income and Employment
6.98 Secondary employment opportunities generated by a growth in the local informal and formal sectors of the economy, most notably in the commercial sectors that will stem from the improved physical environment of affected areas and the reduction in the proportion of household expenditure on water and sanitation.

C. Housing and Urban Development
i) Land and Property Values
6.99 Though land and property markets in Yemen are ill developed and may not be that responsive to changes in urban environmental quality, some increase in land and property values may be expected from Project generated relief.

ii) Reduced Protective Expenditure
6.100 It is argued that further benefits are likely to be obtained from the reduction in household repairs and or protective works (against sewage inflow). Currently, residents have to spend money either protecting their property against incursion or in repairs to damage done.

D. Non Attributable Benefits
6.101 There are also likely to be a number of benefits derived beyond those directly attributable to local populations. These will include:
- Reduced pavement damage and thus reduced VOCs and road maintenance costs;
- Tourism potential: The tourism sector in Yemen has grown rapidly in recent years and is now worth some $50 million per annum, mostly in hard currencies. These benefits would be virtually eliminated for some period by a major health scare, or epidemic.

6.7 Summary of Impacts

<table>
<thead>
<tr>
<th>Phase / Issue (Text ref.)</th>
<th>Impact</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Construction (6.2.A)</td>
<td>Access to lands for topographic and subsoil surveys.</td>
<td>Negligible</td>
</tr>
<tr>
<td></td>
<td>Subsoil investigation pits.</td>
<td>Minor</td>
</tr>
<tr>
<td>Construction Works (6.2.B)</td>
<td>Potential injury and death</td>
<td>Major</td>
</tr>
<tr>
<td>Public Safety</td>
<td>Nuisance value that may in extreme cases affect health</td>
<td>Major nuisance value</td>
</tr>
<tr>
<td>Noise and Construction</td>
<td>Nuisance value that may in extreme cases affect health</td>
<td>Minor health impact</td>
</tr>
<tr>
<td>Disturbance</td>
<td>Nuisance value that may in extreme cases affect health of general population. Vulnerable groups could have much higher health threat.</td>
<td>Minor</td>
</tr>
<tr>
<td>Air Quality (excl. dust)</td>
<td>Traffic on local dirt roads</td>
<td>Moderate</td>
</tr>
<tr>
<td>Waste Soil Material</td>
<td>Removal and disposal of non usable soil materials</td>
<td>Minor</td>
</tr>
<tr>
<td>Hydrogeology, Geology and Topology</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Fauna, Flora and Ecology</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Archaeology/Cultural Heritage</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Off Site Works</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project offices</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Materials Stockpiles</td>
<td>Access</td>
<td>Minor</td>
</tr>
<tr>
<td>Pre-Fabrication Yard</td>
<td>Resource use, Access, Storage</td>
<td>Moderate. Sufficient cumulative impact to warrant attention</td>
</tr>
<tr>
<td>Equipment Maintenance and Cleaning</td>
<td>Storage and use of chemicals, industrial waste disposal (especially oils)</td>
<td>Moderate. Sufficient cumulative impact to warrant attention</td>
</tr>
<tr>
<td>Borrow Pits²⁴</td>
<td>Potential scale of operation. Possibility for numerous new sites. Access requirements. Water resource needs.</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

²⁴ Borrow pits are sites identified for the extraction of fill materials for use in project works.
Access and Construction Traffic | Mix of heavy construction traffic and existing traffic will be a potential source of accidents. | Moderate

Resource Use

Water | Effect on existing resource users | Potentially major

Borrow Material | Reduction in quantum of resources available | Negligible

<table>
<thead>
<tr>
<th><strong>Permanent Impacts (6.5)</strong></th>
<th></th>
</tr>
</thead>
</table>

Land acquisition | None Nil

Property take | None Nil

Cultural Properties | None Nil

Flora and Fauna | Minor Negligible

Malaria | Threat to public health Moderate. Sufficient cumulative impact to warrant attention

Dried Sludge and Wastewater Disposal of material | Potentially major

Effluent

Population relocation and settlement | None Nil

Productive land loss | None Nil

Employment loss | Negligible Negligible

<table>
<thead>
<tr>
<th><strong>Table 6.4 Sanitary Project</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase / Issue (Text ref.)</strong></td>
<td><strong>Impact</strong></td>
</tr>
<tr>
<td>Construction Impacts (6.3.B)</td>
<td></td>
</tr>
</tbody>
</table>

Cesspit Removal | Threat to public health from the opening of the pit, including odor nuisance, access to 20m deep holes, traffic, etc. | Moderate, primarily to vulnerable groups, children, asthmatics, etc.

Removal and disposal of the waste materials from the pits. | Moderate

Scale of import of fill and source of fill | Moderate

Collection, handling and disposal of waste generated by households disconnected from their disposal system. | Moderate

Wastewater Disposal | Fly dumping of cesspit wastes. | Moderate

Soil Contamination | Potentially extensive workforce contact with contaminated materials and casual public access (esp. children) | Minor (depends on results of sample testing program)

Traffic Disruption | Temporary, partial and full closure of sections of Al Qaida road network. | Variable, on a case by case basis. Major overall impact

Local Access | Interference with property access, neighborhood access and access to special sites, (schools | Major (on a site by site basis) but very short-
mosques and such like, or other Public Buildings lived.

### Operations Phase (6.3.C)

<table>
<thead>
<tr>
<th>Social Impacts</th>
<th>Migration and Social Organization: Negligible</th>
<th>Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income and Employment</td>
<td></td>
<td>Negligible, (assumed positive)</td>
</tr>
<tr>
<td>Housing and Urban Development</td>
<td>Promote new housing and urban development or area redevelopment.</td>
<td>Long term moderate threat.</td>
</tr>
</tbody>
</table>

### Table 6.4 Water Supply Project

<table>
<thead>
<tr>
<th>Phase / Issue (Text ref.)</th>
<th>Impact</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Phase (6.4.A)</td>
<td>Storage and use of hazardous chemicals, disposal of wastes and resource use</td>
<td>Major</td>
</tr>
<tr>
<td>Flushing and Disinfection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations Phase (5.4.3)</td>
<td>Maintenance of supplies during construction, isolation of new systems from old, ensure connection of all consumers, prevention of return of illegal connections</td>
<td>Moderate</td>
</tr>
<tr>
<td>Existing System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flushing Existing Lines</td>
<td>Handling and disposal of flushing chemicals</td>
<td>Major</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. Analysis of alternatives

7.01 This section provides a brief description of possible alternatives to the project design (including the "no action" alternative). The reasons why the various alternatives considered were rejected are included in the analysis.

7.1 Introduction

7.02 The presence of raw sewage pooling and flowing throughout the city represents a significant health hazard to the citizens of Al Qaida, illustrating the urgent need to develop a wastewater network in order to improve the critical situation.

7.03 Furthermore, the raw sewage in the streets of Al Qaida poses a risk of cross-contamination of the city's poorly maintained water supply network. This risk, along with the depletion of water resources in the Al Qaida area, illustrates an urgent need to rehabilitate the current water supply system. Based on present population and water production capacity, and taking into account estimated water system losses of 30%, only 14 l/c/d is available for the consumers.

7.04 Moreover, the lack of sewage treatment facilities is clearly inadequate for the future needs of the city. This situation will be further exacerbated by the implementation of the new water supply and sewerage networks.

7.05 In this context, a larger-scale treatment facility is under consideration as part of the longer-term development plan. A discussion of potential alternatives is provided in this section, with recommendations given. These longer-term plans, however, will still be subject to further review at a later date, and therefore will not be included in the EMP contained in this EIA.

7.06 One consideration in the analysis of alternative methods of wastewater treatment involves the ability of NWSA to implement and maintain more advanced, and therefore complex, treatment technologies in the near term. NWSA is currently running a large operational deficit, which seriously undermines their ability to manage any advanced systems at this point. This operating deficit also effects NWSA's ability to secure the competent technical staff needed to support such infrastructure. In this context, NWSA is currently undergoing the institutional reform necessary for solvency.

7.07 An additional concern in this context involves the question of cost recovery. Given the relatively small size of the serviced area in Al Qaida, the system's ability to recover the O&M costs needed for larger treatment works has to be carefully examined.

Methodologies

7.08 Cost estimates are based on preliminary engineering design and actual prices in Yemen and the world market as of late-2000. Recent quotations, where applicable, were the main source of information for unit costs. The costs include land acquisition as well as physical and price contingencies at 10%, and at an inflation rate of 3%. The cost for consulting services including design, preparation of tender documents, tender evaluation and construction supervision has been assumed at 7% of total costs.

7.09 O&M costs are based on actual costs, provided by NWSA, for energy and manpower in Yemen and converted into US$ at an exchange rate of 160 YR = 1 US$. 
7.10 The proposed extension of water supply and wastewater facilities are, where applicable, based on least cost analysis by using the present worth method. The following has been taken into account:

- The planning period is calculated up to 2020;
- Investment and O&M costs are discounted at 3%.

7.11 For further details of the methodologies used and results found, see the Al Qaida Initial Development Plan, August 2001.

7.2 Water Supply

A. Supply Network

i) Scenarios

7.12 For the projection of future water demand through 2020, the following two scenarios have been studied:

Scenario 1:
- The number of house connections would increase to 100% coverage by 2010 and to remain at 100% through 2020;
- The daily per capita water demand at water connections would increase to 70 liter by 2010 and further to 90 liter by 2020;
- Non-domestic water demand would increase from currently 5% to 25% of domestic demand by 2020; and
- Un-accounted for water would decrease from current level to 25% of water production by 2020.

Scenario 2:
- The number of house connections would decrease to 75% coverage by 2010 and to remain at 75% through 2020;
- Non-connected households through 2020 would be served by standpost water supplies;
- The daily per capita water demand at water connections would increase to 70 liter by 2010 and further to 90 liter by 2020;
- The daily per capita standpost water demand would amount to 35 liter;
- Non-domestic water demand would increase from currently 5% to 25% of domestic demand by 2020; and
- Unaccounted for water would decrease from current level to 25% of water production by 2020.

ii) Evaluation of alternatives

7.13 The projections that have been made for every five-year interval (2005, 2010, 2015 and 2020) are shown on table 7.1. An analysis of the data would conclude:
7.14 The emphasis on an increase in water production through the development of another 3 wells will have first priority, since this is expected to significantly increase the per capita water availability. However, this emphasis will defer a needed rehabilitation of the distribution systems and also new extensions needed to connect additional population. This approach will imply a decrease in the connection rate from 97% to 85% by 2005, but during Phase 2 this should be corrected with a 100% connection rate to be reached by 2010. This would further imply an estimated increase in unaccounted for water from 30% to 35% by 2005.

7.15 Provided that groundwater will be available in sufficient quantities at reasonable costs, it might not be feasible to assume anything less than a 100% connection rate. The difference in investment costs between the two scenarios outlined above would be about US$ 4.2 million or about US$63 per capita calculated on the 2020 projected population. However, this matter will be reviewed in subsequent phases taking into account conclusions to be reached on the long-term availability of groundwater.

7.16 The reuse of wastewater should also be considered in the context of the ongoing water development program. It is not expected that treated wastewater, even if treated to highest quality, would be available for potable water supply without having to go through final treatment through infiltration into the ground for subsequent extraction downstream. This is a complicated process, and it should instead be assumed that swapping arrangements could be made with farmers with groundwater to be exchanged for treated effluents to be used for agricultural purposes.

7.17 There is no doubt that the first and most important step needed to reduce water losses and a further pollution of the ground water is the immediate rehabilitation of the drinking water and sewerage systems. The short-term impacts of the construction activities will be very minor compared to the benefits associated with having a safe and reliable drinking water supply.

7.18 The only alternative to the rehabilitation of these systems is the no-project option. Given the health risks associated with the intermittent supply of piped water, combined with the relatively expensive price of bottled water, the no-project option would be unacceptable.

7.3 Wastewater

i) Scenarios

7.19 The two scenarios that have been studied for wastewater collection and disposal are:

Scenario 1:
The coverage of sewer connections would increase to 50% by 2005 and further to 100% by 2010 and thereafter remain at this level; total area to be covered would be about 660 ha; and

**Scenario 2:**
The coverage of sewer connections would increase to 50% by 2005 and thereafter remain at this level. The remaining 50% would rely on on-site facilities.

