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WATER REUSE AND ENVIRONMENTAL CONSERVATION PROJECT

CONTRACT NO. EDH–I–00–08–00024–00 ORDER NO. 04

ENVIRONMENTAL CONSIDERATIONS REPORT FOR AL-EKEDER DISPOSAL FACILITY REMEDIATION MASTER PLAN

June 2015

IMPLEMENTED BY AECOM

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Submitted to:

USAID Jordan

Prepared by:

AECOM

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A geotechnical analysis of the sample collected from the landfill site was made to see whether it would be suitable for use in a liner system as the low permeability layer. The soil is of low to medium plasticity, with a plasticity index of 18.5%, with 34% passing the No.

LIST OF ACRONYMS

CMMP	Construction Environmental Management and Monitoring Plan
DOA	Department of Antiquities
ECR	Environmental Considerations Report
EMMP	Environmental Management and Monitoring Plan
ESIA	Environmental and Social Impact Assessment
ET	Evapotranspiration
HASP	Health and Safety Plan
HMMP	Hazardous Materials Management Plan
IBA	Important Bird Area
IDECO	Irbis District Electricity Company
IEE	Initial Environmental Examination
IUCN	International Union for the Conservation of Nature
JS	Jordanian Standard
JSC	Joint Services Council
JSMO	Jordanian Standard and Metrology Organization
MOA	Ministry of Agriculture
MoEnv	Ministry of Environment
MOH	Ministry of Health
MOMA	Ministry of Municipal Affairs
MRF	Material Recovery Facility
MSL	Mean Sea Level
MSW	Municipal Solid Waste
MWI	Ministry of Water and Irrigation
P2	Pollution Prevention
PPE	Personal Protective Equipment
RDF	Refuse Derived Fuel
RSCN	Royal Society for the Conservation of Nature
RSS	Royal Scientific Society
WAJ	Water Authority of Jordan
WWTP	Wastewater Treatment Plant

1 Introduction

1.1 Project Background and Need for the Project

The USAID Water Reuse and Environmental Conservation Project (WRECP) works throughout Jordan in institutional capacity building, pollution prevention (P2) for industries, solid waste and wastewater management, and water reuse. The project is implemented by AECOM and a team of international and Jordanian partner firms. This five-year project has four primary tasks:

- Task 1 – Institutional and Regulatory Strengthening
- Task 2 – Pollution Prevention and Industrial Water Management
- Task 3 – Disposal Sites Rehabilitation and Feasibility Studies
- Task 4 – Water Reuse for Community Livelihood Enhancement

The overall objective of WRECP is to protect Jordan's water supply through the achievement of the following goals:

- Strengthen the ability of government agencies to monitor and regulate industrial wastewater handling and reuse
- Strengthen the ability of qualified laboratories to analyze industrial wastewater samples, to tell whether it is being treated properly
- Help industries gain access to technologies and expertise to reduce pollution and conserve water and energy
- Improve waste management practices at landfills and improve industrial wastewater treatment
- Help communities generate income through water reuse projects
- Increase public awareness of the benefits of water reuse and proper waste management

Under one of the main project components (Task 3), focused on assessing and rehabilitating waste disposal sites in Jordan, the WRECP has developed a remediation master plan for the existing Al-Ekeder Disposal Facility and established alternatives for facility clean-up. Al-Ekeder Disposal Facility has been chosen because of its size, location and because of the increasing environmental hazard it has posed.

Al-Ekeder Disposal Facility is considered an "environmental hotspot" in Jordan – warranting urgent intervention by all parties concerned with environmental conservation and the protection of water resources in the Kingdom. It is the second largest Disposal Facility in Jordan (only behind Al-Ghabawi) and serves the northern region of Jordan, which has witnessed a dramatic increase in solid and liquid waste generation due to the influx of Syrian refugees in refugee camps and host communities, in addition to industrialization within the waste catchment area. The site is of additional importance because of its close proximity to Jordan's international border with Syria (~1 kilometer).

Al-Ekeder Disposal Facility commenced operations in 1980 and is currently near maximum operational capacity with respect to solid and liquid waste intake. Solid waste is dumped in the active working face of an unlined landfill solid waste landfill with minimal compaction and intermittent disease vector control. Furthermore, municipal wastewater liquid sludge, olive oil mill wastewater (Zibar) and industrial wastewater are discharged into earthen lagoons at the site, allowing the aqueous fraction to evaporate. Dramatic increases in mixed liquid waste generation and disposal at Al-Ekeder eventually caused one of the dikes separating the lagoons to fail. This situation developed into a much larger environmental problem by 1999, when the retaining dikes of several adjacent lagoons breached allowing wastewater to exit

the site and flow towards Syria. To preclude this from occurring again, ten additional lagoons were installed by 2006 to provide additional storage and overflow capacity. To date, Al-Ekeder Disposal Facility consists of 15 liquid industrial wastewater disposal lagoons in addition to a municipal solid waste landfill. Only one of the 15 wastewater lagoons is lined. Almost all liquid wastes are discharged together in the earthen lagoons throughout the site. Only Zibar is disposed of separately. The fact that almost the entire site is unlined poses a significant risk of groundwater contamination by liquid wastes and leachates – which is likely to have geopolitical repercussions due to the fact that the Yarmouk groundwater aquifer is shared with Syria.

Unsustainable operational practices currently deployed at the site pose threats to water resources and the environment; moreover, the massive influx of Syrian refugees into host communities in the Northern region (ongoing since 2011 with no end in the foreseeable future) has and will continue to stress capacity and contribute to continued environmental concerns even further in the absence of strategic intervention at the site.

1.2 Environmental Considerations Report Objectives

A screening process was conducted for the WRECP according to USAID's Environmental Compliance Procedures, Title 22, Code of Federal Regulations, Part 216. USAID conducted an Initial Environmental Examination (IEE) for the various components of the WRECP, including a threshold decision for the proposed Al-Ekeder Disposal Facility Remediation Master Plan. As USAID's action is limited to the funding of a feasibility study and preparation of design documents, the IEE concluded that USAID's actions (i.e. studies/design) would not have the potential for significant adverse environmental impact. However, USAID recognized that implementation (e.g. construction/ implementation) of recommendations made in the Master Plan and depicted in design documents could have potential adverse impacts if not implemented with appropriate controls, or if environmental monitoring is not incorporated into the project. The IEE noted that an Environmental Mitigation and Monitoring Plan, hereafter referred to as an Environmental Management and Monitoring Plan (EMMP) should be prepared, to ensure minimal adverse impacts on human health and the environment for these activities.

The present Environmental Considerations Report (ECR) was not prepared to be a formal Environmental Impact Assessment; instead, it was prepared to confirm that potential environmental impacts that may occur as a result of the project are considered prior to the implementation of the Master Plan and final design. This ECR includes an EMMP to facilitate the implementation of the proposed action in a manner that enhances and sustains the natural and human environment. Prior to the implementation of the activities proposed in the Master Plan and final designs for Al-Ekeder Disposal Facility, an Environmental and Social Impact Assessment (ESIA) in compliance with MoEnv regulations must be prepared for all of the Master Plan activities, and should include major results, conclusions, and recommendations of this study.

This ECR plays a central role in assessing the social and environmental implications of the proposed project activities, identifying the measures necessary to protect resources and related ecosystems. The ECR is concerned not only with impacts on the natural environment, but also with effects on the social environment. Hence, the ECR highlights the need for cross-sector integration involving project developers, municipalities, decision-makers and the public.

The ECR describes various components of the environment of the area(s) to be affected by the project's activities. Data and analyses in the ECR are commensurate with significance of the impact. The ECR includes the polices and controls for the areas concerned, discussions

of direct and indirect effects and their associated significance, and the recommended mitigation measures to minimize the impacts' magnitude.

The main objectives of this ECR for the Al-Ekeder Disposal Facility Master Plan are summarized below:

1. Verify that the project will not have irreversible negative impacts on the natural and human environments
2. