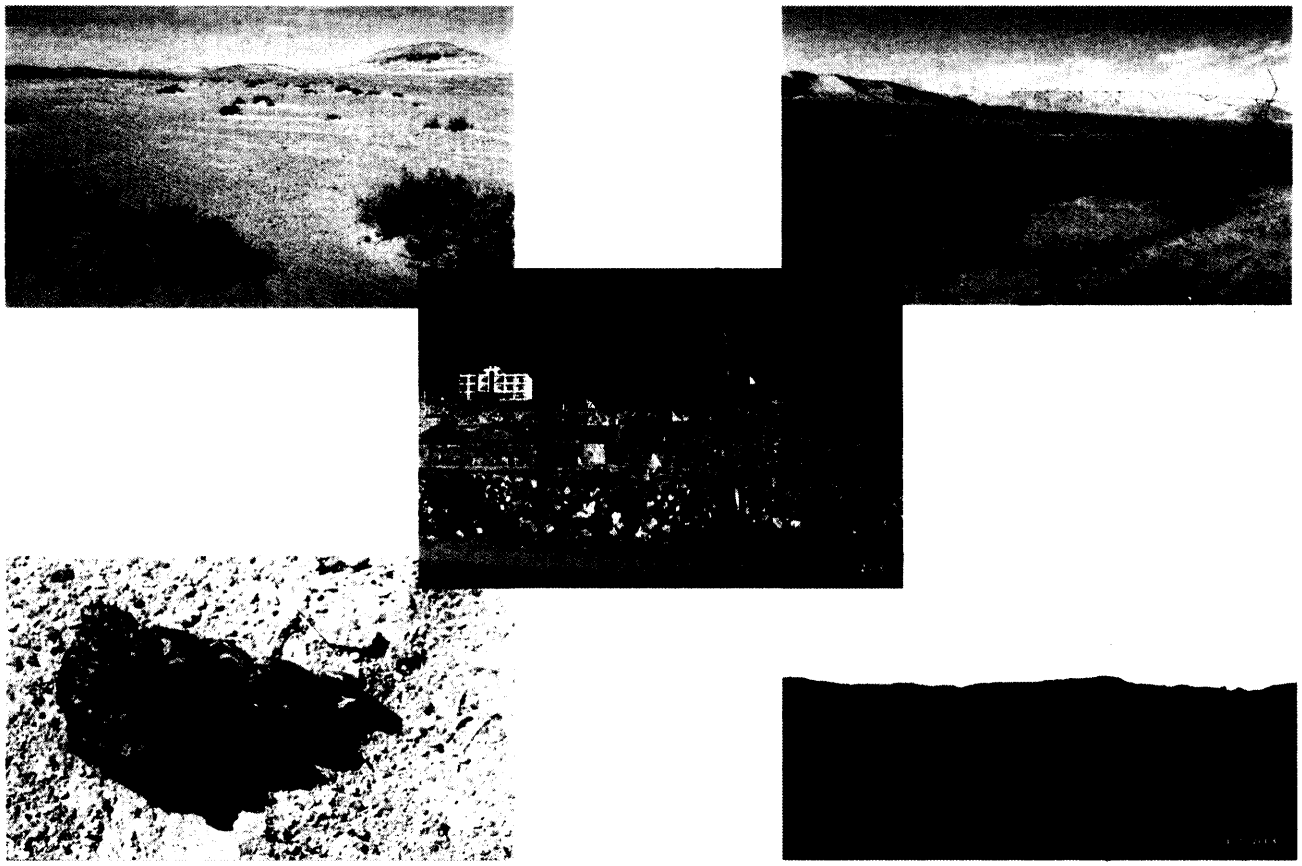
المملكة الاردنية الهاشمية

The Hashemite Kingdom of Jordan

MINISTRY OF WATER & IRRIGATION



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

Executive Summary

June 2004

consolidated consultants
engineering & environment

E991
Vol. 1

EXECUTIVE SUMMARY

ENVIRONMENTAL AND SOCIAL ASSESSMENT REPORT

EXECUTIVE SUMMARY

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

1 OVERVIEW

The shortage of water in Jordan is a chronic problem that dates back as the early as the 1970s. The late King Hussein was always keen at emphasizing that the development of the country's water sector is vital for the development of all other sectors in the country. Also, King Abdullah the Second considers the water issue to be of top priority in the work of the government. These considerations reflect the seriousness of the water problem in Jordan.

In Jordan, the development of the water institutions dates back to the 1951 when the Health Institution was developed to monitor water quality. Afterwards, the Western Ghor Canal Authority and the Central Water Authority were created in 1951 and 1960, respectively. However, these two authorities were replaced by the Natural Resources Authority in 1965. In the same year, the Jordanian Regional Institution for Development of Jordan River and its Tributaries was established with responsibility for developing the water resources of the Jordan River and its tributaries. This institution adopted the Khaled Dam and Jordan Valley projects.

In 1975, the responsibility for drinking water was transferred from the Natural Resources Authority to a newly created authority named the Drinking Water Institution. This institution was responsible for all water projects in the Kingdom except for Amman city for which the Water and Wastewater Authority was formed.

In 1972, the responsibility for the areas below sea level on the Eastern Bank of the Jordan River was transferred from the Natural Resources Authority to a new institution named in 1977 the Jordan Valley Authority (JVA). In 1984, the Drinking Water Institution and the Water and Wastewater Authority were merged into one authority which is the Water Authority of Jordan (WAJ). On October 1st of 1988, the Ministry of Water and Irrigation was created and the Water Authority and the Jordan Valley Authority were placed within this Ministry.

In the early 1990s the water shortage problem started to accelerate after the Gulf Crisis. The lack of water resources became more prominent with the increase in water demand in response to the natural and crisis driven population growth, improvement of living standards, and the development of the economic, industrial and touristic sectors.

In trying to meet the country's growing water demand, groundwater aquifers are being exploited at more than double their sustainable yield in average. This can be attributed to the low investment requirement for developing extra groundwater sources. The situation has reached a level where the toxicity index (pollution load compared to renewable water resources) is high and the water costs compared to GDP do not allow the full cost recovery.

For a number of years supply has been outstripped by demand in the Greater Amman Area and the Water Authority of Jordan has had no option but to implement a water rationing program during the summer months to deal with the water shortage. The situation has been on-going since 1988 and the situation continues to deteriorate each year as demand increases which has lead to a rationing program for the entire year with very low reliability during the summer period. The Disi-Mudawarra to Amman Water Conveyance System will result in a reliable water supply to Amman especially during the summer. This project was proposed many years ago but due to lack of funding, the project was postponed. However, due to the pressing need for additional sources of water, serious efforts have been made to prepare a detailed feasibility study, environmental and social assessment and to secure funding for this project.

At present, the drinking water for Amman is supplied mainly from the upland aquifers and new developed aquifers to the south such as Lajoun Aquifer. Therefore, another important aspect of the Disi project is that its implementation will secure an additional source of drinking water to Amman and thus relieve the upland aquifers from over abstraction. Also, the Disi project will have an indirect effect on the quality of the wastewater which in turn would lead to a better effluent quality to be used for irrigation as a replacement for valuable freshwater.

Once the Disi pipeline is completed it will serve as a Southern National Carrier for Jordan. However, it should be noted that the Disi project would cover only part of the water shortage problem but would not close the country's growing water gap.

1.1 Water Resources Management in Jordan

The scarcity of water in Jordan makes the management of this critical resource very complex from a political, technical, socio-economic and environmental perspective. The water budget of Jordan is around 1 billion cubic meters per annum, which is considered relatively low when compared to social, economic and environmental needs of the country. This scarcity makes the availability of water on a reliable basis very important for to the society. Accordingly, this section will deal with the management issue in order to highlight the importance of integrated management of the water resources in Jordan and the role of Disi water as a part of these resources.

1.1.1 Strategy

The issues addressed in Jordan's water strategy of 1997 are distributed across three levels: resource development, resource management, and shared water resources. These issues are summarized in **Figure 1**.

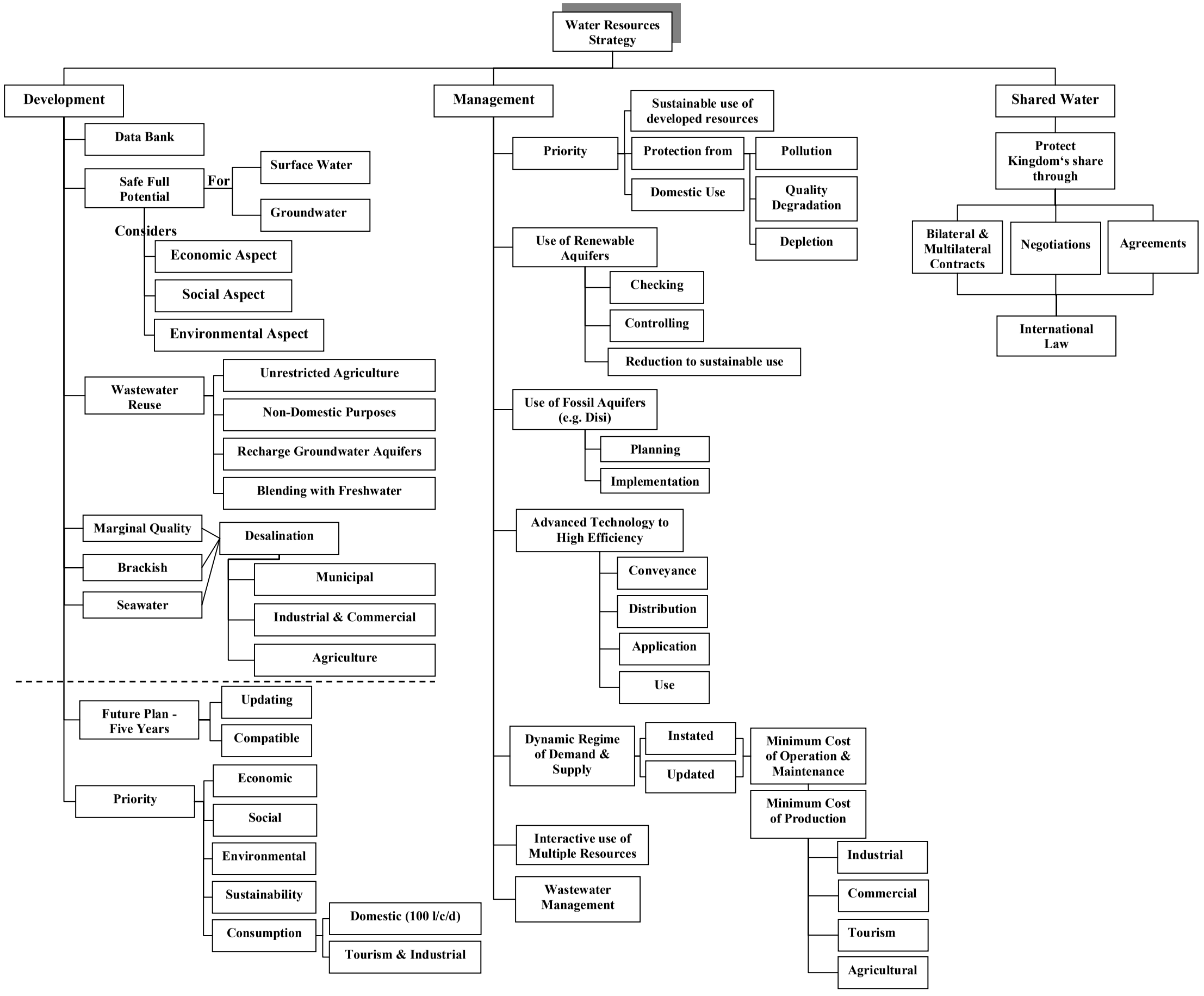


Figure 1: Jordan's Water Strategy

1.1.2 Stakeholders

In Jordan, the policy for water allocation considers the following water stakeholders: domestic, industrial, touristic, and agricultural sectors. The water allocation priority goes first to the domestic sector, followed by the industrial and touristic sectors and last to the agricultural sector. **Table 1** presents the priority of Disi water consumption according to stakeholder shares and importance.

In terms of the Disi water, the stakeholders are as follows:

- Amman city which will utilise the Disi water for domestic needs and for which the allocation of the Disi water will help in relieving the upland aquifers used to supply Amman with required domestic water;
- Locals at Disi area who use the Disi water for their various activities including domestic uses and livestock raising;
- Aqaba city which utilizes at present the Disi water for its domestic needs;
- The Disi farms which utilize the Disi water for irrigation. However, those farms will be closed once their current operating permits are expired; and
- The cities along the Disi conveyor route that will be provided with "turn out" for emergency access if required. At the present these cities have no need for the Disi water since they already have their own water resources that are of good quality.

Table 1: Priority of stakeholders with respect to Disi water consumption

Stakeholder	Total Priority Rate (Sum)	Priority Conditions				
		Present Consumption of Disi Water	Availability of Other Sources	Water Needs		
				Near Future (Up to 2010)	Future (Up to 2020)	Far Future (Up to 2040)
Amman City	********	-	**[1]	**	**	**
Locals at Disi area	****	*	-	*	*	*
Aqaba City	***	*	-	*	*	-[2]
Disi Farms	***	*	-	**	-[3]	-[3]
Cities along the Conveyor Route [4]	*	-	-	-	-	*[5]

[1] Almost all domestic water is imported from outside Amman.
[2] Other sources will be available (e.g. proposed Red Sea – Dead Sea Water Conveyance Project)
[3] Contracts Expire
[4] Cities along the pipeline: Madaba, Karak, Tafileh, Ma'an and Aqaba.
[5] Local sources will not fulfil the growing demand.

1.1.3 Water Balance

The water supply of Jordan integrates the following resources:

- Surface Water;
- Groundwater;
- Treated Wastewater; and
- Non-Conventional Water Sources.

Table 2 (GTZ Study, 1997) presents the future with the present water demand, supply and deficit in Jordan up to the year 2040. **Table 3** (Al-Salihi, 1999) presents the future water supply to Jordan adjusted for rainfall decline in response to climate change.

Table 2 and **Table 3** address three aspects of water resources: demand, supply and deficit. The demand and deficit portions are divided to consumption sectors and the supply portion was divided according to source. Water quality was accounted for and three types were considered:

- Fresh for domestic use;
- Fresh to brackish for industrial and agricultural use; and
- Treated wastewater for industrial and agricultural use.

The irrigation demand was frozen due to lack of water supply for the agricultural sector. No fresh water was considered for irrigation after the year 2010 and a considerable reduction in fresh to brackish water. Treated wastewater could be the only source available for irrigation in most areas in the future.

Disi water was considered as water supply for the domestic sector. However, fresh water deficit for domestic use will start after the year 2010 even with Disi water.

Table 2: Present and future water demand, supply and deficit in Jordan up to the Year 2040 (MCM/yr)**

Item	*Pres. 1993*	*Year 2000*	*Year 2010*	*Year 2020*	*Year 2030*	*Year 2040*
WATER DEMAND TOTAL	**1001.5**	**1244**	**1518**	**1772**	**2025**	**2279**
Surface Water	414.4	400	472	592	592	592
Ground water	535.1	355	387	418	451	482
Demand Management Savings	0	20	20	20	20	20
Treated Wastewater	52	99	162	230	376	522
Desalination Water	0	2	20	37	53	70
Domestic	***218.5***	***367***	***489***	***729***	***969***	***1209***
Surface Water (Fresh)	51.3	172	249	446	497	497
Ground water (Fresh)	167.2	173	200	226	254	280
Demand Management Savings	0	20	20	20	20	20
Desalination Water	0	2	20	37	53	70
Industrial	***43***	***86***	***129***	***143***	***156***	***170***
Surface Water (Fresh to Brackish)	16.7	33.4	50.1	55.5	60.6	66
Ground water (Fresh to Brackish)	26.3	52.6	78.9	87.5	95.4	104
Irrigation	***740***	***791***	***900***	***900***	***900***	***900***
Surface Water	*346.4*	*194.6*	*172.9*	*90.5*	*34.4*	*29*
Fresh Water	268.1	133	128	51	0	0
Fresh to Brackish Water	78.3	61.6	44.9	39.5	34.4	29
Ground water	*341.6*	*129.4*	*108.1*	*104.5*	*101.6*	*98*
Fresh Water	55.3	0	0	0	0	0
Fresh to Brackish Water	286.3	129.4	108.1	104.5	101.6	98
Treated Wastewater	52	99	162	230	376	522
WATER SUPPLY TOTAL	**1001.5**	**876**	**1061**	**1297**	**1492**	**1686**
Fresh Water Total	541.9	478	577	723	751	777
Fresh to Brackish Water Total	407.6	277	282	287	292	297
Treated Wastewater	52	99	162	230	376	522
Brackish Water Desalination	0	2	20	37	53	70
Water Demand Management Savings	0	20	20	20	20	20
Surface Water Total	***414.4***	***400***	***472***	***592***	***592***	***592***
Fresh Water	319.4	305	377	497	497	497
Fresh to Brackish water	95	95	95	95	95	95
Ground Water Total	***535.1***	***355***	***387***	***418***	***451***	***482***
Renewable Total	442.1	262	281	300	320	339
Non-Renewable Total	93	93	106	118	131	143
Fresh Water Total	*222.5*	*173*	*200*	*226*	*254*	*280*
Renewable Water	147.5	98	112	126	141	155
Non-Renewable Water	75	75	88	100	113	125
Fresh to Brackish Total	*312.6*	*182*	*187*	*192*	*197*	*202*
Renewable Water	294.6	164	169	174	179	184
Non-Renewable Water	18	18	18	18	18	18
WATER DEFICIT TOTAL	*	**-368**	**-457**	**-475**	**-533**	**-593**
Fresh Deficit Total	*	**14.35**	**-7**	**-84**	**-280**	**-477**
Treated & Fresh to Brackish Deficit Total	*	**-382.4**	**-450.0**	**-391.0**	**-253.0**	**-116.0**
Domestic (Fresh)	*	**-**	**-**	**-**	***-145***	***-342***
Industrial (Treated & Fresh to Brackish)	*	**-**	**-**	**-**	**-**	**-**
Irrigation Total	*	***-368***	***-457***	***-475***	***-388***	***-251***
Fresh Water	*	14.35	-7	-84	-135	-135
Treated & Fresh to Brackish Water	*	-382.4	-450.0	-391.0	-253.0	-116.0

** Ground water abstractions exceed the safe yield by 25 % in order to fill the Gap.*

** The source considered 1993 as present year and it is kept for reference.

Table 3: Adjusted future water supply (resources) and deficit in Jordan up to the Year 2040 (MCM/yr)

Item	*Year 2000*	*Year 2010*	*Year 2020*	*Year 2030*	*Year 2040*
WATER DEMAND TOTAL	**1244**	**1518**	**1772**	**2025**	**2279**
Surface Water	316.0	372.9	467.7	467.7	467.7
Ground water	280.5	305.7	330.2	356.3	380.8
Demand Management Savings	20	20	20	20	20
Treated Wastewater	99	162	230	376	522
Desalination Water	2	20	37	53	70
Domestic	***367***	***489***	***729***	***969***	***1209***
Surface Water (Fresh)	208.3	291.0	392.6	392.6	392.6
Ground water (Fresh)	136.7	158.0	178.5	200.7	221.2
Demand Management Savings	20	20	20	20	20
Desalination Water	2	20	37	53	70
Industrial	***86***	***129***	***143***	***156***	***170***
Surface Water (Fresh to Brackish)	33.4	50.1	55.5	60.6	66
Ground water (Fresh to Brackish)	52.6	78.9	87.5	95.4	104
Irrigation	***791***	***900***	***900***	***900***	***900***
Surface Water	*74.3*	*31.8*	*19.5*	*14.5*	*9*
Fresh Water	33	7	0	0	0
Fresh to Brackish Water	41.7	25.0	19.5	14.5	9
Ground water	*91.2*	*68.8*	*64.2*	*60.2*	*56*
Fresh Water	0	0	0	0	0
Fresh to Brackish Water	91.2	68.8	64.2	60.2	56
Treated Wastewater	99	162	230	376	522
WATER SUPPLY TOTAL	**717.5**	**880.6**	**1084.9**	**1273.0**	**1460.5**
Fresh Water Total	377.6	455.8	571.2	593.3	613.8
Fresh to Brackish Water Total	218.8	222.8	226.7	230.7	234.6
Treated Wastewater	99	162	230	376	522
Brackish Water Desalination	2	20	37	53	70
Water Demand Management Savings	20	20	20	20	20
Surface Water Total	***316.0***	***372.9***	***467.7***	***467.7***	***467.7***
Fresh Water	241.0	297.8	392.6	392.6	392.6
Fresh to Brackish water	75.1	75.1	75.1	75.1	75.1
Ground Water Total	***280.5***	***305.7***	***330.2***	***356.3***	***380.8***
Renewable Total	207.0	222.0	237.0	252.8	267.8
Non-Renewable Total	73.5	83.7	93.2	103.5	113.0
Fresh Water Total	*136.7*	*158.0*	*178.5*	*200.7*	*221.2*
Renewable Water	77.4	88.5	99.5	111.4	122.5
Non-Renewable Water	59.3	69.5	79.0	89.3	98.8
Fresh to Brackish Total	*143.8*	*147.7*	*151.7*	*155.6*	*159.6*
Renewable Water	129.6	133.5	137.5	141.4	145.4
Non-Renewable Water	14.2	14.2	14.2	14.2	14.2
WATER DEFICIT TOTAL	**-526.6**	**-637.4**	**-687.1**	**-752.0**	**-818.5**
Fresh Deficit Total	**-86.0**	**-128.2**	**-135.0**	**-437.7**	**-640.2**
Treated & Fresh to Brackish Deficit Total	**-440.5**	**-509.2**	**-451.3**	**-314.3**	**-178.4**
Domestic (Fresh)	***-***	***-***	***-100.83***	***-302.71***	***-505.17***
Industrial (Treated & Fresh to Brackish)	***-***	***-***	***-***	***-***	***-***
Irrigation Total	***-527***	***-637***	***-586***	***-449***	***-313***
Fresh Water	-86.0	-128.2	-135.0	-135.0	-135.0
Treated & Fresh to Brackish Water	-440.5	-509.2	-451.3	-314.3	-178.4

1.1.4 Management Measures

Table 4 presents the water resources management measures adopted in Jordan as extracted from the Water Action Plan and the following policies:

- Water Utility Policy (July 1997);
- Groundwater Management Policy (February 1998);
- Irrigation Water Policy (February 1998);and
- Wastewater Management Policy (June 1998).

Management measures adopted by the Kingdom are presented in **Figure 2** that summarises the actions required to manage the water scarcity in Jordan.

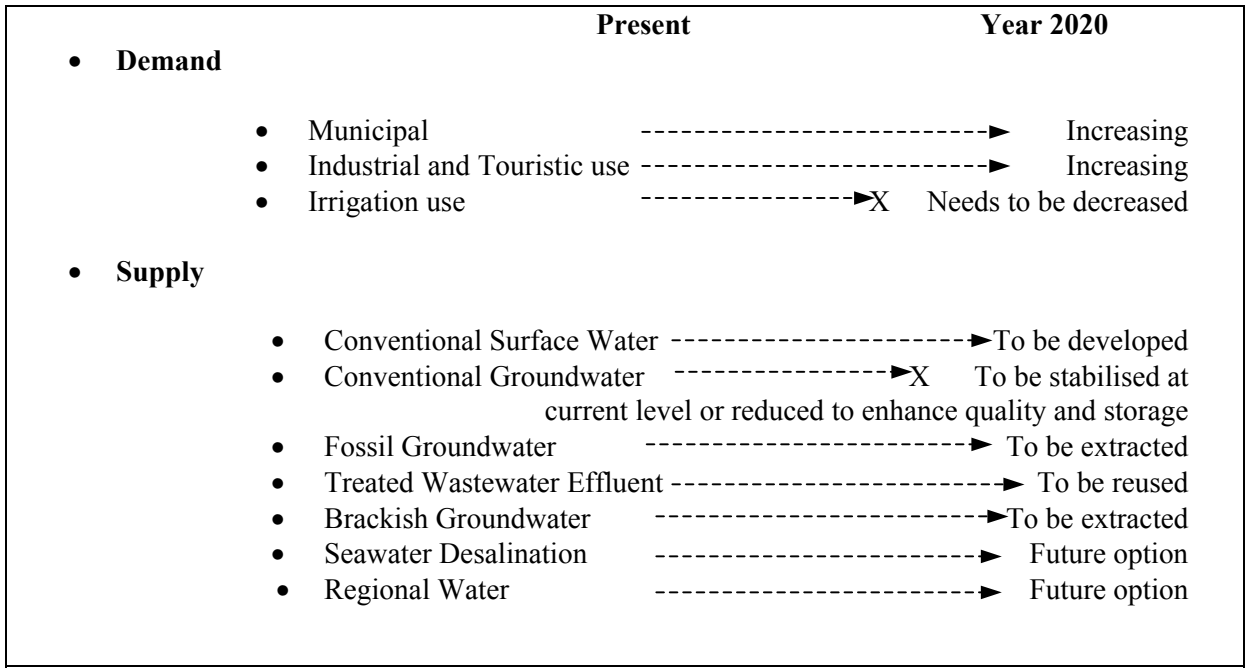


Figure 2: Actions required for management of water scarcity

Table 4: Main water resources management measures adopted in Jordan

	Domestic and Industrial Sectors	Agricultural Sector
Supply Management	- Rehabilitate the institutional structure and enhancement of the laws and by-laws; for example: ▪ New by-law for Groundwater monitoring. ▪ New by-law for wastewater regulations and connection fees to allow for the smooth implementation networks through private lands and plots and to enhance financial viability.	- Rehabilitate the institutional structure and enhancement of the laws and by-laws; for example: ▪ New by-law for Groundwater monitoring. ▪ New by-law for wastewater regulations and connection fees to allow for the smooth implementation networks through private lands and plots and to enhance financial viability.
	- Invest in reservoirs to harvest rainfall	- Use marginal water such as brackish and treated wastewaters in agriculture.
	- Make available an expected 125 MCM per year from fossil aquifers (mainly Disi Aquifer) and through desalination by the year 2005	- Make maximum of rainfall for crop production, and supplementary irrigation shall be employed to maximize production including increasing cropping intensities
	- Implement a program that sets out legal and financial measures aimed at controlling and gradually reducing groundwater withdrawals with final objective of maintaining the safe yield of aquifers - Bring the annual abstractions from the various renewable aquifers to the sustainable rate. Pumping from the groundwater aquifers has to be effected so that the abstraction rate will be close to the annual recharge by the year 2005	- Substitute fresh water with marginal water; Treated wastewater in first place and then fresh to brackish water
	- Develop a wastewater master plan to serve all areas throughout the Kingdom. In parallel, industries will be encouraged to recycle part of their wastewater and to treat the rest to acceptable standards before it is discharged into the sewer or elsewhere, as stated by the policy	- Do not allow diversion of irrigation's waters to other uses without providing a replacement source fit for agricultural use unrestricted by health and public mainly through treated wastewater
	- Pursue a planned and controlled groundwater mining from promising, extensive fossil aquifers as an option to secure incremental supplies for municipal and industrial uses. The groundwater use will take place conjunctively with surface water in places where such joint use has the potential for increasing the available supply	- Bring the annual abstractions from the various renewable aquifers to the sustainable rate. Pumping from the groundwater aquifers has to be effected so that the abstraction rate will be close to the annual recharge by the year 2005
	- Offer brackish water as the highest potential non-conventional means of augmenting the country's water resources. It can be used directly or after desalination	- Isolate treated wastewater from surface and ground waters used for drinking, and the blend treated effluent with relatively fresher (fresh to brackish) water for suitable reuse
	- Store the Jordan River floods at Karama Dam and construction of desalination plant at King Talal Dam to reduce the salinity of stored water in the reservoir	
Demand Management	- Rehabilitate the institutional structure and enhance the laws and by-laws	- Rehabilitate the institutional structure and enhance the laws and by-laws
	- Adjust water tariffs to encourage public to save water and consume less. Increase water tariff by 8 percent in the year 2005 and another 8 percent by the year 2006, and increase operation and maintenance cost recovery from less than 50 percent to more than 100 percent	- Adopt a new by-law for new agricultural use tariff to reduce and control over drafting and illegal wells.
	- Rehabilitate the water supply systems to reduce losses through the networks	- Wastewater is considered a resource
	- Increase efficiency through the training measures, public awareness program.	- After satisfying the local municipal and industrial needs from unallocated water resources, water resources shall be allocated to agricultural production including livestock.
	- "New non-renewable groundwater sources shall be allocated to municipal and industrial uses as a first priority". The policy recognized the importance of the Disi water for domestic use rather than the present agricultural consumption	- Produce high-income products to increase the productivity of the meter cube of water and to pay the full cost of water with no subsidy
		- Recognize the importance of the Disi water for domestic use rather than the present agricultural consumption

1.1.5 Investments

The "Water Sector Planning and Associated Investment Program 2002-2011" (MWI, 2002) compiled the water sector planning and investment projects over the period 2002-2011 as response to the importance of water for all aspects of economic and social development. The program outlined that no single action can remedy the country's water shortages; rather many complementary actions are necessary to increase overall water availability.

Priority criterion for projects implementation shall be based on:

- Economic, social, and environmental considerations;
- Critical Path; and
- Sustainability in the light of:
    - National water balance; and
    - Economic, social, and environmental opportunity cost of forgone alternative uses of water.

This could be facilitated by the following projects as assumed by the report:

- Tapping the Disi aquifer for Amman demand centre;
- Exchanges of consumption between highland cities and agriculture to replace Yarmouk River freshwater by treated wastewater;
- Wehdeh Dam and Wadi Mujib system;
- Hisban/Zara Ma'in brackish water desalination;
- Peace Treaty waters; and
- Losses reduction in Greater Amman and other cities networks.

According to Ministry of Water and Irrigation (MWI) Investment Program 2002-2006, Disi water is part of the year 2005, the year of full utilisation regarding the freshwater resources, and the project is needed to lessen the impacts of groundwater over-abstraction.

The above projects will reduce the groundwater abstraction for municipal and industrial use by 36 MCM for the period 1998 to 2010 and by 25 MCM for longer period 1998 to 2020, as outlined by the World Bank report (2001). In the same time, the wastewater reuse can be increased from 67 MCM in the year 1998 to 232 MCM in the year 2020. Therefore, the reduction in the renewable groundwater abstraction for all uses can reach 122 MCM per year by the year 2020. This will ease the pressure on the Highland aquifers in order to reduce the overdraft and to protect them from salinisation or other types of irreversible damages.

According to the Middle East Regional Study on Water Supply and Demand Development (GTZ, 1997), indicates that the development of national water resources will contribute to bridging the water gap but still it is insufficient to cover the growing water deficit in the region. Therefore, additional new water has to be provided. Water imports from areas outside the region by land and/or sea and desalination of sea water using single seashore plants or the intersea project (Red Sea-Dead Sea Water Conveyance Project) are the main options for supplementing the available conventional water in Jordan and the region. The assessment of the different potential options to meet the future demand has considered the technical and economic/financial aspects, as well as the environmental impacts, and socio-economic impacts and the broad political implications. Sea water desalination seems to be the most suitable development option according to the prevailing conditions and available data.

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 of significant numbers of people 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 northwest Saudi Arabia. Significant exploitation of the Jordanian part of the aquifer started in 1980. At present Aqaba city is provided with 16.5 MCM for domestic purposes and. agriculture is consuming 75 MCM. The binding agreement between the Government of Jordan and the four agricultural companies working in the area indicated that water abstraction from Disi aquifer should not exceed 91 MCM per annum. This use will be terminated in 2011 when the current agreements with these companies will expire. Extensive hydro-geological studies carried out by the MWI indicated that additional 100-120 MCM can be drawn from the Disi aquifer for use in Amman to reduce pressure on renewable ground water resources in the highland region.

Economic and technical feasibility studies of the conveying Disi water to Amman via a pipeline 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. 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 either the development of non-traditional water resources or additional resources to be imported into 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 implies that the Disi conveyor is designed to serve as a "Southern National Carrier" for Jordan. The source of the conveyed water will be the Disi aquifer only until it becomes feasible for the Government of Jordan to develop a major sea water desalination plant at Aqaba city.

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.

A 325 kilometre pipeline is to convey the water from Disi-Mudawarra to Amman city. 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 & 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 3** shows the optimised alignment of the conveyor to Amman.

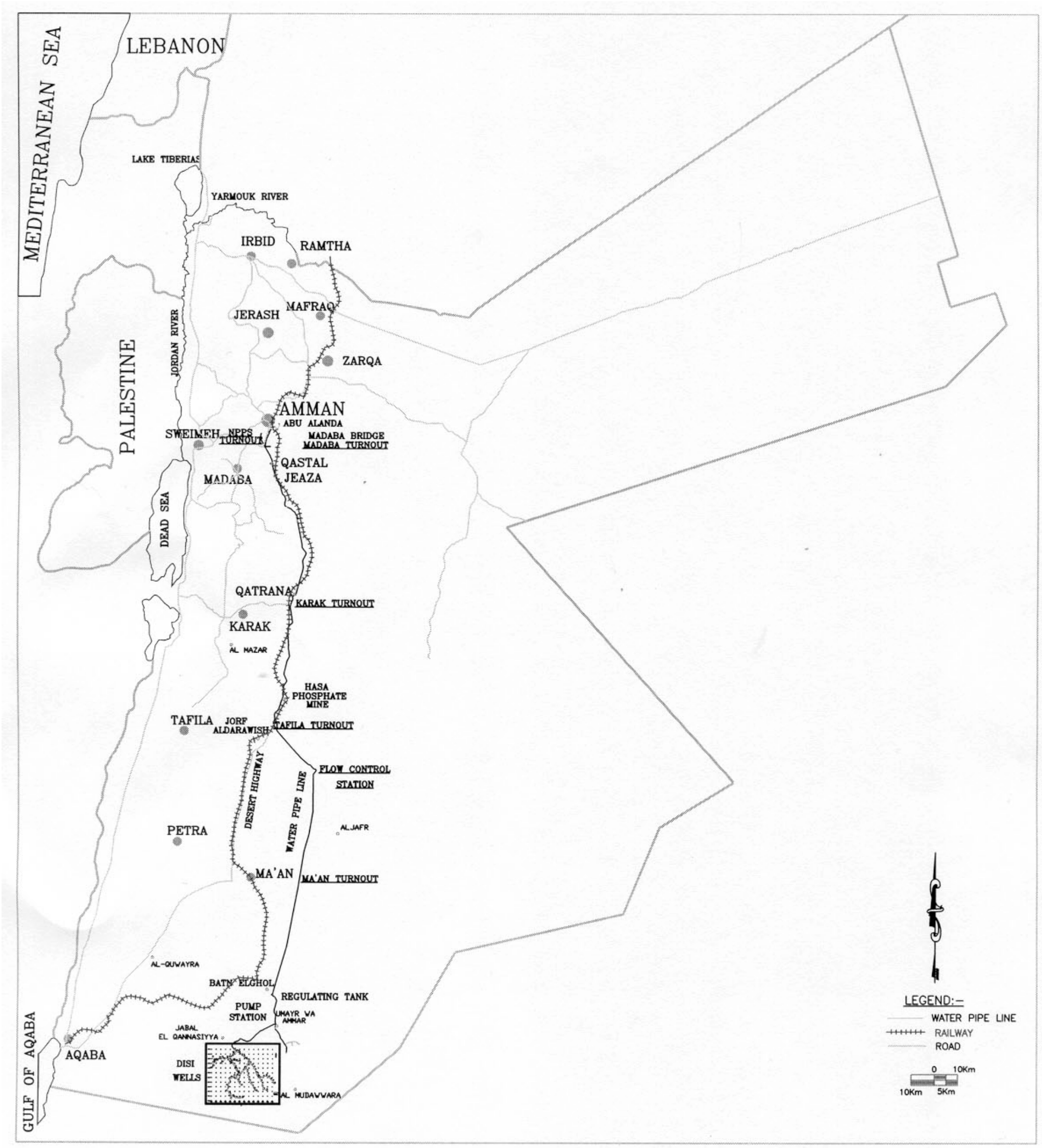


Figure 3: Optimised alignment of the Disi-Mudawarra to Amman water conveyance system

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 5**.

Table 5: 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 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 case 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 Sea-Dead Sea Water Conveyance Project 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. Future proposals for demineralisation of groundwater from deep sandstone formations or 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 Segments

For the purpose of this Environmental and Social Assessment Study, the Consultant has divided the project area into three segments. **Figure 4** represents these segments.

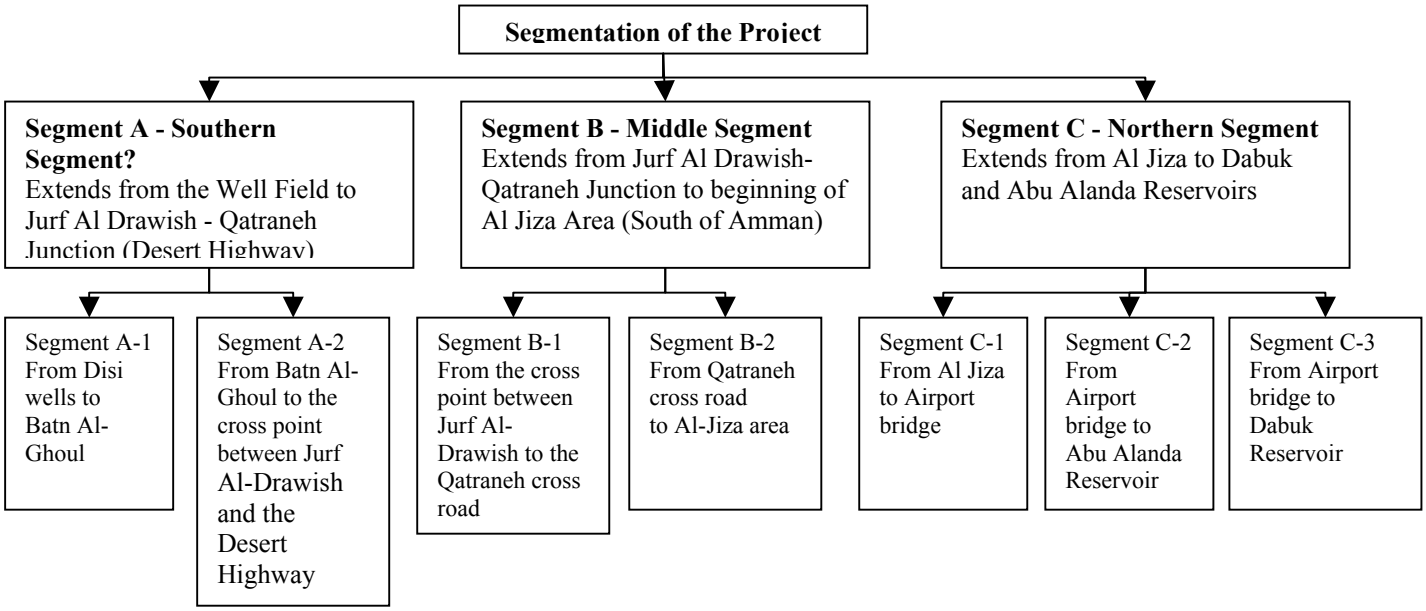


Figure 4: Segmentation of the project area

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 construction project. The Ministry of Water and Irrigation will be responsible for coordination and monitoring of 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 ASSESSMENT PROCESS

The Environmental and Social Assessment study for the Disi-Mudwarra to Amman Water Conveyance System addresses the following issues:

- Policy, Legal and Administrative Framework in Jordan;
- Applicable World Bank Policies;
- Water Sector Environmental and Social Assessment; and
- Project Specific Environmental and Social Assessment.

Public consultation sessions were held in order to determine the scope of the Environmental and Social Assessment and to obtain feedback on the draft study. The draft and final Environmental and Social Assessment were disclosed within Jordan. The final Environmental and Social Assessment will be disclosed at the World Bank InfoShop. The study is supported with maps available on a CD-ROM submitted with the study. The different components of the study are described below.

3.1 Policy, Legal and Administrative Framework in Jordan

This section of the study focuses mainly on the institutional and legislative framework, which includes:

- 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 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.
- Highlight salient features of Jordan's environmental management capacity, in particular factors that affect the implementation of the project.

3.2 Applicable World Bank Policies

This section of the Environmental and Social Assessment 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. It also indicates what safeguard policies are applicable to the proposed project.

3.3 Water Sector Environmental and Social Assessment

The following is a short description of the issues addressed in the Water Sector Environmental and Social Assessment:

Section 1 of the Water Sector Environmental and Social Assessment presents a detailed literature review and discusses Jordan water resources with and without the new resource of Disi aquifer, which is a non-renewable water resource of high quality. This section also addresses, on a geographical basis the current conditions and implications of not developing the using of Disi water.

In **Section 2** of the Water Environmental and Social Assessment, a detailed review of Jordan's water resources is provided with respect to three main issues, which are supply-demand balancing, impacts, and alternatives. In this section, the Consultant provides a review and assessment of the water supply and demand issues based on information from the Ministry of Water and Irrigation and available information on policies, strategies and relevant technical studies for the water sector.

Section 3 describes the hydrological and hydrogeological condition of the Disi area and **Section 4** covers the hydrogeological and hydrochemical assessment of the affected groundwater aquifer systems and addresses the impacts on Disi-Mudawarra groundwater resources due to the project.

Section 5 presents the management plan for the construction sites with respect to issues of sedimentation and diversion of the main wadi sections that could result in high flow disturbance and cause a great deal of erosion.

Finally, **Section 6** presents the main issues and conclusions related to the water sector and to this project.

3.4 Project Specific Environmental and Social Assessment

The ESA report is structured to present the following:

1- Environmental and Social Baseline Conditions;
2- Potential Impacts to the Environmental and Social Settings;
3- Analysis of Alternatives;
4- Environmental and Social Mitigation and Monitoring Measures; and
5- Environmental and Social Management Plan.

Each component 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; and
5- Archaeological and Cultural Heritage Sites.

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

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;
3- Environmental and Social Management Plan (ESMP);
4- ESMP Control;
5- Implementation and Operation;
6- Checking and Corrective Action; and
7- Management Review.

Figure 5 shows the Project-Specific Environmental and Social Management (ESM) process.

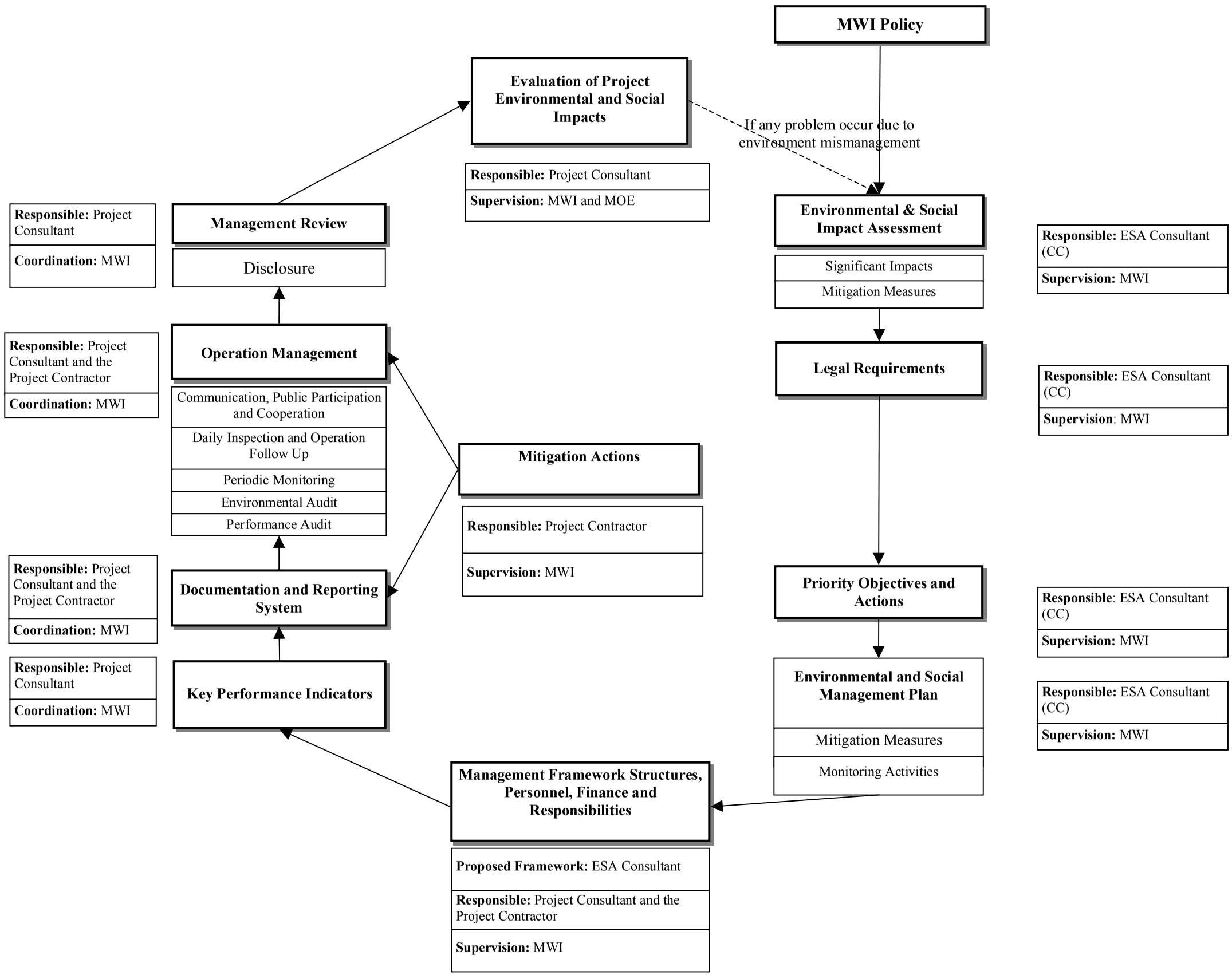


Figure 5: Project-Specific ESMP Process

3.5 Maps to Support Environmental and Social Management Plan

Development of the Environmental and Social Management Plan (ESMP) has been supported by 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. 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 were linked to information sheets listing the anticipated impacts, proposed mitigation measures and monitoring programs.

This system is reproducible and printable to facilitate maximum access by users and adaptability to any change in the plans and/or environmental and social conditions.

4 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The Policy, Legal and Administrative Framework study focuses mainly on:

- 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;
- Salient features of Jordan's environmental management capacity, in particular factors that affect the implementation of the project; and
- Applicable World Bank policies and procedures for the proposed project.

4.1 Institutional and Legislative Framework

4.1.1 Institutions

The role of environmental protection within Jordan is divided between various governmental institutions, including the Ministry of Planning, Ministry of Environment, Ministry of Health, Ministry of Water and Irrigation, Ministry of Agriculture, Ministry of Tourism and Antiquities, Ministry of Energy and Mineral Resources (including the /Natural Resources Authority), and the Aqaba Special Economic Zone. Each of these institutions has articles in their respective laws granting them the responsibility to maintain and monitor some aspects of environmental elements and quality.

The key Institutions involved in the project, the water sector, environmental and social issues are:

- Ministry of Water and Irrigation (MWI)
  It is the only public sector agency at present in the region that integrates the management of different water user sectors, thus allowing for a cross-sectoral perspective in water allocation and management. This integration provides MWI the opportunity to coordinate water resources allocation and management, taking a cross-sectoral perspective that accounts for irrigation, municipal and industrial needs.

- The Water Authority of Jordan (WAJ)
  WAJ is responsible for the construction, operation and maintenance of water supply and sewage facilities and the national water resources management under the Ministry of Water and Irrigation. It is an autonomous corporate body with financial and administrative independence. It formulates water supply and sewage policies and prepares water resources management plans. This organization also has the responsibility of supervising the water supply and sewage services being implemented and water protection related environmental issues.

- Jordan Valley Authority (JVA)
  JVA is the agency acquired the prime authority to plan and implement water services in the Jordan Valley, under the Ministry of Water and Irrigation. As part of this role, JVA has taken measures for strengthened the management for the infrastructure development in the valley. The territory mandated to the Jordan Valley Authority is extensive covering approximately 5,000 km^2, and is home to some 300,000 people. The main activity in the Jordan Valley is agriculture with about 360,000 dunums being cultivated.

- Ministry of Environment
  The Ministry of Environment is the authority in Jordan with lead responsibility for environment protection on national, regional and international level. In addition, all sectors whether government, non-governmental organizations (NGOs) or the public, have to implement the procedures and instructions issued by the Ministry of Environment. Also, they have to coordinate with the Ministry of Environment in relation to environmental issues when dealing with the Donors.

- Ministry of Tourism and Antiquities/ Department of Antiquities
  The responsibilities of Ministry of Tourism and Antiquities / Department of Antiquities are to develop and implement the archaeological policy of the country, promote archaeological sites and conduct public awareness about archaeological sites.

- Non Governmental Organisations (NGOs)
  The NGOs provide an important part of the environmental management process in Jordan. Their programs often compliment the work of government, adding to the existing programs or filling gaps in areas where the government is less active.

4.1.2 Applicable National Environmental Legislation

To date Jordan has issued a number of laws, regulations, instructions, and standards regarding water management, control, monitoring, and protection against pollution. The following are the key policy and legal requirements that relates to the Disi project:

4.1.2.1 Laws

- Environment protection Law No. (1) of 2003;
- Antiquities Protection Law: Antiquities Law No. (21) of 1988;
- Land Acquisition Law No. (12) of 1987;
- Management of Government Property Law No. (17) of 1974; Leasing and Authorization of Government Property By-law No. (53) of 1977;

- Privatisation Law No. (25) of 2000; and
- Labour Law No. (8) of 1996.

4.1.2.2 Regulations and By-laws

- Underground Water Control By-law No. (85) of 2002;
- Subscribers to Drinking Water Network By-law No. (67) of 1994; and
- Instructions:
    - **Water**: (1) Drinking water instruction regarding connecting to drinking water and its amendments No. (1) of 2002, (2) Instruction No. (18) of 1998 and its amendments for industrial and commercial wastewater disposal into, and connecting to the public sewers;
    - **Air**: Vehicle equipping of 2002;
    - **Noise**: Control and prevention of noise of 1997; and
    - **Occupational Health and Safety**.

4.1.2.3 Water Policies

Jordan's Water Strategy (MWI, 1997b) provided the foundation and initiative to formally develop policies addressing specific issues facing Jordan's water sector. To date, four policies have been developed and accepted by the Council of Ministers. These policies are:

1- Groundwater Management;
2- Irrigation Water;
3- Water Utility; and
4- Wastewater Management.

4.1.2.4 Occupational Health and Safety

The following are the applicable instructions concerning "Occupational Health and Safety":

- Initial Check-up for Workers at Corporations of 1999;
- Regular Check-up for Workers at Corporations of 1999; and
- Protection of Employees and Workers against Risks Associated with Work of 1998.

4.2 Applicable Policies of the World Bank

The operations of the World Bank are guided by a comprehensive set of policies and procedures, dealing with the Bank's core development objectives and goals, the instruments for pursuing them, and specific requirements for Bank financed operations. This is set out in the Bank's Operational Manual.

The World Bank requires environmental assessment (EA) of the project to help ensure that it is environmentally sound and sustainable. The Operational Policy 4.01 Environmental Assessment of January 1999 applies to the proposed project. The proposed project, and in accordance to WB environmental screening criteria, is classified as Category A[1].

With respect to Safeguard Policies, the following policies are applicable to the proposed project:

Operational Policy 4.01: Environmental Assessment seeks to ensure sound and sustainable environmental assessment (EA) of projects proposed for the World Bank for financing in order to assist in decision making. Such an EA should be initiated as early as possible in project processing and is integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project.

Operational Policy 4.04: Natural Habitats seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society.

Operational Policy Note 11.03: Cultural Property is to avoid, or mitigate, adverse impacts on cultural resources from development projects that the World Bank finances.

Operational Policy 4.12: Involuntary Resettlement is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas.

Operational Directive 4.20: Indigenous Peoples, underscores the need for Borrowers and Bank staff to identify indigenous peoples, consult with them, ensure that they participate in and benefit from Bank-funded operations in a culturally appropriate way and that adverse impacts on them are avoided, or where not feasible, minimized or mitigated.

Operational Policy 7.50: Projects on International Waterways, provides that World Bank supported projects involving the use of surface or groundwater resources which are shared between two or more countries include a process of notification and provision of information. This is issue is being addressed by the Government of Jordan and World Bank on a separate basis outside the Environmental and Social Assessment..

5 WATER SECTOR ENVIRONMENTAL AND SOCIAL ASSESSMENT

The Water Sector Environmental and Social Assessment provides an evaluation of the key issues in the sector and places the proposed investment project in this broader context.

5.1 Baseline Data

Regarding the Water Sector Environmental and Social Assessment, the water sector team collected the data from the following sources:

[1] (a) *Category A*: A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally an EIA (or a suitably comprehensive regional or sectoral EA) that includes, as necessary, elements of the other instruments referred to in para. 7.

- References listed in the Terms of Reference and other references which could be the most reliable and accurate sources. These are:
    - 1997 Water Utility Policy (GOJ);
    - 1998 Irrigation Water Policy (GOJ);
    - 1998 Wastewater Management Policy (GOJ);
    - 1997 Jordan Water Sector Review (2 Volumes) (World Bank);*
    - 2001 Jordan Water Sector Review Update (World Bank);*
    - 2002 Water Sector Planning and Associated Investment Program, 2002-2011 (GOJ);*
    - Ministry of Water and Irrigation (MWI) Water Sector Action Plan 2002-2006;
    - Final Study for Water Sector Master Plan (JICA);
    - 1997 Jordan's Water Strategy;
    - 1998 Groundwater Management Policy;
    - 1988 Jordan Water Resources Sector Study (World Bank); and
    - 1997 Middle East Regional Study on Water Supply and Demand Development (GTZ).
- The open files of the Ministry of Water and Irrigation (MWI).

In addition, the water sector team and the project manager worked together on the GTZ 1997 Middle East Regional Study on Water Supply and Demand Development and they had communication with the key personnel in the Ministry of Water and Irrigation through a Steering Committee. The present Minister was a member in that steering committee. Therefore, the water sector team studied Jordan's water resources together with the key persons in the Ministry of Water and Irrigation through the scheduled meetings and benefited from their valuable comments.

5.2 Analysis of Alternatives in the Water Sector

Jordan's water condition has been the reviewed at a variety of levels, examined during the development of projects and is the subject of many studies over the last thirty years. This is due to the real scarcity of water in Jordan and the complex management issues that this raises. **Figure 6** presents the estimated year 2000 per capita withdrawal for Jordan compared with countries inside and outside the region. **Figure 6** shows that USA withdrawal is more than 10 folds that of Jordan. Even Israel is about 2 folds of that of Jordan. Jordan is considered to be one of the poorest countries in water resources in the world.

* The document contains key analytical data for Jordan's water sector.

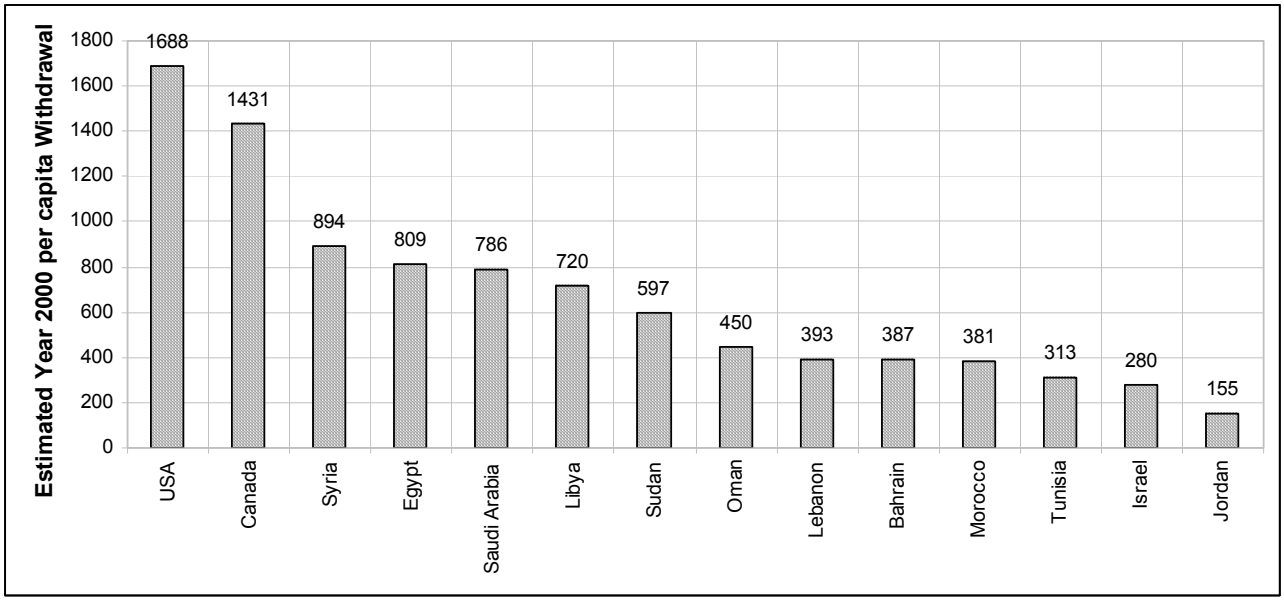


Figure 6: Estimated year 2000 per capita withdrawal for Jordan and other countries (Source: www.worldwater.org/table2)

Disi water could be provided for the present and near future a source of relief that would be key to water problem in Jordan. The former statement is important but at the same time can give a wrong impression about the crucial water situation. The following text will explain in details what kind of options and alternatives Jordan can adopt. The global picture, sometimes is more important than the fine details, therefore, **Table 6** is developed to give sharp and direct picture with respect to:

- Implications of no action alternative, which reflects the main impacts of Jordan's water scarcity;
- Current and Proposed Actions without Disi Project, which explain Jordan's efforts to relief the water problem;
- Cost Effectiveness to check the action against cost affordability now and near future;
- Satisfying Future Demand to check the action supplying water; and
- Sufficiency to check the action for fulfilling the future water deficit.

Table 6: Implications of "No Action Alternative" with the current and proposed actions without Disi project

Implications of No Action[1]	Current and Proposed Actions without Disi Project[2]	Cost Effectiveness[3]	Satisfying Future Demand[4]	Sufficiency[5]
▪ Increasing groundwater drawdown and deterioration of water quality due to overexploitation ▪ Low quality domestic water at water supply networks especially in terms of salinity level ▪ Low quality treated wastewater reaching the Jordan Valley due to low water quality consumed in domestic sector ▪ High deficit in fresh water for domestic water demand ▪ Unreliable rationing programmes of municipal water supplies in summer seasons ▪ Increasing the pumping rates or even continuing pumping at the present rates from affected basins (e.g. Azraq and Amman-Zarqa Basins) to meet the future domestic water demand will adversely affect the basins environmentally (e.g. Azraq oasis)	▪ Freezing irrigated land	✓	✓	×
	▪ Treated wastewater could be the potential source for the irrigation sector. Fast development to replace fresh surface and groundwater with treated wastewater for irrigation.	×	✓	✓
	▪ Institutional reform	✓	×	×
	▪ Further development of surface water to reach the yield	×	×	×
	▪ Management and further development of groundwater to reach the safe yield and financial measures aimed at controlling and gradually reducing groundwater withdrawals from overexploited with final objective of maintaining the safe yield of aquifers	✓	×	×
	▪ Brackish groundwater: • Blended to be used for irrigation • Desalinated to be used for irrigation • Desalinated to be used for domestic	 ✓ × ✓	 × ✓ ✓	 × × ×
	▪ Seawater Desalination at Aqaba	×	✓	✓
	▪ Regional Water and promotion of regional cooperation through the Water Resources Working Groups	✓	✓	✓
	▪ Intersea Project (Red Sea - Dead Sea Water Conveyance Project)	×	✓	✓
	▪ Continuous review of the water tariffs for efficient use of water	✓	×	×
	▪ Ongoing rehabilitation program of the water supply systems to reduce losses through the networks and -reduce response time for repair of network leakages, pressure loss, and sewer blockage	✓	✓	×
	▪ Public awareness campaigns were conducted for enhancing water conservation	✓	×	×
	▪ In agriculture, Jordan is planning to produce high-income products to increase the productivity of the cubic meter of water and to pay the full cost of water with no subsidy.	✓	✓	×
	▪ Private sector participation in providing services for infrastructure development. Started with Amman Management Contract and continuation depends on the evaluation of the performance of the LEMA in Amman	✓	×	×

[1] Main implications if no Disi project
[2] Executed, ongoing, and proposed projects and actions if Disi Project is implemented or not
[3] Cost affordability now and near future
[4] Check for supply potential
[5] Check for satisfying future demand
× Short in satisfying the requirement
✓ Fulfill the requirement completely or for some extend

Water resources in Jordan could be the scarcest resource in the world. Jordanians, whether public or government, are acting accordingly and using wisely each drop of water over the arid to semi arid country. The water shortage has been continuously worse, which has forced Jordan to work hard in order to develop all potential water supplies both conventional and non-conventional. These supplies could be divided according to different categories, such as:

- According to supply source:
    - Conventional water
        - Surface water;
        - Groundwater
            - Renewable
            - Non-renewable;
        - Demand management savings; and
        - Treated wastewater reuse.
    - Non-conventional water
        - Marginal water
            - Fresh to Brackish
            - Grey water;
        - Desalination water
            - Brackish groundwater desalination
            - Sea water desalination.
    - Regional water
        - Inter-Sea project (Red Sea - Dead Sea Water Conveyance Project); and
        - Import water from outside the region.
    - Dry water as import of grains and other agriculture products.

The conventional waters are the most developed sources in Jordan due to the low investment cost required for such development. This fact created an impact on the renewable groundwater, which leads to over exploitation of the source beyond its safe yield. Tapping shallow aquifers requires the lowest investment cost, which leads to salinity of the aquifer and high drawdown. The other source which is close to that is the surface water, which can be divided mainly into two parts:

- Internationally Shared water-Yarmouk and Jordan Rivers; and
- National Water-Rivers, Streams and Wadis in Jordan.

Shared water was developed further through treaties and negotiations with Syria and Israel, which lead to execution (or on the way) of the following projects:

- Adassiya Diversion Weir to increase the supply through the tunnel to the King Abdullah Canal (completed in 2001);
- Adassiya pond (ongoing project) to capture flood water from catchment in-between Wehdeh Dam and Adassiya; and
- Wehdeh Dam (ongoing project) to capture flood water from Yarmouk upper catchment.

Streams and wadis in Jordan are considered as potential surface water resources and Jordan is acting accordingly to save each drop of water. This savings are subjected to feasibility studies for all viable issues such as environmental and social issues, technical feasibility, economic feasibility, and others.

Demand management savings could be the cheapest source of water according to many studies (as an example GTZ 1997). The cubic meter of water could cost as low as 20 cents. Demand management needs low investment and eases the running cost. Therefore, Jordan considers this option with high priority. Over the years the Ministry of Water and Irrigation has undertaken and continues to undertake with the support of Donors a wide range of actions to support water demand management through technical, pricing and education/awareness programs.

The social constrains make the reduction of the agricultural demand too sensitive to tackle. Jordan has no other alternative but to cut from fresh water and to replace it with treated wastewater. This option was implemented with high care due to its environmental impact issues and the need to avoid health risks. The treated wastewater could be the future potential source for agricultural uses.

Jordan is working hard to develop these options, which cannot close the gap between the demand and supply but only reduce it. A schematic figure was prepared to give a clear picture of these options as shown in **Figure 7**. Accordingly, Jordan has started to develop the non-conventional waters, such as using marginal water for irrigation and desalination water for selected domestic uses. The first large-scale desalination plant soon will supply Amman and the Dead Sea resorts with domestic water. **Table 7** presents the planned water development projects, which reflects Jordan's enormous plans to bridge the water gap.

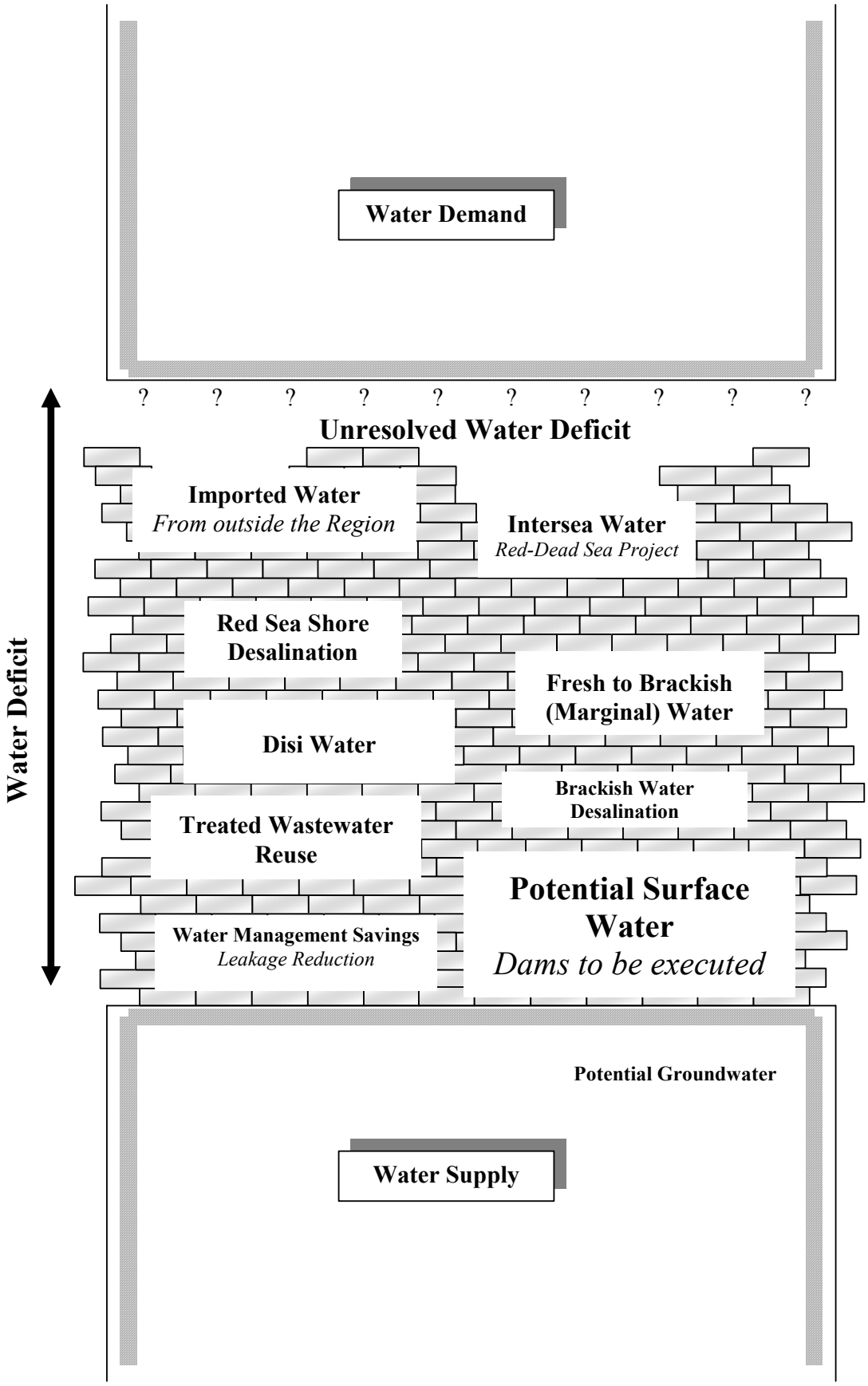


Figure 7: Jordan Water Gap and Bridging Options

Table 7: Planned water development projects and development amount (MCM/yr)

Resource Type	Main Project Name	[1]Existing Develop Amount	Short Term 2001 - 2005	Mid Term 2006 - 2010	Long Term 2011 - 2020	[2]Incremental Develop. Amount during 1998-2020	Total Develop. Amount by 2020 (1+2)	Estimated Cost (JD)/m^3	Remarks
Surface Water	Existing Development Amount	303	-	-	-	-	303		Already Executed
	Wehdeh Dam	-	93	-	-	93	93	145	Feasibility, design and tender documents. Completed.
	Mujib Dam (including base flow) flow (develop.)	-	12	-	-	12	12	26	Ongoing
	Tanur Dam	-	8	-	-	8	8	23	Completed
	Wala Dam	-	5	-	-	5	5	13	Just completed
	Small Dams (Ibn Hammad, Karak, and Middien)	-	-	7	-	7	7	12	Finance is not secured
	Fidan Dam	-	3	-	-	3	3	8	Feasibility. and Tender Document Completed
	Water Harvesting	-		-	15	15	15		Field investigations completed
	Total	303	121	7	15	143	446	227	
Peace Water	Desalination Conveyor to Urban Jordan	33	27	-	-	27	60	-	-
	Storage on Jordan River and Sides Wadis	-	-	30	-	30	30	--	
	Total	33	27	30	-	57	90	100	Ongoing Financing is being sought
Renewable GW	Reduction of the Abstraction	420	-52	-31	-62	-145	275	-	-

Table 7: Planned water development projects and development amount (MCM/yr) (contd.)

Resource Type	Main Project Name	[1]Existing Develop Amount	Short Term 2001 - 2005	Mid Term 2006 - 2010	Long Term 2011 - 2020	[2]Incremental Develop. Amount during 1998-2020	Total Develop. Amount by 2020 (1+2)	Estimated Cost (JD)/ m^3	Remarks
Fossil Fresh Groundwater	Deep GW investigation			-	-	-	-	13	Finance is not secured
	Disi	70	-5[a]	27	38	60	130	420	BOT, Updated Feasibility. Designs and Tender.doc. completed
	Lajoun Wells	-	(11)*	-	-	(11)*	(11)*	13	Completed
	Total	70	-5	27	38	60	130	446	
Brackish Groundwater Desalination (including brackish spring)	W. Zarqa Ma'in/Zara Conveyance Project	-	20**	20**	-	40**	40	70	Feasibility. Completed and awarded as DBO
	El-Lajoun Desalination Project	-	-	13	23	36	36	-	Not yet
	Deir Alla (Abu Ez-Zighan) Desalination Plant	-		-	9	9	9	5	Ongoing
	Total	-	20	33	23	85	85	75	
Sea water Desalination	Aqaba Sea Water Desalination	-	5	-	12	17	17	14	A feasibility study is ongoing
Reuse of Treated Wastewater	As-Samra TP	46	21	-6[b]	22	37	83	105	BOT Feasibility, design and tend. Doc. Comp. Secured. Finance
	Wadi Zarqa TP	-	-	40	14	54	54	59	Feasibility. and design completed
	Existing 5 TPs	2	2	2	2	6	8	-	Feasibility. and design completed
	Aqaba wastewater project	16	25	29	31	85	101	25	Stage 1 comp. Stage II ongoing. Secured Finance
	Total	64	48	65	69	182	246	189	
Ground Total		890	164	131	104	399	1,289	1037	
Total Amount by Target Year		890	1,054	1,185	1,289	-	1,289	1037	

Source: Updated Investment Program 2002 to 2011 and JICA Management Plan 2001

All of the above options will be in short of bridging the future water need gap. **Table 8** extracted from GTZ study 1997 presents the water gap expected at year 2010 and 2040. The water demand could be more than 30 % unsatisfied. Therefore, regional projects could be the only solution for Jordan's future need of domestic water. The intersea project, involving construction of the Red Sea - Dead Sea Water Conveyor, could be more feasible than other projects regarding economy, socially, politically, and environmentally, etc. **Table 9** developed by GTZ 1997 study, estimates the unit cost for such options.

Table 8: Water Demand, Supply and Gap for the Base Scenario (MCM/yr)

Year	2010	2040
Domestic	488	1209
Industrial	129	170
Irrigation	1088	1088
Total demand	1705	2467
Supply	1083	1669
Deficit (%) of Demand	-622 (36.5%)	-798 (32.3%)

Table 9: Non-conventional options for Jordan to ease the water problem

Option	Sub-option	Quantity MCM/yr	Delivery Point	Unit Cost US $/m^3	Total Unit Cost to Amman
Seawater Desalination	Single RO* Desal. Plant	50	Med Coast	0.68	0.97
	Red-Dead Intersea	850	Dead Coast	Not available	1.01
	Med-Dead Intersea	800	Dead Coast	0.42	0.72
Water Import by Sea	Used Tankers	200	Med Coast	0.83	1.12
	New Water Tankers	200	Med Coast	1.12	1.41
	Large Vinyl Bags	200	Med Coast	0.55	0.84
Water Import by Land	Pipeline from Turkey	150	Lower Jordan River	1.44	-
			Amman	1.65	1.65
		200	Lower Jordan River	1.36	-
			Amman	1.54	1.54
	Pipeline from Iraq	150	Lower Jordan River	0.94	-
			Amman	1.13	1.13
	Pipeline from Lebanon	150	Lower Jordan River	0.15	-
			Amman	0.68	0.68

* RO: Reverse Osmosis

The above discussion indicates that Disi water is part of the groundwater option, which can be divided into two main parts:

- Renewable-all aquifers except Disi and Jafer; and
- Non-Renewable-Disi and Jafer.

Renewable groundwater resources represent the main part of the current water supplies in Jordan. The capital Amman receives its water supply for different purposes but solely for domestic uses mainly from:

- Groundwater basins adjacent to Amman specifically Amman-Zarqa Basin, Azraq, and Mujib Basins; and
- Treated Surface water from Yarmouk River at Zai water treatment plant.

The main aquifer systems in these groundwater basins are highly overexploited whereas the Upper Aquifer Complex in the Sara Basin is over pumped by more than twice its safe yield capacity. Similar situation can be said for the Amman-Zarqa Basin. During the last two decades the water table had dropped by tens of meters in these basins whereas discharge of natural water springs had been stopped. For example:

- The two Azraq North and South springs, which were supplying the internationally recognized Azraq Oasis (wetland); and
- Ruseifa and Sukhna springs in the Amman-Zarqa Basin.

Additionally, many hand-dug wells in the Azraq Basin were dried up completely. It is worth mentioning that the water quality in these two basins had been deteriorated by the continuous decline of the water table. The water quality deterioration at Azraq basin is associated with the irrigation of the salty water in the Sabkha at the centre of the Azraq basin. The present groundwater abstraction exceeds the safe yield by more than 230%.

Consequently the salinity of some groundwater wells has been increased from few hundred milligrams per litre to more than few thousands of milligrams per litre. The groundwater salinity in the Amman-Zarqa Basin has also increased from few hundreds of milligrams per litre in the early eighties to more than few thousands by milligrams per litre at the time being specially in the area of the industrial activities in Sara city.

Increasing the pumping rates or even continued pumping with the present rates from these two basins (Azraq and Amman-Zarqa Basins) to meet the future water demand in greater Amman will adversely affect the water resources in these two basins to a point where the two basins will be completely destroyed and consequently rehabilitation and restoration will not be achieved for a very long time.

The future reduction of the rates of groundwater abstraction from these basins will result in sustainable yields and booth increase the quantity and improve the water quality of these groundwater resources over the long term. Such a situation cannot be reached unless other sources for Amman water supply are put in operation. The present water salinity of the supplied water is ranging between 700-900 mg/l. This salinity is still within the Jordanian drinking water standards by taking into consideration the upper limit of the water salinity in the standards which is 1,500 mg/l, which is the expected case of future quality of the supplied water if no other resources of water are used to supply Amman. The continuous use of groundwater for Amman will also negatively affect the quality of the municipal wastewater prior to and after treatment due to its high salinity.

In order to supply Amman with the necessary water supplies, the Ministry of Water and Irrigation has drilled deep wells in the Lajoun area to tap a portion of the Disi Aquifer. The water quality from these drilled wells is not similar to that in Disi area which is further south in Jordan. The salinity of the water from these wells is about double the value of wells in the Dubaydib area and the presence of iron and manganese in the water requires that it be treated by aeration prior to use

for water supply. In addition, the quantity of the discharge from these wells is lower than those in southern Jordan.

In the case of water supplies being provided to Amman from the Rum Aquifer (Dubaydib Well field), which has a salinity of less than 300 mg/l, the wastewater will be significantly less saline which will allow for a better quality effluent from the SWWTP. In addition, if alternative treatment technologies were adopted at the SWWTP such as the use of mechanical treatment, a better quality treatment could be obtained than from the currently used natural stabilization ponds. When combined these changes would allow for the collected flood and treated wastewater in the King Talal reservoir to be acceptable for use on most crops in the Jordan Valley.

The Disi-Amman Water Conveyor is listed by Ministry of Water and Irrigation as a PSP project. The proposed project has been given the highest priority by the MWI for construction because it will provide water of excellent quality to Amman at a time when there is great need to reduce overdraft of water from rechargeable aquifers on the plateau. Also it should facilitate the filling of the Al- Wehdeh reservoir even if the dam is completed during a drought period. Besides the Disi pipeline will be an important link in the development of a national pipeline network. Should the Red Sea – Dead Sea Water Conveyor or an alternative water transfer project be developed in the future, the Disi pipeline would be critical for the transfer of water back to the south. This would be done to conserve the Disi reservoir for emergencies or to supply water to the south if the Disi reservoir by then has been fully exploited.

Finally, water resources of Jordan continue to be scarce. If they are allocated based on sound scientific information and value oriented pricing, this precious national resource has the potential of meeting demands and contributing to the national economy for several decades more. The use of reclaimed water and water-efficiency schemes must continue to be implemented. Once these fairly traditional initiatives have been exhausted, additional supplies such as desalination of brackish water and the Red-Dead Seas project may become more attractive.

5.3 Potential Impacts

Table 10 presents a summary of the potential impacts of the Disi-Mudawarra Water System on the Water Sector in Jordan. The direct and indirect implications were summarised on the basis of using Disi water. The cumulative impacts developed in **Table 10** show the importance of the Disi water for Jordan. **Figure 8** explains these impacts in terms of enhancing the domestic water in both directions; the consumed water and the resulting wastewater influent to the Amman wastewater collection and treatment system.

Table 10: Potential Impacts of the Disi-Mudawarra Water System on the Water Sector in Jordan

	Direct	Indirect	Cumulative
Physical	▪ Supply additional domestic water to the Greater Amman Area and increase the share of per capita for domestic demand ▪ Relieve the over exploited aquifers and elevate the water table level in the relieved aquifers	▪ Reduce the damage in quality of groundwater in the relieved aquifers where the high water table will lower the hydraulic gradient between the fresh water and the lower quality	▪ Improve the quality of water in the relieved aquifers
Biodiversity	▪ The reduction in the abstraction will increase the baseflow of streams which in turn would enhance the biodiversity at wetlands associated to the streams	▪ The reduction in the abstraction will enhance the renewable process of the Azraq aquifer and associated wetland as an example which in turn would enhance the biodiversity at Azraq Oasis	▪ Enhance the wetlands condition in many areas of Jordan
Agricultural	▪ Reduce the salinity at irrigated lands due to reduction in salinity accumulated in soil column ▪ Enhance soil characteristic for more profitable condition for better growing crops	▪ The treated wastewater will be of better quality and of reliable quantity again due to the characteristics of the Disi source and the treated wastewater in KTDR will be acceptable for irrigation purposes for most crops planted in the Jordan Valley	▪ Improve the cropping condition in the southern Ghour
Social	▪ A reliable quantity and a better quality of water will have positive implications on health aspects of the society	▪ Increase in the reliability of the system will decrease the losses and enhance the water consumption share for poor households	▪ Improve the health condition of consumers due to reliable and good quality water consumed

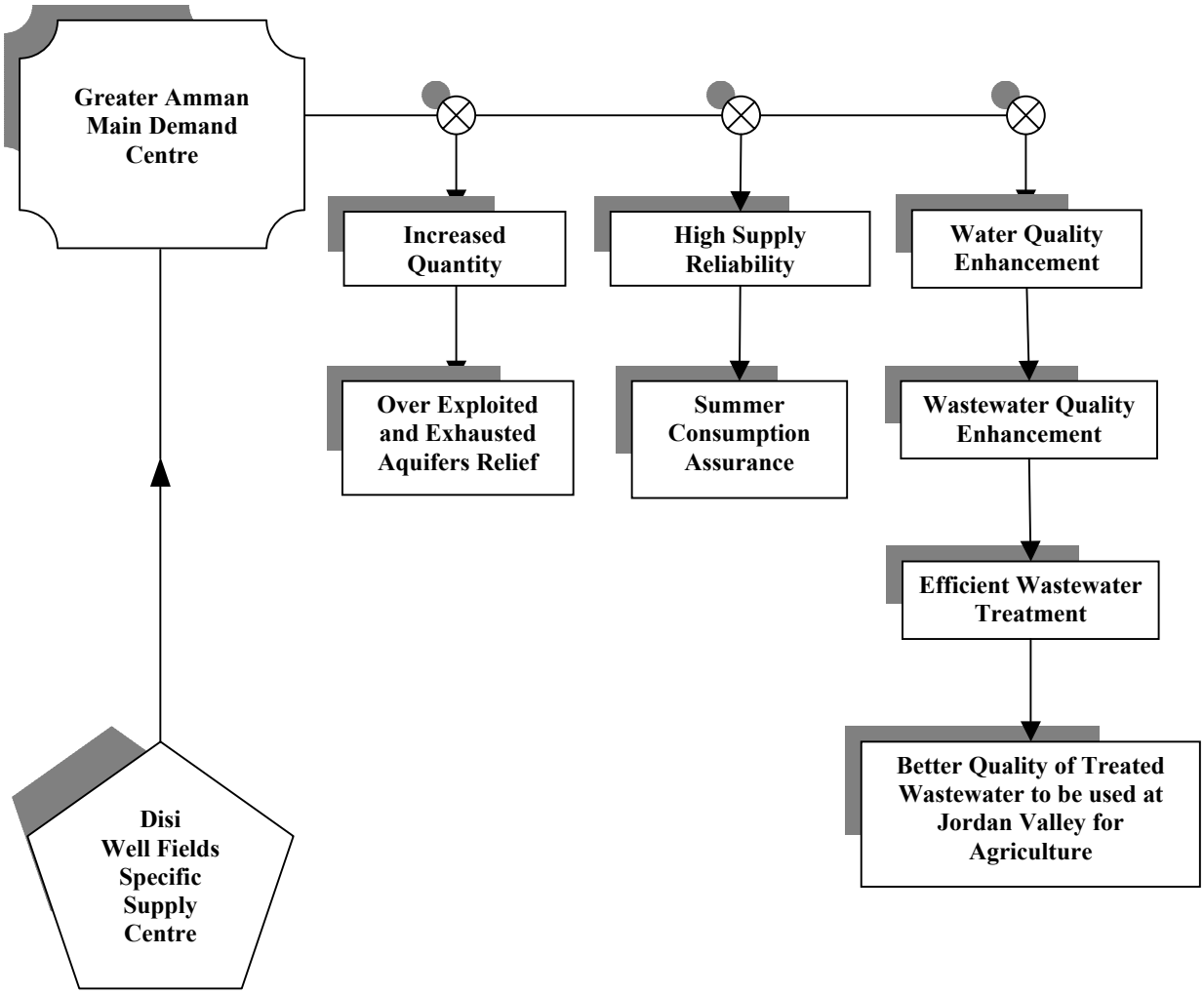


Figure 8: Illustration of the reason for conveying Disi Water to Amman

5.3.1 Direct and Indirect

The Water Sector Environmental and Social Assessment identified the following potential impacts associated with the proposed project:

- It would withdraw fossil water from the Disi aquifer and convey it to Greater Amman for domestic water supply and industry.
- The Disi water would provide Greater Amman with access to a reliable high quality source of water that improves public health and overall environmental conditions.
- The use of Disi water will improve the quality of wastewater conveyed to the SWWTP and later to the King Talal Dam Reservoir which will in turn allow for an enhanced treated effluent for agricultural use in the Jordan Valley.
- The use of Disi water would provide an opportunity to relieve the overexploitation of upland aquifers and provide an opportunity for their rehabilitation and restoration.
- Important hydrological benefits would occur to the Azraq aquifer and its associated wetland of international significance that have been very adversely impacted by excessive withdrawal of groundwater.

- Although the Disi project would provide significant amounts of water to Greater Amman it would not close the gap in water demand and will need to be complemented with actions to both mobilize additional water resources and to address demand management especially non-traditional sources.

5.3.2 Cumulative Impacts

5.3.2.1 Disi Aquifer System

The impact of the Disi project is centred on the availability of fresh water, which can elevate the pressure from the overexploited aquifers such as those of thee Azraq and Amman-Zarqa basins. Therefore, the simulation of the existing groundwater flow and solute transport models of Azraq and Amman-Zarqa basins took into consideration the operation of Disi Mudawarra conveyance system as "with" and the present situation "without" the proposed project, in order to define the problems of groundwater withdrawal and deterioration in both basins.

In order to stimulate the benefits of Disi 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 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.

The above detailed simulation has been carried out in order to prove the effectiveness of the Disi water to relief the constrain of the overexploited aquifers. The proposed reduction can be handled and can be replaced by Disi water. As a result of the use of Disi water the wastewater will be of better quality due to the good quality of the water consumed in Amman. This will enhance the quality of the disposed treated wastewater, which will be consumed in Ghor area of the Jordan Valley for irrigation. This could be among the most important cumulative impact from the Disi project.

5.3.2.2 Overall Cumulative Impacts

Cumulative impacts include all individual or collective impacts that will affect positively or negatively the society concerned and economic 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.

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 involves 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; and
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.

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 will occur as a result of the Disi water quality. The wastewater produced will be of better quality due to the quality of the consumed water. This will be reflected on the treatment process and the quality of the treated wastewater. The treated wastewater will enhance the condition of irrigated land in the direction of more profitable cropping.

Over extraction of ground water from Azraq, Amman-Zarqa basins in the last 20 years to cover water shortages in the cities of Amman, Zarqa and Irbid has substantially affected water tables in all aquifers at both basins. Mining of ground water aquifers at Azraq has far exceeded recharge to the extent that Azraq ponds and their associated wildlife and vegetation have been significantly reduced in size and their quality degraded. A large portion of the Azraq Oasis which served as a sanctuary for migrating birds, turned now been turned into 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 and in the case of Azraq allow for partial restoration of the oasis and its wetland functions.

5.4 Environmental and Social Management Plan

The Disi water resource is a very valuable one and efficient management of it is therefore critical. This high standard of management is needed in order to maximise the benefits of staged development of the resource and conveyance system to Greater Amman. (Harza Group-Executive Summary, 1996).

In general, it is crucial that the Water Authority of Jordan be equipped with the manpower capacities and capabilities especially to co-ordinate various imminent major projects. As this project is of a complex nature and will also be the largest water conveyance scheme to be implemented in Jordan, it is imperative that a “Project Specific Office” be established as soon as

possible within the Water Authority of Jordan. This will ensure that the competent professionals to be assigned to this office are involved at the outset with the formulation and development of system components of not only this project but also other pending projects.

5.4.1 Elements

The Water Authority of Jordan has identified the several elements that can be implemented to enhance the Environmental and Social Management Plan in the Water Sector; the following are some of these elements:

- Implementing the rationing program for water supply all over the Kingdom;
- Implementing comprehensive programs for rehabilitation of water supply networks to reduce losses;
- Replacing the fresh water by marginal water in irrigation;
- Limiting the water provided for agriculture and preventing any expansion;
- Implementing projects for desalination of brackish water for domestic use;
- Implementing training programmes for capacity building of its employees;
- Conducting public awareness campaigns related to availability of water and its wise use;
- Monitoring the water quality at their sources;
- Monitoring abstractions from wells by installing meters; and
- Prevention of new wells without prior licensing.

The specific elements related to the management of the Disi Project have been identified based on the findings of the water sector study team and the extensive discussions carried out with key personnel in MWI. These are listed below:

- The implementation of the Disi project should remain on schedule and not to be deferred;
- Emergency turnouts should be provided on-route;
- Using the Disi water only for domestic consumption in Greater Amman;
- No agriculture water from Disi after the end of ongoing contracts;
- Disi area and Aqaba will continue to use Disi water for domestic consumption;
- After the operation of the Disi conveyor, the monitoring results will be used to conduct a groundwater solute transport model, which is normally constructed on the flow model, in order to simulate the future water quality changes due to water abstraction from Dubaydib area only or Dubaydib and Batn El-Ghoul wellfields.

5.4.2 Parties Responsible

Table 11 below presents the main responsible parties in the project.

Table 11: Parties responsible

Key Institution	Responsibility
Ministry of Water and Irrigation	Development of integrated management of different user sectors
Water Authority of Jordan	The construction, operation and maintenance of water supply and sewage facilities
Jordan Valley Authority	Implementing water supply services in the Jordan Valley and replacing the fresh water by treated wastewater in irrigation
Ministry of Environment	Environment protection (monitoring & mitigation)
Ministry of Health	Monitoring water quality of the source
Ministry of Municipal Affairs	Urban planning, and solid waste collection
Department of Antiquities	Monitoring and protection of archaeological sites
Royal Society for Conservation of Nature	Monitoring and protection of natural habitats along the corridor

5.5 Institutional Strengthening and Capacity Building

The Ministry of Water and Irrigation including its two authorities the Water Authority of Jordan and the Jordan Valley Authority have extensive programmes for capacity building of their employees. A training centre was established where regular training is carried out for all employees and in particular for engineers and technicians to keep them well informed of new techniques and improve their skills in operation and maintenance of the different facilities in the water sector.

The objectives of having these training programs are:

- To achieve the objectives set by the Ministry of Water and Irrigation of Jordan;
- To assist the WAJ and JVA in responding to their needs by building the capacities and setting plans for the available personnel;
- To encourage and motivate the employees in exerting their best efforts in achieving the public objectives;
- To change the behaviour of the individuals so that they become responsive to crisis events and able to find appropriate solutions for problems faced;
- To achieve best use of available human resources by redistributing the employees in order to have them in positions suitable to their capabilities;
- To provide the trainees with the knowledge, experience and recent methods for developing their work performance, building their administrative and functional capacities, and enhancing their productivity;
- To assist the trainees in achieving their ambitions towards personal development and advancement;
- To assist in attracting human resources and maintaining them for the longest possible time period;
- To enhance career planning of which training constitutes a main support; and
- To assist in finding new leaders in the sector.

The continued use of these training programs and development of special training to meet the specific needs of the Ministry of Water and Irrigation staff involved will be important for successful implementation and operation of the Disi project.

6 PROJECT SPECIFIC ENVIRONMENTAL AND SOCIAL ASSESSMENT

The Project Specific Environmental and Social Assessment provides an evaluation of the proposed investment project including both the construction and operation phases.

6.1 Baseline Environmental and Social Data

6.1.1 Physical Environment

6.1.1.1 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.

In the highlands, the climate is 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. 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.

6.1.1.2 Geology, Geomorphology and Structure

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 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; and
- 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”.

6.1.1.3 Seismic Status

Segment A (from Disi well field to Jurf Al Drawish-Desert Highway meeting point) 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 (5.7 on Richter scale). No serious damages were reported in Aqaba area due to these earthquakes.

6.1.1.4 Air Quality and Noise Level Status

The major sources of noise and dust within Segment C (from Al Jiza to Dabuk and Abu Alanda Reservoirs – Amman Area) of the project corridor 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 (from Jurf Al Drawish-Desert Highway meeting point to Al Qatraneh) and A-2 (From Batn El-Ghoul to Jurf Al Drawish-Desert Highway meeting point) 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.

6.1.2 Biological Environment

The biological environment along the proposed alignment has been subject to a field based study program that found that Segment A, in the southern section of the project area, was the most sensitive segment of the alignment from an ecological perspective. It crosses some significant biological areas at Hizma Basin, which includes Rum and Disi areas. The area of Hizma basin is considered an important bird area in Jordan and is highlighted as an important area for conservation. The Jordanian desert, on the other hand, enjoys special ecological characteristics and supports a wide variety of habitats harbouring diverse communities and offering a variety of migrant bird species the vital refuge they need during their long journeys.

Biogeographically, the alignment crosses the four different bio-geographic regions recognized in Jordan, i.e. Mediterranean region, Irano-Turanean region, Sudanian Sub-Tropical region, and Saharo Arabian region. The dominant habitat type in the project area is the Hammada type and specifically the gravel Hammada. Hammada areas are usually devoid of vegetation except at wadi runoffs that can support vegetation.

Irano-Turanean (treeless zone) realm is evident at the alignment part that extends along the Desert Highway (Segment C-1) where soil is moderately productive and is best used for moderate herbivory. Substantial green stands accrue at large wadis such as wadi Al-Abiad and wadi Al-Hasa.

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. The most common species found there are *Artemisia herba-alaba, Achillea fragrantissima, Astragalus spinosa, Zilla spinosa, Rheum palaestinum, Reichardia tengitana,* and many others.

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,* and *Hammada salicornica*.

The Mediterranean bioregion (C) is mainly the non-forest Mediterranean type that is devoid of naturally occurring forest elements. Human plantations, afforestations and private farms account for the existing tree stands in the area.

Various habitats have been identified along the alignment. These are:

- Runoff vegetation that is mainly confined along wadis crossing the desert and offers suitable habitats for a variety of plant species;
- Sand dunes vegetation that is restricted to sandy areas at Mudawarra, Batn El-Ghoul, Rum and Disi;and
- Hammada vegetation, which covers vast areas of the eastern Plateaus of Jordan and provides microhabitats for wildlife.

The southern segment is considered the richest in term of habitat diversity. Three local hotspots for management were identified in this segment. These hotspots are Important Bird Areas (IBAs), which are sites providing essential habitat to one or more species of breeding, wintering, and/or migrating birds. Furthermore, these sites are ecologically important owing to their unique habitats and natural resources supporting a wide variety of faunal and avifaunal communities. Namely, these areas are:

- Wadi Abu Tarfah (a part of a larger Wadi): The area is home for threatened mammals such as the caracal and the desert gazelle, *Gazella subgutturosa*;
- Hisma Basin – Rum-Disi (Rum area is home for various threatened plant species such as *Acacai raddiana*, and endemic species such as *Cleome arabica* and some threatened mammals also inhabit the area such as the hyena, the Arabian wolf, Porcupine, and desert gazelle; and
- The Desert Plains Covering the Middle and Southern Segment. Hammada habitat is wintering ground for specific migratory birds along the palaearctic migratory route, where important population of global important colonies follow this route and utilize the area in winter time, like Cranes (*Grus grus*). Hence, it represents a major flyway for migratory birds, which indeed considered a major part for the African Eurasian flyway. Migratory birds follow this flyway during migration from their breeding ground in the north and wintering grounds in the south. A more detailed description on these areas is presented in the main report.

In terms of floral diversity, a total of 150 vascular plants were recorded and basically, 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. Significant plant communities were recorded along the alignment such as the *Tamarix nilotica* stands along Al-Abiad and Al-Hasa wadis and the limestone Hammada vegetation at wadi runoffs. *Acacia* stands that occur in Abu Tarfa wadi and extends to Disi and are dominated by *Acacia raddiana*, which is considered regionally, threatened species; Sand dunes vegetation dominated by *Haloxylon persicum* at Rum area; and Haloxylon-Hammada salicornicum association at Batn El-Ghoul area.

Faunal diversity was also investigated. A number of endangered animals were recorded and the most important ones indicated. The Hammada provide habitat for a variety of other wildlife, including mammals and insects. Small mammals such as Jerboas and hares are an important food source to many birds of prey.

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 due to the lack of awareness of the ecological role such species play in a given ecosystem.

Reptilian diversity was also investigated and a total of 46 species are expected to dwell areas along the alignment. Three CITES species were identified: the desert Monitor (*Varanus gresius*), the Spiny tailed lizard (*Uromastix aegyptia microlepis*) and the European camealeon (*Camealeo camaeleon*).

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. These areas are also important for birds of prey, including migratory, 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. In fall, the Badia provides food to attract migrating larks, buntings, and a wide variety of Chats. Large flocks of waterfowl and wildfowl sometimes feed in flooded portions of Qa'a's during migration, and it is considered the most important wintering habitat along the Eurasian Migratory Flyway. 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. These are the Black Vulture (*Aegypius monachus*), the Corncrake (*Crex crex*) and the Houbara Bustard (*Chlamydotis undulata*).

6.1.3 Agricultural Resources

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 agricultural practices in the Disi area depend on non-renewable water resources, which cannot be sustained indefinitely. Agricultural production process in Disi area indicates an adverse impact in exploiting the groundwater resource from Disi aquifer. The resource is primarily non-renewable and will, on the very long run, be depleted. Moreover, the resource is used to produce agricultural products in an inefficient way. At Disi farms, same level of outputs is being produced with more irrigation water as compared to other places where irrigated agriculture is practiced in the country. For example, wheat grown in Disi area needs 3.6 times irrigation water as much as wheat grown in other places in the country. On average and under irrigated agriculture conditions, one kilogram of wheat produced in Jordan needs 380 litres of water annually, while in Disi area, production of one kilogram of wheat needs 1,360 litres of water annually.

The large-scale farming companies will not witness a direct impact until 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 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. All four large-scale agricultural companies will leave the production process with a total planted area of more than 40 thousand dunums. As the result of closure of these agricultural operations; 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 12** shows planted areas and water consumption of large scale agricultural companies.

Table 12: Planted areas and water consumption of large scale agricultural companies

Company	Total Available Area (Dunums)	Agricultural Types (Dunums)			Total Area Planted (Dunums)	Total Water Consumption per Company (MCM)
		Field Crops	Vegetables	Trees		
RUM	50,000	8,165	5,647	4,000	17,812	13.00
WADICO	12,481	2,728	3,382	50	6,160	4.50
GRAMECO	25,000	4,500	5,800	540	10,840	8.30
ARICAD	21,156	4,933	7,035	50	12,018	8.50
TOTAL	108,637	20,326	21,864	4,640	46,830	34.30

Source: Disi Agricultural Station

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% between now and when their operations will be end in 2011.

6.1.3.1 Water Consumption

According to the agreements between the government and the companies operating in the study area, these companies can consume up to 91 MCM annually. But these companies are not operating at full capacity; area planted on average was 41,802 dunum and formed 37% of total rented area of 108,637 dunum. **Table 13** 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 13: 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

Irrigated agriculture in Disi-Mudawarra area is considered to be a water-intensive form of agriculture compared to the rest of the irrigated agriculture in Jordan. **Table 14** 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.

Table 14: 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 Ministry of Agriculture data

According to **Table 14**, 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.

Several areas of agricultural activities exist on the route from Jizeh to Abu Alanda that may be subject to limited impact; for example, cutting trees, dust on trees, and restriction on mobility. Dust-related problems may be easily solved through water sprinkling. The problem of cutting trees may be attended to through replanting or compensation.

6.1.4 Social Aspects

The baseline socio-economic conditions in Jordan have been discussed in detail. The population of Jordan is increasing at a growth rate of 3.5% per annum. At a horizon year 2020, the population of Jordan is expected to grow to about 10 million persons characterized by a young structure. At present average family size is 6 persons. Spatial distribution of the population in the direct and indirect zones of influence has been projected by five years intervals for the period 2000-2020.

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. The economy of Jordan is heavily service oriented, and the population source of income is usually generated from agriculture, trade, transit transportation and small and middle scale industries. The household economy in the project area depends mainly on government and municipal services, tourism, limited agriculture, livestock potentials, small shops and handicrafts.

The Gross Domestic Product in Jordan has been growing fairly rapidly from 2,612 million JD in 1990 to 4,597.9 million JD in 1995 and further to 5,767 million JD in 1999. The contribution of agriculture to the GDP declined substantially from 14% in the early 1970s to 2% in 1999. In the meantime, the gap in the balance of trade widened from a deficit of 1.349 billion JD in 1995 to 1.913 billion JD in 2000.

Education played a very important role in the build-up of highly qualified professionals in almost all fields of science. Qualified Jordanians working abroad used to be and still are a major source of foreign currency income through transfers of almost one billion JD per annum to their families and deposits in national banks.

Employment varies widely between urban and rural areas. About 40% of the labour force is employed by government and other community activities. Unemployment is in the range of 14-16%. Total employment in agriculture amounted to 4.05% only, while a survey of social needs in the project area indicated that unemployment in Disi-Rum aquifer area is around 40$.

Taking into consideration evolution in the structure of water tariffs since early 1970s, it has been emphasized that political rather than economic factors have always been considered in changing water tariffs. 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. The cost of water has been subsidized for the first two social panels.

Government policies and successive social and economic development programs since mid 1950s encouraged settlement of Bedouins communities in the project area. The Bedouins in the project area are deep rooted in the land of their ancestors. Their life has changed substantially from a Bedouin life living on pastoral areas to settled communities in a number of towns and villages as the result of government sponsored programs and self-determination of the Bedouin populations over the last 40 years. The primary estimates of the Bedouin population in the south of Jordan indicate that they may exceed 35,000.

The Jordanian Acquisition Law No. (12) for the year 1987 and its amendments provide a modern and legally comprehensive framework for land acquisition. The process of private land acquisition is based on 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. An investigation into this matter indicated that all necessary land parcels or property required for the construction of the conveyance system have already been expropriated and compensated by the MWI. It is not expected that any additional land or property will be

expropriated as a result of the project construction either along the pipeline corridor or at the terminal reservoirs.

Permission has been obtained from the Ministry of Public Works and Housing in 1998 to construct the Disi pipeline in the right-of-way of the Desert Highway, within the road itself, and when necessary in the narrow lanes leading to Abu Alanda Reservoir. Obviously, it should be stated that all necessary procedures to expropriate private land or to allocate Treasury Land for the Disi project have been acquired. All new expropriation issues resulting from any modifications to the pipeline alignment would be carried out consistent with the provisions of the Land Acquisition and Resettlement Framework (LARPF) provided in **Annex C24** of Part C – Main Report.

6.1.5 Archaeological Resources Assessment

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.

The archaeological and cultural heritage investigation carried out for the project showed that nine sites are located within the project direct and indirect zones of effect. Within Segment B (Jurf Al Drawish to Al Qatraneh), only one archaeological site was identified which is Al-Qatraneh Castle. The other eight archaeological sites are located within Segment C (Al-Jiza to Abu Alanda Reservoir through the Air port road). These sites are the Press, Area of Cave of Seven Sleepers, Cave of the Seven Sleepers, Al-Juwayda Mausoleum, the Mausoleum, Al- Qastal, Al - Jiza Pool, and the Byzantine Church.

6.2 Analysis of Project Specific Alternatives

6.2.1 No Action/Without Project

The “No Action” or “Without Action” alternative would avoid all the potential construction and operational phase impacts associated with the proposed project. Under this scenario no additional groundwater would be extracted from the Disi aquifer for use in Greater Amman. Adoption of such a scenario would allow for continued over extraction of the highland and Azraq aquifers with resulting adverse impacts to their water quantity and quality and allow the continued degradation of the Azraq wetland. The “No Action” alternative would also deprive the residents of Greater Amman to a high quality source of water with increased reliability of access to water, an improved and more treatable wastewater effluent and better treated water for reuse in the Jordan Valley.

6.2.2 Development of the Well Field

Two alternative sites were considered originally by Harza in 1997 for the development of the well field; namely the Dubaydib site, which was adopted by Brown and Root in 2001 in the final engineering designs 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 the drawdown in the water level will be less. 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 for both sites, and 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 were Dubaydab area is currently quite more accessible then Bat El-Ghoul since it is closer to the large-scale farms in Disi. Both these areas are remote and similar issues exist with regard to the timing of construction, oversight of construction crews, actions to rehabilitate construction areas and monitoring to control access.

6.2.3 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 afterwards 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) alignment as the final alignment to the proposed project with one modification at Abu Alanda area. This modification was solely suggested by the Consolidated Consultants archaeology 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 forested area within the same area.

The evaluation of the three alternatives to the pipeline alignment revealed that both Brown and Root alternative and the optimised one has more potential impacts to the biological environment than the alignment proposed by Harza. This is due to the fact that Harza alignment tended 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 susceptible to disturbance by the pipeline construction. The environmental and social effects of the three proposed alternatives were found to be almost similar with slight preference to the Harza alternative; however, in all cases the impacts were found to be limited in their scope with impacts that could be addressed through proper design, mitigation measures and monitoring activities. When economic aspects of each of the alternatives were evaluated the Optimized Brown and Root alternative was the most favourable.

Table 15 below presents a summary of the analysis of project specific alternatives.

Table 15: Analysis of project specific alternatives

Issue of Concern (Components)	Alternatives					
	No Action/Without Project	Alternatives to the Development of the Well Field		Pipeline Alignment Alternatives		
		Dubaydib	Batn El Ghoul	Optimized (final alignment as per of the Brown and Root Design with modification made by CC at the Seven Sleepers Area)	Brown and Root Alignment	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

6.3 Potential Impacts – Construction Phase

The following discussion presents the potential impacts of the proposed project on the physical, biological, agricultural, social and archaeological environment anticipated to occur during construction activities.

6.3.1 Potential Impacts on Physical Environment

The proposed project is anticipated to have impacts on the local physical environment including potential increases in noise levels, dust generation, solid and liquid waste generation, and construction access roads. Also, permanent impacts are anticipated to result from landscape damage, change of natural drainage system and local geomorphology. On the other hand, the landscape damage, change of natural drainage system and local geomorphology impacts were found to be cumulative in nature.

6.3.1.1 Temporary Impacts

(a) High Noise Levels

The segments impacted by the increase in noise levels include Segment (C-1), Segment (C-3) and the populated areas in Segment (B-2) of the project corridor. The source of this noise level increase will be due to (a) site preparation and different construction activities, and (b) the movement of heavy machinery and different construction vehicles.

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

(b) Increased Dust Levels

Segments (C-1), (C-3) and (B-2) of the project corridor will be impacted by the expected increases in dust levels. During this phase, increased dust levels is anticipated to result from site preparation, cut and fill operations, in addition to the movement of the construction machinery.

(c) Generated Fluid Wastes

Both preparation and construction phases will result in generation of fluid waste. This waste generation is anticipated to have significant effect on the project corridor within Segments (C-1) and (C-3) and also the nearby populated areas in Segment B.

The fluid waste will be generated mainly by:

- Work force (domestic fluid waste) and the expected amount range between 9-18 m^3/capita/year. The accumulation points for such fluid waste will be at the established project offices, camps and storage locations; and

- Routine maintenance and servicing of vehicles and construction machines as well as from the different construction activities.

The effect of the inadequate management of the generated waste will include:

- Threats to public health such as water borne diseases;
- Pollution of groundwater aquifers especially the shallow aquifer system along the project corridor; and
- Threat to biological habitats, especially in Segments A and B of the project.

(d) Generated Solid Wastes from Construction Activities

Construction activities are anticipated to generate huge quantities of solid wastes, including:

- Sand and rock fragments in addition to metals, wooden and plastic fragments that will result from the different construction and installation activities; and
- The human solid wastes, which is estimated to be 0.5 kg/capita/day in average generated by the project workforce.

Inadequate management practices of the generated solid waste will result in the following impacts:

- Threats to public safety and health especially in Segments (C-1) and (C-3) and the populated parts of Segments B and A of the project;
- Change in the local geomorphology and local drainage system and impacting the biodiversity system in Segments A and B of the project corridor; and
- Threat to 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. The potential impacts of the incorrectly constructed/routed access roads include:

- Change in local geomorphology and the natural landscape, especially in Segments A and B of the corridor;
- Damage to natural habitats and destruction of natural vegetation, especially in Segments A and B; and
- Threats to public safety and damage to private properties (in some parts of the route) especially is Segment C.

6.3.1.2 Permanent Impacts

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

The project area is of multi-geomorphological conditions including wadis, flat areas, and hilly areas. Landscape damage and the change in natural drainage systems and local geomorphology will result from the following major actions during the construction phase:

- Unwisely planned construction activities;
- Unnecessary damage caused by construction activities outside the project route and outside the defined areas of operations;
- After completing the construction activities, landscape damage and change in geomorphology might occur due to the presence of untreated borrow pit sites and spoil heaps in addition to landscape scarring;
- The temporary dislocation of the existing drainage patterns; and
- Accumulation of solid waste piles for prolonged periods or permanent disposal within the project corridor.

Landscape damage, in addition to the change in the natural drainage systems and local geomorphology, is a major cumulative impact on the physical environment. The impacts of these alterations are anticipated to accumulate and persist even after the completion of the construction activities.

The magnitude of these impacts is considered to be medium to high within Segments A and B of the project corridor.

Monitoring and evaluation of the cumulative impacts on the physical environment are required to be carried out within the project corridor on regular basis by the Construction Consultant-Environmental and Social Management Plan (ESMP) Coordinator.

6.3.2 Potential Impacts on Biological Environment

A detailed description of impacts on biological conditions and their significance were indicated. Such impacts would affect particularly the habitats for local wildlife and the prevalent vegetation associations and species. Main ecological concerns include:

- Loss of habitats particularly at the southern zone (Eastern Plateaus and Batn-El-Ghoul);
- 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 phase; and
- Wildlife persecution and/or vegetation cover removal mainly during construction phase. Fragmentation of desert habitats and the new development if not restored will exacerbate this phenomenon.

These impacts during construction and operation phases were identified and evaluated.

During the construction phase, several temporal 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. These conditions will result in alteration of surface morphology and natural water runoffs schemes; unavoidable removal of vegetation cover and tree stands (mainly *Tamarix* and *Acacia*); disturbance to breeding and migratory bird species. As the southern segments of the project lie along the bird migration flyway and two Important Bird Areas (IBAs), it becomes crucial to synchronize spatially and temporally the excavation activities in order to avoid disturbances during breeding and migration seasons. This synchronization can be achieved through developing an activity programme and avoiding night activities so that breeding seasons are not interrupted and migration seasons are avoided and kept undisturbed.

The potential negative cumulative impacts of the project on the biological conditions that are anticipated to result from construction activities include:

- Fragmentation of desert habitats that are already under mis-utilization;
- Increased human interference due to increased accessibility to relatively remote areas and sites such as Batn El-Ghoul;
- Persecution of wildlife due to increased accessibility;
- Disturbance to breeding and migratory bird species; and
- Introduction of exotic species.

6.3.3 Potential Impacts on Agriculture

It is not anticipated that the proposed project will result in direct or indirect impacts of significance to large-scale farming. It should be noted that the operational agreements for the four large-scale agricultural companies are planned not to be renewed by the Government when their current permits expire. The anticipated closure of these four agricultural companies would reduce the planted area of the country by more than 40,000 dunums with an annual production of 100,000 tons. At the same time the phasing out of these companies would save more than 34 MCM of freshwater annually. Any mitigation activities for the closure of the agricultural companies would need to be addressed as part of the decision and planning process adopted by the Government of Jordan for their closure.

Regarding the small scale agricultural activities that exist on the route from Jizeh to Abu Alanda, those may be subject to limited impact. These impacts include:

- Cutting trees;
- Dust on trees; and
- Restriction on mobility.

6.3.4 Potential Impacts on Socio-Economic Conditions

Assessment of the project social impacts has been studied in the direct and indirect zone of influence of the project in the project direct and indirect zone of influence. Although the improvement of water quality and quantity in Greater Amman Area is the main aim of the Disi project, people living in the project area, including Bedouin populations, should have the opportunity to increase their income on a short and/or long-term basis by having access to job opportunities either in the temporary stages of construction or in the permanent stage of operation

and maintenance. However, local agriculture, sheep and camel grazing in the areas is anticipated to continue as their main source of income.

Temporary social disturbances such as traffic disturbance, disruption in water and power supplies are expected. Disruption in business or loss of income will be minimal. It will be the duty and responsibility of the Contractor to take all precautions and mitigation measures to prevent damages to properties during construction.

Cumulative impacts of the Disi-Amman project on social settings include all individual or collective impacts that will affect positively or negatively the societies concerned and their economic and social activities during the project lifetime. Those impacts comprise the different stages of the project set-up from construction, operation, maintenance and administration during the concession period of 40 years.

The positive cumulative impacts of Disi-Amman project will result from the reliable provision of high quality water to Greater Amman. Improvement in public health conditions is closely associated with the availability of clean and sufficient water supply. In addition to that, the project will save considerable quantities of water for other domestic, industrial and tourist purposes.

The project will provide a limited number of job opportunities during and after construction to qualified engineers, skilled technicians and unskilled labour. However, experience gained through and after construction will provide essential background for the construction of other water projects such as the proposed Red Sea -Dead Sea Water Conveyance Project. The socio-economic development of Bedouins localities can be looked at within the general framework of the social development plan of the government. However, it is expected that the project will have direct impact on the employment level in the Disi area and along the pipeline by providing temporary employment during the construction phase and some permanent jobs during the operational phase.

The negative cumulative impacts are minimal. The population increase during the concession period will ultimately increase demand to the extent that new water resources of considerable scale must be explored within the next 20-25 years. It is understandable that a rise in water tariff as a reflection of the rise in water cost will be inevitable. However, the Government policy has always been in support of subsidy of water charges in low social strata of the population. Any increase in water tariff for the first two or three blocks of water use will be minimal.

The planned termination of the agreements with the agricultural companies in 2011 will result in the loss of the investments they have made in buildings, non-movable equipment and land development. The production of more than 52,000 mature olive trees and fruits will be lost, while in the meantime demand for agricultural products will far exceed supply due to limitations in land and water resources.

An Environmental and Social Management Plan has been formulated and is summarized in Section 6.7 below. The purpose of this plan is to provide a framework for planning and implementation of a number of mitigation and monitoring activities to address environmental and social issues during the implementation and operation of the proposed project. Specialized experts and agencies will take all necessary steps to observe, monitor and mitigate any difficulty that might be faced by the Contractor.

The management plan includes also the ways and means to provide employment for Bedouin workers employed by the agricultural companies. Their number is very small and they will be easily absorbed in the project labour force.

6.3.5 Potential Impacts on Archaeological and Cultural Heritage Sites

Three sites were found to be under a direct threat by the project. These are the area of Cave of Seven Sleepers and the Mausoleum. For the Cave and the area of the Cave, the avoidance measure proposed to select an alternative route away from those sites and this has been accepted by the Ministry of Water and Irrigation and incorporated into the project. Thus, the threat was eliminated. For the Mausoleum, it is recommended to prevent excavation or construction near the site.

The other sites were found to be away from direct threats. Still indirect impacts or accidents might affect theses sites. In addition, given the high density of archaeological and cultural heritage sites in Jordan, the project will use "chance find" procedures should unknown or unrecorded archaeological sites be located during the course of excavations. The proposed mitigation and conservation measures are understood to be reliable and cost-effective measures that comply with the Jordanian Antiquities Law No. (12) of 1976 and the Regulations of Archaeological Excavation and Surveys. The Contractor should strictly adhere to the proposed measures in coordination with the Department of Antiquities.

Table 17 presented the project-specific mitigation measures targeting the protection and conservation of the archaeological and cultural heritage sites located within the project direct and indirect zone of effect.

6.4 Potential Impacts – Operation Phase

During the operation phase of the project only the biological environment is subject to potential impacts. With respects to the physical, agricultural, social and archaeological settings, as presented no potential impacts were found to be significant.

6.4.1 Potential Impacts on Physical Environment

During the operation phase of the project, no impacts are anticipated to affect physical environmental conditions except for an impact on the Disi aquifer which might occur due to abstraction from Batn El-Ghoul well field. This potential impact relates to 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.

6.4.2 Potential Impacts on Biological Environment

During the operation phase of the project, various temporal and permanent impacts are expected. These include disturbance to breeding and migratory bird species and other wildlife and increased human interference due to increased accessibility. These will accordingly lead to an increased accidental and deliberate persecution of wildlife.

The anticipated negative cumulative impacts of the project on the biological conditions during the operation phase are mainly related to the increased accessibility to the project area created during the construction phase and maintained during the operation. Those impacts are:

- Fragmentation of desert habitats that are already under mis-utilization;
- Increased human interference due to increased accessibility to relatively remote areas and sites such as Batn El-Ghoul;
- Persecution of wildlife due to increased accessibility;
- Disturbance to breeding and migratory bird species; and
- Introduction of exotic species.

6.4.3 Potential Impacts on Agriculture

It is not anticipated that the Disi project will have an impact on the inhabitants of the area and the locally owned farms on the short and longer run. 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.

6.4.4 Potential Impacts on Socio-Economic Conditions

The public safety of local residents 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 concentrated in areas where these installations are located with a special focus on Segment (A).

6.4.5 Potential Impacts on Archaeological and Cultural Heritage Sites

None of the twenty-six listed archaeological sites within this zone are located within the project corridor, and, during the operation phase of the project, none of them is under direct or indirect threat by the proposed project activities.

6.5 Cumulative Impacts

6.5.1 Positive Cumulative Impacts

Business and Services: Cumulative increase in employment during and after the pipeline construction will create parallel demand on local products and services including:

- Purchase of products, materials and equipment from the locals;
- Procurement of printing materials;
- Furniture and office material will increase as a matter of progress in project;
- Administration will have demand on foodstuff, agricultural products and local food;
- Industry will accumulate as employment increase;
- Demand on services including transportation, fuel, energy and accommodation will increase accordingly; and
- 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 zones of influence.

Restoration of Depleted Aquifers: Disi project will clearly minimize the heavy burden of extraction of groundwater from Azraq, Zarqa and Amman aquifers. Consequently, the chance of these aquifers to be renewed will be an important cumulative benefit from the project.

6.5.2 Negative Cumulative Impacts

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.

Traffic Disturbance: Two road systems with high traffic density will be significantly disturbed by the expected construction activities. Those road systems are:

- **The Desert Highway that serves and connects Amman to the southern governorates**. This road provides major access for the southern governorates, namely Karak, Tafila, Ma'an and Aqaba, where it connects those governorates with Amman and the northern parts of the Kingdom. Also, this road is nationally and regionally essential to the imported and exported cargo transportation through the port of Aqaba. This includes the phosphate transportation from the mines in Al-Hasa area to the Aqaba Port.
- **The roads system located between Madaba Bridge and Abu-Alanda reservoir (Segment C-1)**. This road system currently suffers from high traffic density being the main route utilized by east Amman residencies and also serves the industrial city in Sahab area. This roads system will be subjected to additional increase in traffic density during the project construction phase.

Traffic disruptions will result from:

- Increase in traffic density of heavy trucks transporting the construction equipment and materials from the Aqaba port using the Desert Highway to the proposed construction stations along the project corridor. In addition, different construction activities will result in increased traffic density and traffic disturbance along the Desert Highway segment of the project route and nearby local road systems wherever construction activities are applied.
- Partial and/or total closure of local road systems, especially within Segments (C-1) and (C-3) of the project route. In Segment B, the impacted areas will include the Desert Highway residential neighbourhoods and the services establishments.
- Diverting the traffic through temporary access roads or by 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.

Partial and/or total closure of the Desert Highway and the Railway at several locations is expected. The disruption will be at four to five locations on the Desert Highway wherever the pipeline is designed/required to cross the road left-right or vice versa. Also disruptions are anticipated to occur at two locations on the Railway.

It will be the duty and responsibility of the Contractor to take all precautions and mitigation measures to prevent damages to properties during construction.

Effect on Locals and Employees Public Safety: Potential risks to public and workers safety are anticipated to be significant in Segments (C-1), (C-3) and in the residential areas in Segment B of the proposed project corridor. The main sources of risk are:

- Car accidents and vehicular-pedestrian conflicts due to the expected construction-caused traffic conjunctions and from modification to known roads;
- The movement and operations of heavy equipment within the construction corridor. This impact is considered significant to the up mention road systems and to the Rum-Disi road;
- Deep excavations close to residential areas and open trenches especially in Abu Alanda, Aljiza and Qatraneh areas. The presence of such excavation holes and trenches will be a significant threat to pedestrians, school students in their daily trip on foot to/from the nearby schools and on vehicles and their drivers moving within or close to the project corridor and especially during night time;
- Stored materials including fuel and other chemicals along the project present a threat to the public safety of the nearby residential areas in addition to the safety of the project workforce; and
- Ignorance and non compliance by the equipment operators and construction workers of safety requirements including not wearing protection helmets, insufficient lighting during working at night shifts, and absence or shortage in first aid materials and personnel.

