المملكة الاردنية الهاشمية

The Hashemite Kingdom of Jordan

MINISTRY OF WATER & IRRIGATION



# Environmental and Social Assessment
# Disi-Mudawarra to Amman Water Conveyance System

## Main Report – Part C: Project Specific Environmental & Social Assessment

*Volume 1 of 2*

*June 2004*

consolidated consultants
engineering & environment

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| | |
|---|---|
| ARICAD | Arab International Company for Agricultural Development |
| ASEZ | Aqaba Special Economic Zone |
| ASEZA | Aqaba Special Economic Zone Authority |
| a.s.l | Above Sea Level |
| BOO | Build, Own, Operate |
| BOOT | Build, Own, Operate, Transfer |
| BOT | Build, Operate, Transfer |
| CC | Consolidated Consultants Engineering and Environment |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CMS | Conservation of Migratory Species |
| CRM | Cultural Resources Management |
| CSCs | Common Services Councils |
| DADP | Disi Area Development Plan |
| DAI | Development Alternatives, Inc. |
| DEHC | Department of Environment and Health Control |
| DOA | Department of Antiquities |
| DOS | Department of Statistics |
| Dunum | A dunum represents 1,000 $m^2$ (1 Dunum = 0.1 hectare) |
| EA | Environmental Assessment |
| EC | Electrical Conductivity (expressed in µS/cm) |
| EIA | Environmental Impact Assessment |
| EIRR | Economic Internal Rate of Return |
| EPC | Executive Privatisation Commission |
| EPL | Environment Protection Law |
| ERC | Electricity Regulatory Commission |
| ESA | Environmental and Social Assessment |
| ESMP | Environmental and Social Management Plan |
| ESSD | Environmental and Socially Sustainable Development |
| EU | European Union |

| | |
|---|---|
| FAO | Food and Agriculture Organization |
| FOE | Friends of Environment |
| GCEP | Government Corporation for Environment Protection |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GOJ | Government of Jordan |
| GRAMECO | Grains, Fodders and Meat Production Company |
| GTZ | German Agency for Technical Cooperation |
| ha | Hectares (1 ha = 10 dunums) |
| IBAs | Important Bird Areas |
| IRR | Internal Rate of Return |
| IT | Information Technology |
| JACA | Jordan Aqua Conservation Association |
| JD | Jordanian Dinars (1 JD = 1.41 US Dollars; 1 JD = 1.16 Euros) |
| JES | Jordan Environment Society |
| JIB | Jordan Investment Board |
| JISM | Jordan Institute for Standards and Metrology |
| JREDS | Jordan Royal Ecological Diving Society |
| JUST | Jordan University of Science and Technology |
| JVA | Jordan Valley Authority |
| KAC | King Abdallah Canal |
| KTDR | King Talal Dam Reservoir |
| l/c/d | Litres per Capita per Day |
| LEMA | Lyonnaise des Eaux, Montgomery Watson Arabtech Jardaneh - a private operator |
| MCM | Million Cubic Meters |
| MEMR | Ministry of Energy and Mineral Resources |
| MMA | Ministry of Municipal Affairs |
| MOA | Ministry of Agriculture |
| MOE | Ministry of Environment |
| MOH | Ministry of Health |

| | |
|---|---|
| MOP | Ministry of Planning |
| MOT | Ministry of Tourism |
| MPWH | Ministry of Public Works and Housing |
| MSS | Marine Science Station |
| MWI | Ministry of Water and Irrigation |
| NES | National Environmental Strategy |
| NGO | Non-Governmental Organization |
| NPV | Net Present Value |
| NRA | National Resources Authority |
| O&M | Operation and Maintenance |
| OMS | Operation and Management Support project |
| PC | Project Company |
| PMU | Project Management Unit |
| ppm | Parts Per Million |
| QACU | Quality Assurance and Compliance Unit |
| RO | Reverse Osmosis |
| RSCN | Royal Society for Conservation of Nature |
| RSS | Royal Scientific Society |
| SCBA | Social Cost Benefit Analysis |
| SCS | US Soil Conservation Service |
| SOP | Standard Operating Procedures |
| sp./spp. | Specie(s) |
| SWWTP | As-Samra Wastewater Treatment Plant |
| TRC | Telecommunication Regulatory Commission |
| TOR | Terms of Reference |
| TSP | Total Suspended Solids |
| UFW | Unaccounted for Water |
| USAID | United States Agency for International Development |
| USD | US Dollars (1 USD = 0.709 JD; 1 USD = 0.83 Euros) |

| | |
|---|---|
| WADICO | Al Wafa for Agricultural and Animal Development |
| WAJ | Water Authority of Jordan |
| WERSC | Water and Environment Research and Study Centre |
| WHO | World Health Organization |

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# MAIN REPORT – PART C
# PROJECT-SPECIFIC ESA

# MAIN REPORT – PART C: PROJECT-SPECIFIC ESA

## 1 INTRODUCTION

The proposed Disi-Mudawarra to Amman Water Conveyance System is being undertaken by the Ministry of Water and Irrigation (MWI) of the Hashemite Kingdom of Jordan. The development and implementation of this project pose a range of significant environmental and social issues since it will be based on the use of a non-renewable fossil groundwater aquifer and require changes in the existing patterns of water use. While justified under the unique water resources management situation in Jordan, such a development was subjected to a detailed environmental and social impact study that allows decision makers and stakeholders to understand the potential impacts at the sectoral and project specific levels over the short-, medium-, and long-term.

### 1.1 Background

Jordan is known for its scarce water resources. Throughout history, the people in Jordan have suffered from water shortages due to the semi-arid climate that is associated with limited annual rainfall. Over the past few decades, the problem was enormous due to high natural population growth, rural to urban migration and major influxes of population in response to political and economic crises in the Middle East. These trends have resulted in increased demand from domestic and industrial users.

The main water resources in Jordan are groundwater sources, surface water resources and treated wastewater effluent. The variability in the surface water resources left no choice but the use of groundwater resources to cover part of the shortage.

The total renewable safe yield of the groundwater resources in the whole of Jordan is 277 MCM/year, which does not include the Disi aquifer as this is a non-renewable source. Although extraction from these sources exceeded this safe yield by more than 200 MCM/year in recent years, Water Authority of Jordan (WAJ) was unable to meet the substantially increasing demand. The declining per capita water availability in Jordan, the limited storage capacity and projected future water deficits are presented in **Section 3** of the Main Report - Par B.

Continuation of this overexploitation of groundwater sources at these high levels will lead to mining these sources as well as deteriorating the quality of abstracted water, which will lead at the end to an extensive damage of the aquifers. Therefore, the Ministry of Water and Irrigation (MWI) and WAJ laid out planning strategies for utilising water resources to ensure optimum use in conjunction with municipal demands. The water resources strategy included existing and potential sources. Investment programs were developed to implement new projects such as water harvesting, dams and rehabilitation and restructuring water systems to minimize the unaccounted for water (UFW). Concentration was made on demand management and public awareness programmes. New sources were identified to relief the existing groundwater source and allow the natural recharge of these sources and to restore their water quality which shall relief part of water shortage in Greater Amman area.

One of the major water demand centres is Greater Amman area. The water supply in the area has been outstripped by the demand and rationing program was implemented by WAJ during the summer months since 1988. This situation is deteriorating each year by the increase of demand and therefore, MWI had to consider the option of implementing the Disi Project by conveying water from the southern part of Jordan to Amman.

The contract for preparation of the feasibility study and preliminary design for the Water Conveyance System from Disi-Mudawarra to Amman was awarded by MWI to Harza Group. The feasibility study and preliminary design were submitted to the Ministry in 1996 and the detailed design and tender documents in 1997. An optimisation of the design was later awarded to Brown and Root North Africa who submitted their report in 2001.

The Disi Aquifer, also known as Rum aquifer system, is a transboundary aquifer that extends from south of Jordan into Saudi Arabia where it is known as Saq Aquifer System. However, both the Rum and the Saq actually form one aquifer system with the larger portion located within Saudi Arabia. Generally, the groundwater flows from the Saudi Arabia in the south towards north east Jordan and in Central Jordan it deviates to north west and lastly towards west where it discharges its water in the Dead Sea and in the deep wadis draining the eastern highlands towards the Rift Valley.

## 1.2 Project Objectives

The main objective of this project is to supply additional high quality water to Greater Amman region from the deep fossil Disi Aquifer by conveying the water a distance of approximately 325 km from Amman. For a number of years water has been outstripped by demand in the Greater Amman Region and MWI has no option but to implement a water rationing program during the summer months. This situation has been ongoing since 1988, and is becoming more complex each year as water demand in this area increases. The provision of this reliable additional water supply would provide an opportunity for Jordanian authorities to reduce groundwater abstractions in the Greater Amman Region and allow for partial restoration of renewable resources in this region.

The project has also a secondary objective and that is to provide five emergency turnouts from the conveyance pipeline that will run from the water well field in the south of Jordan due north to the south of Amman. These turnouts will be located at key locations to ensure reliable water supply to secondary urban areas along the pipeline under emergency conditions and for short durations.

## 1.3 Organization of the ESA Study

The ESA process has consisted of the following main preparation activities:

- Consultation and Communication Program
- Three Rapid Diagnostic Field Reports
- Annotated Outline of the ESA Study - Parts A, B, and C
- Preliminary Draft ESA Main Report - Parts A, B, and C
- Draft ESA Reports - Executive Summary and Parts A, B, and C
- Final ESA Reports - Executive Summary and Parts A, B, and C

The Consultation and Communication Program was prepared in the planning phase of the ESA study. This program provided the framework of principles and approaches for the communications of social and environmental concerns and information to diverse audiences. It is planned for the study team and the proponent to respond to public concerns about exposure to social and environmental impacts and risks. The overall advantage of this communication program is to ensure that the anticipated adverse impacts and risks can be effectively mitigated.

The purpose of this program is to ensure the involvement of the best available information, experience and knowledge within the local and national community in the assessment. Local communities' communication and active public participation is an important tool in the ESA and in the implementation of the project-specific environmental and social management. This tool ensures that the proposed project messages are constructively formulated, transmitted, and received and that they result in meaningful feed back by the recipient, this would result achieving the following:

- Better understanding and appreciation of target groups to the proposed project conditions and benefits.
- Project communications more credible by local communities and affected populations.
- Community participation in helping and making choices to develop suitable and acceptable avoidance/mitigation scenarios.

Also, early at the beginning of this study the Consultant conducted rapid diagnostic assessment for both biological and archaeological settings within the project corridor, this preliminary assessment served as the basis for the impacts assessment of the project-specific impacts on biological, archaeological and cultural heritage resources, and as a framework of requirements to be reviewed by the MWI and considered for the Build-Operate-Transfer (BOT) terms of reference and for other parties involved in the project. The three submitted Rapid Diagnostic Reports are as follows:

1- Social, Resettlement and Land Acquisition Issues in Abu Alanda to the airport highway water pipeline segment: This report investigated in a diagnostic manner four main tasks of the TOR in order to verify available data and to design and conduct relevant surveys and investigations that might lead to proper analysis of each task.
2- Ecological Issues in the areas close the Wadi Rum Protected Area: This revised the previous designs, updated information on previously conducted assessments and considered new areas, which were recently proved to be of great ecological values, and are important for the survival of threatened species or containing characteristic and unique communities. It addressed the current ecological status of the project alignment. It also indicated the hot spots identified along the proposed alignment.
3- Archaeological and Historic Issues in the northern and southern water pipeline segments: This diagnostic report provided a diagnosis of the main archaeological and cultural heritage sites and issues along the project locations of all facilities related to the pipeline.

The Annotated outline consisted of the full table of contents used for the ESA in each of Parts A, B and C.

The Final Report is the sixth and the final of the required technical reports and its purpose is to provide the complete details of all work performed, analyses made, and justification of options and recommendations proposed. This report builds upon the reports completed previously and the comments raised by MWI. The Final Report is submitted in five separate sections which comprise the executive summary and the three parts of the study. These sections are as follows:

- **Executive Summary** which is prepared in both Arabic and English languages.
- **Main Report- Part A** which presents an overview of the Disi-Mudwarra to Amman Water Conveyance System project. More specifically, this section of the study addresses the following issues:
    - Policy, Legal and Administrative Framework in Jordan
    - Applicable World Bank Policies

    - Description of the Proposed Project
- **Main Report- Part B** which is the Water Sector Environmental and Social Assessment. It provides a full picture of the water shortage problem in Jordan and the steps taken to reduce this shortage by development of local sources. More specifically, Part B addresses the following issues:
    - Water resources trends and water balance
    - Water policies and trends
    - Water sector management structure
    - Improvements in water use efficiency and conservations
    - Use of economic incentives
    - Environmental and social challenges in the water sector in Jordan
- **Main Report- Part C (Volumes 1, 2 and Maps)** which is the Project Specific Environmental and Social Assessment. Volume 1 of Part C is the main report and Volume 2 includes annexes referred to within Volume 1 except for **Annex C5** which is included in the document referred to as Maps. Main Report- Part C assesses the project-specific environmental and social concerns with regard to the following major subjects:
    - Physical Environment
    - Biological Environment
    - Agricultural Resources
    - Social Settings
    - Archaeological and Cultural Heritage Sites

Each of these sections stands alone so that it can be reviewed separately from the rest of the report's sections.

## 1.4 Description of Parts A, B and C of the ESA Study

**Main Report: Part A - Overview** addresses the policy, legal and administrative framework in Jordan. It focuses mainly on the institutional and legislative framework related to the institutions involved in the management and monitoring of the environment in Jordan, the institutions concerned with legislation and regulation of the sector, and the institutions tasked with enforcing these, with a view to determine the status of the legal and institutional context and to assess the environmental management capacity of the Kingdom, in particular those of relevance to the project. Also, this section highlight salient features of Jordan's environmental management capacity, in particular factors that affect the implementation of the project. It also addresses the set of policies and procedures that guide the operations of the World Bank and that are set out in the Bank's Operational Manual and indicates what safeguard policies are applicable to the proposed project.

**Main Report: Part B - Water Sector Assessment** of the Environmental and Social Assessment Study for the Disi project provides a full description of the background context against which the Disi project will be implemented. More specifically, this section:

1- Places the project and related activities in the context of the broader series of short-, medium- and long-term actions; and
2- Describes the evolving water policy framework in Jordan from 1997 – 2002, the analysis of alternative development scenarios for the water sector, the specific and cumulative impacts and measures to strengthen the water sector.

In achieving those objectives, Part B addresses the following:

- Water resources trends and water balance;
- Water policies and trends;
- Water sector management structure;
- Improvements in water use efficiency and conservations;
- Use of economic incentives; and
- Environmental and social challenges in the water sector in Jordan.

**Main Report: Part C - The project specific ESA** assesses the project-specific environmental and social concerns with regard to the following major subjects:

1- Physical Environment
2- Biological Environment
3- Agricultural Resources
4- Social Settings
5- Archaeological and Cultural Heritage Sites

The assessment process is based on the findings from site investigations, field surveys, consulting affected populations and groups, literature review, and pin pointing sensitive habitat and archaeological sites.

The ESA encompasses analysis and documentation of the existing baseline conditions with regard to the assessed subject areas within the project corridor. Also, the analysis includes evaluation of the alternatives to the proposed project including the “No action” alternative and alternatives to the development of the well field, alignment of the pipeline, and sitting of supporting facilities.

The direct and indirect zones of effect were identified and potential impacts were assessed and quantified whenever possible. The impacts were found to be either temporary or permanent in nature. Cumulative impacts were also evaluated and suitable mitigation and management programs were suggested.

To uphold the governmental environmental policy, a planning phase to identify the shape and framework of the Environmental and Social Management Plan (ESMP) has been completed during the environmental and social assessment phase. The ESMP is structured as follows:

1- Rational and Justification
2- Planning and Framework of the ESMP
3- Environment and Social Management Plan (ESMP)
4- ESMP Control
5- Implementation and Operation
6- Checking and Corrective Action
7- Management Review

## 1.5 Relationship between Parts A, B and C of the ESA Study

The relationships between Parts A, B and C of the ESA Study are recognized in order to understand their inter linkages.

As discussed in the TOR, the proposed project's development and implementation present a range of significant environmental and social issues since it will be based on use of a non-renewable fossil groundwater and require changes in the existing patterns of water use. This was discussed in "Part B-Water Sector Assessment" and the reflection was considered in "Part C-Project Specific Environmental and Social Assessment" with the help of "Part A-Overview" that presented the legal and institutional tools. Under the unique water resources management situation in Jordan, this development is subjected to detailed environmental and social impact studies to allow decision makers and stakeholders to understand the potential impacts at the sectoral and project specific levels. The Environmental and Social Management Plan (ESMP) in Part C provides the proposed framework for mitigation, monitoring, and institutional development actions, as investigated in Part A, to be integrated into the design and implementation of the project. It also provides a sense of the present and future implications on the water sector in Jordan. **Figure 1** presents a schematic diagram for the general links between the three parts of the ESA study.

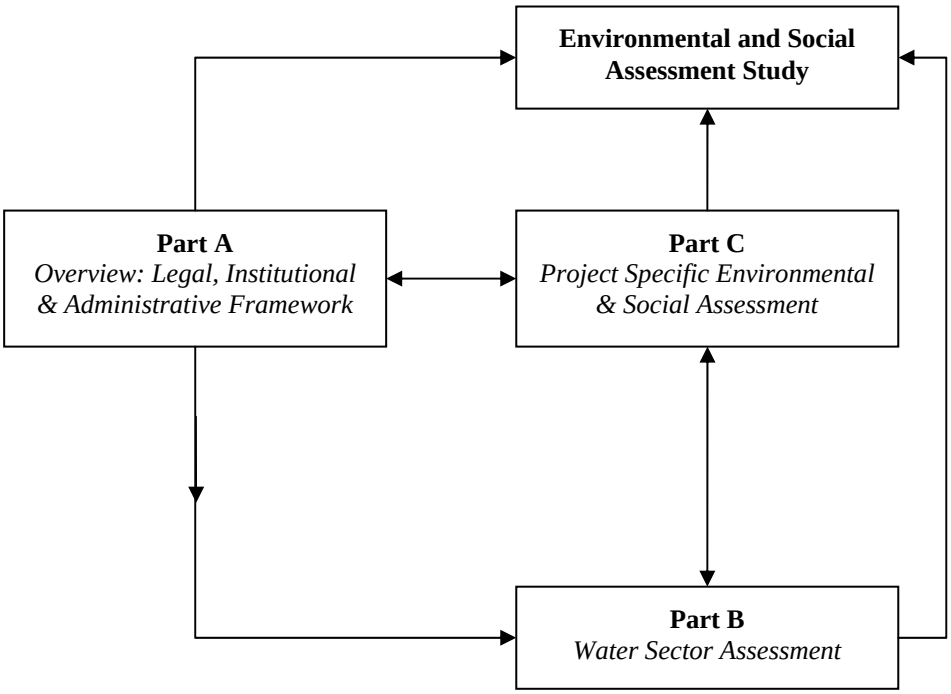



**Figure 1: Schematic diagram linking the three parts of the ESA study**

## 1.6 Consultations during the ESA Study

Public consultation is a powerful tool to ensure the involvement of potentially affected groups and national capacities in the decision-making process with regard to the environmental and social aspects of their concern. The consultations allow the participation of stakeholders so as to identify social and environmental concerns at the beginning of the ESA process. Also it is considered as an important tool for informing and educating the public in order to enhance their understanding and appreciation to the following:

- The need and nature of the proposed development;
- The need to protect and properly manage our environment;
- The potential impacts of the project on the environmental, socio-economical and archaeological settings; and
- The public role in protecting their local environment.

During the course of the ESA development, a set of communication and consultation activities have been conducted in order to ensure that the stakeholders' views, issues of concern, foreseen impacts and worries are taken into consideration while assessing the project related impacts. It is anticipated that the construction of the Disi-Mudawrra to Amman Water Conveyance System will profoundly affect all the current and future social changes of the population in the project area and to a large extent the natural and the built-up environment as well as the status of water resources in Jordan. For elaborating on the social and environmental assessment study, it was decided that two-way discussions of substantive issues must be held with stakeholders from national and local governmental organizations and interested individual citizens. Hence, the Government and the Consultant have undertaken a two phase consultation process; the first phase was when the study was started and the second when the draft ESA was ready.

For the first phase of public consultation, under the auspices of the Ministry of Water and Irrigation, two scoping sessions were held on March 27$^{th}$ and April 3$^{rd}$ 2003 in Amman and Aqaba, respectively. Both sessions have been attended by a wide spectrum of government, national and NGO's representatives during which background materials on the project have been distributed and discussed by all parties concerned. Scoping sessions identified substantive issues of specific concern and feedback comments and views were collected and classified. These discussions were very helpful in disseminating all necessary information to the public. The outcome of these sessions indicated unanimous support to the project.

In addition to the public consultation, the Consultant started the consultation process with direct interviews with the Governors and Mayors in the five Governorates of the south in addition to other stakeholders in the region. The objectives of the project as well as the conveyance system alignment and the direct and indirect benefits to the population in the area have been extensively presented. Comments and views of the Governors have been recorded and presented in the procedures to be taken to achieve the study purposes. All views were in fact very constructive and in favour of the project as a major indispensable water project. For a record of the interview statements, refer to **Annex C1: Record of Interviews**.

As for the second phase of public consultation, the sessions aimed at presenting to the project-affected groups the findings of the Draft Environmental and Social Assessment (ESA) Study and the relevant ESA material. Hence, under the auspices of the Ministry of Water and Irrigation, three second phase of public consultation sessions were held on November 13$^{th}$, 18$^{th}$ and 20$^{th}$ in Abu Alanda, Amman and Aqaba, respectively. The sessions have been attended by a wide spectrum of government, national and NGO's representatives during which Arabic and English summaries of the ESA study were distributed and discussed by all parties concerned. The outcome of these sessions was helpful in pinpointing several issues that needed to be highlighted in the final study.

The following two sub-sections present a summary of the significant issues identified during the first and second phases of public consultations.

### 1.6.1 First Phase of Public Consultation

For elaborating on the environmental and social impacts associated with the project as well as on the status of water resources in Jordan in the assessment study, the Consultant held two scoping sessions - one in Amman and one in Aqaba. Amman scoping session was held on March 27th, 2003 and targeted population of Amman and Madaba areas. The Aqaba scoping session was held on April 3rd, 2003 and hosted the target population of Disi, Aqaba, Tafileh and Ma'an. The aim of having two scoping sessions was to insure that the community representatives of the areas influenced by the Disi-Mudawarra to Amman water conveyance project would have the chance to participate in the scoping sessions.

Of the 87 invitees to Amman scoping session, 53 attended the consultation and of the 61 invitees to Aqaba scoping session 38 attended. Those attendees represented various stakeholders including ministries and governmental authorities, international organizations, non-governmental organizations, universities, community representatives and private sector.

The environmental and social issues that need to be assessed were identified from the results of the scoping activities. This was mainly through the focus group discussions, scoping session questionnaire results and the issues raised during the questions and comments. The issues identified as significant and to be addressed in the Environmental and Social Assessment Study are presented in **Table 1**. For a complete record of the public consultation sessions, refer to **Annex C2: Scoping Statement and Record of Public Consultation**.

**Table 1: Significant issues identified in the public consultation sessions**

| Assessed Component | Significant Issues |
|---|---|
| Water Resources | • Justification of the project need; and<br>• Contribution of the Disi project to Jordan's water budget and other alternatives considered for facing the water shortage problem. |
| A-biotic Environment | • Potential impact of noise on nearby local communities and workers at the project construction site at Segment C of the project and at Segments A and C of the project during operation phase due to the pump stations.<br>• Potential impact of increased dust levels in all segments of the project area only during the construction phase. The concern is mainly for:<br>  • Public safety for workers and local communities; and<br>  • Nearby farms in the project and nearby areas.<br>• Change in the geomorphological system of the Segment A area to a large extent.<br>• Fluid and Solid wastes resulting from the construction phase at all three segments of the project, including:<br>  • Cutting and demolition wastes;<br>  • Construction material wastes;<br>  • Oil and grease residues; and<br>  • Human wastes of the workers.<br>• Tectonic activity in the Segment A area and its impact on the project during both construction and operation phases.<br>• Increase in traffic during construction phase along the three segments of the project area due to vehicles related to the project especially heavy vehicles and the traffic problems associated with them.<br>• Opening temporary access roads haphazardly in order to reach to the construction sites at Segment A.<br>• Potential impact on soil stability at Segment C of the project area.<br>• Potential impact on air quality during the construction phase and along the three segments of the project with consideration to effects of silica and vehicles emissions.<br>• Public safety for the workers and the local communities at all segment of the project during the construction phase.<br>• Transportation from Aqaba Port and the need to coordinate with the Port Institute. |
| Biotic Environment | • Destruction of vegetative cover (especially acacia at Batn El-Ghoul area).<br>• Increase in hunting of flora, fauna and birds by the workers on the project.<br>• Hunting of the Oryx that will be reintroduced and of the Ghazal by the workers on the project construction.<br>• Accumulation of solid waste.<br>• Disturbance of natural habitats (Hammad, Sand Dunes, Qeea'an, and wadis).<br>• Potential impact on important bird areas and important natural habitats. |
| Agricultural Resources | • Impacts of the increase in dust levels on the farms within Segment A of the project area.<br>• Sustainability of agricultural activities in the Disi area in terms of cost return, economical value and social value.<br>• Reduction of soil fertility due to new imported soil in the area extending from Jiza to Amman.<br>• Reduction of the agricultural areas or removing olive trees along the conveyor route. |

**Table 1: Significant issues identified in the public consultation sessions (contd.)**

| Assessed Component | Significant Issues |
|---|---|
| Social Component | • Allocation of percentage of required labour for the local residents alongside the pipeline and in Disi.<br>• Consideration of the rules for public safety during digging and construction by coordinating efforts with the Ministry of Public Works and Housing, the Municipality of Greater Amman, and the Department of Traffic.<br>• Launching public awareness campaign explaining the benefits of the project before and during work.<br>• Compensation for damage incurred to commercial institutions (especially at Qatraneh, Al-Jiza, and Abu Alanda).<br>• Studying of the available services (especially high voltage lines and towers bases) and obstacles at the path of the pipeline before offering tender for the project.<br>• Keeping away from cross-roads as much as possible.<br>• Coordination with the various service establishments.<br>• Improvement of public health due to improvement of the water quality which is a positive impact.<br>• Disruption of traffic movement for residents and large vehicles. This impact is expected to be along the Desert Highway and the last third of the conveyor route.<br>• Public health and safety considerations during the construction phase.<br>• Indigenous people (Badia area and the tribes available there).<br>• Coordination with the army in order to identify possible mine areas along the route of the conveyor. |
| Archaeological and Cultural Heritage | • Impact on archaeological sites at Segment C mainly the Cave of Seven sleepers and the Khirbet Es-Suq Mausoleum. |

### 1.6.2 Second Phase of Public Consultation

The second phase of public consultation aimed at presenting to project-affected groups the findings of the Environmental and Social Assessment (ESA) Study in terms of both the Water Sector ESA and the Project Specific ESA. Three second phase consultation sessions were held in Abu-Alanda, Amman and Aqaba, consecutively. Abu-Alanda second consultation session targeted the areas of Abu-Alanda, Khirbet Es-Suq, and El-Quesmeh whereas Amman session targeted Amman, Madaba and Al Jiza areas. Aqaba consultation session hosted the target population of Disi, Aqaba, Tafileh, Ma'an and Alqatraneh areas.

In Amman, 93 people were invited; however, 48 attended from several ministries, universities, non-governmental organizations (NGOs) and companies. In Aqaba, 49 people were invited but 28 attended. As for Abu-Alanda, invitations were done by door-to-door visits to randomly selected residences and commercial shops along the portion of the conveyor route passing through the areas of Abu-Alanda, Khirbet Es-Suq, and El-Quesmeh.

The participants in all the areas commented on the various aspects of the project and the likely areas of impact. The significant comments are summarized as follows.

- Contractor compliance to proper procedures of implementation and construction.
- Issue of holes being dug and left open for a long time without any protection and without providing access roads to pass at places where these holes interrupt entrance into commercial shops along the road.
- Issue of damaging utilities and interrupting the services provided by those utilities.
- Concern that at the end of the construction the Contractor does not restore the streets back to their original conditions.

- The alternative sources of water for the Disi people since the Disi water is nonrenewable.
- Whether the Disi project will lead to a change in the water tariff.
- The effect of the project on the Cave of Seven Sleepers area, the Mosque and the people in the area.
- The need to have coordination between the Ministry of Water and Irrigation and the Ministry of Public Works and Housing regarding the route of the Disi Conveyor.
- The environmental and psychological impacts on the local people in the Disi area because of the termination of contracts for agricultural farms and the consequent loss of work opportunities.
- Providing training for locals from Disi area in order to employ them in the operation of the Disi project.
- To have the wells, pumping stations and any other project structure that is visible within the boundaries of the Rum Reserve designed to be in harmony with their surrounding environment especially that the area is a touristic one.
- The long term benefits of the Disi project.
- The right of the Disi people to have drinking water and give the organizations the right to dig alternative wells for small agricultural activities and livestock.
- The effect of the project on the quality of the Disi water.
- Measures that will be adopted by the Ministry of Water and Irrigation to ensure that the Contractor conforms to the environmental and social management plan.

For a complete record of the public consultation sessions, refer to **Annex C3: Draft ESA and Record of Public Consultation.**

## 1.7 ESA Disclosure

A complete copy of the Environmental and Social Assessment Study will be disclosed at the following locations:

- Ministry of Water and Irrigation
- Ministry of Environment
- Aqaba Special Economic Zone

The Executive Summary in both Arabic and English would be made available at a number of locations in Jordan. These locations were selected in coordination with the Ministry of Water and Irrigation and are summarised below:

- Ministry of Public Works and Housing
- Ministry of Health
- Ministry of Municipal Affairs
- Ministry of Agriculture
- Royal Society for Conservation of Nature
- Department of Antiquities
- Governorates of Karak, Tafileh, Ma’an and Madaba

The complete Disclosure list is provided in **Annex C4**- Part C of the Main Report. The Government will also provide a copy of the Environmental and Social Assessment to the World

Bank under a cover letter that authorizes the Bank to disclose these documents to its Board of Executive Directors and at the InfoShop in Washington, D.C. The World Bank will be provided with both printed and electronic copies of the document for this purpose.

## 1.8 Maps to Support Environmental and Social Management Plan

The developed Environmental and Social Management Plan (ESMP) is supported with maps produced at a scale of 1:25,000 to show the route of the conveyor and affected areas as well as proposed mitigation measures (see **Table 2**). These are included in Part C of the Main Report. The ESMP is also supported by GIS maps elaborated with a set of topographical maps and satellite imageries. This system is prepared to present the project-specific sensitive environmental, social and archaeological settings identified within the project direct and indirect zone of effect. The presented sensitive sites are linked to information sheets listing the anticipated impacts, proposed mitigation measures and monitoring programs.

It should be noted that only one biological hot spot is shown on the maps of scale 1:25000 as the remaining biological hot spots are outside the project corridor and the drawing boundary. However, all the biological hot spots are shown on the GIS maps.

The GIS base maps are reproducible and printable to facilitate maximum usability by users and adaptability to any change in the plans and/or environmental and social conditions. GIS maps are provided on three CD-ROMs included in **Annex C5**. The contents of these CDs are as follows:

- CD-1: GIS base maps and satellite images
- CD-2: Part 1-Topographical maps scale 1:25,000
- CD-3: Part 2-Topographical maps scale 1:25,000

A list of the available maps along with their respective locations is presented in **Table 2**. Copies of the base maps showing the conveyor route and hot spots are included in **Annex C5**.

**Table 2: List of project related maps**

| Map Number | Map Description | Scale |
|---|---|---|
| Drawing No. (001) | From Station (0+000) to Station (6+000) | 1/25,000 |
| Drawing No. (002) | From Station (6+000) to Station (22+000) | |
| Drawing No. (003) | From Station (22+000) to Station (36+000) | |
| Drawing No. (004) | From Station (36+000) to Station (50+000) | |
| Drawing No. (005) | From Station (50+000) to Station (65+000) | |
| Drawing No. (006) | From Station (65+000) to Station (79+000) | |
| Drawing No. (007) | From Station (79+000) to Station (93+000) | |
| Drawing No. (008) | From Station (93+000) to Station (107+000) | |
| Drawing No. (009) | From Station (107+000) to Station (126+000) | |
| Drawing No. (010) | From Station (126+000) to Station (143+000) | |
| Drawing No. (011) | From Station (143+000) to Station (151+000) | |
| Drawing No. (012) | From Station (151+000) to Station (174+000) | |
| Drawing No. (013) | From Station (174+000) to Station (188+000) | |
| Drawing No. (014) | From Station (188+000) to Station (204+000) | |
| Drawing No. (015) | From Station (204+000) to Station (219+000) | |
| Drawing No. (016) | From Station (219+000) to Station (233+000) | |
| Drawing No. (017) | From Station (233+000) to Station (250+000) | |
| Drawing No. (018) | From Station (251+000) to Station (266+000) | |
| Drawing No. (019) | From Station (266+000) to Station (282+675.731) | |
| Map C1 | The locations of archaeological sites within Segments B and C | Not to scale |

# 2 PROPOSED PROJECT

Rapid population increase in the main cities of Amman, Zarqa and Irbid has placed unprecedented demands on water resources. Total demand is approaching one billion cubic meters per year, which approximates the limits of Jordan's renewable and economically developable water resources. Current demands in many areas particularly in Amman have not been met satisfactorily and the costs of developing new water resources are rising rapidly. Although the water sector has been given high priority in all socio-economic development plans since early 1970's, the situation was complicated by the turmoil in the region and the compulsory migration to Jordan from other Arab Countries.

Disi is a fossil water aquifer extending from the southern edge of the Dead Sea in Jordan to Tabuk area in the Saudi Arabia. Wide exploitation of the Jordanian part of the aquifer started in 1980. At present Aqaba city is provided with 16.5 MCM for domestic purposes. Agriculture is consuming 75 MCM. The binding agreement between the Government of Jordan and the four agricultural companies working in the area indicated that growing water abstraction from Disi aquifer should not exceed 91 MCM per annum. This agreement will be terminated in 2011. Extensive hydro-geological studies carried out by the MWI indicated that additional 100-120 MCM can be drawn to Amman to elevate pressure on renewable ground water resources in the region.

Economic and technical feasibility studies of the project have been extensively studied by Harza Group in 1998 including three alignment alternatives. The pipeline alignment has been re-evaluated by Brown and Root in 2002 and readjusted in 2003 to avoid as far as possible private land acquisition. Capital and operation and maintenance costs have also been reconsidered in the light of new pricing schedule. The newly adjusted design will in most part of the project follow the alignment of the desert highway from Disi to Amman.

## 2.1 Origin and Scope

The Disi-Mudawarra to Amman Water Conveyance System project has been conceived by the Water Authority of the Ministry of Water and Irrigation of the Hashemite Kingdom of Jordan. The main objective of the project is to convey additional water to Greater Amman Area from the Disi aquifer, to meet the urgent municipal requirements.

The Disi project is important and of priority because it provides a reliable source of high quality water that is essential to cover part of the freshwater gap in Jordan’s supply-demand balancing process. At the same time it would not close the country’s growing water gap which requires additional resources to be imported to the country.

The Disi water will form the major portion of the extra water that is planned to partially replace the low quality groundwater consumed domestically in Amman. This issue is of high importance when considering that all the produced wastewater in Amman is directed towards the biggest treatment plant in Jordan As-Samra plant. This in turn will help in upgrading the quality of the treated wastewater, which is stored in King Talal Reservoir and used to fill to some extent the irrigation water urgent needs in Middle Jordan Valley.

This project will be executed on a Build, Operate, Transfer (BOT) basis. The Contractor will own and operate the project for a duration of 40 years after which the ownership of the project will be transferred to the Government of Jordan who will then continue to operate the project. However, in the BOT contract, the source of water is not specified to be the Disi Aquifer. The Conveyor is designed for a life-time that exceeds 50 years, but the Government of Jordan has kept its right to

stop the use of Disi water at any time during those 40 years and use the Conveyor to convey desalinated water from Red Sea at Aqaba. This means that the Disi aquifer will be used until a desalinization plant at Aqaba City becomes feasible. Afterwards, the Disi conveyor will be used to convey desalinated water and thus can be considered as a "Southern National Carrier" for Jordan.

## 2.2 Location

Jordan is located within the eastern margins of the Mediterranean climatic zone of the eastern Mediterranean. However, much of Jordan can be classified as semi-desert, with only the western high lands enjoying a Mediterranean climate.

In the highlands, the climate is relatively temperate. In the desert the temperature may reach more than 40 °C. In the Jordan Valley, wadi Araba and Aqaba region the temperature may rise to 45 °C in summer, while in winter the temperature in those areas falls to few degrees above zero.

Over 95% of the land area in Jordan has an annual rainfall of less than 200 mm, while only about 2% has more than 350 mm/year rainfall. Snowfall most frequently occurs on the higher hills. The potential evaporation rates range from about 1,600mm/year in the extreme north-western edges in Jordan to more than 4,000 mm/year in the Aqaba and Azraq areas.

Within the project area, the geology is of sedimentary origin, ranging in age from Cambrian to Recent. The lower part of the sedimentary succession comprises mainly sandstones of Paleozoic and lower Mesozoic age and is represented by three differentiated geological groups locally known by the names "Rum, Khreim and Kurnub Groups", while the upper part is mainly composed of limestones, marls and cherts of upper Mesozoic and Cenozoic age and represented by two differentiated geological groups, named locally as "Balqa and Ajloun Groups". The project area passes through two major geological zones. These are the Sandstone of south Jordan and the limestone plateau. The major geomorphologic features include wadis, trough mountains and hills. The structural setting within the project area is represented by a series of intercalated fluting system in addition to another folding system.

The project area is the area between the Disi well fields and Greater Amman and comprises Governorates of Greater Amman, Madaba, Karak, Tafileh, Ma'an and Aqaba. The water will mainly be abstracted from the Dubaydib well field in the Disi-Mudawarra area south of Jordan and conveyed to Amman. The average abstraction from this well field will be 100 MCM/year. Due to in evitable seasonal variations in demands, the flow will be increased in summer to 120 MCM/year and reduced to 80 MCM/year in winter.

The length of the Disi-Mudawarra to Amman conveyor is 325 km. The original route of the conveyor was designed by Harza in 1997 to run adjacent to the main north-south highway with the conveyance pipeline situated within the right-of-way of the highway. A more feasible alternative route for the southern half of the conveyance was proposed by Brown and Root North Africa in 2001, where the pipeline bypasses Ma'an city through the desert and meets the original alignment just before Jurf Al Drawish. This new alignment will allow a conveyance of 150 MCM/year with minimum additional facilities in addition to a considerable reduction in the construction cost. The components of this new design are substantially the same as those in the original final design. **Figure 2** shows the optimised alignment of the conveyor to Amman.

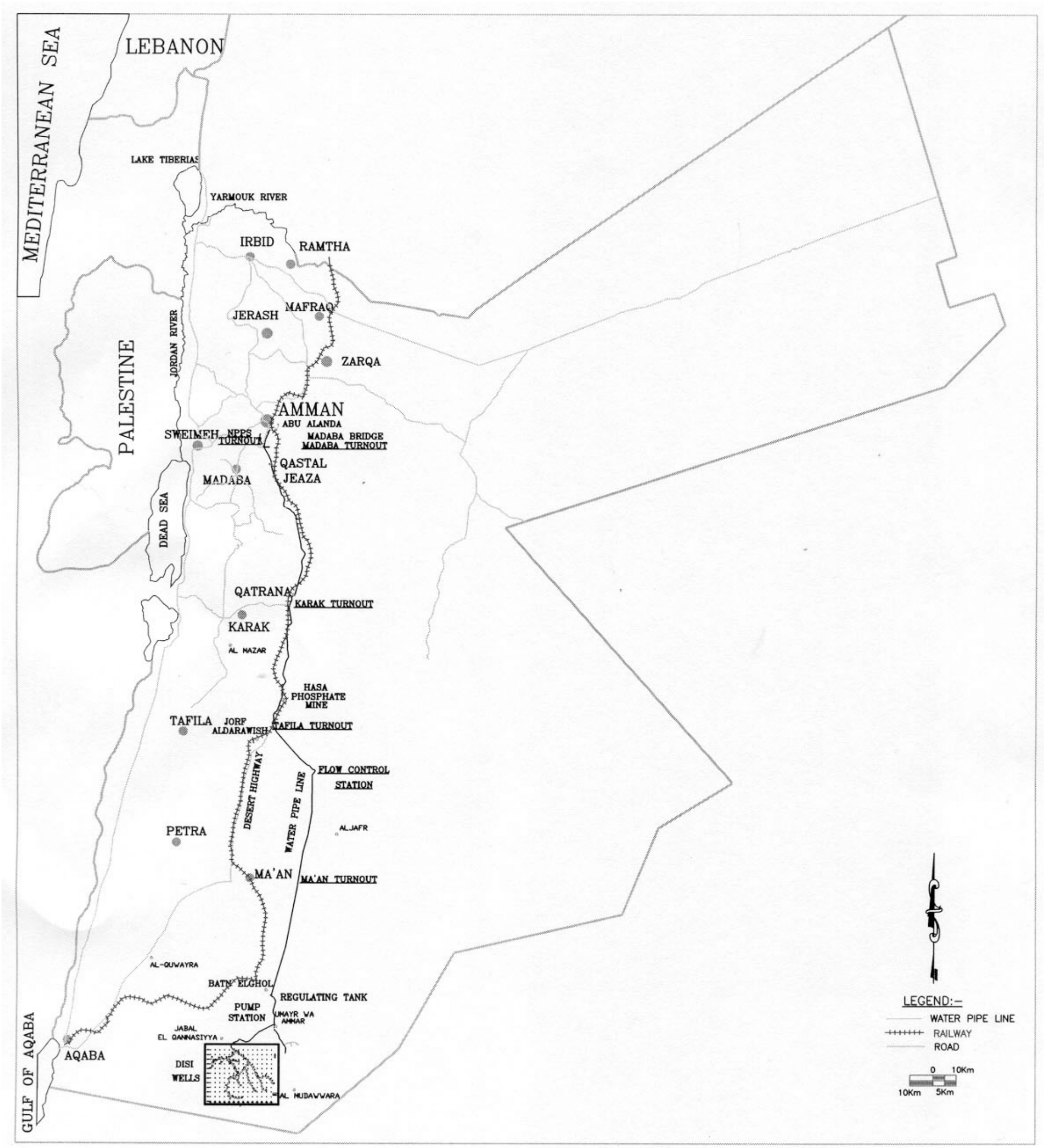



**Figure 2: Optimised alignment of the Disi-Mudawarra to Amman water conveyance system**

The southern well field is the promising source for water. The northern source is a standby which can be connected if the quantity dropped below the 100 MCM. This minimises the risk on Ministry of Water and Irrigation and its Guarantor and encourages participation of private sector in the BOT construction project.

## 2.3 Major Elements

The elements of the Disi project can be divided into the well field facilities and the conveyance facilities. These components are as follows:

- Major well field facilities:
    - Well-pump, riser and wellhead;
    - Power supplies and standby generation;
    - Control and communication facilities including associated instrumentation; and
    - Minor access roads.

- Major conveyance facilities:
    - Conveyance pipeline, appurtenances and access roads;
    - Railway, wadi and road crossings;
    - Collector reservoir/Balancing Tank and pump stations;
    - Regulating Tank;
    - Flow control station;
    - Fixed and mobile disinfection stations;
    - Power supplies, standby generation;
    - Control centres, accommodation, workshop and depot;
    - In-line booster station; and
    - Terminal Reservoir.

A total of 65 wells will be constructed in the Dubaydib well field to produce a flow rate of 120 MCM/year. It is expected that 55-60 wells will yield the required flow leaving a number of wells for standby/rotation. If production is to be increased to 150 MCM/year in the future, a total of 68 wells will be required but 80 wells are to be drilled to allow for rotation/standby or to supplement low yielding wells.

A pumping station near the well field raises the water from the well field to a regulating tank on a high point some 20 km north of the start point. The water is pumped from a collector reservoir downstream of the well field through a 1,800 mm diameter steel pipeline to the regulating tank in the vicinity of Batn El-Ghoul. The regulating tank at Batn El-Ghoul is designed to meet control requirements. The tank is also designed with internal baffle walls to ensure sufficient contact time for chlorination.

Turn-outs at Tafileh, Karak and Ma'an Governorates are emergency turn-outs recommended for operational flexibility as these three governorates currently have sufficient water supplies of suitable quality and reliability.

From the regulating tank, there is a gravity flow to a new reservoir at Abu-Alanda, southeast of Greater Amman. However, before reaching Abu-Alanda reservoir and at Madaba Bridge, the conveyor splits into two branches: the Dabuk and the Abu-Alanda branches. The Dabuk branch is an 1,000 mm diameter steel pipe that extends from Madaba Bridge to an existing pipe at National

Park Pump Station and then towards a newly constructed tank reservoir at Dabuk. The Abu-Alanda branch is a 1,600 mm diameter steel pipe that flows to an existing and new reservoir at Abu-Alanda.

From the regulating tank to the bifurcation point at Madaba Bridge, the water flows under gravity through a 2,000 mm diameter steel pipe. A flow control station is located about half way along the conveyance in the vicinity of Jurf Al Drawish. There are also a number of air valves and washouts to facilitate the draining and filling of the pipeline for maintenance purposes. This pipeline follows the route of the main highway from Aqaba to Amman and crosses the highway and the adjacent railway line at several locations. There are also a number of isolation valves along the pipeline.

The final design allowed for a flow of 80 MCM/year to the Abu-Alanda reservoirs at the same time as a flow of 40 MCM/year to Dabuk reservoir. At these flow rates, flow to Abu-Alanda is under gravity head from Batn El-Ghoul regulating reservoir but booster pumping is required to achieve the flow to Dabuk.

The conveyance flow is directed to the new Abu-Alanda reservoir which is 10 m lower than the existing reservoir. The higher reservoir will be supplied by small pumps located at Abu-Alanda. Flow to the new reservoir at Abu-Alanda will be by gravity from the regulating tank up to a total flow of 120 MCM. Booster pumping will be required on this branch if the conveyance flow is to be increased in the future.

At Abu-Alanda there is an existing concrete reservoir of 12,000 $m^3$ capacity with an inlet level of 999.45 m a.s.l. There is to be a new reservoir of 150,000 $m^3$ capacity in three separate tanks at a lower elevation of 983.6 to 989.1 m a.s.l.

To the south of Abu-Alanda, about a third of the flow is split and directed towards a new reservoir at Dabuk in the north west of Greater Amman. The Dabuk reservoir is higher than Abu-Alanda and the recommended scheme is to include booster pumping on this branch. There is a considerable variation in elevation between the regulating tank and the lowest elevations in the pipe route and, to reduce the required pressure rating of the conveyance in the northern part of the route, a flow control station is included. The flow control station has three control valves, each located between isolating valves, plus chlorination facilities, a standby generator and fuel tank, guard room and control/switch room. The valve room and controls are enclosed under an industrial type building.

The receiving reservoir at Dabuk is a newly commissioned 250,000 $m^3$ concrete reservoir in operation. This reservoir receives water at present from Deir ‘Alla source. This reservoir will store water from both the Disi scheme and the Deir ‘Alla schemes in the future.

To achieve lower head, astute control measures (i.e., a reduction in isolation valves and the introduction of an off-line pressure relief vent to be used when isolation of the downstream conveyance is achievable) will be used.

A summary about the key elements of the project is presented in **Table 3**.

**Table 3: Summary of the key elements of the project**

| **Components** | | |
|---|---|---|
| **Well Field Facilities** | **Number of Wells** | **Depth** |
| Dubaydib Well Field | 65 production wells (55-60 wells for production and the rest are standby) to produce a maximum flow of 120 MCM/year | About 800m |
| **Conveyance Facilities** | **Characteristics of Pipe** | **Remarks** |
| Main Conveyance Pipeline | 1,800-2,000 mm; Steel Pipeline | |
| Dabuk Branch | 1,000 mm; Steel Pipeline | A connection will be made from this pipe to the reservoir |
| Abu-Alanda Branch | 1,600 mm; Steel Pipeline | This will replace or twin the existing 600 mm steel pipe from National Park Pump Stations (NPPS) to Abu-Alanda |
| Southern Pump Stations | A total of four pumps with additional two pumps to act as a pair and one under maintenance. Each pump is designed to lift the supply through 160 m. | |
| Batn El-Ghoul Regulating Tank | Provide 6 hours storage; 2x42,000 $m^3$<br>Provides 3 to 4 hours emergency storage | |
| Jurf Al Drawish Flow Control Station | Three flow control valves, each located between isolating valves; plus chlorination facilities; standby generator & fuel tank; guard room and control/switch room | |
| Booster Pump Station on Dabuk Branch | | |
| **Reservoirs** | **Characteristics of Reservoirs** | **Remarks** |
| Dabuk Reservoir | 250,000 $m^3$; Concrete reservoir that is already in operation | |
| Abu-Alanda Reservoir | 12,000 $m^3$; Concrete reservoir | |

It is a well known fact that this fossil aquifer in Disi has a life span which extends in the best cases to 100 years; therefore the Government of Jordan laid plans that include the Disi Project as part of the framework of water management and development of new resources. The Disi water can fulfil part of the water shortage and is not the complete solution for the problem. Even with all the new sources, due to municipal demands being in excess of available water sources, by year 2015 Ministry of Water and Irrigation will have no choice but to find another new non-traditional source, this being desalination, i.e. from the Gulf of Aqaba, to not only meet local demands in Aqaba itself, but also to extend to the remainder of Jordan through either utilising this project water conveyance system and/or the proposed Red-Dead Sea Canal that will include provisions for desalinization of salt water.

Hence, there is a distinct possibility of expanding the role of the water conveyance system into becoming a genuine southern water main after its planning horizon, particularly if the pipeline were to be twinned at that stage. Any future proposals for deep sandstone demineralisation and as stated above, any future Aqaba desalination options would require conveyance to Amman. In both of these cases, the Disi conveyance system would be the obvious choice of conveyance. The Aqaba supply could be linked at the existing collector reservoir at Batn El-Ghoul. This would allow mixing of desalinated or demineralised water with Disi aquifer water to improve the water quality.

## 2.4 Project Segmentation

For the purpose of this Environmental and Social Assessment Study, the Consultant has divided the project area into three segments. These three segments are as follows:

- Segment A (Southern Part) which extends from the Well Field to Jurf Al Drawish - Qatraneh Junction (Desert Highway)
    - Segment A-1: from Disi wells to Batn El-Ghoul
    - Segment A-2: from Batn El-Ghoul to the cross point between Jurf Al-Drawish and the Desert Highway
- Segment B (Middle Segment) which extends from Jurf Al Drawish-Qatraneh Junction to the beginning of Al Jiza Area (South of Amman)
    - Segment B-1: from the cross point between Jurf Al-Drawish to the Qatraneh cross road
    - Segment B-2: from Qatraneh cross road to Al Jiza area
- Segment C (Northern Segment) which extends from Al Jiza to Dabuk and Abu-Alanda Reservoirs
    - Segment C-1: from Al Jiza to Airport bridge
    - Segment C-2: from Airport bridge to Abu-Alanda Reservoir
    - Segment C-3: from Airport bridge to Dabuk Reservoir

**Figure 3** represents those three segments.

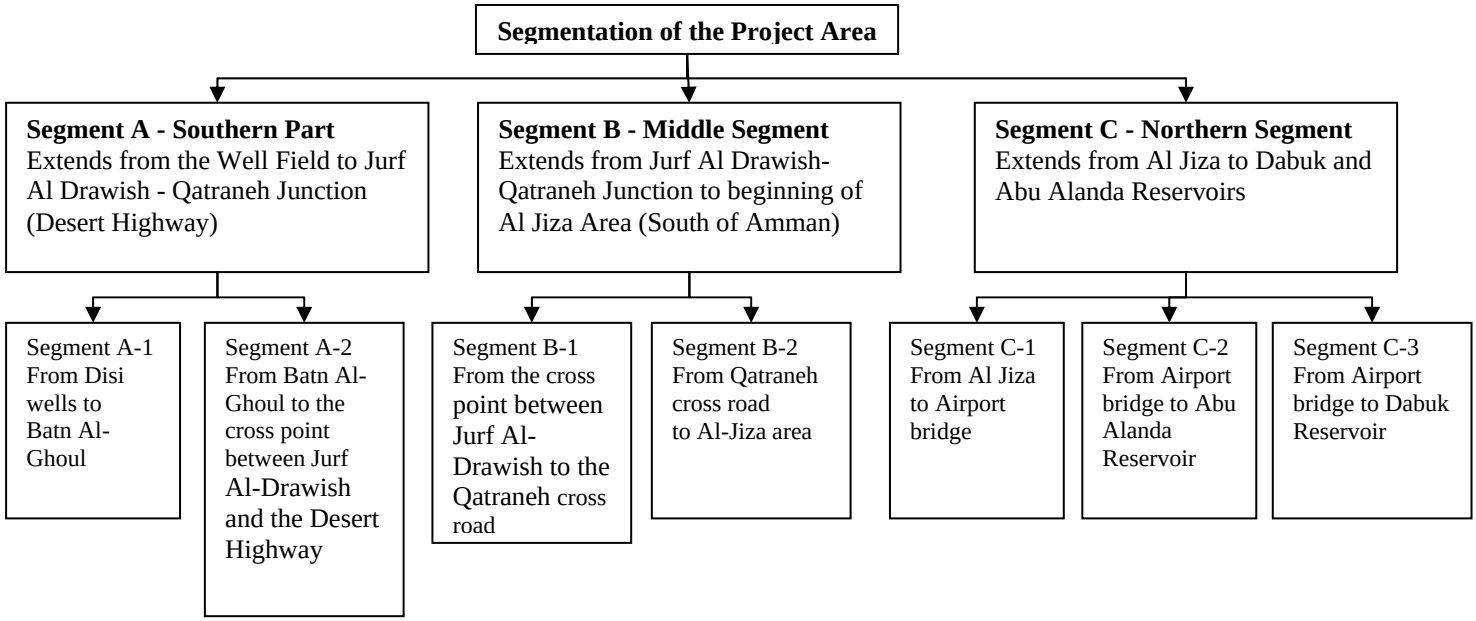



**Figure 3: Segmentation of the project area**

The ESA study defines the project's direct zone of effect to exist within a 50 m wide corridor along the conveyor alignment and around the well field. The indirect zone of effect is defined as the area within a 1,000 m wide corridor along the conveyor alignment and a 100 m wide boundary around the well field.

## 2.5 Construction and Operational Phases

### 2.5.1 Project Implementing Organization

The Disi Project will be constructed and operated by the private sector as BOT contract. The Ministry of Water and Irrigation (MWI) will be responsible for coordination and monitoring the construction and operational phases of the proposed project. MWI will employ a consultant to monitor various activities during construction as well as monitoring contactors implementation of identified mitigation measures under this study.

Since the conveyance system will pass through different cities along its alignment to Amman, it is essential to get the local government involved during the construction and operational phases. Their role will be to help the contactor in getting required local labour, approving required detours for the traffic if needed and assist in previous announcement of areas affected by construction.

### 2.5.2 Operation of the Project and Its Benefits

Local labour and technicians will be involved in the operation of the system. Training of employees will be part of the BOT contract to ensure that they can effectively operate and maintain the project once the BOT contract ends and final transfer takes place. The systems will be linked at it final destination to Abu-Alanda and Dabuk reservoirs feeding the water supply network in Amman. In addition there will be emergency turnouts along the route as mentioned earlier.

Several anticipated benefits have been identified for this new system including the following:

- Improving the quality of the supplied water to Amman;
- Relieving the over-abstracted aquifers by reducing pumping to their safe yield and allowing natural recharge to take place;
- Providing a reliable supply in Amman which enhances the implementation of the rationing program for distribution of water;
- Improving environmental health conditions especially in areas which are getting water less than what is required by any health standards;
- Improving the quality of the treated wastewater in As-Samra Wastewater Treatment plant which is directed toward the Jordan Valley and used for irrigation; and
- Providing and emergency supply to communities along the route.

# 3 ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

## 3.1 Environmental Baseline Conditions

### 3.1.1 Physical Environment

#### 3.1.1.1 Climate

Jordan is located within the eastern margins of the Mediterranean climatic zone of the eastern Mediterranean. Much of Jordan can be classified as semi-desert, with only the western high lands enjoying a Mediterranean climate. Climatologically, Jordan can be divided into four major zones[1]. These are:

- The Mediterranean Zone: This region is restricted to the highlands of Jordan.
- The Irano-Turanian Zone: In Jordan, this zone is transitional between the Mediterranean zone and the other zones and is represented by a narrow strip of variable width surrounding the entire Mediterranean zone except in the north of Jordan.
- The Eastern Desert Zone or "Saharo-Arabian" zone: This zone forms most of the territory of Jordan.
- Sudanian Zone or "Sub-tropical or Afro-tropical" zone: This zone extends from the Dead Sea area and continues to the south covering Wadi Araba area, the most southern parts of Jordan and end at the tip of the Gulf of Aqaba.

In the highlands, the climate is relatively temperate; cold and wet in the winter with temperatures reaching a few degrees below zero during night, to hot and dry in summer with temperatures reaching 35 ºC at noon and dropping at night to less than 20 ºC. In the desert, temperatures reach more than 40 ºC during summer and drop in winter to a few degrees above zero. Temperatures in the Jordan Valley, Wadi Araba and Aqaba region can rise to 45 ºC in summer, while in winter the temperature in those areas falls to a few degrees above zero.

Over 95% of the land area in Jordan has an annual rainfall of less than 200 mm, while only about 2% has more than 350 mm/year rainfall. Snowfall occurs occasionally in all parts of Jordan with the exception of Wadi Araba – Jordan Valley rift, and most frequently occurs on the higher hills.

The potential evaporation rates range from about 1,600 mm/year in the extreme north-western edges of Jordan to more than 4,000 mm/year in the Aqaba and Azraq area. The high evaporation potential all over the country makes precipitation especially in the eastern and southern parts of the country ineffective because the precipitated water readily evaporates, leaving soil deprived of their moisture content and hence, not allowing the development of plants.

Meteorological data collected from the main climatological stations along the proposed project corridor are presented in **Annex C6**.

#### 3.1.1.2 Geology, Geomorphology and Structure

The brief account of geology given here is derived largely from the maps and reports prepared by Bender (1968 and 1974) in addition to many reports prepared by the Natural Resources Authority (NRA) of Jordan.

[1] UNDP, The General Corporation for The Environment protection, 1998: Jordan Country Study on Biological Diversity.

Jordan can be divided into five physiographic regions, based on its general topography and geology:

- The Basement Complex area in the southern parts of Jordan close to the Aqaba city.
- The Sandstone area of southern Jordan.
- The Limestone Plateau in the highlands and interior deserts.
- The Basalt desert in the North-eastern Parts of Jordan.
- The Rift Valley, forming Jordan's western borders.

Within the project area, the geology is of sedimentary origin, ranging in age from Cambrian to Recent. The sedimentary succession is thick and ranges between 2,000 and 3,000 m formed mainly due to series of regional sea regression and transgression. The lower part of the sedimentary sequence comprises mainly of sandstones of Paleozoic and lower Mesozoic age, and is represented by three differentiated geological groups, known locally by the names "Rum, Khreim and Kurnub Groups". The upper part of this sequence is mainly composed of limestones, marls and cherts of upper Mesozoic and Cenozoic age, represented by two differentiated geological groups, named locally as "Balqa and Ajloun Groups". The project area is passing through two major geological zones, these are, the Sandstone of south Jordan and the Limestone plateau.

**(i) The Sandstone area of Southern Jordan:** The zone starting from Disi area, including the Disi well field, until Ras El-Naqab escarpment is located within the "Sandstone of South Jordan" zone that occupies an area of about 8,000 $km^2$ and overlies unconformable the Pre-Cambrian basement complex. This area is characterized by the extensive outcropping of the Sandstone geological groups, starting with the oldest, these groups are: Rum, Khreim and Kurnub. These groups are represented by thick, bedded, massive and friable sandstone varying in colour.

**(ii) The Limestone Plateau:** The area located between Ras al-Naqab and Amman city is located within the limestone Plateau, and dominated by extensive outcropping of the two carbonate sedimentary "Balqa and Ajloun Groups" geological groups. Commonly, these two groups are composed of hard limestone, with or without chert beds, and alternates with softer, more easily eroded layers, forming craggy outcrops in cultivated areas and stepped hill profiles in desert areas. They were deposited in near shore environments, lagoons and reefs at a time when a warm, shallow sea full of marine life covered the whole of the Middle East region. These beds are often fossiliferous containing shells and echinoids. In many cases, the limestone contain significant amounts of hard chert (or flint), which is less easily eroded than the limestone. In the highlands, it forms outcrops and ridges, whereas in the desert it often forms a remnant surface layer of shattered pieces on the desert surface. Stratigrahically, the Ajloun group is composed of two formations, while the Balqa group includes three formations. The Ajloun group is collectively referred to as the "A (1-7)" and the Balqa as the "B (1-4)".

The major geomorphologic features that can be identified along the proposed project corridor include wadis, toughs, hilly areas and mountains (see **Table 4**). The majority of these wadis display a classic centripetal drainage pattern, with all wadis draining from the western encircling highlands to the flat low areas in the east, especially to Al-Jinaiz trough near Al-Hasa area and to El-Jafer trough, which is the largest concave in Jordan.

**Table 4: Major geomorphologic features located "within /close to" the project corridor**[2]

| Feature | Remarks |
|---|---|
| **Wadi Systems (From the North to The South)** | |
| Wadi Wala | In Segment B |
| Wadi Mujb | In Segment B |
| Wadi Qatrana | In Segment B |
| Wadi Al-Hasa | In Segment B |
| Wadi Nijil | In Segment B |
| Wadi Arja | In Segment B |
| Wadi Jurdanah | In Segment B |
| Wadi Maan | In Segment B |
| Wadi Uqeiqa | In Segment B |
| Wadi Abu Tarfa | In Segment B |
| Batn El-Ghol | In Segment A, a very wide wadi |
| **Troughs** | |
| Qa el Jinz | In Segment B, South of Al-Hasa Mines |
| Qa El-Jafer | In Segment B, the Biggest trough in Jordan |
| Qa Al-Disi | In Segment A |
| **Mountains** | |
| Jabal El-Qannasiyya | In Segment A, northwest of the Disi well field |

The structural setting within the project area is represented by a group of intercalated fluting systems (trending North-South; East-West; Northwest-South east) and folding systems.

### 3.1.1.3 Surface Water, Groundwater, and Water Quality

### (a) Meteorology and Recharge Rainfall

This section presents the baseline data for meteorological condition of the Disi area. The aim is to furnish the hydrogeology section with the relevant data. The baseline data will be assembled, evaluated, and presented according to *Task 11* as stated in the TOR. All the meteorological data are listed in **Annex C7**.

**Table 5** presents ten rainfall stations at Disi area. Thiessen polygons were constructed in **Figure 4** to define the effective area for each rainfall station, which are outlined in **Table 5**. The rainfall for Disi area is calculated for the period 1991/1992 to 2001/2002 and presented in **Figure 5** as MCM rainfall over the Disi area. The average rainfall over Disi area is estimated by Thiessen Polygons at 26 mm per year, which is very low rainfall.

Disi rainfall is compared with Jordan rainfall in **Figure 5** and the match is clear. Isohyetal lines are drawn in **Figure 6** for Disi area and the average rainfall is estimated at 37 mm. The Isohyetal method is more accurate than the Thiessen Polygons method. Both values are low and the recharge could be very limited.

The renewable resource available from the Rum aquifer is a subject of debate. Recharge studies in arid zones in Jordan by Lloyd et al. (1966), and Caro and Eugleson (1981) have shown that no recharge by direct infiltration takes place when average annual rainfall is less than 200 mm. Calculations from published reports of annual infiltration into the aquifer vary from 0 (nil) to 20 mm per year, which could be very high according to average rainfall of 37 mm per year. This

[2] Japan International Cooperation Agency, 1990: Water Resources Study of The El-Jafer Basin-Draft Final Report.

corresponds to a maximum figure of 4 MCM per year direct recharge within the Jordanian section of the aquifer. Indirect recharge from runoff may provide a similar figure. Consequently, it may be concluded that a safe yield of not more than 10 MCM per year recharge occurs in the Jordanian sections of the Rum Aquifers.

**Table 5: Ten rainfall stations at Disi Area**

| Station ID | Station Name | Palestine North | Palestine East | Altitude (masl) | Rainfall (Av. mm) | Area ($m^2$) | Area (%) |
|---|---|---|---|---|---|---|---|
| ED0002 | RAS EN-NAQB | 935.0 | 197.0 | 1570.00 | 122.3 | 173,011,296 | 3.15 |
| ED0015 | FASSU'A ST. | 908.5 | 236.2 | 1150.00 | 20.6 | 594,481,523 | 10.81 |
| ED0016 | WADI RATMA | 915.0 | 193.0 | 900.00 | 30.3 | 434,342,155 | 7.90 |
| ED0017 | WADI NASIF | 902.0 | 209.0 | 850.00 | 16.1 | 432,423,105 | 7.86 |
| ED0018 | WADI MAS'ADA | 896.0 | 177.0 | 850.00 | 30.4 | 62,202,393 | 1.13 |
| ED0019 | WADI ARADA | 899.0 | 225.0 | 920.00 | 22.4 | 292,179,999 | 5.31 |
| ED0020 | QA'KHREIM | 882.0 | 220.0 | 830.00 | 17.3 | 2,283,857,072 | 41.52 |
| ED0021 | WADI SABIT | 872.0 | 173.0 | 850.00 | 29.1 | 57,096,474 | 1.04 |
| ED0022 | WADI MUQUR | 872.0 | 193.0 | 1000.00 | 42.6 | 768,644,308 | 13.97 |
| ED0023 | QA'EL-GHAL | 882.4 | 208.0 | 910.00 | 18.6 | 402,488,145 | 7.32 |
| Disi Area | | | | | 26.1 | 5,500,726,469 | 100.00 |

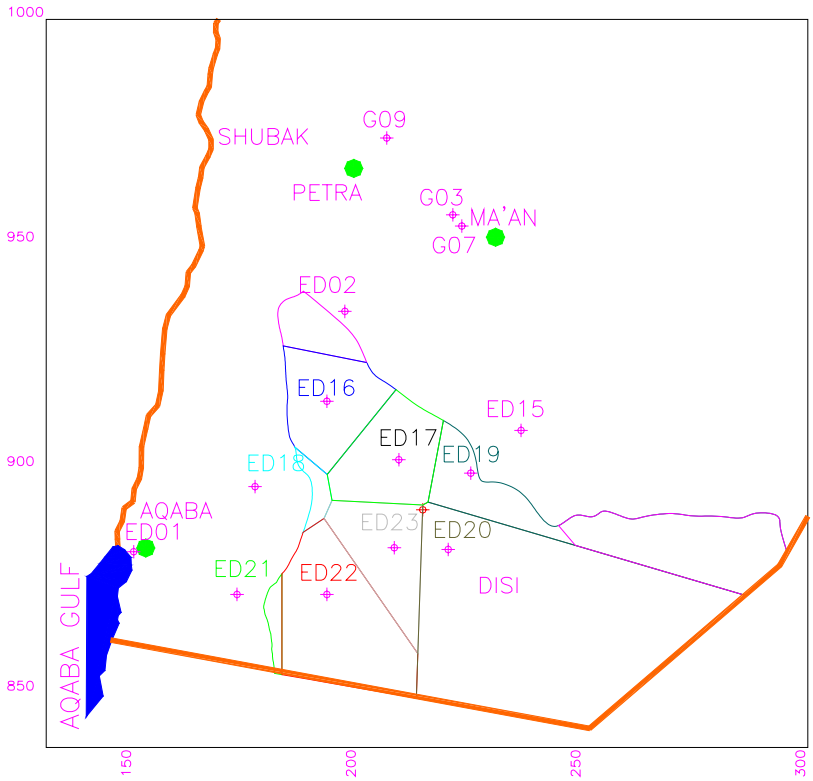



**Figure 4: Thiessen Polygons for Disi Area**

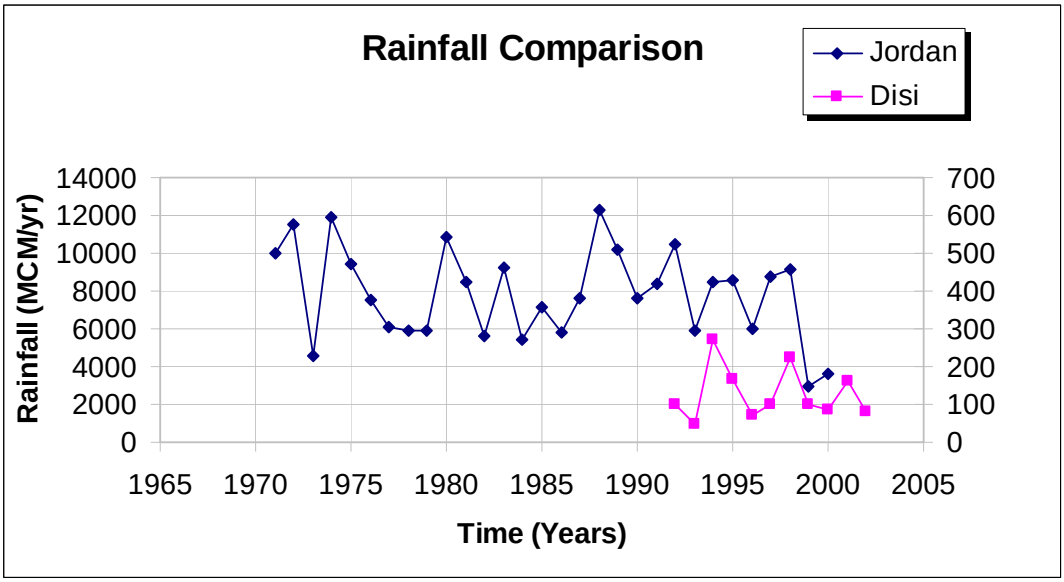



**Figure 5: Disi rainfall pattern compared with Jordan rainfall pattern**

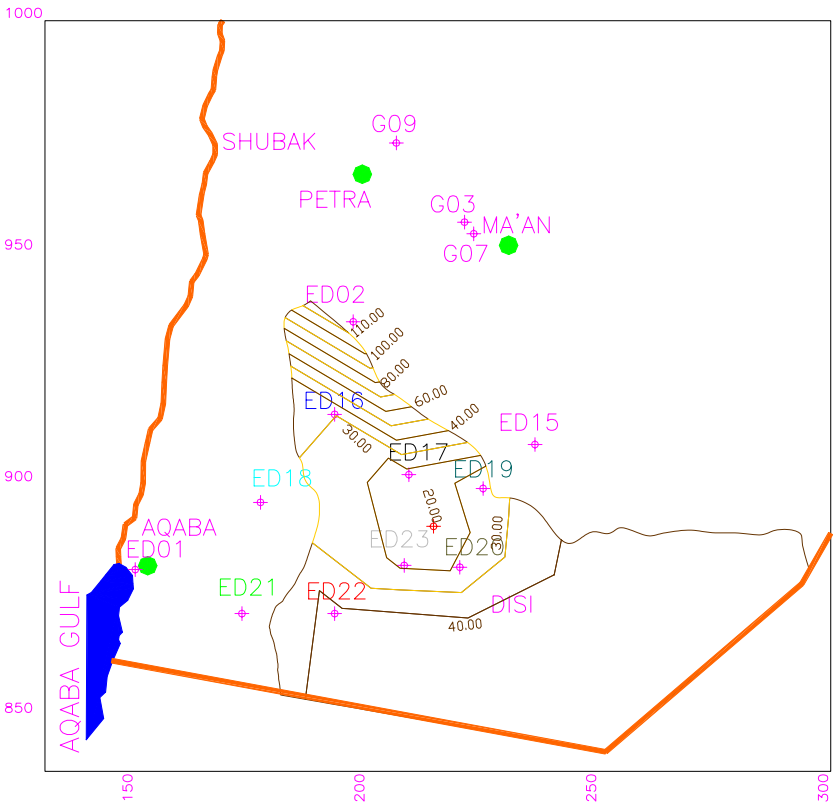



**Figure 6: Isohyetal lines for Disi rainfall**

## (b) Geology

Geological sections are presented for all related aquifers. Surface geology and geological sections were developed in order to analyse the related aquifers, such as:

- Disi Aquifers (Confined and Unconfined).
- Highland Aquifers.
- Azraq Aquifer.

This geological information is the baseline data, which will help the evaluation of impacts and the development of the mitigation measures. The related information are presented in **Section 4** of this report.

## (c) Surface Hydrology

The major wadis flanking the alignment were analysed and flood flow was estimated for each wadi. **Drawings 1** to **7** that show the catchment areas for these wadis are presented at the end of this sub-section. **Drawing 8** presents all catchments flanking the alignment with the route of Disi pipeline and the effective rainfall stations for each catchment (**Drawing 8** is also presented at the end of this sub-section). **Table 6** presents the main characteristics for the mentioned wadis together with the flood peak for return period of 10-year:

**Table 6: Main Characteristics of Wadis Flanking the Alignment**

| Wadi from North | | Station on Alignment (km) | Catchment Area ($km^2$) | Length of Wadi (km+m) | | Elevation (masl) | | Wadi Slope (%) | Peak Flow 10-Yr ($m^3/s$) |
|---|---|---|---|---|---|---|---|---|---|
| # | Name | | | Total | To Centroid | Divide | Outlet | | |
| 1 | Mujib and Wala-North | 0-200 | 422.002 | 34+661 | 14+685 | 900 | 750 | 0.56 | 132.331 |
| 2 | Qatrana | | 59.877 | 9+941 | 5+106 | 850 | 750 | 0.88 | 21.847 |
| 3 | Mujib and Wala-South | | 736.337 | 36+310 | 25+768 | 950 | 800 | 2.74 | 25.762 |
| 4 | Hasa | 15+900 | 115.981 | 10+497 | 7+498 | 900 | 800 | 0.19 | 3.965 |
| 5 | Abu Turfa et al. | 76+300 | 4033.623 | 73+868 | 31+291 | 1500 | 875 | 0.77 | 179.746 |
| 6 | Batn El-Ghoul | | 66.281 | 16+924 | 7+390 | 1100 | 900 | 1.19 | 1.666 |

The search for flood flow records in the Ministry of Water and Irrigation and the Jordan Valley Authority revealed that there are no data on the flood flows for the above wadis at the locations of crossing the alignment. The reason is that there is no flood flow recorders installed in these locations since there was no need for the record at such places before the Disi project. Since no measured flood flow data are available, synthetic hydrological techniques were adopted to get an estimate of the annual flood flow volume of all wadis.

The US Soil Conservation Service (SCS) unit hydrograph and the Alternating Block Method were used to arrive at an estimate of the peak flood rates; the 10-Year peak flood values were computed. The SCS was used to convert rainfall storms into floods. The following is a description of the method.

The Synthetic Unit-Hydrograph (UH) and Synthetic Storm Hyetograph were used to determine the flood flow for the catchment areas. There are many proposed formulae to follow, e.g. SCS and Snyder's methods which are known to be the most commonly used to derive a synthetic unit hydrograph. The SCS dimensionless UH is based on an extensive analysis of measured data.

The following equations are used to estimate the UH peak flow and time to peak:

$$q_p = \frac{2.083AR}{t_p}$$

$$t_p = \frac{D}{2} + 0.6t_c$$

$$D = 0.133t_c$$

$$t_p = 0.67t_c$$

where:

$q_p$ = Peak discharge ($m^3/s$).
$A$ = Area of drainage basin ($km^2$).
$R$ = Rainfall excess (1 cm for UH).
$t_p$ = Time to peak (hr).
2.083 = Peak attenuation factor with dimensions factor.
$D$ = Duration of rainfall excess (hr).
$t_c$ = Time of concentration (hr).

Snyder analysed a large number of hydrographs from basins in USA ranging in areas from 25 to 25000 $km^2$. On the basis of his study he proposed the following formulae in 1938:

$$q_p = \frac{C_p AR}{t_p}$$

$$t_p = C_t \left(LL_c\right)^{0.3}$$

$$t_r = t_p / 5.5$$

$$t'_p = t_p + \frac{t'_r - t_r}{4}$$

where:

$C_p$ = Coefficient ranging from 4 to 5 (higher values for a flash flood).
$C_t$ = Constant equal to 1.2 for mountainous areas, 0.72 for foothills and 0.35 for valley areas.
$L$ = Length of the main stream from outlet to divide (km).
$L_c$ = Distance from outlet to a point on stream nearest to the centroid of the basin (km).
$t_r$ = Rainfall standard duration (hr).
$t'_r$ = Modified standard duration (hr).
$t'_p$ = Basin lag after modification (hr).

Snyder's UH was of less peak flow and longer time to peak compared to the SCS Unit Hydrograph, therefore, SCS method is adopted for peak flow estimations, as shown in **Annex C8** for 10-Yr return period.

The Alternating Block method is a simple way of developing a design hyetograph from the Intensity-Duration-Frequency (IDF) curves. The design hyetograph produced by this method specifies the precipitation depth occurring in successive time intervals. For the 10-Yr return period, the intensity is calculated from the IDF formulae of the effective rainfall stations according to the effective percentage of each. The rainfall stations are presented in **Drawing 8**. The corresponding precipitation depth is found as the product of intensity and duration. The Soil Conservation Service (1972) developed a method for computing abstractions from storm rainfall as:

$$P_e = \frac{(P - I_a)^2}{P - I_a + S}$$

$$I_a = 0.2S$$

$$S = 25.4\left(\frac{1000}{\text{CN}} - 10\right)$$

Curve number (CN) of 75 is used for normal antecedent moisture conditions (AMC II) and hydrologic soil group C-D. The design storm hyetographs are presented in **Annex C8**. The unit hydrograph is applied to find the direct discharge for each return period. The discrete convolution equation is used to yield the direct runoff:

$$Q_n = \sum_{m=1}^{n \le M} P_{em} U_{n-m+1}$$

**Figure 7**, **Figure 8** and **Figure 9** show the unit hydrograph, the design storm hyetograph, and the flow hydrograph respectively, for part of Wadi Mujib and Wala-North at a return period of 10-Yr for the hyetograph and flow hydrograph, as an example.

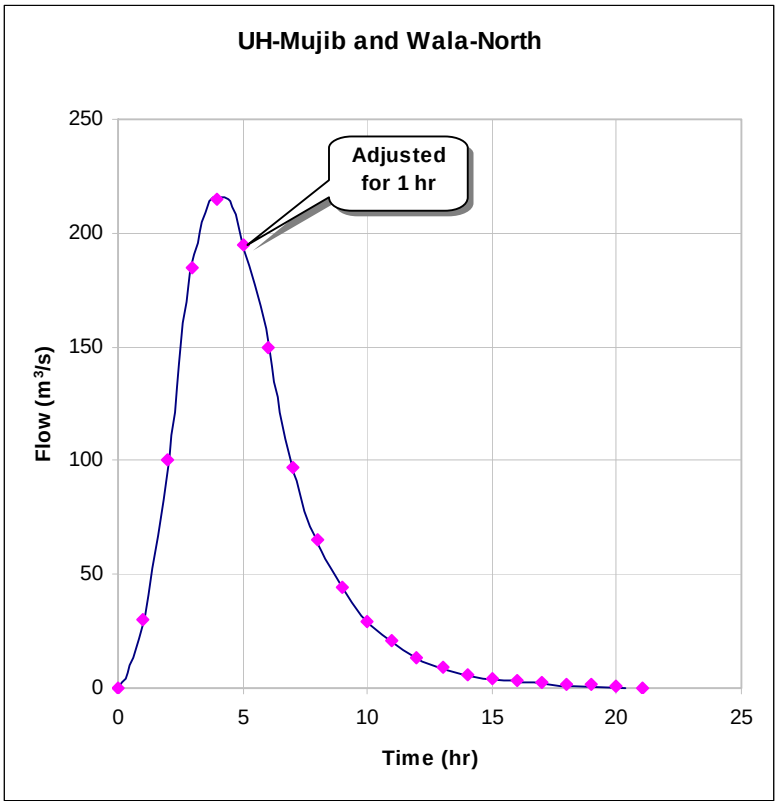



**Figure 7: Unit-Hydrograph of Wadi Mujib and Wala-North**

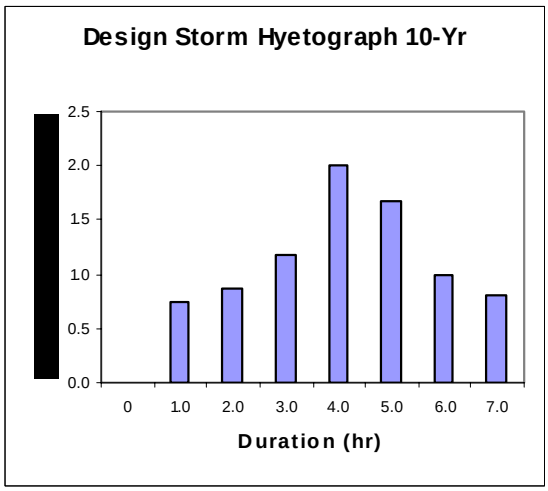



**Figure 8: The design storm hyetograph (Effective Rainfall)**

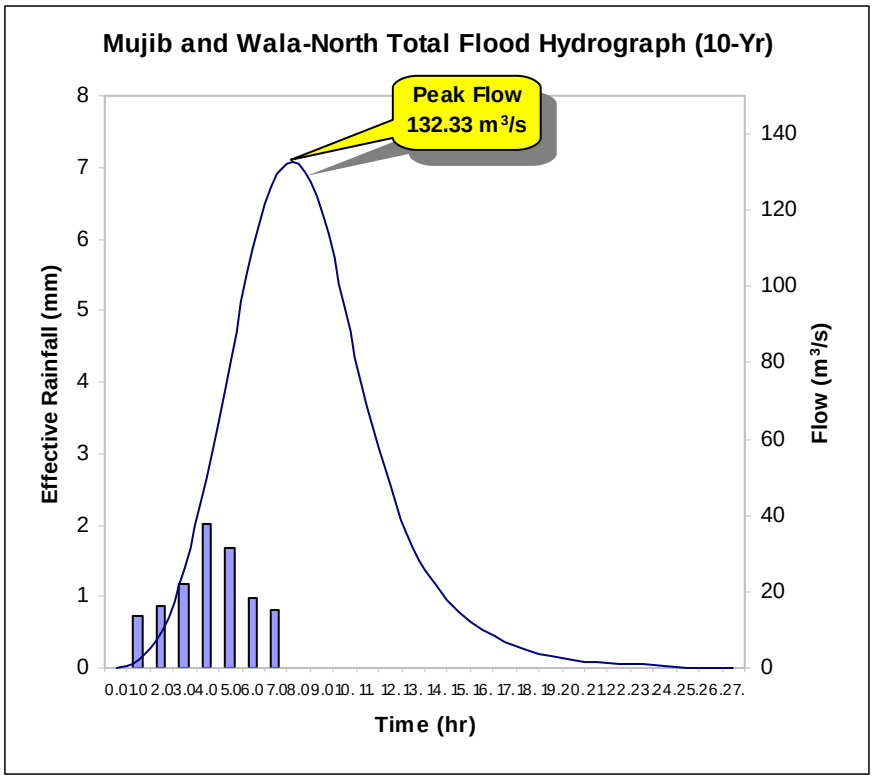



**Figure 9: The flow Hydrograph for Wadi Mujib and Wala-North at 10-Yr return period with effective rainfall**

The rainfall intensity is selected on the basis of the design rainfall duration and return period. The return period of 10-Yr is explored at the proposed of alignment crossing as a need to protect the construction site from unexpected flood. This return period is used for such works and similar works. The design duration is equal to the time of concentration for the drainage area. In literature, there are a number of equations and methods to estimate the time of concentration with different boundary conditions. The most applicable eight equations representing different watersheds were used to estimate the time of concentration and the minimum was considered. The following equations were used:

*California Culverts*

$$t_c = 60\left(11.9(L/1609.3)^3/(3.281H)\right)^{0.385}$$

*SCS Lag Equation*

$$t_c = \frac{100(3.281L)^{0.8}\left[(1000/\mathrm{CN})-9\right]^{0.7}}{1900(100S)^{0.5}}$$

*Izzard*

$$t_c = \frac{41.025(0.0007(I/25.4)+c)(3.281L)^{0.33}}{S^{0.333}(I/25.4)^{0.667}}$$

*Kirpich*

$$t_c = 0.0078\,(3.281L)^{0.77}\,S^{-0.385}$$

*Kerby*

$$t_c = 1.44\left(Ln'S^{-0.5}\right)^{0.467}$$

*Federal Aviation*

$$t_c = 1.8(1.1-C)(3.281L)^{0.5}/(100\,S)^{0.333}$$

*Kinematic Wave*

$$t_c = 0.94(3.281\,Ln)^{0.6}\,(I/25.4)^{-0.4}\,S^{-0.3}$$

*Bransby Williams*

$$t_c = 21.3(L/1609.3)(0.386\,A)^{-0.1}\,S^{-0.2}$$

where: $t_c$ = Time of concentration, in min.
$L$ = Length of longest watercourse, in m.
$S$ = Slope of flow path, in m / m.
$H$ = Elevation difference between divide and outlet, in m.
$n'$ = Retardance Roughness.
$n$ = Manning's Overland Roughness.
$I$ = Rainfall Intensity in mm/hr.
$A$ = Watershed Area in km$^2$.
$c$ = Retardance Coefficient.
*CN = SCS runoff curve number, according to land use, hydrologic soil group, and moisture condition, weighted value is calculated.*

For cases where the channel slope is not uniform, a weighted slope may provide an index that better reflects the effect of slope on the hydrologic response of the watershed. The following defines the channel slope index:

$$S_i = \left(\frac{n}{k}\right)^2$$

In which $n$ is the number of segments into which the channel is divided, and $k$ is given by:

$$k = \sum_{i=1}^{n} \frac{1}{(\Delta e_i / l_i)^{0.5}}$$

In which $\Delta e_i$ is the difference in elevation between the end points of channel segment $I$, and $l_i$ is the length of segment $i$. The channel is divided into segments where the slope is relatively constant over each segment. **Figure 10** presents the slope index for Wadis Abu Turfa et al.

**Wadi Abu Turfa et al. Profile**

| Station (km+m) | Elevation (masl) | Slope (m/m) | $Slope^{0.5}$ | $1/Slope^{0.5}$ |
|---|---|---|---|---|
| 0+000 | 875 | | | |
| 5+618 | 900 | 0.0044 | 0.0667 | 14.9913 |
| 20+291 | 950 | 0.0034 | 0.0584 | 17.1307 |
| 34+963 | 1000 | 0.0034 | 0.0584 | 17.1300 |
| 43+005 | 1050 | 0.0062 | 0.0789 | 12.6817 |
| 48+518 | 1100 | 0.0091 | 0.0952 | 10.5003 |
| 57+740 | 1200 | 0.0108 | 0.1041 | 9.6035 |
| 64+233 | 1300 | 0.0154 | 0.1241 | 8.0580 |
| 68+515 | 1400 | 0.0234 | 0.1528 | 6.5430 |
| 71+983 | 1500 | 0.0288 | 0.1698 | 5.8898 |
| | | | | 0.77% |
| | | | | Slope Index |

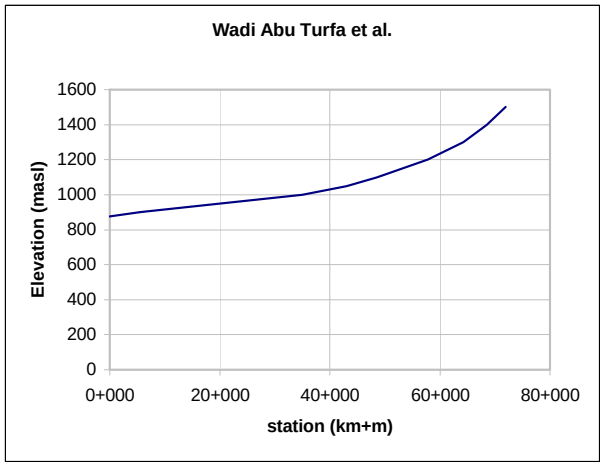



**Figure 10: Stream Profile for Wadi Abu Turfa et al. with Slope Index Calculation**

Intensity-Duration-Frequency (I-D-F) curves were developed using data from Ministry of Water and Irrigation of the available records for each rainfall station as indicated in the **Annex C8**. 3 Parameter Log Normal, Gumble Extremal Type I and Log Pearson Type III distribution were found to be the most fit distributions to the actual data through a comprehensive comparison with other distributions using the software HFA and FRAH. The I-D-F curves are exhibited in **Annex C9** and **Figure 11** shows I-D-F curves for Aqaba-Airport rainfall station.

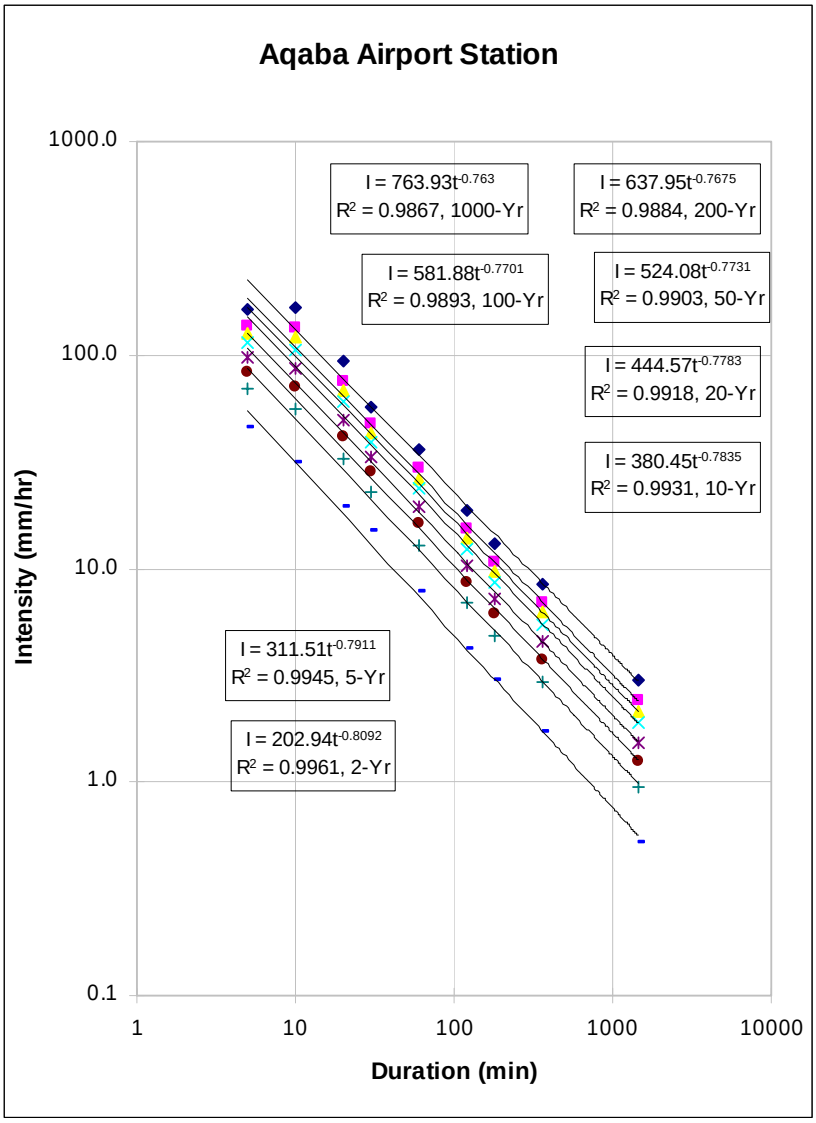



**Figure 11: I-D-F Curves for Aqaba-Airport Rainfall Station**

The rainfall intensity depends on the time of concentration that should be read from the curves. In order to reduce the error in reading the curves two different formulas are developed for calculating the intensity out of the estimated rainfall intensity. These formulas are in the following format:

$$I = \frac{a}{t^{b}}$$

*and*

$$I = \frac{a}{t + b}$$

where: $a$ & $b$ = Parameters for each return period and rainfall station.
$t$ = Duration, in min.

The first equation is used due to high coefficient of determination ($R^2$) value, as shown in **Figure 11** and **Annex C9**.

The FlowMaster software is used for the purpose of calculating the flow depth at the crossing sections. **Annex C10** is developed to estimate the flow depth in the crossing sections. The method estimated the flood depth of Wadi Hasa at 2.43 m and 1.59 m at Wadi Qatrana. **Figure 12** and **Figure 13** show the two crossing sections of Wadi Abu Turfa et al. with flood depth of 3.65 m and 6.52 m, respectively. Abu Turfa group of wadis are crossing the alignment at different sections. Both investigated sections show very shallow depth of water at a flood flow of 10-Year return period.

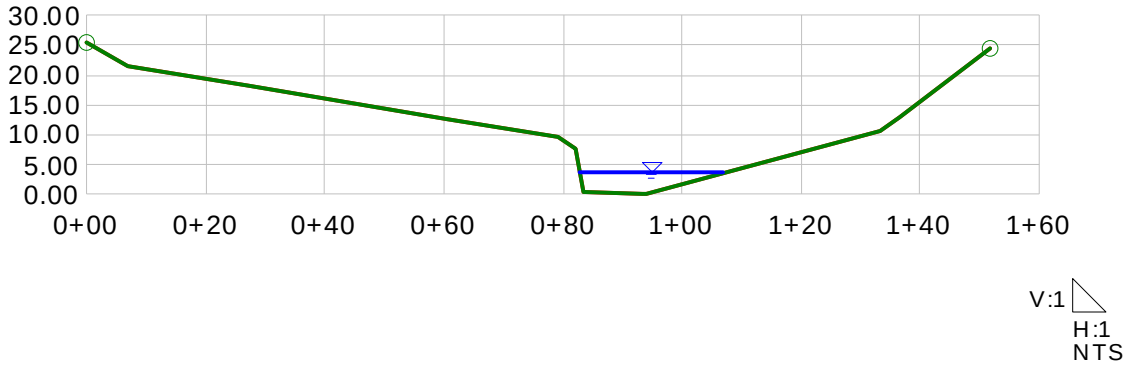



**Figure 12: Wadi Abu Turfa Cross-Section 1**

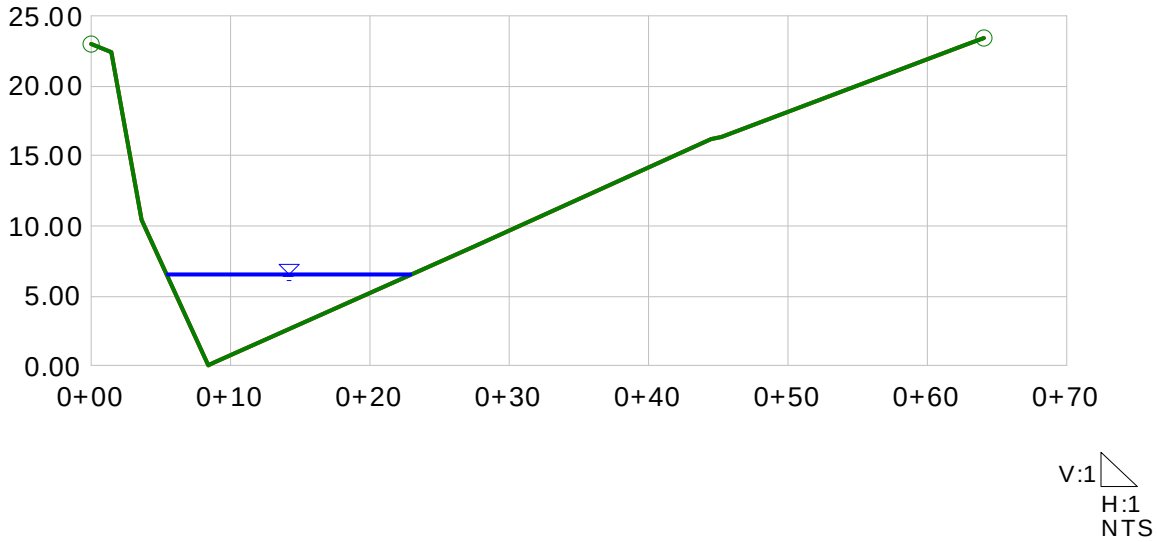
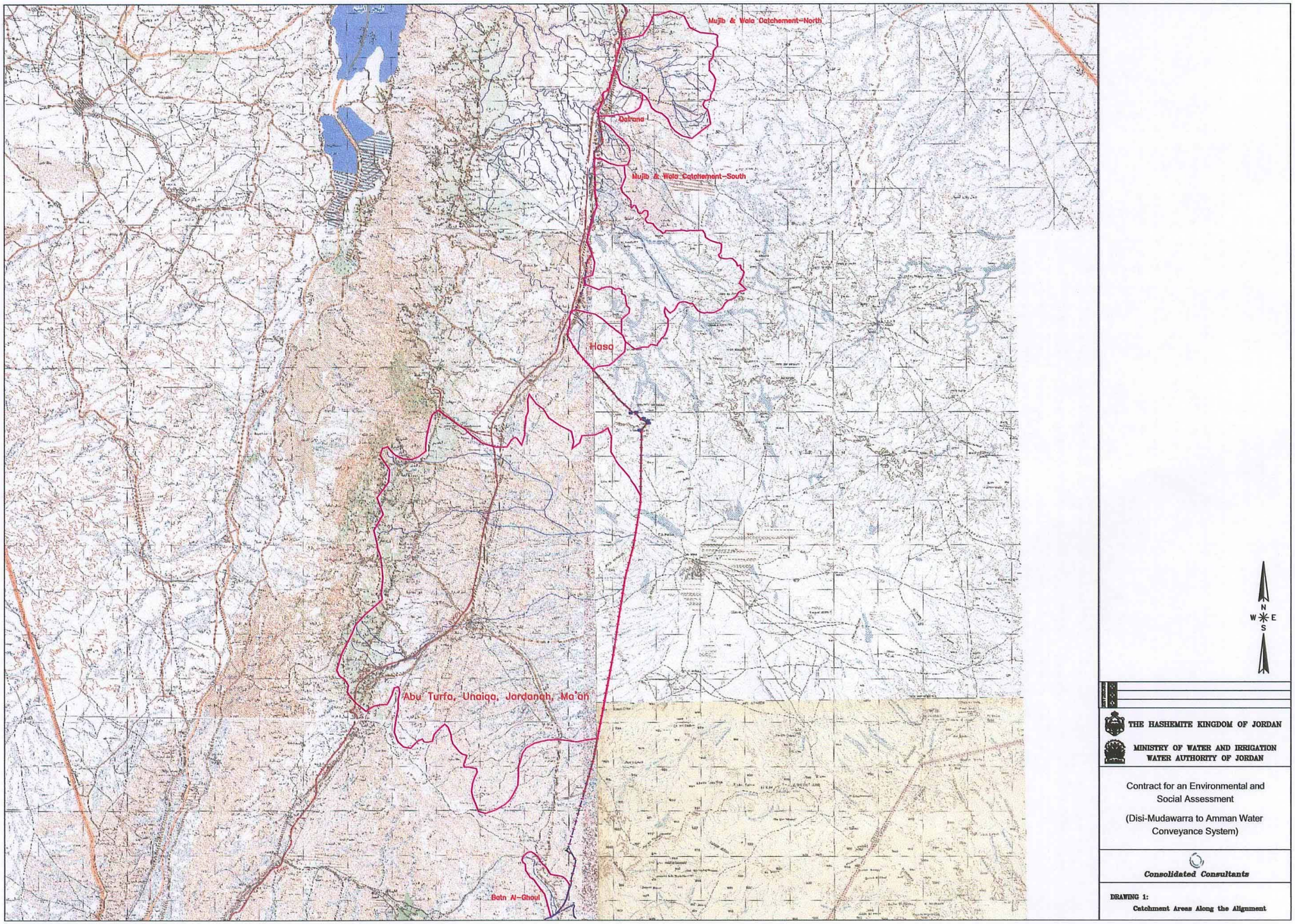
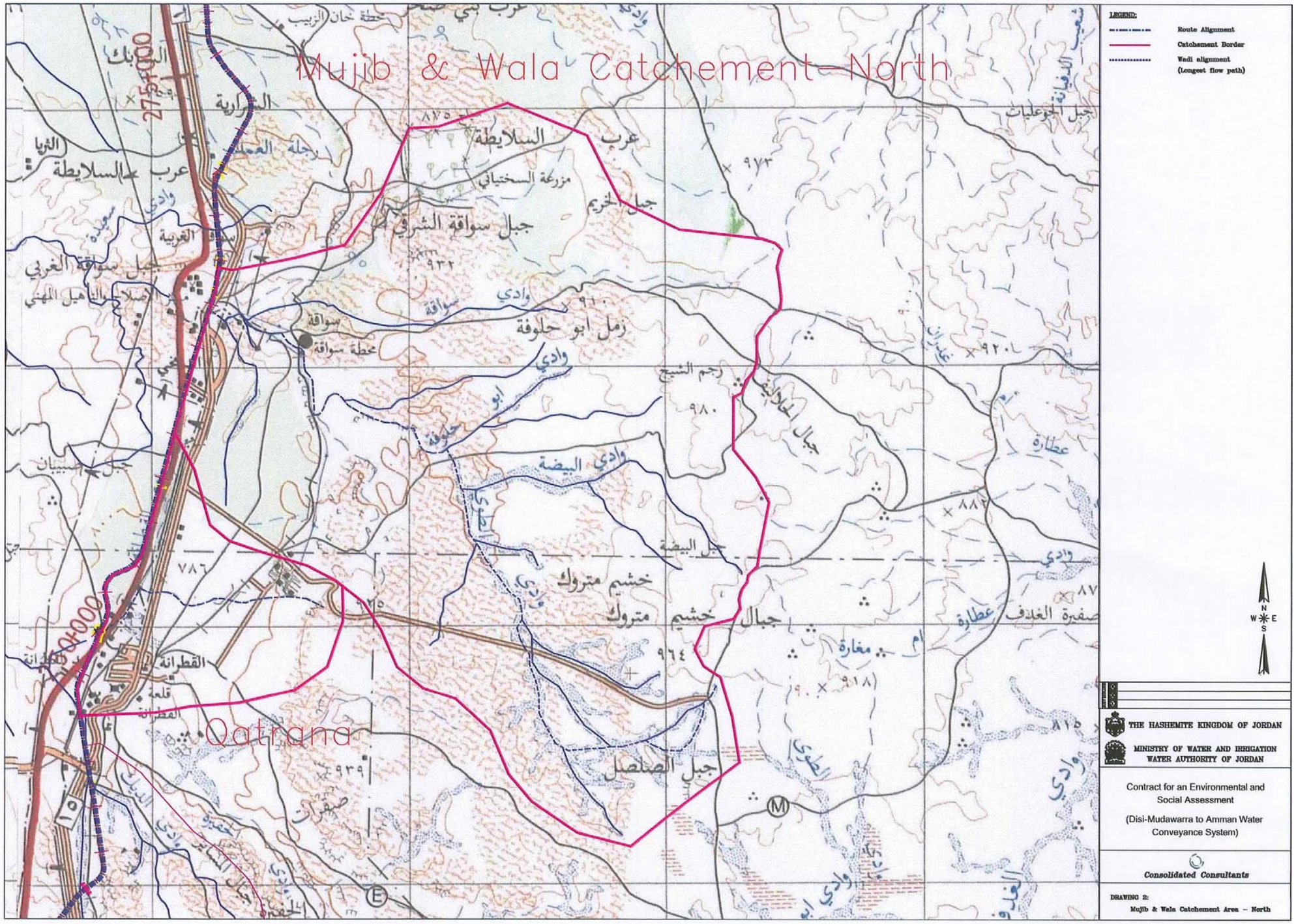