7.20 Relevant data for the two scenarios are shown in Table 7.2 below.

**B. Calculation parameters**
7.21 The wastewater generation rate is estimated at 85% of the supplied water amount at connections, while households with standpost water supply are assumed to have on-site wastewater disposals. The stormwater allowance has been estimated at 1.5 times average wastewater flow. Because of dry weather conditions and a low groundwater table, infiltration has not been taken into account.

7.22 The following specific loads for wastewater have been assumed:
- BOD$_5$ = 50 g/PE/d,
- Suspended Solids = 50 g/PE/d,
- N = 10 g/PE/d,
- P = 2.5 g/PE/d.

7.23 It is further assumed that half of the unsewered population uses septic tanks, and that every 500 inhabitants are producing 1 m$^3$ of faecal sludge per day.

7.24 The wastewater collection system and its associated stormwater system shall be designed as separate systems.

**C. Wastewater Collection**
7.25 The amount of industrial/commercial wastewater is currently considered to be of secondary importance for the public sewerage system as there are no plans for the establishment of any major industries. If this were to take place, appropriate arrangements would have to be made for effluent disposals.

7.26 For the wastewater collection network a minimum diameter of DN 200 is recommended. The minimum diameter for house connections is, depending on the slope, proposed to be DN 100 or DN 150. Network density would increase from 100 m/ha in 2005 to 200 m/ha in 2020. The required pipe length for different pipe diameters has been estimated according to the ratio 1:4 (DN 250 to DN 400:DN 200).

7.27 Lengths of pipes to be laid during different phases for the two scenarios have been summarized in Table 7.2. Pipes to be selected are proposed to be made of ductile iron or vitrified clay (steep slopes) and PVC or concrete (normal slopes). The house connections are proposed to be made of PVC.

**D. Wastewater treatment**
7.28 In order to enable unrestricted use for irrigation, the effluent quality should satisfy the following criteria:
7.29 The treatment capacity measured in BOD$_5$ load should, under Scenario 1, increase from about 2,300 kg/day in 2010 to about 3,600 kg/day in 2020. Under Scenario 2 corresponding loads would be about 1,200 kg/day in 2010 and 1,900 kg/day in 2020. The treatment works could be extended in stages with the first stage covering the period to about 2010. The initial investment requirements would then be lower under Scenario 2 than under Scenario 1.

7.30 Treatment works to be constructed should also be designed for receiving sludge from septic tanks.

7.31 The wastewater treatment plant (Appendix J, Process Calculations) is proposed to be located east of town, in order to provide gravity flow and to reduce the risk for groundwater pollution (refer to Figure 4.6). A simple treatment process is proposed to be selected, in order to facilitate maintenance and operation and to reduce relevant recurrent costs. In this context two alternatives have been reviewed: 1) a lagoon system and 2) a trickling filter system.

7.32 The two alternatives are briefly reviewed in the following paragraphs:

**Alternative 1: Lagoon- system**

7.33 A lagoon- system would require a surface area of about 20 ha (Scenario 1, 2020). The wastewater would be discharged into a narrow valley (width about 200 m), presently used as farmland. By using the whole width of the valley, the length of the lagoons would be approximately 1 km. The construction of lagoons in this area would involve a large amount of excavation and backfilling, due to the rocky soils and the hilly topography.

7.34 The lagoon area would also have to be fenced (about 2.5 km) in order to avoid uncontrolled wastewater use by farmers for cattle and field irrigation, which could have adverse health implications.

7.35 Treatment efficiency for lagoons is lower than that for conventional treatment plants. By using surface loads of 15 g/m$^2$, an effluent-concentration of 45 mg/l for BOD$_5$ could be reached.

**Alternative 2: Trickling filter with a pre-stage sedimentation pond**

7.36 The topography at the proposed treatment site would allow wastewater to flow downhill by steps, which would be advantageous for the design of trickling filters. The cascades would provide oxygen input, and the filter material of volcanic stone would provide biological treatment through bacteria breeding.

7.37 It is proposed that pre-treatment would also be installed under this scenario, including an anaerobic sedimentation pond to remove coarse material and to decrease the BOD$_5$-load on the trickling filter. Downstream provisions should be made for a second pond for secondary sedimentation. Required surface area for the two ponds would be less than two ha.

7.38 The relatively small area for this treatment plant could easily be fenced and guarded to avoid uncontrolled wastewater use. Sludge would remain in the ponds, in order to be
stabilized and removed as required, with the sludge to potentially be applied directly as a soil conditioner.

7.39 Treatment efficiency for this system is higher than can be achieved under a simple lagoon-system. An effluent quality of less than 25 mg/l for \text{BOD}_5 would be expected to be achieved. This effluent could then be discharged into an adjacent wadi and used for irrigation.

7.40 The least cost analysis of these two options can be found in the Development Plan. In summary, pre-treatment, with an anaerobic sedimentation pond in combination with trickling filter, using the natural slope of the hill, and a final sedimentation pond have been proposed for implementation.

**Proposed interim arrangements:**

7.41 Due to financial constraints, an interim arrangement has been proposed for execution during the first phase. This will consist of pre-treatment and a septic tank to be designed for a \text{BOD}_5 load of 1,500 kg/day, with the effluent, after aeration through cascading, to be discharged to the wadi. The treatment efficiency will be about 50% of that which would be provided by a trickling filter system, such that the use of effluent for irrigation should be restricted. During the dry season most of the effluent is expected to infiltrate into the ground.

7.42 The interim arrangements are expected to be in place during the first phase with an extension to include full treatment through the use of trickling filters to take place during Phase 2. These proposed arrangements provide for a significant improvement of existing conditions.

**E. Evaluation of alternatives**

7.43 An evaluation of the alternatives through a least cost analysis would conclude the following:

7.44 Proposed per capita investments for wastewater collection and treatment are reasonable for both scenarios, without taking into account investments to be made by non-connected households for the installation or improvement of on-site facilities. Although water availability will increase under Phase 1 to about 50 l/c/d, it is still rather low and might still be accommodated by existing or improved on-site disposal systems. The justification for proposed investments is based on the difficulties to provide on-site facilities in the center of the town with its rocky soil conditions.

7.45 The water consumption will remain low even after Phase 1, and under more favorable conditions regarding soil permeability a central wastewater collection system would not be justified. The design of the network should take the low flow into account in order to reduce the risk and frequency of clogging.

7.46 The financial and economic analyses of these two options can be found in the Development Plan. In summary, final design depends on the actual setting of tariffs for the different customer categories. This decision will be decided through final negotiations of all involved parties on the final implementation concept and schedule as well as other issues such as detailed loan conditions, electricity tariffs, etc.

7.47 The two scenarios will differ in the design of the trunk-main to the treatment works, which will be executed in the first phase. Due to the topography of the area, it would seem to be unlikely to go for a 100% connection rate and one could assume that fringe
areas would far into the future be served by on-site facilities. A reasonable assumption might be 75% but this will be elaborated further at the detail design stage.

7.48 The provision of wastewater treatment will, for financial reasons, be extended in stages with the first stage to include primary treatment only. Secondary treatment will subsequently follow, with the timing to be decided based on experience to be gained from first stage treatment, actual pace of sewer connections, and the availability of funds. The environmental impact from the discharge of primary treated effluents will be closely monitored, including its potential use for irrigation.

7.49 The first phase investments address urgently required works and represent minimum requirements. The investment requirements during subsequent phases are expected to be significantly higher in view of the need to rehabilitate the water distribution system, to provide for an increasing standard in water availability, and to extend wastewater treatment to a level enabling unrestricted use of treated effluents for irrigation.

7.50 Clearly, option 3 (the no-project option) is not a viable alternative. The current situation is already critical, and will surely worsen if nothing is done. A further steep rise in wastewater generation is expected, due to the planned augmentation in water supply realized through the rehabilitation of the current supply system and further exploitation of the country's water resources. Moreover, the projected increase in the region's population will further exacerbate this situation.

7.51 Cesspits are already utilized in unsewered sections of the city. In these areas, residents often do not maintain their cesspits, as is evidenced by the raw sewage that overflows from many of these pits. Furthermore, those residing close to wadis, the cliff beside the city, or roadside ditches will likely continue to discharge their wastes into these areas if no sewer network is made available. Under these scenarios, the groundwater will eventually be contaminated, and health problems due to raw sewage flowing throughout the city will only increase. Contamination would eventually reach even the deepest aquifer if the actual conditions do not improve.
8. Environmental Management Plan

8.1 Introduction

8.01 The remaining sections of this report, Sections 8 and 9, contain the Environmental Management Plan (EMP), Mitigation Plan, and the Monitoring and Implementation Program for the Project.

8.02 This Section outlines the Management Plan and its associated mitigation measures. In general terms, it comprises the following six elements:

- Environment and Safety Officer (Section 8.2)
- Public Consultation Program (Section 8.3)
- Monitoring Program (Section 8.4)
- Proposed Malaria Abatement Program (Section 8.5)
- Survey of Polluting Industries (Section 8.6)
- Sludge and Wastewater Re-use Study (Section 8.7)

8.03 Section 9 will describe the Monitoring and Implementation Program as it relates to the project cycle.

8.04 Due to the proximity of Al Qaida to Taiz, and for reasons of cost and efficiency associated with economies of scale, many of the costs of this program are partly or wholly covered under the Taiz EMP. Most notable among these mitigation measures is the utilization of a common Environment and Safety Officer, who will oversee the implementation and monitoring of the EMP.

8.05 For this reason, this section will repeat many of the items found in the Taiz EMP, noting differences if and where they exist.

8.2 Environment and Safety Officer

8.06 NWSA does not have an established schedule of responsibilities and training on matters relating to the environment, nor does it have line responsibility to which all levels of staff owe accountability. This has just started at the EPC with technical assistance from the Dutch Government. For this project, therefore, an Environmental Safety Officer (ESO), with a thorough knowledge of site conditions and safety practices, should be appointed to the project implementation unit (PIU).

8.07 During this project (until the project completion report is finalized) the ESO will be directly responsible for ensuring the implementation of the environmental management plans for both Taiz and Al Qaida. He will also be responsible for liaising with all parties involved in the project, especially the engineering team and environmental consultants, and advise as necessary on all environmental matters concerning the project and in relation to the EMP. The project ESO will report directly to the PIU Director. The ESO will be responsible for monitoring all compliance with EMP directives. His responsibilities, and indicative ToR for this position, are included as an Annex 8.1 to this section.
8.3 Consultation Program

A. Programs

8.08 It is important that the EA take the necessary measures to ensure adequate public consultation. The ESO will therefore work with the PIU to set-up, conduct, and record public consultation meetings. The ESO will also assist in coordinating the EA with government agencies, in obtaining the views of local NGOs and affected groups, and in keeping records of meetings and other activities, communications, and comments and their disposition.

8.09 This program comprises two main components: (i) public meetings; and (ii) newspaper and television articles and programs. Each of these is summarized below.

i) Public Meetings

8.10 At least four public consultation meetings will be held in Al Qaida, where input from all affected parties will be solicited. Every effort will be made to notify the public of any major project decisions and public works that are likely to disrupt daily activities in project areas. Methods used will include public meetings, media announcements, and both formal and informal discussions with affected parties. The EA will include a detailed plan for the continuation of such public and private interactions.

8.11 For each public consultation, the following shall be done as a minimum: an agenda proposed, a Project summary sheet distributed, a list of attendees made (sign-up sheet) and notes taken. Major points/concerns raised by stakeholders shall be made part of the EMP.

8.12 The first public consultation for each city will take place prior to the commencement of civil works. The objective of this public meeting is to obtain comments and other feedback from the public and interested stakeholders on: (i) the scope of the Environmental Assessment and Environmental Management and Monitoring Plan; and (ii) the broad outlines of the proposed Project. Results of this public consultation will be reflected in a semi-annual Environmental Report.

8.13 The second and third public meetings will be held in the areas identified by the Client where civil works have already commenced or where there will be significant environmental impacts. In order to allow construction planning that, to the extent possible, reflects feedback from residents and other interested parties, these meetings will be held within two months of the start of construction activities.

8.14 The final public meetings will be held near the end of the Project’s civil works and should record stakeholders’ overall reaction to the Project and suggestions for improving implementation of future phases of the Development Plan.

ii) Newspaper and Television Coverage

8.15 A parallel newspaper and television campaign will take place in an attempt to reach affected parties whom, for whatever reason, were not able to attend the public consultation meetings. The purpose of this media campaign will be to inform residents of construction activities that may pose health hazards, or might affect their ability to work or commute.
8.16 If possible, at least one live television program will be held prior to the commencement of civil works, in order to discuss the potential impacts of the projects' works, and to provide information to residents on how to facilitate the construction process.

8.4 Monitoring Program

A. Introduction

8.17 A comprehensive monitoring program will be necessary, to both systematically monitor changes in the environment, which are directly or indirectly caused by project activities, and to respond to complaints from residents. The monitoring program will be the responsibility of the ESO, who will contract out laboratory work, etc., as needed.

8.18 Random sampling, of both fixed sites and construction sites will be undertaken together with measurements prompted by complaints by local residents. Clearly the nature and extent of this program cannot fully be determined at this time, but an indicative random program is drawn up below to which a 20% contingency is to be applied for complaint based works.

8.19 The Monitoring Program will comprise two main stages:

- A **baseline sampling program**: includes the establishment of baseline conditions for the purpose of monitoring changes (positive or negative) during the construction phase

- A **construction phase monitoring program**: includes an outline of the construction phase monitoring program.

8.20 The construction phase monitoring program will also include site visits, which are designed to identify any new (foreseen or unforeseen) impacts that might occur during construction activities. For this reason, section D below includes general guidelines for construction activities (on site and off site) and specific measures proposed in response to impacts of concern outlined in Section 6.

B. Baseline Sampling Program

8.21 The baseline-sampling program, carried out before the project implementation, serves two purposes:

- to establish a reference for comparison throughout project implementation, and

- to reveal any remaining information gaps, which could not be filled during the EIA.

8.22 Baseline conditions for the program will be established during the pre-construction phase with relevant measurements taken to establish, as far as is possible, the ambient conditions. The program of works should ensure that the baseline conditions defined represent actual conditions for 2001. Each parameter will be measured at least once prior to the commencement of work in each area.
C. Construction Monitoring Program

8.23 The construction phase monitoring program will be established in order to monitor any changes in the baseline conditions, which result from construction activities or project components.

8.24 This program will be elaborated upon in the following sections, and summarized in Section 9. Where possible, results of overlapping sampling and testing programs of other competent authorities will be utilized. Caution will be used, however, in the interpretation of these studies, in part dependent on the reporting authority. TWSSLC in Taiz, for example, has an ill-equipped laboratory, which will be upgraded in the context of its current restructuring efforts. Until they have upgraded these facilities, use of their test results should be used sparingly.

D. General Construction Practices

8.25 Appendix C to this report provides broad guidelines for good construction practice that may be included, if required, in potential contract negotiations. Adherence to these guidelines would largely eliminate the majority of construction related impacts.

8.26 The following text therefore addresses only those issues that are of particular concern for the projects assessed, or which are not usually encountered in the construction process.

i) Public Safety

8.27 The major public health (and safety) concerns are addressed below. However there are a number of measures that could be undertaken on site to limit the risk of an accident involving the public.

- appropriate trench crossing facilities should be provided in sufficient number to permit safe crossing of trenches to gain access to private properties.

- trenches should be open for as little time as possible.

- appropriate alternative pedestrian routes, that separate pedestrians from road traffic, should be provided. Where restrictions in roadway space are such that the risk of pedestrian - vehicular conflict is significantly heightened, temporary closure of the access may be considered.

- use of temporary fences to isolate the deeper (>3m) trenches.

- the use of all heavy and mobile equipment shall be strictly controlled with all drivers and operators required to be licensed and all heavy equipment operated in strict accordance with manufacturer guidelines or Yemeni Guidelines. Particular note shall be made by site inspectors of incidences where equipment requiring two man crews or driver and observers are operated by one man.

ii) Public Health

8.28 As noted above, prior to the initiation of the construction of the project the population shall be advised of the nature and extent of the works proposed.

8.29 As part of that program the Public shall be made aware of the potential additional threats to their health that may be generated and measures available to reduce risks.
They will be advised of what to do in the event of a person falling victim to one or other threat. Options will include:

- self-treatment options, where available
- where to obtain medical attention, and when.

8.30 Hospitals and clinics currently exist in and around the project area, as well as in nearby Taiz. The hospitals have emergency rooms and are attended by doctors and medical staff 24 hours a day. The clinics are open between 8 and 12 hours a day and are staffed by qualified medical staff.

8.31 If necessary, as part of the project, it may be appropriate to establish a temporary clinic or clinics (within existing facilities) dealing with populations from affected areas. It will be the responsibility of the ESO to determine this need, on the basis of the proximity of existing facilities to construction areas. Preference will be given to the use of existing medical facilities, where available.

8.32 If established, this clinic could also be cited as the point of contact for project affected persons for obtaining health advisory services. It need not be necessary for the clinic to be open on a permanent basis or to have a qualified doctor available at all open times. A health professional should, however, be available at all times.

iii)  Employee Health and Safety

8.33 Any threat of contaminants to workers should be classified into one of three categories:

- Nil
- Minimal Risk
- Threat to both the workforce and the pipeline

8.34 In the case of minimal risk, simple mitigation measures such as the wearing of appropriate clothing and education of the workforce of the risk and preventative measures proposed would be sufficient.

8.35 If a significant threat to health is identified, tests should be retaken to confirm the threat and to establish rates of die off of pathogens. It would be expected that simple exposure will be sufficient treatment. However this will increase the number of pits open at any one time with significant adverse impacts elsewhere.

8.36 In the case of a defined persistent threat the area in the immediate vicinity of the pipe should be excavated and the waste material carted off to a dumpsite approved by NWSA and EPA. Approved methods of handling and disposal will be required.

iv) Collection, Storage and Disposal of Household Wastewater

8.37 During construction it is anticipated that up to 9 m$^3$ per day of wastewater will be generated by households temporarily disconnected from their cesspits. This waste must be collected, stored, transported to the WWTP in Taiz and disposed of at an appropriate inlet designated by TWSSL. These must be clear requirements of the bid documents.

8.38 Of concern here is to ensure that operations to:

- connect the temporary system,
- store wastewater,
- empty to tanker,
- disconnect the temporary system,
- move system, and connect to permanent system,

are carried out in a manner that prevents (or minimizes) spillage of wastewater and in the event of spill that there are adequate means available to contain it and neutralize it.

8.39 This will require the establishment of a unit (or as many as required by the contractor to meet his work schedule) within the construction work force specifically trained for carrying out these works. No other workers shall be permitted to handle or use the equipment.

v) **Fill Material Storage and Use**

8.40 The quantities of fill material required to be on site at any one time will require that effective site management be in place. For indicative purposes it is assumed that some 45 m$^3$ per day will be required for use on site. Given the urban nature of the site and the relative speed with which the construction site will proceed upstream, it is recommended that contractors be required to bring and use material, without temporary storage, on site.

8.41 Where necessary, temporary storage may be permitted, provided that:
- it is for a maximum period of 5 days.
- all existing access is maintained.
- no residual material is left at site.
- heaps are located at all times in areas to be temporarily acquired for construction purposes.
- heaps are not located within immediate proximity to any pit or operational trench. In such cases, “immediate proximity” would be a distance that allowed for immediate movement of material from the heap to the pit or trench, or where children playing on the heap would be in danger of tumbling into the excavation.

vi) **Access Management**

8.42 In all cases special management measures will need to be in place to ensure access and egress to the site is managed without damaging surrounding properties and, where required, to maintain public access.

8.43 In most cases, in local neighborhoods, it would be recommended that individual roads are closed for vehicular traffic and pedestrian movement, and that property access is catered to by defined routes clearly marked on site. Where roads are not closed measures as outlined in (i) above will be required to protect public safety and as in section (vii) below for traffic management.

8.44 Very specific measures will be required to ensure that all access points to a site are supervised and that drivers and operators respect the specific regulations on speed, routes etc. defined in an approved access plan.
8.45 The approved access plan should be defined in a plan and on the ground. The document should outline:

- permitted access routes, by vehicle type
- permitted times of use of routes
- speeds on access routes
- site control, parking and unloading areas

8.46 On site signs will clearly identify approved roads. All drivers shall be required to be trained on the contents of the plan and advised of the implications of ignoring it.

8.47 In cases where construction work is slated to take place in the immediate vicinity of special sites, (schools, mosques and the like) or other Public Buildings, specific access issues will be raised. Minimum access provision as outlined below will be required.

Table 8.1: Minimum Access Provision Guidelines

<table>
<thead>
<tr>
<th>Facility</th>
<th>Requirement</th>
<th>Main Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mosque</td>
<td>24 hour access</td>
<td>Safety of access during the hours of darkness</td>
</tr>
<tr>
<td>School</td>
<td>Access as required</td>
<td>Safe and secure access for children</td>
</tr>
<tr>
<td>Public Buildings</td>
<td>Maintaining normal service</td>
<td>Minimizing inconvenience to potential users in the event of closure</td>
</tr>
</tbody>
</table>

vii) Traffic Management

8.48 Traffic management plans will be required for all secondary and primary roads. The plan for these roads will be based on a program of diversions along parallel roads with restricted access (or no access) for local residents and in the case of wider roads (i.e., 4 lanes or more, closure of one side of the road.

8.49 The Contractor shall prepare and submit all plans to NWSA, the traffic department and the local civil defense and other authorities for approval before construction can begin.

viii) Abatement of Noise and Air Pollution

- Noise

8.50 The noise from construction activities will be derived primarily from the operation of equipment. In this regard noise levels can be mitigated as follows:

(i) the contractor will ensure that the equipment utilized in the construction of the project is fitted with appropriate noise muffling devices that will conform to the sound level emissions stipulated in Table 8.2 or other appropriate standards.

8.51 Equipment not covered in these regulations should, where appropriate and reasonable, be fitted with appropriate muffling devices.

8.52 Equipment and vehicles that are excessively noisy, (in relation to the values in Table 8.3 below) either according to the statute or otherwise defined, due to poor engine
adjustment, damage to noise amelioration equipment or other inefficient operating conditions shall not be operated.

Table 8.2: Suggested Noise Standards for Construction Equipment

<table>
<thead>
<tr>
<th>Activity</th>
<th>Source</th>
<th>Limitation Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenching</td>
<td>Impact Drill</td>
<td>75</td>
<td>55</td>
</tr>
<tr>
<td>Structure</td>
<td>Concrete mixer / concrete pump</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Surfacing</td>
<td>Roller</td>
<td>70</td>
<td>55</td>
</tr>
</tbody>
</table>

Source: Malaysian Environmental Quality Act 1974 and Guidelines

Table 8.3: Typical Noise Standards: Motor Vehicle Noise

<table>
<thead>
<tr>
<th>Category of Vehicle</th>
<th>Maximum Sound Level Permitted (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used for the carriage of goods. Permitted maximum weight does not exceed 3.5 tons. Engine is less than 200 hp DIN</td>
<td>81</td>
</tr>
<tr>
<td>Used for the carriage of goods. Permitted maximum weight exceeds 3.5 tons. Engine is less than 200 hp DIN</td>
<td>86</td>
</tr>
<tr>
<td>Used for the carriage of goods. Permitted maximum weight does not exceed 3.5 tons. Engine is 200 hp DIN or more.</td>
<td>88</td>
</tr>
</tbody>
</table>

Source: Malaysian Environmental Quality Act 1974 and Regulations

(ii) where smaller, noisy equipment is in operation, it may be placed behind screening or within a temporary enclosure. These will provide some noise attenuation.

(iii) the contractor will ensure that equipment operated intermittently is shut down, or at a minimum, throttled down during idle periods.

8.53 In addition, general noise abatement measures, such as those below should be utilized.

- restricting all operations involving heavy machinery and traffic to between 6 a.m. and 7 p.m.
- informing the public of the expected time and duration of works that may emit significant noise levels.

8.54 Permission to extend periods of operation may be provided the relevant municipality authority, but should as a matter of principle only be approved in two cases:

- an emergency
- in cases where it can be argued that a short period of additional working will provide significant long term benefits to communities affected by construction activity.

8.55 Extended periods (> 3 days) of overtime working shall not be permitted except in exceptional cases.
Air Pollution excluding dust abatement

8.56 In the conduct of general construction activities and the operation of other equipment, the contractor should be required to utilize all practical methods and devices as are reasonably available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants. These will include:

- the methods of handling cement and pozzoloid shall include means of eliminating atmospheric discharges of dust.
- equipment and vehicles that show excessive emissions of exhaust gases due to poor engine adjustment or other inefficient operating conditions should not be operated.

8.57 The contractor shall comply with applicable regulations concerning the prevention of air pollution in force in Yemen. In the conduct of construction activities and the operation of equipment, the contractor shall utilize all practical methods and devices as are reasonably available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants.

8.58 Any bituminous mixing plant shall not emit or discharge dust or solid particles in excess of the following limits:

<table>
<thead>
<tr>
<th>Source</th>
<th>Standard A (gm/Nm³)</th>
<th>Standard B (gm/Nm³)</th>
<th>Standard C (gm/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary Plant</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Mobile Plant</td>
<td>0.7</td>
<td>0.7</td>
<td>0.4</td>
</tr>
</tbody>
</table>

where:
- a mobile plant is defined as plant that operates for a period not exceeding 24 months and which has a rated production capacity not exceeding 60 ton per hour.
- standard C is applicable to all new premises or facilities.
- Dust Abatement

8.59 During the performance of the work required the contractor should be responsible for all the labor, equipment, materials and other means necessary required. They shall also carry out proper and efficient measures, wherever and as often as necessary, to prevent dust that has originated from his operations from damaging dwellings, or causing a nuisance or health hazard to persons.

8.60 Specific dust suppression measures may include:

- establishment of, and strict compliance with, speed restrictions for all vehicles operating within the construction site, or on access roads to the site.
- using coverings for all vehicles transporting materials likely to give off excessive dust emissions.
- wetting of areas and provision of wind breakers should be used for dust abatement, where appropriate

8.61 The contractor will be held liable for any damage resulting from dust originating from his operations.

ix) Vibrations

8.62 Some of the houses within the investigation corridor are quite old and in a relatively poor condition. Heavy vibrations resulting from ramming, densifying or excavating activities may lead to a damage of these houses. Therefore vibration-avoiding technologies should be applied and possible effects of vibrations on the bordering built-up areas should be monitored.

E. Construction: Off Site Facilities

i) Construction Offices/Yards

8.63 Beyond ensuring that appropriate health and safety standards for offices are met, no mitigation measures are likely to be required for the site offices.

8.64 For the stockpile yard, assuming no storage of hazardous materials, the only requirements are to ensure that adequate access is provided to the main road network. In this case direct access may be:

- via a dedicated access road from the site to the primary road
- direct frontage access to the primary road
- via a secondary public road assessed as suitable for the heavy truck movements anticipated. Suitability in this case being a function of the land uses in the area, the width of the road, its surface and condition, lines of sight and the junction with the primary network.

8.65 Sites located beyond these parameters should be the subject of individual review.

8.66 The prefabrication yard will require access to adequate water supplies and immediate access to suitable (for heavy traffic) roads. Location criteria for the yard will be as for the stockpile yard with the addition that it should as far as is possible be located to:

- minimize additional dust and noise nuisance values (beyond ambient levels) on surrounding populations,
- limit the potential impact on surrounding populations of the water storage and use requirements. In this context, NWSA should be required to review and approve the water sources to be used and the proposed size of any storage facilities.

8.67 The maintenance equipment yard will be the source of the most concern. It will potentially generate a number of wastes (solid and liquid) that should be collected, stored and disposed of in an approved manner.

8.68 To facilitate this prior to operations the contractor shall be required to list the materials to be used at site and define the procedures to be applied for waste control and management. If equipment is to be leased, lessors should be informed that their facilities will be subject to inspection and audit.
8.69 Where possible the contractor should be encouraged to recover, treat and reuse materials, in particular lubricants.

8.70 Accidental spill and leakage of chemicals stored on site could pose a serious potential threat to water resources and public health. Accordingly it is proposed that the contractor be required to submit to the NWSA an inventory of the materials to be stored on site, together with a preliminary indication of the quantities of material that may be present at any one time.

8.71 Clearly these indications of quantity will by necessity, be indicative only. NWSA should, if necessary, consult with specialist units in government for advice on the precautionary measures to be taken in terms of both the planning and construction of the camp and the required procedures for the storage and handling of such material.

8.72 They should then inform the Contractor of these requirements. It is expected that these will include, at a minimum, specific operational requirements such as:

- definition of any materials to be isolated from each other
- use of proper protective clothing, equipment by employees
- proper handling techniques
- other safety requirements, ventilation, firefighting equipment

8.73 However, depending on the advice of the specialist agencies, it may also include specific site design criteria, including measures to contain and isolate spills and leakages to specific areas through the use of hard stands, internal drainage and the construction of holding tanks.\(^{25}\)

8.74 Location criteria for the yard should be as indicated above for the stockpile yard.

8.75 Finally in all cases contractors should be obliged to prepare a plan for the restoration of any site utilized for the project to its former status. This will be submitted to NWSA for approval. In most cases this will simply mean the removal of all waste and temporary facilities established at site. Some permanent structures, hard stand area for example may need to be broken up and taken away.

\(\text{ii) Access and Traffic}\)

8.76 Mitigation of the impacts likely to accrue from construction traffic should take two forms:

- Access Control
- Definition of approved access routes

8.77 Access control will require the restriction of turning movements to approved access points to and from existing. It may also require restrictions on the timing of use, with construction traffic prohibited, outside of specified, supervised hours.

8.78 Prior to commencement of the contract the contractor should be required to submit to the executing authority a plan outlining:

\(^{25}\) In general terms and in all matters related to public health and safety it is preferred that the contractor submit a CASHES Plan for approval to NWSA.
8.79 Approved access routes should also be defined in a plan and on the ground. The document should outline:

- permitted access routes, by vehicle type
- permitted times of use of routes
- speeds on access routes
- site control, parking and unloading areas

8.80 On site signs will clearly identify approved roads. All drivers shall be required to be trained on the contents of the plan and advised of the implications of ignoring it.

8.81 If wide or abnormal loads are required to be transported to the construction site they should, wherever possible, be transported during the early hours of the morning. Appropriate times of transport (but not unloading etc.) would be between 23:00 and 05:00 hours.

iii) Construction: Resource Use

8.82 Two forms of resource use are anticipated:

(i) Water Use; On and Off site

8.83 Significant quantities of water will be utilized on site in construction. In this context, local communities may be affected in two ways:

- the quantity of water available from their water sources has been reduced by construction activities.
- their water sources are contaminated.

8.84 Contractors should be required to bring all water on site in tankers and be allowed to fill their tankers only at sites defined in agreement with NWSA. These may be new facilities located at construction yards, in communities, or pre existing facilities.

8.85 This recommendation is recognized as potentially restrictive. However, such are the costs of non-NWSA water sources and such is the potential for community concern (and resistance) that it is considered prudent to eliminate any potential for concern.

8.86 Off site, NWSA should again be required to approve the water source proposed for use by the Contractor in the context of existing, local patterns of use, availability of alternative supplies (for communities or existing users) and the likely peak quantity of water required as measured against existing consumption patterns.

8.87 In general terms the development of new sources (wells) should not be approved unless no reasonable alternative is available or unless the well is capped and taken out of production by project end.

(ii) Borrow material
8.88 Borrow material will be required to be transported to the site in substantial quantities.

8.89 Four options for accessing material are reviewed below in descending order of preference from an environmental perspective.

<table>
<thead>
<tr>
<th>Table 8.5: Borrow Material Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>(i)</td>
</tr>
<tr>
<td>(ii)</td>
</tr>
<tr>
<td>(iii)</td>
</tr>
<tr>
<td>(iv)</td>
</tr>
</tbody>
</table>

8.90 The principal criteria in the above is the desire to limit the number of new borrow pits developed on a one off project basis. Nevertheless, it is recognized that allowing contractors a free hand in obtaining borrow material will result in the least cost option and least likelihood of construction delays and claims.

8.91 Accordingly, it is assumed that at least some new sites will be opened. Sites for development shall be approved by NWSA in consultation with other appropriate bodies as required. Issues to be assessed will be:

- greatly elevated noise levels
- dust emissions in processing and from stockpiles
- water consumption
- wastewater disposal
- introduction of additional heavy traffic on roads accessing the site,
- security, etc.

8.92 Site Development and Access Plans shall be submitted along with the request for approval.
8.93 Provided the site developed is relatively remote from residential areas and can be easily secured these impacts are all readily manageable. On completion of operations the contractor will be required to make good the site.

8.94 Where pre-existing sites are used site owners and operators should be informed that they will be subject to inspection and audit in line with project requirements.

8.5 Malaria Abatement Program

A. Introduction

8.95 One of the biggest environmental issues for the Taiz area is the incidence of malaria, where over 7,000 cases were reported in 1998. In the same year, Al Qaida reported almost 9,000 cases, although this figure should be taken with caution. Nevertheless, given the severity of the problem, it has been decided to include in the EIA for the Taiz Pilot Project a malaria abatement program. This program will be designed as a part of the Taiz Environmental Management Program and the EMP will contain money to carry out whatever measures are appropriate and sustainable. Given the proximity of Al Qaida to Taiz and the Taiz WWTP, Al Qaida is also expected to benefit from this program, both in terms of a general decrease in mosquitoes in the area, and in terms of lessons learned.

8.96 The most critical weakness of urban EAs is the tendency to analyze each investment component or subproject in isolation, failing to draw connections between them, and failing to view them in relation to the broader urban environment. This problem appears to a greater extent in urban rather than in other sectors. This abatement program will attempt to avoid this, by working with both local and national health officials in the design and implementation of control methods. It will also work closely with the Taiz Municipal Project, which is working on the extension of the city's flood control network, as well as the development of an urban waste strategy.

8.97 In this context, the aim of this program is to supplement the health sector's national malaria program, primarily through vector control strategies. These strategies will be targeted at reducing or controlling mosquito breeding areas that are associated with Taiz's water sector infrastructure, including project components of both this project and the ongoing municipal development project. The program will also assist the health sector's efforts to provide Insecticide Treated Bednets (ITB) to residents living in project areas that are known to suffer from high incidence rates of malaria.

8.98 In order to achieve this, a two-step process will be undertaken as part of the EMP under this project, as follows:

Step 1: A malaria expert will be hired under the project, to design a malaria abatement program for Taiz. The program will be designed in cooperation with the MENA Health Sector's support for the National Malaria Control Program, and also with the regional RBM team, headquartered in Cairo, in order to draw upon their substantial experience in this area. The malaria expert will design this program based on state-of-the-art knowledge of both worldwide and Yemeni experience.
Step 2: The program will be implemented under the project by the ESO, in a manner appropriate for Taiz and in coordination with existing programs currently being undertaken in Yemen, and especially in Taiz.

8.99 This program will not involve itself in immunization, detection or treatment efforts, for which the health sector has considerable expertise and is thus better positioned to both design and implement. The World Bank, through IDA, will be supplementing these efforts through its support of the National Malaria Control Program. A separate project is currently under preparation in this context. If deemed necessary, however, this program may aid in the establishment of a small health clinic near the WWTP area during the lagoon rehabilitation phase of the project, as this phase is likely to temporarily increase the malaria problem in this area.

B. Methodologies

8.100 A variety of methods for malaria control have been used to control malaria the world over, and documentation on results, both good and bad, is extensive. While it is not the purpose of this EIA to design, or even provide strict guidance on the design of, the malaria abatement program, the following section outlines various methodologies that might be applied in the case of Taiz. While this is not an exhaustive treatment, it is recommended that the resulting program examine these methods during program design.

i) Insecticide Treated Nets

8.101 One of the primary strategies for malaria control is through the use of insecticide treated nets (ITNs). These are often nylon bednets or curtains treated with lambda-cyhalothrin (at 25 mg/m²) or cyfluthrin (at 50 mg/m²), but can be treated with other insecticides such as pyrethroid. Studies have shown a 20 to 63% reduction in malaria disease rates following the introduction of insecticide-treated nets. Different methodologies have also been developed to obtain longer lasting insecticide impregnated bed nets, which may maintain their effectiveness after being washed twenty or more times. Two products are on field tests “Permanet” and “Olynet”. Results are very promising and the regional WHO office recommends the use of these nets. A provisional World Bank guide on specifications for ITNs can be found in Appendix F of this document.

8.102 The use of insecticide treated materials on a large scale can result in huge health benefits, and they are a cost-effective intervention. In many cases, however, the introduction of insecticide treated materials requires behavioral changes, particularly where the use of bednets is low, so it is not always clear how these benefits can be obtained. Moreover, some form of cost recovery might have to be built into the program simply in order to sustain it, but this might have an important adverse influence on coverage. In particular, a policy of cost recovery will reduce access for poorer groups in the population. An apparently simple intervention thus becomes difficult to implement when the issues of coverage, accessibility, equity, and sustainability are considered.

8.103 Many people in and around Taiz work in large-scale agriculture or private manufacturing. One approach to bednet distribution could be through these large employers, although it would have to be coupled with public education campaigns on their use. These employers might even be willing to share the cost, if an argument is made as to the potential benefits to their workforce. One key technical issue will be what
system can be developed to promote re-treatment of the nets. Coupling bednets with the National Program's improved capacity for diagnosis and treatment of malaria cases, along with the implementation of vector control activities (see below), would probably go a long way to mitigating the problem.

**ii) Vector Control**

8.104 Historically, vector control (in this case mosquito control) methods have had mixed results, with large sums of money being spent, with few long-term results.

8.105 There are serious limitations to the use of pesticides for vector control. Individual applications of biocidal agents seem to produce sustained results only when the vector species are locally extirpated. Thus, multiple applications are necessary for vector control, often at substantial cost. Environmental contamination resulting from pesticide use is itself a risk to public health and nontarget species (e.g., natural predators of vectors), and resistance to pesticides often develops in the vector populations. Moreover, most insecticides are ineffective in highly polluted waters, so their use in and around the treatment lagoons is not advised. A provisional WHO guide on the use of various pesticides can be found in Appendix G.

8.106 The bacteria BTI (*Bacillus thuringiensis israelensis*) have long been recognized as a natural method of killing mosquito larvae without harming other life forms. A mosquito-control program in Red Deer, Alberta uses BTI to get rid of the insects without harming the environment. Use of the larvae-killing bacterium reduced the mosquito population by an average of 85 percent. The city received the 1993 National Environment Award from the Canadian Association of Municipal Administrations for its program, in which BTI is applied with a manual fertilizer spreader in the sedge surrounding mosquito breeding grounds. For the past five years, BTI alone has been applied on 1,600 mosquito hatching sites within a five-kilometer radius of Red Deer's city limits.

8.107 The costs of producing the bacteria, however, are often too high for a developing nation. Given the potentially limited application area in Taiz (around the treatment lagoons and agricultural dam), however, the costs may actually be relatively low. A cost-benefit analysis would have to be made in the process of program design to determine if such a solution is viable for the Taiz area.

8.108 Moreover, less expensive natural options also exist for the production of BTI. Researchers from Lima's Instituto de Medicina Tropical Alexander von Humboldt (IMT AvH), at the Universidad Peruana Cavetano Heredia (UPCH), for example, have utilized 'Yucca tea' as a 'natural laboratory' for BTI production.

8.109 Their method involves growing BTI using the 'tea' from boiled yucca plants, which is then applied to malaria-breeding ponds to kill mosquito larvae. This process originated from a successful seven-year pilot project using coconuts to ferment BTI in Salitral, a community in Peru's northern coastal region. The project ended in 1998, but the community continues to use the method with minimum supervision from the MIT AvH team. This method is interesting, as the Peruvian community was directly involved in producing a mosquito larvicide for malaria prevention. The process was transferred to local communities with funds from the International Development Research Center (IDRC), the Canadian embassy, and the Pan American Health Organization (PAHO).

8.110 Mosquito control in the breeding site may be further achieved by introducing predators to complement or augment other approaches. Larvivorous fish (such as
mosquito fish: *Gambusia holbrooki*) are the only biological agents commercially available for practical use in dams and the like, and can be a valuable component of an integrated control program, either alone or together with chemical control agents. Fish help to keep down undesirable weeds and can be a source of food and income. Almost 100 years have passed since the mosquito fish was first spread by humans for mosquito control. Although not a panacea, it has been a consistent scourge of malarial mosquitoes and now has the added distinction of being the widest-ranging freshwater fish on earth. It has been used effectively in North America and Europe in helping to eliminate malaria.

8.111 A successful implementation of this type of strategy was developed and implemented in the port city of Assab, Ethiopia. In a 12-month trial program, the native cyprinodontid fish *Aphanius dispar* was added to several randomly selected cisterns, water storage barrels, ritual ablution basins in mosques, and wells throughout the city. The fish were restocked every month, where necessary, to replenish populations. During the study, mosquitoes were found in 34% of the unstocked sites, and anopheline mosquitoes in 4% of the unstocked sites. *Aphanius dispar*, by contrast, kept overall mosquito presence to 4.5% of the stocked sites and anopheline mosquito presence to just 0.4% of the stocked sites.

8.112 The addition of fish to these water storage containers was well accepted by the residents, who became aware of the role of larvivorous fish in mosquito control and found the fish to be useful for keeping their water free of other aquatic organisms. As a result, Ethiopia's National Organization for the Control of Malaria and other Vector-Borne Diseases, in collaboration with municipality and health authorities of Assab, have stocked all 367 major wells in the city with *Aphanius dispar* and are distributing the fish to homeowners who wish to add them to their water storage containers. This method may be quite useful for use in Taiz, as natural and social environments in Ethiopia are similar to those in Yemen in many ways. Preference should be given, however, to the use of any suitable indigenous Yemeni fish, as foreign species may bring about undesirable side effects (such as eating any indigenous species).

8.113 There are several other important environmental management strategies for vector control that can be applied to water projects, including such activities as siting dams or reservoirs at high altitudes or away from the community and adopting a range of environmental manipulations. These include water level management, flushing of streams, intermittent irrigation, lining canals, changing water salinity, desiccation by trees, housing improvements, and similar measures, which can prevent worsening of malaria and schistosomiasis and may even help to improve their control.

8.114 Design of any wetland areas or ponds is important: shallow water and dense vegetation promote mosquito production. Deeper habitats with cleaner steeper margins, and more open water, produce fewer mosquitoes. Water and vegetation management can reduce mosquitoes: aeration and sprinkler systems, and flooding and drainage regimes, can reduce larval densities; vegetation thinning can assist mosquito predators. For this reason, the ESO for this project should closely monitor the rehabilitation of the treatment lagoons, and any modifications to the agricultural dam brought about by the Taiz Urban Project.

8.115 Strategic removal of marginal and floating vegetation, and associated debris, will usually greatly assist in reducing mosquito populations. When plants become dense, and when they die and/or become lodged, mosquito predators cannot easily locate their prey.
Anopheles and other species find shelter in surface algae, so reduction of algae (a problem currently found in the treatment lagoons) is also important.

iii) Approach

8.116 The consultant will not be required to travel to Yemen for the design of the malaria program. He or she should, however, be an accomplished epidemiologist, with experience designing similar programs in the region. Preference will be given to candidates who are familiar with the Taiz area. The ESO will provide any and all documentation and information necessary for the design of the program, and will act as a liaison between the consultant and project staff. The ESO will also perform, or contract out, any studies needed to learn more about the life cycle of local anopheline mosquitoes. The consultant will contact the following agencies and organizations, in order to coordinate efforts, and utilize information and resources available:

- National Malaria Control Program staff on both local and national levels.
- WHO’s RBM office in Cairo.
- IDA staff in Washington who are responsible for the support of the National Malaria Program.
- Local health officials.

8.117 The program will seek methods that are both sustainable and cost-effective in the short and long term. Education programs, where necessary, will be included in such a way that local capacity to sustain and enhance awareness of the program is an integral part of any long term solutions. Once drafted, the ESO will be responsible for the implementation and monitoring of the program.

8.118 The World Bank’s Pesticide Safeguard will apply to this project if the project is involved in any kind of pesticide purchase or program that employs pesticides (i.e. if the final plan includes spraying or the re-treatment of ITNs). It may apply to the procurement of ITNs, but that depends on what exactly is being bought, and how it is deployed. The degree to which the safeguard applies also depends on what pesticides are used (DDT requires special handling, for instance) and how often. It also depends on the length of commitment to the program (e.g. if a commitment is made to re-treating ITNs in the future). Details of this safeguard are found in Appendix H of this document.

8.119 Since the full nature of the plan is not known at this point, the details cannot be put in the current Environmental Data Sheet, nor can the degree to which the Safeguard Policy applies to the project be known. Therefore, there will have to be a Chemical Management Plan (CMP) if the abatement program, when finalized, contains significant pest management issues, as defined in Appendix H. The implementation of any pesticide-related portion of the EMP will therefore wait until after the abatement program itself is designed. The program will then be integrated in conjunction with the first semi-annual review, applying the policy at that point, doing a CMP if necessary, and integrating any such plan into the EIA, EMP and Environmental Data Sheet.
8.6 Sludge and Wastewater Re-use Study

A. Introduction

8.120 Neither Taiz local branch nor local Al Qaida NWSA officials currently have a comprehensive program for the disposal or re-use of sludge or treated wastewater. Currently sludge from the Taiz WWTP or from local cesspits in both cities, when removed, is dumped in a landfill or haphazardly in uninhabited areas, and wastewater effluent in Taiz is utilized in an ad-hoc way by local farmers.

8.121 Phase 1 of the project will include the rehabilitation of the existing treatment lagoon system in Taiz, which will create a large amount of dried sludge that will then need to be disposed of. Project works in Al Qaida will result in a much smaller, but still significant amount of sludge and wastewater to be generated by a new treatment system.

8.122 For these reasons, and to develop a long-term solution for sludge and treated wastewater, a formal wastewater and sludge reuse policy will be developed as part of the Taiz EMP. This study will be completed in sufficient time to influence the disposal of sludge generated as part of the rehabilitation works. This study will also examine wastewater reuse and the disposal of sludge generated by new treatment works in Al Qaida.
### 8.7 Summary

Table 8.6 Monitoring and Mitigation Program

<table>
<thead>
<tr>
<th>Phase / Issue</th>
<th>Significance</th>
<th>Reference*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre Construction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to land</td>
<td>Negligible</td>
<td>Consultation (8.3)</td>
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<tr>
<td>Test Pits</td>
<td>Minor</td>
<td>Construction Guidelines (Appendix C)</td>
</tr>
<tr>
<td><strong>Construction Works</strong></td>
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<td></td>
</tr>
<tr>
<td>Public Safety</td>
<td>Major</td>
<td>8.3.A, 8.4.D.(i)</td>
</tr>
<tr>
<td>Noise and Construction Disturbance</td>
<td>Major nuisance value</td>
<td>8.34D.(viii)</td>
</tr>
<tr>
<td>Air Quality (excl. dust)</td>
<td>Minor</td>
<td>8.4.D.(viii)</td>
</tr>
<tr>
<td>Dust</td>
<td>Moderate</td>
<td>8.4.D.(viii)</td>
</tr>
<tr>
<td>Waste Soil Material</td>
<td>Minor</td>
<td>None</td>
</tr>
<tr>
<td>Hydrogeology, Geology and Topology</td>
<td>Negligible</td>
<td>None</td>
</tr>
<tr>
<td>Fauna, Flora and Ecology</td>
<td>Negligible</td>
<td>None</td>
</tr>
<tr>
<td>Archaeology/Cultural Heritage</td>
<td>Negligible</td>
<td>None</td>
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<tr>
<td><strong>Off Site Works</strong></td>
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<td></td>
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<td>Project offices</td>
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<td>8.4.E</td>
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<td>Materials Stockpiles</td>
<td>Minor</td>
<td>Inspection and Audit</td>
</tr>
<tr>
<td>Pre-Fabrication Yard</td>
<td>Moderate. Sufficient cumulative impact to warrant attention</td>
<td>Inspection and Audit</td>
</tr>
<tr>
<td>Equipment Maintenance and Cleaning</td>
<td>Moderate. Sufficient cumulative impact to warrant attention</td>
<td>Inspection and Audit</td>
</tr>
<tr>
<td>Borrow Pits₂⁶</td>
<td>Moderate</td>
<td>Inspection and Audit</td>
</tr>
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<td><strong>Resource Use</strong></td>
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<td>Water</td>
<td>Potentially major</td>
<td>8.3.E.(iii)</td>
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<tr>
<td>Borrow Material</td>
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<td>8.3.E.(iii)</td>
</tr>
<tr>
<td><strong>Permanent Impacts</strong></td>
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<td>Land acquisition</td>
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<tr>
<td>Property take</td>
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</tr>
<tr>
<td>Cultural Properties</td>
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<td>None</td>
</tr>
<tr>
<td>Flora and Fauna</td>
<td>Minimal</td>
<td>None</td>
</tr>
</tbody>
</table>

₂⁶ Borrow pits are sites identified for the extraction of fill materials for use in project works.
8.8 Annex 8.1: ToR for Environment and Safety Officer

a) Construction: Inspections and Audits

8.123 The ESO will have responsibility for a series of semi-annual environmental audits, which may be contracted out to responsible agencies, or individuals, on a commercial basis. Independent reports of audit findings will be prepared as part of the contract. The results of these audits will be included in a semi-annual environmental report (discussed later in this ToR). The reporting schedule for these reports can be found in Table 9.2.

b) Environmental Quality Monitoring

8.124 The ESO will contract, and directly supervise and manage contractors which will be employed to carry out the required monitoring and testing programs, and provide the assessment reports. Each report should contain as a minimum the following sections:

- sampling, methodologies, equipment calibration reports, other background material
- the empirical findings
- statements of any extreme events or incidents reported that might abnormally influence the empirical findings
- analysis of the findings highlighting any changes of significance and possible, probable causes of change
- recommendations on actions to be taken
- follow up on any previous recommendations

8.125 All reports prepared should be submitted to the ESO and EPC, and circulated to relevant agencies, NGOs etc.

c) Construction Monitoring

Inspection Reporting

8.125 After each inspection a report shall be compiled that is location and activity specific, and which identifies areas of contractor non-compliance with the EMP, and which provides guiding remarks on actions to be taken. The significance of the non-compliance shall also be noted. These reports shall be prepared by the ESO. Copies of these reports shall be sent to the EPC, the supervising engineer, and the Contractor for their action.
8.126 Every six months the inspection reports shall be compiled into a review document that shall highlight any areas of persistent negligence by the contractor. This document shall also contain records of any communications between the supervising engineer, ESO and the Contractor on matters relating to the environment.