Infrastructure, Utilities and Social Disturbances: The proposed pipe route crosses and passes by a large number of utilities/facilities that serve residential areas in Segments C and B of the project corridor and many areas located close to this corridor. Many of these utilities are anticipated to impose specific constraints on the work design and execution. As a result of the pipeline trench excavations, disturbance to local populations along the inhabited area may stem from the following types of accidents:

- A large segment of the pipeline trench will be 4 m in width by 4 m in depth. It might be hazardous to pedestrians particularly children, unless otherwise protected/isolated by a suitable structure;
- Disturbance to water supply and wastewater services might occur if, by accident, pipelines or wastewater network are broken down. This will also pollute domestic water supplies through local water distribution system (within or close to the incidence site(s)). This situation will (in case it occurs) pose a significant threat to public health;
- Disturbance to power supply is anticipated to occur especially when there is a need to relocate electricity poles far from the course of the pipeline;
- More than 80 commercial buildings including over 350 shops have been counted along the pipeline alignment. Thus, business disruption may lead to the temporary loss of income; and
- 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 can be temporarily removed during construction and re-erected in a suitable place.

The magnitude of the disturbance to infrastructure utilities varies significantly from one site to another. Still all disturbances are considered in this study and should be treated properly in the work statements issued by the construction Contractor to the construction Consultant and by the work permits issued by the Consultant.

The environmental and social registered impacts are presented in **Table 16**.

Table 16: 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.
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.

Table 16: Registered Environmental and Social impacts (contd.)

No.	Anticipated Significant Impacts	Zone Type and Magnitude of Effect						
		A1	A2	B1	B2	C1	C2	C3
1.2.4	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 16: 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 Bedouin Populations	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
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 Safety of Local Resident and Employees, 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

Table 16: Registered Environmental and Social impacts (contd.)

No.	Anticipated Significant Impacts	Zone Type and Magnitude of Effect						
		A1	A2	B1	B2	C1	C2	C3
1.3.8	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
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			

6.6 Environmental and Social Management Plan

The project policy dictates that the environment and social aspects are to be managed in the way other parts of the project development are in order to enhance sustainable development. The project Environmental and Social Management Plan (ESMP) was formulated (i) to enable compliance with the Jordanian environmental regulations presented in the **Section 3-a: Policy, Legal and Administrative Framework**, (ii) to account for relevant World Bank Policies, regional and international agreements, and (iii) to recognize the relationships between the project 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 achieve environmentally sound development.

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 for the purpose of designing and implementing suitable training interventions.

6.6.1 Management Objectives, Structure and Responsibility

The project environmental and social objectives, mitigation, monitoring and evaluation actions have been proposed on the basis of the findings of the Environmental and Social Assessment Study. These objectives and targets require the approval of the Government of Jordan and other project sponsors and should be periodically reviewed and updated to ensure consistency with overall environmental and social policy.

The overall objectives include:

- To promote closer integration of impact assessment into planning, policymaking 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; and
- To compensate for non-restorable settings and for interim disruption whenever needed.

The detailed project-specific environmental and social management objectives and targets identified for the proposed project are presented in **Table 17** and **Table 18** in terms of mitigation and monitoring objectives as part of the project Environmental and Social Management Plan (ESMP) Matrix.

Table 17: Site-specific mitigation measures based on project activities

Project Phase	Affected Component	Potential Impact Type	Zones of Potential Significant Occurrence
Construction Phase	Physical Environment	***Temporary Impacts***	
		1- High Noise Levels	The residential areas located close to the proposed new Abu Alanda reservoir
			The neighbourhoods and "service/commercial" establishments located between Abu Alanda reservoir and Amman-Madaba bridge, and
			All the establishments located between Amman-Madaba bridge and Aljiza area within the project corridor and the Qatraneh area within Segment (B-2).
		2- Increased Dust Levels and associated increase in the potential public and workers health problems	The residential areas located close to the proposed new Abu Alanda reservoir
			The neighbourhoods and "service/commercial" establishments located between Abu Alanda reservoir and Amman-Madaba bridge, and
			All the establishments located between Amman-Madaba bridge and Aljiza area within the project corridor and the Qatraneh area within Segment (B-2).
		3- Generated Fluid Wastes:	
		▪ Threatening public health	The residential areas located close to the proposed new Abu Alanda reservoir
			The neighbourhoods and "service/commercial" establishments located between Abu Alanda reservoir and Amman-Madaba bridge, and
			All the establishments located between Amman-Madaba bridge and Aljiza area within the project corridor and the Qatraneh area within Segment (B-2).
		▪ Polluting groundwater aquifers especially the shallow aquifer system along the project corridor and	All segments
		▪ Threatening biodiversity elements	Segments A & B-1
		4- Generated Solid Wastes from Construction Activities	
		▪ Threatening public safety and health	The residential areas located close to the proposed new Abu Alanda reservoir
			The neighbourhoods and "service/commercial" establishments located between Abu Alanda reservoir and Amman-Madaba bridge, and
			All the establishments located between Amman-Madaba bridge and Aljiza area within the project corridor and the Qatraneh area within Segment (B-2).
		▪ Changing the local geomorphology and local drainage system and impacting the biodiversity system	Segments A & B
		▪ Threatening faunal elements along the waste disposal locations.	Segments A & B-1
		5- Visual Impact	All Segments
		6- Access Roads Construction	
		▪ Changing local geomorphology and the natural landscape	Segments A & B
		▪ Damaging natural habitats and destroying natural vegetation	Segments A & B-1
		▪ Threatening public safety and damaging private properties	Segments C & B-2
		Permanent Impacts	
		1- Landscape Damage, Change of Natural Drainage System and Local Geomorphology	Segments A & B
		2- Visual Impact caused by accumulated solid waste and changed landscapes	All Segments
	Biological Environment	**1- Fragmentation of desert habitats that are already under mis-utilization;**	Segments A & B-1
		2- Increased human interference due to increased accessibility to relatively remote areas and sites such as Batn El-Ghoul;	Segment A
		3- Persecution of wildlife due to increased accessibility;	Segments A & B
		4- Disturbance to breeding and migratory bird species; and	Segment A
		5- Introduction of exotic species.	Segments A & B
	Agriculture	**1- Impacts to the large-scale Agriculture**	
		▪ Post to the expiration of the large-scale farming agreements 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, 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. It is expected that other irrigated areas in Jordan will cover the shortage in supply of agricultural products. However, no mitigation measures are relevant.	Segment A
		2- Impacts to the small-scale agricultural activities ▪ Cutting trees; ▪ Dust on trees; and ▪ Restriction on mobility.	Agricultural activities that exist on the route from Jizeh to Abu Alanda

Table 17: Site-specific mitigation measures based on project activities (contd.)

Project Phase	Affected Component	Potential Impact Type	Zones of Potential Significant Occurrence
Construction Phase	Socio-economic Conditions	**1-Traffic Disturbance**	
		▪ Increased traffic density and traffic disturbance	Along the Desert Highway segment of the project route and near by local road systems where ever construction activities are applied.
		▪ Partly and/or total closure of local road systems	Segments (C-1)
			Segments (C-3)
			The residential neighbourhoods and the services establishments along the Desert Highway within segment (B).
		▪ Partially and/or total closure of the Desert Highway and the Railway at several locations is expected. The disruption will be at four to five locations on the Desert Highway where ever the pipeline is designed/required to cross the road left-right or vice versa, also disruptions is understood to occur at two locations on the Railway	Segment B
		▪ Diverting the traffic through temporary access roads or by to detours through residential areas and congested areas,	Segments C-1 & C-3
		▪ Traffic congestion as result of the daily movement of heavy trucks transporting equipments and materials along the project working areas.	All Segments
		2-Effect on Locals and Employees Public Safety: The following safety risks are anticipated ▪ Car accidents and Vehicular-pedestrian conflicts due to the expected construction-caused traffic conjunctions and from modification to known roads. ▪ Deep excavations close to residential areas and open trenches especially in Abu Alanda, Aljiza and Qatraneh areas. The presence of such excavation holes and trenches will be of great threat to pedestrians, school students in their daily trip on foot to/from the nearby schools and on vehicles drivers and moving within or close to the project corridor and especially during night time. ▪ 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. ▪ Ignorance and non compliance with the construction workers safety requirements including not wearing protection helmets, insufficient lighting during working at night shifts, and absence or shortage in first aid materials and personnel.	Segments C-1, C-3, and the residential neighbourhoods and the services establishments along the Desert Highway within segment (B).
		▪ The movement and operations of heavy equipments within the construction corridor of the Desert Highway - Rum-Disi road.	Desert Highway - Rum-Disi road.
		3-Infrastructure Utilities and Social Disturbances. ▪ The proposed pipe route crosses and passes close to a large number of utilities/facilities that serves residential areas. ▪ Many utilities are anticipated to impose specific constrains on the work design and execution. **4-As a result of the pipeline trench excavations, disturbance to local societies along the inhabited area may stem from the following accidents:** ▪ 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/isolated by a suitable structure. ▪ Disturbance to water supply and wastewater services might occur if by accident pipelines or wastewater network are broken down, this will also pollute domestic water supplies through local water distribution system (within or close to the incidence site/s). This situation will posses (if happened) significant threat to public health. ▪ Disturbance to power supply is anticipated to occur, were temporary effect is highly potential to occur especially when there is a need to relocate electricity poles far from the course of the pipeline. ▪ More than 80 commercial buildings including over 350 shops have been counted along the pipeline alignment. Business disruption may lead to the temporary loss of income. ▪ 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 can be temporarily removed during construction and re-erected in a suitable place.	Segments C & B
	Archaeological and Cultural Heritage Sites	**1-Direct threat of damage to:** ▪ The area of Cave of Seven Sleepers; ▪ The Cave of the Seven Sleepers; and ▪ The Mausoleum.	Segment A
		2-Indirect impacts or accidents might affect the: ▪ Al - Qatraneh Castle; ▪ The Press; ▪ Al - Juwayda Mausoleum; ▪ Al- Qastal; ▪ Al - Jiza Pool; and ▪ The Byzantine Church.	Segment A & B

Table 17: Site-specific mitigation measures based on project activities (contd.)

Project Phase	Affected Component	Potential Impact Type	Zones of Potential Significant Occurrence
Operation Phase	Biological Environment	**1-Fragmentation of desert habitats that are already under mis-utilization**	Segment A & Segment B-1
		2-Increased human interference due to increased accessibility to relatively remote areas and sites such as Batn El-Ghoul	Segment A
		3-Persecution of wildlife due to increased accessibility	Segment A & Segment B
		4-Disturbance to breeding and migratory bird species	Segment A
		5-Introduction of exotic species.	Segment A & Segment B
	Social	**1-Positive health implications of the regular water supply to Amman City**	Segment C
Cumulative Environmental and Social Impacts		**1-Landscape Damage, Change of Natural Drainage System and Local Geomorphology**	Segments A & B
		2-Potential Impacts on Biological Environment:	
		▪ Fragmentation of desert habitats that are already under mis-utilization	Segment A & Segment B-1
		▪ Increased human interference due to increased accessibility to relatively remote areas and sites such as Batn El-Ghoul	Segment A
		▪ Persecution of wildlife due to increased accessibility	Segment A & Segment B
		▪ Disturbance to breeding and migratory bird species	Segment A
		▪ Introduction of exotic species.	Segment A & Segment B

Table 18: 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: • *Time executing crossing structures could be scheduled at 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.*			
	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 18: 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: *- 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.*			
	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 18: 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 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 18: 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: - Providing preventive barriers around machines dangerous parts to avoid 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 providing any insulation or earthing systems required for workers safety. - 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: • *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 sub-Contractor, 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 sub-Contractors.* • *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 18: 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 18: 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: - *Noise (Equivalent Sound Pressure Level, LAeq)* - *Vibration*			
	20	**Monitor Solid Waste Management**			
	20.1	The monitoring of solid waste management operations should cover the following: - *Solid waste generation, including quality and quantity.* - *Collection and transportation efficiency.* - *Suitability of final disposal sites.* - *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: - *Maintained pre-project land utilization and access.* - *Maintained Runoffs Habitat.* - *Natural vegetation cover is maintained.* - *Hunting is banned.* - *Accidental kills are minimum.* - *Breeding seasons are undisturbed.* - *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: - Safe passageways dedicated for the use of herders especially in Segments A and B. - Removal of trees within farms along the route from Qatraneh to Amman and their re-plantation or compensation. - 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 18: 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: - 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, harm to persons including disruption of work or business 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. - 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: - Disruption to the archaeological features. - The implementation of the Cultural Resources Management (CRM) activities - 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. - 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*	All segments	The Project Consultant	Department of Antiquities
Operation Phase		**Protecting Biological Environment**			
		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 18: 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

Achieving the identified objectives require clear delineation of responsibilities. Primarily, it is the responsibility of the Contractor to implement and monitor the Environmental and Social Management Plan, where the Contractor should strictly adhere to the suggested mitigation measures and the Environmental and Social Management Plan programs, and define new aspects and mitigate impacts. Also, the Contractor should monitor the environmental and social indicators, and document for precautions and actions taken.

On the other hand, the Project Consultant (to be hired by the Ministry of Water and Irrigation) will be representing the Ministry of Water and Irrigation and should ensure the project compliance/non-compliance with the legal requirements and the Environmental and Social Management Plan recommendations. Also, the Project Consultant will be responsible for monitoring the environmental and social aspects, the project conformance/non-conformance, performance auditing, and the construction completion evaluation.

The Project Management Unit (PMU) will hold the responsibility of the overall Environmental and Social Management Plan supervision.

The proposed Environmental and Social Management Plan (ESPM) management structure reflect the assigned responsibilities as part of the overall project management structure, where four management hierarchies has been identified within the project Operation Level as presented in **Figure 9**. These are:

- ESMP Implementation Level (Private Sector - Contractor);
- ESMP Follow up, Monitoring, Auditing and Evaluation Level (Private Sector-Consultant);
- ESMP Administration and Coordination (Government Project Management- Ministry of Water and Irrigation); and
- Project Administration Level (Project Management Unit-PMU).

The responsibilities identified in **Figure 9** are for the firms with respect to the management hierarchies mentioned above, where the suggested individual staff positions are only indicative to their management levels.

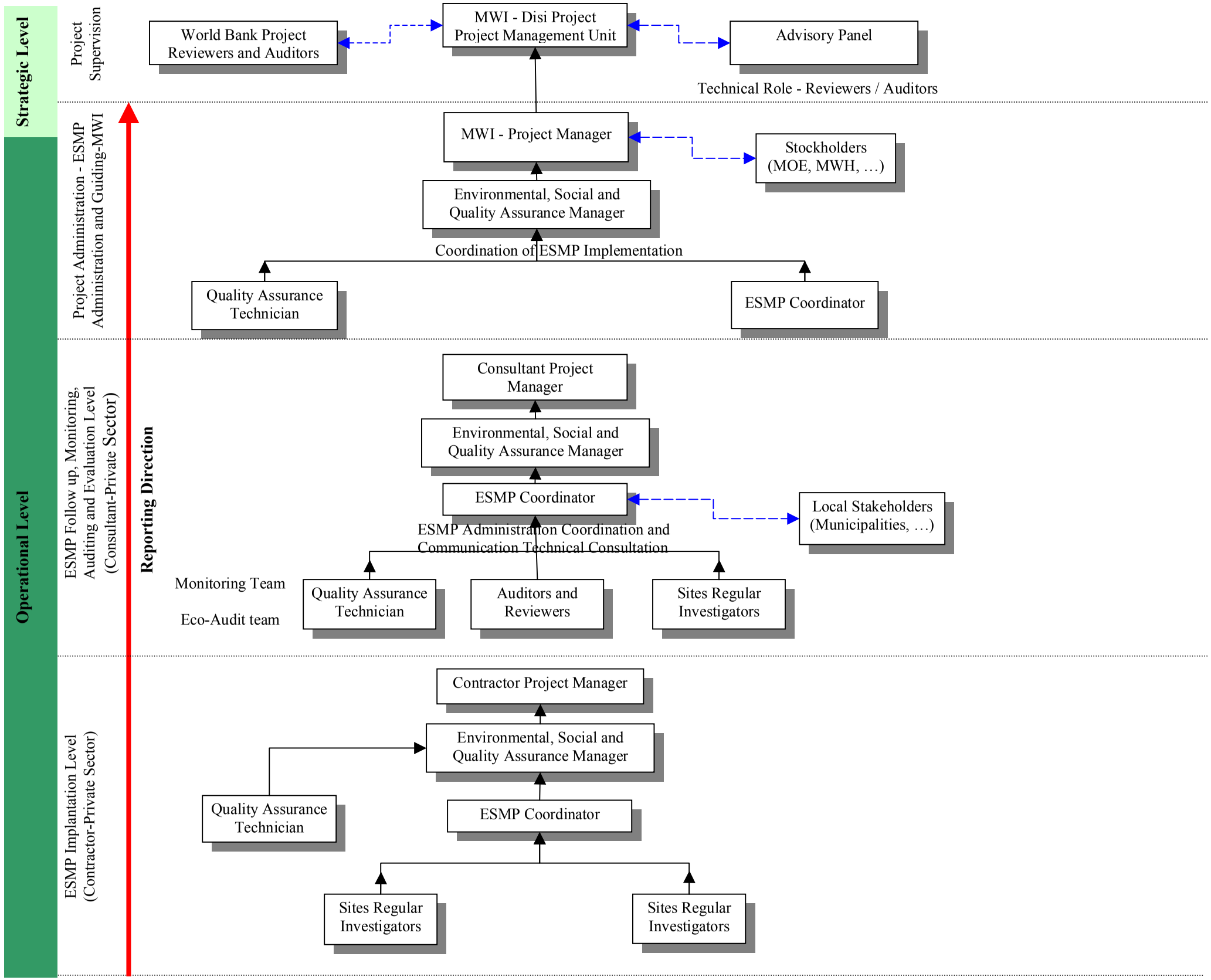


Figure 9: ESMP management structure

As the structure demonstrates, the prime Environmental and Social Management Plan implementation falls under the responsibility of the Contractor, where an Environmental and Social Management Plan Management Unit is suggested to undertake this responsibility. This unit will be directed by the management representative- Environmental and Social Management Plan Coordinator-, who will be supported by two technical staff. This unit might also act as a Quality Control Unit. This structure also indicates the reporting system that should be applied.

The proposed ESMP Coordinator should have a B.Sc. degree with at least 15 years of experience or M.Sc. with 8 years of experience and have experience in at least three projects in the field of Environmental Impact Assessment or Environmental Management.

The Contractor should ensure effective implementation and operation of the Environmental and Social Management Plan. This can be achieved by ensuring that: roles, responsibilities and authorities are defined, documented and communicated; and management is committed to providing the human, technical and financial resources required for the ESMP.

The Management Representative (Environmental and Social Management Plan Coordinator) is appointed, and assigned defined roles, responsibilities, and authority for: ensuring that the Environmental and Social Management Plan requirements are established, implemented, and maintained in accordance with the stated legal requirements and approved standard; and reporting on the performance and effectiveness of the Environmental and Social Management Plan to top management and using this reporting as the basis for Management Review.

The duties of the Contractor - ESMP Coordinator are explained in more detail in **Table 19**.

Table 19: The duties of the proposed Contractor - Environmental and Social Management Plan (ESMP) Technical Assistant

Preparation stage	▪ Develop Environmental and Social Management (ESM) Statement prior to each construction phase. These statements should detail the ESM procedures applicable to mitigate anticipated impacts. ▪ Ensure efficient implementation of the Precautionary ESMP Mitigation Programs and Procedures with regard to the sites and construction activities selection criteria. ▪ Ensure the construction of the fluid waste collection for the project offices in the locations, which are agreed upon between the municipalities, the Consultant and the Contractor. ▪ Ensure the establishment of the temporary access roads in the locations agreed upon with Ministry of Public Works and Housing, the consultant and the contractor. ▪ Ensure effective communication and cooperation with local communities especially in Segments C and B. ▪ Report to the project Consultant.
Construction stage	▪ Ensure efficient implementation of the ESMP mitigation programs and procedures. ▪ Coordinate and follow up with responsible governmental and non-governmental agencies working in the field of environmental conservation. ▪ Ensure continuous and efficient communication with local communities. ▪ 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. ▪ Report to the project consultant

A similar Environmental and Social Management Plan Management Unit should be initiated to hold the responsibilities relevant to the following objectives:

- To ensure that roles, responsibility and authorities are defined documented and communicated;
- To monitor, audit and evaluate the efficiency of the Environmental and Social Management Plan implementation and operation;
- To evaluate and update the aspects register; and
- To ensure efficient implementation of the Environmental and Social Management Plan programs and procedures. This can be achieved by the following operational objectives:
    - Ensuring that the Environmental and Social Management Plan requirements are established, implemented, and maintained in accordance with the stated legal requirements and approved Standard.
    - Reporting on the performance and effectiveness of the Environmental and Social Management Plan to top management and using this reporting as the basis for Management Review.