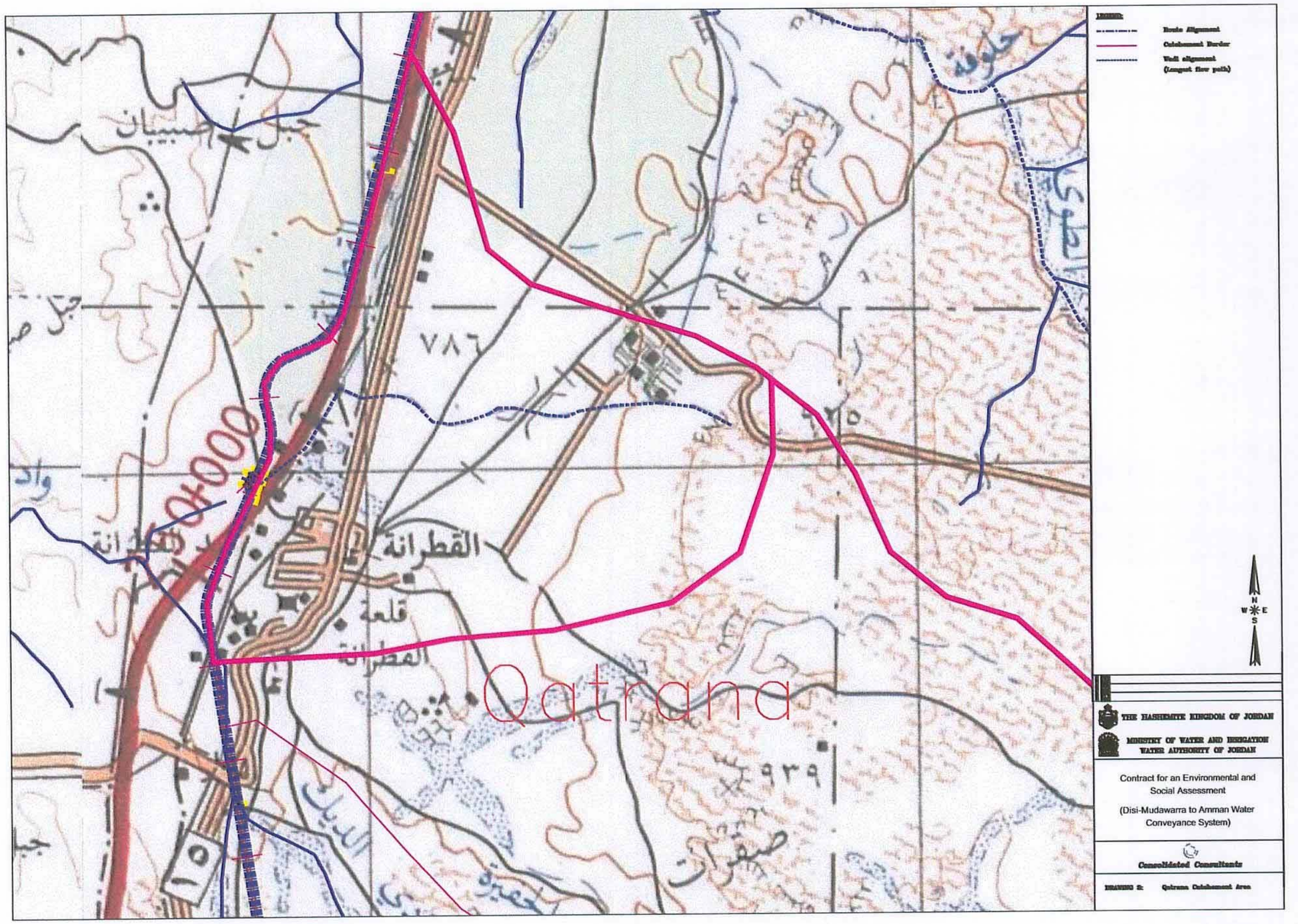

**Figure 13: Wadi Abu Turfa Cross-Section 2**



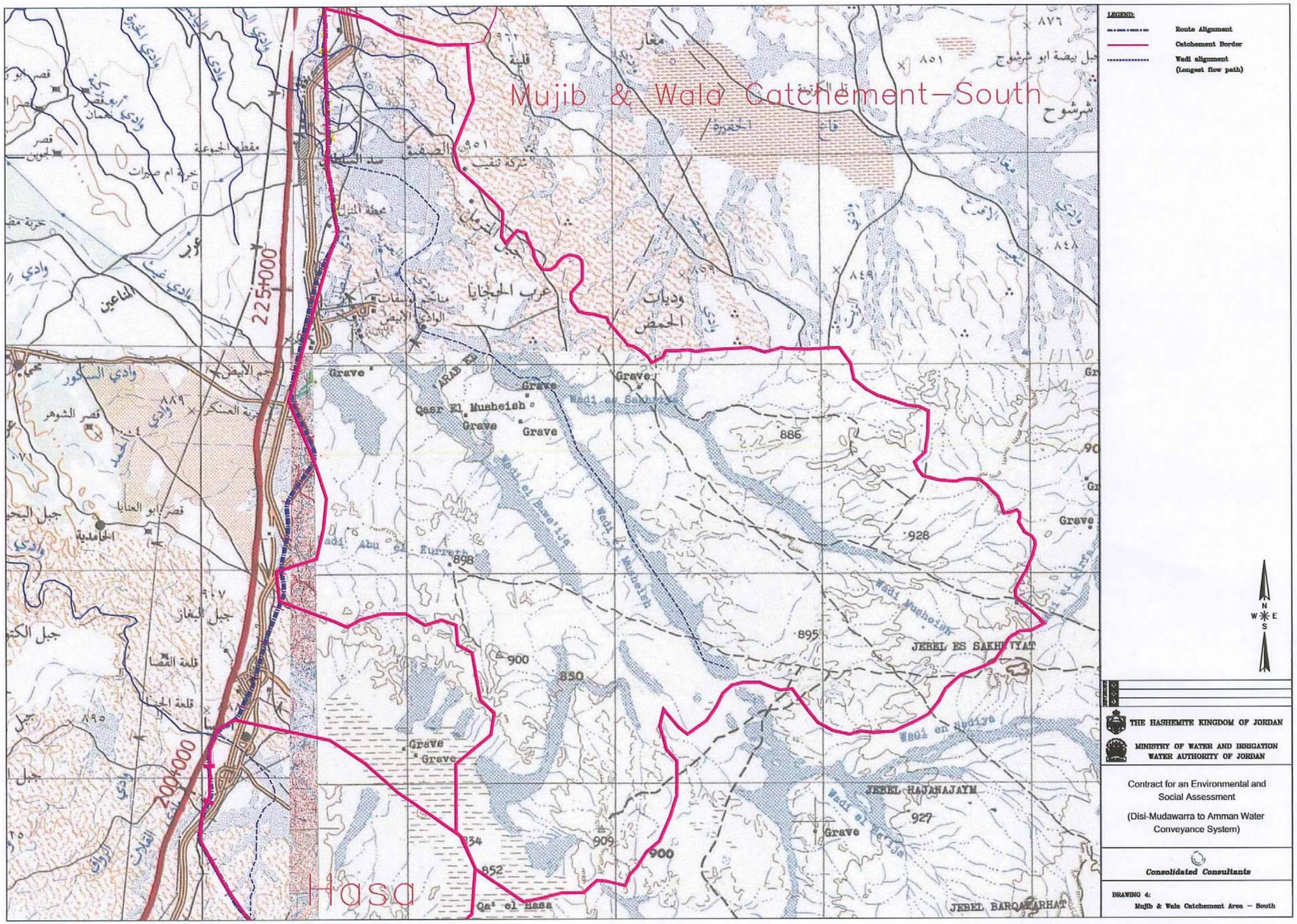

**Drawing 1: Route of the Disi-Mudawarra to Amman water conveyor**



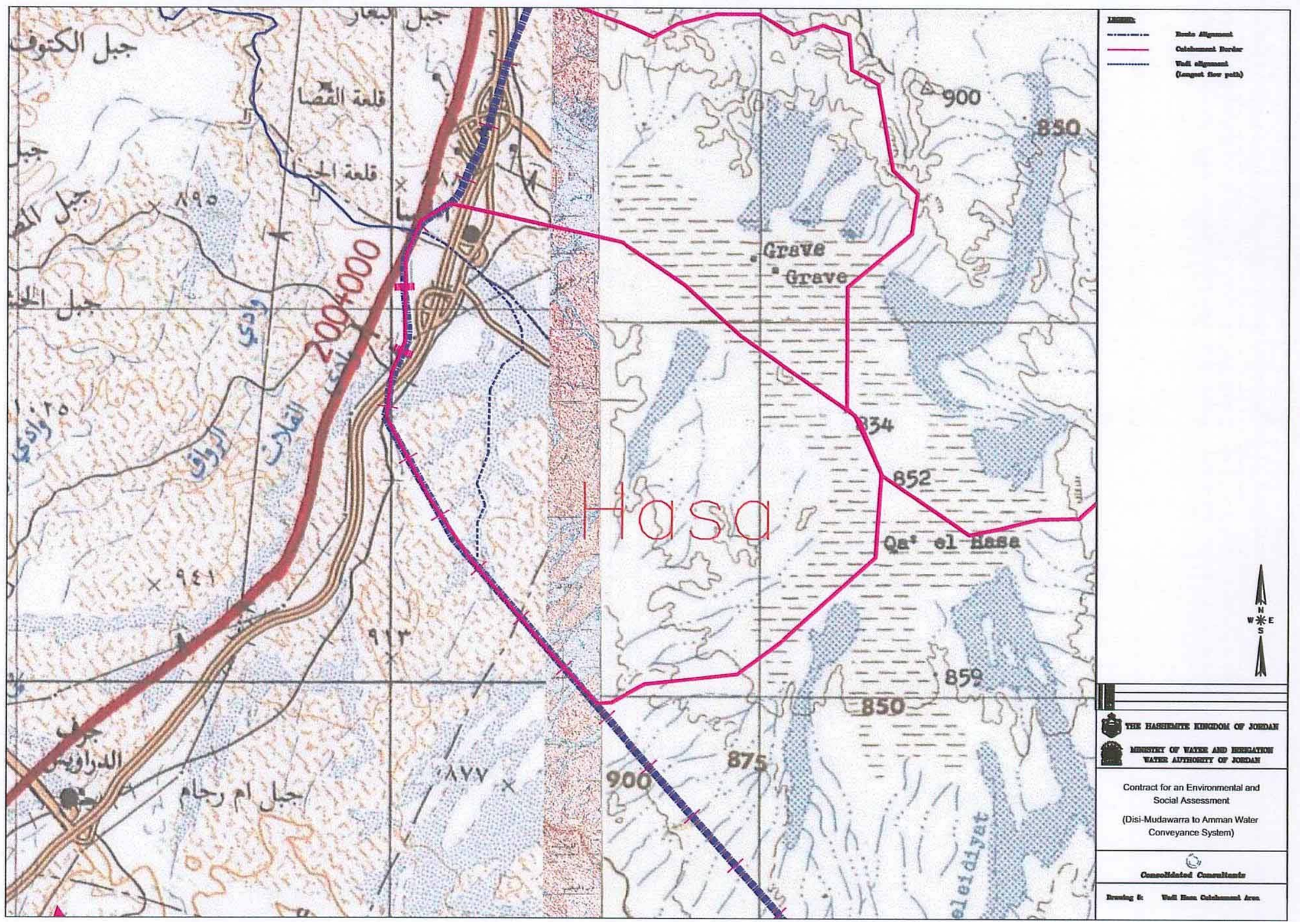

**Drawing 2: Mujib and Wala catchment area- North**



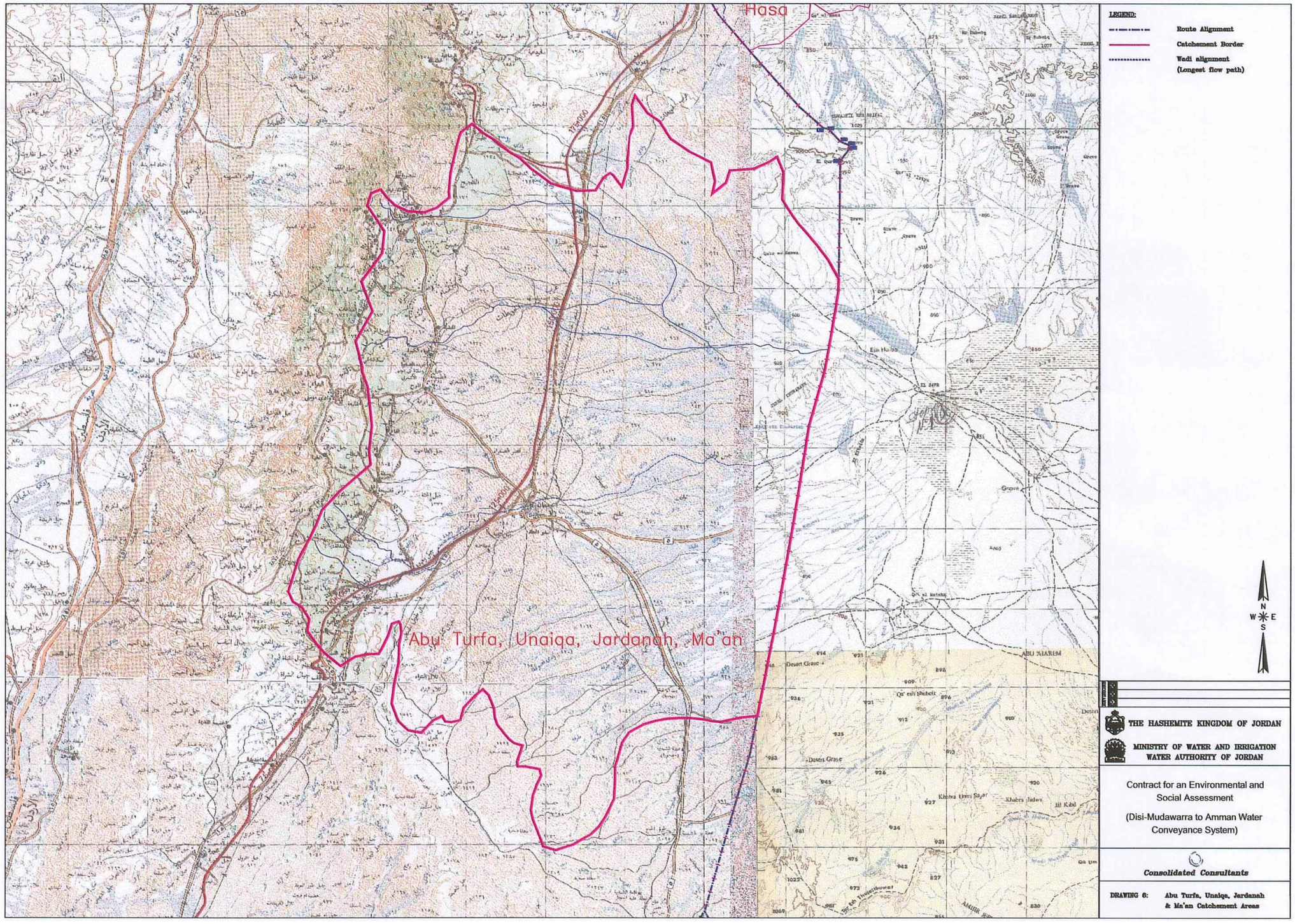

**Drawing 3: Qatraneh catchment area**



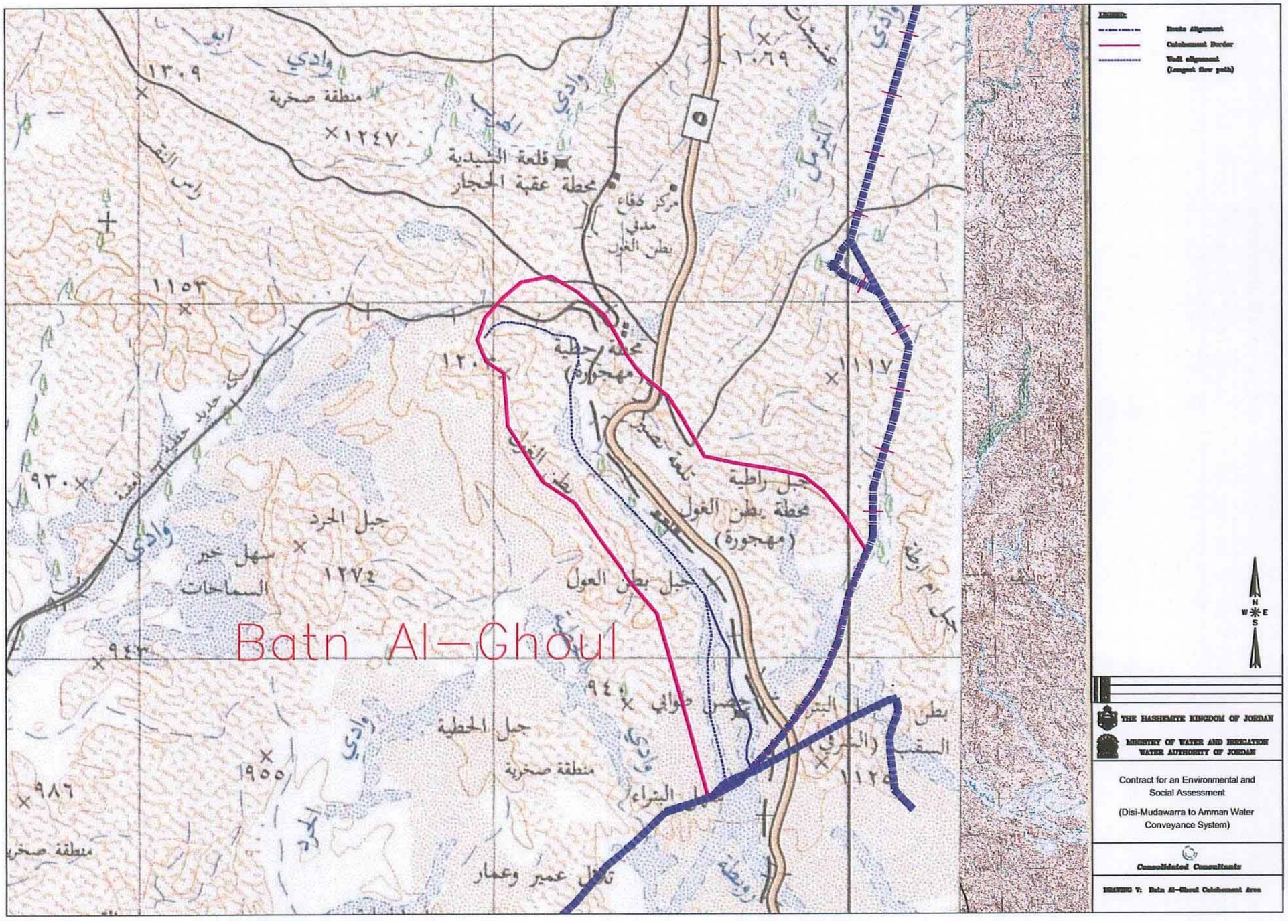

**Drawing 4: Mujib and Wala catchment area- South**



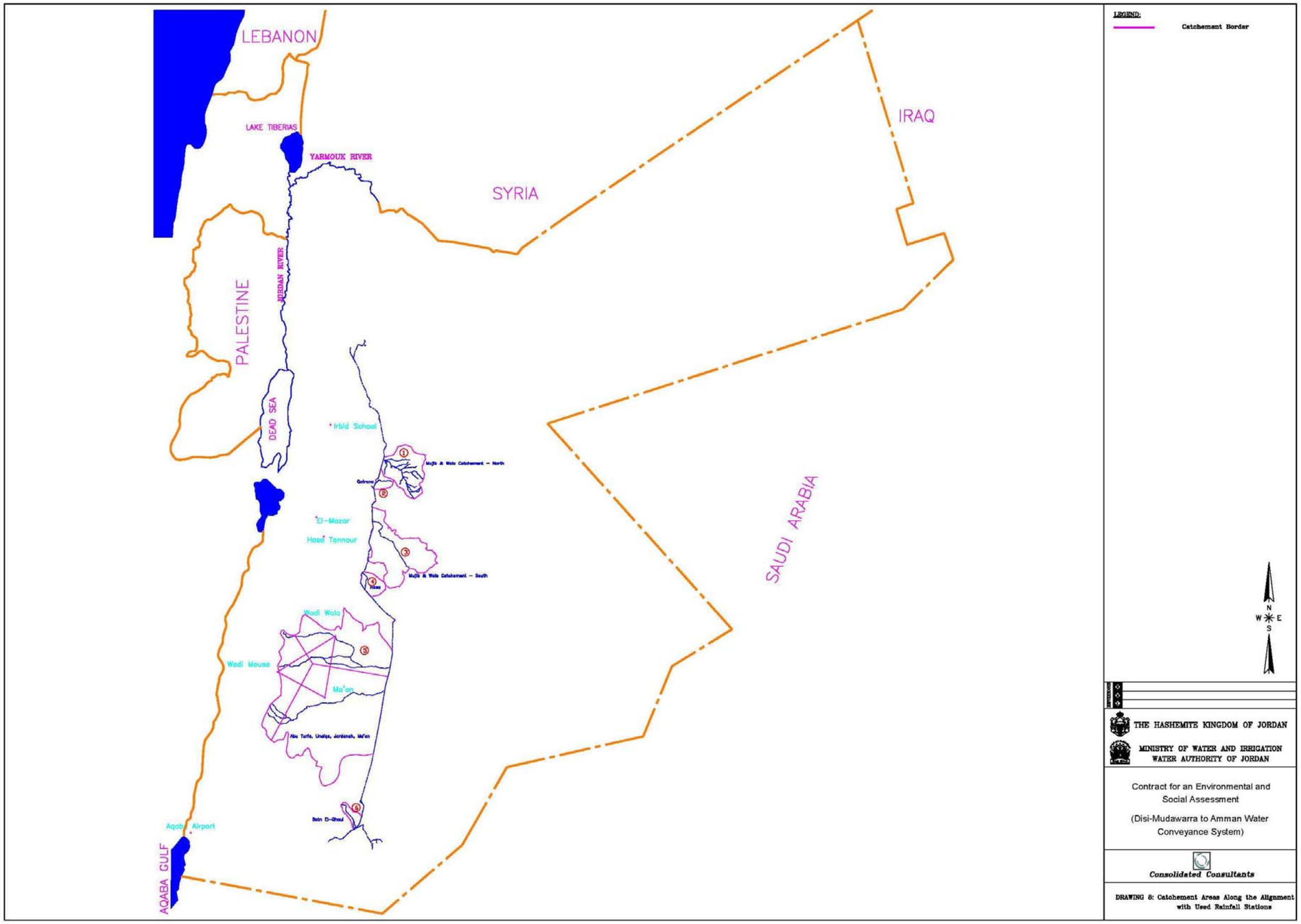

**Drawing 5: Wadi Hasa catchment area**




**Drawing 6: Abu Turfa, Unaiqa, Jardanah and Ma'an catchment area**




**Drawing 7: Batn El-Ghoul catchment area**




**Drawing 8: Catchment areas along the alignment with used rainfall sections**

### (d) Groundwater Hydrogeology

Similar to the surface hydrology section, this section deals with groundwater hydrogeology. Baseline data and analysis is developed for relevant aquifers in **Section 4**. The detail analysis and the data are listed in **Annexes C11, C12, and C13**. The baseline data is assembled, evaluated, and presented according to *Task 11* as stated in the TOR and subjected to the needs through the course of the project. The data comprise all relevant data such as aquifer characteristics, drawdown, abstractions, quality, and available waters. The data is integrated to give a clear view for the addressed aquifers.

### 3.1.1.4 Seismic Status

Segment A of the project corridor is located within the Aqaba region. The Gulf of Aqaba and the Red Sea region is well known for being an active seismological region. Between 1994 and 1999 there were 15 earthquakes recorded in the Aqaba area. The highest magnitude occurred in 1995. No serious damages were reported in Aqaba area due to these earthquakes. Details of these earthquakes are presented in **Table 7** [3].

**Table 7: Seismic events in Aqaba Area for the period of 1994-1999**

| Date | | Location (UTM) | | Magnitude (Richter scale) |
|---|---|---|---|---|
| Year | Month | Latitude | Longitude | |
| 1994 | February, 3 | * | 34.77 | 5.1 |
| | September, 1 | 29.32 | 34.86 | 3.2 |
| | November, 7 | 29.31 | 34.96 | |
| 1995 | March, 21 | 29.36 | 34.97 | |
| | November, 23 | 29.33 | 34.75 | 5.7 |
| | November, 24 | 29.31 | 35.08 | 4.50 |
| | November, 29 | 29.35 | 34.83 | 4.1 |
| | December, 01 | 29.33 | 34.69 | 4.4 |
| | December, 02 | 29.31 | 34.66 | 4.6 |
| 1996 | January, 8 | 29.25 | 34.73 | 4.4 |
| | January, 17 | 29.25 | 34.60 | |
| | February, 2 | 29.24 | 34.67 | 4.5 |
| | February, 2 | 29.23 | 34.66 | 4.0 |
| | February, 12 | 29.22 | 34.68 | 4.1 |
| | April, 11 | 29.25 | 34.96 | 3.2 |
| | December, 2 | 29.21 | 34.63 | |
| 1997 | February, 21 | 29.14 | 34.65 | 4.4 |
| 1999 | December, 8 | 29.30 | 34.80 | 4.0 |

Source: Natural Resources Authority-Internal Reports, 2000

### 3.1.1.5 Air Quality and Noise Level Status

Based on the project corridor segmentation presented in **Section 2.4** of this report, the following discussion presents the baseline conditions of air quality and noise levels within the relevant segments.

[3] Natural Resources Authority- Internal Reports, 2000.

Within Segment C of the project corridor, the major sources of noise and dust can be related to different human activities, though no primary source(s) of noise and/or air quality deterioration can be identified.

Segments (B-1) and (A-2) suffer from air quality deterioration and high noise levels due to the phosphate extraction and manufacturing processes practiced in the Hasa and Al-Abyiad mines and carried by the Jordanian Phosphate Mining Company. These processes result in accumulation of hills of friable carbonate rocks subjected to the blowing winds causing high dust levels, and impacting major parts of the Desert Highway most of the year. Moreover, the noise pollution associated with mining activities can be considered to some extent localized.

The transportation of the phosphate by heavy trucks using the desert highway and by the railway to Aqaba port, contributes to elevating the noise level along the scattered neighbourhoods located close to the Desert Highway within Segments (B-1) and (A-2).

Communications and meetings with the representatives of the water and environment studies centre in the Royal Scientific Society indicated the absence of any collected base line data for the project corridor area. RSS representatives mentioned that data collection usually done based on a previous request (From a governmental agency(s) or from the private sector within the context of a specific project).

### 3.1.2 Biological Environment

The biological environment investigated in this study was based on extensive flora, fauna and avifauna surveys, which have been conducted to identify the various ecological properties, species and critical habitats occurring along the alignment. Several publications and studies by Jordanian and non Jordanian Researchers, and national technical reports and studies were consulted. Collected or observed specimens have been identified using several authoritative books and field guides available.

International and local species conservation status of plant, fauna and avifauna species was assigned according to the IUCN, and the country study on biodiversity. And the surveys covered occurring flora and fauna along the alignment as well as highlighting the regional ecology of the areas crossed by the alignment.

Furthermore, results of surveys were presented to cope with the alignment segmentation, which are the southern, middle and northern segments. The southern most Segment (A) includes the part of the alignment that crosses the desert 40 km east of the Desert Highway to converge at the pumping area at Disi area. This segment crosses some significant biological areas at Hizma Basin, which includes Rum and Disi areas. These two sites have received considerable attention in terms of field surveys being of unique value and because of their rarity in terms of both geology and biodiversity. The area of Hizma basin is considered an important bird area in Jordan according to Birdlife International criteria and is highlighted as an important area for conservation4. In the same segment, the alignment crosses part of the Jordanian desert, which also enjoys special ecological characteristics. This segment supports a wide variety of habitats harbouring diverse communities and offering a variety of migrant bird species giving the vital refuge they need during their long journeys.

[4] Evans, 1994; RSCN, 2000; GCEP, 1998; Hatough-Bouran *et al.* 2000

The middle Segment (B) encompasses the alignment that falls in the right-of-way of the Desert Highway from Al Jiza to Jurf Al Drawish in Tafilah district in the south. This part crosses areas of low urbanisation along the Desert Highway, private farms, industrial areas and sites of afforestation activities.

Lastly, the northern Segment (C) encompasses heavily populated and urbanized areas along the alignment in the eastern parts of Amman where the collection reservoir is located. It extends south to Al Jiza along the Desert Highway. Many fallow lands and private fields are located in this segment.

#### 3.1.2.1 Biogeography and Vegetation Types

Biogeographically, the alignment crosses the four different bio-geographic regions recognized in Jordan[5] Map shown in **Figure 14**. The dominant habitat type in the project area is the Hammada type and specifically the gravel Hammada. However, sandy and runoff Hammada are also common. Hammada areas are usually devoid of vegetation. But since the area is interspersed with many run offs and wadis of various sizes, substantial vegetation can be supported. These areas are usually suitable sites for grazing herds in the Jordanian desert.

The bioregions identified in the area are:

1- Mediterranean region;
2- Irano-Turanean region;
3- Sudanian Sub-Tropical region; and
4- Saharo Arabian region.

[5] Al-Eisawi, 2000, 1997, 1985; Kruschner, 1986

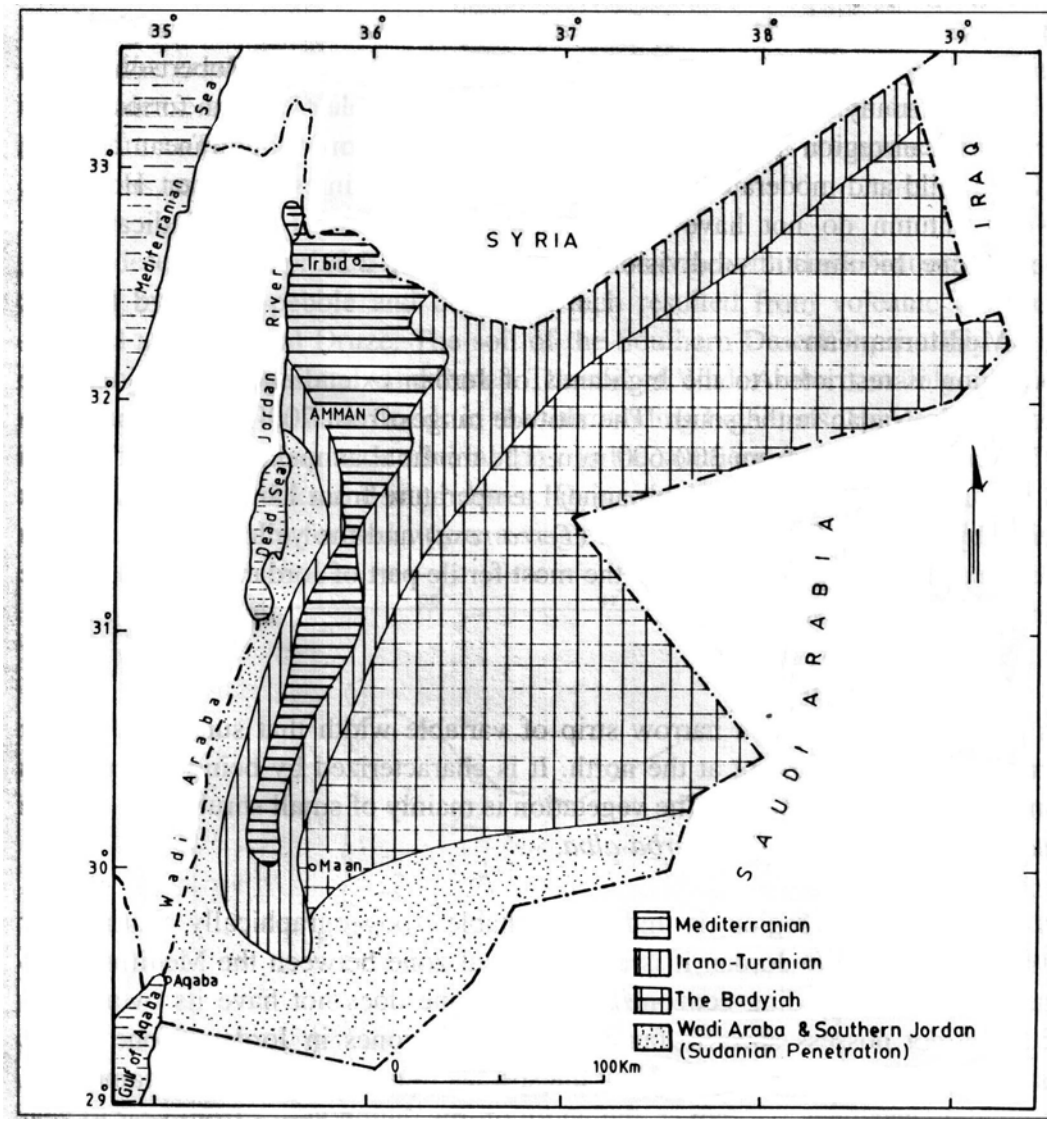



**Figure 14: Biogeographical regions recognized in Jordan**

The Mediterranean bioregion Segments (C-2) and (C-3) are mainly the non-forest Mediterranean type that is devoid of naturally occurring forest elements. Human plantations, forestations and private farms occur for the existing tree stands in the area. Main plant species are *Nerium oleander, Cuppressus* spp. *Pinus* sp. Other species include: *Euphorbia heirosolymitana, Plantago* spp. *Urginea maritime, Notobasis syriaca, Inula viscosa Anchusa* spp. *Erodium* spp. and many other annuals.

Irano-Turanean realm is evident at the alignment part that extends along the Desert Highway (Segment C-1). The soil is mostly poor, eroded and has the calcareous or loos type. This soil is moderately productive and is best used for moderate grazing. The Irano-Turanean parts are treeless zones where steppe grassland vegetation dominates. Substantial green stands occur at large wadis such as wadi Al-Abyad and wadi Al-Hasa dominated by *Tamarix nilotica* shrubs.

Saharo Arabian on the other side is present along the alignment that crosses the desert areas of Segments (A-2) and B. The soil is very poor and mostly of the Hammada type with some sandy, saline soils or mud flats. The vegetation is very poor, and is restricted to watersheds and water runoffs where enough moisture is available to support some vegetation. These have been described as a monotonic segment in terms of ecological features being generally of desert character. The vast stretches of the deserts covering the upper two segments can be described as

Flintstone desert (Al-Hammad); with flat or hilly desert areas that are often intersected by broad wadis and large mudflats (Qa's), which are seasonally flooded according to the amounts of rainfall. The most common species found there are *Artemisia herba-alaba, Achillea fragrantissima, Astragalus spinosa, Zilla spinosa, Matthiola* spp. *Rumex vesicularis, Rheum palaestinum, Reichardia tengitana, Retama reatam, Anabasis syriaca, Plantago* spp. *Schismus barbatus.*

The Sudanian realm is evident in area north of and within Disi north of Aqaba (Segment A-1). The soil is mostly sandy. Saline soils occur discretely in this region. There are also hilly limestone regions, the high mountains of wadi Rum as well as the sand dunes of Al-Mudawarra desert in the south. Vegetation is related to tropical varieties like *Acacia* spp. *Cleome africana, Halocnemum strobiulaceum, Hammada salicornica*.

Wadi Rum has been indicated in earlier assessments as an area that will be impacted directly by the then-adopted alignment (Harza, Bowell Technical reports). Wadi Rum has always been considered as an important ecological and geological formation in southern Jordan. It is also part of the golden tourism triangle in addition to Petra and Aqaba. The site has been also attempted to be a world heritage site based on the above-mentioned criteria.

### 3.1.2.2 Habitats and Hotspots

#### (a) Habitats

Various habitats have been identified along the alignment according to their accruing vegetation. These are described below.

##### Runoff Vegetation

Runoff vegetation is mainly confined along wadis crossing the desert and offers suitable habitats for a variety of plant species (see **Figure 15**). Wadis and their branching range from few meters to hundreds of meters in width.

**Runoff vegetation in Wadi Abu Tarfa**

**Tamarix stands at Wadi Abu Tarfa**

**Figure 15: Runoff vegetation and Tamarix stands in desert ecosystem in Wadi Abu Tarfa**

### Sand Dune

Special and unique habitats in the southern segment with highly adapted flora and fauna (see **Figure 16**). These habitats are quite fragile and therefore require special interventions. Dunes of Wadi Rum are dominated by the sand dune fixatives mainly *Haloxylon persicum* and *Hammada salicornica.*

**Figure 16: Sand dune habitat**

### Hammada Vegetation

Hammada vegetation represents the dominant type of vegetation in the southern and middle segments along the alignment. It is specifically termed as limestone hammada. **Figure 17** shows the Hammada planes. Usually these plains are devoid of vegetation except at crossing runoffs.

**Figure 17: Hammada Plains**

## (b) Hotspots

The following areas have been identified as the most significant to the project due to the types of habitats they encompass. Basically, the habitats listed above do occur at these particular areas. The important issue about it however, is their remoteness and reduced accessibility in addition to their unique floral and faunal elements.

These hotspots are vast areas in term of their extent and biological significance and therefore it is of interest to treat each as one functioning unit to maintain their integrity that are stemming out from their diversity. The project would have impacts during construction and operation especially along the alignment corridor and supporting facilities. Therefore it becomes crucial to limit construction and operation activities to a well-identified corridor, which we estimate about 50 m at maximum accompanied with synchronised excavation and filling processes and restoring of damaged habitats.

The lower segment is considered the richest in terms of habitat diversity. This stems from the fact that these areas represent a blend of intertwining bio-geographical regions mainly the Saharo Arabian and Sudanian realms. A number of hotspots were identified at this segment. These sites have been highlighted in recent country inventories such as the National Country Study on Biodiversity (GCEP, 1998), and the Important Bird Areas (IBAs) in Jordan (Evans, 1994; RSCN, 2000).

Many sites are exceptionally important for the habitats and ecosystems that they encompass and for the survival of bird species dependent upon them. BirdLife International, using globally agreed criteria, rigorously applied to the bird species and numbers they hold, has carefully identified these sites. Sites, which qualify are termed Important Bird Areas (IBAs) which are sites providing essential habitat to one or more species of breeding, wintering, and/or migrating birds. These IBA sites vary in size but are usually discrete and distinguishable in character, habitat, or ornithological importance from surrounding areas (see **Annex C14**).

The hotspots identified in the lower segments are IBAs, which are sites providing essential habitat to one or more species of breeding, wintering, and/or migrating birds. The sites vary in size but are usually discrete and distinguishable in character, habitat, or ornithological importance from surrounding areas.

These hotspots were identified as ecologically important owing to their unique habitats and natural resources supporting a wide variety of faunal and avifaunal communities.

### Wadi Abu Tarfah

| | |
|---|---|
| District: | Ma'an |
| Area: | 172 km² |
| Status: | Part of it is a grazing reserve, IBA |
| Coordinates - Palestine Grid: | E 234032 N 930778 |

Flat, Hammada desert plateau intersected by flat, shallow wadis extends to Qa' El-Jafer to the north. There is a grazing reserve at the site where access is restricted, and the Hijaz railways run through the western part of the site. Two mani wadis cross the area (Wadi Abu Tarfa and Wadi Masol) which ultimately end at Qa'a El-Jafer.

The area exhibits high vegetation coverage (see **Figure 18**) especially at wadi beds, which support tick vegetation of *Artemisis* sp. *Achillea fragrantissima, Atriplex halimus, Zilla spinosa, Anabasis* sp., *Astragalus spinosa,* and *Hammada salicornica*. Dispersed *Tamarix* sp. trees and *Acacia* sp. trees also occur in the area.

***Rumex cyprius***

***Zilla spinosa* –Desert species**

**Figure 18: Plant species within Wadi Abu Tarfah**

The area is home for threatened mammals such as the caracal and the desert gazelle, *Gazella subgutturosa,* in addition to small mammals of rodents and reptiles.

Breeding birds include several species of larks, Wheatears, and other desert species. Migrants include several passerine species that rest in the wadi vegetation; as well as many raptors passing over during autumn migration. Houbara Bustard and Lanner Falcon threatened species are reported by the locals to be occasionally present from autumn to spring.

### Hisma Basin – Rum-Disi

| | |
|---|---|
| District: | Ma'an-Aqaba |
| Area: | 1,478 km² |
| Status: | Not protected: Part of it is Rum Wildlife Reserve, IBA |
| Coordinates - Palestine Grid: | E 200046 N 888170 |

This consists of an isolated tract of huge, precipitous, sandstone and granite mountains ranging up to 1,754 m (Jebel Rum) in height, and separated from each other by flat sandy corridors. The main use is tourism and pastoralism. Uncontrolled off-road driving is causing destruction of the sand dune habitats (see **Figure 19**). Parts of this site have been declared protected, while other areas at Disi and Sahl As-Suwwan are used for intensive agriculture.

**Figure 19: Proposed pipeline route from Batn El-Ghoul to Disi well field**

Rum area is home for various threatened plant species such as Acacia raddiana, and endemic species such as *Cleome arabica* (see **Figure 20**). Other species include *halocnemum strobilaceum, Citrillus colocynthis, Eremobium aegyptiacum, Linaria haeleva, Asphodelus* sp. (see **Figure 20**) and many others. Some threatened mammals also inhabit the area such as the hyena, the Arabian wolf, Porcupine, and desert gazelle.

**Rum-Disi endemic *Cleome arabica*** **Rare *Asphodelus microcarpus***

**Figure 20: *Cleome arabica* and *Asphodelus* sp.**

Breeding birds include Short-toed Eagle, Verraux's Eagle (former breeder), Lanner Falcon (rare), Barbary and Sooty Falcons, Lesser Kestrel (rare), Lammergeier (former breeder), Griffon Vulture (rare), Sand Partridge, Chukar, Hume's Tawny Owl, Hooded, Mourning and White-crowned Black Wheatears, Arabian Babbler, Tristram's Grackle, Sinai Rosefinch and Trumpeter Finch.

Winter visitors include Steppe Eagle, Saker (rare), Desert Warbler and Pale Rock Sparrow (rare). Imperial Eagle, Honey Buzzard, Egyptian Vulture (may breed), Crane and White Stork are uncommon autumn migrants.

Al Hizma Basin (the southern most end of the project) is home of a variety of resident and breeding birds, in addition to lying on one of the main routes of birds migrating between Eurasia and Africa. These migrants include several globally endangered species, which depend on the natural habitats of the area and adjacent mountains for resting and feeding.

Accessible water resources in the Disi farms attract and support wildlife of all surrounding areas as well as migrating birds. The loss of water supplies thus affects all populations of wild animals in vast areas surrounding such resources.

### Desert Plains Covering the Middle and Southern Segment

This is a desert landscape of flint plains (Hammada) and gently rolling country, interspersed with shallow wadis (see **Figure 21**). The main landuse is nomadic pastoral mainly in the spring and after rain season where green cover flourishes at wadi beds and runoffs.

**Figure 21: Desert landscape of flint planes - Hammada**

The open flat or rolling Hammada desert with scattered limestone hills and wide shallow wadis extending from south airport to Ma'an is locally covered with dense desert scrub. Generally, the habitat covering this part of the route is monotonic and no hotspots were identified along the track in terms of ornithological importance scrub (see **Figure 22**).

**Figure 22: The open flat or rolling Hammada desert with scattered limestone hills and wide shallow wadis**

However, the area remains an important wintering and pass over flyway for many migratory birds. In addition, the Hammada ecosystem covering most of this segment provide habitat for a variety of other wildlife, including mammals and reptiles. Small mammals such as Jerboas and hares are an important food source to many birds of prey. Breeding birds include Temminck's and Desert Larks. In autumn/winter Crane, Houbara Bustard, Montagu's and Pallid Harriers, Imperial Eagle, Lanner Falcon, Saker and Pale Rock Sparrow are frequent at this part of the route.

In fall, this habitat provides food to attract migrating larks, buntings, and a wide variety of Chats. It also represents a stop over site for migratory birds following north-eastern route through Jordan.

Hammada habitat is wintering ground for specific migratory birds along the Palaearctic migratory route (see **Figure 23**), where important population of global important colonies follow this route and utilize the area in winter time, like Cranes (*Grus grus*).

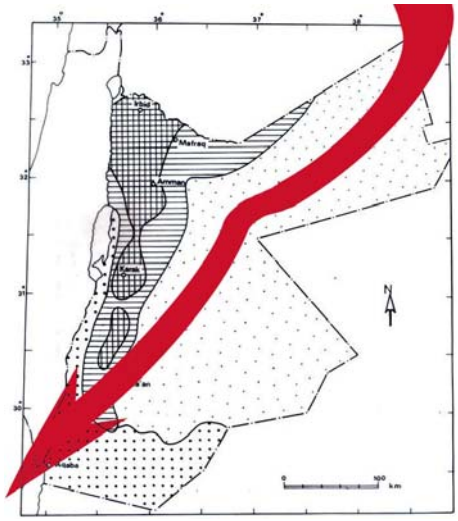


**Figure 23: Birds migration route across Jordan**

### 3.1.2.3 Flora Diversity and Status

In terms of floral diversity, a total of 150 vascular plants were recorded especially in the flora study part of the assessment (**Annex C15**). This checklist is corresponding to the zoning suggested, and status or remarks are highlighted as well.

#### (a) Species Diversity

Basically, the species diversity reflects habitat diversity and is related to changing physical and edaphic factors along this extended alignment that crosses the four bio-geographical regions in Jordan. A number of planted species (especially tree species) do also occur along the alignment mainly in the part adjacent to the Desert Highway (Segment B). Also, many parts are under cultivation and ploughing for forage production.

The tremendous network of wadi and surface run offs along the alignment is the main factor for sustaining green growth especially in the desert parts of xeric conditions. The relative high productivity at such areas promoted the establishment of two main grazing reserves along or close to the alignment (Wadi Abu-Tarfa at Segment A, and Daba'a at Segment B). Although the latter is rather out of scope in terms of this assessment, however, it was earlier indicated as a suitable habitat for some newly recorded and rare plant species that occur only within the boundary of this reserve (Al-Eisawi, 1997; 2000).

Other rare and rather beautiful species members of the Iris family occur at distant areas from the alignment at Qatraneh (Segment B). This includes the bulbous *Iris aucheri*, and the rhizomatous *Iris nigricans* or what is known as the Black Iris of Jordan. Both species are considered locally threatened and endemic to the eastern Mediterranean (Al-Khader, 1997).

#### (b) Communities

Significant plant communities were recorded along the alignment such as:

1- The *Tamarix nilotica* stands along Al-Abyad and Al-Hasa wadis.
2- *Acacia* stands that occur in Abu Tarfa wadi and extends to Disi and are dominated by *Acacia raddiana*, which is considered regionally, threatened species. The taxonomic status of these Acacia trees was identified as *A. raddiana*. Earlier reports indicated this species as *A. arabica*.
3- Limestone Hammada vegetation at wadi runoffs.
4- Sand dunes vegetation dominated by *Haloxylon persicum* at Rum area.
5- Haloxylon-Hammada salicornicum association at Batn E-Ghoul area.
6- Afforestation tree stands along the highway within segment C.

### 3.1.2.4 Fauna Diversity and Status

The aridity and harsh conditions within the project area provides selective habitats for diversified faunal elements that differ in niches, home and feeding ranges. Reptiles and small mammals like rodents enjoy short home and feeding ranges. However, larger mammals such as wolf, hyena,

caracal, Gazelles and foxes require much larger home and feeding ranges. A number of endangered animals were recorded and the key species are indicated in **Table 8**[6].

**Table 8: Endangered fauna reported in the area**

| Scientific Name | English Name | Status |
|---|---|---|
| *Canis aureus* | Golden Jackal, Asiatic Jackal | Locally Endangered |
| *Canis lupus* | Syrian Wolf | Locally Endangered |
| *Caracal caracal* | Caracal | CITES Appendix I, IUCN |
| *Felis margarita* | Sand Cat | CITES Appendix II, IUCN |
| *Felis silvestris* | Wild Cat | CITES Appendix II |
| *Gazella subgutturrosa* | Goitered Gazelle | Locally Endangered |
| *Hyaena hyaena* | Stripped Hyena | Locally Vulnerable |
| *Mellivora capensis* | Ratal, Honey Badger | CITES Appendix III |
| *Vormela peregusna* | Marbled Polecat | IUCN |
| *Vulpes ruepellii* | Ruepell's Fox | IUCN |
| *Chamaeleo chamaeleon* | Chameleon | CITES Appendix II |
| *Varanus griseus* | Desert Monitor | CITES Appendix I |
| *Uromastyx aegyptia* | Spiny tailed lizard | CITES Appendix II |

Hammada habitat is home to a diversity of wildlife: mammals and birds-including some of Jordan's most rare birds. These birds need large sparsely vegetated patches of habitat for successful breeding. The Hammada provide habitat for a variety of other wildlife, including mammals and reptiles. Small mammals such as Jerboas and hares are an important food source to many birds of prey.

### (a) Mammals

Mammals occurring within the project area include a number of globally threatened species such as the Striped Hyena, *Hyaena hyaena*, Arabian wolf, *Canis lupus*, and Rupelli Fox, *Vulpes rupellii*. Large mammalian species have always received considerable conservation efforts being highly susceptible to persecution and the lack of awareness of the ecological role such species play in a given ecosystem.

Arabian Oryx, *Oryx leucoryx*, has been reintroduced by the Royal Society for the Conservation of Nature (RSCN) within Rum Reserve. The release is planned to be in two stages. The first stage is to transfer a small herd from the Shumari Reserve and release them within selected enclosed (fenced) releasing area within Rum Reserve. Primarily, this release is combined with a comprehensive monitoring program of the transferred animals, and public awareness program targeting related stakeholders within the community. The second stage is to release the Oryx free in the wild within the reserve boundaries. But since this animal is known to have a wide feeding ground, it is anticipated to disperse within the whole area, including Batn El-Ghoul area.

Currently, there has been a transfer of authority for managing the Rum reserve from RSCN to Aqaba Special Economic Zone Authority (ASEZA). No clear monitoring scheme and release programme has been yet identified. Nevertheless, ASEZA, along with its plans to promote Aqaba in particular and Jordan in general before international tourism, has dedicated a special attention to concepts of eco-tourism. Rum area, Rum reserve and Batn El-Ghoul area are among the unique habitats at the Hizma basin to promote nature based tourism.

[6] Amr, 1999; Disi, 2002, Disi, et.al, 1988, Hatough-Bouran, 2000

## (b) Reptiles

Reptiles contain diversified groups of organisms that have an impact on the intra and inter-specific interaction among individuals and populations. This status gives them a rank in the ecosystem participating in the equilibrium of the ecosystem at large.

Reptilian diversity was also investigated and three CITES species were identified: *Varanus gresiu*, (desert Monitor), *Uromastix aegyptia microlepis* (the Spiny tailed lizard), and *Camealeon camaeleon* (the European camealeon) (see **Figure 24**). In addition, it is expected that a variety of snakes and lizards do inhabit the different habitats of the project (refer to **Annex C16**). A total of 46 species are expected to dwell areas along the alignment.

**Figure 24: Tracks of a large desert reptile**

Some of the species are mainly restricted to the southern segment of the alignment (refer to **Annex C16**). The sandy habitats of Wadi Rum, Disi area, Mudawwarah and Batn El-Ghoul areas are one of the most important areas for certain lizards and snakes.

Three of the venomous snakes of Jordan inhabit some of the habitat occurring along the alignment such as the Sand Horned Viper and false Horned Viper at the sand dunes of Rum and Disi area. This requires a precautionary approach in maintaining the diversity while minimizing risks to project field personnel.

## (c) Birds

The Badia represents a major flyway for migratory birds. Considerable proportions of birds of Jordan were recorded to breed, dwell or pass through the Badia. Some of these birds are only known to occur in this area. Moreover, the Badia encompasses several IBAs of Jordan, in addition to many habitats of biological significance (refer to **Annex C17**) (Al-Budieri, 1995; GCEP 1998, Hatough-Bouran, 2000; Evans, 1994; RSCN 2000).

These areas are also important for birds of prey, including migratory birds such as the wintering Imperial Eagle and Buzzards, where they rely on these habitats for hunting and roosting. Many raptor species congregate overnight at communal traditional roost sites while on migration. This desert ecosystem provides crucial habitat for many species of birds throughout the year. Birds

relying on desert, like a wide variety of larks and other desert dwellers, build nests, raise young, and forage during the summer months.

In fall, the Badia provides food to attract migrating larks, buntings, and a wide variety of Chats. Large flocks of waterfowl and wildfowls sometimes feed in flooded portions of Qa'a's during migration which is considered the most important wintering habitat along the Eurasian Migratory Flyway. It also represents a stop over site for migratory birds following the north-eastern route through Jordan.

In spring, most migrants in the region travel along the western (Egyptian) shorelines of the Red Sea before crossing into Asia from Africa at the Sinai Peninsula. Where more than 800,000 migrants, including more than 300,000 western honey Buzzard, and more than 300,000 Common Buzzards are reported by the northern most eastern tip of the Red Sea, after which most of them head northeast through the Jordanian desert (Raptor Watch, 2000).

Over 300 species of birds were recorded at the area, which until recently was a significant area for breeding and non-breeding water birds Three globally threatened bird species occurring in the Jordanian Desert were recorded (see **Table 9**). Species recorded in the area, which are threatened or declining throughout all or large parts of their range in the Middle East are presented in **Table 10**. Species, which have relatively small total world ranges with important populations in the Middle East, are shown in **Table 11**. The Hammad habitat supports distinctive ecosystems and species constituting an important component of global biodiversity.

**Table 9: Globally threatened bird species occurring in the Jordanian Desert**

| Common Name | Scientific Name | Status | Convention |
|---|---|---|---|
| Black Vulture | *Aegypius monachus* | Winter visitor | Appendix 2 of the Bonn Convention |
| Corncrake | *Crex crex* | Passage migrant | Appendix 2 of the Bonn Convention |
| Houbara Bustard | *Chlamydotis undulata* | Winter visitor | Appendix 2 of the Bonn Convention |

**Table 10: Species that are threatened or declining throughout all or large parts of their range in the Middle East**

| Common Name | Scientific Name | Status | Convention |
|---|---|---|---|
| White Stork | *Ciconia ciconia* | Passage migrant | Appendix 2 of the Bonn Convention |
| Honey Buzzard | *Pernis apivorus* | Passage migrant | Appendix 2 of the Bonn Convention |
| Egyptian Vulture | *Neophron percnopterus* | Occasional breeder | Appendix 2 of the Bonn Convention |
| Griffon Vulture | *Gyps fulvus* | Resident | Appendix 2 of the Bonn Convention |
| Levant Sparrowhawk | *Accipiter brevipes* | Passage migrant | Appendix 2 of the Bonn Convention |
| Lesser Spotted Eagle | *Aquila pomarina* | Passage migrant | Appendix 2 of the Bonn Convention |
| Lanner Falcon | *Falco biarmicus* | Passage migrant | Appendix 2 of the Bonn Convention |
| Saker | *Falco cherrug* | Passage migrant | Appendix 2 of the Bonn Convention |

**Table 11: Species, which have relatively small total world, ranges with important populations in the Middle East**

| Common name | Scientific name | Status |
|---|---|---|
| Sand Partridge | *Ammoperdix heyi* | Resident |
| Finch's Wheatear | *Oenanthe finchii* | Winter visitor |
| Red-tailed Wheatear | *Oenanthe xanthoprymna* | Winter visitor |
| Hooded Wheatear | *Oenanthe monach* | Resident |
| Pale Rock Sparrow | *Carpospiza brachydactyla* | Summer breeder |

## 3.2 Agricultural Baseline Conditions

The Hashemite Kingdom of Jordan has been facing a chronic imbalance in the population - water resources equation, which is manifested by a substantial imbalance in the foreign trade in food commodities ($110 per capita in 1997)[7], and rationing of municipal water serviced to the population once a week. The total renewable freshwater resources of the country amount to an average of 750 MCM[8] per year. The population of 1997 is around 4.4 million people, growing at an annual rate of 3.5%. The per capita share was 160 cubic meters per annum in 1997 and declines at a rate equal to that of the population increase[8].

Agriculture in Jordan consumes about 65% of the available water resources, with an irrigated area of about 843,000 dunums[9] (84,300 ha)[8]. The strong historical tradition, significant investments and economic importance of irrigated agriculture in Jordan are competing with escalating demands for water for non-agricultural sources.

The production of food in semi arid countries like Jordan is hardly possible without irrigation. The irrigated areas are located in the Jordan Valley (some 33,000 hectares), and in the Plateau (some 44,100 hectares). Some 400,000 hectares are fit for dry land farming, but this potential is practiced on half of the potential area due to the insecurity associated with erratic rainfall and other reasons. Irrigated agriculture, however, provides most of the agricultural production in the Kingdom and offers the higher percentage of agricultural jobs and other relevant support services.

In the Jordan Valley, irrigation water is largely from surface sources fed by low annual rainfall. The irrigation in the Jordan Valley is the result of large scale investments for collection and distribution of surface water supplemented by some ground water that is conveyed by the King Abdullah Canal and other structures to the area for agricultural use.

Because of the huge imbalance in the population-water resources equation, the treated wastewater effluent is added to the water stock for use in irrigated agriculture. It will constitute a substantial percentage of the irrigation water in future years.

In most Middle Eastern countries, agricultural water use accounts for more than 80% of the total water demand. Special attention ought to be paid to optimising agricultural water use while at the same time maintaining the same level of net profit for different activities. Traditionally, most of agricultural and farming economics studies focus on the increase in the yield of farming activities. Little has been done to evaluate the economics of farming based on real water costs. One farmer responded to a question about agricultural feasibility of growing bananas in the region, saying, “if you only want to consider economics, you close down agriculture,” and he continued, “and you can close down the country” (National Geographic, May 1993, pp. 66).

### 3.2.1.1 Agriculture and Jordan’s Economy

Although agriculture is a relatively minor component of the Jordanian economy, its impact is broad since input servicing and output marketing contribute to the value added of the service and industrial sectors. Between 1995 and 2000, agriculture continued to provide 2 to 3% of the current GDP.

[7] Ministry of Water and Irrigation, Irrigation Water Policy – Paper No. 2. February 1998
[8] See Part B, Section 4.1.
[9] Each 1 dunum equals to 0.1 hectare (i.e., 1 ha = 10 dunums).

The rapid development in Jordan after independence in many fields was supported by a considerable development of agricultural production. However, the growth rates in the other sectors of the economy considerably exceeded the growth of the agricultural sector. Thus, the relative importance of agriculture to the economy has been reduced, although the absolute contribution of this sector to the gross domestic product has steadily increased due to the following factors:

1- The maturing of public investments in land and water development in the Jordan Valley;
2- Private sector investments in new technology - drip irrigation, plastic culture, etc.; and
3- A shift to the production of high value horticultural crops coupled with a buoyant domestic and export market.

### 3.2.1.2 Livestock Production in the Badia Region[10]

According to FAO recent study[11], the main livestock production system in the past was the nomadic grazing where flocks moved through the range according to the availability of forage and water. Recently, the nomadic system shrank and most of the flocks changed to the semi-extensive (semi-settled) system because nomads are settled in the steppe area and have started to cultivate newly acquired lands.

The characteristics of animal production under the extensive system in the Badia region are as follows:

- The young Bedouin males joined the labour force and migrated to large cities and other Arab states, causing a big impact on the rural and Bedouin societies as the number of young people ready to take shepherding and herding as a job began to decrease.
- The spread of the motor vehicle has made it possible to transport the animals feed and water, and the people, reducing the rhythmic movement from one pasture to another according to the grass and water availability.
- Grazing in the area is communal. This kind of grazing is enhanced by the use of pick-up trucks in transportation of people, feeds and animals.
- The majority of flocks no longer move a long distance. The movement of stock is seasonal and between few places in the area. This is because governmental or private sector companies provided new water resources. The water supply is available in most villages in the Badia region.
- The settlements of sheep owners are near strategic places or wells.
- The changes in the herd structure, sheep are increasing in number while the number of goats and camels is decreasing. This is because the consumers in Jordan prefer sheep meat and the marketing of sheep is easier than that of other animals.
- There is a change in the system of production, from the extensive (nomadic) system to the semi-intensive system, which fits the settlement in permanent housing and the maximum production of milk.
- The grazing system has changed to one of continuous grazing in the same place and staying around the settled area. The sheep of Badia are using the cereal stubble available in the barley regions.

[10] Badia is the arabic synonym of a desert; however Badia is considered to be semiarid when compared to a true desert. Badia forms more than two third of Jordan.
[11] FAO. (1994) “Sheep production under extensive systems in the Near East, Jordan Pastoral System:” A case study. Near East Regional Office. Food and Agriculture Organization of the United Nations.

- Grazing in the Badia is seasonal and provides enough feed for the spring only, and then the flocks move to the cereal stubble and in drought years they rely on hand feeding of concentrate.
- The sheep may move around 500-1,000 km each year. The daily movement is in the range of 2-3 km.

### 3.2.2 Description of the Current Agricultural Settings along the Alignment

#### 3.2.2.1 Agricultural Baseline Conditions in Segment (A): Disi Area

Directorate of Disi was founded by the administrative division by-law No. (47) of the year 2000 which came into effect on January 1, 2001.

#### (a) Site Description: Location, Borders and Surface Area

- The Disi District is located to the East of the Aqaba Governorate, 70 km away. It borders Saudi Arabia from the East and South, Ma'an Governorate from the north-east and Quweirah from north-west. Its surface area is 953.42 $km^2$.
- Five villages are in the area, with a total population of 3,500 of which 49.5% are male.
- Villages are: Al Disi (1,750 inhabitants), Tweiseh (1,100 inhabitants), Muneishir (1,400 inhabitants), Al-Ghoul (180 inhabitants), and Al Tuwayel (100 inhabitants).
- People's livelihood in these areas depends on agriculture (for example, 1,500 20-litre olive oil containers were locally produced in 2002), livestock and tourism in Wadi Rum.

The locations of the above mentioned agricultural areas are shown on the GIS base maps provided on CDs in **Annex C5**.

#### (b) Related Agricultural Support organizations

There are three important agricultural related entities: Disi Agricultural Centre, Disi Water Centre, and Disi Agricultural Cooperative Association. These entities are described below.

**Disi Agricultural Centre**

Disi Agricultural Centre provides agricultural services, extension and veterinary services. An agricultural engineer presides this centre, aided by a veterinary medical assistant. Centre's commodities comprise one tractor and ploughs. Arable land suitable for irrigated agriculture is around 250,000 dunums, of which 150,000 dunums is in the production process and currently planted with olive trees. Pasture area is 50,000 dunums mainly used to feed small ruminants and camels. The distribution of olive trees in the Disi area is presented in **Table 12**.

**Table 12: Distribution of Olive Trees in the Disi Area**

| Village | Mature Olive Trees | Juvenile Trees | Total |
|---|---|---|---|
| Disi | 7,610 | 190 | 7,800 |
| Tweiseh | 15,770 | 1,460 | 17,230 |
| Tuwayel | 7,550 | 2,200 | 9,750 |
| Mneishir | 3,190 | - | 3,190 |
| Al Ghal | 9,850 | 3,950 | 13,800 |
| **Total** | **43,970** | **7,800** | **51,770** |

Source: Disi Agricultural Station

Other trees are grown in the area by local farmers like peach, nectarine, apricots, plums, apples, guavas, grapes, figs, citrus, grenades, cactus and Japanese quince. However, overall number of trees grown by small-scale farmers is very modest.

### Disi Water Centre

The centre provides services related to water to all district villages. Five wells provide water supply to all villages in the area. The distribution of these wells is presented in **Table 13**.

**Table 13: Distribution of wells in the Disi Area**

| Wells | Demand Area | Capacity ($m^3$/hour) | Daily operation (hours/day) | Annual Consumption ($m^3$) |
|---|---|---|---|---|
| Disi | Disi | 50 | 24 | 438,000 |
| Tweiseh | Twiseh | 50 | 24 | 438,000 |
| Muneishir | Muneishir | 50 | 16 | 292,000 |
| Al Ghal | Al Ghald | 5 | 24 | 438,000 |
| Shakiriyeh | Shakiriyeh, Rum, Salihiyeh | 80 | 18 | 525,600 |

Source: Disi Agricultural Station

### Disi Agricultural Cooperative Association

It provides agricultural services and other benefits for 215 settled Bedouins operating farms growing mainly olive trees. Most of the agricultural activities in the district are based in Tuwayel and Tweiseh areas.

## (c) Agricultural Baseline Conditions / Commercial Irrigated Agriculture (Disi-Mudawarra Area)

Large scale irrigated agriculture has been practiced in the Disi-Mudawarra Area since 1986. Four Agricultural companies are operating in the area: Arab International Company for Agricultural Development (ARICAD), Alwafa for Agricultural and Animal Development (WADICO), Grains Fodders and Meat Production Company (GRAMECO) and Rum Agricultural Company (RUM). The binding agreement between the government of Jordan and these companies stated that (i) area planted with field crops and forages should be more than 50% of the total area of the project and that (ii) the annual abstraction of ground water should not exceed 91 MCM given that planted areas should not be less than 65% of total area of the project. **Table 14** and **Figure 25** shows total area and maximum amounts of water to be abstracted by each company.

**Table 14: Area and maximum amounts of water to be abstracted by each company**

| Company | Area (Dunums) | Number of Wells | Water (MCM/year) |
|---|---|---|---|
| RUM | 50,000 | 26 | 35 |
| WADICO | 12,481 | 5 | 10 |
| GRAMECO | 25,000 | 10 | 25 |
| ARICAD | 21,156 | 10 | 21 |
| TOTAL | 108,637 | | 91 |

Source: Disi Agricultural Station

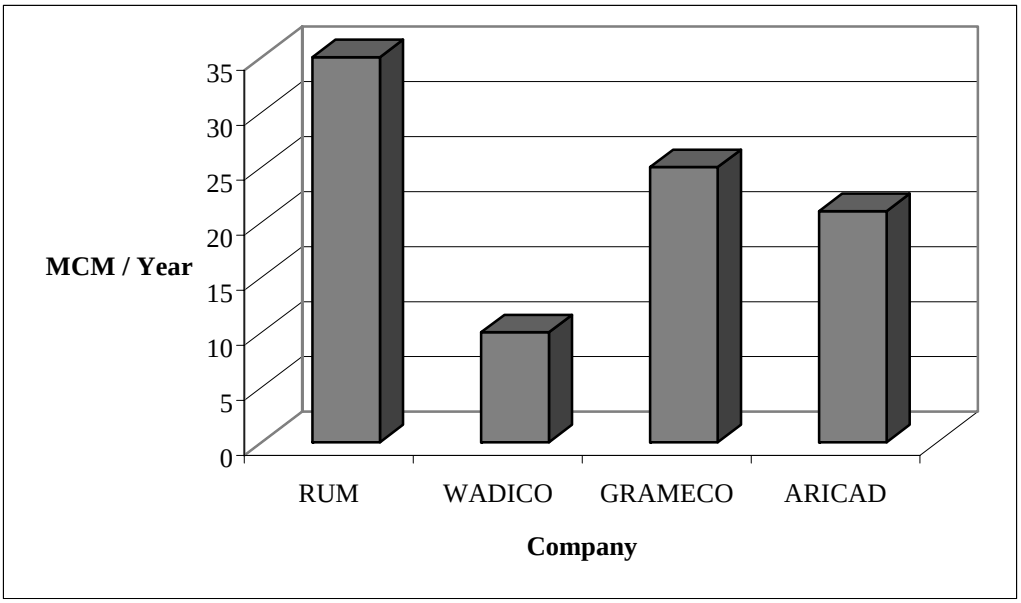



**Figure 25: Maximum water abstraction by each farm company at Disi area**

Total area exploited by these companies adds up to 108,637 dunums. Rum Agricultural Company has the largest area and number of available wells with a pumping capacity of 35 MCM per year. WADICO, on the other hand, has only 12,481 dunums and 5 wells with a pumping capacity of 10 MCM per year.

According to the underground water monitoring by-law, the new water tariff for agricultural wells will be applied to the Disi farms. Accordingly, it is expected that the water consumption will be reduced around 30%.

**Table 15** and **Figure 26** shows planted areas of different types of crops and their percentage importance of total area for each company as an average for the period 1997-2000. On average, the four companies planted 43.11% of the total area available for agriculture. Rum Agricultural Company planted 16.33% field crops, 11.29% vegetables, 8% trees, adding up to a total of 35.62% of available area for production. WADICO planted 21.86% field crops, 27.1% vegetables, 0.4% trees, adding up to a total of 49.36% of available area for production. GRAMECO planted 18% field crops, 23.2% vegetables, 2.16% trees, adding up to a total of 43.36% of available area for production. ARICAD planted 23.32% field crops, 33.25% vegetables, 0.24% trees, adding up to a total of 56.81% of available area for production.

**Table 15: Planted areas of different types of crops and their percentage importance of total area for each company as an average for the period 1997-2000**

| Company | Total Area (Dunum) | Field Crops | | Vegetables | | Trees | | Planted | |
|---|---|---|---|---|---|---|---|---|---|
| | | Area (Dunum) | Percent (%) | Area (Dunum) | Percent (%) | Area (Dunum) | Percent (%) | Area (Dunum) | Percent (%) |
| RUM | 50,000 | 8,165 | 16.33 | 5,647 | 11.29 | 4,000 | 8.00 | 17,812 | 35.62 |
| WADICO | 12,481 | 2,728 | 21.86 | 3,382 | 27.10 | 50 | 0.40 | 6,160 | 49.36 |
| GRAMECO | 25,000 | 4,500 | 18.00 | 5,800 | 23.20 | 540 | 2.16 | 10,840 | 43.36 |
| ARICAD | 21,156 | 4,933 | 23.32 | 7,035 | 33.25 | 50 | 0.24 | 12,018 | 56.81 |
| **Total** | **108,637** | **20,326** | **18.71** | **21,864** | **20.13** | **4640** | **4.27** | **46,830** | **43.11** |

Source: Ministry of Agriculture

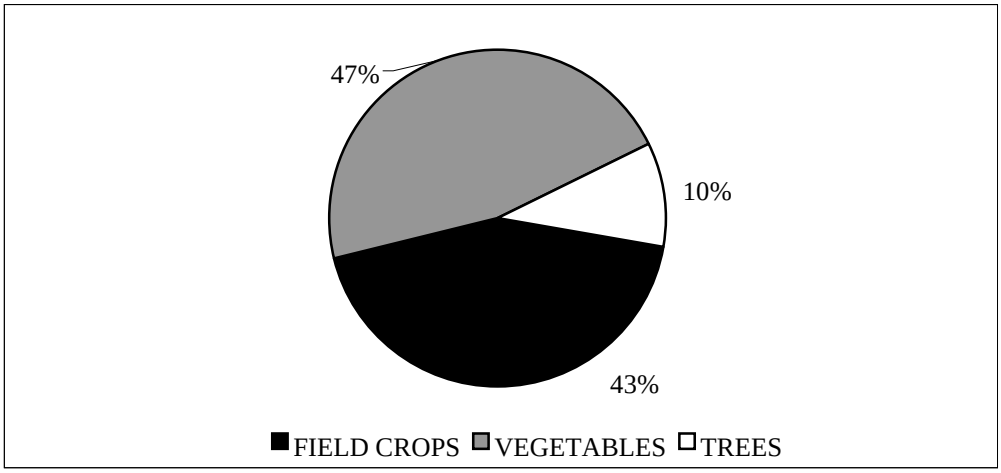



**Figure 26: Percentage planted areas of different crops**

### Production of Wheat and Barley

As shown in **Table 16**, the 1997-2001 average areas grown with wheat and barley were 10,450 and 4,190 dunums, respectively, with a production of 5,975 tons of wheat and 2,934 tons of barley. The percentage of production of these companies to total production of Jordan was 8% for wheat and 5% for barley (see **Table 17** and **Figure 27**).

**Table 16: Areas and production of wheat and barley for the four companies (An annual average based on 1997-2001 data)**

| Company | Area (Dunums) | | Production (tons) | |
|---|---|---|---|---|
| | Wheat | Barley | Wheat | Barley |
| RUM | 5,480 | 1,185 | 3,124 | 830 |
| WADICO | 1,290 | 810 | 735 | 567 |
| GRAMECO | 1,000 | 1,915 | 570 | 1,341 |
| ARCAD | 2,680 | 280 | 1,528 | 196 |
| TOTAL | 10,450 | 4,190 | 5,957 | 2,934 |

Source: Ministry of Agriculture

**Table 17: Percentage importance of production of wheat and barley of the four companies to total national production of Jordan**

| Item | Company Production (tons) | Total National Production (tons) | Percent |
|---|---|---|---|
| Wheat | 5,957 | 73,200 | 8 |
| Barley | 2,934 | 54,533 | 5 |

Source: Based on Ministry of Agriculture data


**Figure 27: Wheat and barely production in Disi area and in Jordan**

On average for the period 1992-1997, Jordan produced 73,200 tons of wheat and 54,533 tons of barley annually. These amounts formed around 13 and 10% of total local production and imports of wheat and barely, respectively. The average production, imports and percentage importance to total production and imports are presented in **Table 18**.

**Table 18: Average production, imports and percentage importance to total production and imports**

| Item | Average Production (Tons) | Imports (Tons) | Total (Tons) | Percent (%) |
|---|---|---|---|---|
| Wheat | 73,200 | 500,133 | 573,333 | 12.7 |
| Barley | 54,533 | 496,183 | 550,716 | 9.9 |

### Water Consumption

According to the agreements between the government and the companies operating in the studied area, these companies can consume up to 91 MCM annually, but these companies are not operating at full capacity. The area planted on average is 41,802 dunum and forms 37% of total rented area of 108,637 dunum. **Table 19** shows the annual average of water consumption of the most frequent planted crops by the four companies for the period 1999-2001 in the study area.

**Table 19: Water consumption for selected crops as an annual average for the period 1999-2001**

| Crop | Area (Dunum) | Percent to Total Area | Water Consumption ($m^3$/Dunum) | Water Consumption ($m^3$/Crop) | Percent of Total Water Consumption |
|---|---|---|---|---|---|
| Wheat | 8,497 | 20 | 1,000 | 8,497,000 | 25 |
| Barley | 2,863 | 7 | 800 | 2,290,400 | 7 |
| Potato | 15,696 | 38 | 750 | 11,772,000 | 34 |
| Onions | 2,627 | 6 | 700 | 1,838,900 | 5 |
| Watermelon | 1,400 | 3 | 500 | 700,000 | 2 |
| Yellow corn | 2,550 | 6 | 750 | 1,912,500 | 6 |
| Alfalfa | 1,988 | 5 | 1,600 | 3,180,800 | 9 |
| Vegetables | 641 | 2 | 500 | 320,500 | 1 |
| Fruit trees | 5,540 | 13 | 700 | 3,878,000 | 11 |
| **Total** | **41,802** | **100** | | **34,390,100** | **100** |

Source: Ministry of Agriculture

According to **Table 19**, 25% of water consumed by these large-scale farming companies goes to production of wheat, 34% to production of potatoes, while 11% to fruit trees' production and 1% to vegetables' production, so on and so forth.

Irrigated agriculture in Disi-Mudawarra area is considered to be a water-intensive agriculture compared to the rest of the irrigated agriculture in Jordan. **Table 20** shows water consumption ($m^3$/kg) for selected crops as an annual average for the period 1999-2001. For example, one kilogram of hard wheat required 1.53 $m^3$ of water, while one kilogram of watermelon required 0.15 $m^3$ of water. A detailed comparison between irrigation water used in the agricultural production process in Disi area and the rest of the country is presented in **Section 3.2.4** in **Table 21** and **Figure 28**.

**Table 20: Total, cost, net revenue and water consumption ($m^3$/kg) for selected crops as an annual average for the period 1999-2001**

| Crop | Total Revenue (JD/kg) | Total Cost (JD/kg) | Net Revenue (JD/kg) | Water Consumption ($m^3$/kg) | Net Revenue on water (JD/$m^3$) |
|---|---|---|---|---|---|
| Spring potato | 0.190 | 0.175 | 0.015 | 0.234 | 0.066 |
| Summer potato | 0.170 | 0.150 | 0.020 | 0.206 | 0.098 |
| Summer onions | 0.100 | 0.090 | 0.010 | 0.209 | 0.049 |
| Winter onions | 0.115 | 0.103 | 0.012 | 0.149 | 0.084 |
| Summer watermelons | 0.075 | 0.063 | 0.012 | 0.150 | 0.079 |
| Winter watermelon | 0.100 | 0.080 | 0.020 | 0.150 | 0.135 |
| Yellow corn | 0.120 | 0.184 | (0.064) | 0.847 | (0.075) |
| Hard wheat | 0.189 | 0.243 | (0.053) | 1.532 | (0.035) |
| Bread wheat | 0.121 | 0.189 | (0.067) | 1.188 | (0.057) |
| Barley | 0.105 | 0.169 | (0.063) | 1.056 | (0.060) |

Source: Based on data collected from the field and from the Ministry of Agriculture

According to **Table 20**, some crops appear to have negative net revenue, which implies lack of rational justifying producing these crops under such conditions. However, the companies are obliged to produce these crops to meet the terms of their agreements with the Government. The agreement between the Government of Jordan and these companies stated that area planted with field crops and forages should be more than 50% of the total area of the project.

No action by the Government or the companies is considered to have these guidelines changed although they do not make any sense from an economic point of view or water resources management perspective.

#### 3.2.2.2 Agricultural Baseline Conditions on Segments B and C: the Route from Amman to Qatraneh

Many agricultural practices are dispersed on the road from Amman to Qatraneh. These farms are of small scale and distributed along the alignment with a few meters to 100 meters from the main and access roads. Those are as follows:

- Olive Farm with 200 trees, owned by Mr. Khaled Huneiti
- Front yard with 30 olive trees near Suleiman Al Abdulla Complex
- Jweideh plains planted with wheat and barley
- An olive farm at the end of the street, opposite Jweideh Silos
- At 28 km from Amman are some plains planted with feed crops and olive trees
- At 37 km from Amman is the Arab Farm owned by Hatem Sultan, other smaller farms and plastic houses
- At 38 km from Amman is the roman reservoir used for irrigation
- At 39 km from Amman is Sunnouqrot poultry Farms and Yanbou' farms
- At 42 km from Amman within the Bashiliyeh Area are two farms across from each other, mainly olive trees
- At 58 km from Amman, two farms across the street from each other
- At 59 km from Amman, plastic-tunnel farm
- At 61 km from Amman, large-scale olive farm
- At 64 km from Amman, Barakeh farm
- At 76 km from Amman, some live stock herding spot
- At 82 km from Amman, Wataniyeh poultry farms
- At 94 km from Amman, Qatraneh Farm
- At 97 km from Amman, Qatraneh slaughter-house

Apart from above-listed agricultural activities, the road remains desert and devoid of any significant agricultural activities.

### 3.2.3 The Sustainability of Large-Scale Agriculture in the Disi Area

Sustainability is a concept that considers use of resources from a long-term perspective. There have been many attempts to define sustainability, but most are rooted in the general concept of intergenerational equity. Sustainable development maybe defined for example as meeting the needs and wants of people of the current generation while leaving equal or better opportunities for people of generations to follow.

Sustainable agriculture can be defined as a set of ever-changing agricultural production and marketing systems that are sustainable forever and for everyone. A sustainable agriculture must be capable of maintaining its value to human society forever. One cannot prove empirically that one system of agriculture is sustainable and another is not. It would take forever to collect the

necessary data. Thus, agriculture must be ecologically sound, economically viable, and socially responsible.

Creating a truly sustainable farming system is a very difficult task. Farmers must choose individually for themselves what methods are best for their own situation. Farmers must worry about maintaining soil fertility, stopping soil erosion, avoiding soil compaction, protecting their crops from pests, using adequate amounts of water, working within political systems, making a liable wage, and creating a product that is safe to eat.

The characteristics of a sustainable agricultural system are as follows:

1- A sustainable agricultural system is based on the rational of renewable and/or recyclable resources. A system that depends on non-renewable water resource, such as the case in Disi, cannot be sustained indefinitely. A sustainable system would use renewable water sources such as rainfall, river water, and renewable groundwater. However, use of resources such as groundwater at rates greater than recharge depletes reserves and cannot be sustained.
2- Any system that degrades or depletes the productivity of its resource base will eventually lose its ability to produce, and thus, is not sustainable. Likewise, any system that pollutes or poisons its environment in the process of producing will eventually lose its net value to society and likewise is not sustainable. A sustainable agricultural system protects the integrity of natural systems so that natural resources are continually regenerated. Sustainable agricultural systems should maintain or improve groundwater and surface water quality and regenerate healthy agricultural soils.
3- A sustainable agricultural system improves the quality of life of individuals and communities. In order to bring development to the Disi Area, the agricultural companies must offer people a good standard of living including diverse employment opportunities, health care, education, social services and cultural activities. Young people must be afforded opportunities to develop rural enterprises, including farming, in ways which care for the land so that it may be passed onto future generations in as good or in better condition that it was received.
4- A sustainable agricultural system is profitable. Economic viability is necessary to maintain control over resource use. A system that lacks economic viability eventually must sacrifice control over its resources to some economically viable alternative. Large-scale agriculture in the Disi Area will not stay in business if they pay for the water they consume. If opportunity cost of water is to be considered in the calculations of profit, agricultural farms in Disi area would not be considered economically profitable.
5- A sustainable agricultural system is guided by a land ethic that considers that long- term good of all members of the land community. An agro-ecosystem should be viewed as a dynamic interdependent community composed of soil, water, air and biotic species. All parts are important because they contribute to the whole. This ethic strives to protect the health of the land community that is its capacity for self-renewal.

### 3.2.4 A Comparison of Water Consumption (Disi vs. the rest of the Country)

A comparison between irrigation water used in the agricultural production process in Disi area and the rest of the country shows that farming process in Disi needs much more water than the rest of the country to produce the same level of output as shown in **Table 21** and **Figure 28**. For example wheat grown in Disi area needs 3.6 times irrigation water as much as wheat grown in other places. On average and under irrigated agriculture conditions, one kilograms of wheat

produced in Jordan needs 380 litres of water annually, while in Disi area, production of one kilograms of wheat needs 1,360 litres of water annually. One kilogram of yellow corn grown in Disi area needs 850 litres of water annually, which is almost twice as much as the water requirements in the rest of the country. Barely grown in Disi area needs 1.5 times irrigation water as much as Barely grown in other places. One kilogram of barely produced in Jordan needs 710 litres of water annually, while in Disi area, production of one kilograms of barely needs 1,060 litres of water annually. One kilogram of potatoes grown in Disi area needs 220 litres of water annually, which is almost 150% of the water requirements in the rest of the country.

**Table 21: Water consumption per one kilogram of output for selected crops in the Disi area and the rest of the country**

| Crop Type | Country | Disi | Ratio = Disi / Country |
|---|---|---|---|
| Wheat | 0.38 | 1.36 | 3.60 |
| Barely | 0.71 | 1.06 | 1.50 |
| Yellow corn | 0.45 | 0.85 | 1.90 |
| Potato | 0.15 | 0.22 | 1.50 |
| Water melon | 0.14 | 0.15 | 1.10 |
| Onions | 0.13 | 0.67 | 5.00 |

Source: Based on data collected from the field and Ministry of Agriculture data

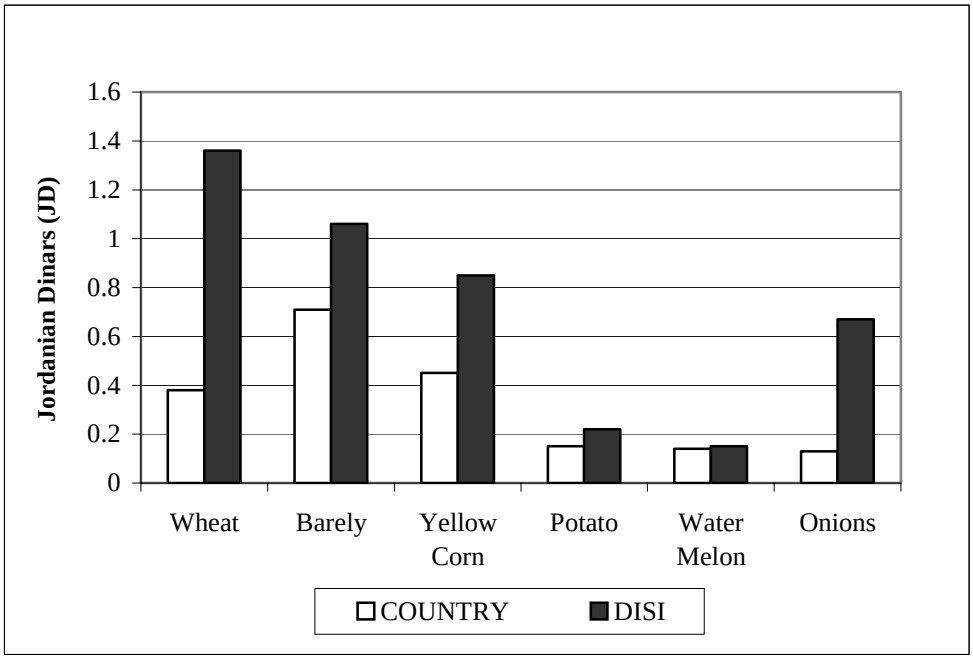



**Figure 28: Water consumption per one kilogram of output**

A closer look at the input levels used in the agricultural production process in Disi area indicates an adverse impact in exploiting the groundwater resource from Disi aquifer. The resource is non-renewable and will, on the very long run, be depleted. Moreover, the resource is used to produce agricultural products in an inefficient way. Same level of outputs could be produced with less irrigation water compared to other places were irrigated agriculture is practiced in the country.

## 3.3 Social Assessment

### 3.3.1 Social and Economic Baseline Conditions

#### 3.3.1.1 Background

Jordan is a semi-arid country with an average precipitation ranging from 600 mm per annum in the North West part of the country declining to 350 mm in the middle, and to less than 50 mm in the eastern and southern desert areas. Therefore, Jordan has been and will be facing challenges in its water sector not only due to the scarce water resources but also due to the abnormally high population growth rates and the problems associated with it including high pressure on these resources as well as infrastructure and services. The water sector has been given high priority in all socio-economic development plans since early 1970s.

Due to the conflict in the Middle East, Jordan has witnessed many waves of involuntary migration that have significantly contributed to the abnormal increase in population, of which the last was due to the influx of over 300,000 Jordanians residing in the Gulf States as well as 250,000 Iraqis and Arabs from other nationalities as a result of the Gulf War. In addition to that, the number of Egyptian workers in Jordan was estimated to exceed 80,000 persons.[12]

Rapid population increase in the main cities of Amman, Zarqa, and Irbid has placed unprecedented demands on water resources. Total demand is approaching one billion cubic metres per year, which approximates the limit of Jordan's renewable and economically developable water resources. It should be outlined that Jordan's water resources consist primarily of surface and groundwater, and for several years now, renewable groundwater resources have been extracted at an unsustainable rate in order to meet the increasing demand. Consequently, surface and groundwater quality in some areas is deteriorating. Current water demands in many areas particularly in Amman have not been met satisfactorily and the costs of developing new water resources are rising rapidly.

As standard of living steadily increases and as water demands for industry and tourism rise rapidly, greater pressure was placed on the already stretched resources further driving the per capita water availability down and placing Jordan well within the ten poorest water nations on earth. **Table 22** includes some comparative figures that reflect the decrease in water supply in the last ten years.

**Table 22: Jordan water supply ($m^3$/C/yr) by sector according to the MWI**

| Year | Population | Per Capita $m^3$ | | | |
|---|---|---|---|---|---|
| | | Domestic | Industrial | Irrigation | Total |
| 1994 | 4,139,458 | 52.18 | 5.80 | 161.61 | 219.59 |
| 1996 | 4,444,000 | 53.10 | 8.10 | 137.26 | 198.47 |
| 1998 | 4,755,700 | 49.62 | 7.99 | 131.21 | 188.824 |
| 2000 | 5,039,000 | 47.43 | 7.34 | 107.36 | 162.13 |
| 2001 | 5,182,000 | 47.47 | 6.37 | 95.52 | 149.36 |

The strategy adopted by the Ministry of Water and Irrigation[8] stresses the need for improved resources management with particular emphasis being placed on the sustainability of present and future uses. Special care is advocated for protection against pollution, quality degradation, depletion of water resources and achieving the highest practical efficiency in the conveyance system.

[12] DOS (Department of Statistics)- The Jordanian Returnees Survey 1994, Statistical Yearbook 1994.

Disi is a fossil groundwater aquifer extending from the southern edge of the Dead Sea in Jordan to Tabuk area in the Saudi Arabia. The exploitation of this aquifer started long time ago in Saudi Arabia (Tabuk area and its surroundings) for agricultural production as well as for domestic purposes. Development of the Jordanian part of the aquifer, on a significant basis, started in 1980. At present Aqaba city is provided with 16.5 Million Cubic Meters (MCM) for domestic purposes, while agriculture in the area is consuming 75 MCM. The binding agreement between the Government of Jordan and the four agricultural companies working in the area indicated that growing water abstraction from Disi aquifer should not exceed 91 MCM per annum.[13] The amount of water used by large-scale farms at Disi area is determined by the contracts between the Ministry of Finance and the farms owner companies. These contracts will expire by 2011, at which time a decision will need to be made by the Government concerning extension in their current form or with modifications. The Ministry of Water and Irrigation has indicated that it does not anticipate that the leases will be extended in their current form, as the country's water policy prioritize supplying water for domestic sector over agricultural sector.

Extensive studies carried out by the Ministry of Water and Irrigation indicated that additional 100-120 MCM can be drawn to Amman to elevate pressure on renewable ground water resources in the region. It is expected that total pumping from groundwater resources in Amman will be reduced to 60 MCM from the present level of 90 MCM (Extensive study on Disi Aquifer will be presented in the water sector study).

### 3.3.1.2 Spatial Distribution and Characteristics of Population

#### (a) Population in the Direct and Indirect Zones of Influence

The population of Jordan is 5,329,000 and it is increasing at a growth rate of 3.5% per annum. This rate of increase indicates that the population will double itself in a period of about 20 years. The average life expectancy at birth is 68.8 years for males and 71.1 years for females and the sex ratio is 105:100. The rise in life expectancy through a short period of time is a salient indicator to the socio-economic development in the country as well as to the efficient medical health care provided by the government, the armed forces and the private sector.[14]

The population of Jordan is characterized by a young age structure. About 51% of the population is under age 15 and only 5% is above age 65. Average family size is 6 persons. According to 1994 census 8% of the total population live outside the country, and 9% of Greater Amman population live outside

Urbanization in Jordan has been growing very fast mainly in the last 30 years. About 78.7% are living in urban centres and total density rate is 58 persons/km$^2$. The population of Greater Amman Municipality amounted in 2002 to 1.811 million. The city is divided into 41 municipal zones.

For the purpose of this study, the population of Jordan by locality was divided into two categories:

1- Population in the primary zone of influence including all localities that might be directly influenced by the construction of Disi Project. This category includes all towns and villages in Disi well-field as well as all localities along the pipeline corridor from Batn El-Ghoul to the southern outskirts of Amman.
2- Population in the secondary zone of influence including the 12 Governorates of Jordan.

[13] Social and Economic Indicators, DOS (Department of Statistics)- Statistical Yearbook, 2001.
[14] Population Division Estimate, DOS.

## (b) Population Projections

Using different population growth scenarios, population projections for the intervals 2010, and 2020 have been carried out for both zones.

Population in the primary zone of influence amounted in 1994 population census to 179,725 including a very small percentage of Bedouins living in the southern areas around Disi area. Almost all populations in that zone are living in well-organized municipalities and villages in new built houses. All towns and villages are provided with running inside water, electricity, schools, clinics and municipal and other service facilities. The main source of water to localities in Disi area which includes six towns and villages comes from Disi Aquifer; other localities along the pipeline corridor from Al-Jurf to Amman are provided with drinking water from under ground wells in each area.

Taking into account a growth rate of 3.5% per annum, the population in the primary zone will increase from 235,000 in 2002 to 312,000 in 2010 and to 440,000 in 2020 (see **Table 23**). It is unlikely that population growth rate in these localities will decline substantially at least in the foreseen future.

**Table 23: Population projections for the primary zone of influence 2010-2020 (Summary)**

| Projections | Growth Rate | 1994 Census | 2002* | 2010 | 2020 |
|---|---|---|---|---|---|
| Low | 2.8 | 179,725 | 235,000 | 280,000 | 368,000 |
| Medium | 3.2 | 179,725 | 235,000 | 297,500 | 408,000 |
| High | 3.5 | 179,725 | 235,000 | 312,000 | 440,000 |

N.B: For detailed information see **Tables 1, 2 and 3** in **Annex C18**
* Source: Department of Statistics

According to 1994 census, the population of Jordan amounted to 4,139,458 persons. At a moderate growth rate of 3.2% per annum (other things being equal), the population of Jordan is expected to increase to 6.9 million in 2010, and to 9.4 million in 2020 according to medium projections. Taking into account the prevalence of 3.5% growth rate throughout this period, the population of Jordan is expected to rise to 7.2 million in 2010 and to 10.1 million in 2020 according to high projections. A summary of population projections is presented in **Table 24**.

**Table 24: Population projections for Jordan 2010-2020 (Summary)**

| Projections | Growth Rate | 1994 Census | 2002* | 2010 | 2020 |
|---|---|---|---|---|---|
| Low | 2.8 | 4,139,458 | 5,329,000 | 6,439,000 | 8,487,000 |
| Medium | 3.2 | 4,139,458 | 5,329,000 | 6,852,000 | 9,389,000 |
| High | 3.5 | 4,139,458 | 5,329,000 | 7,178,000 | 10,125,000 |

N.B: For population projections by Governorate. See **Tables 4, 5 and 6** in **Annex C18**
* Source: Department of Statistics

Based on 2002 population estimates by the Department of Statistics, it can be noted that the population in Greater Amman Area amounted to 34% of Jordan's population. Knowing that most water supplied to Amman is imported from nearby areas and forming a great pressure on the aquifers leading to their salinisation and drawdown in water level, the importance and significance of supplying the Disi water to Amman can be realised. Several anticipated benefits have been identified for supplying Disi water to Amman as presented below:

- Providing a reliable supply in Amman which enhances the implementation of the rationing program for distribution of water;
- Improving environmental health conditions especially in areas which are getting water less than what is required by any health standards;
- Relieving the over-abstracted aquifers by reducing pumping to their safe yield and allowing natural recharge to take place; and
- Improving the quality of the supplied water to Amman;

### 3.3.1.3 Population Economic Characteristics

### (a) The Economy of Jordan

Jordan is a middle-income country with very limited natural resources, deriving significant proportion of its income from the remittances of Jordanians working abroad and from foreign aid. Income is usually generated from agriculture, trade, transit transportation from Europe to Saudi Arabia and the Gulf States. Foreign assistance to the Government of Jordan is of great importance in narrowing the budget deficit. However, in the last four years and upon the advice of the World Bank and the International Monetary Fund, Jordan has exerted strenuous effort to follow-up economic and financial reform aimed at creating a dynamic economic base. Equal attention has been directed to agriculture, mining, manufacturing as well as education, health and social programs. More recently, the Governors have been delegated power to implement socio-economic development plans in their jurisdictions.

The economy of Jordan is a heavily service-oriented economy. Taking into account the global economic situation, the GDP in Jordan has been recently growing at a rate slightly above the population growth rate. Economic growth presented in GDP is explained in **Table 25**.

**Table 25: Main economic indicators 1998-2001**

| Indicator | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|
| GDP at Current Prices (million JD) | 5609.8 | 5767.3 | 5992.1 | 6258.8 |
| GDP at Constant Prices (million JD) * | 5027.5 | 5181.4 | 5390.9 | 5616.3 |
| GDP Growth Rate at Current Prices | 9.2 | 2.8 | 3.9 | 4.5 |
| GDP Growth Rate at Constant Prices* | 3.0 | 3.1 | 4.0 | 4.2 |
| GDP per capita (in JD) | 1,179 | 1,177 | 1,189 | 1,208 |
| Inflation Rates | 3.1 | 0.6 | 0.7 | 1.8 |
| Consumer Price Index | 103.1 | 103.7 | 104.4 | 112.7 |

* Since 1994, One Dollar = 0.71 JD
Source: D.O.S Jordan in Figures, 2002

The GDP in Jordan grew fairly rapidly from 2,612 million JD in 1990 to 4,597.9 million JD in 1995 and further to 5,767.3 million JD in 1999.

The most striking feature of the economy of Jordan is the rapid decline of agricultural contribution to the gross domestic product. Contribution of agriculture to the GDP declined from 14% in the early 1970s to 6.2% in 1992 and to only 2.0% in 1999 due to the collapse in the prices of agricultural products on one side, and to the competition of other producing countries in the traditional markets of Jordan, in Saudi Arabia and the Gulf States on the other side. Other sectors, including manufacturing, energy, services and finance, are growing at acceptable rates with respect to the economic conditions in the region.

It should be noted that the balance of trade in Jordan has always been suffering from chronic and ever increasing deficit. Deficit in the balance of trade increased from JD 1.349 billion in 1995 to JD 1.913 billion in 2000.

In food production, Jordan is far from being self sufficient in products like sugar, wheat, meat, fish and dairy products. Food imports depend essentially on fluctuations in agricultural production from one year to another. Food import increases in the years of drought and decreases in good rainy seasons. Imports of food and live animals in the last five years are shown in **Table 26**.

**Table 26: Food and live animal imports and exports 1996-2000 in Million JD**

| Year | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|
| Imports | 686 | 540 | 532 | 484 | 519 |
| Exports | 160 | 181 | 165 | 127 | 116 |
| Food Deficit | 526 | 359 | 367 | 357 | 403 |

DOS-Statistical Yearbook 2000, Foreign Trade

Jordan is self sufficient in fruits, vegetables and many other food items. However, deficit in the food trade has prevailed over long time despite the increase in agricultural production.

Austerity measures taken by the Government of Jordan to achieve genuine economic reforms have kept inflation rates at the lowest possible level. Inflation rates remained around or less than 1% for the last 5 years.

The economy in the project area outside the Amman Governorate includes a variety of patterns including government employment in the civil service, municipalities and military; industrial employment in the phosphate industry; tourism in Wadi Rum; small shops and crafts; transportation; commercial agriculture; and subsistence agriculture and livestock production spread particularly among the young generation. Unemployment and lack of income have brought about resentment and frustration among the population. Leaders in the project area expressed their concern that the construction of Disi project should create more jobs to the unemployed people in the area either during construction or/and maintenance during the operational phase.

## (b) Labour Force

Since education has been given first priority in the socio-economic development programs in Jordan for the last forty or fifty years, the country was able to build highly educated professionals in almost all fields of science and engineering. Jordanians working abroad particularly in Saudi Arabia and the Gulf States used to be and still are a major source of foreign currency income through transfers to their families and relatives, and their deposits in national banks. Their contribution to the development of the business, consulting and construction sectors has been prominent.

The labour force by economic activity was not classified in 1994 population census. Labour statistics are gathered by successive employment surveys which are far from being complete or accurate. Paid and unpaid employees in the public and private sectors, excluding agriculture and armed and security forces, amounted in 2000 to 701,900 of which 560,166 are males and 141,784 are females. Average monthly payment per person is JD 226.[15]

[15] Employment Survey, DOS (Department of Statistics)-Statistical Yearbook, 2001.

Contrary to what has been expected as a result of the Gulf War and its aftermath events, remittances of Jordanians working abroad increased from JD 871.8 million in 1995 to JD 1,179.8 million in 1999.

### (c) Employment

Employment in Government and other community activities account for 37.24% of total employed persons 15 years of age and over. Similarly, employment in the manufacturing activities, electricity and construction account for 20.35% of total labour force.

The number of Jordanians working in agriculture is very low. Total employment in agriculture accounts for 4.05% only. Since agriculture is becoming industrial-oriented, the majority of employment in agriculture is made up of foreign labour. Female education particularly in the Jordan Valley was a major determinant for females to refrain from working in the field to office job and other services.

Unemployment in Jordan is in the range of 14-16% of total labour force 15 years of age and over, and underemployment is in the range of 25-30%. A survey of social needs in the project area particularly in Disi-Rum aquifer area indicated that unemployment is around 40% among the population in working age. Most of the officials, mayors, and village council members deeply expressed their concern about lack of job opportunities among the new generation and further lack of income resources. They truly expect that the Disi project will provide job opportunities for a great number of the young people; however, they are limited in skills and education.

The number of non-Jordanian workers holding legal permits amounted in 2000 to 110,580 persons of which 91,136 workers or 82.4% were Egyptians mostly working in the service sectors. The actual number of Egyptian workers in Jordan might be between 150.000-200.000 thousand since a great number of them are working illegally in the country.

### (d) Evolution of Water Tariffs

Political rather than economic factors have always been considered in the construction of water and irrigation tariffs in Jordan. Irrespective of cost recovery of operation and maintenance, the Government of Jordan targeted the affordability to pay for water consumption by all social and income strata in the society. More recently, the MWI realized that this policy is very costly and the Government cannot continue to subsidize water sector and that water fees collection should be as close as possible to the cost of water services. Subsidy is currently amounting to over JD 50 million annually.

Water tariff structure has been changed many times since 1975. **Table 27**, **Table 28**, **Table 29**, and **Table 30** present the municipal and irrigation water tariff as applied before 1/10/1997.

**Table 27: Municipal water tariff structure 1997**

| Greater Amman | | All Other Regions Of Jordan | |
|---|---|---|---|
| **Water Use ($m^3$)** | **1997 Tariff (JD)** | **Water Use ($m^3$)** | **1997 Tariff (JD)** |
| 01-20 | Minimum Charge (2 JD) | 01-20 | Minim Charge (1.3) |
| 21-40 | 0.14 | 21-40 | 0.075 |
| 41-50 | 0.179 | 41-50 | 0.102 |
| 51-60 | 0.242 | 51-60 | 0.146 |
| 61-70 | 0.308 | 61-70 | 0.191 |
| 71-80 | 0.373 | 71-80 | 0.236 |
| 81-90 | 0.438 | 81-90 | 0.280 |
| 91-100 | 0.507 | 91-100 | 0.329 |
| 101-150 | 0.667 | 101-150 | 0.437 |
| 151-200 | 0.850 | 151-200 | 0.681 |
| 201 and over | 0.850 | 201and over | 0.850 |

Source: MWI Water use in cubic meter per three-months period

**Table 28: Jordan Valley Irrigation Tariff Structure (1996)**

| Water Use (Cubic meters per agricultural Unit/Month) | Tariff (JD / $m^3$) |
|---|---|
| 0-1000 | 0.008 |
| 1001-2000 | 0.012 |
| 2001-3000 | 0.020 |
| >3000 | 0.035 |
| Average | 0.015 |

Source: World Bank, 1997

Taking into account differences in household income, affordability and social conditions, a progressive water and wastewater tariff has been applied as of 1/10/1997 dividing the country into four categories:

- Amman Governorate
- Zarqa Governorate
- The rest of the governorates and the Jordan Valley
- Non-Residential

**Table 29: Amman Governorate water and wastewater tariff calculations (Residential)**

| Consumption $m^3$/quarter | Meter fee/quarter | Water Bill JD/Quarter | WW Bill JD/Quarter |
|---|---|---|---|
| 0 - 20 | 0.300 | 2 | 0.600 |
| 21 - 40 | 0.300 | 0.14 (X) – 0.8 | 0.04 (X) – 0.2 |
| 41 - 130 | 0.300 | $0.006556\ (X)^2 - 0.12224\ (X)$ | $0.002889\ (X)^2 - 0.07556\ (X)$ |
| > 130 | 0.300 | 0.85 (X) | 0.350 (X) |

(X) = Water consumption in $m^3$/quarter

As of 1/1/2003, the rate was raised by 0.5 JD for block 0-20, and by 0.5 JD for all other blocks.

**Table 30: Other Governorates water and wastewater tariff calculations (Residential)**

| Consumption m³/quarter | Meter fee/quarter | Water Bill JD/ Quarter | WW Bill JD/Quarter |
|---|---|---|---|
| 0 - 20 | 0.300 | 1.3 | 0.6 |
| 21 - 40 | 0.300 | 0.075 (X) – 0.2 | 0.035 (X) – 0.1 |
| 41 - 130 | 0.300 | 0.004517 $(X)^2$ – 0.10568 (X) | 0.001828 $(X)^2$ – 0.038103 (X) |
| > 130 | 0.300 | 0.85 (X) | 0.35 (X) |

(X) = Water consumption in m³/quarter

As of 1/1/2003, the rate was raised by 0.5 JD for the 0-20 block and by 1 JD for all other blocks.

Non-residential water consumption including commercial, industrial and tourist establishments is treated in a straightforward tariff as 1 JD/$m^3$ plus 0.560 JD for wastewater charges with minimum charge of 5 $m^3$ irrespective of quarterly consumption.

## (e) Affordability to Pay for Water Consumption

Affordability to pay for water fees is strongly associated with the average income of the household. There is no agreement on the optimal percentage to be paid by the household but it differs from one country to another depending on availability of clean water resources, cost of service and average income. The World Bank and many other international organizations considered that affordability would be fair and acceptable if it lies in the range between 1 to 2.5% of the household income.

GDP per capita is a misleading criterion for the calculation of the population affordability to pay for water services. The latest available information on the household income and expenditures on water service dated back to 1997 household survey, that is, before the application of the new water tariff.

**Table 31** and **Table 32** present the billed water consumption and revenues by block for Jordan and Greater Amman Municipality.

**Table 31: Water consumption and revenues by block excluding Amman 2000**

| Water Block (m³) | No. of Bills | Consumption (m³) | Amount (JD) | Percentage of Bills (%) | Percentage Consumption (%) | Percentage Revenues (%) |
|---|---|---|---|---|---|---|
| 0 - 20 | 423,344 | 4,717,091 | 864,462 | 27 | 6 | 4 |
| 21 - 40 | 535,310 | 16,689,999 | 1,489,675 | 35 | 23 | 6 |
| 41 - 70 | 413,999 | 21,870,268 | 3,374,652 | 27 | 30 | 14 |
| 71 - 100 | 110,645 | 9,168,023 | 2,715,029 | 7 | 13 | 11 |
| 101 and more | 59,906 | 20,522,016 | 15,897,994 | 4 | 28 | 65 |
| **Total** | **1,543,204** | **72,967,397** | **24,341,812** | **100** | **100** | **100** |

Source: Ministry of Water and Irrigation-Finance Department

**Table 32: Water consumption and revenues by block in Amman 2001**

| Water Block ($m^3$) | No. of Bills | Consumption ($m^3$) | Amount (JD) | Percentage of Bills (%) | Percentage Consumption (%) | Percentage Revenues (%) |
|---|---|---|---|---|---|---|
| 0 - 20 | 362,376 | 3,844,402 | 1,052,720 | 32 | 8 | 6 |
| 21 - 40 | 383,126 | 11,571,792 | 1,655,143 | 34 | 25 | 9 |
| 41 - 70 | 270,381 | 14,247,792 | 3,589,710 | 7 | 13 | 15 |
| 71 - 100 | 75,898 | 8,280,329 | 2,831,627 | 7 | 13 | 15 |
| 101 and more | 48,416 | 10,891,742 | 9,305,277 | 4 | 24 | 50 |
| **Total** | **1,140,197** | **46,936,057** | **18,434,477** | **100** | **100** | **100** |

Source: Ministry of Water and Irrigation- Finance Department

Water consumption pattern indicates that 29% of customers outside Amman and 33% of customers in Amman fall in the category 0 - 40 meters consumption per quarter. In general, monthly fees paid by the household per month is JD 1.224 in the 0 - 20 water block in Amman Governorate, JD 1 in Zarqa and JD 0.967 in the rest of the Governorates as revealed in **Table 33**. This amount is affordable even by the least privileged household in the Kingdom assuming average household income is 150 JD per month. As presented in **Table 33,** this rate amounted to 2.79 JD, 1.92 JD and 1.9 JD in the three categories of Amman, Zarqa and Other Governorates, respectively.

**Table 33: Comparison of water bills value in JD by category and consumption**

| Consumption / Category | 20 $m^3$ | 40 $m^3$ | 60 $m^3$ | 80 $m^3$ | 100 $m^3$ |
|---|---|---|---|---|---|
| Amman Governorate | 3.672 | 8.368 | 24.838 | 48.117 | 79.230 |
| Zarqa Governorate | 2.972 | 5.756 | 16.229 | 31.641 | 52.304 |
| Other Governorates | 2.900 | 5.600 | 15.714 | 30.603 | 50.568 |

Special concession rates are granted to many social institutions in the country such as homes for the elderly, handicapped special training schools and orphanages sponsored by the Ministry of Social Affairs or the public societies.

## (f) Cost and Benefit of the Project

The cost and benefit of the project was derived from the Final Feasibility Study Report prepared by Harza Group in 1996. Section 6 of Harza's study deals with the economic evaluation of the project. The approach adopted in the evaluation comprised the following:

- Identifying the effective utilisation of the supplied water by Disi conveyor;
- Assessing the least cost solution;
- Determining if the economic benefits exceed the economic costs; and
- Identifying the non-quantifiable benefits that will influence the decisions on the project.

A comparison of costs and benefits was carried out to establish whether the Disi project's contribution to the future improvements in the economic and social welfare of the community in Amman is of greater value than the resource costs incurred by the national economy. The environmental impact of the project was also considered in assessment of viability of the project.

The economic evaluation considered the economic cost of water and the need to increase the water tariff to cover, not only the operation, but also the capital cost and water cost. Since then, there has been changes in the water tariff as mentioned in the above two **Sections (d) and (e)**. The capital investment and operating costs for the least cost scenario were used to derive the long term incremental costs of supply for different discount rates as presented below:

| Discount Rate | Unit Cost (JD/$m^3$) |
|---|---|
| 6% | 0.44 |
| 8% | 0.52 |
| 10% | 0.61 |

It should be highlighted here that these costs are prior to increasing the tariff as mentioned under **Section (d)** above.

The economic benefits of water comprise both quantifiable and non-quantifiable benefits, which can be divided into:

- Incremental water supply;
- Resource cost saving;
- Socio-economic benefits; and
- Water strategy/conservation.

The first two can be considered as quantifiable while the last two are non-quantifiable. Based on the evaluation of the above four benefits, the economic viability of the project was assessed by Harza Group where the evaluation showed that the project is economically viable at the full range of projected tariff rates as presented in **Table 34**.

**Table 34: Economic viability of the project was assessed**

| Average Water Tariff at | NPV at 10% (Million JD) | NPV at 6% (Million JD) | IRR |
|---|---|---|---|
| JD 0.45/$m^3$ | -47.4 | 86.7 | 8.1% |
| JD 0.60/$m^3$ | 22.8 | 210.9 | 10.8% |
| JD 0.75/$m^3$ | 92.2 | 335.1 | 13.2% |

## (g) Water Use in the Southern Section of the Project Area

Water consumption from Disi aquifer is divided into the following activities:

1- Agriculture: Large scale irrigated agriculture in Disi-Mudawwara area started in 1986 by four specialized companies that utilized 10,864 hectares of treasury land rented for a maximum period of 30 years ending in 2011. It is estimated that total exploitation of groundwater amounted in 2002 to 75 MCM. It is understood that the Ministry of Water and Irrigation does not plan to extend the agreements for these four specialized companies beyond their current expiration dates and that the water saved would be used to meet domestic demand in the greater Amman Region.

2- Domestic Water Consumption:
   a. Aqaba City is drawing 16.5 MCM of which 14.5 MCM are utilised for domestic purposes, and 2 MCM for public utilities in the city.
   b. Disi sub-district: As the population in the Disi sub-district have been considered for long time as under privileged, the area was provided with 2.1 MCM in 2002

free of charge. More recently, the MWI has proposed that the people of this area should pay for at least the operation and maintenance costs. Two proposals therefore have been suggested; either to install water meters for subscribers or to pay a flat rate of 5 JD per connection per quarter. Both suggestions have been strongly opposed by the majority of inhabitants in the area.

3- Industrial Water Consumption: Industrial water consumption in Aqaba amounted in 2002 to about 8 MCM. Three major industrial companies are drawing this amount from their own ground wells. These companies are namely:
   a. The Jordanian Phosphate Company;
   b. The Potash Fertilizers Compound; and
   c. The Aqaba Thermal Station.

Generally, water consumption for industry will remain constant since these companies intended for future expansion either to desalinate seawater, or to use reclaimed treated wastewater as suggested by Aqaba Water and Wastewater Master Plan.

### 3.3.1.4 Education

The majority of the population in Jordan is educated. Illiteracy rate among population 15 years of age and over is 11% (5.6% for males and 16.2% for females). Education is compulsory for males and females up to the ninth grade. More than 27% of the population of Jordan is enrolled in kindergarten, basic and secondary education. About 70% of all students are in governmental schools.

Out of 1,407,729 students below university education, 51% are males and 49% are females.

Academic and institutional education achieved steadfast progress during the last 15 years. There are 8 state universities, 9 private universities and 4 academic technical institutions. Total university enrolment amounted in the academic year 1999-2000 to 105,813. The rate of female enrolment in the academic education is 47.9%.

Students enrolled in post graduate studies at Jordanian universities amounted for the same academic year to 6,670 of which 5,304 in studies leading to a Master Degree.

It should be emphasized that due to Jordan's limited natural resources, education became the most important aspect of social and economic development. The participation of qualified and highly educated Jordanians in the development of Saudi Arabia and the Gulf States started as early as 1950.

### 3.3.1.5 Public Health

More than 80% of the population of Jordan is medically insured. Medical insurance is sponsored by the following three different institutions:

1- The Ministry of Health - Medical Insurance Corporation: This type of medical insurance covers almost all Government employees. It includes medical treatment, hospitalisation, and medicine free of charge. Medical premiums paid by the insured employee are 3% of gross salary.

2- The Armed Forces: All military personnel and security forces including retired persons are also medically insured for treatment, hospitalisation and medicine.
3- Establishments employing 5 persons and more must be subscribed in the Social Security Program at the Social Security Corporation. Normally, this type of insurance is applied to all risks including labour accidents. Charges paid by employees are in proportion to their gross salary, where 5.5% is paid by the employee and 10% paid by the establishment. For medical treatment in the private insurance companies, the actuarial principles are applied.

More than 1,230 medical centres and clinics of the Ministry of Health are spread all over towns and villages in the Kingdom. Comprehensive health centres and some of the primary health centres include maternal clinics, child clinics and dental clinics. All towns and villages in Disi project area are provided with either a comprehensive or a primary health clinic. Medical treatment in the area is free of charge.

Jordan is becoming a very well known country in the Middle East for advanced technology in the field of medicine. Thousands of citizens from neighbouring Arab countries, Yemen and Africa come to Jordan every year for medical treatment. At present Jordan has 86 hospitals of which 52 are private hospitals. Total hospital beds amounted in 2000 to 8,705 beds, that is, 590 persons per bed as compared to 1,500 in 1993.

This improvement in the health sector is reflected through the figures related to waterborne diseases (diarrhoea, vomiting, dehydration, gastrointestinal infections, typhoid, amoebae, mouth infection, urinal trait infection or stones). For example, regarding diarrhoea it is noticeable that the average of diarrhoeas occurrence has extremely decreased significantly during the last ten years. The average of occurrence of diarrhoea in 1993 was 3,025.3 per 100,000 and had decreased to 2,080.4 per 100,000 in 2002 (see **Table 35**).The same principle applies to typhoid disease, where the average of this disease decreased form 10.6 per 100,000 in 1993 to 0.8 per 100,000 in 2002.

**Table 35: Incidence rate per 100,000 population of diarrhoea during 1993**

| Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|
| Incidence rate /100,000 | 3,025.3 | 2,749.1 | 2,465.5 | 2,712.8 | 2,381.6 | 2,122.8 | 2,165.6 | 2,039.5 | 2,034.6 | 2,080.4 |

A close examination of statistics on water borne diseases did not prove the authenticity of the figures since the number of diarrhoea cases is reported only by some clinics of the Ministry of Health. However, diseases like typhoid, summer diarrhoea, and dysentery, are closely associated to contaminated drinking water, in addition to the general hygiene conditions of the household itself. Low income of the household and women educational standard play a very important role in this aspect.

Water resources in Jordan are clean and in strict conformity to the Jordanian and WHO Standards. Water resources are strictly controlled by WAJ. More than 50,000 samples are examined by WAJ laboratories every month. Any water resource is shut down and treated immediately should any sign of contamination of any type appears in laboratory test.

Despite all these tests and measures that control the quality of dinking water, a number of events related to water contamination occurred during the last 20 years. The most important one occurred 5 years ago. After signing the Peace treaty between Jordan and Israel, A new pipeline was constructed between Lake Tiberius and King Abdullah Canal (KAC) to provide Jordan with its share from flood water stored in the lake. This water flows through KAC until it reaches the intake leading to the pump station providing Zai water treatment plant and thereafter to Amman.

Unfortunately, the brown algae in the new water source was not detected at the intake and the activated carbon in the plant was ineffective and requires replacement. This resulted in pumping algae and consequently contaminated water to Amman.

His Majesty, Late King Hussein, was concerned with the problem and immediately sent his private plane to bring the needed activated carbon. This incident was the subject of extensive coverage in the media, was of broad concern to society and the Government of Jordan has no choice other than firing all the responsible persons whether in the Ministry or in the plant. Since then, strict monitoring of the sources water is carried out as well as required testing, and whenever a sign of contamination which can not be handled by the plant is detected, the plant will temporarily be shut down. This will prevent any contamination incidents and ensures that the plant is running efficiently.

Sources of water contamination may be attributed to the following:

- Leakage in the corroded and deteriorated old water network in Amman. At present WAJ is endeavoured to replace all mains and laterals by a new water network in most parts of the city.
- Intermittent pumping of water supply, which may allow contaminants to infiltrate to the system.
- Lack of public awareness. It is well known that water is stored in roof tanks made of galvanized steel or fibreglass. Unless sedimentation of various particles is removed regularly, the possibility of growing bacteria will generally affect the health conditions of the household.

The availability of treated water sold by water vendors, and the wide spread use of reverse osmosis apparatus at house hold level has played a very important role in the household negligence to clean water tanks in which water is stored as a result of the intermittent pumping during the week. Due to over extraction from underground water resources, it became imperative that water pumping must be rationed for each quarter of Amman City according to a specific time table.

In general, the public health conditions in Jordan are very satisfactory irrespective of the fact that poverty does exist in the country. Total expenditures on public health amounted in 2001 to JD 337.6 million of which JD 202.8 was the share of the Government, while expenditures of the private sector amounted to JD 134.8 million.

### HIV/AIDS

AIDS is considered to be one of the dangerous diseases that threaten the life of many people around the world. Fortunately the incidence of this disease in Jordan is very limited, where 59% of the infected cases discovered in Jordan in 2002 are non-Jordanians and about 86.7% of these cases were infected with HIV outside Jordan. The number of infected and carrier people did not exceed 333 until 3/12/2003 of which 201 are non-Jordanians[16]. Although the incidence rate is very low compared to other countries, the Ministry of Health (MOH) is working very hard to control the transmission of this disease through many programs and publications that increase public awareness regarding AIDS. MOH also implemented many programs and put many regulations that control blood transfusion, surgical operations and infections in hospitals. For detailed information on HIV in Jordan see **Annex C19**.

[16] Rai Newspaper 3/12/2003.

It is not expected that Disi project will make any increase in these cases neither in the construction nor the operation phases as all foreign technicians, engineers and labourers should follow the regulations in the country and carry out the required tests before getting their residency.

### 3.3.1.6 Tourism

Wadi Rum, which is part of Disi area, is a unique desert landscape characterised by beautiful desert scenery and Rum Mountain which rises up to 1,200 m above sea level. The area is a winter resort visited by tourists from all over the world. Horse and camel riding are the most attractive sports particularly in Wadi Rum. Local population provide the horses and camels which over time have been a major source of income to local people. The number of tourists visiting Wadi Rum according to their main countries of origin and by month are presented in **Table 36** and **Table 37**, respectively.

**Table 36: Number of visitors to Wadi Rum by nationality 1998-2002**

| Year / Nationality | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|
| U.S.A | 2,949 | 3,999 | 2,552 | 919 | 918 |
| Canada | 99 | 295 | 337 | 604 | 221 |
| Other Americans | 168 | 198 | 812 | 978 | 200 |
| **Total Americans** | **3,216** | **4,492** | **3,701** | **2,501** | **1,339** |
| Germany | 13,487 | 13,250 | 14,582 | 5,810 | 3,368 |
| France | 15,717 | 19,443 | 24,214 | 5,628 | 5,447 |
| U.K. | 4.703 | 4,033 | 6,459 | 4,140 | 4,684 |
| Italy | 9,572 | 11,548 | 12,729 | 3,791 | 1,637 |
| Spain | 3,177 | 4,638 | 6,060 | 3,356 | 2,437 |
| Belgium | 2,855 | 2,024 | 2,597 | 2,723 | 394 |
| Switzerland | 353 | 1,367 | 2,581 | 1,898 | 308 |
| Austria | 1,971 | 3,871 | 3,576 | 3,029 | 460 |
| Netherlands | 3,864 | 3,805 | 4,196 | 2,454 | 1,632 |
| Greece | 266 | 221 | 301 | 1,210 | 19 |
| Russia | 7 | 18 | 84 | 31 | 160 |
| Sweden | 112 | 125 | 221 | 122 | 166 |
| Denmark | 130 | 342 | 227 | 114 | 17 |
| Other Europeans | 6,858 | 3,351 | 12,563 | 3,034 | 2,958 |
| **Total Europeans** | **63,072** | **68,036** | **90,390** | **37,340** | **23,687** |
| Indonesia | 48 | 15 | 67 | 390 | 12 |
| Japan | 2,026 | 1,758 | 2,499 | 1,278 | 453 |
| Hong Kong | | 0 | 127 | 235 | 133 |
| Singapore | | 0 | 0 | 526 | 0 |
| Malaysia | | 0 | 0 | 0 | 25 |
| Other Asian | 78 | 108 | 55 | 285 | 193 |
| **Total Asian** | **2,152** | **1,881** | **2,748** | **2,714** | **816** |
| Australia | 355 | 710 | 1,401 | 194 | 305 |
| New Zealand | 70 | 200 | 338 | 56 | 51 |
| Arabs | 73 | 19 | 380 | 177 | 644 |
| Jordan | 514 | 298 | 912 | 1,069 | 3,370 |
| Israel | 2,006 | 2,716 | 3,004 | 0 | 176 |
| African countries | | 0 | 0 | 0 | 38 |
| **Grand Total** | **71,458** | **78,352** | **102,904** | **44,051** | **30,426** |

Source: Statistics Department, Ministry of Tourism and Antiquities, Jordan/Wadi Rum 12/22/2003

**Table 37: Number of visitors to Wadi Rum by month 1997-2002**

| Month | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | Change |
|---|---|---|---|---|---|---|---|
| January | 2,920 | 3,326 | 4,220 | 3,04 7 | 1,469 | 885 | -39.75% |
| February | 4,365 | 3,409 | 5,265 | 6,436 | 2,953 | 1,832 | -37.96% |
| March | 7,152 | 6,004 | 5,202 | 15,718 | 6,152 | 3,052 | -50.39% |
| April | 9,895 | 10,326 | 10,171 | 24,258 | 7,730 | 4,650 | -39.84% |
| May | 5,229 | 7,178 | 8,596 | 13,750 | 4,682 | 3,275 | -30.05% |
| June | 2,088 | 2,438 | 3,860 | 6,564 | 1,799 | 2,352 | 30.74% |
| July | 2,088 | 2,747 | 2,955 | 1,427 | 2,868 | 1,180 | -58.86% |
| August | 4,754 | 4,852 | 5,593 | 5,752 | 5,167 | 2,618 | -49.33% |
| September | 4,905 | 5,742 | 7,018 | 5,915 | 2,898 | 2,351 | -18.88% |
| October | 8,960 | 12,104 | 12,134 | 11,437 | 5,174 | 3,894 | -24.74% |
| November | 6,507 | 9,178 | 8,324 | 6,330 | 2,624 | 2,612 | -0.46% |
| December | 3,557 | 4,154 | 5,014 | 2,270 | 535 | 1,725 | 222.43% |
| **Total** | **63,214** | **71,458** | **78,352** | **102,904** | **44,051** | **30,726** | **-30.93%** |

Source: Statistics Department, Ministry of Tourism and Antiquities, Jordan/Wadi Rum 12/22/2003

There are 7 desert camps providing full accommodation to tourists under the supervision of the Ministry of Tourism and Antiquities. Modern tourist services in these camps are mixed with the traditional features of the Bedouin life and traditions.

Only 55 km from the Disi main road, very luxurious hotels of Aqaba are also providing superb services including swimming on the beautiful Aqaba beaches. However, it should be stated that the contribution of the local people in Disi to these services are very limited due to lack of training and social attitudes.

### 3.3.1.7 Social and Economic Development Program

Jordan's current economic performance, together with high levels of poverty and unemployment makes it essential to devise a modern social safety-net system that will serve the Kingdom effectively for the next twenty-five years and beyond. Poverty is a serious problem in Jordan. Based on the 1997 Household Expenditures and Income Survey, the World Bank estimated that the poverty line is JD 313.5 per person per year, although other organizations have different calculations of this line. Poverty in Jordan lies within 15-30% of the population.[17]

The Ministry of Planning-Regional Planning Directory developed in 2001 a three years regional development plan for 2002-2004 for each Governorate except for Aqaba, where Aqaba Special Economic Zone Authority (ASEZA) is responsible for the socio-economic development of the region.

Aqaba Special Economic Zone Authority (ASEZA) master plan did not include any projects that depend on Disi groundwater[18]. In addition, a new development plan for Aqaba has not been issued yet and its preparation will start in 2004 by Aqaba Governorate Development Office.

The regional development plan is a description of the status quo in each Governorate rather than a perspective plan for economic development. However, two points have been considered as a common aspect of all plans:

[17] The Ministry of Social Development: Poverty Alleviation for Stronger Jordan (May, 2002).
[18] Source: www.aseza.gov.jo

1- The increase of employment since 45,000 more jobs are needed annually.
2- The abatement of poverty by increasing family assistance obtained by the poor from the National Relief Fund.

### 3.3.2 Social and Cultural Characteristics of the Indigenous Peoples

#### 3.3.2.1 Overview

By World Bank definitions the terms “indigenous peoples”, “indigenous ethnic minorities”, “tribal groups” and “scheduled tribes” describe social groups with a social and cultural identity distinct from the dominant society that makes them vulnerable to being disadvantaged in the development process.

Indigenous peoples as far as this study is concerned can be identified in particular geographic areas by the presence in varying degrees of the following characteristics:

1- A close attachment to ancestral territories and to the natural resources in these areas;
2- Self-identification and identification by others as members of a distinct cultural group;
3- An indigenous language and identification by others as members of a distinct cultural group;
4- Presence of customary social and political institutions; and
5- Preliminary subsistence-oriented production.

To prevent any tribal disputes over grazing land, the Government of Jordan delineated tribal grazing rights to each of the major tribes and has strictly implemented it over 60 years. In fact Bedouins in Jordan do not differ or are distinguished from the rest of the population in religion or cultural heritage. They differ to some extent in their cultural habits, mode of life, and political aspirations. Tribal social structure, as described by tribal members, is based on the ramification of matrilineal ties among men. In reality, matrilineal ties also were significant in providing access to material and social resources.

Tribes in Jordan were groups of related families claiming descent from a supposed founding ancestor. Within this overall loyalty, however, descent from intermediate ancestor defined several levels of smaller groups within each tribe. Tribal settlement started in mid 1930s and expanded rapidly after mid 1950s. However, sedentarization was neither completely voluntary nor as a result of an official settlement policy. Rather, it appeared to be a natural response to changing political and economic circumstances, particularly the formation and consolidation of the state.

For a long time, the Bedouin population roaming the eastern desert between Saudi Arabia, Jordan, Iraq and Syria, has taken the opportunity provided by military service to move beyond camel, sheep and goat grazing as the primary source of livelihood. Some of them became ministers, members of the parliament, high-ranking officers in the military as well as in the security forces. Supported by the government educational system, a great number of Bedouins became doctors, engineers and scholars. Subsequently a large segment of the Bedouins settled down in the cities of Amman and Zarqa. They are related to their tribes only by blood. Government policies encouraged settlement by providing schools, medical services, and the development of water resources. The proportion of people living the traditional Bedouin lifestyle dwindled from 3.5% in 1960 to less than 1% in 1995.

Taking into consideration the World Bank criteria of indigenous people, the following points have been ascertained:

- The Indigenous Peoples of Jordan are deep rooted in the land of their ancestors.
- The Indigenous Peoples are not ethnically identified. They are Arabs and predominantly Moslems with no separate cultural and educational entity.
- The Tribal Customary Law has been cancelled in 1985. The Civil Law provisions are applied equally to all citizens irrespective of religion or ethnic composition. However, some of the tribal norms and traditions closely related to the prevention of crime, offence or revenge, have been incorporated in the Penal Code.
- Subsistence-oriented economy is practiced at a very limited scale in the semi-nomadic society. Camel and sheep grazing is still the main source of income to families in this sub-group.
- Out of the 110 seats in Lower House of the Parliament in Jordan, Bedouins are represented by 6 seats divided equally among Bedouins in the north, central and south of Jordan. Their representatives have been active in defending the Bedouins social, economic and political interests.

Looking into the Bedouin settlement areas, most of them live to the west and along the project line. The meetings with tribal leaders, revealed that they have no objection whatsoever to any project implemented by the Government.

Some of the Bedouins, mainly the Sheikhs have settled down in some agricultural land where they have been licensed to dig groundwater wells and to practice agriculture. However, privileged Bedouins are ardent to keep their privileges. They have always been looking forward to government aid particularly in the years of drought or calamities.

The estimate of the Bedouin population in southern Jordan that is living a traditional lifestyle exceeds 35,000 persons.

Although the Bedouin tribes of Jordan have been mapped and classified since the 1940s of the last century, information gathered from the Badia Forces in the area and mayors of major cities and governors indicated the following:

1- Southern Bedouins: Southern Bedouins normally live in Wadi Araba north of Aqaba city, Wadi Rum, Qa'a Al Disi, El-Jafer, Ma'an, Al Jurf, Al Hasa, Qatraneh and Husienieh. In general, their presence in these areas is almost governed by the availability of water and grazing land for their sheep. Most recently the construction of the desert highway brought about a variety of job opportunities to their localities.

   In the Disi area, Al Zawydeh Tribe, Muznah and Mara'beh live in Disi sub-district. The main villages in this area are Diseh (the centre of the sub-district) Tuwaiseh, Mnaishir, Al Ghal and Al Tawil.

2- Central Bedouins- South of Amman, Madaba, Al Jiza to Qatraneh: Bani Sakhr

   Bani Sakhr has two branches:

   a. Ka'abneh Tribe comprised of the following sub-tribes:
      i. Kharshan which includes 9 families
      ii. Jubur which includes 7 families
   b. Tuwaqa Tribe comprised of the following sub-tribes:

i. Ghubein which includes 28 families (a family may include a number of households).
ii. Amir which includes 12 families
iii. Huqeiesh which includes 14 families

3- Bedouins in the southern areas are divided into two main tribes:
   a. Bani 'Atiyya: comprised of 6 sub-tribes
   b. Huweitat (which is the biggest tribe in Jordan) is divided into the following sub-tribes and families:

| Sub-tribe | Families |
|---|---|
| Hajaya | 16 |
| Mana'in | 5 |
| Matalqa | 10 |
| Tuweiha | 13 |
| Suliemaniyin | 11 |
| Nu'eiymat | 5 |
| Muhalf | 33 |

More than 98% of all villages in Jordan are supplied with inside running water, electricity, schools, clinics, asphalted roads and communication systems including all Bedouin villages in Disi area and along the pipeline corridor.

Most of the people living in the Disi area depend on agriculture and/or grazing as a main source of income. The area of the farms owned by Disi residents is very small compared to that owned by the four agricultural companies working in Disi. For this reason, some of the Disi residents work in these companies mainly as field workers. **Table 38** shows the number of workers in these companies.

**Table 38: Employees in the Disi agricultural companies**

| Company Name | Jordanian Employees | Non-Jordanian workers |
|---|---|---|
| GRAMICO | 296 | 195 |
| RUM | 135 | 107 |
| ARICAD | 67 | 348 seasonal workers (Jordanians & non-Jordanians) |
| WADICO | NA | NA |

Its is difficult to know the exact number of Bedouin workers or the percentage of Bedouins in the above numbers since as mentioned earlier in **Section 3.3.2.1**, Bedouins in Jordan do not differ from the rest of the population in religion or cultural heritage and they have Jordanian nationality.

For the purpose of the social assessment, the study team carried out interviews with Sheikhs who are at the same time the leaders of their tribes (see **Annex C1: Interview Records**). Their opinion or views represented in many ways the individuals in their communities.

In addition, a meeting was held with the Sheikhs of Disi area, after the second phase of consultation in Aqaba, for discussing their concerns regarding the Disi project and any clarifications that they might require (see **Annex C1**). These discussions revealed the following points of views and requests:

- For Bedouins, water is a resource that should be shared with all people and should not be considered as a resource owned only by the residents of the area.

- They request that training to be provided for locals from Disi area in order to employ them in the operation of the Disi project.
- The addition of one Fils to the water bill (Fils of Disi) for the purpose of development of the Disi area.

### 3.3.2.2 Settlement of the Bedouin

The settlement program for the Bedouin population in the Disi area started in 1957 with the assistance of the Italian Government. In this program, the Italian Government assisted in the establishment of a small pilot project for the resettlement of 16 Bedouin families in Disi, including the digging of two groundwater wells for agriculture as well as for drinking water. Later in 1963, the project was transferred to the Ministry of Agriculture. The project has been further extended to include 25,000 hectares of cultivable land of which 15,000 hectares are at present irrigated land. Grazing land was estimated at 5,000 hectares.

A brief description of other settlement projects is indicated below:

1- El-Jafer Agricultural project: Established in 1963 on 245 hectares and allocated later into 5 hectares farm units.
2- Al Arja Project: Established in 1969-74 and financed by the Republic of Germany on 120 hectares.
3- Al Qasimieh Agricultural Project: Established south of Ma'an City on 117 hectares.
4- Tall-Burma Project: Established in 1968-71 on 100 hectares divided into 40 farm units.

The number of families or individuals who were affected by these projects is unknown. The study team tried to find this data by contacting several ministries and departments (Department of Statistics, Ministry of Water and Irrigation, Ministry of Planning and Ministry of Social Development), but unfortunately no data was found.

It should be emphasized that the process of Bedouin settlement has already been achieved by a long-term policy or by the self-determination of the Bedouin populations to change to a more urban and sedentary lifestyle. The construction of a nationwide road network played very important role in the population access to almost all parts of the country, and consequently to the economic, social and cultural centres in the Kingdom.

### 3.3.2.3 Land Acquisition and Resettlement

Involuntary resettlement under development projects, if unmitigated, often gives rise to severe economic, social, and environmental risks. Involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out. For these reasons, World Bank policy objectives indicated that Involuntary Resettlement should be avoided where feasible, or minimized, exploring all viable alternative designs.

Mass resettlement of the population as a result of a development project never happened in Jordan. Involuntary resettlement is closely associated with land or property acquisition for the implementation of a public utility or infrastructure project.

In the case of the Disi-Amman Water Conveyance Project, the final design avoided human settlement, private property, commercial areas, and agricultural and grazing land to the fullest extent possible. Only within Segment C, in the vicinity of greater Amman, are there issues related to involuntary acquisition of limited parcels of land and potential short-term disruption of business during the construction phase. However, these lands are already acquired and the details of these land acquisitions are included in **Annex C20**.

### 3.3.3 Land Acquisition Framework and Policy

#### 3.3.3.1 Legal Background

The Jordanian Acquisition Law No. (12) for the year 1987 and its amendments are in fact relatively modern and legally comprehensive. The process of acquisition is based on legal and administrative principles aiming at giving the proprietor and all other related beneficiaries fair and just compensation for the acquired properties with all their legal rights vested in the law. The acquisition completed prior to starting the ESA for Disi were carried out based on the above mentioned law.

However, any new land acquisition and resettlement required for the project will be carried out in accordance with the Land Acquisition and Resettlement Framework (LARPF) provided in **Annex C24**.

#### 3.3.3.2 Land Acquisition Procedures

For the purpose of the construction of Disi-Amman Water Conveyance, three types of properties have to be acquired, namely:

- Private land and property.
- Government or Treasury Land.
- Authorization from the Ministry of Public Works and Housing to construct the pipeline within the road's right-of-way or within the road itself.

#### 3.3.3.3 Disi Conveyance Segmentation

For the purpose of verifying land acquisition along the corridor of the conveyance system the project alignment was divided into the following segments (see **Figure 29**):

- Segment A: From well field to Jurf Al Darawish-Qatraneh Junction on the desert highway
    - A-1: From well field to the end of Batn Al Ghoul area
    - A-2: From Batn Al Ghoul to Ma'an - El-Jafer road (Ma'an Turnouts)
    - A-3: From El-Jafer - Ma'an road to Al Jurf-Qatraneh Junction (Tafileh Turnout)
    - A-4: From Jurf-Qatraneh junction to end of Qatraneh district (Karak Turnout)

- Segment B: From end of Qatraneh district to end of Al Jiza district

- Segment C: End of Al Jiza District to Amman
  - C-1 Al Jiza to Madaba Bridge (Madaba Turnout)
  - C-2 Madaba Bridge to Abu-Alanda Reservoir
  - C-3 Madaba Bridge to Dabuk Reservoir

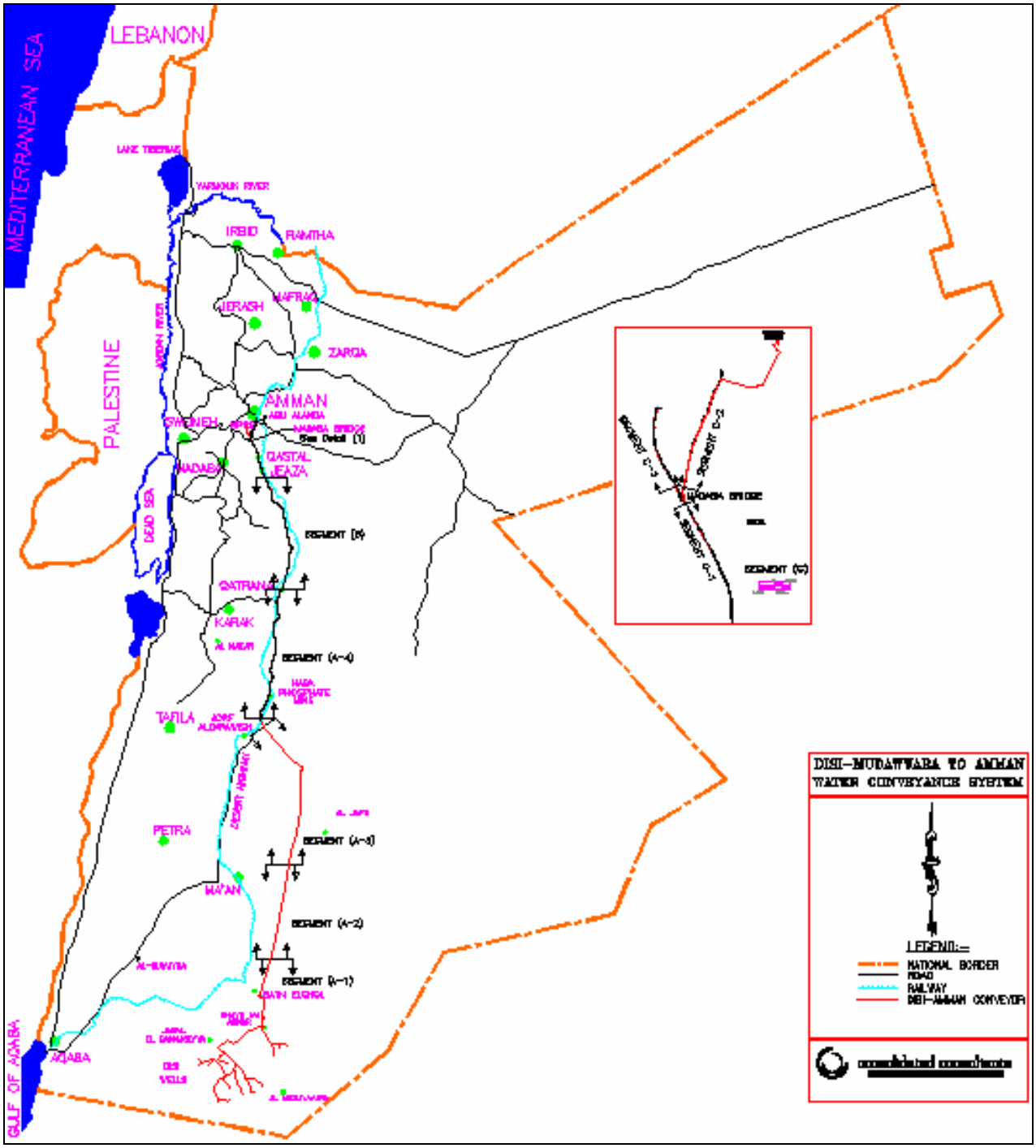



**Figure 29: The project segments**

### 3.3.3.4 Land Allocation and Acquisition

The following are the lands acquired for the purpose of the Disi project:

1- Treasury Land Allocation: In accordance with the provisions of the Land Acquisition Law No. (12) for the year 1987, and in accordance with the request of the Ministry of Water and Irrigation No. MA/5/1/1/10876, the director of Land Survey Department and the Director of State Property Department agreed to suspend all land allocation in Disi Area unless all procedures are implemented.
2- Treasury land allocation has been confirmed including:
    a. The pipeline corridor from Disi well field to the Jurf-Qatraneh Junction, segments A1-A3.
    b. The two well fields in Disi (56,000 + 7,000 hectares).
    c. Batn El-Ghoul under ground well (2.75 hectares).
    d. Pumping station No. 1 in Mudawarra (2.646 hectares).
    e. Pumping station No. 2 in Sahl-Alsuwwan (2.7 hectares).
    f. Al Jurf Flow Control Station (0.26 hectare).
3- Private land acquisition: The following private parcels have been expropriated and compensated in 2001 by the MWI (Segments C-2 and C-3):
    a. Abu-Alanda Reservoir area (number of parcels, total area 4.367 hectares).
    b. Dabuk parcels 115 and 117 (total area 0.4685 hectare for the construction of pumping station right-of-way).
    c. Other small parcels and land residuals.

For more details on land acquisition, refer to **Annex C20**.

### 3.3.3.5 Construction in the Right-of-Way of the Desert Highway

Permission has been obtained from the Ministry of Public Works in 1998 to construct the Disi pipeline in the right-of-way of the Desert Highway and within the road itself in the narrow lanes leading to Abu-Alanda Reservoir. The course of the pipeline has recently been modified particularly in the last segment to avoid any damage to the archaeological and heritage sites close to the reservoir particularly the Cave of the Seven Sleepers and the mosque.

Obviously, all necessary procedures to expropriate private land or to allocate Treasury Land for the Disi project as indispensable public utility have been acquired. It is quite evident that any additional expropriation of private land as a result of modifications in the pipeline alignment can be carried out without any delay or difficulty, taking into account the provisions of Land Acquisition Law No. (12) and the agreed Land Acquisition and Resettlement Policy Framework (**Annex C24**). However, the cost of any additional land acquisition will have to be incurred by the Government of Jordan, although this is a remote possibility since all required private land has already been expropriated.

The costs of land acquisition are incorporated in the capital costs of the project as modified by Brown and Root in the “Design Review and Optimisation Report”.

If the Contractor needs to use a land or a private property outside the right-of-way for construction purposes, the rental or purchase of the land to be used will be his own responsibility.

The temporary direct and/or immediate negative impacts on the population during the construction phase are anticipated to be:

- Traffic disruption.
- Noise and dust pollution.
- Disruption of local nomadic tribes who guide their sheep from one side of road to the other.
- Loss of business activity.
- Displacement of existing population.
- Disruption of other land uses.
- Loss of exposure.
- Stress on the local infrastructure while it provides support for pipeline construction.
- The present of many power lines in the right-of-way poses a serious potential impact, during the construction of the pipeline. The impacts of power disturbance, service delays, inconvenience to residents and loss of income.
- Loss of visual amenities.

## 3.4 Archaeological Baseline Conditions

The investigation of the archaeological and cultural settings in this study was based on extensive field surveys, which have been conducted to identify all archaeological and cultural heritage resources occurring along the alignment including any graveyards or burial sites, and to define significance to the study based on the possibility of direct or indirect impacts that might be imposed by the proposed project. Several publications and studies by Jordanian and non-Jordanian researchers along with national technical reports and studies were consulted.

The identification of potential project-specific impacts and the development of mitigation and monitoring measures were basically based on the field visits observations. Those surveys were conducted by a team of three experts in archaeological and cultural resources and in environmental management, headed by a Jordanian archaeologist. Details of the team members are presented in **Annex C 22**.

Thirty-five sites were identified within the project area. Eight sites within Segment (C) from Al Jiza to Abu-Alanda Reservoir and twenty-six sites within Segment (A) covering the area between Disi and Jurf Al Drawish. Only one site was identified within Segment (B) which is Jurf Al Drawish to Al Jiza.[19]

Most of the identified sites are best represented by Roman and Byzantine periods. The identified sites fall under the following categories:

- Settlement sites such as Qastal;
- Cave of Seven Sleepers; and
- Various sites with olive oil presses (more details are given in section five).

The locations of archaeological sites within Segments B and C are shown in **Map C1**.

[19] Note: The numbering of the sites and coding has been changed since the Rapid Diagnostic Report to be consistent with the scheme adopted for the overall report, which divides the project area into south to north oriented segments for analysis and presentation purposes.

### 3.4.1.1 Archaeological Sites Located within Segment (A): Jurf Al Drawish – Disi

Twenty-six sites were identified within Segment A, all of which are located out of the defined project corridor. **Table 39** presents the names of these sites, their JADIS reference[20], location and description. As **Table 39** indicates and based on the findings of field investigation, there are no archaeological sites located within the defined corridor of the pipeline. **Figure 30** presents an overview of the Disi area and Jurf Al-Drawish.

**Table 39: The twenty-six sites identified within Segment (A)**

| Site No. | JADIS No. | Site Name | Site Location | Description |
|---|---|---|---|---|
| A-1 | 2288001 | Quweirat Ghazi | Ma'an- Disi | Paleolithic/Neolithic/ Nabatean Epi-Paleolithic |
| A-2 | 2288002 | Umm Hawish | Ma'an- Disi | Paleolithic/ Nabatean |
| A-3 | 3644001 | Biyar Bein Murra | Ma'an- Disi | Epi/ Paleolithic and Neolithic /Chalcolithic |
| A-4 | 2295001 | El- Mutrab | Ma'an- Disi | Pottery Neolithic and Chalcolthic Roman/ Byzantine/Ayyubid and Maulur |
| A-5 | 2295002 | El- Hammam | Ma'an- Disi | Roman/Byzantine/ Umayyad/Abbasid and Fatimid/Ayyubid and Mamluk |
| A-6 | 2299003 | KH. Eddjaniya | Ma'an- Disi | Roman |
| A-7 | 3696002 | No name site | Ma'an- Disi | Roman |
| A-8 | 3798007 | No name site | Ma'an- Disi | Roman |
| A-9 | 3896007 | No name site | Ma'an- Disi | Byzantine |
| A-10 | 399002 | Hk- Kilwa | Ma'an- Disi | Ottoman /Modern |
| A-11 | 2295004 | Mahattat Ma'an | Ma'an- Disi | Ottoman /Modern |
| A-12 | 2297001 | Mathattat Abu El-Jurdhan | Ma'an- Disi | Ottoman /Modern |
| A-13 | 2298001 | Mahattat Uneiza | Ma'an- Disi | Ottoman /Modern |
| A-14 | 2389001 | Mahattat Batn E-Ghoul | Ma'an- Disi | Ottoman /Modern |
| A-15 | 2390002 | Mahattat Fassu'a | Ma'an- Disi | Ottoman /Modern |
| A-16 | 2390003 | Mahattat Hattiya | Ma'an- Disi | Ottoman /Modern |
| A-17 | 2393001 | Mahattat Abu- Tarfah | Ma'an- Disi | Ottoman /Modern |
| A-18 | 2394001 | Muhattat Musawal | Ma'an- Disi | Ottoman /Modern |
| A-19 | 2485001 | Mahattat El-Mudawwara | Ma'an- Disi | Ottoman /Modern |
| A-20 | 2487002 | Mahattat Tulul Esh-Shahm | Ma'an- Disi | Ottoman /Modern |
| A-21 | 2488002 | Mahattat Rrmal | Ma'an- Disi | Ottoman /Modern |
| A-22 | 2492002 | Mahattat Esh-Shidiya | Ma'an- Disi | Ottoman /Modern |
| A-23 | 2295003 | Isfir Mahatta | Ma'an- Disi | Modern |
| A-24 | 2295005 | Ma'an | Ma'an- Disi | Modern |
| A-25 | 2485002 | El-Mudawarra | Ma'an- Disi | Modern |
| A-26 | 2696002 | El-Jafer | Ma'an- Disi | Modern |

[20] JADIS is an archaeological data information system for Jordan in which each described archaeological site is given a reference number (code). This data system also document sites locations.

**General view of the Disi area**

**The surveyed area in Disi**

**The surveyed area of Jurf Al-Drawish**

**General view o the area of the pipe route**

**Figure 30: General overview of the surveyed area in Disi and Jurf Al-Drawish**

### 3.4.1.2 Archaeological Sites Located within Segment (B): Al Qatraneh - Jurf Al Drawish

**Site One: Al - Qatraneh Castle**

| | |
|---|---|
| Site No.: | B-1 |
| Site Name: | Al - Qatraneh Castle |
| Site Location: | Al - Qatraneh Village |
| Coordinates - Palestine Grid: | 248885 E 1072573 N |
| Site Assessment: | Low Significance |

Al-Qatraneh Castle is one of the famous castles on the right side of the main highway toward Aqaba City. Some scholars reported limited information regarding the earliest known historical occupation on the site.

The existing remains consist of square fort two stories high. The gate opens towards the south direction, while the large pool is located to the east of the castle and very close to the modern highway (see **Figure 31**).

**Al-Qatraneh Castle**

**Internal view of Al-Qatraneh Castle**

**The water pool of Al-Qatraneh**

**The water system of Al-Qatraneh (see the arrow)**

**Figure 31: Al-Qatraneh Castle**

Based on the previous explorations, the building was built during the Turkish rule, while other scholars dated the structure earlier to the Ayubbi-Mamluk era and developed during the Ottoman and Turkish rule.

The standing structure was restored and protected by a joint project between Department of Antiquities of Jordan and the Ministry of Culture in Turkey. So the standing structure still represents one of several pilgrim stations on the pilgrims' route from Damascus to Arabia.

### 3.4.1.3 Archaeological Sites located within Segment (C): Reservoir - Abu-Alanda - Air port – Al Jiza

Eight sites were identified within Segment C, all of which are located within the direct or indirect zone of effect of the defined project corridor. **Table 40** presents the names of these sites, their location and description. The text below document to the baseline conditions of these sites.

**Table 40: Archaeological Sites Located within Segment (C)**

| Site No. | Site Name | Site Location | Coordinates - Palestine Grid |
|---|---|---|---|
| C-1 | The Press | Abu-Alanda Town | 242015 E 1145595 N |
| C-2 | Area of the Cave of Seven Sleepers | Abu - Alanda | 242265 E 1145328 N |
| C-3 | The Cave of Seven Sleepers | Abu - Alanda | 242232 E 1145354 N |
| C-4 | Al - Juwayda Mausoleum | Al - Juwayda plains | 240620 E 1142778 N |
| C-5 | The Mausoleum | Khirbet Es-Suq | 237997 E 1141984 N |
| C-6 | Al- Qastal | Al- Qastal | 239181 E 1128372 N |
| C-7 | Al - Jiza Pool | Al- Jiza | 240409 E 1123500 N |
| C-8 | The Byzantine Church | Al - Jiza village/ under modern houses | 240619 E 1123315 N |

## (a) Site One: The Press

Site No.: C-1
Site Name: The Press
Site Location: Abu-Alanda Town
Coordinates - Palestine Grid: E 242015 N 1145595
Site Assessment: Low significance

The Press site is located in a flat area used by local people for agricultural purposes. The remains consist of a medium square shaped basin with another small basin attached. The function of the site could be determined from the similarities with other identical rock cut grape presses in the surrounding area. One such press is located in the courtyard of the Cave of Seven Sleepers. The location of the press in the fertile plains indicates the function of the press during the Roman and Byzantine periods. The site possibly was connected with the nearby site Cave of Seven Sleepers and the nearby site to the east which was called Khirbet al- Raqeem.

The field investigations revealed the presence of several pottery shreds scattered around the remains. The area of the press was used in the Early Roman period and continued to be used during the late Roman period, and the area was heavily used and settled in the Byzantine period.

The field investigation indicated nothing regarding the early Islamic period and this means that the Muslims concentrated only on the Cave of Seven Sleepers.

## (b) Site Two: Area of Cave of Seven Sleepers

Site No.: C-2
Site Name: Area of the Cave of Seven Sleepers
Site Location Abu - Alanda
Coordinates - Palestine Grid: E 242265 N 1145328
Site Assessment: High significance

The site is located east of the Cave of Seven Sleepers (see **Figure 32**).

**Figure 32: Track of the pipe near the eastern side of the Cave of Seven Sleepers**

The whole area around the cave represents a holy zone. According to field investigations, the area is considered by the Department of Antiquities as an important extension for the cave toward the eastern direction. The field investigations also revealed the following remains at the site:

- **Burial Caves:**
  Different kinds of caves were dug in the natural limestone rocky area. Graves were dug inside these caves to burry the dead. Some of these burial caves were robbed. Remains of pottery shreds and bone fragments are still visible in front of some of these caves and date back to the Byzantine period; the $5^{th}$ -$6^{th}$ century AD. Some of these graves were found silty and affected by the erosion during winter season.

- **Cist Tombs:**
  This kind of tombs is dug in the natural limestone rock. The tomb consists of a rectangular shape measuring from 170-1,490 cm and 80 cm wide and up to 60 cm in depth. What distinguishes these tombs is their general shape. The tombs were dug in groups, with three Cist tombs in each group in different directions. Investigations revealed huge decorated slabs of limestone used to cover the Cist tombs. The majority of these tombs were robbed during the past years, while the rest suffer from destruction caused by natural factors.

- **Rock-Cut Signs:**
  The surface indications revealed numerous rock-cut signs possibly to extract ashlars for architectural purposes and to cut columns, architraves etc. The quarries are located east and west of the main cave. They were possibly used during Roman and Byzantine periods. In general the rock-cut signs are scattered everywhere in Abu-Alanda Town.

- **Flints Scattered:**
  A lot of flint tools were scattered over the slope of the site. These flints represent flakers, blades cores, etc. They date broadly to Neolithic period. This indicates that the area might have been settled earlier than the Roman and Byzantine periods. The early man may have used the natural caves in this area and hunted animals in the surrounding zone, while the fertile plains played a vital role for early settlement in the area.

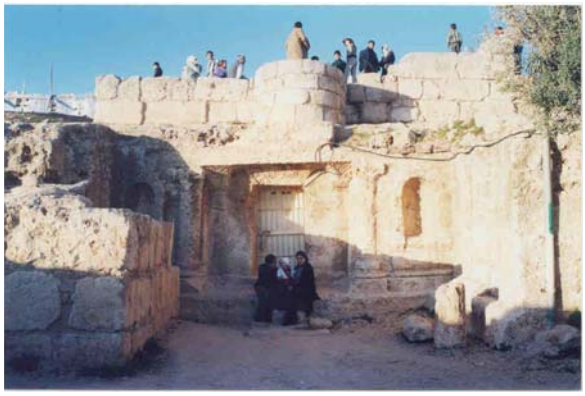
- **Pottery Shreds Scatter:**
  The pottery shreds discovered in the area represent shreds of body, bases, handles, and neck. The shreds came from the burial cave and represent part of the offerings of the dead.

### (c) Site Three: Cave of the Seven Sleepers

| | |
|---|---|
| Site No.: | C-3 |
| Site Name: | The Cave of Seven Sleepers |
| Site Location: | Abu - Alanda |
| Coordinates - Palestine Grid: | E 242232 N 1145354 |
| Site Assessment: | High Significant and directly threatened |

The story of the Seven Sleepers occurs both in Islam (as sura 18 of the Koran) and in Christianity ('The Seven Sleepers of Ephesue' in Jocobus de Voragine's 13th century collection of apocrypha known as 'The Golden Legend). In each case the story concerns a group of young men escaping from persecution by local pagan ruler and fall asleep in a cave (see **Figure 33**). Through divine intervention they sleep safely for a hundred years or more and wakeup after the area has been converted to the appropriate religion.

**The proposed Laura near the pipe route**



**The Cave of Seven Sleepers**

**Figure 33: The proposed Laura near the pipe route and the Cave of Seven Sleepers**

According to Qur'an, a group of young men known for their commitment to Christianity were prosecuted by the Roman Emperor of the time. Seeking refuge in a cave, they fell into a deep sleep that lasted 300 solar (309 lunar) years. On waking they found themselves citizens of the Byzantine Empire. It is stated that they were accompanied by a dog. Seven skulls and what appear to be dog bones may be seen through a hole in one of the cave's eight closed tombs.

The Christian account goes that during the reign of the emperor Decius Christians in Ephesus suffered persecution for their faith. Seven young Christians escaping from the cruelty of Decius took shelter in this cave, which lies on the slope of Panayir Mountain. Falling into a deep sleep that lasted 200 years, they awoke in the reign of the Emperor Theodosius II, and saw that Christianity had become the official religion. Because of their miraculous sleep, the seven people were considered to be sacred, and were buried in the same cave after their natural lives have passed. A church was built to mark it.

Vorgaine sets the story in Ephesus (in modern Turkey); the Qur'an version more clearly identifies with this cave in southern suburb of Amman. This identification must have accrued by the 8th century as the Umayyads built a mosque near the location. The cave is actually a rock-cut

Byzantine necropolis containing six sarcophgi, one of which is considerably smaller than the rest (in the Sura 18 version it's six men and their dog- hence the smaller number tombs).

The holy text, the pilgrims and travellers' description and the archaeological discoveries prove that this cave is the real one among the other suggested caves in different countries.

### (d) Site Four: Al - Juwayda Mausoleum

| | |
|---|---|
| Site No.: | C-4 |
| Site Name: | Al - Juwayda Mausoleum |
| Site Location: | Al - Juwayda plains |
| Coordinates - Palestine Grid: | E 240620 N 1142778 |
| Site Assessment: | Low Significance |

A medium structure built of well-cut ashlars located on the right side of Juwayda-Sahab Road alignment (see **Figure 34**). The site is partly preserved and the western wall is still standing to the height of the roof. A lot of well-cut ashlars and other remains still scattered around the building such as cistern, remains of walls, etc.

**Figure 34: General view of the Mausoleum (Family Tomb)**

The structure severely suffered from pollution and deterioration caused by the natural and human factors during the last centuries. According to the assessment conducted by travellers and historians, the building served as a mausoleum. The site may have connection with other similar sites such as the Cave of Seven Sleepers and Khirbet Es-Suq Mausoleum.

No systematic excavation was conducted in the area of the site. Department of Antiquities built a fence around the site to reduce the human threat and to offer more protection to the existing remains.

### (e) Site Five: The Mausoleum

| | |
|---|---|
| Site No.: | C-5 |
| Site Name: | The Mausoleum |
| Site Location: | Khirbet Es-Suq |
| Coordinates - Palestine Grid: | E 237997 N 1141984 |
| Site Assessment: | Medium Significance/Direct Threat |

This site is located on the right side of the main road, built of well-cut white limestone ashlars (see **Figure 35**). The structure is square in its shape, 12x12 m, and its remains are still standing to up to 3 m above the ground. The internal ports and divisions were totally destroyed by local activities many years ago.

**Figure 35: General view of the Family Tomb**

According to the travellers, the site is dated back to Roman period and was built to serve as a mausoleum and reused during the Byzantine period. The site now severely suffers from pollution resulting from vehicles and the threats of vibration are increasing day after day.

### (f) Site Six: Al- Qastal

| | |
|---|---|
| Site No.: | C-6 |
| Site Name: | Al-Qastal |
| Site Location: | Al-Qastal |
| Coordinates - Palestine Grid: | E 239181 N 1128372 |
| Site Assessment: | Low Significance |

Al-Qaustal is a large complex with a residential palace, a mosque, a bathhouse, a cemetery, domestic quarters and water harvesting systems (see **Figure 36**). The palace is about 68x68 m in dimensions. It has four 'three-quarter round corner' towers and, in all, 11 semicircular towers in between. Each of the facades contains three of the semicircular towers except for the east one, which has four towers of which two of them flank the entrance gate.

**Figure 36: Byzantine and Islamic remains of Al-Qastal**

Originally, the palace is believed to have consisted of two storeys, although the upper storey has not survived. The ground floor is composed of six bayts (self -contained units) arranged around a central courtyard, with each bayt consisting of four rooms and a court.

The mosque is located to the north of the palace and has a rectangular hall measuring 16x5 m. The entrance is through a rectangular court measuring 17x10 m. It is built of the same stone cut in the same size and shape as the palace. A minaret with a spiral staircase of 6 m in diameter is still standing with a height of 6 m and connected to the north-western corner of the mosque. It may well be the oldest surviving minaret in Islam.

It is believed that the inner sanctuary of the mosque was initially covered in wood but was replaced later by a stone barrel vault. The originally thin walls consequently were enlarged to support the weight and lateral thrust of the new roof. The cemetery, which is the earliest Muslim cemetery in Jordan, is located to the south west of the palace. A number of inscribed tombstones belonging to the Umayyad and Abbasid periods have survived and are now displayed in the Madaba Archaeological Museum. It could be of interest to note that earlier tombs of the cemetery are oriented towards Jerusalem.

The water collecting systems include a dam located about 1 km to the east of the palace. The dam was made of a 400 m long wall 4.30 m thick. A cistern, which measures 30 x 22 x 6 m, is located about 1 km to the northwest of the palace, and about 70 small cisterns are dispersed around the area of the palace.

Although it is agreed that most of the complex is Umayyad, considerable debate exists concerning its exact date. A reference in a later historical account supports the suggestion that is was completed before 126/744, but the actual time of construction is difficult to determine. It was also reused as residential quarters between the $6^{th}$ /$12^{th}$ and $10^{th}$ /$16^{th}$ century, during the Ayyubid and Mamluk eras, and a few minor additions to the Qastal complex date from that period.

## (g) Site Seven: Al Jiza Pool

| | |
|---|---|
| Site No.: | C-7 |
| Site Name: | Al Jiza Pool |
| Site Location: | Al Jiza |
| Coordinates - Palestine Grid: | E 240409 N 1123500 |
| Site Assessment: | Low Significance |

On the right side of the airport highway towards south, there is a large water pool situated near the police station (see **Figure 37**). The pool represents one of the important elements of the water system in Al Jiza village during the past and recent days.

**The existing large water pool at Al Jiza** **A traditional building near the water**

**Figure 37: Al Jiza Pool**

The municipality of Al Jiza conducted a restoration project on the pool so as to reuse and develop the remains for daily usage.

The restoration project succeeded in building a fence, enforcing the walls and maintaining the channels and water aqueducts which drains the rain water toward the pool. According to previous exploration, the pool dated back to Islamic Period (Umayyad).

## (h) Site Eight: The Byzantine Church

| | |
|---|---|
| Site No.: | C-8 |
| Site Name: | The Byzantine Church |
| Site Location: | Al Jiza village/ under modern houses |
| Coordinates - Palestine Grid: | E 240619 N 1123315 |
| Site Assessment: | Low Significance |

The Byzantine remains are located on the left side of Al Jiza highway, not far away from the large pool, and just opposite the police station. The area is well known for the local people as one of the promising locations for antiquities.

According to the owner of the land where the remains are located, the existing remains are under control of the Department of Antiquities of Jordan.

The discovered remains consist of medium cylindrical pillars, well-cut limestone ashlars and mosaic pavement (see **Figure 38**). The extension of the site is undetermined but may be extending under the modern highway toward the large pool.

**Figure 38: Remains of the Byzantine Church**

Depending on the available material, the site dated back to the Byzantine period and may represent a church.

The local people reported some information about a robbed cemetery to the east of the site.

# 4 ANALYSIS OF PROJECT SPECIFIC ("TECHNICAL") ALTERNATIVES

The boarder analysis of alternatives for water resources is presented in **Section 5** of Main Report– Part B. Five main issues of concern have been identified to analyze the project alternatives and for each of those issues several sub-issues were also considered. These issues and sub-issues are as follows:

1- Physical Environment:
- Landscape Damage, Change of Natural Drainage System and Local Geomorphology
- Noise Levels
- Dust Generation
- Waste Generation

2- Biological Environment:
- Loss of Habitat and habitat fragmentation
- Increased accessibility to remote areas
- Wildlife Disturbance
- Wildlife persecution/vegetation and tree removal
- Disturbance to bird migration and breeding

3- Agricultural Environment:
- Impacts on the large-scale Agriculture
- Termination of the Large-scale Farming Companies with the government
- Impact on large scale farms (dust, tree cutting, …etc.)
- Impacts on the farms located along the alignment (olive farms)

4- Social Settings:
- Public Health
- Traffic Disturbance
- Effect on Locals and Employees Safety
- Disturbances to Infrastructure Utilities
- Disturbances to Social Settings and Local Business

5- Archaeological and Cultural Heritage Resources.

These issues are basically in line with the impact analysis presented later. The main overarching concerns are the habitat fragmentation especially in the Hammada area, increased accessibility to remote areas such as Disi and Batn El-Ghoul, and impacts to archaeological and cultural heritage recourses within the direct and indirect zone of effect. The proposed alternatives do, however, have more or less similar impacts of varying degrees. Following is a description for the analysis of the identified alternatives.

## 4.1 No Action/Without Project

This alternative indicates that without project necessarily mean that all defined impact sources during the construction, operation and remediation phases do not occur. The "no action/without project" alternative can be judged to possess no impacts, or in other words to cause no change to existing environmental and social settings neither within nor out of the proposed project corridor. This anticipation is basic to all potential project-specific impacts except for the public health concern related to potential positive improvement of water quantity and quality supplied to citizens. Without the project it is understood that direct pumping of water through the system might be difficult to secure and people will need storage in household tanks where contamination becomes a potential threat.

This per say will not affect the issues of concern highlighted above. However, it should always be appreciated that, ecological concerns have always been raised toward conserving biological habitats in the desert area and sand dunes habitats that occur in Jordan at different localities. It is a national concern to preserve biodiversity in general and natural habitats in particular. In addition, cultural resources conservation and management have always been a major concern that is treated with full attention and care.

On the other hand, the large-scale farming companies will not witness a direct impact till the end of their agreement with the government. Once the current agreement held between the government and the companies expires, two possibilities arise: first, renewal of the agreements and second, termination of the agreements. Renewal of the agreements might bring different conditions. The mitigation measures will have to be covered within the agreement itself. If the current agreement is not renewed, however, no mitigation measures are relevant. All four large-scale agricultural companies will leave the production process with a total planted area of more than 40,000 dunums. A trade off arises; the country will be saving more than 34 MCM of fresh water annually. At the same, the supply of agricultural products will loose more than 100 thousand tons annually. It is expected that other irrigated areas in Jordan will cover the shortage in supply of agricultural products.

**Table 41** presents a summary of the analysis of project specific alternatives.

**Table 41: Analysis of project specific alternatives**

| Issue of Concern (Components) | Alternatives | | | | |
|---|---|---|---|---|---|
| | | Alternatives to the Development of the Well Field | | Pipeline Alignment Alternatives | |
| | No Action/Without Project | Dubaydib | Batn El-Ghoul | Optimized final alignment by Brown and Root with modifications made by CC | Optimized final alignment by Brown and Root without modifications made by CC | Harza 1997 (alignment along the desert highway) |
| **Physical Environment** | | | | | | |
| Landscape Damage, Change of Natural Drainage System and Local Geomorphology | 0 | -3 | -3 | -3 | -3 | -3 |
| Noise Levels | 0 | -2 | -2 | -2 | -2 | -3 |
| Dust Generation | 0 | -2 | -2 | -2 | -2 | -3 |
| Waste Generation | 0 | -3 | -3 | -3 | -3 | -3 |
| | | | | | | |
| **Biological Environment** | | | | | | |
| Loss of Habitat and habitat fragmentation | 0 | -2 | -3 | -3 | -3 | -2 |
| Increased accessibility | 0 | -2 | -3 | -3 | -3 | -1 |
| Wildlife Disturbance | 0 | -2 | -3 | -3 | -3 | -1 |
| Wildlife persecution/vegetation and tree removal | 0 | -2 | -3 | -3 | -3 | -1 |
| Disturbance to bird migration and breeding | 0 | -2 | -3 | -3 | -3 | -1 |
| | | | | | | |
| **Agricultural Environment** | | | | | | |
| Impacts on the large-scale Agriculture | | | | | | |
| *Termination of the Large-scale Farming Companies with the government* | 3 | 0 | 0 | 0 | 0 | 0 |
| *Impact on large scale farms (dust, tree cutting, …etc)* | 0 | 0 | 0 | 0 | 0 | -1 |
| Impacts on the farms located along the alignment (olive farms) | 0 | 0 | 0 | -1 | -1 | -2 |
| | | | | | | |
| **Social Settings** | | | | | | |
| Public Health | -2 | 0 | 0 | 0 | 0 | 0 |
| Traffic Disturbance | 0 | 0 | 0 | -3 | -3 | -3 |
| Effect on Locals and Employees Safety | 0 | 0 | 0 | -3 | -3 | -3 |
| Disturbances to Infrastructure Utilities | 0 | 0 | 0 | -2 | -2 | -3 |
| Disturbances to Social Settings and Local Business | 0 | 0 | 0 | -3 | -3 | -3 |
| | | | | | | |
| **Archaeological and Cultural Heritage Resources** | 0 | 0 | 0 | -2 | -3 | -3 |

Ranking
( 3): high positive effect
( 2): medium positive effect
( 1): low positive effect
( 0): No effect
(-1): low negative effect
(-2): medium negative effect
(-3): high negative effect

## 4.2 Development of the Well Field

Two alternative sites were considered originally by Harza in 1997 for the development of the well field. These are the Dubaydib site, which was adopted by Brown and Root in 2001 during optimisation of the design, and Batn El-Ghoul site. The first well field is located in the unconfined aquifer area of Rum aquifer and the second is located in the confined aquifer area of Rum aquifer where the Khreim Group is the confining layer.

Using the two well fields in Dubaydib and Batn El-Ghoul can produce the required water quality, and a lesser drawdown in the water level. But due to the lateral lithological variations in the Rum aquifer, the water in Batn El-Ghoul contains higher Fe and Mn concentrations (more than 5 mg/l), which needs treatment to be removed since pumping into a reservoir is not sufficient to remove these quantities. The other problem which might occur due to abstraction from Batn El-Ghoul well field is the expected water quality deterioration due to the downward leakage from the Khreim Group (containing highly saline water) as development proceeds. To prevent such a process from occurring, limited volume of water is to be abstracted from this well field keeping the water level of Rum aquifer higher than the confining layer of the Khreim Group.

The analysis of both alternatives revealed almost similar environmental and social settings of both sites. Also it revealed the same kind and magnitude of potential impacts to occur for both sites during the construction, operation and remediation phases with one exception. This exception is related to the anticipated increased accessibility to the sites during the operation phase where Dubaydab area is currently quite more accessible then Batn El-Ghoul since it is closer to the large-scale farms in Disi. But still, both areas are remote and sensitive in terms of biological diversity.