**Audit Reports**

8.127 Audit reports shall be prepared following each audit. These reports will be submitted by the sub-contractor to the ESO. The ESO shall review the documents and circulate to the site owners and operators with any additional recommendations from the PIU included. The reports should comprise:

- Background data, time, facility, operations underway, etc.
- Statement of Findings of the Audit.
- Statement of compliance with the recommendations of the previous audit.
- Recommendations for future action.

8.128 As with all reports from contractors received by the ESO/PIU, the originals will be filed and held, available for reference by any concerned party.

**Semi-Annual Environmental Reports**

8.129 The ESO will be responsible for the preparation of semi-annual Environmental Reports. These reports should be produced throughout the construction period. They will be prepared following the World Bank semi-annual supervision missions, and based in part on the findings of the environmental audit and consultation processes. It is envisaged that each report will have two main sections:

I) **Review of Project Performance**

8.130 This will outline the performance, from an environmental perspective, of all agencies involved in the Project; improvement or deterioration, as measured against previous baselines and established targets where appropriate; and establish new performance targets.

8.131 In the latter context, it is recommended that appropriate, specific targets be employed in the assessment process to ensure that the findings permit direct comparison with previous performance and in the context of defined objectives. In this way, performance indicators can be monitored over time, so that increases (or decreases) in performance or efficiency can be monitored over time.

8.132 The assessment should draw on the findings of the inspection reports, monitoring programs and environmental audits.

II) **Review of Project Works**

8.133 This would comprise a review of all actions undertaken within the Project in the previous period. It would include as a minimum:

- Progress reports on project and program implementation
- Comparison to Baseline Indicators
- Summary report on training programs / workshops held etc.
- Activity report on the awareness campaign
• Activity report of site inspections program
• Activity report from the monitoring and audit program

8.134 In general terms each report should contain:

• background to the project / program / works
• summary statements of methodologies adopted
• summaries of findings
• analysis of environmental audits
• a statement of lessons learnt
• any new mitigation measures to be implemented
• recommendations for future works

End of Project Report

8.135 On completion of project construction works, the ESO should prepare an end of project monitoring review report. This shall contain:

• background to the project
• the empirical findings of the monitoring program and the site inspections
• a statement on the methodologies adopted for monitoring, the suitability of equipment utilized, its performance, the practical and technical difficulties experienced in collecting and analyzing the data. Recommendations for future works
• a statement on suitability of resources available for monitoring and inspection and recommendations for future works
• a statement on the efficiency, or otherwise, of mitigation measures proposed
• a statement on the significance of any changes identified, both physical and social, as compared to those predicted
• a statement of lessons to be learnt and recommendations on any actions to be taken to ensure that these lessons are translated into positive actions on future projects
• a summary statement of the overall impact on the environment of the construction phase.
9. Environmental Monitoring Program

9.1 Introduction

9.01 An environmental monitoring and mitigation program for the rehabilitation of the water and sanitation project is outlined in order to address the environmental impacts before, during and after the project implementation. A specification of this plan is elaborated upon in the following section. However, this plan may need to be modified in close cooperation with the local authorities when a decision about the final technical design has been made. It will also need to be modified and re-evaluated at a later date, in order to cover subsequent phases of this project.

9.02 One of the overall objectives of this monitoring and mitigation program is to ensure the possibility of correcting the planned measures to mitigate adverse impacts. Many of these impacts have been foreseen, but the degree of each impact may differ from the one expected. This relates in particular to the construction activities (air pollution, noise, excavation works).

9.03 Unforeseen impacts can be mitigated before and during the construction phase of the project, if identified in a timely fashion. The following plan prepares for this through the hiring of an environmental and safety office, and through a prescribed semi-annual environmental review performed throughout the project cycle.

9.04 Planned and random sampling, combined with site visits and a public consultation program, will provide the means for the identification of project impacts on the environment. To this end, a detailed sampling program will be elaborated upon in the following section. This program will include the establishment of baseline conditions, which can then be used to form a basis for comparison. In addition, uncertainties related to information gaps are addressed in the baseline-monitoring plan. Results of the sampling and site visit program will be included in the semi-annual review.

9.05 The following section outlines this plan, along with its associated costs. Most of these costs are related to the monitoring program that has been elaborated upon in the preceding section, and are summarized here.

9.06 Table 9.1 summarizes the mitigation plan by issues, and their associated costs. These costs are broken down, by item, in the section that follows, with detailed tables found in Annex 9.1.
Table 9.1: Summary Matrix of Mitigation Measures and Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Potential Negative Impact</th>
<th>Mitigation Measure</th>
<th>Implementation Responsibility</th>
<th>Monitoring Responsibility</th>
<th>Total Phase 1 Cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewage from destroyed cesspits and households</td>
<td>Contamination resulting from improper disposal of sewage.</td>
<td>Controlled transport to Taiz WWTP. Temporary disposal measures and waste dilution if necessary. Cesspit Sampling.</td>
<td>Contractor</td>
<td>PIU ESO</td>
<td>1,400</td>
</tr>
<tr>
<td>Improved living conditions for Anopheles</td>
<td>Increase in incidence of malaria</td>
<td>A Malaria Abatement Program will be designed and implemented under the project.</td>
<td>ESO in conjunction with local malaria and health officials</td>
<td>PIU, ESO</td>
<td>0</td>
</tr>
<tr>
<td>Dried wastewater sludge.</td>
<td>Improper use and lack of storage space.</td>
<td>Sludge re-use policy study to be performed and financed under the Project.</td>
<td>PIU</td>
<td>ESO, with assistance from IDA Resident Mission</td>
<td>0</td>
</tr>
<tr>
<td>Effluent and Influent monitoring at WWTP.</td>
<td>Low quality wastewater.</td>
<td>Regular sampling will be included in the mitigation measures.</td>
<td>Independent sampling contractor</td>
<td>PIU ESO</td>
<td>1,900</td>
</tr>
<tr>
<td>Soil &amp; Groundwater.</td>
<td>Contaminated soil and groundwater in construction areas and downstream of WWTP.</td>
<td>Proper clothing and worker education. Proper disposal if warranted. Soil and groundwater downstream of the WWTP and in the project area will be monitored to determine if contamination has occurred</td>
<td>Contractor, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>4,950</td>
</tr>
<tr>
<td>Noise</td>
<td>Disturbances during construction.</td>
<td>Use of heavy equipment restricted from 7 p.m. to 6 a.m. Proper noise muffling devices, traffic routing and monitoring.</td>
<td>Contractor, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>180</td>
</tr>
<tr>
<td>Dust</td>
<td>Disturbances during construction.</td>
<td>Use of dust suppression measures such as wetting, dust covers and speed restrictions. Monitoring will be carried out.</td>
<td>Contractor, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>180</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------</td>
<td>---------</td>
<td>-----</td>
</tr>
<tr>
<td>Water Use: On and Off Site</td>
<td>Water contamination. Reduced public water levels.</td>
<td>Contractors will be required to bring all water on site in tankers and only be allowed to fill their tankers at approved sites. Water storage provisions must be made.</td>
<td>Contractor, PIU, NWSA ESO</td>
<td>ESO</td>
<td>0</td>
</tr>
<tr>
<td>Hazardous Chemicals</td>
<td>Improper disposal of chemicals used to flush water lines.</td>
<td>Supply of proper training and safety gear. Spill contingency plans.</td>
<td>Contractor</td>
<td>PIU ESO</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Route to Taiz WWTP. Concentrations limited to WWTP's technical capacity to treat.</td>
<td>NWSA, TWSSLC, WWTP Staff, Independent sampling contractor (lab tests)</td>
<td>PIU ESO</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Medical Clinic</td>
<td>Construction site related injuries.</td>
<td>A temporary clinic will be established in project areas that do not have easy access to local facilities.</td>
<td>ESO</td>
<td>Contractor, ESO</td>
<td>8,600</td>
</tr>
<tr>
<td>Public Consultation</td>
<td>Unnecessary disruption of affected communities.</td>
<td>An extensive public consultation program will continue to be undertaken, including the use of radio, TV, town meetings, and household surveys.</td>
<td>PIU</td>
<td>ESO</td>
<td>2,600</td>
</tr>
<tr>
<td>ESO &amp; Information Campaign</td>
<td>Non-compliance with Management Plan.</td>
<td>An Environmental Safety Officer (ESO) will be hired to monitor mitigation measures and disseminate relevant information to public.</td>
<td>PIU, TWSSLC</td>
<td>IDA</td>
<td>3,000</td>
</tr>
<tr>
<td>Environmental Reviews</td>
<td>Non-compliance with Mitigation Plan.</td>
<td>Semi-annual reviews performed to examine compliance with mitigation plan, regulatory requirements, and to identify potential environmental problems.</td>
<td>ESO, with assistance from WB Environmental Specialist as part of IDA supervision missions</td>
<td>IDA</td>
<td>300</td>
</tr>
</tbody>
</table>

**Total Cost** | 23,010 |
9.2 General

The implementation of the environmental monitoring and mitigation plan for the Project will occur in three distinct phases, according to the following program schedule:

Table 9.2: Implementation Schedule

<table>
<thead>
<tr>
<th>Event</th>
<th>Implementation Date*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I) Pre-Construction Phase</td>
<td></td>
</tr>
<tr>
<td>Establish ESO</td>
<td>-6</td>
</tr>
<tr>
<td>Initiate Baseline Studies (pre-construction testing), and Monitoring Program</td>
<td>-5</td>
</tr>
<tr>
<td>Public Meetings to discuss commencement of Construction Activities</td>
<td>-4</td>
</tr>
<tr>
<td>Design and Implementation of Malaria Abatement Program</td>
<td>-3</td>
</tr>
<tr>
<td>Commencement of Sludge and Wastewater Re-use Study</td>
<td>-2</td>
</tr>
<tr>
<td>II) Construction Phase</td>
<td></td>
</tr>
<tr>
<td>Initiate Construction Monitoring and Supervision: Inspections, Audits and Random Sampling</td>
<td>0</td>
</tr>
<tr>
<td>Initiate Operations Monitoring</td>
<td>0</td>
</tr>
<tr>
<td>IDA Supervision Mission, Public Meetings, and Environmental Audit</td>
<td>1</td>
</tr>
<tr>
<td>Submission of semi-annual Environmental Report</td>
<td>2</td>
</tr>
<tr>
<td>IDA Supervision Mission, Public Meetings, and Environmental Audit</td>
<td>7</td>
</tr>
<tr>
<td>Submission of semi-annual Environmental Report</td>
<td>8</td>
</tr>
<tr>
<td>IDA Supervision Mission, Public Meetings, and Environmental Audit</td>
<td>13</td>
</tr>
<tr>
<td>Submission of semi-annual Environmental Report</td>
<td>14</td>
</tr>
<tr>
<td>IDA Supervision Mission, Public Meetings, and Environmental Audit</td>
<td>19</td>
</tr>
<tr>
<td>Submission of semi-annual Environmental Report</td>
<td>20</td>
</tr>
<tr>
<td>IDA Supervision Mission, Public Meetings, and Environmental Audit</td>
<td>25</td>
</tr>
<tr>
<td>Submission of semi-annual Environmental Report</td>
<td>26</td>
</tr>
<tr>
<td>IDA Supervision Mission, Public Meetings, and Environmental Audit</td>
<td>31</td>
</tr>
</tbody>
</table>
Audit

<table>
<thead>
<tr>
<th>Description</th>
<th>Phase 1 Costs (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission of semi-annual Environmental Report</td>
<td>32</td>
</tr>
<tr>
<td>Completion of Construction for Al Qaida</td>
<td>35</td>
</tr>
</tbody>
</table>

III) Post-Construction Phase

<table>
<thead>
<tr>
<th>Description</th>
<th>Phase 1 Costs (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDA Supervision Mission, and End of Civil Works Report</td>
<td>36</td>
</tr>
<tr>
<td>Submission of End of Civil Works Report</td>
<td>37</td>
</tr>
</tbody>
</table>

*in terms of months before or after the commencement of construction activities

The details of this program are elaborated upon in the following section, according to the implementation order specified in Table 9.2. The ESO will be responsible for the implementation of this program, and will thus use this section as a guide.

9.3 Pre-Construction Phase

9.07 Table 9.3 summarizes the components of the Pre-Construction Phase EMP, and associated costs.

Table 9.3: Pre-Construction Phase Cost Summary

<table>
<thead>
<tr>
<th>Parameter/ Description</th>
<th>Reference</th>
<th>Phase 1 Costs (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESO Costs</td>
<td>9.3.A</td>
<td>3,000</td>
</tr>
<tr>
<td>Establishment of Baseline Conditions</td>
<td>9.3.B</td>
<td>1,610</td>
</tr>
<tr>
<td>Public Consultation</td>
<td>9.3.C</td>
<td>1,100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5,710</td>
</tr>
</tbody>
</table>

9.08 An Environmental Safety Officer (ESO), with a thorough knowledge of site conditions and safety practices, will be appointed to the project implementation unit (PIU). Although costs for the ESO are covered under the Taiz EMP, an additional $3,000 transportation allowance will be provided to cover Phase 1 transportation costs for the Al Qaida portion of this work. An indicative ToR for this position is included in Section 8.5.

C. Establishment of Baseline Conditions

9.09 All testing will be contracted out to an independent sampling contractor, who will be contracted by the PIU and monitored by the ESO. Costs associated with establishing baseline conditions are found in Table 9.4. Costs will be incurred in YR. A more detailed breakdown of these costs can be found in Annex 9.1 to this section.

9.10 The ESO will also conduct a small survey of local flora and fauna, in order to establish baseline conditions in proposed construction areas. The results of this survey
will aid in determining the need for selective replanting of trees or re-establishment of habitat, if any.

Table 9.4: Establishment of Baseline Conditions for Monitoring Program

<table>
<thead>
<tr>
<th>Parameter/Description</th>
<th>Quantity: Al Qaida</th>
<th>Unit Rate (US$)</th>
<th>Total Cost (US$)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesspit waste liquid testing</td>
<td>4</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Soil testing</td>
<td>6</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Dust</td>
<td>1</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Noise</td>
<td>1</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Ground-water</td>
<td>6</td>
<td>50</td>
<td>750</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>1,610</strong></td>
</tr>
</tbody>
</table>

* For breakdown, see Table 9.11

D. Public Consultation

9.11 As outlined in Section 8.3, a public consultation program will be undertaken, which will include a media campaign and a series of public meetings. Prior to the start of construction, the ESO will organize additional public meetings in both Taiz and Al Qaida to inform the public of what they might expect from upcoming construction activities, and to elicit feedback that might be integrated into the EMP.

9.12 Radio and/or television addresses will be undertaken prior to the commencement of project works, and newspaper articles will be published prior to the commencement of works in different sections of the city.

9.13 The schedule for the public meetings is outlined in Table 9.1.

E. Design of Malaria Abatement Program

9.14 A Malaria Expert, with a thorough knowledge of vector control methods, will be appointed by the ESO. The Malaria Expert will be paid under the Taiz EMP for the elaboration of an abatement program, with recommended control methods outlined in Section 8.5.

F. Sludge and Wastewater Re-use Study

9.15 A sludge and wastewater re-use study will be contracted out by the ESO. Monies will be allocated under the Taiz EMP for this purpose. The study will be completed prior to the completion of Phase 1 works.

9.4 Construction phase

9.16 Table 9.5 summarizes the components of the Construction Phase EMP, and associated costs.
Table 9.5: Construction Phase Cost Summary

<table>
<thead>
<tr>
<th>Parameter/Description</th>
<th>Reference</th>
<th>Phase 1 Costs (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring Program</td>
<td>9.4.A</td>
<td>6,900</td>
</tr>
<tr>
<td>Environmental Review</td>
<td>9.4.B</td>
<td>300</td>
</tr>
<tr>
<td>Public Consultation</td>
<td>9.4.C</td>
<td>500</td>
</tr>
<tr>
<td>Medical Clinic</td>
<td>9.4.E</td>
<td>8,600</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>17,300</td>
</tr>
</tbody>
</table>

B. Environmental Monitoring Program

9.17 It will be necessary to monitor the physical environment of the construction sites. This will require quantitative assessments derived from monitoring sites:

- to monitor alterations in existing physical, chemical and biological characteristics of the environment.
- to determine whether any detected changes in environmental components are caused by the project or natural occurrences.
- to determine the impacts of non compliance with EIA and EMP requirements by the contractor, in particular to monitor emissions and discharges and ensure compliance with local, national and international standards.
- to determine the effectiveness of the ameliorating measures.
- to highlight areas of concern unforeseen in the EIA and EMP and provide a basis for recommending further mitigation measures.

9.18 The following section describes the environmental conditions to be sampled, along with general guidelines on the execution of the sampling program not contained in Section 8.

9.19 For the Monitoring Program to be effective it will be necessary, during the course of construction and operation, for authorized agents from key agencies (NWRA, NWSA and EPC) and the ESO to occasionally conduct inspections for the purpose of determining compliance with the EMP and all applicable regulations and statutes. Access to all sites related to the project must therefore be guaranteed.

9.20 Accordingly, the contract documents and operating agreements shall incorporate a phrase with similar intent to that outlined below.

*Any officer authorized in writing by EPC, NWRA or NWSA, and the ESO may at any time enter any premises whether prescribed or otherwise, and may:*

- Examine and inspect equipment, control equipment, monitoring equipment or plant;
- Take samples of any pollutants that are emitted, discharged or deposited or are likely to be or are of a class or kind that are usually emitted, discharged or deposited from such premises;*
• Examine any books, records or documents relating to the performance or use of such equipment, control equipment, monitoring equipment or plant or relating to the emission, discharge or deposit from such premises;
• Photograph such premises as he considers necessary or make copies of any book, records or documents seen in the course of such examination.

i) **Air and Noise Pollution**

9.21 During the construction phase there will be an increase in air pollution, directly from the construction site and the construction vehicles (noise, dust, exhaust fumes) and indirectly from traffic congestion caused by the construction activities. Attention should be paid that these impairments remain as low as reasonable achievable by means of noise-reduced construction technology, moistening of open areas, traffic management etc.).

9.22 A complaint based ambient air and noise pollution monitoring program will be made available for construction areas in Al Qaida, and in the vicinity of the proposed treatment facility. The testing sites will be selected according complaints received concerning construction activities. As such, no monies will be set aside for this program at this point. Project money will be used for any random testing.

9.23 Ambient impairments, at least NOx, SO2, CO, dust, noise and vibrations, should be measured before the beginning of construction activities, in order to reveal the baseline pollution levels. The measurements should refer to the existing ambient air quality standards, specified by the respective National Standards and permitted pollution levels, or WHO equivalents where missing. In order to integrate the measurements into a possibly already existing air pollution measurement system, and to avoid double work, the decision for the placing and equipping of the measuring stations should be made in close cooperation with the responsible city authorities and research institutes.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust &amp; Pollution</td>
<td>TSP</td>
<td>06:00-22:00</td>
</tr>
<tr>
<td>Noise</td>
<td>Leq</td>
<td>06:00-22:00</td>
</tr>
</tbody>
</table>

ii) **Biological Conditions**

9.24 Biological conditions in the construction areas should be registered in a field survey in order to establish baseline conditions of local flora and fauna. This survey will also help determine whether additional mitigation or compensation measures are needed to protect natural interests. The survey should include a survey of flora and fauna, especially in rural areas, since these are potentially the most vulnerable areas along the entire investigation corridor.

9.25 Given the arid and urban nature of much of the environment surrounding the project areas, impacts on biological conditions are expected to be minor and transitory.
survey of this type may also help in identifying potentially larger unseen threats to the surrounding environment, such as unseen groundwater contamination.

9.26 This survey will be carried out by the ESO, utilizing any such existing surveys, and conducted on a quarterly basis, prior to and throughout the project cycle.

iii) Contamination of Groundwater

9.27 A program for the monitoring of pollution of selected groundwater sources will be established. Initially it is proposed to identify three or four smaller wells within the study area for monitoring purposes. The ESO, in consultation with the contractor, will specify the sites to be covered, with the estimated costs described in Annex 9.1 to this section.

9.28 The wells should be the subject of a quarterly monitoring program, preferably starting at least three months before construction activities occur, and located in the immediate areas of influence. This will allow pre-project baseline conditions to be established. Possible changes in yield and quality of these groundwater extraction points should be observed during the period of excavation works.

9.29 The monitoring program will also address surface waters in wadis, as well as the water extracted from nearby well fields, which might potentially be contaminated by construction activities. Testing performed at the well fields should be done in close collaboration with NWSA and NWRA, in order to ensure that past and current testing is included in the results.

9.30 Water quality measurements should comprise the expected significant waste water contaminants from housing and industry, including heavy metals, persistent organic compounds, nitrogen compounds, mineral oil compounds, phosphate, and chloride, as outlined in Table 9.7. The analysis should refer to the existing Yemeni and WHO standards and guidelines to establish acceptable standards.
Table 9.7: Project Monitoring Program

<table>
<thead>
<tr>
<th>Environmental Components</th>
<th>Indicator Parameters</th>
<th>Frequency</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater and well Quality</td>
<td>Coliform Count, Organic compounds, Ammonium Nitrate, Heavy Metals, Phosphate, Total nitrogen, pH, Chloride, Volatile Organic Compounds (VOC), Mineral Oil Compounds, Total Hardness</td>
<td>Quarterly</td>
<td>Five selected wells (three located within the study area and two downstream of the WWTP), and selected groundwater sources.</td>
</tr>
<tr>
<td>Water Depth</td>
<td></td>
<td>Quarterly</td>
<td></td>
</tr>
</tbody>
</table>

iv) **Soil Conditions**

9.31 As a supplement to the above, prior to construction a number of test samples should also be carried out to determine baseline conditions, and to establish the potential nature and severity of the contamination of soils in which the contractors staff will work. The soils should be tested for:

- Microbiological contamination (mainly pathogens)
- Soil acidity and chemical contamination.

9.32 Five sites should be tested per quarter during the construction phase, with all sites also sampled prior to the mobilization of construction works.

v) **Loading of Treatment Facilities**

9.33 A program for the monitoring of the interim treatment facility in Al Qaida will also be established. Sampling will take place every two months, with three random sampling events taking place per annum. Sludge disposal attributable to the project will also be monitored on a quarterly basis, in order to ensure that this sludge is being disposed of properly. The ESO will work with NWSA personnel, to ensure that any analysis they make is also available as part of the monitoring program. In this context, there is still a justifiable need within the project framework to:

- ensure that waste loads during the initial phases of the project do not overwhelm the works undergoing construction in Al Qaida.
- ensure that the wastes discharged and re-utilized meet the national standards.
9.34 Monitoring will be made according to the following schedule:

Table 9.8: Project Monitoring Program

<table>
<thead>
<tr>
<th>Environmental Components</th>
<th>Indicator Parameters</th>
<th>Frequency</th>
<th>Location</th>
</tr>
</thead>
</table>
| WWTP Influent and Effluent | - BOD₅  
- Suspended Solids  
- pH  
- Nematodes  
- Volume in m³/day sent for treatment | Monthly.  
Plus 3 Random samples / annum after known shock loading | At WWTP’s inlet and outlet sumps |
| WWTP Sludge Disposal | - Tons disposed of properly | Quarterly |          |

vi) Site Inspections

9.35 Regular and frequent site inspections will be required to permit the ESO to monitor the performance of the contractor, and at a later date system operators, with regard to compliance with the stipulations contained in this EMP and the EIA.