One of the major assignments of the Consultant - Environmental and Social Management Plan Management Unit is to establish the base line to be used for the various elements of the monitoring plan during the pre-construction phase with relevant measures taken to establish, as far as possible, the ambient condition.

6.6.2 Impact Mitigation and Management Programs

As part of the ESA process for new projects, environmental and social management programs are compiled concerning all aspects where site-specific features are taken into account. These management programs are designed to ensure that set objectives and targets are accomplished and responsibilities, methods, and time frame for completion are established.

Each program includes one or more procedure that tends to achieve the stated objective(s) as appropriate.

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 monitoring program is an applied research program to develop the tools necessary to monitor and assess the environmental and social settings status and trends in response to the 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 to the impact occurrence and/or performance non-conformance.

The following are the proposed mitigation measures and monitoring programs to address the anticipated project impacts. The success of the recommended mitigation measures and monitoring programs depends largely on proper training and awareness to project staff and efficiency of restoration when required. **Table 17** presented to the site-specific mitigation measures and monitoring activities based on their relevance to the project activities.

6.6.2.1 Mitigation Measures during Construction Phase

(a) Mitigating Impacts to the Physical Environment

Conserve Natural Landscape and Natural Resources

The following avoidance measures should be applied:

- 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, and maximum care should be applied not to inflict unnecessary alteration to the local landscape and natural resource;
- Changing the geomorphology, the local drainage systems, in addition to flora demolition should be prohibited outside the proposed project corridor;
- Avoid unnecessary excavation processes and off-road works especially at wadi crossings, hammad and sand dunes areas and utilize the existing roads instead of making new ones whenever applicable;
- Avoid accumulation of excavation piles during rainy season;
- Avoid accumulation of excavated material through synchronizing excavation and filling processes;
- Strictly avoid dumping and accumulation of excavation materials and other solid wastes in the wadi crossings;
- Avoid as much as possible building permanent facilities; instead consider the use of mobile residence facilities;
- Avoid sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible; and
- Avoid planting or seeding of crops and exotic species.

After work completion, all work areas should be rehabilitated, smoothed and graded in a manner to substantiate the natural appearance of the surrounding landscape. The restoration option is upon incidence of impact and mainly directed to:

- Restoring as much as possible the surface morphology to maintain natural water flow; and
- Restoring wadi side banks in order to maintain natural water flow and reduce erosion.

The above listed mitigation measures should be applied and taken into consideration during the site selection and establishment of the different project offices.

Installing Appropriate Fluid Waste Collection System

In this regard, impermeable septic tanks for domestic wastewater collection should be constructed by the contracting company to serve each of the project main offices and in any temporary workstations, construction camps, storage yards and staging areas along the project route.

It should be listed in the construction contract that periodical maintenance for the machines is prohibited within the project site and that those machines and vehicles should be maintained at specialized maintenance stations.

Whenever accidental leakage of fluid waste occurs, the Contractor is responsible to clean the polluted area.

Applying Appropriate Solid Waste Collection System

To manage the expected solid wastes, the following measures should be applied:

- Ensure maximum utilization of the generated cut materials (dirt and rocks) in the fill process;
- 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;
- The generated domestic solid waste by the project employees should be collected properly and transported 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;
- Prolonged accumulation of solid waste (both construction and domestic) is prohibited. The selected temporary dumping sites should be treated only as solid waste transfer stations;
- 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; and
- Restoration of the 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 resulting from the construction camps, storage yards and staging areas.

Dust Control

To reduce dust spreading during the construction phase 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.

Noise Control

Working night shifts should be reduced as much as possible in populated areas. The Jordanian Regulation for ambient noise levels should be applied during this phase and should be a major tool in designing the construction activities schedule.

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 and far from schools or any social establishment especially for Segments C and B of the project;
- Far from the ecologically sensitive habitats, wadis, runoffs and wadi side banks, and sand dune habitats in addition to avoiding vegetated areas;
- Has easy access to the construction sites; to the existing primary roads and to the existing infrastructure; and
- Located outside any known aquifer recharge zones (if possible).

Representatives from Ministry of Water and Irrigation and from the local municipalities should participate in this selection. It should be taken into consideration, that the contractor is responsible for restoring the selected site to its original condition.

Correct Selection for the Access Roads

In the preparation stage, the Contractor and the Consultant in association with the Traffic Department and Ministry of Public Works and Housing should conduct a detailed survey for selecting the temporary access roads to be used by small and medium sized vehicles during the construction phase in Segments C and B. 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 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 in 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 in order to reduce the magnitude of the impact.

(b) 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 biological environment, especially within Segments A and B. These mitigation measures include:

- **Avoidance actions**: Precautionary approach is often the most cost effective one. These include:
    - 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;
    - Avoid as much as possible removal of green cover;
    - Minimize night activities;
    - Avoid wildlife persecution, hunting, animal and plant collection;
    - Avoid unnecessary movement of project staff mainly at night;
    - Avoid planting or seedling of crops and exotic species;

- Avoid introduction of pets;
- Avoid sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible;
- Avoid unnecessary accumulation and burning of wastes; and
- Avoid as much as possible building of permanent facilities and instead consider the use of mobile residence facilities.

- **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.

(c) 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; and
- 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.

(d) Mitigating Social Impacts

Resettlement Framework

While all necessary land parcels or property required for the construction of the conveyance system have already been expropriated and compensated by the Ministry of Water and Irrigation, any new land expropriation issues resulting from modifications to the pipeline alignment would be carried out in accordance with the provisions of the Land Acquisition and Resettlement Framework (LARPF) provided in Annex C 24 of Part C- Main Report.

Disi Area Development Plan

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; and
- 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.

The provisions to address the above issues are described in the Disi Area Development Plan provided in Annex C25 of Part C – Main Report.

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.

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); and
   - Obtaining property by force or aggression (Articles279-287)

Since it had been reported by the Ministry of Water and Irrigation and the Ministry of Public Works and Housing 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:

1- 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); and
2- 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).

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; and
- 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.

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.

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 service and commercial shops, factories, buildings and the

like. The Project Company (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.

(e) 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. The mitigation measures for possible impacts on archaeological sites have been formulated to comply with the above-mentioned law and regulation.

In general, while there is no requirement for any site discovered during the survey to be destroyed, "No Destroy" protection measures are recommended. 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 and Antiquities;
- Penalties for non-compliance;
- Shifting the construction activities for a distance that is enough as to protect the site;
- Following "Chance-find" Procedures;
- Use of exclusion areas; and
- 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, four points could be added to contract documents which would be beneficial for the protection of archaeological sites. These are as follows:

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 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 the archaeological excavation would not delay construction activities.

4- Archaeological Chance Find

- If any archaeological site or remains were found during construction, the Contractor should directly contact the Department of Antiquities.
- If any sites were 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 will be included in the Bill of Quantities as a provisional sum.
- 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 and of which any portion is in the right-of-way. 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.

(f) Monitoring Physical Environment

Conducting Site Inspection

The Environmental and Social Management Plan Coordinator 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 Ministry of Environment, Ministry of Water and Irrigation and the responsible municipalities should have a free passage and access to all parts of the project and at all times.

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 two 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. 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; and
- 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 is known to have this capacity in Jordan.

Monitoring of Solid Waste Management

The monitoring of solid waste management operations should cover the following:

- Solid waste generation, including quality and quantity;
- Collection and transportation efficiency;
- Suitability of final disposal sites; and
- Solid waste accumulation within the project corridor in terms of volumes and frequency of removal.

(g) Monitoring of Biological Environment

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 (Consultant, ESMP Coordinator);
- Maintained Runoffs;
- Natural vegetation cover is maintained (Consultant, ESMP Coordinator, Royal Society for Conservation of Nature and Ministry of Agriculture);
- Hunting is banned (ESMP Coordinator);
- Accidental kills are minimum (Consultant, ESMP Coordinator);
- Breeding seasons are undisturbed (Consultant, ESMP Coordinator); and
- Migration seasons are avoided (Consultant, ESMP Coordinator).

The monitoring methodology comprises the following activities:

- Monitor the natural conditions of surface water flow between pre and post project activities including runoffs habitat and geomorphology;
- Monitor plant communities' changes;
- Monitor habitat deterioration (some species can be used as indicators for habitat deterioration such as *Citrillus* and *Peganum* sp.);
- Monitor accidental killing of animals (car accidents, falling in ditches, persecution, etc.);
- Monitor wintering bird species;

- Monitor key herpeto-faunal and faunal species;
- Monitor oil spills and solid waste accumulation; and
- Monitor accessibility to Abu-Tarfa area and to Disi area through Batn El-Ghoul.

(h) Monitoring of Agricultural Resources

The following components should be monitored on regular basis:

- Safe passageways dedicated for the use of herders especially in Segments A and B;
- Removal of trees within farms along the route from Qatraneh to Amman and their re-planting or compensation; and
- Availability of safe passageways that can eliminate inconvenience arising from restrictions on mobility for farms along the route.

(i) Monitoring Social Aspects

The following social component should be monitored as part of the ESMP monitoring program:

- 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; and
- 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.

Monitoring the 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 at the Ministry of Public Works and Housing in association with the Greater Amman Municipality in addition to the different municipalities along the project corridor.

(j) 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 and Antiquities. 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; and
- Special procedures in the vicinity of sites defined as requiring protection. These include:
    - Site by fencing;
    - Site rescue excavation;
    - Site restoration; and
    - Signage system to the site.

6.6.2.2 Operation Phase

(a) Protecting Biological Environment

During the operation phase of the project, it is the responsibility of the Ministry of Environment, the Ministry of Agriculture and the Royal Society for the Conservation of Nature (RSCN) to 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. On the other hand, it is the responsibility of the Operator to:

- 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;
- Avoid as much as possible removal of green cover;
- Minimize night activities;
- Avoid wildlife persecution, hunting, animal and plant collection;
- Avoid unnecessary movement of project staff mainly at night;
- Avoid planting or seedling of crops and exotic species;
- Avoid introduction of pets;
- Avoid sand dunes areas (especially at Disi and Batn El-Ghoul areas) as much as possible;
- Avoid unnecessary burning and accumulation; and
- Avoid as much as possible building of permanent facilities and instead consider the use of mobile residence facilities.

The monitoring responsibility should be coordinated between the Ministry of Environment, the Ministry of Agriculture and the Royal Society for the Conservation of Nature and meetings be held on regular basis against the above mentioned impacted features. The monitoring of the employees adherence to the stated mitigation measures should be assigned to project operating firm. It is proposed that specialized monitoring will be conducted on a regular basis to ensure compliance with the full range of measures to be taken by the government, RSCN and the Operator.

(b) Mitigating and Monitoring Social Impacts

Applying and Monitoring Appropriate Public Safety Program

This program is designed for both the workers and the local communities located close to the booster and pumping stations along the project route. All these stations 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 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.

The expected fluid and solid wastes resulting from the project facilities should be disposed of properly and as follows:

- The human fluid wastes should be disposed of to the wastewater collection system (where available) or to appropriate septic tanks and pumped out on monthly basis;
- The fluid wastes resulting from the daily work activities should be collected in special tanks and sent on monthly basis to the nearest dumping site; and
- The resulting solid wastes should be collected on a weekly basis and sent to the nearest dumping site.

The Jordanian Regulation for ambient noise levels should be applied to control the expected noise levels generated from operating the pumping stations especially those located close to the residential areas.

It is the responsibility of the Environment Department at the Ministry of Water and Irrigation 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.

6.6.2.3 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 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 southern part of Jordan; for example, reuse the pipeline to convey water from a desalination project.

6.6.3 Implementation, Operation and Control

Effective implementation and operation of the Environmental and Social Management plan 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; and
- Emergency Preparedness and Response.

6.6.3.1 Training, Awareness and Competence

Efficient implementation and operation of the Environmental and Social Management Plan (ESMP) require both the Consultant and the Contractor to have competent capacities, wise management and environmentally 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 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 educated 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:

- Training needs are identified. Training requirements for each operational unit within the project are established;
- Personnel are trained in their specific environmental responsibilities that are directly related to significant aspects, targets, and objectives of the ESMP;
- Personnel that do not have a significant role, receive awareness training;
- New-hires and re-assigned personnel are given appropriate training on the specific aspects of their new positions;
- Personnel are kept abreast of regulatory changes that impact their job performance; and
- Training includes communication of the following:
    - Requirements of the ESMP and the importance of regulatory compliance with policy;
    - Potential effects of the employee's work, both negative and positive:
    - Responsibility in achieving compliance with policies, regulations and ESMP requirements; and
    - Consequences of failure to comply with the above.

The proposed awareness and training sessions can be conducted by either the ESMP Management Unit or by a/ reputable independent consultant.

6.6.3.2 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; and
- Consultant – Local and National Stakeholders Communication Channel.

The overall advantage of this communication program is to ensure that the anticipated adverse impacts and risks can be effectively mitigated.

The ESMP-Technical Coordinator 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, wealth and environment. Also, the ESMP-Technical Coordinator 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.

6.6.3.3 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 Terms of Reference (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.

After a drill or incidents occurrence, these processes should be reviewed and modified.

6.6.4 Checking Corrective Action and Management Review

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 prepared and reported in accordance to the stated reporting structure. Also it should be available to the public and stakeholders through the identified information centres including Ministry of Water and Irrigation, World Bank and the project offices.

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 should effectively utilize all available information, including internal and external audit findings, environmental concerns, objectives, targets, non-compliance, and corrective and preventive actions in order to improve the ESMP implementation.

The review results will be recorded and maintained and the concerned personnel will implement the resulting decisions and actions taken.

Along the project route, the major sources of noise and dust within Segment C can be related to the different human activities without the presence of any major source for noise and/or air quality deterioration. As for Segments (B-1) and (A-2), these suffer from air quality deterioration and high noise levels due to the phosphate extraction and manufacturing process practiced in the Hasa and Al-Abiad mines. These activities result in the accumulation of hills of friable carbonate rocks that are subjected to the blowing winds causing high dust levels and impacting a major part of the Desert Highway most of the year.

In addition to its usage to transport phosphate from the mines in Al-Hasa area to the Aqaba port, the Desert Highway serves and connects the central and northern parts of the Kingdom with the southern Governorates. Accordingly, this highway suffers from high traffic density caused by a mixture of vehicles. Also, the roads system located between Madaba Bridge and Abu-Alanda reservoir (Segment C-1), suffers at present from high traffic density as it is serving as the main route used by the residences of east Amman and serving the industrial city in Sahab area. This road 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.

With relation to the physical environment, and during the construction phase, the expected temporary impacts include: high noise levels, increased dust levels, fluid and solid wastes generation, locals and employees public safety, ongoing infrastructure utilities disturbance, construction of access roads, and traffic disruption. The only expected permanent impact that might result during this phase is the damage to landscape and change in natural drainage system and local geomorphology. In the operation stage, the potential impacts are those related to abstracting water from the Disi aquifer.

The proposed mitigation measures to reduce the impacts in the construction stage to minimal level include the following:

- Conservation of natural landscape and natural resources;
- Installation of appropriate fluid waste collection system;
- Application of appropriate solid waste collection system;
- Control of air quality, dust and noise;
- Correct selection of the project offices and camps location;
- Reduction of the expected traffic disruption;
- Formulation of public safety program for the locals and the workers in the project; and
- Correct selection of the access roads. During the operation stage, it is recommended to apply appropriate public safety measures.

During the construction phase, the monitoring of the above listed mitigation plans will be the responsibility of the project company in association with representatives from the major governmental authorities related to such a project, while in the operation stage the monitoring program should be the responsibility of the Ministry of Water and Irrigation.

7 CONSULTATIONS TO SUPPORT PREPARATION OF 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 role of the public in protecting their local environment.

During the course of development of the ESA a set of communication and consultation activities have been conducted in order to ensure that the stakeholders' views, issues of concern, foreseen impacts and concerns are taken into consideration while assessing the project related alternatives and impacts. 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. The results of those consultation sessions are presented below.

7.1 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 MWI with the support of 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 20**.

Table 20: Significant issues identified in the first phase of public consultation

Assessed Component	Significant Issues
Water Resources	▪ Justification of the project need. ▪ 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. ▪ Potential impact of increased dust levels in all segments of the project area only during the construction phase. The concern is mainly for: • Public safety for workers and local communities; and • Nearby farms in the project and nearby areas. ▪ Change in the geomorphological system of the Segment A area to a large extent. ▪ Fluid and Solid wastes resulting from the construction phase at all three segments of the project, including: • Cutting and demolition wastes; • Construction material wastes; • Oil and grease residues; and • Human wastes of the workers. ▪ Tectonic activity in the Segment A area and its impact on the project during both construction and operation phases. ▪ 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. ▪ Opening temporary access roads haphazardly in order to reach to the construction sites at Segment A. ▪ Potential impact on soil stability at Segment C of the project area. ▪ 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. ▪ Public safety for the workers and the local communities at all segment of the project during the construction phase. ▪ 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). ▪ Increase in hunting of flora, fauna and birds by the workers on the project. ▪ Hunting of the Oryx that will be reintroduced and of the Ghazal by the workers on the project construction. ▪ Accumulation of solid waste. ▪ Disturbance of natural habitats (Hammad, Sand Dunes, Qeea'an, and wadis). ▪ 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. ▪ Sustainability of agricultural activities in the Disi area in terms of cost return, economical value and social value. ▪ Reduction of soil fertility due to new imported soil in the area extending from Jiza to Amman. ▪ Reduction of the agricultural areas or removing olive trees along the conveyor route.

Table 20: Significant issues identified in the first phase of public consultation (contd.)

Assessed Component	Significant Issues
Social Component	▪ Allocation of percentage of required labour for the local residents alongside the pipeline and in Disi. ▪ 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. ▪ Launching public awareness campaign explaining the benefits of the project before and during work. ▪ Compensation for damage incurred to commercial institutions (especially at Qatraneh, Al Jiza, and Abu Alanda). ▪ 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. ▪ Keeping away from cross-roads as much as possible. ▪ Coordination with the various service establishments. ▪ Improvement of public health due to improvement of the water quality which is a positive impact. ▪ 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. ▪ Public health and safety considerations during the construction phase. ▪ Bedouin (Badia area and the tribes available there). ▪ 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.

7.2 Second Phase of Public Consultations on the Draft 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 second consultation session targeted Amman, Madaba and Al Jiza areas. Aqaba second consultation session hosted the target population of Disi, Aqaba, Tafileh, Ma'an and Al-Qatraneh 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 in **Table 21**.

Table 21: Significant issues identified during the second phase of public consultation

Assessed Component	Significant Issues
Water Resources	▪ 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 quality of the Disi water.
A-biotic Environment	▪ 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.
Social Component	▪ Providing training for locals from Disi area in order to employ them in the operation 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 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. ▪ The long term benefits of the Disi project.
Archaeological and Cultural Heritage	▪ The effect of the project on the Cave of Seven Sleepers area, the Mosque and the people in the area.
Construction Related Issues	▪ 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. ▪ 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. ▪ 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.

7.3 Disclosure

Materials were provided by the Ministry of Water and Irrigation and the Consultant in Arabic and English for participants in the First and Second Phase consultation processes and also made available at selected locations in the project area.

The Executive Summary in Arabic and English and the Main Report in English of the Environmental and Social Assessment will be disclosed at a number of locations in Jordan as listed below and at the InfoShop of the World Bank in Washington, D.C.

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; and
- Aqaba Special Economic Zone.

The Executive Summaries in English and Arabic for the Disi Environmental and Social Assessment Study will be disclosed at the following locations:

- 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; and
- Governorates of Karak, Tafileh, Ma'an and Madaba.