Dubaydab lies near to the agricultural fields in Disi and is more or less accessible to locals and farmers. Also, there is a monitoring point for underground water, which is visited regularly by the employees of the Ministry Water and Irrigation. The area is moderately disturbed and few Acacia trees occur in it. Well field establishment in that area will add to habitat destruction due to increased accessibility as well as disturbance and persecution of wildlife. However, this impact is relatively less than the impact magnitude anticipated if the well field were to be constructed in Batn El-Ghoul area. Batn El-Ghoul is relatively more remote and pristine than Dubaydib area though visited by pastoralists. It is dominated by relatively high canopy cover of Acacia trees in areas with hard substrate and alluvial fans from surrounding mountains. Sand dunes habitats do also occur in the area.

In conclusion the above demonstrates that constructing the well field at the Dubaydib area will result in impacts of a higher magnitude than at Batn El-Ghoul area.

## 4.3 Alignment of the Pipeline

The pipeline alignment was primarily designed by Harza in 1997 to run adjacent to the main north-south highway with the conveyance pipeline situated within the right-of-way of the highway. This alternative was amended afterward by Brown and Root, where the pipeline bypass Ma'an city through the desert and meets the original alignment just before Jurf Al Drawish. This study deals with the Brown and Root (2001) optimised alignment for the proposed project with one modification carried out by Consolidated Consultant (CC) at Abu-Alanda area. This modification was solely suggested by the archaeological and biological diversity teams to prevent the potential direct damage to the Cave of Seven Sleepers and the area of this cave since both are

important archaeological and cultural resources, and also to avoid the removal of any tree from the same area.

The evaluation of the pipeline alternatives revealed that the optimised alignment by Brown and Root has more potential impacts to the biological environment than the alignment proposed by Harza. This is due to the fact that Harza alignment tends to avoid remote areas with high ecological sensitivity. On the other hand, Harza alternative shows higher magnitude for potential impacts to the social settings along the Desert Highway since more infrastructure utilities and local businesses are susceptible to disturbance by the pipeline construction. The environmental and social effects of the proposed alternatives were found to be almost similar with slight preference to the Harza Alternative. However, when considering the economical aspects of each of the evaluated alternatives, the preference would be for the Optimized Brown and Root Alternative with modifications by CC.

Three scenarios were evaluated: two scenarios for the optimized alignment by Brown and Root (one with modifications carried out by CC and the other without CC modifications), and the third scenario for the original alignment by Harza. Basically, the three alignments share common Segments (B and C) from the reservoir area till Jarf Al-Drawish area where construction will be at the right-of-way of the Desert Highway. The modified alternative, however, has an additional advantage of avoiding the planted Pine trees that serve two main purposes; the aesthetic value and the control of slope erosion.

The three alternatives in Segment C will impact primarily, plantations along desert highway. Harza alignment continues to Wadi Rum area along the highway and thus will generate slight to moderate impacts especially to wadis crossing the highway. The optimized alignment by Brown and Root with and without modifications, on the other hand, will take a different alignment starting from the end of Segment B till the well field. These two alignments will cross vast areas within the eastern plateaus and therefore will have high impacts (within construction corridor) due to habitat fragmentation and vegetation destruction within the hammada plains, mud flats and desert runoff wadis where substantial green cover exists in spring season and after rainy season.

Furthermore, these two alignments will provide the access by roads during construction and operation in these relatively remote areas. This increased accessibility will result in an increased disturbance and persecution to wildlife. Disturbance to migratory and breeding birds utilizing desert plains and mud flats for roosting and breeding is also expected by these two alignment schemes. The same impacts are also expected in wadi Abu Tarfa, Disi and Batn El-Ghoul areas.

It can be concluded that as far as the biological conditions are concerned, the optimized alternative by Brown and Root with and without modifications will generate greater impacts than Harza alternative, while if social and archaeological settings are concerned, Harza's will generate greater impacts that will require appropriate mitigation and monitoring measures.

# 5 ENVIRONMENTAL AND SOCIAL IMPACTS

Anticipated environmental and social impacts have been identified and studied for the nature and magnitude of each impact. Some of these impacts were found to be temporary in nature such as traffic disruption, while other impacts were found to be permanent. Both, temporary and permanent impacts may cause direct, indirect or cumulative effects on the existing environmental and social conditions. A summary of those impacts is presented in **Table 47**.

## 5.1 Impacts on the Physical Environment

This sub-section addresses the potential impacts of the project on the physical environment with the direct and indirect zones of effect. Those impacts have been identified according to the phase of occurrence (i.e., construction and operation phases) and the nature of impact (i.e., temporary, permanent, direct, indirect and cumulative).

### 5.1.1 Construction Phase

During the project's construction phase, the identified temporary impacts on the physical environment relate to noise levels, air quality and dust generation, solid and liquid waste generation, and construction of access roads, whereas the identified permanent impacts relate to damage and change to landscape, natural drainage system and local geomorphology.

#### 5.1.1.1 Temporary Impacts

#### (a) High Noise Levels

Project construction activities are planned to last for about 4 years. During this period, the construction will be carried out at least 6 days per week with an average of 8 working hours/day. Still the Contractor might decide to carry out construction 7 days/week and for longer working hours than 8 per day. During this period, rise in noise levels is highly potential to exceed the Jordanian Noise Standards. This rise in noise level is anticipated to be significant in Segment (C-1), Segment (C-3) and the populated areas in Segment (B-2) of the project corridor. The impact sources are:

- Site preparation activities;
- The different construction activities; and
- The movement of the heavy machinery and the different construction vehicles.

Within Segments (C-1) and (C-3), the major impacted areas are: (i) the residential areas located close to the proposed new Abu-Alanda reservoir, (ii) the neighbourhoods and "service/commercial" establishments located between this reservoir and Amman-Madaba bridge, and (iii) all the establishments located between Amman-Madaba bridge and Aljiza area within the project corridor. While within Segment (B-2), the Qatraneh area will be impacted by the expected noise levels.

### (b) Increased Dust Levels

The expected increases in dust levels during this phase, will result from site preparation, cut and fill operations, in addition to the movement of the construction machinery. These activities will have negative impacts on both Segments (C-1), (C-3) and (B-2) of the project corridor. In Segments (C-1) and (C-3), the impacted areas are (i) the residential areas located close to the proposed new Abu-Alanda reservoir, (ii) the neighbourhoods and "service/commercial" establishments located between this reservoir and Amman-Madaba Bridge, (iii) All the establishments located between Amman-Madaba Bridge and Al Jiza area within the project corridor. While in Segment (B-2), the Qatraneh area will be affected by increase of dust levels.

The standards to be used in the assessment of dust levels are referred to in **Annex C21**.

### (c) Generated Fluid Wastes

During the pre-construction and construction stages, several types of fluid wastes will be generated. These are:

- The fluid wastes generated by the work force. In this regard, and by applying the assumptions that the daily consumption of water among the work force is 90 l/capita/day (2/3 of this quantity is fluid wastes) and that the duration they spend in the project varies between 12-24 hours, the estimated yearly quantity of resulting domestic fluid wastes per capita will range between 9 $m^3$ to 18 $^{m3}$. The accumulation points for such fluid wastes will be the established project offices, the camps and the storage yard that will be established along the project corridor.
- The fluid wastes generated from the routine maintenance and servicing of vehicles and construction machines.
- The fluid wastes from different construction activities.

Unwise management for this issue might lead to:

- Threatening the public health, especially in Segments (C-1) and (C-3) of the project and the populated areas in Segment B.
- Polluting the groundwater aquifers especially the shallow aquifer system along the project corridor.
- Threatening the biodiversity elements, especially in Segments A and B of the project.

### (d) Generated Solid Wastes from Construction Activities

Construction activities in such a large-scale project are anticipated to generate huge quantities of solid wastes, including:

- Sand and rock fragments that will result from the site preparation activities and the cut operations for installing the pipe and the other related water "pumping/collection" facilities.
- Metals, wooden and plastic fragments resulting from the different construction activities and especially the pipe installation process, and the other related water "pumping/collection" facilities.

- The human solid wastes, which is estimated to be 0.5 kg/capita/day on average. The accumulation of such wastes will be concentrated at the project offices, camps and storage yard that will be constructed within the project corridor area.

Inadequate management practices regarding these issues will result in the following impacts:

- Threatening the public safety and health especially in Segments (C-1) and (C-3) and the populated parts of Segments B and A of the project.
- Changing the local geomorphology and local drainage system and impacting the biodiversity system in Segments A and B of the project corridor.
- Threatening faunal elements along the waste disposal locations.

#### (e) Access Roads Construction

Establishing access roads might be required during this phase to serve the construction activities along the project corridor (i.e., to help the project vehicles to reach the work sites, to help the vehicles transporting the equipments of the project to reach their destination, and to serve the local traffic). Incorrectly constructed/routed access roads will have a number of negative impacts, such as:

- Changing the local geomorphology and the natural landscape, especially in Segments A and B of the corridor.
- Damaging natural habitats, especially in Segments A and B.
- Destroying natural vegetation, especially in Segments A and B.
- Damaging private properties (in some parts of the route) especially is Segment C.
- Threatening the public safety especially in Segment C due to the change in the directions of previously known road directions.

### 5.1.1.2 Permanent Impacts from Construction Activities

#### (a) Landscape Damage, Change of Natural Drainage System and Local Geomorphology

The project area has multi-geomorphological features including wadis, flat areas, in addition to hilly areas. These multi-geomorphological features are very important from an environmental point of view and require conservation, especially in Segments A and B of the project corridor. The different construction activities associated with this phase and without considering the environmental conservation issue will operate on changing the local geomorphology along the proposed project corridor, which will be a major negative impact of this project.

Landscape damage, change of natural drainage and local geomorphology will result from three major actions during this phase. These are:

1- Poorly planned construction activities (i.e., not taking the environment issues into consideration during planning the construction activities along the proposed pipe route), through the following actions:
    a. The regular construction activities in order to install the proposed water pipeline along the project route from Disi to Amman.

b. Establishing the project offices and the workforce camps.
c. Establishing the material and equipment storage yards.
d. Establish the pumping and boosters stations.

2- Unnecessary damage caused by activities, including damages outside the project route and outside the defined areas for operations.

3- Also, after completing the construction activities, landscape damage and change in geomorphology might occur due to:
   a. Presence of untreated borrows pit sites that are unsightly, potentially dangerous with uncontrolled access, and act as a potential breeding ground for insects.
   b. Presence of spoils heaps that are an unsightly potential source of additional sediments load, especially in Segments A and B of the project corridor.
   c. Landscape scarring which might be a potential source of future erosion concerns.

Moreover, the temporary dislocation of the existing drainage patterns, especially in Segments A and B of the project corridor is predictable during this phase as cut and fill operations take place. If proper care is not exercised to provide sufficient cross drainage, construction activities may lead to the following impacts:

- Formation of ponds associated with localized potential threats to the human health and potential damage to surrounding soils and vegetations.
- Localized rising of water tables associated with increased threat of pollution and the presence of localized surface water.
- Flooding with consequent damage to the nearby establishments.

### (b) Erosion and Sedimentation

Construction sites can be a great source of sedimentation and any diversion of the main wadis could result in high flow disturbance and cause a great deal of erosion. Therefore, the Consultant highly recommends careful and well designed crossing structures with no disturbance of the nature of flow sections of the flanking wadis.

The nature of the flanking wadis is intermittent flow streams with dry sections for a long period at the dry season, which could be from the end of April to mid-October. The flow in the wet season is distributed among many sections created by the wadi during its lifetime. Braided channels are the main features of the flanking wadis. The wadi is divided into several channels, which continuously join and separate, as shown in **Drawing 5** for the group of wadis of Abu Turfa. This could explain the erosion capability of the wadis at such stage of wadi regime. However, the crossing plan should take into consideration the nature of the wadi at the crossing station.

### (c) Wadi Crossing

Referring to **Section 3.1.1.3(c)**, the flanking wadis were defined and the flood flow for each wadi was estimated for a return period of 10-Years. The 10-Year return period was considered due to the nature of the work and the rainfall characteristic of the project area. Therefore, this return period provides enough protection for the contractor to execute a crossing structure in wintertime

and the provided insurance could cover floods of higher return periods. The dry season is considered the best duration for executing such crossings without any danger of flooding.

The flood analysis shows very limited depth of floodwater at the flow sections for 10-Year return period if compared with the total flow section. This will give an idea about the great width and depth of the crossing section.

### (d) Visual Impact

Permanent visual impact is anticipated to occur as a result of three main impact sources which are:

- The establishment of permanent structures within the project direct zone of effect. This includes the support facilities, pumping stations, and other structures.
- The changes made to the landscape of the site- if not rehabilitated- with respect to the different construction activities.
- The construction of aerial high-voltage electricity supply.

Temporary impact is also anticipated to occur as a result of the above mentioned changes to the landscape and many other construction activities. These activities would result in significant visual impact within segment A, which in turn will affect the potential for eco-tourism development within Batn El-Ghoul area.

## 5.1.2 Operation Phase

During the operation phase of the project, no impacts are anticipated to affect physical environmental conditions.

### 5.1.2.1 Impacts on the Disi Aquifer

In the area located between Disi and Mudawarra, there are more than 80 wells drilled during the last five decades. Most of these wells were drilled during the last two decades. The abstracted water from these wells are used for domestic industrial purposes for Aqaba, domestic local communities distributed all over the area, and most of the abstracted amount is used for agricultural purposes utilized by many agricultural companies such as Rum Company, GRAMECO, Wafa and Arab Agriculture Company. **Table 42** presents the total amounts that were abstracted from the wells and distributed all over the area for different purposes during the last 6 years.

**Table 42: Abstraction amounts from Disi-Mudawarra area**

| Year | Abstracted Amount MCM/year | No. of Wells |
|---|---|---|
| 1996 | 69.8 | 71 |
| 1997 | 72.9 | 72 |
| 1998 | 65.2 | 71 |
| 1999 | 66.3 | 72 |
| 2000 | 61.6 | 71 |
| 2001 | 55.3 | 69 |

The abstracted amounts from the Disi-Mudawarra area were taken from both the unconfined aquifer in Disi-Sahl Suwaan area and the confined aquifer in the Mudawarra area.

The water quality in this area is considered excellent water as there is no deposits of the Khreim Group present in the area where the water occurs in unconfined conditions.

Three wells were drilled. A detailed report was submitted to the Ministry of Water and Irrigation (Scott Wilson, 2002). Two wells of these three wells were drilled and tested and the third one is drilled as an observation well in Dubaydib area. A summary of these wells is presented in **Table 43**.

**Table 43: Hydrogeological summary of the recently drilled wells in Dubaydib area**

| Borehole | Aquifer System | Borehole Type | Depth (mbgl*) | Transmissivity ($m^2/d$) | Storage coefficient | Specific Capacity ($m^3/d/m$) | Water Level (mbgl) | Water quality | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | EC (µS/cm) | pH |
| DBP-1 | Rum | Test / production | 500 | 1,100 – 2,400 | 0.02-0.06 | 360 | 123.6 | 350 | 6.9 |
| DBO-1 | Rum | Observation | 400 | 2,900 – 4,000 | 0.005 | - | 121.7 | 310 | 8.0 |
| DBP-2 | Rum | Test / production | 500 | 300 – 1,400 | 0.006 | 100 | 88.7 | 365 | 6.9 |

* mbgl: meters below ground level

The obtained results correspond to the unconfined nature of the encountered aquifer in OBP-1 and OBPO-1 wells. The water quality changes of the two production wells (DBP1 and DBP2) during eight day pumping test duration are presented in **Table 3** and **Table 4** of **Annex C13**. These two tables show that the water quality is excellent and acceptable for drinking purposes.

The water level decline was very limited during the last decade as indicated in the observation wells distributed in the confined and unconfined areas of the Rum Aquifer System.

Most of the studies carried out on the Disi Mudawarra groundwater resources restricted the well field location to Dubaydib area at unconfined aquifer. The most prominent study was the Scott Wilson (1995), where two abstraction scenarios concentrating on the Dubaydib well field were studied. These scenarios are as follows:

- **Scenario 1:** abstraction of 120 MCM/year from Dubaydib wellfield in addition to the current abstraction of 75 MCM/year rising to 87 MCM/year (for Aqaba domestic and industrial purposes, local supply and agricultural activities) and 977 MCM/year in Tabuk in Saudi Arabia. This scenario was carried out for 50- and 100- year development periods.

- **Scenario 2:** additional abstraction of 150 MCM/year from Dubaydib wellfield beside the other existing abstractions in Disi-Mudawarra area as well as in Saudi Arabia in Tabuk. This scenario was also carried out for 50- and 100- year development periods.

The estimated drawdown results due to the first scenario for the two periods are 24 m and 81 m, respectively. The maximum drawdown due to 100-year abstraction period is corresponding to 190 m below ground level. This level is still above the feasible economic water depth, which is 250 m below ground level. On the other hand, the estimated drawdown resulting from the second scenario for the 50 year and 100-year abstraction periods are 140 m below ground level and 210 m below ground level, respectively. The latter pumping level is still higher but closer to the economic pumping level.

In the above two scenarios, where 120 MCM/year or 150 MCM/year are to be abstracted from Dubaydib well field, the drawdown in the water level will not exceed the economic level taking into consideration the continuous present abstraction from the Rum aquifer for agricultural, domestic and industrial purposes. But, if the abstraction for agricultural purposes is terminated after the set period of operation according to the original contracts, the estimated drawdown in the Dubaydib well field will be less than the estimated levels. As indicated by the tested boreholes drilled through the Rum aquifer, the whole water column is almost of the same quality from top to bottom. In this case the water quality during the whole period of abstraction will not be changed dramatically and the variations will not exceed couple of hundreds of µS/cm. This means that the electrical conductivity will not exceed 500 – 550 µS/cm. The maximum allowable limit is 850 µS/cm as outlined by the Jordanian Standards of year 2001. Regarding other chemicals, the water contains relatively small amounts of Fe and Mn (less than 1 mg/l). Such concentrations need no treatment whereas pumping into a collection reservoir will be enough to oxidize them and produce a good water quality.

When using the two well fields in Dubaydib and Batn El-Ghoul to produce the required water quality, the drawdown in the water level will be less giving more feasible operating costs. In addition, the higher yields of the wells in the confined aquifer in Bath El-Ghoul can act to shorten the collectors lengths and maintenance costs. But due to the lateral lithological variations in the Rum aquifer, the water in Batn El-Ghoul contains higher Fe and Mn concentrations (more than 5 mg/l), which needs treatment to be removed since pumping into a reservoir is not sufficient to remove these quantities, as pointed out with Dubaydib well field.

Such a problem can be bridged if mixing in appropriate portions between Dubaydib well field water with Batn El-Ghoul well field water is carried in order to reach a value within the Jordanian Drinking Water Standards. The Standards of year 2001 indicate maximum allowable content of Fe and Mn by 1 and 0.2 mg/l, respectively.

The other most important problem, which might occur due to abstraction from Batn El-Ghoul well field, is the expected water quality deterioration due to the downward leakage from the Khreim Group (containing highly saline water) as development proceeds. To prevent such a process from occurring, limited volume of water is to be abstracted from this well field keeping the water level of Rum aquifer higher than the confining layer of the Khreim Group. This was concluded depending on a study carried out by El-Naser and Gedeon (1997) and published in the publications of *International Atomic Energy Agency*. In this study, the authors showed the expected water quality changes of the Rum Aquifer due to different mixing ratios with the Khreim Aquitard water.

It is suggested that Dubaydib well field be operated to produce the needed water amount where good water quality can be pumped during the whole period. But, if Batn El-Ghoul well field is going to be operated, good management should be carried out to preserve a good quality of the water to be conveyed to Amman.

## 5.2 Impacts on Biological Conditions

The ecological characteristics, as well as biodiversity in general, will be affected by the construction activities and later during operation and maintenance activities. The impacts are foreseen as being significant within the southern zone of the project, Segment A, which extends between Disi wells and Jurf Al Drawish. A detailed description of such impacts and their significance is provided below. Such impacts would affect particularly the habitats for local wildlife and impact the prevalent vegetation associations and species. Segment A and B were of

less significance since the middle segment alignment is expected to be on the right-of-way of Desert Highway and the northern segment is already a heavily populated and disturbed zone with few natural areas remaining. However, the middle segment encompasses main wadi systems such as Al-Hasa and Al-Abyad. These two wadis are rich in terms of biodiversity and intervention and, therefore, require immediate restoration. Major ecological concerns include:

- Loss of habitats particularly at the southern zone (Eastern Plateaus and Batn El-Ghoul at wadi runoffs and sandy habitats, respectively).
- The expected increase of accessibility to particular habitats in the southern zone including Batn El-Ghoul and accordingly maintenance operations and increased disturbance to wildlife.
- Wildlife disturbance during the construction.
- Wildlife persecution and/or vegetation cover removal mainly during construction phase.

### 5.2.1 Construction Phase

During the construction phase, several temporary and permanent impacts are anticipated. These are mainly due to excavation and drilling activities, increased accessibility and vehicle movement into some relatively remote areas, and human interference with wildlife and vegetation.

#### 5.2.1.1 Temporary Impacts

The temporary impacts on biological conditions associated with the construction phase of the project include:

- Alteration of surface morphology and natural water runoffs schemes. This is important since vegetation cover at desert plains is confined to wadi (mainly Hasa and Al-Abyad and other smaller wadis that occur frequently along the alignment).
- Unavoidable removal of vegetation cover and tree stands (manily *Tamarix* and *Acacia* in both Wadi Abu Tarfa and Disi area respectively). This necessitates the avoidance of unnecessary removal of vegetation cover and trees to maintain the natural vegetation cover as much as possible.
- Disturbance to breeding and migratory bird species: As the southern segments of the project lie along the bird migration flyway and two IBAs (Hizma basin and Wadi Abu-Tarfa), it becomes crucial to synchronize spatially and temporally excavation activities to avoid disturbances during breeding and migration seasons through developing an activity programme and avoiding night activities so that breeding seasons are not interrupted and migration seasons are avoided and kept undisturbed.
- Disturbance to wildlife especially at night due to machinery or resident staff.
- Accumulation of Domestic liquid and solid wastes mainly from machinery and staff.
- Accumulation of excavation materials and debris.

#### 5.2.1.2 Permanent Impacts

The permanent impacts on biological conditions associated with the construction phase of the project include:

- Fragmentation of habitats along the desert. Desert plateaus in Jordan are already suffering from fragmentation and scarring by road and development activities. The new development, if to occur with no restoration, will exacerbate this phenomenon. However, this is largely limited to the southern segment of the alignment.
- Increased human interference due to increased accessibility. The construction of maintenance roads will increase accessibility to remote areas such as Disi and Batn El-Ghoul. These areas were of limited access due to difficulty of the terrain and therefore there is an expected increase in accidental and deliberate persecution as well as disturbance of wildlife.

### 5.2.2 Operation Phase

During the operation phase of the project, the following impacts are anticipated mainly due to accessibility for maintenance operations:

- **Temporary Impacts which include:**
    - Disturbance to breeding and migratory bird species and other wildlife.

- **Permanent Impacts which include:**
    - Increased human interference due to increased accessibility will accordingly lead to an increased accidental and deliberate persecution of wildlife.
    - Accumulation of litter and solid wastes.

## 5.3 Impacts on Agricultural Resources

As discussed in the description of existing agricultural conditions, the agricultural activities within the project's zone of effect have been classified into two main categories. The first category includes the locally owned farms that are of small to medium size. The second includes the large-scale farms that are owned by Jordanian companies.

The following discussion presents the potential impacts of the project on both types of agricultural activities.

### 5.3.1 Impact on Local Agricultural Communities in Disi Area

While it is not anticipated that the Disi project will have a large negative impact on the inhabitants of the area on the short and longer run, however, this may not be the case. The villages in the area will most likely end up facing the same water shortage problems, like the rest of the country, once the Disi basin water supply runs short or becomes inadequate to meet the needs augmented by a rise in population and expansion. However, a positive immediate impact may present itself in the form of creation of employment opportunities for members of the local communities with the ongoing project during the construction phase.

An undetermined number of small ruminant and camel herders roam the area in search of water and fodder for their livestock. Their livelihood stands to undergo some impact during the construction phase of the project.

The impact includes an increase in death accidents of animals due to unsafe construction sites and vehicle accidents, and an increase in noise levels. However, the severity of the impact depends on the contractor's compliance with suggested mitigation measures.

### 5.3.2 Impact on Large-Scale Farming Companies

On the commercial side, the large-scale farming companies will not witness a direct impact until the end of their agreement with the government (i.e., 2011) if original conditions and regulations stipulated in this agreement are respected by both parties. The proposed Disi project will not have a direct or indirect impact on the large scale farms during the construction and the operation phases.

The large-scale farming companies will not witness a direct impact until the end of their agreement with the government. Once the current agreement signed between the government and the companies expires, two possibilities arise: first, renewal of the agreement and second, agreements termination. Renewal of the agreement might bring different conditions.

All four large-scale agricultural companies will leave the production process with a total planted area of more than 40 thousand dunums. A trade off arises; the country will be saving more than 34 MCM of fresh water annually. At the same, the supply of agricultural products will loose more than 100 thousand tons annually.

Total area exploited by these companies adds up to 108,637 dunums. Rum Agricultural Company has the largest area and number of available wells with a pumping capacity of 35 MCM per year. WADICO, on the other hand, has only 12,481 dunums and 5 wells with a pumping capacity of 10 MCM per year.

According to the underground water monitoring by-law, the new water tariff for agricultural wells will be applied to the Disi farms. Accordingly, it is expected that the water consumption will be reduced around 30%.

It should be noted that the decision of termination and/or renewal of the agreements between the government and the commercial companies has nothing to do with the Disi project.

### 5.3.3 Impact on Agricultural Activities along the Route from Qatraneh to Amman

Several agricultural activities exist on the route that may be subject to limited impact; for example, cutting trees, dust on trees, restriction on mobility, etc. This applies also to the agricultural activities that exist on the route from Al Jiza to Abu-. Dust-related problems may be easily solved through water sprinkling. Problem of cutting trees may be attended to through replanting or compensation. Ensuring availability of safe passageways can eliminate any inconvenience arising from restrictions on mobility.

A list of agricultural activities along the route from Qatraneh to Amman that might be affected during the construction phase of the project is provided in **Section 3.2.2.2**. The nature of the impact includes cutting trees, dust on trees, and restriction on mobility.

## 5.4 Impacts on Socio-Economic Settings

### 5.4.1 Construction Phase

#### 5.4.1.1 Impacts on Social Settings

Social aspects in the project direct and indirect zone of influence (as defined in **Section 2.4**) are very much complementary and inter-woven to the extent that one actually cannot be separated from the other. Although the provision of reliable supplies of high quality water to Greater Amman is the main objective of the Disi Project, people in the project area – including Bedouin population should be allowed to enhance their way of life. This could include having access to employment opportunities during the construction and/or operational phases of the project. Impacts on the socio-economic conditions of the population may extend to the following aspects:

- Employment: The feasibility studies prepared by Harza and later Brown and Root do not include a detailed description of and analysis of project related employment opportunities including both skilled and unskilled labour. However, the majority of the work during the construction phase requires skilled construction personnel and specialists for electro-mechanical work that will also be needed during the operational phase. Given the nature of these skills it would be difficult to find such highly skilled people in the direct zone of influence other than in south Amman. Nevertheless, each contractor usually maintains his own team of engineers and technicians on permanent basis. Therefore an increase in the local employment in the small towns and villages along the pipeline route, consists of male workers for digging, trenching, services and camp guards in unskilled positions only is expected. In the post construction phase only few persons will have the chance to have long-term employment.

- Services: Taking into consideration the duration of the pipeline construction of about four and a half years, and the number of workers and employees in the project, a temporary increase in business activities along the route including catering, restaurants, services, fuel sales, transportation and many other activities is anticipated. Consequently an increase in employment in these activities will further enhance economic life of the local populations.

- Worker Health and Safety: The immediate impact on public health will be mainly in Amman. It includes the improvement of water quantity and quality. Direct pumping of water through the system may eliminate the need for storage in household tanks and reduce contamination.

  The provisions of emergency water turnouts to other localities along the pipeline route suffering from water degradation may also improve health standards in these localities.

- Workers Health and safety: the construction workers on any construction site might be exposed to occupational dangers including electrical dangers such as static or dynamic electrical dangers, mechanical accidents that could lead to limbs loss, chemical poisoning, or site related works such as car accidents.

- Boomtown Impact: It is expected that a growth of informally established services and housing adjacent to the permanent and temporary facilities of the project will take place during the construction phase (this is known as boomtown impact).Such impact can be considered positive (to some extent) taking into consideration the high unemployment rate in Jordan in general and especially in the areas located within segments B and C of the

project corridor. Many small coffee shops, supermarkets and restaurants are located along the desert road are currently closed (owned manly by the locals will have the chance to start business again which may indirectly provide jobs for many people and general improvement to the economical situation of the local communities in these areas. On the other hand the services provided by these facilities should be subjected to monitoring from the responsible governmental agencies (ministry of health, and the local municipalities) to insure that all the services provided (food and drinks) are within the standards.

Abu-Alanda is a commercial – industrial area where most of the services needed by the Project are available so no growth is expected to take place there. Anyway, this is not the case with other towns on the path. Disi, Qatraneh and Al Jiza are small-undeveloped towns and many of the services related to the construction phase may not be available there. The people living there or new people who may live in these towns will provide these services. This may lead to some development and expansion in these towns.

Also, along the route (in desert) where the contractor will build some camps (Segment A-2/A-3) some people will live there to provide some services but it is not expected that this will be significant enough for new towns to develop in these areas since the only demand for services will be the project.

#### 5.4.1.2 The Project Direct and Indirect Impact on Bedouin Life

As it has been explained before (Indigenous Peoples: Para 1.2), the Bedouin Settlement Program was initiated by the Government of Jordan in mid 1950s. Permanent settlements in the project area have grown to major cities and villages provided with all services including water, electricity, educational institutions, roads and communication facilities. The number of pastoral Bedouins declined substantially to less than 1% of total population taking into account all Bedouin population in the Kingdom. The socio-economic development of these localities can be looked-at within the general framework of the social development plan. However, it is expected that the project will have direct impact on the employment level in the Disi area by alleviating the high level of unemployment at least temporary during the construction phase.

#### 5.4.1.3 Projected Social and Cultural Changes in Bedouin Life

It should be borne in mind that evolution of social and cultural life of Bedouins in the project area is taking place as a result of the Government economic and social policy whether the Disi Project is constructed or not. Government departments and institutions have been active in the area for a long time. These departments are:

- Disi Agricultural Centre: This centre provides agricultural extension, agricultural and veterinary services to all farmers in the region.
- Disi Comprehensive Medical Centre: In addition to routine medical services, this centre provides dental health services, laboratory tests, X-ray and pharmacy. Medical services are almost free of charge.
- Disi Water Office
- Disi Local Development Centre: It provides social and financial assistance to the least privileged families in the region including vocational rehabilitation to the young and the establishment of family productive projects.
- Disi Post Office

- Disi Village Agglomeration Municipality: It provides all municipal services to the region.
- The Ministry of Education: The first secondary school in the area was established in 1962. At present, there are six primary and two secondary schools in the region with a total enrolment of 1,306 male and female students.
- Public Societies and Clubs: There are five public societies and sports clubs in the region
- Rum Agricultural Company: The Company is at present exploiting 5,000 hectares of Disi land for the production of vegetables and fodders, and 600 hectares for the production of fruits. About 100 persons of the area's labour force are employed by this company.
- Tourist Camps: There are seven tourist camps in Wadi Rum which provides full accommodation for tourists in the area.

#### 5.4.1.4 Impact of Land Acquisition

Land acquisition has already been carried out by the Ministry of Water and Irrigation and compensation for private land have been paid in accordance with the provisions of Land Acquisition Law No. (12). It is not expected that additional private land would be expropriated since the policy of the MWI is to avoid expropriation as much as possible. It is most probable that the pipeline construction will mainly utilise the right-of-way in all phases.

Regarding the construction of the pipeline in accordance with the modified alignment, it is not expected that any damage will occur to the trees along the pipeline route since all trees are planted at a distance from the 100 meters right-of-way. In addition to that, the pipeline alignment is designed to avoid high voltage electric line and commercial boards.

The social, economic and legal impact of land acquisition combined with the social effect of population resettlement may extend to all business and commercial activities in the direct zone of influence, particularly on economic activities along the pipeline route. The Contractor must therefore, take all precautions to prevent damage to private properties during the construction phase and also to provide all necessary facilities to secure sustainability of business and industry.

The selection of campsites, storage yards or any other land needed for the project must be (made in) consultation with the MWI and the selection criteria in **Section 8.3.6.1(a)-point 6** must be applied.

#### 5.4.1.5 Traffic Disturbance

The general practice for all authorities in Jordan to avoid traffic disturbances during construction is to advertise in local newspapers and television about such disturbance before construction starts and announce the detours to avoid traffic disturbances. This activity is generally organised between the contracting authority, the contractor and the traffic police. However the expected impacts related to traffic disruption are discussed below.

The Desert Highway serves and connects the capital Amman with the southern governorates and is considered the major access for the residents of these governorates to the northern parts of the Kingdom. This highway is used also to transport phosphate from the mines in Al-Hasa area to the Aqaba Port. Accordingly, this highway is subjected to high traffic density caused by a mixture of vehicles.

It is expected that the Disi pipeline will cross the Desert Highway in four or five points and the railway in two points. The construction of detours either around the road-crossings or around a number of bridges becomes inevitable. It would be the duty of the Contractor in this case to decide on the location, length and methods of the construction of these detours. However, in all cases, traffic might be disturbed at certain points where the intervention of the Traffic Police Department shall be necessary to avoid traffic delay or suspension.

The preparation stage for this project including water pipes transportation form Al-Aqaba Port to the scattered main construction stations along the project corridor, in addition to the different construction activities, will increase the traffic density along the Desert Highway and will cause a general traffic disruption along the project route.

The road system located between Madaba Bridge and Abu-Alanda reservoir (Segment C-1) suffers presently from high traffic density since it is the main route used by the residences of east Amman and serves the industrial city in Sahab area. This roads system will be subjected to another increase in traffic density during the construction phase in order to connect the proposed main water pipe with the New Abu-Alanda reservoir.

In a specified manner of discussion, traffic disruptions will result from:

- The increase in traffic density of heavy trucks transporting the construction equipment and materials from the Aqaba port on the Desert Highway.
- The partly and/or total closure of the local road system, especially within Segments (C-1) and (C-3) of the project route. While in segment B, the impacted areas will be the residential neighbourhoods and the services establishments located “on /close to” the Desert Highway.
- Diverting the traffic through temporary access roads or by to detours through residential areas and congested areas, especially in Segments (C-1) and (C-3).
- The daily movement of heavy trucks transporting equipments and materials along the project working areas.
- The partly and/or total closure of the Desert Highway in several locations along the project corridor when the construction activities require changing the location of the water pipe from the right side of the road to left side or “vice versa”.

This traffic disturbance may lead to delay of travel time for passengers using the road. But this delay is temporary in nature. It is also not expected that travel fares would subsequently increase.

### 5.4.1.6 Public Health and Safety Risks

The expected construction activities on this large-scale project will pose some impacts on the public safety especially at Segments (C-1) and (C-3) and in the populated parts of Segment B of the proposed project corridor. These effects will extend to impact the safety of the work force in this project. The expected impacts will result from:

- Car accidents between private cars due to the expected traffic conjunctions resulting from the different construction activities and from modification to known roads, especially in Segments (C-1) and (C-3).
- Vehicular-pedestrian conflicts along the project route in general and especially within Segments (C-1) and (C-3) and Segment B of the project corridor

- Deep excavations close to residential areas especially in Abu-Alanda, Al-Jiza and Qatraneh areas. The presence of such excavations might be of great threat to the young locals (especially school students in their daily trip on foot to/from the nearby schools.
- Falling in trenches especially in Abu-Alanda, Al-Jiza and Qatraneh areas. Such trenches are dangerous for both of the vehicles drivers and pedestrians moving within or close to the project corridor and especially during night time.
- The movement and operations of heavy equipment within the construction sites and along the project corridor, and the expected car accidents with/between the construction vehicles and machinery.
- Stored materials including fuel and other chemicals along the project corridor threats the public safety of the nearby residential areas in addition to the safety of the project workforce.
- After completing the construction works, presence of abandoned equipment or materials; unsightly and potentially dangerous to the public safety of the locals along the project corridor.
- Not wearing protection helmets (the Project workers).
- Working night shifts (the Project workers).

#### 5.4.1.7 Infrastructure Utilities and Social Disturbances

The proposed pipe route crosses and passes close to a large number of utilities/facilities that serve the residential areas in Segments C and B of the project corridor, in addition to many areas located close to this corridor. Many of these utilities will impose specific constrains on the design of work and the execution of work.

As a result of the pipeline trench excavations, disturbance to local residents along the inhabited area may stem from the following accidents:

1- A large segment of the pipeline trench will be 4 m width by 4 m depth. It might be hazardous to pedestrians particularly children, unless otherwise protected by a suitable structure.
2- Disruption in water supply and wastewater services might occur if by accident pipelines or wastewater network is broken down and pollute the domestic water distribute through local the water distribution system (within or close to the incidence site/s). This situation will represent (if happened) a severe threat to the public health.
3- Disruption in power supply might temporary occur if there was a need to relocate electricity poles far from the course of the pipeline.
4- More than 80 commercial buildings including over 350 shops have been counted along the pipeline alignment. Disruption of business may lead to the temporary loss of income.
5- Along the desert highway from Amman to Jurf junction, the Greater Amman Municipality installed about 60 electrified advertisement boards 6 m by 2 m for rent to commercial and industrial companies. Some of these boards have been erected within the right-of-way of the road. These boards will be temporarily removed during construction and re-erected in a suitable place.

The potential impacts severity of damaging these utilities varies greatly for each facility and is defined in a tabulated form in **Table 44**.

**Table 44: Potential impacts severity of damaging the utilities/facilities that serve the residential areas in Segments C and B of the project corridor**

| Facility | Impacts of Damage | Severity of Impact |
|---|---|---|
| High Voltage Electricity | ▪ Interruption of supply.<br>▪ Personal injury<br>▪ Expense of repair and delay of works | ▪ Widespread productive losses and inconvenience to the public<br>▪ Likely death of operator<br>▪ Very severe |
| Medium Voltage Electricity | ▪ Interruption of supply<br>▪ Personal injury<br>▪ Expense of repair and delay to works | ▪ Significant productive losses and inconvenience to the public<br>▪ Likely death of operator<br>▪ Severe |
| Low Voltage Electricity | ▪ Interruption of supply<br>▪ Personal injury<br>▪ Expense of repair and delay to works | ▪ Localized but significant productive losses and inconvenience to the public<br>▪ Likely death or serious injury to operator<br>▪ Minor |
| Major Water Transmission Pipes | ▪ Interruption of supply.<br>▪ Expense of repair and delay to works | ▪ Widespread productive losses and inconvenience to the public<br>▪ Very severe |
| Water Distribution Mains | ▪ Interruption of supply<br>▪ Expense of repair and delay to works | ▪ Potentially significant productive losses and inconvenience to the public<br>▪ Severe |
| Local Water Distribution | ▪ Interruption of supply | ▪ Localized but significant productive losses and inconvenience to the public<br>▪ Minor |
| Telephone Cables | ▪ Interruption of services<br>▪ Expense of repair and delay to works | ▪ Disruption to national and international communications<br>▪ Limited |
| Telecommunication Cables | ▪ Interruption of supply<br>▪ Personal injury<br>▪ Expense of repair and delay to works | ▪ Extreme Disruption to national and international communications<br>▪ Nil to minor, but very severe when occurs |

### 5.4.1.8 Eligibility for Loss of Income or Business

Compensation for property damage, loss of income, or person's injuries during the construction phase is governed by the general provisions of the Civil Law – Articles 256-287. Unless otherwise specified in the Contract, compensation for all damages that might occur to private property or loss of income, as an act of the Contractor during the construction period, would be the responsibility of the Contractor himself. However, the Claimant should legally prove all damages in the Court.

Consulting the Ministry of Water and Irrigation and the Ministry of Public Works and Housing, it has been emphasized that even during the construction of large scale water and road projects, compensations for loss of income or business never occurred. Government projects as public utilities have always been considered and respected as a procedure for the public good. Nevertheless, prevention of damage to private property during the construction phase, and compensations should explicitly be the responsibility of the Contractor in the awarded agreement.

Loss of income will be compensated by the Contractor only if it is due to Contractor negligence. Otherwise, it will be compensated by the project.

### 5.4.2 Operation Phase

The locals' public safety could be threatened during the operation phase due to the unreasonable actions that might be done by some locals against the pumping stations and the booster units. This impact is distributed where these installations are located with a special focus on Segment (A) where major installations will be done and on Segment (C) where a major reservoir is going to be constructed.

## 5.5 Impacts on Archaeological Resources

Due to the nature of the project and the archaeological and cultural heritage sites located within the project corridor discussed earlier in this document, the construction and operation of this pipeline may affect some of the existing archaeological and cultural heritage, and if any, undiscovered features/sites. Detailed information on the archaeological sites, cultural resources, graveyards and individual graves located within the project corridor including potential impacts are presented in **Annex C22**.

The following discussion presents the anticipated impact of the project on each archaeological site.

### 5.5.1 Archaeological Sites Located within Segment (A): Jurf Al Drawish - Disi

None of the twenty-six listed archaeological sites within this zone are located within the project corridor, and also, none of them is under direct or indirect threat by the proposed project activities. Still, precaution and management measures should be taken into consideration regarding the need to conserve any chance-found sites, or any changes to the project alignment that might affect these sites.

### 5.5.2 Archaeological Sites Located within Segment (B): Al Qatraneh - Jurf Al Drawish

#### 5.5.2.1 Site B-1: Al - Qatraneh Castle

Al-Qatraneh Castle is not threatened directly by the pipe construction. Still, construction activities should be shifted away at least 50 m from the site boundaries.

### 5.5.3 Archaeological Sites located within Segment (C): Reservoir Abu-Alanda - Airport - Al Jiza

#### 5.5.3.1 Site C-1: The Press

The site is not directly threatened by the pipe construction. Nevertheless the construction activity should be done away from the site; a distance of 50 m could be enough as a protective distance for the site. However, it should be noted that the expanding agricultural activities within the surrounding area are threatening the Press and, hence, the Department of Antiquities (DOA) should protect the site from this threat.

#### 5.5.3.2 Site C-2: Area of Cave of Seven Sleepers

Based on the remains identified in the site such as the caves and tombs, it is recommended to change the route of the pipe toward the east. The above-mentioned remains are directly threatened by the construction activities, which may lead to further damage to the main Cave of Seven Sleepers. The proximity of the construction activities near the cave will impact the archaeological plaster and other remains inside the cave itself.

#### 5.5.3.3 Site C-3: Cave of Seven Sleepers

Since the site is directly threatened by the project, the pipeline should follow the existing road and avoid passing through the whole fenced area, with a buffer zone of at least 25 to 50 m. Based on the ESA preparers recommendations, the Ministry of Water and Irrigation decided to adopt the optimised pipeline alignment that follows the existing road in order to protect this site. This action is necessary and should be ensured and monitored.

#### 5.5.3.4 Site C-4: Al – Juwayda Mausoleum

The site is not directly threatened by construction activities. No excavation or construction should be allowed or be permitted near the site. Scattered well-cut ashlars (if found) should be returned to the site in coordination with Department of Antiquities so as to facilitate the restoration activities in the future.

#### 5.5.3.5 Site C-5: The Mausoleum

The site is located close to main road. This puts it under direct threat if the pipeline construction is within this side of the road. It is recommended to avoid constructing the pipeline on the road-side of the mausoleum, or at least to construct the pipeline with a minimum distance of 25 m from the mausoleum to avoid destruction to this sensitive feature.

#### 5.5.3.6 Site C-6: Al Qastal

This site is considered out of the project corridor. Still, this site might have scattered artefacts relevant to the site within the project corridor.

#### 5.5.3.7 Site C-7: Al – Jiza Pool

The site is not directly threatened by pipeline constructions, while digging activities should be kept under control, so as to avoid the vibration which would result from the movements of the vehicles and heavy machinery during construction.

The anticipated threat to the pool is coming from the expected cracks in body of the pool. The contractor should avoid the area of the pool.

#### 5.5.3.8 Site C-8: The Byzantine Church

The site is not threatened by the pipe construction but the Department of Antiquities representative should control the digging operation area and coordinate with the contractor for chance find procedure. The existing remains may extend to the western side under the new constructed highway.

# 6 CUMULATIVE PROJECT SPECIFIC IMPACTS

## 6.1 Cumulative Impacts on the Physical Environment

### 6.1.1 Landscape Damage, Change of Natural Drainage System and Local Geomorphology

Landscape damage, in addition to the change in the natural drainage system and local geomorphology, is the major cumulative impact on the physical environment. The process that leads to this condition come from different actions during the construction phase, and its impacts will continue even after the construction activities finish. Such impacts will result from:

- Site preparation.
- Regular construction activities along the proposed project corridor.
- Construction of access roads, especially in Segments A and B of the project corridor.
- Dumping of cut materials in local drainage systems, especially in Segments A and B of the project corridor.

### 6.1.2 Disi Aquifer System

Incremental Depletion of the Disi Aquifer: The Disi project will mine non-renewable fossil groundwater from the Disi aquifer which cannot be recharged. This use of non-renewable resources is recognized by the Government of Jordan and it plans to partially replace the use of Disi water in the future thorough the introduction of large scale desalinisation of water at Aqaba and through construction of the Red Sea – Dead Sea Water Conveyance Project.

In order to define the problems of groundwater withdrawal and deterioration in both groundwater basins, namely Azraq and Amman-Zarqa basins, the already prepared groundwater flow and solute transport models of the two basins were simulated taking into consideration the operation of Disi Mudawarra conveyance system as “with” and the present situation “without” the proposed project. The benefits gained from the scenario “with” the Disi-Mudawarra project is explained below.

In order to stimulate the benefits of Disi-Mudawarra project on the groundwater resources of Amman-Zarqa basin, the groundwater abstraction of the year 2000 will be reduced by 25% and 50% of the abstracted amount of 2000 after extending the same abstraction till the year 2008, which is the expected date of Disi-Mudawarra project operation, and the reduction percentage is simulated to 2050. Reducing the abstracted amount of 2000 by 25% showed that the water level will rise by 15 meters and the water quality will be improved by 4,500 µS/cm (i.e., becomes 5,500 µS/cm). The second part of this scenario is to reduce the abstraction rate of the year 2000 gradually by 50% up to 2008; after 2008, this reduced rate is to be maintained up to the year 2050. The water level in this case will rise by 25 m and the water quality will be improved by 6,200 µS/cm (i.e., becomes 3,800 µS/cm).

As for Azraq Basin, the scenario simulated a 50% and 25% reduction of its present abstraction rate from the AWSA wells (domestic purposes). The results of these two options show that by the reduction of AWSA wells abstraction by 50%, the water level will be recovered by 8 meters while the EC-values will stay the same as in the year 2000. Similar value was found to occur in the same observation well (AZ-12) when abstraction rates of AWSA wells are reduced by 25%. This observation well is located near AWSA- well field. But for AZ-10, the water level and the EC will stay the same because the well is located near the farm area.

More details on the overall impacts of withdrawing groundwater from Disi Aquifer are provided in the Main Report: Part B-Section.

## 6.2 Cumulative Impacts on Biological Conditions

There are both direct and indirect negative cumulative impacts of the project on the biological conditions. Directly, the project will:

- Add to the habitat fragmentation, especially at the Desert habitats, which are already facing this impact.
- Loss of habitats and biodiversity at remote areas of Disi and Batn El-Ghoul.
- Disturbance to breeding and migratory bird species.
- Introduction of exotic species.
- Increased accessibility to some remote areas.
- Increased accessibility, indirectly, can lead to the following:
    - Increased persecution of wildlife due to increased accessibility.
    - Malpractices and waste accumulation.

Positively, if and only if the accessibility to remote areas can be monitored and controlled, the new access roads can assist in promoting eco-tourism.

## 6.3 Cumulative Impacts on Social Settings

Cumulative impacts on social settings include all individual or collective impacts that will affect positively or negatively the society concerned and economic and social activities during the project life. Those impacts comprise the different stages of the project set-up from construction, operation and maintenance and administration during the concession period. Cumulative impacts therefore, can be divided into two categories:

- Positive Cumulative Impacts; and
- Negative Cumulative Impacts.

### 6.3.1 Positive Cumulative Impacts

#### 6.3.1.1 Employment

It is clear that the policy adopted by the Ministry of Water and Irrigation is to build the Disi Conveyance System on BOT basis (Build, Operate and Transfer). The project assets will be transferred to the MWI following the termination of the Concession Period of 40 years including the construction phase of about 4.5 years. The project implies the establishment of a competent private company with long outstanding experience in similar projects to undertake the following process:

1- Production of 100-120 MCM from Disi aquifer including the digging of 65-85 ground wells.
2- The construction and maintenance of the pipe.

3- The utilisation of the five turnouts to supply the five other governorates with water in case of emergency.
4- The Administration of the system through the project life.

The role of the Contractor is to supply water to WAJ terminal reservoirs of Abu-Alanda and Dabouq. The distribution of water through the existing network and collection of water fees will be the responsibility of WAJ. It is expected that the same personnel of WAJ, offices and collection system will continue through the Concession Period.

Obviously, employment of engineers, surveyors, technicians, skilled workers, unskilled workers, administrators, computer programmers, and many other personnel will proportionately increase with the progress in project development. The Contractor should present detailed analysis of job-opportunities and job-description in his plan of investment to the MWI phased out by the project construction and operation stages. The role of the MWI will extend beyond the direct supervision of the project implementation to the right applications of laws and regulations of the Ministry and close investigation of the contract specifications and conditions to prevent illegal action that could be undertaken by the Contractor or his aids.

#### 6.3.1.2 Business and Services

Cumulative increase in employment during and after the pipeline construction will create parallel demand on local products and services including:

- The purchase of materials and equipment from the local manufacturers or imported to the local market. Procurement of printing matters, furniture, and office material will increase as a matter of progress in project administration.
- Demand on services including transportation, fuel, energy and accommodation will increase accordingly.
- Demand on foodstuff, agricultural products and local food industry will accumulate as employment increases.

Considerable amount of monthly wages and salaries will downstream to the social expenditures of a large segment of the population working or benefiting from the project. It will enhance the economic and social livelihood of the population in the direct and indirect zone of influence. Consequently, benefits and income are likely to be fairly distributed to different social strata. Sales tax, income tax and other taxes will increase in accordance with the annual increase in wages and salaries.

It is expected that all towns and cities along the route (Aqaba, Disi, Ma'an, Tafileh, Qatraneh, Al Jiza, Amman and Abu-Alanda) will be affected by cumulative demands for business and services.

#### 6.3.1.3 The National Economy

Capital investment in the Disi Conveyance System may approach JD 550 million, that is, almost 25% of Jordan's GDP spread over 5 years. The chronic deficit in the annual budget does not allow allocating such a huge investment to one project. The BOT concept may accordingly liberate such investment for the implementation of other water projects in other regions of the Kingdom.

Deficit in industrial water is a major constraint to industrial development in Jordan, particularly in the Industrial State in Sahab 20 km south of Amman. Gradual increase in drinking water resources in Amman will further improve water supply for industry.

#### 6.3.1.4 Public Health

The Disi Conveyance System will ultimately provide continuous water supply of best quality to Amman residential area. It will have positive cumulative impact on the public health in the region as well as on other areas in the direct zone of influence where salinity is increasingly affecting drinking water supply from underground resources. A clean water supply combined with good public awareness will have direct and cumulative impact on the household health conditions overtime. It is expected that substantial decline in water borne diseases such as typhoid, paratyphoid, brucellosis and amoebic diarrhoea will occur as a result of the Disi water quality.

#### 6.3.1.5 Restoration of Depleted Aquifers

Over extraction of ground water from Azraq, Zarqa and Amman aquifers in the last 20 years to cover water shortages in the cities of Amman, Zarqa and Irbid has substantially affected water tables in all these aquifers. Mining of water aquifers like Azraq far exceeded recharge to the extent that Azraq ponds, wild life and vegetation are extinct. For instance, Azraq, which was once a very alive oasis and sanctuary for migrating birds, turned now to be sheer desert. It is expected that water tables in these aquifers may be restored to normal within 10-15 years should the present level of extraction come to end. The supply of Disi water resources to Amman would eventually assist in the restoration of depleted aquifers.

### 6.3.2 Negative Cumulative Impacts

Disi Project is actually not without social, economic and financial negative implications. The negative cumulative impacts are discussed below.

#### 6.3.2.1 Population Growth versus Water Supply

The population of Jordan is growing at 3.5% per annum. In the meantime, Amman (the Capital) is growing at about 4.7% per annum taking into account the natural increase and internal migration to the city. The population of Amman will double itself in about 18 years. It can be concluded therefore, that, although Disi Project will supply 100-120 MCM in addition to other water resources, population growth rate over the next 20-40 years will be the major constraint to water supply efficiency. Water shortages in Amman will increase unless other major water projects such as the Wehdeh Dam and the Red-Dead Sea Canal are materialized.

#### 6.3.2.2 Economy and Finance

Investment in the Disi Project on BOT basis implies the following financial components:

- Recovery of capital cost
- Recovery of operation and maintenance cost
- Recovery of replacement cost of depreciated components

- Profit on capital investment

Investment in water projects in Jordan is included in the general framework of the construction of infrastructure. Therefore, recovery of capital cost has not been given in the past, very much weight in the construction of water tariffs, taking into consideration average income and the household affordability to pay for the service. Annual returns on water sales cover almost the operation and maintenance costs only.

Ostensibly, there will be substantial differences in the cost per $m^3$ supplied by the present network and the Disi Project. Although a Regulatory Law is expected to co-ordinate and compromises both conditions, an increase in water tariffs becomes inevitable. Any additional financial burden will affect the social and economic life of the population.

#### 6.3.2.3 Agriculture and Food Supply

Arable land suitable for irrigated agriculture in the Disi area is about 25,000 hectares of which 15,000 is at present in production and currently planted with olive trees. About 52,000 olive trees are in production. Other trees are grown by local farmers like peach, nectarine, apricots, plums, apples, guava, grapes, figs, citrus, grenades, cactus and Japanese quince. Pastoral area of 5,000 hectares is mainly used to feed small ruminants and camels. Forage, like gloves and Alfa Alfa, is produced at limited scale.

In the year 2020, the population of Jordan will grow to about 10 million and perhaps to 20 million in 2040. Consequently, demand for agricultural products will far exceed supply due to limitations in land and water resources. It is true that all related consultations advocated the extensive use of reclaimed treated waste water in agriculture particularly in the Jordan Valley with reservations on limited agriculture, but the need for additional agricultural products will persist.

The irrigated agriculture provides most of the agricultural production in Jordan and offers a high percentage of agricultural jobs and other relevant support services.

Since 1986, large scale irrigated agriculture has been practiced in the Disi-Mudawarra area. Four agricultural companies are operating in the area. Total area exploited by these companies adds up to 108,637 dunums. On average, the four companies planted 43.11% of the total area available for agriculture.

The average areas grown with wheat and barley were 10,450 and 4,190 dunums, respectively. The percentage of production of these companies to total production of Jordan was 8% for wheat and 5% for barley.

For the period 1992-1997 Jordan production of wheat and barley on average was 73,200 tons and 54,533 tons respectively, annually. There amounts farmed around 13 and 10 % of total local production and imports of these two commodities respectively.

Some crops appear to have negative net revenue, which implies lack of rational justification for producing such crops.

Large-scale agriculture in the Disi Area will not stay in business: first; if they pay for the water they consume, and secondly; because the farming process in Disi needs much more water than the rest of the country to produce the same level of output.

The termination of water supply in 2011 to irrigated areas in Disi will result in the following:

1- The loss of capital invested by farm companies over 25 years
2- The loss of agricultural production of 52,000 olive trees and seasonal agriculture.
3- The loss of employment.
4- The loss of vegetation and the desertification of 25,000 hectares in the area.

However, it seems that there is no other alternative.

As a result of government unwillingness to renew contracts providing free water to large farms in Disi Area by the year 2011. Several negative impacts will result which are not related to conveying Disi water to Amman.

However, about 25,000 hectares is the arable land suitable for irrigated agriculture in the Disi Area Of which 15000 at present in production and currently planted 52000 olive trees. Other crops are grown by local farmers such as peach, nectarine, apricots, plums, apples, guava, grapes, figs, citrus, grenades, cactus, and Japanese quince.

Therefore, there will be direct and indirect impacts resulting from government decision not to renew contracts providing free water to farmers in Disi Area.

- **On the economic level:**
  The direct and in direct impacts will be unemployment and lost of income, which will lead to low standard of Living, low income, and lose of revenues. Other impacts will be a decrease in agriculture's contribution to gross national product of Jordan particularly relating to export of goods and commodities outside Jordan. This will increase also Jordan trade imbalances, and affect the country's Agri-business associated with commodities production in Disi Area.

  Other impacts are related to women employment in small businesses, Livestock production, rural farming industries, and in-house farming's as well as, the impact on Livestock production and increase in prices of goods and commodities.

- **On the social level:**
  There will be several direct and indirect impacts stemming out of either as a result of economic impacts or as cumulative conclusions for ending commercial agriculture. The economic impact will cause poverty, internal migration from countryside to cities, population imbalance and unsuitability and social uncertainty.

  Family relations will be affected with poverty, lower standard of Living, lose of income and jobs having more time on hand with unemployment. This will lead to social problems such as domestic violence and crime. In addition, it will create population imbalances either through pregnancy or internal migration.

  Another social impact is related to limiting rural development which will lead to an overall decline in social conditions in the fields of health, education, and decreasing their ability to develop their know how, skills, and active participation in permanent development.

# 7 EVALUATION OF CUMULATIVE PROJECT SPECIFIC IMPACTS

## 7.1 Evaluation of Cumulative Impacts on the Physical Environment

The only impact of cumulative nature on the physical environment is the change of natural drainage system and local geomorphology.

The magnitude of this impact can be considered to be medium to high within Segments A and B of the project corridor. Such impact will result from different construction activities. In the absence of wise and conscious implementation of the environmental management plan, these activities such an impact will result in increased destruction and/or modification of local geomorphology and drainage system. This impact will continue even after completing the construction activities.

Evaluation of such an impact and the results should be presented to the project environment committee in the presence of the Contractor representative on a regular basis and through direct field survey.

## 7.2 Evaluation of Cumulative Impacts on Biological Conditions

### 7.2.1 Construction Phase

As stated earlier, during the construction phase, several temporal and permanent impacts are anticipated. This is mainly due to excavation and drilling activities, increased accessibility and vehicle movement into some relatively remote areas, and human interference.

The associated temporary impacts are evaluated based on the following:

- Alteration of surface morphology and natural water runoffs schemes has been highlighted due to the fact that most vegetation in such arid areas is confined to sites of enough moisture for green growth. It is expected that some main wadis such as Wadi Hasa and al-Abyad will be highly impacted. This is expected to affect local and down stream plant populations and accordingly other wildlife.
- Removal of vegetation cover and tree stands (at Wadi Al-Abyad) accelerates the erosion of mainly side banks along wadis and debris accumulation.
- Disturbance to breeding and migratory bird species, which will affect the regional and international bird migration.

The permanent impacts are evaluated stemming from the following:

- Regional fragmentation of habitats in the desert ecosystem that is continuously under pressure of development, particularly the limestone Hammada. This is a persisting environmental concern in the Jordanian desert;
- Increased human interference due to increased accessibility and promotion of urbanization of unique sites at Batn El-Ghoul; and accordingly
- Increased accidental and deliberate persecution of wildlife that remains one of the threats facing biodiversity in the country.

### 7.2.2 Operation Phase

Temporary impacts are evaluated based on the disturbance to breeding and migratory bird species especially if large maintenance operations are taking place.

The permanent impacts are evaluated stemming from the following:

- Increased human interference due to increased accessibility; and consequently
- Increased accidental and deliberate persecution of wildlife.

## 7.3 Evaluation of Cumulative Impacts on Social Settings

Evaluation of social and economic impacts and performance of any project usually follows the completion and implementation of that project. Social, economic and environmental benefits or shortcomings are closely associated with the project objectives and specifications in design, implementation and administration. The concession period of 40 years is a very long period for a single committee or organization to follow-up the social and economic cumulative impacts of the project. Therefore, this period can be divided into the following five years interval phases:

1- The construction phase;
2- The first five years interval of operational phase; and
3- Every five years following the O&M phase.

Evaluation of social impacts should be the responsibility of the Ministry of Water and Irrigation. It is suggested that an “Evaluation Committee” headed by the Project Manager and responsible to the Minister be established and be comprised of the following experts:

1- Hydrogeological Engineer
2- Social Scientist
3- Financial Expert
4- Administrator
5- Water Quality Expert

To arrive at consistent and comparative statistics on social settings, the same principles of evaluation should be followed through the project lifetime. At the end of each interval, an “Evaluation Report” should be prepared to describe the project efficiency and the direct and indirect implications on population, employment, health, tariff changes and evolution, and financial and economic status of the project.

For each topic to be evaluated, a very detailed questionnaire can be prepared. Under the supervision of each expert, field surveys shall be carried out by selected staff trained and prepared for this purpose. The evaluation report will be the guideline for the Ministry to suggest to the Contractor any correction or modification to his “Plan of Action”.

In case of emergency or deviation from the project specified objectives this committee shall be called to evaluate and follow-up unordinary events irrelevant to these objectives and report to the Minister.

# 8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

## 8.1 Rational and Justification

The project process adopted by the Government of Jordan is based on a commitment to integrate environmental and social issues into the design and implementation of the processes. The project Environmental and Social Management Plan (ESMP) was formulated to enable compliance with the Jordanian environmental regulations presented in the **Main Report-Part A: Overview**, to account for relevant World Bank Policies, regional and international agreements, and to recognize the relationships the project develop with its stakeholders.

The key principle behind ESMP formulation is ensuring proper, wise and conscious implementation of the proposed mitigation and monitoring measures in order to ensure environmentally sound development.

ESMP is integrated in nature, and addresses a set of considerations important to management and must be factored into the decision making process. The ESMP development and implementation is a continuous process.

The first stage involves conducting the ESA, which includes the identification of environmental concerns, compilation of environmental and social ESMP-Aspects Registers, setting of objectives and targets, and conceptual design of mitigation measures. The ESMP actions were designed to facilitate maximum protection of environmental, socio-economical and archaeological resources during different project phases. These actions are detailed in **Sections 8.3.68.3.7** and **8.3.7** and summarised in **Annex C22**.

The second stage of the process is the implementation stage were implementation of mitigations, monitoring, auditing and evaluation, and plan adaptation will be carried out.

The third and final stage includes evaluating the recovery of affected areas and the efficiency of mitigation, there to establish restoration activities if necessary.

An organizational structure has been developed in order to enable effective implementation of the proposed ESMP. This structure defines responsibilities related to the environmental requirements raised by the proposed project and responses necessary to cope with these requirements in an effective fashion.

The proposed ESMP addresses the issue of environmental awareness and environmental training, whereby environmental training needs of staff at business units are determined in order to design and implement suitable training interventions.

## 8.2 Planning and Framework of the ESMP

To uphold the governmental environmental policy, a planning phase to identify the shape and framework of the ESMP has been completed during the environmental and social assessment phase.

The ESMP is structured as follows:

1- Rational and Justification
2- Planning and Framework of the ESMP
3- Environment and Social Management Plan (ESMP)
4- ESMP Control
5- Implementation and Operation
6- Checking and Corrective Action
7- Management Review

**Figure 39** shows the ESMP process.

In order to support the implementation of the ESMP, a series of maps with associated details in the form of site-specific mitigation summary sheet has been prepared. This tool will allow the construction Contractors, Consultant and their field crew to effectively apply the findings and recommendations on site (**Table 2** and **Annex C5**).

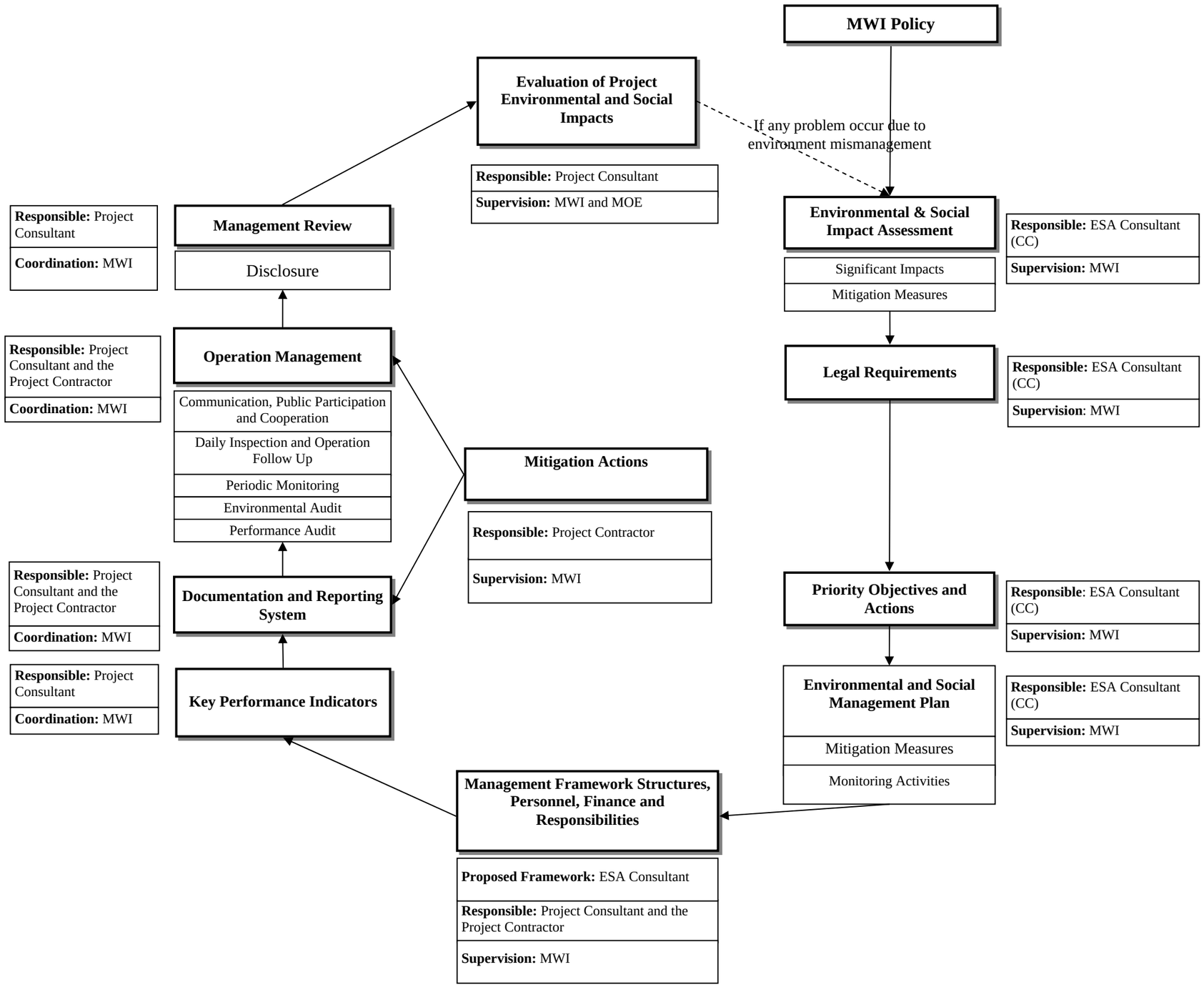



**Figure 39: ESMP planning process**

## 8.3 Environmental and Social Management Plan (ESMP)

### 8.3.1 Environmental Policy and Commitment

The Ministry of Water and Irrigation is committed to achieving sound environmental management and performance as a government policy. An environmental and social management plan (ESMP) is an effective management tool in ensuring legal compliance, avoiding to the extent possible and/or mitigating impacts, reducing potential risk, and providing for continual environmental and social monitoring as part of a formal due diligence process. The project design recognizes that protection of the environment, minimization of adverse social impacts, and adoption of measures to reduce risks to human health and safety all support sound development practice, conserve resources, improve the well being of communities and safeguard employees and the general public

To implement the policy, the project should:

- Operate in conformance with all regulatory requirements and environmental, social, health and safety standards and policies.
- Strengthen the proactive approach adopted by the project for environmental, social, health and safety issues by increasing awareness and knowledge among all levels of employees and committing to the protection and well being of each employee.
- Promote impact avoidance with the emphasis on minimization of waste production and disturbance to the existing environmental and social systems and utilities, and include environmental, health and safety considerations among the criteria by which project construction, operation and remediation are evaluated.
- Require each employee to take the responsibility for the environmental, health and safety performance and security of themselves, fellow employees and the project.
- Assess the project environmental, health and safety performance and programs and commit to continuous improvement towards the project target goals of zero accidents and minimization of potential adverse environmental and social impacts.
- Communicate the commitment of the Government and private sector sponsor to assure environmental and social soundness during the construction and operational phases to the project employees, local communities and other stakeholders.

### 8.3.2 Policy, Legal and Administrative Requirements

The project has been designed to comply with the applicable policy, legal and administrative procedures of the Hashemite Kingdome of Jordan and the World Bank. The "**Main Report – Part A: Overview"** provides a review of these requirements. This section of the Main Report also covers:

- Review of the institutions involved in the management and monitoring of the environment in Jordan, the institutions concerned with legislation and regulation of the sector, and the institutions delegated with enforcement, with a view to determine the status of the legal and institutional context and to assess the environmental management capacity of the Kingdom, in particular those of relevance to the project
- Highlight salient features of Jordan's environmental management capacity, in particular factors that affect the implementation of the project.

### 8.3.3 Structure and Responsibility

Primarily, it is the responsibility of the Contractor to implement and operate the ESMP, where the Contractor should strictly adhere to the suggested mitigation measures and ESMP programs, and define new aspects and mitigate impacts. Also, he should monitor the environmental and social indictors, and document for precautions and actions made.

On the other hand, the Consultant should ensure the project compliance with the legal requirements and the ESMP recommendations. Also, the Consultant is responsible for monitoring the environmental and social aspects, the project conformance/non-conformance, performance auditing, and the construction completion evaluation.

The proposed ESMP implementation and operation management structure reflect the assigned responsibilities as part of the overall project management structure, where three operation management hierarchies has been identified within the project Operation Level as presented in **Figure 40**. These are[21]:

- ESMP Implantation Level (Contractor-Private Sector)
- ESMP Follow Up, Monitoring, Auditing and Evaluation Level (Consultant-Private Sector)
- Project Administration - ESMP Administration and Guiding Level. (Project Management Unit-PMU-MWI)

At the strategic level, the overall project supervision shall be assigned to the MWI- Disi Project Administration Committee. Environmental and Social Advisory Panel will be employed by the committee to help supervising (technical role) and monitoring ESMP related activities. The World Bank will be monitoring the project compliance with respect to its World Bank policies and procedures relevant to the project.

[21] When it comes to ESMP management, the terms Contractor and Consultant are referring to firms/private sector companies.

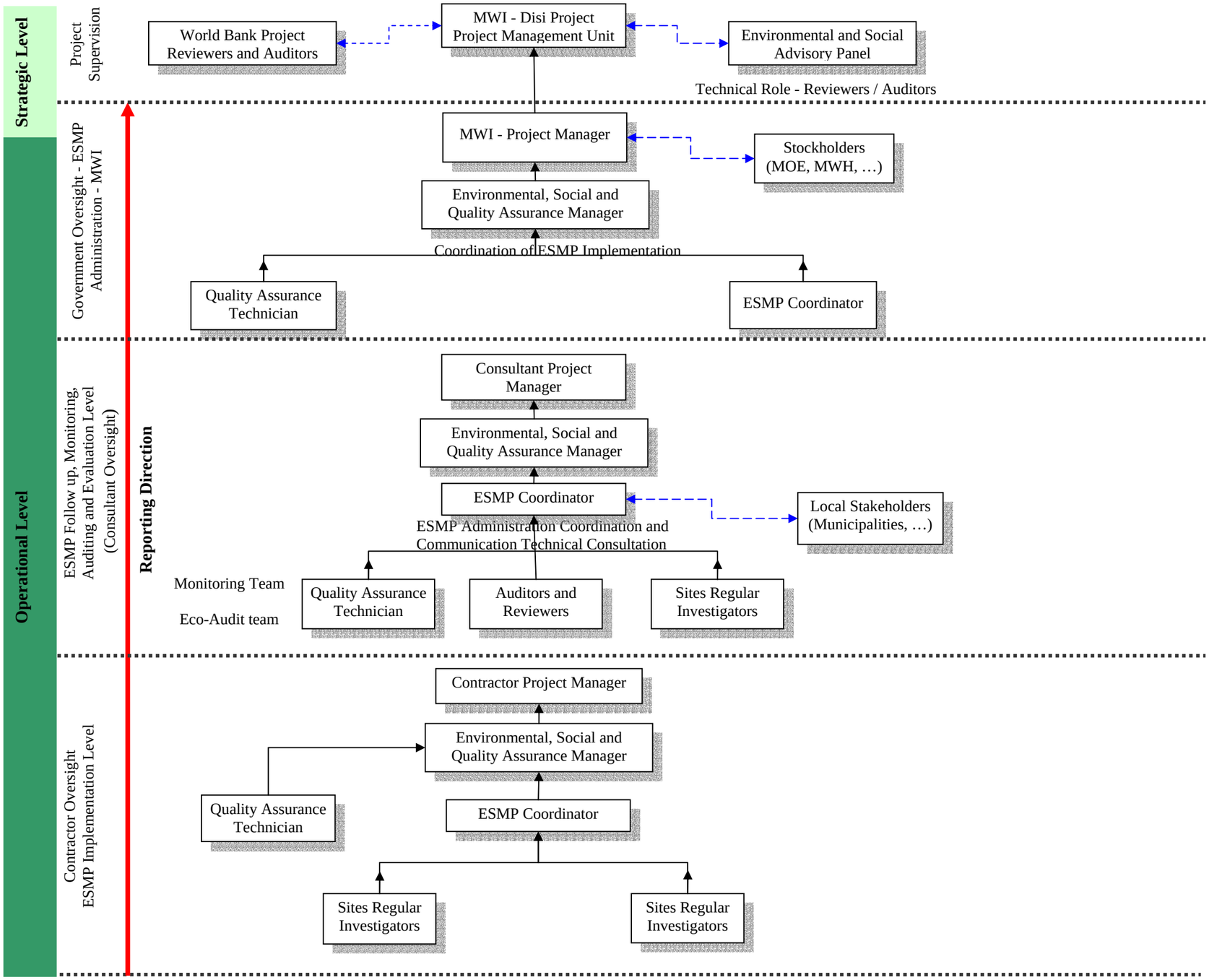



**Figure 40: ESMP management structure**

As the structure demonstrates, the prime ESMP implementation falls under the responsibility of the Contractor (private sector), where an ESMP Management Unit is suggested to undertake this responsibility. This unit will be directed by the Contractor management representative- ESMP Coordinator-, who will be supported by one or two technical staff. This unit will be reporting to the Environmental, Social and Quality Assurance Manager. This structure also indicates to the reporting system that should be applied.

The Contractor, from one side, should ensure effective ESMP implementation and operation. This can be achieved through ensuring that:

1- Roles, responsibility and authorities are defined, documented and communicated.
2- Management is committed to providing resources essential to the implementation and control of the ESMP. These include the human resources and specialized skills, technology and financing.
3- The Management Representative (ESMP Coordinator) is appointed, and assigned defined roles, responsibilities, and authority for:
    a. Ensuring that the ESMP is implemented in accordance with the policy, legal and administrative procedures applicable to the project and subject to the environmental and social provisions of the various legal agreements associated with the project.
    b. Reporting on the performance and effectiveness of implementation of the ESMP to senior project management of the private sector, and in parallel providing briefings and copies to the Ministry of Water and Irrigation and the Construction Contractor. Copies of these reports would be provided to the World Bank and the Environmental and Social Advisory Panel. These reports would be used to monitor progress of ESMP implementation and if necessary make modifications to the ESMP.
    c. Coordinating the activities for the Contractor with the Environmental and Social Advisory Panel.
    d. Undertaking external relations and outreach activities associated with environmental and social aspects of the project.

The duties of the ESMP Coordinator are explained more in **Table 45**.

**Table 45: The duties of the Contractor - ESMP Coordinator**

| | |
|---|---|
| **Preparation stage** | ▪ Develop Environmental and Social Management (ESM) Statement prior to each construction phase. These statements should detail to the ESM procedures applicable to mitigate anticipated impacts.<br>▪ Ensure efficient implementation of the Precautionary ESMP Mitigation Programs and Procedures with regard to the sites and construction activities selection criteria.<br>▪ Ensure the construction of the fluid waste collection for the project offices, construction camps, storage yards and other facilities in the locations, which were agreed upon between the municipalities, the Consultant and the Contractor.<br>▪ Ensure the establishment of the temporary access roads in the locations agreed upon with the Ministry of Public Works and Housing, the Department of Antiquities, the consultant and the contractor.<br>▪ Coordinate with the Natural Resources Authority, Ministry of Environment and Department of Antiquities on issues concerning selection and review of quarry sites, borrow pits and disposal sites.<br>▪ Ensure effective communication and cooperation with local communities especially in Segments C and B<br>▪ Produce necessary report and documents as per of the reporting system mentioned in **Table 49** and ensure all documents and reports control.<br>▪ Quality control review of all detailed working drawings to ensure conformity and adequate environmental protection to meet the requirements for the Site Specific Mitigation Summary Sheets. This would include review of the noise reduction mitigation measures for the design of the pumping stations. |
| **Construction stage** | ▪ Ensure efficient implementation of the ESMP mitigation programs and procedures.<br>▪ Coordinate and follow up with responsible governmental and non-governmental agencies working in the field of environmental conservation.<br>▪ Ensure continuous and efficient communication with local communities.<br>▪ Give a special attention to the issue of public safety, especially in Segments C and B of the project within the populated residential neighbourhoods, and insure the continuous application of these measures during the construction phase.<br>▪ Coordinate with the Department of Antiquities concerning its field based oversight during construction in sensitive areas and the application of archaeological "chance find" procedures for the management of unanticipated finds during construction.<br>▪ Reporting to the project consultant |

The technical staff suggested to support the Contractor - ESMP Coordinator would hold the responsibility of site regular investigation to ensure proper implementation of the project ESMP in addition to other technical responsibilities delegated to those staff by the ESMP Coordinator; these delegated responsibilities could be any of the above-mentioned ESMP Coordinator duties (**Table 45**).

The project consultant would employee a similar ESMP Management Unit to be supervised by the ESMP Coordinator who would be the representative of the Consultant and supported by one or two technical staff. This unit will be reporting to the consultant Environmental, Social and Quality Assurance Manager.

The ESMP Management Unit would have the following responsibilities:

1- To ensure that roles, responsibility and authorities are defined documented and communicated.
2- To monitor, audit and evaluate the project environmental and social aspects as per of the ESMP summary table presented in **Table 46**.

3- To monitor, audit and evaluate the efficiency of ESMP implementation and operation.
4- To evaluate and update the ESMP summary table presented in **Table 46**.
5- To ensure efficient implementation of the ESMP programs and procedures. This can be achieved by the following operational objectives:
    a. Ensuring that the ESMP requirements are established, implemented, and maintained in accordance with the stated legal requirements and approved Standard.
    b. Reporting on the performance and effectiveness of the ESMP to top management and using this reporting as the basis for Management Review.
    c. Monitoring the available and effective use of funds and other resources required for implementation of the ESMP.
    d. Adjusting the implementation scheduled for the ESMP to keep it consistent with the overall schedule for the project.
6- To coordinate preparation of supplemental environmental and social studies as required in order to support the effective implementation of the ESMP.
7- To undertake supplemental consultation, Disclosure and related outreach activities during implementation of the ESMP.

The technical staff suggested to support the Consultant - ESMP Coordinator would hold the responsibility of site regular investigation, environmental and social monitoring, ESMP performance audit and eco-audit in addition to other technical responsibilities delegated to those staff by the ESMP Coordinator.

One of the major assignments of the Consultant -ESMP Management Unit is to establish the baseline information for the environmental and social monitoring program during the pre-construction phase. This should include additional studies on air quality, noise and waster quality to establish ambient conditions in areas that would be directly affected by the project.

### 8.3.4 Environmental and Social Objectives

The proposed environmental and social objectives for the project have been established on the basis of the ESA study, including the public consultation process, and should be reviewed and updated on periodic basis as the project proceeds with implementation.

The overall objectives include:

- To promote closer integration of impact assessment into planning, policy making and overall project management.
- To avoid to the extent possible the occurrence of impacts by the project on the environmental and social settings.
- To minimize to the extent possible the unavoidable impacts.
- To restore the impacted social and environmental settings rapidly.
- To compensate for non-restorable settings and for interim disruption whenever needed.

The detailed environmental and social management objectives and targets identified for the proposed project are presented below in terms of mitigation and monitoring objectives as part of the project and in **Table 46**.

**Table 46: ESMP Site-Specific Procedures and Responsibilities**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | | **Mitigating Impacts to the Physical Environment** | | | |
| | **1** | **Conserve Natural Landscape and Natural Resources** | | | |
| | **1.1** | **Avoidance Measures** | | | |
| | 1.1.1 | The project construction corridor should be defined and proper signage system should be established. The corridor should not exceed 50 meters. | All segments | The Project Contractor | The Project Consultant |
| | 1.1.2 | Where clearing is required for permanent works, approved construction activities and for excavation operations, construction activities should be limited as much as applicable to minimum areas of the project construction corridor | Segments A & B | | |
| | 1.1.3 | Changing the geomorphology, the local drainage systems, in addition to flora demolition should be prohibited outside the proposed project corridor. | Segments A & B | | |
| | 1.1.4 | Avoid unnecessary excavation processes and off road especially at hammad areas and sand dunes and utilize the existing roads instead of making new ones whenever applicable. | Segments A & B | | |
| | 1.1.5 | Avoid accumulation of excavation piles during rainy season. | All segments | | |
| | 1.1.6 | Avoid accumulation of excavated material through synchronizing excavation and filling processes. | All segments | | |
| | 1.1.7 | Prohibit dumping solid wastes in the wadi crossings. | A & B | | |
| | 1.1.8 | Avoid as much as possible building of permanent facilities and instead consider the use of mobile residence facilities. | All segments | | |
| | 1.1.9 | Avoid vegetated sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible. | A | | |
| | 1.1.10 | Avoid planting or seeding of crops and exotic species. | Segments A & B | | |
| | **1.2** | **Wadi Crossing Mitigations** | Segments A & B | The Project Contractor | The Project Consultant |
| | 1.2.1 | Apply bridge-crossing structures for wadi crossings | | | |
| | 1.2.2 | Avoid lowering the pipeline to the bed of the wadi section to avoid erosion hazard due to the nature of the wadis at such regime stage of the streams. The Contractor should plan for diverting the flood flow if construction is carried out in the rainy season and should define the location of the flow section(s) and preferably cross these sections with bridge crossing. Assurance for the flow capacity for such sections must be accompanied by a comprehensive flood study. | | | |
| | 1.2.3 | The Contractor should consider and apply the following crossing mitigations:<br>• *Time executing crossing structures could be scheduled at dry period between May and October.*<br>• *Minimum protection against floodwater must be against flow of 10-Year return period for diverting the flow and protecting the site.*<br>• *Insurance must cover the higher return period flood flow.*<br>• *Stream development should be planed carefully with a comprehensive flood flow analysis.*<br>• *The Contractor should avoid any disturbance to main flow section unless a well design is considered to minimize erosion and sedimentation processes.*<br>• *Spoil materials should be disposed away from the flow areas at sites with no potential of storm water flow in order to eliminate any sediment movement, which could end at the flow sections. These sediments could cause reduction in flow area and site flooding.* | | | |
| | **1.3** | **Erosion and Sedimentation Control** | Segments A & B | The Project Contractor | The Project Consultant |
| | 1.3.1 | Develop the crossing site hydraulically and extend it before and after the crossing section with a minimum distance of ten times the flow section width in order to eliminate any flow disturbance and to smooth the flow which will eventually minimise the erosion process. | | | |
| | 1.3.2 | Discharge construction material spoil out of the flow sections at sites with no potential of storm waters to carry these materials to the flow sections. This will eliminate the sedimentation in the flow sections, which could reduce the flow section and lead to flooding the site. | | | |
| | **1.4** | **Rehabilitation and Restoration Measures** | | | |
| | 1.4.1 | Restore as much as possible changed surface morphology to maintain natural water flow. | All segments | The Project Contractor | The Project Consultant |
| | 1.4.2 | Restore wadi side banks to maintain natural water flow and reduce erosion. | | | |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | **2** | **Installing Appropriate Fluid Waste Collection System** | | | |
| | 2.1 | Construct impermeable septic tanks for domestic wastewater collection to serve each of the project main offices and in the temporary workstations along the project route in addition to the construction camps, storage yards and staging areas. | All segments | The Project Contractor | The Project Consultant |
| | 2.2 | Prohibit the periodical maintenance for the machines to occur within the project site. All machines and vehicles should be maintained at specialized maintenance stations. | | | |
| | 2.3 | Whenever accidental leakage of fluid waste occurs, the Contractor is responsible to clean the polluted area. | | | |
| | **3** | **Applying Appropriate Solid Waste Collection System** | | | |
| | 3.1 | Ensure maximum utilization of the generated cut materials (direct and rocks) in the fill process. | All segments | The Project Contractor | The Project Consultant |
| | 3.2 | Establish, operate and monitor temporary solid waste dumping sites within the construction corridor, the generated and temporary dumped solid wastes in these sites should be placed and emptied on biweekly basis and transferred (if not utilized as filling materials in the construction activities) to defined solid waste dumping sites out of the project corridor. Such dumping sites should comply with the stated criteria and approved from the related authorities including the Ministry of Water and Irrigation and the Ministry of Environment. | | | |
| | 3.3 | Prohibit solid waste accumulation within or close to defined hotspots, archeological sites, farms, residential areas, water runoffs, vegetated hammed areas and sand dunes. | | | |
| | 3.4 | Prohibit prolonged accumulation of solid wastes. The selected temporary dumping sites should be treated only as solid waste transfer stations. | | | |
| | 3.5 | Properly collect the generated domestic solid waste by the project employees and transported it to the closest municipal landfill. This requires prior coordination with related municipalities. The Contractor should ensure the efficiency of waste collection and transport system though no waste is being mismanaged or accumulated. | | | |
| | 3.6 | The temporary solid waste dumping stations (solid waste transfer stations) should:<br>*- Avoid using runoffs, wadis and sand dune areas as temporary solid waste storage ground (especially at Disi and Batn El-Ghoul areas) as much as possible.*<br>*- Avoid accumulation of excavated material through synchronizing excavation and filling processes.*<br>*- Avoid as much as possible removal of green cover.* | | | |
| | 3.7 | Apply restoration of the areas used as temporary storage grounds soon after finishing the use of each site. | | | |
| | **4** | **Dust Control** | | | |
| | 4.1 | Apply (spray) water to the construction surface and other piled materials such as sand as much as needed. | Segments (C-1), (C-3) & (B-2) | The Project Contractor | The Project Consultant |
| | **5** | **Noise Control** | | | |
| | 5.1 | Reduce working night shifts as much as possible in populated areas. | Segments (C-1), (C-3) & (B-2) | The Project Contractor | The Project Consultant |
| | 5.2 | Apply the Jordanian Regulation for ambient noise levels during this phase as a major tool in designing the construction activities schedule. | All segments | | |
| | **6** | **Correct Selection of the Project Offices, Support Facilities, Camps and Temporary Waste Disposal Sites** | | | |
| | 6.1 | For a correct selection of the project offices, camp, and temporary waste disposal site's), the following criteria should be applied: | | The Project Contractor | The Project Consultant, Representatives from MWI |
| | | *- Located outside populated residential areas and far from schools or any social establishment especially for Segments C and B of the project.* | Segments (C-1), (C-3) & (B-2) | | |
| | | *- Located away with a suitable distance from ecologically sensitive habitats, wadis, runoff and wadi side banks, and sand dune habitats.* | Segments A & B | | |
| | | *- Located away from vegetated areas.* | | | |
| | | *- Located away with a suitable distance from archeological suites.* | All segments | | |
| | | *- Located away with a suitable distance from the farms.* | | | |
| | | *- Easy access to the construction sites; to the existing primary roads and to the existing infrastructure* | | | |
| | | *- Located outside any known aquifer recharge zones (if possible).* | | | |
| | 6.2 | Ensure that all buildings and support facilities established within the project has no or very minimal permanent visual impact, this can be achieved by applying designs that are consistent with the visual features of the construction area. The construction designs of the aerial high-voltage electricity supply proposed to pass through Segment A should be verified and approved by related authority.. | Segments A & B | The Project Contractor | The Project Consultant |
| | 6.3 | Restore the selected site to its original condition | All segments | | The Project Consultant, Representatives from MWI |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | **7** | **Correct Selection for the Access Roads** | | | |
| | 7.1 | Determine based on detailed surveys alternative temporary access roads to the roads anticipated to be partially or totally closed. The maximum usage of the present access roads within the project areas, noise levels, private properties protection, and public safety should be considered. Relevant governmental authorities should approve engineering specifications for these roads and the types of vehicles to use these access roads. | Segments C & B | The Project Contractor | Consultant in coordination with the Traffic Department and the MPWH. |
| | 7.2 | The proposed service roads within remote areas located within the project corridor in Segment A should avoid to the extent possible the biological sensitive habitat and plant communities, especially the runoffs and sand dunes vegetation. It is highly recommended to follow the existing road tracks used by the locals within these areas whenever applicable. | Segment A | | Consultant in coordination. |
| | | **Protection of Biological Diversity** | | | |
| | **8** | **Avoidance actions: Precautionary approach is often the most cost effective one. This includes:** | | | |
| | 8.1 | Strictly prohibit the removal of the Acacia trees community. | Segment A | The Project Contractor | The Project Consultant, & the Ministry of Agriculture-department of Forestry |
| | 8.2 | Strictly prohibit green cover removal -unnecessary removal within the construction corridor or any removal out side the corridor- by the Contractor and consultant employees either by collection or burning or any mean of removal | Segments A & B | | The Project Consultant |
| | 8.3 | Minimize night activities. | | | |
| | 8.4 | Avoid unnecessary movement of project staff mainly at night. | | | |
| | 8.5 | Avoid wildlife persecution, hunting, animal and plant collection. | | | |
| | 8.6 | Avoid planting or seedling of crops and exotic species. | | | |
| | 8.7 | Avoid introduction of pets. | | | |
| | 8.8 | Avoid sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible. | Segments A | | |
| | **9** | **Restoration actions** | | | |
| | 9.1 | Upon incidents ensure the restoration of biological diversity and biological communities' characteristics and features. | Segment A | | |
| | | **Protection of Agricultural Resources** | | | |
| | **10** | **Precautionary Measures** | | | |
| | 10.1 | Ensure safe passageways for the herders. | Segments A & B | The Project Contractor | The Project Consultant |
| | 10.2 | Ensure availability of safe passageways to eliminate any inconvenience arising from restrictions on mobility for farms along the route. | | | |
| | **11** | **Restoration actions** | | | |
| | 11.1 | Re-plant or compensate for removed trees (mainly olive) within farms along the route from Qatraneh to Amman. | Segments A & B | The Project Contractor | The Project Consultant and the Ministry of Agriculture |
| | 11.2 | Re-plant or compensate for forestry stands | | | |
| | | **Mitigating Social Impacts** | | | |
| | **12** | **Disi Area Development Plan** | | | |
| | 12.1 | Adopt and implement the proposed Disi Area Development Plan provided in **Annex C23**. | Segments A & B | The Project Contractor | MWI |
| | **13** | **Resettlement Framework** | | | |
| | 13.1 | Adopt and implement the proposed Resettlement Framework provided in **Annex C24**. | All Segments | The Project Contractor | MWI |
| | 13.2 | Employ Bedouin workers in Disi irrigated large-scale farms in the project as guards or manual workers during the construction period or even during operation and maintenance phase. | Segment A | | |
| | 13.3 | Ensure the supply of water to the small number of livestock to continue after the expiration of the farms contracts. | | | |
| | **14** | **Business Disruption** | | | |
| | 14.1 | Take all precautions to prevent damage to private properties during construction or infliction of harm to persons including disruption of work or business to individuals along the pipeline corridor. | Segments B & C | The Project Contractor | The Project Consultant |
| | 14.2 | Ensure safe access to the businesses located along the project alignment | | | |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | **15** | **Reduce the Expected Traffic Disruption** | | | |
| | 15.1 | Avoid the closure of the main roads whenever possible. | All segments | The Project Contractor | The Project Consultant and the Traffic Department |
| | 15.2 | Carry out all construction activities that might require closure of some roads quickly and at one time to minimize the disruption | | | |
| | 15.3 | Allocate and ensure safe traffic detours to serve the impacted traffic movement including loops, bridges or others. Such detours should be of sufficient capacity to cope with the disrupted traffic. | | | |
| | 15.4 | Limit the movement of the construction machinery to the direct project area | | | |
| | 15.6 | Prohibit the movement of this machinery outside the project area during peak traffic hours | Segments C & B | | |
| | 15.7 | Limit the movement time for heavy trucks transporting equipments and materials to the project areas to non-peak traffic hours, and do not allow them to use internal roads between residential areas close to the project site. | All segments | | |
| | 15.8 | Use covering for all vehicles transporting raw materials from/to the project site. | | | |
| | 15.9 | Apply strong restriction for the allowable speed limits for all the project vehicles. | | | |
| | 15.10 | Install all necessary signs and measures to facilitate safety and strict traffic control. | | | |
| | 15.11 | Arranging all the above listed issues should be through coordination with the Traffic Department for a proper traffic management. | | | |
| | 15.12 | A quick and comprehensive rehabilitation program should be conducted for the Southern Amman (Segments C-2 and C-3) city roads system during the preparation stage for this project to accommodate the traffic density. | | | |
| | **16** | **Formulate Public Safety Program for the Locals and the Workers in the Project** | | | |
| | 16.1 | Abide by all items related to safety as outlined in the tender documents and follow all the procedures that could prevent any possible dangers whether these dangers are electrical, mechanical, chemical, or related to site works, and this can be done by:<br>- Providing preventive barriers around machines dangerous parts to avoid the wrong access to these parts.<br>- Providing warning signs that make the workers aware of the dangers related to machines or site area.<br>- Following all the procedures that could prevent static or dynamic electrical dangers and providing any insulation or earthing systems required for workers safety.<br>- Providing scheduled maintenance to deferent machines used during the construction or the operation. | All segments | The Project Contractor | The Project Consultant |
| | 16.2 | The Contractor should maintain insurance policies issued by an insurer allowed by law to do business in Jordan that cover the following:<br>• *Workmen's compensation and all other social insurance in accordance with the statutory requirements of the country or state having jurisdiction over the Contractor's employers.*<br>• *Damages or compensation payable at law in consequence of any accident or injury to any workman or other person in the employment of the Contractor or any sub-Contractor, save and except an accident or injury resulting from any act or default of the employer or his servants.*<br>• *Injury which may occur to any person by arising out of the execution of project and caused by the Contractor or his sub-Contractors.*<br>• *Car bodily injury which shall include coverage for all owned, non-owned and hired vehicles used in the performance of the services.* | All segments | | |
| | 16.3 | Locate access facilities so as to provide a safe passage for the pedestrians crossing within the project areas. It is recommended that these facilities be in the form of protected pedestrian bridges. | Segments (C-1), (C-3) & (B-2) | | |
| | 16.4 | Provide and properly maintain all temporary roads and other work required including access to existing carriage, factories, shops, building and the like. This include installing operating and maintaining all required temporary signing, signals, barriers and other safety measures that can assist in conserving the public and the workers safety. | All segments | | |
| | 16.5 | Ensure suitable disclosure of information with regard to project components relevant to the public and workers safety, including access roads. | | | |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | | **Conservation of Archaeological and Cultural Resources** | | | |
| | **17** | Avoidance actions | | | |
| | 17.1 | Implement the Cultural Resources Management (CRM) program in coordination with CRM monitoring groups including the Department of Antiquities / Ministry of Tourism. | All segments | The Project Contractor | The Project Consultant & the Department of Antiquities |
| | 17.2 | Apply penalties for non-compliance. These penalties should be identified and informed to the Contractor and his employees. | | | |
| | 17.3 | Shift the construction activities for a distance that is enough as to protect identified archeological sites. | Segments B & C | | The Project Consultant |
| | 17.4 | Follow "Chance-find" Procedures. | All segments | | |
| | 17.5 | Conduct exclusion areas. | | | |
| | 17.6 | Adopt special procedures in the vicinity of sites defined as requiring protection. These include protecting the site by fencing, conducting site rescue excavation, conducting site restoration, and implementing signage system to the site. | Segments B & C | | The Project Consultant & the Department of Antiquities |
| | 17.7 | Once the final alignment has been fixed and the extent of any earthworks and borrow pits is known, sites that remain classified as not threatened should be revisited and fully documented for record purposes. | All segments | | The Project Consultant |
| | 17.8 | A set of final engineering drawings, on which archaeological sites within or immediately adjacent to the construction area are defined, should be addressed by the Contractor to the Consultant and to the Department of Antiquities (DOA) prior to starting work.. | | | |
| | 17.9 | In general, for projects entering the construction stage, the following four points could be added to contract documents which would be beneficial for the protection of archaeological sites: | | | The Project Consultant & the Department of Antiquities |
| | 17.9.1 | **Borrow Areas:** | | | |
| | | The locations of borrow areas and quarry sites selected by the Contractor should be approved by the Department of Antiquities (DOA) to prevent antiquities being damaged by quarrying or borrow excavation. Such inspection should not be unreasonably delayed. | | | |
| | 17.9.2 | **Observation of Construction Excavation:** | | | |
| | | In areas where the Department of Antiquities knows or suspects the existence of remains under the surface, but where there is insufficient time for archaeological excavation (or the importance of the site dose not warrant full scale investigation prior to construction), a representative of DOA should be present during the opening of any excavation or borrow pit to identify and record any archaeological remains found. | | | |
| | 17.9.3 | **Additional Salvage Excavation:** | | | |
| | | In areas where DOA has determined that further salvage excavation will be necessary, based on the information developed during the Final Design phase, salvage excavation will be carried out at the beginning of the construction phase. Construction activities should be scheduled so as to leave any such area until late in the construction process, and thus the archaeological excavation would not delay construction activities. | | | |
| | 17.9.4 | **Archaeological Chance Find:** | | | |
| | | If any archaeological site or remains found during construction the Contractor should directly contact the Department of Antiquities. | | | |
| | | If any site found during construction and will be damaged by construction activities, the Department of Antiquities will assess the discovered remains and will carry out an emergency salvage excavation. Salvage excavation means archaeological excavation conducted during construction phase, it should be conducted only when an archaeological site is found by accident (chance find) during construction. Given the short time available for a salvage excavation, this type of work should be avoided. | | | |
| | | The available short time for salvage excavations cannot be considered an authorization to destroy the discovered remains or site. Since each site must be given proper consideration and analysis before its destruction can be authorized. | | | |
| | | The cost of the further salvage excavation should be included as part of rates provided in the Bill of Quantities. | | | |
| | | The Contractor should seek the written approval of the Department of Antiquities before the removal of any chance find building, foundation, structure, fence and other obstruction over 50 years old, any portion of which is in the R.O.W. all designated salvageable material shall be removed, without causing unnecessary damage, and in sections or pieces which may be readily transported, and shall be started by the Contractor at approved locations, for later use or possession of the department of Antiquities | | | |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | | **Monitoring Physical Environment** | | | |
| | **18** | **Conduct Site Inspection** | | | |
| | 18.1 | Conduct site inspection on daily basis to monitor all construction activities according to the prepared construction schedule from an environmental point of view. | All segments | The Project Contractor | The Project Consultant |
| | 18.2 | Provide free passage and access to all parts of the project and at all times to authorized representatives from the MOE, MWI and the responsible municipalities. | | | |
| | **19** | **Monitor Air Quality and Noise Level** | | | |
| | 19.1 | An air quality-monitoring program should be applied to monitor the dust levels and air emissions from vehicles at least four times per year at selected sites along the project layout. The major parameter to be measured is Total Suspended Particles (TSP). | All segments | The Project Contractor | The Project Consultant |
| | 19.2 | Conduct noise level monitoring program once a month during the construction phase, and each time should extend for 24 hours. The major parameters to be measured include but are not limited to:<br>- *Noise (Equivalent Sound Pressure Level, LAeq)*<br>- *Vibration* | | | |
| | **20** | **Monitor Solid Waste Management** | | | |
| | 20.1 | The monitoring of solid waste management operations should cover the following:<br>- *Solid waste generation, including quality and quantity.*<br>- *Collection and transportation efficiency.*<br>- *Suitability of final disposal sites.*<br>- *Solid waste accumulation within the project corridor in terms of volumes and frequency of removal.* | All segments | The Project Consultant | PMU |
| | | **Monitoring of Biological Environment** | | | |
| | **21** | For the biological environment, the frequency of monitoring is mostly periodical (every three months) combined with follow up on daily basis and annual auditing. The following indicators should be monitored:<br>- *Maintained pre-project land utilization and access.*<br>- *Maintained Runoffs Habitat.*<br>- *Natural vegetation cover is maintained.*<br>- *Hunting is banned.*<br>- *Accidental kills are minimum.*<br>- *Breeding seasons are undisturbed.*<br>- *Migration seasons are avoided.* | Segments A & B | The Project Consultant | PMU |
| | **22** | Monitor the natural conditions of surface water flow between pre and post project activities including runoffs habitat and geomorphology, the frequency of monitoring is mostly periodical (every three months) | Segments A & B | The Project Consultant | PMU |
| | **23** | Monitor plant communities' changes, the frequency of monitoring is mostly periodical (every three months) | | | |
| | **24** | Monitor habitat deterioration (some species can be used as indicators for habitat deterioration such as *Citrillus* and *Peganum* sp.). | | | |
| | **25** | Monitor accidental killing of animals (car accidents, falling in drilled ditches, persecutions, etc.). | | | |
| | **26** | Monitor wintering bird species. | | | |
| | **27** | Monitor key herpetofaunal and faunal species. | | | |
| | **28** | Monitor oil spills and solid waste accumulation | | | |
| | **29** | Monitor accessibility to Abu-Tarfa area and to Disi area through Batn El-Ghoul. | Segment A | | |
| | | **Monitoring of Agricultural Resources** | | | |
| | **30** | The following indicators should be monitored for compliance with the suggested mitigation measures:<br>- Safe passageways dedicated for the use of herders especially in Segments A and B.<br>- Removal of trees within farms along the route from Qatraneh to Amman and their re-plantation or compensation.<br>- Availability of safe passageways can eliminate any inconvenience arising from restrictions on mobility for farms along the route. | All segments | The Project Consultant | PMU |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| | | | | Implementation Responsibility | Licensing and Compliance Monitoring Responsibility |
| Construction Phase | | **Monitoring Social Aspects** | | | |
| | **31** | The following indicators should be monitored for compliance with the suggested mitigation measures:<br>- Employment: this includes the percentage of locals and foreigners to the total employment.<br>- Business Disruption: should include, but not be limited to, damage to private properties during construction, harm to persons including disruption of work or business along the pipeline corridor.<br>- Public safety measures and public safety program implementation and efficiency.<br>- Locals complains about project related disturbances, noise and health aspects.<br>- Traffic disruption incidence including location of occurrence, duration, actions made to mitigate the impact and if any accidents resulted from such disruption.<br>- Disruption of infrastructure utilities including telephone connections, electricity, water, sewer and other utilities.<br>- Implementation of the Traffic Disruptions Control Program. Such component should be under the direct supervision of the Traffic Department in each of the different project areas.<br>- Monitor the maintenance of pedestrians crossing facilities to be constructed along the project layout in coordination with the authorized departments in the MPWH in association with the Greater Amman Municipality in addition to the different municipalities along the project corridor. | All segments | The Project Consultant | PMU |
| | | **Monitoring Archaeological and Cultural Heritage Sites** | | | |
| | **32** | The following components should be monitored on regular basis:<br>- Disruption to the archaeological features.<br>- The implementation of the Cultural Resources Management (CRM) activities<br>- Compliance / non-compliance with the “Chance-find” procedures, exclusion areas, and shifting the construction activities for a distance as enough as to protect the site.<br>- Special procedures in the vicinity of sites defined as requiring protection. These include:<br>** Site by fencing*<br>** Site rescue excavation*<br>** Site restoration*<br>** Signage system to the site* | All segments | The Project Consultant | Department of Antiquities |
| Operation Phase | | **Protecting Biological Environment** | | | |
| | **33** | **Preventive Measures** | | | |
| | 33.1 | Prohibit removal of green cover, control accidental and deliberate persecution of wildlife caused and disturbance to breeding and migratory bird species by the increased accessibility to the sensitive habitat within segment A. this can be achieved through proper awareness activities, site signage and regular patrolling. | Segment A | The Project Contractor | Ministry of Environment, the Ministry of Agriculture and the Royal Society for the conservation of Nature |
| | 33.2 | Avoid the removal of the Acacia trees community and translocation of those unavoidable ones in coordination with related authorities including the Ministry of Agriculture and the Royal Society for the Conservation of Nature. | | | The Project Consultant |
| | 33.3 | Avoid as much as possible removal of green cover. | | | |
| | 33.4 | Minimize night activities. | | | |
| | 33.5 | Avoid wildlife persecution, hunting, animal and plant collection. | | | |
| | 33.6 | Avoid unnecessary movement of project staff mainly at night. | | | |
| | 33.7 | Avoid planting or seedling of crops and exotic species. | | | |
| | 33.8 | Avoid introduction of pets. | | | |
| | 33.9 | Avoid sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible. | | | |

**Table 46: ESMP Site-Specific Procedures and Responsibilities (contd.)**

| Phase | No. | Mitigation and ESM Procedures | Zones | Responsibilities | |
|---|---|---|---|---|---|
| Operation Phase | | **Mitigating and Monitoring Social Impacts** | | | |
| | **34** | **Monitoring Wadi Crossings** | | | |
| | 34.1 | Development of monitoring criteria for post-construction performance of wadi crossing is essential for a successful plan to minimize the impact of wadi crossing during construction phase. | All segments | The Project Contractor | The Project Consultant |
| | **35** | **Applying and Monitoring Appropriate Public Safety Program** | | | |
| | 35.1 | All the booster and pumping stations along the project route should be fenced and have daily guarding system. In addition to that, the local communities should understand through the public media and the local schools within the project corridor, the importance of conserving all of the project facilities. More over all the workers in these stations should weir safety equipments such as safety helmets and shoes during their work shifts and should get a specialized public safety course related to such facilities. | All segments | The Project Contractor | The Project Consultant |
| | 35.2 | The expected fluid and solid wastes resulted from the project facilities should be disposed probably as the following: (i)The human fluid wastes should be disposed to the wastewater collection system (Where available) or to appropriate septic tanks and pumped out on monthly basis. (ii)The fluid wastes resulted from the daily work activities should be collected in special tanks and sent on monthly bases to the nearest dumping site. The resulted solid wastes should be collected in weekly bases and sent to the nearest dumping site. | | The Project Contractor and The Project Consultant | |
| | 35.3 | The Jordanian Regulation for ambient noise levels should be applied to control the expected noise levels to generate from operating the pumping stations especially those located close to the residential areas. | | | |
| | 35.4 | It is the responsibility of the environment department in MWI in association with the local municipalities and the Greater Amman municipality (for sites located within the Jurisdictions of Amman municipality) to supervise and monitor the implementation of the above listed measures. | | | |
| Remediation Phase | | **The mitigation measures proposed to cope with the anticipated construction-remediation phase are dealt with as construction impacts, while the overall project remediation impacts will be the same as those described for the construction phase.** | All segments | The Project Contractor and The Project Consultant | MWI |
| Project-Specific overall Environmental and Social Management Requirements | | **Establishing an Environmental and Social Management Unit with at least one experienced ESMP-Coordinator.** | All segments | The Project Contractor | The Project Consultant |
| | | **Conducting suitable and effective staff training and awareness activities to ensure the project employees understanding, appreciation and adherence to the suggested environmental and social management requirements.** | All segments | The Project Contractor | The Project Consultant |
| | | **Ensuring public participation in the overall ESMP implementation through effective disclosure of information such as announcement of roads closer and access roads provided, and through public consultation and feed-back mechanism.** | All segments | The Project Contractor | The Project Consultant |

### 8.3.5 Environmental and Social Aspects

Environmental and social ESMP-Aspects Register has been developed during the ESA and forms an integral part the ESMP. It provides an account of the identified impacts during the assessment.

The register is the result of wide consultation and detailed investigation of the environmental and social concerns, project activities and impacts. The identification of the ESMP-Aspects Register included the involvement of the local communities and project stakeholders through the process of public communication and during the course of scoping.

On an ongoing basis, the Ministry of Water and Irrigation and the Contractor, on the basis of recommendations made by the ESMP Management Unit, ESAP or other parties, may adjust the design of the ESMP to address new environmental and social issues identified during the course of project implementation. The implementation of the ESMP and the project more broadly should be managed in a manner that allows it to respond to significant issues raised by local communities and other stakeholders as part of the communication and consultation process to be undertaken during project implementation.

Proposed changes to the scope, schedule and funding of the ESMP are reported to the Ministry of Water and Irrigation and Contractor by the ESMP Coordinator. Proposed changes to the ESMP should be undertaken on a proactive basis to avoid adverse impacts and when project based experience indicates clear benefits from a change in approach. The work of the ESMP Management would be subject to routine review by the Ministry of Water and Irrigation, Environmental and Social Advisory Panel and World Bank.

The environmental and social registered impacts are presented in **Table 47**.

**Table 47: Registered Environmental and Social impacts**

| No. | Anticipated Significant Impacts | Zone Type and Magnitude of Effect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | B1 | B2 | C1 | C2 | C3 |
| **1** | **Construction Phase and/or Remediation Phase** | | | | | | | |
| **1.1** | **Biological Environment** | | | | | | | |
| **1.1.1** | **Habitat** | | | | | | | |
| 1.1.1.1 | Habitat Fragmentation | High cumulative | High cumulative | | | | | |
| 1.1.1.2 | Alteration of surface morphology and water runoffs schemes | High direct | High direct | | | | | |
| 1.1.1.3 | Increased human interference | Medium cumulative | Medium cumulative | | | | | |
| **1.1.2** | **Species** | | | | | | | |
| 1.1.2.1 | Removal of vegetation cover and tree stands | High direct | High direct | Medium direct | Medium direct | Medium direct | Medium direct | Medium direct |
| 1.1.2.2 | Persecution of wildlife | Direct, Indirect, cumulative | Direct, Indirect, cumulative | | | | | |
| 1.1.2.3 | Disturbance to breeding and migratory bird species | Direct, Indirect, cumulative | Direct, Indirect, cumulative | | | | | |
| 1.1.2.4 | Introduction of exotic species | Indirect, cumulative | Indirect, cumulative | | | | | |
| **1.2** | **A Biotic Environment** | | | | | | | |
| 1.2.1 | High Noise Levels | High, temporary direct impact. | High, temporary direct impact. | Low- Medium, Temporary direct impact. | Low- Medium, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. |
| 1.2.2 | Increase Dust Levels | Low, temporary direct impact. | Low, temporary direct impact. | Low, temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. |

**Table 47: Registered Environmental and Social impacts (contd.)**

| No. | Anticipated Significant Impacts | Zone Type and Magnitude of Effect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | B1 | B2 | C1 | C2 | C3 |
| 1.2.3 | Generated Fluid Wastes | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. |
| 1.2.4 | Generated Solid Wastes | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. | High, Temporary direct impact. |
| 1.2.6 | Selecting the Location for the project Offices & Camps | | | Low- Medium temporary direct impact | Low- Medium temporary direct impact | High temporary direct impact | High temporary direct impact | High temporary direct impact |
| 1.2.7 | Incorrectly constructed or routed access roads | | | | | High, Temporary direct impact | High, Temporary direct impact | High, Temporary direct impact |
| 1.2.8 | Landscape Damage, Change of Natural Drainage system and Local geomorphology through: 1- Unwisely planed construction operations. 2- Unnecessary damage by the construction activities outside the defined areas for operations. 3- Landscape scarring leading to future erosion, 4- Temporary dislocation of existing drainage patterns | Medium to high temporary direct impact | Medium to high temporary direct impact | Medium to high temporary direct impact | Medium to high temporary direct impact | | | |
| 1.2.9 | Wadi Crossing | Medium to high permanent direct impact | Medium to high permanent direct impact | Medium to high permanent direct impact | Medium to high permanent direct impact | | | |
| 1.2.10 | Erosion and Sedimentation | Medium to high permanent direct impact | Medium to high permanent direct impact | Medium to high permanent direct impact | Medium to high permanent direct impact | | | |

**Table 47: Registered Environmental and Social impacts (contd.)**

| No. | Anticipated Significant Impacts | Zone Type and Magnitude of Effect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | B1 | B2 | C1 | C2 | C3 |
| 1.2.11 | Visual Impact caused by establishment of permanent structures like pumping stations and other support facilities including power supply lines | Medium to high permanent direct impact | Medium to high permanent direct impact | Medium to high permanent direct impact | | | | |
| **1.3** | **Social** | | | | | | | |
| 1.3.1 | Impacts on Indigenous Peoples | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | | | |
| 1.3.2 | Resettlement | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact |
| 1.3.3 | Land Acquisition | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact | None to low temporary direct impact |
| 1.3.4 | Traffic Disruptions | | | Medium Temporary direct impact and high when crossing the Desert Road | Medium Temporary direct impact and high when crossing the Desert Road | High, Temporary direct Impact | High, Temporary direct Impact | High, Temporary direct Impact |

**Table 47: Registered Environmental and Social impacts (contd.)**

| No. | Anticipated Significant Impacts | Zone Type and Magnitude of Effect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | B1 | B2 | C1 | C2 | C3 |
| 1.3.5 | Disturb of the existing infrastructure and utilities including water supply and wastewater services, electrical power supply and others | | | High, Temporary direct impact | High, Temporary direct impact | High, Temporary direct impact | High, Temporary direct impact | High, Temporary direct impact |
| 1.3.6 | Risk to Locals & Employees Safety especially pedestrians | Not significant for the locals and high for the project employees | Not significant for the locals and high for the project employees | Low-Medium Temporary direct impact for the locals and high for the project employees | Low-Medium Temporary direct impact for the locals and high for the project employees | High Temporary direct impact for the locals and high for the project employees | High Temporary direct impact for the locals and high for the project employees | High Temporary direct impact for the locals and high for the project employees |
| 1.3.7 | Disruption of business may lead to the temporary loss of income. | | | | Low-Medium Temporary direct impact | Low-Medium Temporary direct impact | Low-Medium Temporary direct impact | Low-Medium Temporary direct impact |
| 1.3.8 | Property damage and loss of income | | | | Low-Medium Temporary direct impact | Low-Medium Temporary direct impact | Low-Medium Temporary direct impact | Low-Medium Temporary direct impact |
| **1.4** | **Agriculture Environment** | | | | | | | |
| 1.4.1 | Removal and cut of trees close to the pipeline | | | | Medium and direct | Medium and direct | Medium and direct | Medium and direct |
| 1.4.2 | Limitation of the accessibility to the farms | | | | Low and direct | Low and direct | Low and direct | Low and direct |
| **1.5** | **Archaeological Sites** | | | | | | | |
| 1.5.1 | Archaeological sites | | | Medium, indirect and direct | Medium, indirect and direct | Medium, indirect and direct | Medium, indirect and direct | Medium, indirect and direct |

**Table 47: Registered Environmental and Social impacts (contd.)**

| No. | Anticipated Significant Impacts | Zone Type and Magnitude of Effect | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | B1 | B2 | C1 | C2 | C3 |
| **2** | **Operation Phase** | | | | | | | |
| **2.1** | **Biological Environment** | | | | | | | |
| **2.1.1** | **Habitat** | | | | | | | |
| 2.1.1.1 | Increased human interference and accessibility | Cumulative | Cumulative | | | | | |
| **2.1.2** | **Species** | | | | | | | |
| 2.1.2.1 | Persecution of wildlife | Direct, indirect and cumulative | Direct, indirect and cumulative | | | | | |
| **2.2** | **A Biotic Environment** | | | | | | | |
| 2.2.1 | Threatening the public safety of local populations | Medium, permanent direct impact | Medium, permanent direct impact | Medium, permanent direct impact | Medium, permanent direct impact | | | |

### 8.3.6 Management Programs for Mitigation of Impacts

As part of the ESA process for new projects, environmental and social management programs are being compiled in all aspects where site-specific features are taken in account. These management programs are prepared to address project specific mitigation and monitoring needs.

Each program includes procedures for mitigation measures and monitoring activities that are designed to achieve the stated objectives established for the ESMP

The following mitigation measures should be strictly adhered to, in order to avoid impact, risk or hazard whenever anticipated. When the impacts are unavoidable the impact should be minimized to the extent possible and the settings should be rehabilitated appropriately to restore the natural condition. Compensation schemes should be applied whenever needed as a consequence of the interim damage and disruption or as compensation to the permanent damage.

The following are the proposed mitigation measures foreseen for the expected impacts. The success of the foreseen mitigation measures depends largely on proper training and awareness to project staff and efficiency of restoration when required. **Table 46** presents the site specific mitigation measures based on their relevance to the project activities.

#### 8.3.6.1 Construction Phase

#### (a) Mitigating Environmental Impacts

**1- Conserve Natural Landscape and Natural Resources**

During the construction phase, the Contractor should apply the maximum care not to inflict unnecessary damage to the local landscape and natural resources. Only, where the clearing is required for permanent works, for approved construction activities and for excavation operations, local geomorphology, natural drainage systems, all trees and natural vegetation must be conserved and protected from the damage that might result from the construction activities. Changing the geomorphology, the local drainage systems, in addition to flora demolition should be prohibited outside the proposed project corridor. Furthermore, dumping solid wastes in the wadi crossings should be prohibited. It is crucial to identify a project corridor, which should not exceed 50 meters width and within which all excavation and project related constructions should be limited.

Other avoidance activities include:

- Avoid unnecessary excavation processes and off road especially at hammad areas and sand dunes and utilize the existing roads instead of making new ones whenever applicable.
- Avoid accumulation of excavation piles during rainy season.
- Avoid as much as possible removal of green cover.
- Avoid accumulation of excavated material through synchronizing excavation and filling processes.
- Avoid accumulation of excavation materials and other solid wastes.
- Avoid as much as possible building of permanent facilities and instead consider the use of mobile residence facilities.
- Avoid sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible.

- Avoid planting or seeding of crops and exotic species.

Moreover, and after work completion, all work areas should be rehabilitated, smoothed and graded in a manner to confirm the natural appearance of the surrounding landscape. The restoration option is upon incidence of impact and mainly directed to:

- Restore as possible changing surface morphology to maintain natural water flow.
- Restore wadi side banks to maintain natural water flow and reduce erosion.
- It is as important to synchronize excavation and restoration in such in such a manner that the back filling and restoration process is undertaken in a continuous manner with the excavation process. This is to avoid accumulation of debris and excavation materials for long periods and allow for restoration process to proceed.

Also, the above listed mitigation measures should be applied and taken into consideration during the site selection and establishing the different project offices.

**2- Erosion and Sedimentation Control**

During the construction phase and in order to control generated erosion and sedimentation, the contractor should:

- Develop the design of the crossing site hydraulically and extends it before and after the crossing section with a minimum distance of ten times the flow section width in order to eliminate any flow disturbance and to smooth the flow which will eventually minimise the erosion process.
- Dispose construction material spoils from the flow sections at sites with limited or no potential for storm waters to carry these materials to the flow sections. This will eliminate the sedimentation in the flow sections, which could reduce the flow section and lead to flooding the site. Any flooding could cause an erosion process, which will damage the site.

**3- Wadi Crossing Mitigations**

The contractor should:

- Apply bridge-crossing structures for wadi crossings.
- Avoid lowering the pipeline to the bed of the wadi section to avoid erosion hazard due to the nature of the wadis at such regime stage of the streams. The contractor should plan for diverting the flood flow if construction is carried out in the rainy season and should define the location of the flow section(s) and preferably cross these sections with bridge crossing. Assurance for the flow capacity for such sections must be accompanied by a comprehensive flood study.
- The contractor should consider and apply the following crossing mitigations:
  - Construction of crossing structures should be scheduled during the dry period between May and October.
  - Minimum protection against floodwater must be against flow of 10-Year return period for diverting the flow and protecting the site.
  - Insurance must cover the higher return period flood flow.
  - Stream development should be planed carefully with a comprehensive flood flow analysis.
  - The contractor should avoid any disturbance to main flow section unless a well design is considered to minimize erosion and sedimentation processes.

- Spoil materials should be disposed away from the flow areas at sites with no potential of storm water flow in order to eliminate any sediment movement, which could end at the flow sections. These sediments could cause reduction in flow area and site flooding.

**4- Installing Appropriate Fluid Waste Collection System**

During the preparation stage for this phase, the contracting company should construct an appropriate temporary fluid wastes collection system in each of the project main offices and in any temporary workstations along the project route in addition to the construction camps, storage yards and staging areas. The recommended method is the impermeable septic tanks that will be emptied regularly and sent to the nearest fluid wastes treatment station. In selecting the site for the impermeable septic tanks, the hydrogeological conditions should be taken into consideration.

As for the expected fluid waste that might result from machines and vehicles maintenance, it should be listed in the construction contract that periodical maintenance for the machines should be at a special maintenance compound that is properly established within the project site. Any generated wastes should be transferred to identified disposal sites by the Engineer in agreement with concerned municipalities.

Whenever accidental leakage of fluid waste occurs, the Contractor is responsible to clean the polluted area.

**5- Applying Appropriate Solid Waste Collection Systems**

Seeing that the quantity of cut materials will be a measure source of solid wastes in this project, it is recommended to use these materials in the fill process. Also, during the construction phase, a specific area should be designated as a temporary solid waste dumping area.

The generated solid wastes during the construction phase should be placed in the temporary disposal sites, emptied on weekly basis and transferred to the defined appropriate final solid waste disposal sites along the project corridor that is suitable for the generated wastes.

The Jordanian legislation prohibit the disposal of solid wastes outside the construction sites. Therefore the proposed temporary dumping site(s) should be located within the identified construction zone. This zone should not exceed 50 meters in width. The final solid waste disposal sites should comply with the stated criteria and should be approved from the related authorities including the Ministry of Municipal Affairs, Ministry of Water and Irrigation and the Ministry of Environment.

Also, the Contractor may have to pay “gate fees” to use final disposal sites operated by the municipalities.

The domestic solid waste generated by the project employees should be collected properly and transferred to the closest municipal landfill. Such activity requires prior coordination with the related municipalities. The Contractor should ensure the efficiency of waste collection and transport system though no waste is being mismanaged or accumulated.

Precautionary approach is also needed to:

- Avoid unnecessary and prolonged solid waste accumulation especially at hammad areas and sand dunes.

- Avoid using runoffs, wadis and sand dune areas as temporary solid waste storage ground (especially at Disi and Batn El-Ghoul areas) as much as possible.
- Avoid accumulation of excavated material through synchronizing excavation and filling processes.
- Avoid as much as possible removal of green cover.

Restoration of the areas used as temporary storage grounds should be applied soon after finishing the use of each site.

The above listed mitigation measures should be applied also for all types of solid wastes resulted from the construction camps, storage yards and staging areas.

**6- Mitigating Visual Impacts**

In addition to the up mentioned mitigation measures that mitigate the primary cause of the impact, additional measures should be applied. These are as follows:

- The contractor should ensure all buildings and support facilities established within the project has no or at maximum very minimal permanent visual impact, this can be achieved by applying designs that are consistent with the visual features of the construction area. The contractor may consult with ASEZA and the RSCN on this regard. Visual impact can be minimized by:
  - Designing the buildings to reflect existing visual elements and colours within the nearby of the proposed building, and by
  - Using local construction materials, for example black stones instead of white or cement walls.
- The construction designs of the aerial high-voltage electricity supply proposed to pass through segment A should be verified and approved by ASEZA Environment Commission.

**7- Dust Control**

In order to reduce dust spreading due to the construction activities and its negative impacts on the residential areas, especially in Segments (C-1), (C-3) and (B-2) of the project, the Contractor should apply water to the construction surface and other piled materials such as sand as much as needed. Sometimes it may be required to spray water as needed especially in residential areas.

**8- Noise Control**

In order to control the expected high noise levels during the construction phase, working night shifts should be reduced as much as possible in populated areas. The Jordanian Regulation for ambient noise levels presented in **Table 48** should be applied during this phase of the project and should be a major tool in designing the construction activities schedule.

For areas where the noise level is anticipated to exceed 85 dB, warning signs should be posted indicating that hearing protection is required. This might be applicable to the pumping stations and the locations that might witness use of explosions if any.

Local communities living within the areas where noise levels anticipated to exceed the maximum allowable levels within residential areas in cities should be notified in advance, and construction activities within those locations should be limited to daytime only.

**Table 48: The Jordanian Regulations for Ambient Noise Levels**

| Area | Maximum Allowable Noise level (dB) | |
|---|---|---|
| | Day | Night |
| Residential areas in cities | 60 | 50 |
| Residential areas in towns | 55 | 45 |
| Residential areas in villages | 50 | 40 |
| Residential areas with light industries | 65 | 55 |
| Areas of Heavy industries | 75 | 65 |
| Areas for educational, health and religious services | 45 | 35 |

Source: Official news paper, No.4238 Nov.1997
See **Annex C21** for the Jordanian Noise Regulation and the Acoustic Guide

**9- Correct Selection of the Project Offices, Camps and Temporary Waste Disposal Sites**

For a correct selection of the project offices, camp, and temporary waste disposal site(s), the following criteria should be applied:

- Located outside the heavily populated residential areas especially for Segment C of the project.
- Far from schools or any social establishment especially for Segments C and B of the project.
- Far from the ecologically sensitive habitats, wadi, runoff and wadi side banks, and sand dune habitats.
- Avoiding vegetated areas.
- Easy access to the construction sites.
- Easy access to the existing primary roads.
- Easy access to existing infrastructure.
- Located outside any known aquifer recharge zones (if possible).
- Far for a safe distance from archaeological sites, graveyards and/or individual burial sites.

It should be taken into consideration, that restoring the selected site to its original condition is a must, and that the Contractor should be responsible on achieving this issue.

Representatives from Ministry of Water and Irrigation, Department of Antiquities, Ministry of Environment, the project consulting firm and the local municipalities should participate in this selection. The Contractor should submit in his Preconstruction Environmental and Social Statement (Report) detailed documentation and description of the selected or alternatives locations (including the restoration work) to the project offices, camps and temporary waste disposal sites. Subject to this selection, the project consulting firm should inform and coordinate with the MWI, where the MWI will establish a committee to involve representatives from the Ministry of Water and Irrigation, Department of Antiquities, Ministry of Environment, and the local municipalities to review and approve or disapprove the selection. If the selection is disapproved it might be possible to the established committee to suggest alternatives to the selection. When the committee approves the selected locations, MWI would issue approval documents to the Contractor.

**10- Correct Selection for the Access Roads**

Before starting the construction activities, a detailed survey should be conducted for selecting the temporary access roads to be used by small and medium sized vehicles during the construction phase in Segments C and B. The consulting office in association with the

Traffic Department and MPWH should conduct this survey. In selection of temporary access roads, the maximum usage of the present access roads within the project areas should be considered.

Also, the temporary access routes should be selected carefully, especially where such roads traverse, or originate in, residential areas in order to reduce noise levels, protect private properties, and reduce risks to public safety. The relevant governmental authorities should approve engineering specifications for these roads and the types of vehicles to use these accesses.

The proposed service roads within the remote areas within Segment (A) should avoid to the extent possible the biological sensitive habitat and plant communities, especially the runoffs and sand dunes vegetation. It is highly recommended to follow the existing road tracks used by the locals within these areas whenever applicable.

Correct selection of access roads should recognize archaeological sites, graveyards and/or individual burial sites as sensitive areas that should be avoided. Whenever avoidance is not practical, proper mitigation measures should be applied. The mitigation measures presented in **Section 8.3.6.1:part (d)** are also applicable.

**11- Protection of Biological Diversity**

In addition to what is stated above as mitigation measures, the following actions should be strictly adhered to in order to mitigate the project anticipated impacts on the biological environment, especially within Segments A and B. These mitigation measures include:

1- Precautionary approach is often the most cost effective one. This includes:

- Strictly prohibit the removal of the Acacia tree community.
- Minimize night activities and avoid unnecessary movement of project staff mainly at night.
- Strictly Prohibit wildlife persecution, hunting, animal and plant collection.
- Prohibit planting or seeding of crops and exotic species.
- Avoid introduction of pets.
- Limit construction activities within the sand dunes areas (especially at Disi and Batn El-Ghoul areas) to the minimum construction corridor of not more than 50 meters.
- Prohibit unnecessary burning and use of natural vegetation as firewood.
- Minimize as possible building of permanent facilities and instead consider the use of mobile residence facilities.

2- Restoration actions

This is upon incidence of impact and mainly directed to the restoration actions mentioned above. Such restorations should ensure the restoration of biological diversity and biological communities' characteristics and features. As for tree stands identified earlier (Acacia, Tamarix, afforestation trees), translocation, re-plantation and/or compensation to responsible authorities within the Ministry of Agriculture, to re-plant the removed stands or trees. It is highly recommended to involve representatives from the Ministry of Environment, Ministry of Agriculture and the Royal Society for the Conservation of Nature in verifying these restoration actions when submitted within the Contractor Preconstruction

Environmental and Social Statement (report). Such involvement can be established through proper communication channels between the Consultant, MWI and those parties.

In order to comply with the above mentioned mitigations and to ensure conformity to the Site Specific Mitigation, all working construction drawings (including restoration work) should be verified by the Contractor ESMP Coordinator, verified and approved drawings should be submitted by the Contractor with his Preconstruction Environmental and Social Statement (report) to the Consultant, again all drawings should be verified by the Consultant ESMP Coordinator.

### (b) Protection of Agricultural Resources

Agricultural mitigation measures are as follows:

- Ensure safe passageways dedicated for the use of herders especially in Segments A and B.
- Establish mitigation measures for possible negative impact on large-scale farming companies. Once the current agreement held between the government and the companies expires, two possibilities arise: first, renewal of the agreement, and second, agreements termination. Renewal of the agreement might bring different conditions. The mitigation measures will have to be covered within the agreement itself. If the current agreement is not renewed, however, no mitigation measures are relevant.
- Replant or compensate for removed trees within farms along the route from Qatraneh to Amman.
- Ensure availability of safe passageways can eliminate any inconvenience arising from restrictions on mobility for farms along the route.

### (c) Mitigating Social Impacts

#### 1- Disi Area Development Plan

A number of measures have been taken to avoid adverse impacts on the population in the Disi area that includes the Bedouin population. The location and design of the pipeline and other structures will minimize any adverse impacts related to land acquisition as the existing right-of-way is being used for project construction. Provision of water for irrigation to the large-scale agriculture farms located in the Disi area will be continued until the expiry of their lease period in order to minimize any disruption in their activities and to give them sufficient notice to make alternative plans. As for small-scale local farms, water supply will continue as the farmers can form social corporations and request the MWI to supply them with water. Additional measures proposed to mitigate possible adverse impacts on the Bedouin population are presented in **Annex C23**.

#### 2- Resettlement Framework

It has been explained in previous sections that no resettlement of the population in the Disi area, particularly the Bedouin population, will occur as a result of the construction of the conveyance system. However, two points have to be made in this respect:

- The number of Bedouin workers in Disi irrigated farm projects does not exceed 50 persons. Most of these workers are guards and seasonal employees. As their number is small, they can be easily absorbed in the project as guards or manual

workers during the construction period or even during operation and maintenance phase.

- The number of livestock at the Disi farm area is limited to small number of camels, sheep and goats owned by local Bedouins for local consumption. At present water is provided to livestock from five groundwater wells owned by the Water Authority. The supply of water to the small number of livestock should continue.

In case the need for resettlement arises, the resettlement framework presented in **Annex C24** should be followed**.**

**3- Foreign Employment**

A close investigation into the number of Egyptian workers on Disi farm projects indicated that their number does not exceed 100. Almost all of them are employed on temporary basis. Seasonal employment of Egyptian workers particularly during olives or fruit harvest is the most dominant practice. Provisions of the Labour Law in Jordan are not applicable to temporarily recruited persons and agricultural workers. Therefore, the termination of Egyptians work in the year 2011 will have no direct or indirect obligations to the present employers or the Contractor to provide this segment of workers with end of service compensations or reemployment.

**4- Business Disruption**

The Contractor should take all precautions to prevent damage to private properties during construction or infliction of harm to persons including disruption of work or business to individuals along the pipeline corridor. These precautions should be part and parcel of the contract. Therefore, the Contractor stands responsible for his action or behaviour contrary to the provisions of the Contract.

Action of mischief in the Civil Law of Jordan is divided into two parts:

1- **Part one:** General Provisions (Articles 256-272)
This part includes damage to property and responsibility of action

2- **Part two:**
This part includes all actions that may lead to personal impairment or harm to wealth or body:

- Impairment (Articles 273-274)
- Deliberate damage of property (Articles 276-278)
- Obtaining property by force or aggression (Articles279-287)

Since it had been reported by the MWI and the MPWH that over the past three decades no claim for loss of income or disruption of business as a result of infrastructure construction had been submitted or compensated, it is very much doubtful that such claim might be presented as a result of the construction of Disi Project. Responsibility for damage of private property and business disruption however, can be divided into two parts:

- Negligence of the Contractor to the contract conditions and the instructions of the Consultant, his mischief or that of any of his employees, are governed by the provisions of the employment contract specified in (Chapter 3: Act 1).

- If the Contractor abided strictly by the contract conditions, and followed the Consultant's instructions completely and correctly, any damage might occur to other persons or property shall be the responsibility of the Owner (Chapter 3: Act 3).

**5- Reduce the Expected Traffic Disruption**

In order to avoid and control the expected traffic disruption and the expected accidents that might result, in addition to control of the noise levels during the construction phase, the following mitigation measures should be applied:

- Avoid the closure of the main roads whenever possible.
- Carry out all construction activities that might require closure of some roads very rapidly and at one time though the disruption would be minimum
- Allocate and ensure alternative routes to serve the impacted traffic movement including loops, bridges or others. Such alternatives should be of sufficient capacity to cope with the disrupted traffic.
- Limit the movement of the construction machinery to the direct project area especially for Segments C and B.
- Prohibit the movement of this machinery outside the project area during peak traffic hours, especially for Segments C and B.
- Limit the movement time for heavy trucks transporting equipments and materials to the project areas to non-peak traffic hours, and not allow them to use internal roads between residential areas close to the project site.
- Use covering for all vehicles transporting raw materials from/to the project site.
- Apply strong restriction for the allowable speed limits for all the project vehicles.
- Install all necessary signs and measures to facilitate safety and strict traffic control.

Arranging all the above listed issues should be through coordination with the Traffic Department for a proper traffic management.

Furthermore, the traffic plans that will be prepared by the construction contractor require a written submittal to the traffic department and written approval prior to the beginning of each construction phase or stage.

On the other hand, and due to the expected increase in the traffic density within the other parts of the Southern Amman (Segments C-2 and C-3) city, a quick and comprehensive rehabilitation program should be conducted for the roads system in these parts of the city during the preparation stage for this project. all the roads in this part of the city that are expected to be used as a temporary access roads during the construction stage should be subjected to a quick and comprehensive rehabilitation program during the preparation stage for this project. Moreover, the MPWH should undertake a rehabilitation program for the road system in general in this part of Amman immediately after completion the construction activities within segment C of the project corridor.

**6- Formulate Public Safety Program for the Locals and the Workers in the Project**

In Segments C and B of the project corridor and especially in the populated areas, and where the services establishments are located, access facilities should be located to provide a safe passage for the pedestrians crossing within the project areas. It is recommended that these facilities be in the form of protected pedestrian bridges.

During the course of the work, the contractor and under the project company (PC) supervision should be responsible for providing and properly maintaining all temporary roads and other work required including access to existing carriage, factories, shops, building and the like. The PC duties include installing operating and maintaining all required temporary signing, signals, barriers and other safety measures that can assist in conserving the public and the workers safety.

The safety measures mentioned below (**point 7**: **Formulate Workers Health and Safety Program**) are as valuable for protecting both public and work staff. These measures should be strictly adhered to.

**7- Formulate Workers Health and Safety Program**

The contractor should follow all the procedures that could prevent any possible dangers whether these dangers are electrical, mechanical, chemical, or related to site works, and this can be done by:

- Providing preventing barriers around machines dangerous parts to prevent the wrong access to these parts.
- Providing warning signs that make the workers aware of the dangers related to machines or site area.
- Following all the procedures that could prevent static or dynamic electrical dangers and provide any insulation or earthing systems required for workers safety.
- The contractor must provide scheduled maintenance to deferent machines used during the construction or the operation.
- The contractor also should maintain insurance policies issued by an insurer allowed by law to do business in Jordan that cover the following:
  - Workmen's compensation and all other social insurance in accordance with the statutory requirements of the country or state having jurisdiction over the contractor's employers.
  - Damages or compensation payable at law in consequence of any accident or injury to any workman or other person in the employment of the contractor or any subcontractor, save and except an accident or injury resulting from any act or default of the employer or his servants.
  - Injury which may occur to any person by arising out of the execution of project and caused by the contractor or his subcontractors.
  - Car bodily injury which shall include coverage for all owned, non-owned and hired vehicles used in the performance of the services.

## (d) Conservation of Archaeological and Cultural Resources

The Jordanian Antiquities Law No. (12) of 1976 and the Regulations of Archaeological Excavation and Surveys provide the basis for the conservation of archaeological sites in Jordan (see **Annex C21**). The mitigation measures for possible impacts on archaeological sites have been formulated to comply with the above-mentioned law and regulation.

In general, there is no requirement for any site discovered during the survey to be destroyed. On the other hand, whenever impact is expected, the mitigation measures might include one or more of the following:

- Cultural Resources Management (CRM) implementation in addition to coordination of responsibilities with CRM monitoring groups including the Department of Antiquities / Ministry of Tourism.
- Penalties for non-compliance.
- Shifting the construction activities for a distance that is enough as to protect the site.
- Following "Chance-find" Procedures.
- Exclusion areas.
- Adopting special procedures in the vicinity of sites defined as requiring protection. These include protecting the site by fencing, conducting site rescue excavation, conducting site restoration, and implementing signage system to the site.

Once the final alignment has been fixed and the extent of any earthworks and borrow pits is known, sites that remain classified as not threatened should be revisited and fully documented for record purposes.

A set of final engineering drawings, on which archaeological sites within or immediately adjacent to the construction area are defined, should be addressed by the Contractor to the Consultant and to the Department of Antiquities prior to starting the work.

In addition, details of the site specific measures outlined in the next section will be provided as instructions to the contractor.

In general, for projects entering the construction stage, three points could be added to contract documents, which would be beneficial for the protection of archaeological sites:

**1- Borrow Areas:**

The locations of borrow areas and quarry sites selected by the contractor should be approved by the Department of Antiquities to prevent antiquities being damaged by quarrying or borrow excavation. Such inspection should not be unreasonably delayed.

**2- Observation of Construction Excavation:**

In areas where the Department of Antiquities knows or suspects the existence of remains under the surface, but where there is insufficient time for archaeological excavation (or the importance of the site dose not warrant full scale investigation prior to construction), a representative of Department of Antiquities should be present during the opening of any excavation or borrow pit to identify and record any archaeological remains found.

**3- Additional Salvage Excavation:**

In areas where the Department of Antiquities has determined that further salvage excavation will be necessary, based on the information developed during the Final Design phase, salvage excavation will be carried out at the beginning of the construction phase. Construction activities should be scheduled so as to leave any such area until late in the construction process, and thus construction activities would not be delayed by the archaeological excavation.

**4- Archaeological chance find and salvage excavation:**

It shall be the responsibility of the Contractor to obtain all information available from the Supervisor of the Cultural Resources Management Office of the Department of Antiquities regarding the location of any know archaeological site in the construction area, and he shall

make this information available to the Engineer's Representative as soon as he obtains it. If any known sites will be threatened by construction, agreement must be reached with the Department of Antiquities in order to minimize damages to the site. It shall also be the Contractor's responsibility to notify the supervisor of the Cultural resources Management Office of the Department of Antiquities of antiquities are encountered in any area during construction, and Clause 27 of the General Conditions of contract must be closely observed and also specifications set in articles 15 of the antiquities Law No. 21 (1988).

If any site found during construction and will be damaged by construction activities, the Department of Antiquities will assess the discovered remains and may will carry out an emergency salvage excavation. Salvage excavation means archaeological excavation conducted during construction phase. It should be conducted only when an archaeological site is found by accident (chance find) during construction. Given the short time available for a salvage excavation, this type of work should be avoided.

The available short time for salvage excavations cannot be considered an authorization to destroy the discovered remains or site. Since each site must be given proper consideration and analysis before its destruction can be authorized.

The cost of the further salvage excavation will be included in the bill of Quantities as a provisional sum.

The Contractor shall seek the written approval of the Department of Antiquities before the removal of any chance find building, foundation, structure, fence and other obstruction over 50 years old, any portion of which is in the construction zone. All designated salvageable material shall be removed, without causing unnecessary damage, and in sections or pieces which may be readily transported, and shall be stored by the Contractor at approved locations for later use or possession of the Department of Antiquities. The Contractor should also note that the chance find procedure covers graveyards and individual burial sites.

Further site-specific mitigation measures are listed in **Table 46**.

### 8.3.6.2 Operation Phase

The mitigation measures required during the operation phase relate only to the application of appropriate public safety measures for both the workers and the local communities located close to these stations. All the booster and pumping stations along the project route should be fenced and have daily guarding system. In addition to that, the local communities should understand through the public media and the local schools within the project corridor, the importance of conserving all of the project facilities.

Moreover, all the workers in these stations should wear safety equipments such as safety helmets and shoes during their work shifts and should get a specialized public safety course related to such facilities.

On the other hand, the expected fluid and solid wastes that will result from the project facilities should be disposed of as the follows:

The domestic fluid wastes should be disposed to the wastewater collection system (where available) or to appropriate septic tanks, which will be designed to be compatible in volume with

the expected number of workers in each station. These septic tanks should be pumped out on monthly basis.

The fluid wastes that are expected to result from the daily work activities or from the regular maintenance activities should be collected in special tanks and transported on monthly bases to the nearest suitable and approved treatment/dumping site. The resulting solid waste should be collected on a weekly basis and sent to the nearest approved dumping site.

In order to control expected elevated noise levels during the operation phase of this project, the Jordanian Regulation for ambient noise levels presented in **Table 48** should be applied. The pumping stations should be placed inside a sound insulating (enclosure) to contain the generated noise. The design specifications of these enclosures should ensure that the walls are massive and air tight enough to contain noise and that absorbent lining on the interior surfaces of the enclosure will reduce the reverberant build up noise within it.

Supervising the implementation of the above listed mitigation measure should be the responsibility of the environment department in MWI in association with the local municipalities and the Greater Amman municipality (for sites located within the Jurisdictions of Greater Amman Municipality).

#### 8.3.6.3 Remediation Phase

The mitigation measures proposed to cope with the anticipated impacts will be same as those described for the construction phase if the remediation alternative is to remove the pipeline for any reason. Such alternative is not recommended, and it would be more efficient to reuse the pipeline in case other water resources are allocated form the south part of Jordan; for example, reuse the pipeline to convey water from a desalination project.

### 8.3.7 Environmental and Social Monitoring

The monitoring program is an applied research and analysis activity to support cost-effective and timely assessment of the status and trends in environmental and social conditions in response to different project activities. Also, it is necessary to assess the project performance against the desired mitigation measures, and compliance with the regulations and standards in order to protect people's health and safety, and the environment health and performance.

Monitoring activities should be applied to direct monitoring indicators whenever applicable. Indirect indicators can be monitored instead of direct ones whenever it would provide acceptable indication of the occurrence of specific impacts and/or compliance with provisions of the ESMP.

The sequence, frequency and responsibilities for the monitoring activities are included in **Table 46**.

#### 8.3.7.1 Construction Phase

### (a) Monitoring Environmental Aspects

#### Conducting Site Inspection

The ESMP Coordinator and the entire Environment Unite staff should conduct site inspection on daily basis to monitor all construction activities according to the prepared construction schedule from an environmental point of view. Authorized representatives from the MOE, MWI and the responsible municipalities should have a free passage and access to all parts of the project and at all times.

#### Monitoring Wadi Crossings

Development of monitoring criteria for post-construction performance of wadi crossing is essential for a successful plan to minimise the impact of wadi crossing during construction phase. The main considerations for such plan are listed below:

- Time of execution of crossing structures could be scheduled at the dry period between May and October.
- Minimum protection against floodwater must be against the flow of 10-Year return period for diverting the flow and protecting the site.
- Insurance must cover the higher return period flood flow.
- Stream development should be planed carefully with a comprehensive flood flow analysis.
- The contractor should avoid any disturbance to main flow section unless a well design is considered to minimize erosion and sedimentation processes.
- Spoil materials should be disposed away from the flow areas at sites with no potential of storm water flow in order to eliminate any sediment movement, which could end at the flow sections. These sediments could cause reduction in flow area and site flooding.

#### Air Quality and Noise Level Monitoring

An air quality-monitoring program should be applied to monitor the dust levels and air emissions from vehicles. This program should be done at least four times per year at selected sites along the project layout. The major parameter to be measured includes but is not limited to Total Suspended Particles (TSP).

Noise level monitoring program should be conducted during day and night times. Frequency of this program should be once a month during the construction phase, and each time should extend for 24 hours. The major parameters to be measured include but are not limited to:

- Noise (Equivalent Sound Pressure Level-LAeq)
- Vibration

It is understood that the Contractor will coordinate with reputable research institution to conduct the proposed air quality and noise monitoring programs. The Royal Scientific Society and the Environmental Research Centre at the Hashemite University are known to have this capacity in Jordan.

### Solid Waste Management Monitoring

The monitoring of solid waste management operations should cover the following:

1- Solid waste generation, including quality and quantity.
2- Collection and transportation efficiency.
3- Suitability of final disposal sites.
4- Solid waste accumulation within the project corridor in terms of volumes and frequency of removal.

Consultant ESMP Coordinator and Environment Unit Inspection Staff should carry out solid waste monitoring on a weekly interval basis. This can be achieved through direct field inspection. Also, local municipalities' claims should always be taken in account and documented.

### Maintenance of Pedestrian Crossing Facilities

It is the responsibility of the Contractor and the Consultant to monitor the maintenance of pedestrian crossing facilities to be constructed along the project layout in coordination with the authorized departments in the MPWH in association with the Greater Amman Municipality in addition to the different municipalities along the project corridor.

### Biological Environment Monitoring

For the biological environment, the frequency of monitoring is mostly periodical monitoring (every three months) combined with follow up on daily basis and annual auditing.

The following are the biological environment monitoring indicators and responsibilities:

- Maintained pre-project land utilization and access through monitoring the natural conditions of surface water flow between pre- and post-project activities including runoffs habitat and geomorphology and accumulation of debris and oil spills. The Consultant Environment Unit should monitor these indicators.

- Natural vegetation cover is maintained. By monitoring plant communities' changes and habitat deterioration (some species can be used as indicators for habitat deterioration such as *Citrillus* and *Peganum* sp.). It is the responsibility of the Consultant Environmental Unit to monitor natural vegetation cover. Other expert and concerned parties namely the Royal Society for the Conservation of Nature (RSCN) and Ministry of Agriculture might be involved and should be given free access to the monitored locations. These parities would have more involvement in monitoring restoration activities relevant to natural vegetation.

- Hunting is banned and accidental kills of animals are minimized (car accidents, falling in drilled ditches, persecutions, etc.). The Consultant Environmental Unit should hold this responsibility.

- Breeding seasons are undisturbed, migration seasons are avoided and accessibility to Abu-Tarfa area and to Disi area through Batn El-Ghoul are monitored. Consultant Environmental

Unit should hold this responsibility and coordination with the Royal Society for the Conservation of Nature (RSCN) is required.

### (b) Agricultural Resources Monitoring

The following components should be monitored on regular basis:

1- Safe passageways dedicated for the use of herders especially in Segments A and B.
2- Removal of trees within farms along the route from Qatraneh to Amman and their re-plantation or compensation. This should include information on the trees' number, age, productivity, ownership, location and the compensation and/or re-plantation action.
3- Availability of safe passageways can eliminate any inconvenience arising from restrictions on mobility for farms along the route.

### (c) Monitoring Social Aspects

The following social component should be monitored as part of the ESMP monitoring program:

- Land Acquisition and Involuntary Resettlement: the Land Acquisition and Resettlement Policy Framework provided in **Annex C24** included the details on this regard.
- Employment: this includes the percentage of locals and foreigners to the total employment.
- Business Disruption: should include, but not be limited to, damage to private properties during construction or to inflict harm to persons including disruption of work or business to individuals along the pipeline corridor.
- Public safety measures and public safety program implementation and efficiency.
- Locals complains about project related disturbances, noise and health aspects.
- Traffic disruption incidence including location of occurrence, duration, actions made to mitigate the impact and if any accidents resulted from such disruption.
- Disruption of infrastructure utilities including telephone connections, electricity, water, sewer and other utilities.
- Implementation of the Traffic Disruptions Control Program. Such component should be under the direct supervision of the Traffic Department in each of the different project areas.

### (d) Archaeological and Cultural Heritage Sites Monitoring

The following components should be monitored on regular basis:

- Cultural Resources Management (CRM) implementation in addition to coordination of responsibilities with CRM monitoring groups including the Department of Antiquities / Ministry of Tourism. This includes monitoring disruption to the archaeological features.
- Compliance / non-compliance with the stated mitigation measures
- Shifting the construction activities for a distance as enough as to protect the site.
- Following "Chance-find" Procedures.
- Exclusion areas.
- Special procedures in the vicinity of sites defined as requiring protection. These include:
    - Site by fencing

- Site rescue excavation
- Site restoration
- Signage system to the site

## 8.4 ESMP Control

The ESMP should ESMP should include provisions to ensure the adherence of the various cooperating parties to its full and timely implementation and monitoring. To achieve this, a control system needs to be implemented. The elements of this control process are to include:

1- Document and Record Control: This is a procedure through which all ESMP associated documentation and records are stored and distributed. This will include the maintenance and updates of the register of environmental aspects and the responsibility for the dissemination of information to involved parties. It is the responsibility of the Contractor ESMP Coordinator, the Consultant ESMP Coordinator and the MWI-Project Manager to ensure the carry out and pursue this control element.

2- Checking and Corrective Action: This dictates that all incidents of deviation from the planned criteria or activities be reported and action taken to rectify the situation and minimize the chance for its recurrence. The Contractor ESMP Coordinator and the Consultant ESMP Coordinator hold the responsibility of carrying out and pursuing this element.

3- Claims: A provision should be made to register and review incident or other claims made against the project or project related personnel or activities by the public or any party. Action needs to be taken to address any such claims where they are shown to be valid and requiring such action. Consultant ESMP Coordinator holds the responsibility of carrying out and pursuing this element.

4- Auditing: The implementation of the ESMP should be audited on a regular basis. Audit reports are the basis for verification of the compliance of the various parties, the completion and implementation of programs and restoration plans, and the effectiveness of such actions and other elements of the ESMP. The audit will be used to review and will rely on the monitoring data. Consultant ESMP Coordinator holds the responsibility of carrying out and pursuing this element.

5- Review Process: A periodic (annual) review of the ESMP and environmental incidents needs to be done through the course of the project. Necessary modifications and adjustments can be decided through this formal and timely review process. Changes and new issues need to be communicated to the parties responsible for their implementation and monitoring as well as the communities in the project area and other stakeholders.

The proposed reporting system encompasses the following reports:

- Pre-Construction Environment and Social Management Statement
- Progress Reports
- Audit Reports
- Annual Reports
- Evaluation Report of the Project Environmental and Social Impacts

**Table 49** presents the proposed reporting system, reporting frequency, responsible preparers and evaluators. These reports and documents should be disclosed and made available to the public of

Jordan through the MWI – Data Room and the Ministry of Environment. Also, these documents will be made available through the World Bank.

**Table 49: The Proposed Reporting System**

| Report | Report Type | Reporter | Reported to/Evaluator | Frequency |
|---|---|---|---|---|
| Stage Specific Pre-Construction Environment & Social Management Statement | A statement that document to preconstruction environmental & social conditions, planned construction activities & anticipated impacts within the proposed construction area for construction stage. Also, this report should address all mitigation & monitoring measures & all necessary restoration work to be implemented. In addition all working construction drawings should be attached to this report, these drawings shall be subject to the ESMP Coordinators verification & approval.<br>The report should address the plans for supplemental public consultations & public disclosure within the geographical area covered by the report. | Contractor ESMP Coordinator (Through the Contractor Environmental, Social & Quality Assurance Manager). | Consultant ESMP Coordinator (Through the Consultant Environmental, Social & Quality Assurance Manager). | Prior construction progress to each new construction area. |
| Progress Report | Document to the ESMP implementation progress, limitations & difficulties based on regular monitoring. This includes checking & corrective actions, & claims. Also the progress report should address the conducted public consultation sessions. | Contractor ESMP Coordinator (Through the Contractor Environmental, Social & Quality Assurance Manager). | Consultant ESMP Coordinator (Through the Consultant Environmental, Social & Quality Assurance Manager). | Monthly, Quarterly (every three months) & Annually. |
| Emergency Management Plan | The plan should document for emergency preparation, including the health & safety programs (for public & employee communities) for all key procedures reviewed, in addition to all necessary adequate & correct emergency equipment. | Contractor Environment, Social & Quality Assurance Department (Manager). | Consultant Environment, Social & Quality Assurance Department (Manager). | Prior construction progress to new construction area. |
| Environmental & Social Emergency Request for Action & Response Reports | Request for Action. This report/letter should specify the nature & location of emergency & the action required to be made by the contractor. | Consultant ESMP Coordinator (Through the Consultant Environmental, Social & Quality Assurance Manager). | Contractor Environment, Social & Quality Assurance Department (Manager). | Directly whenever emergency situation is triggered. |
| | Environmental & Social Emergency Response Reports. This report should document the nature & location of emergency & the action made to by the contractor to correct the situation & to eliminate the source of emergency. Also the report should document to the occurred damages in terms of nature & magnitude, & the adaptations made – if any to the Emergency Management Plan subject to the lessons learned from occurred situations. | Contractor ESMP Coordinator (through the Contractor Environment, Social & Quality Assurance Manager. | Consultant Environment, Social & Quality Assurance Manager (copy to the Consultant ESMP Coordinator). | Subject to the occurrence of emergency situations (within one week maximum from the date of situation occurrence)/ |
| Audit Reports | ESMP Performance, Conformance & Non-conformance Audit & Eco-Audit, this should also include checking & corrective actions, & claims. | Consultant ESMP Coordinator (Through the Consultant Environmental, Social & Quality Assurance Manager). | MWI – Project Manager;<br>Environmental & Social Advisory Panel; & World Bank. | Quarterly (every three months) & Annually. |
| Project Environmental & Social Management Evaluation Report | Evaluation Report of the Project Environmental & Social Impacts. The evaluation should also document to all conducted management practices & to evaluate the effect of these practices | Consultant ESMP Coordinator (Through the Consultant Environmental, Social & Quality Assurance Manager). | MWI – Project Manager<br>Environmental & Social Advisory Panel; & World Bank. | Once upon construction completion. |

## 8.5 Implementation and Operation

Implementation and operation of this ESMP plan should evolve from deep understanding and appreciation of the Contractor to the project nature, environmental and social requirements, and should demonstrate the integration of environmental and social management as part of the overall project management.

Effective implementation and operation of the ESMP require clear-cut identification of responsibilities that will guide assigning tasks. Other implementation related components include:

- Training, awareness and competence
- Communication
- Environmental Management Documentation
- Document Control
- Operational Control
- Emergency Preparedness and Response

### 8.5.1 Training, Awareness and Competence

Efficient implementation and operation of the ESMP require both the Consultant and the Contractor to have competent capacities, wise management and environmentally and socially aware employees. The Management representative- ESMP Coordinator- should have sufficient experience in environmental and social management, and good communication skills, while the technical support staff should have considerable experience in environmental and social monitoring, auditing and evaluation.

On the other hand, the project employees should be environmentally aware of the project nature and impacts, so they would develop their appreciation and thorough commitment to the ESMP requirements, complexity and integrity. Furthermore, acting according to the ESMP programs and procedures is obligatory, where similar awareness and training activities will ensure faithful and competent commitment of the employees to these requirements, and reduce the cost of enforcement.

Each employee should be trained and motivated to appreciate and act according to the issued mitigation measures. Such requirement should be tackled in the pre-construction phase in order to have the employees acting as per of the stated course of procedures and actions. During the construction phase, the employees' acts and awareness level should be monitored and developed.

Adequate training of senior staff and orientation of project staff is also considered as a cost effective means to reduce impacts.

The ESMP Unit (Management Representative) should ensure the following in order to fulfil the awareness and training requirements:

1- Training needs are identified. Training requirements for each operational unit within the project are established.
2- Personnel are trained in their specific environmental responsibilities that are directly related to significant aspects, targets, and objectives of the ESMP.
3- Personnel that do not have a significant role, receive awareness training.

4- New-hires and re-assigned personnel are given appropriate training on the specific aspects of their new positions.
5- Personnel are kept abreast of regulatory changes that impact their job performance.
6- Training includes communication of the following:
    a. Requirements of the ESMP and the importance of regulatory compliance with policy.
    b. Potential effects of the employee's work, both negative and positive.
    c. Responsibility in achieving compliance with policies, regulations and ESMP requirements.
    d. Consequences of failure to comply with the above.

For example, of the main issues for which such training and awareness to be delivered are:

- Safety measures (for the public and the employees).
- Use of the maps that have been prepared to support site specific understanding of the environmental and social mitigation and monitoring measures.
- Synchronizing spatially and temporally excavation activities to avoid disturbances during breeding and migration seasons through developing an activity program.
- Minimising night activities to reduce disturbance to wildlife mainly in Batn El-Ghoul area.
- The ecological importance of some sites and wildlife conservation ethics.
- The archaeological importance of some sites and archaeological and cultural heritage sites conservation. This includes review of key archaeological sites to be avoided and the use of the archaeological “chance find procedures” and measures if graveyards or individual graves are encountered
- Avoiding unnecessary movement of project staff mainly at night.

The proposed awareness and training sessions can be conducted by either the ESMP Management Unit or by an independent reputable consultant.

### 8.5.2 Communication

Efficient communication should be maintained at both external and internal levels. The external communication can be demonstrated in three main channels:

- PMU – Consultant Communication Channel
- Contractor – Consultant Communication Channel
- Consultant – Local and National Stakeholders Communication Channel

The over all advantage of this communication program is to ensure that the anticipated adverse impacts and risks can be effectively mitigated.

The ESMP-Technical Assistant should effectively communicate internally with the variant project components and divisions, and externally through the defined channels and about the public concerns and complains of implementing the proposed project, project effects on their health, social welfare and environment. Also, the ESMP-Technical Assistant should communicate and cooperate on continuous basis with the related authorities, projects and utilities providers in order to avoid or minimize to the extent possible disruptions.

Communicating internally and externally- if effective- will ensure:

- Better understanding and appreciation of target groups to the proposed project conditions and benefits.
- No or minimum disruption by the project to other developed/under-development projects and vice versa.
- Minimum impacts and risks.
- Community participation in helping and making choices to develop suitable and acceptable avoidance/mitigation scenarios.

The communication responsibilities include the following:

- A documented procedure is maintained for communication of internal and external environmental and social information regarding environmental and social issues and concerns.
- Processes for receiving and responding to internal and external interested parties concerns relative to the environment are established.
- The environmental policy and performance is communicated both internally and externally. This includes the results of the environmental audits and other analyses.
- The documented communication procedure was adequately developed to foster continual improvement.

### 8.5.3 Emergency Preparedness and Response

Emergency preparedness should be given the priority during the ESMP implementation and operation, where all key procedures should be reviewed for emergency preparation, including the health and safety programs (for public and employee communities) that have to be established in compliance with the Jordanian standards issued by the Ministry of Public Works and Housing, Ministry of Labour, Ministry of Health and the Ministry of Water and Irrigation. Also, these programs should comply with the standards and regulations stated in the project TOR.

The Contractor should develop procedures for managing these potentialities and to train key personnel on these procedures. Also he should ensure that adequate and correct emergency equipment are available where they should be.

The Emergency Management Plan should be prepared by the Contractor Environment and the Social and Quality Assurance Department. Both the Quality Assurance Unit and the Environment and Social Management Unit should be heavily involved, as it is understood that the overall plan development and implementation responsibility should be held by the department head. The prepared plan documents should clearly identify implementation responsibilities.

The Emergency Management Plan should be reviewed and verified by the Consultant Environment, Social and Quality Assurance Department, where the Consultant ESMP Coordinator should verify environmental and social emergency preparedness. Also, the implementation of this plan should be monitored and evaluated by the Consultant.

Whenever environmental and/or social emergency situation is triggered, the Consultant ESMP Coordinator should directly inform the Contractor requesting him to respond according to the stated plan. After a drill or incidents occurrence, these processes should be reported on, reviewed and modified by the Contractor ESMP Coordinator. In turn, the Consultant ESMP Coordinator

should hold the responsibility of reviewing and verifying the Contractor reports and plan adaptations.

## 8.6 Checking and Corrective Action

The ESMP implementation and performance should be monitored continually; performance, conformance and non-conformance audit should be applied on quaternary basis in order to adapt the plan by adopting effective corrections whenever needed. Environmental audit (Eco Audit) should be conducted on annual basis.

All records should be stored in a well-ordered and easily accessible manner, enabling individual items to be located easily and ensuring that the records are protected. The audit reports should be reported in accordance to the stated reporting structure. Also it should be available to the public and stakeholders through the identified information centres including MWI, World Bank and the project offices.

The Consultant should hold the responsibility of functioning eco auditing. The selected auditors can be employees from the Consultant Environmental and Social Management Unit or can be private Eco Audit Organization. Either way, the selected auditors should hold acceptable experience with relevant tasks and capable of undertaking such responsibilities, and should be accepted by the Ministry of Water and Irrigation. Also, the ESMP Panel may conduct eco auditing whenever the panel find it to be necessary.

For the purpose of the Disi Project, the ESMP highly recommends involving archaeological audit as part of the Environmental Audit, thereto cover but not limited to the following scope of work:

1- Changes to the natural environment triggered by affected physical environment. This includes:
   - Landscape damage, change of natural drainage system and local geomorphology
   - Increased noise levels
   - Increased dust levels
   - Solid and fluid waste mismanagement
   - Access roads construction
   - Visual impacts

2- Changes to biological environment. These include:
   - Loss of habitats particularly at the southern zone (Eastern Plateaus and Batn-El-Ghoul at wadi runoffs and sandy habitats, respectively).
   - Increase of accessibility to particular habitats in the southern zone including Batn El-Ghoul due to maintenance operations and disturbance to wildlife.
   - Hunting, persecution or capturing of wild species.
   - Wildlife disturbance during the construction.
   - Cutting trees and removal of vegetation cover.

3- Impacts to archaeological, cultural heritage resources, and graves and graveyards.

The corrective and preventive actions based on audit findings and their consequences are monitored. The audit findings per audit cycle are summarized into an audit report and reviewed during the management review meeting.

## 8.7 Management Review

A top management review of the ESMP should be applied on a periodic basis as per a documented procedure to ensure its continued suitability and effectiveness. During the review, management effectively utilize all available information, including internal and external audit findings, environmental concerns, objectives, targets, non-conformance, and corrective and preventive actions in order to improve the ESMP Implementation.

The review results will be recorded and maintained and the resultant decisions and actions taken will be implemented by the concerned personnel.

ESMP has been designed to ensure maximum environmental and social protection, better coordination and cooperation between the project stakeholders and minimum cost implications. The cost implications associated with the implementation of the ESMP are presented in **Annex C25**. These cost estimates cover the operation cost of the management units, cost implications for the site specific mitigation measures and required monitoring programs.

# 9 CONCLUSION

A comprehensive study of the project components and feasibility studies carried out by the consultants since the beginning of the planning phase of the project indicated the following:

- The project is technically feasible, has limited adverse environmental and social impacts and is broadly accepted as a national priority by a wide range of stakeholders at the national level and communities within the direct and indirect zone of influence. The project will provide Greater Amman area with 100-120 MCM of fossil water of best quality.
- The "No-project" alternative will be catastrophic. The over-mining of the present water aquifers will eventually lead to the depletion of these aquifers to a level beyond any possibility for restoration.
- Social and economic impacts of the project will not differ in magnitude or effect from any other infrastructure project in Jordan. Experience with the construction of bridges, tunnels, water projects and thousands of kilometres of the road network showed that these projects were completed efficiently and smoothly without any social or economic unrest to the public.
- Taking into consideration the volume of work needed to construct the Disi conveyance system, it is expected that the implementation of a very elaborate scheme of work, clear and detailed TOR, and proper supervision will lead to a successful water project.

On the other hand, the project is anticipated to cause temporary and permanent impacts on the environmental conditions within the direct and indirect zone of effect. Some of these impacts can be avoided while others will have minimal effects if the potential impacts were to be mitigated properly.

Some of the project activities might cause deleterious effects on the environment if not mitigated properly. The ESMP provides the procedures and the implementation framework for mitigating and monitoring the potential impacts of the project on the environmental and social settings and for the monitoring of the project performance in accordance to the policy, legal and regulatory requirements described in **Part A: Overview** of the Main Report.

The Contractor is required to strictly adhere to the provided ESMP including the continuous evaluation and adaptation of this plan during the course of project construction and operation phases.