9.36 Site inspections should be carried out on a regular basis but not necessarily to a structured pattern. However during construction, as a minimum, the program outlined in Table 9.9 should be observed.

9.37 To facilitate inspections, a checklist of items to be considered similar to that provided in Appendix D shall be drawn up. The checklist should be distributed to all parties concerned with construction, which should also receive a briefing by the ESO prior to initiation of construction works.

Table 9.9: Frequency of Site Inspections during the Construction Phase

<table>
<thead>
<tr>
<th>Principal Activity</th>
<th>No. of Inspections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site opening</td>
<td>Minimum 2 per month</td>
</tr>
<tr>
<td>Trenches / pipe laying</td>
<td>3 per quarter</td>
</tr>
<tr>
<td>General Activity</td>
<td>3 per quarter</td>
</tr>
<tr>
<td>Camp/ Maintenance Facility / Pre- Fabrication Yard</td>
<td>2 per year</td>
</tr>
<tr>
<td>Borrow sites</td>
<td>1 per year</td>
</tr>
<tr>
<td>WWTP</td>
<td>2 per site, per year</td>
</tr>
<tr>
<td>Pre-existing Facilities (excl. WWTP)</td>
<td>3 inspections (total) per year</td>
</tr>
</tbody>
</table>
C. Semi-Annual Environmental Review

i) Objectives

9.38 The environmental review process provides an assessment of the project, environmental management activities and the effectiveness of the system in fulfilling GOY environmental policy. In implementing the review schemes, project areas perceived as having the highest environmental risk are stressed. The review program has the responsibility to:

- examine compliance with regulatory requirements
- examine line management systems, plant operations, monitoring practices etc.
- identify current and potential environmental problems especially during the operational phase of the project
- check the predictions in the EIA and assure the implementations and application of recommended practices and procedures.
- make recommendations for the improvement of the management system of the operation.

ii) Frequency

9.39 The reviews should be performed every six months, during annual IDA supervision missions, and six months later, with reports generated one month later. The reporting schedule is outlined in Table 9.2.

iii) Implementation

9.40 All reviews will be performed by the SO, with assistance from World Bank project supervision personnel (ToR for the environmental aspects of IDA supervision missions are in Appendix E). The content of each review should reflect contain all elements of the EMP, plus any new issues brought up during public consultations, or found during the monitoring program. Construction monitoring reports and results of the sampling programs should be included in the review.

9.41 A $50 materials cost is estimated, per review.

D. Public Consultation

9.42 The public consultation and awareness program comprises three components: (i) public meetings; (ii) newspaper and television articles and programs; and (iii) household surveys. Meetings organized by the ESO will be held semi-annually before and during the construction period, coinciding with IDA supervision missions whenever possible. Feedback elicited during these meetings will be used by the ESO in the semi-annual Environmental Reports. In this way, any necessary changes to the mitigation plan will be incorporated.

E. Malaria Abatement Program

9.43 As described in Section 8.5, a Malaria Abatement Program will be implemented under the Project. The program will be designed prior to the commencement of
construction works, such that program design is able to influence design and construction decisions.

9.44 Costs for the implementation and monitoring of this program are covered under the Taiz EMP. The ESO will be responsible for the implementation of this program, in coordination with local and national malaria and health officials. The ESO will also be responsible for the hiring and supervision of any specialized personnel required for the implementation of this program.

F. Additional Project Requirements

i) NGO Involvement

9.45 It is also important that, wherever possible, the project helps develop the capacity of NGOs. At this stage, as with all projects, it is difficult to define NGOs that could be directly supported in the program. It will be the responsibility of the PIU and the ESO to identify and encourage NGO involvement.

ii) Health Clinic

9.46 As part of the project it may be necessary to establish a health clinic (within an existing facility) dealing with populations from affected areas. Clinics should be established in cases where project construction is taking place in areas that are not readily served by local health facilities.

9.47 Determination of this need will be the responsibility of the contractor, with guidance from the ESO. Implementation and monitoring will be done by the ESO and the PIU, in coordination with local health officials. Potential costs for the clinic are US$8,600; details for which can be found in Table 9.16 of Annex 9.1.

iii) Potential Additional Costs to the Contractor

9.48 Table 9.17 in Annex 9.1 represents costs that will be directly incurred by the contractor during project implementation, in order to conform to the Environmental Management Plan. Some of these costs (such as those for water storage) may not be necessary, but project funds will be made available for these purposes, if and when they occur.

9.5 Mitigation and Monitoring during Operation

9.49 After the decision for the final technical design has been made, a more detailed EIA must be elaborated, which more fully quantifies any unavoidable environmental impacts of the project. For these impacts, compensation measures (e.g. replanting of trees, etc.) must be developed. These compensation measures may begin during the construction phase, but should be completed by the beginning of the operations phase. The results of the implementation of the compensation measures should be monitored by the ESO and local environmental protection authorities, in order to ensure that the original goals of these measures have been met, and to correct false developments.

9.50 The results of the Public Consultation Program, the Malaria Abatement Program and the Sludge and Wastewater Re-use Study will be critical components of these compensation measures.
### 9.6 Annex 9.1: Detailed Cost Tables

#### Table 9.10: Establishment of Baseline Conditions for Monitoring Program

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sites per Event</th>
<th>Days per Event</th>
<th>Events</th>
<th>Unit Rate YR</th>
<th>Total Cost YR</th>
<th>Total Cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesspit waste liquid testing</td>
<td>4</td>
<td>0.25</td>
<td>4</td>
<td>7,000</td>
<td>28,000</td>
<td>200</td>
</tr>
<tr>
<td>Soil testing</td>
<td>4</td>
<td>0.25</td>
<td>6</td>
<td>7,000</td>
<td>42,000</td>
<td>300</td>
</tr>
<tr>
<td>Dust</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>25,200</td>
<td>25,200</td>
<td>180</td>
</tr>
<tr>
<td>Noise</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>25,200</td>
<td>25,200</td>
<td>180</td>
</tr>
<tr>
<td>Ground-water</td>
<td>5</td>
<td>0.5</td>
<td>6</td>
<td>7,000</td>
<td>105,000</td>
<td>750</td>
</tr>
</tbody>
</table>

#### Table 9.11: Random Sampling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No. of Sites</th>
<th>Samples/da per event</th>
<th>Days per Event</th>
<th>Events per yr.</th>
<th>Unit Rate YR</th>
<th>Total Cost YR</th>
<th>Total Cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>?</td>
<td>25,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>?</td>
<td>25,200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Complaint based only

#### Table 9.12: Operations Phase: Phase 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No. of Sites</th>
<th>Samples per site/event</th>
<th>Events per yr.</th>
<th>Unit Rate YR**</th>
<th>Total Cost YR</th>
<th>Total Cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater &amp; wells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>7,000</td>
<td>70,000</td>
<td>5</td>
</tr>
<tr>
<td>Micro-biological</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>7,000</td>
<td>70,000</td>
<td>5</td>
</tr>
<tr>
<td>WWTP*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>7,000</td>
<td>21,000</td>
<td>3</td>
</tr>
<tr>
<td>Micro-biological</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>7,000</td>
<td>21,000</td>
<td>3</td>
</tr>
</tbody>
</table>

*Influent and effluent

**Rate per day. Each event has ½ day duration.

---

27 Annual costs
Table 9.13: Additional Sampling Costs, US$\textsuperscript{24}

<table>
<thead>
<tr>
<th>Program Element</th>
<th>Item</th>
<th>Unit</th>
<th>Quantity per yr</th>
<th>Unit Rate ($)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesspit content samples</td>
<td>Slurry sample</td>
<td>Test</td>
<td>4</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Sludge sample</td>
<td></td>
<td>4</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Sub Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Soil samples</td>
<td>Soil samples</td>
<td>Test</td>
<td>6</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>700</strong></td>
</tr>
</tbody>
</table>

Table 9.14: Summary of Construction Monitoring Costs, US$

<table>
<thead>
<tr>
<th>Item</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust</td>
<td>0</td>
</tr>
<tr>
<td>Noise</td>
<td>0</td>
</tr>
<tr>
<td>WWTP</td>
<td>1,800</td>
</tr>
<tr>
<td>Groundwater</td>
<td>3,000</td>
</tr>
<tr>
<td>Cesspits</td>
<td>1,200</td>
</tr>
<tr>
<td>Soil</td>
<td>900</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,900</strong></td>
</tr>
</tbody>
</table>

Table 9.15: Summary of Public Consultation Costs, US$

<table>
<thead>
<tr>
<th>Item</th>
<th>Total</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio, TV, Newspaper</td>
<td>140</td>
<td>As necessary</td>
</tr>
<tr>
<td>Public Meetings</td>
<td>360</td>
<td>2 per year</td>
</tr>
</tbody>
</table>
Table 9.16: Potential Costs of Clinic

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost, US$</th>
<th>Costs Breakdown</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic</td>
<td>0</td>
<td>Building provided by Government Dept.</td>
<td>Replicated for all project areas</td>
</tr>
<tr>
<td></td>
<td>3,000</td>
<td>Nurse: 1 x 6 months x $500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,600</td>
<td>Physician: 0.3 x 6 months x $2000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,000</td>
<td>Medicines lump sum</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,600</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9.17: Potential Additional Costs to the Contractor

<table>
<thead>
<tr>
<th>Phase / Issue</th>
<th>Cost, US$</th>
<th>Costs Breakdown</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off Site Works</td>
<td>10,000</td>
<td>Lump Sum</td>
<td>For all contracts</td>
</tr>
<tr>
<td>Additional costs for water storage and provision</td>
<td>2,500</td>
<td>Lump Sum</td>
<td>For all contracts</td>
</tr>
<tr>
<td>Sanitation Projects</td>
<td>25,000</td>
<td>Lump Sum</td>
<td>For all contracts</td>
</tr>
<tr>
<td>Tanker waters to site. Fill only at approved sites</td>
<td>25,000</td>
<td>Lump Sum</td>
<td>For all contracts</td>
</tr>
<tr>
<td>Possible additional costs in use of a dedicated unit(s) only.</td>
<td>25,000</td>
<td>Lump Sum</td>
<td>For all contracts</td>
</tr>
</tbody>
</table>

28 It is assumed that the project facility will be housed within an existing government clinic or equivalent. All costs are for staff and other consumables. These are listed as separate costs because of the need for project specific training in reporting and recording and the dissemination of information.
10. Literature:

- http://www-x.nzz.ch/format/broadcasts/broad_14.htm
To: Mr. Alex McPhail  
The World Bank  
Washington DC  

Subject: Proposed Urban Water Project (IDA Ref: P057602)  
Environmental Impact Assessment for Al-Qaidah  

Dear Mr. McPail,

We are pleased to forward the Final Draft of the Environmental Impact Assessment (EIA) for the City of Al-Qaidah (dated December, 2002), that has been prepared by the Government of Yemen with the assistance of Dorsch/Gitac Consultant.

We would like to inform you that a copy of this report would be available for public inspection in the following locations in Yemen:

Ministry of Electricity and Water  
Sana'a  
Water & Environment Center (WEC) in Sana’a University  
Sana’a  
Environment Protection Authority (EPA)  
Sana’a  
World Bank Resident Mission  
Sana’a  
Al-Saad for Culture and Sciences Library  
Taiz  
Environmental Center in Taiz University  
Taiz  
Taiz Water and Sanitation Local Corporation  
Taiz  
Al-Qaidah Water and Sanitation Branch  
Al-Qaidah  

In addition, I authorize this draft to be placed in the World Bank InfoShop in Washington DC, where it can be made available for public inspection.

Sincerely,

Eng. Yahya Ali Al-Ali
Minister of Electricity and Water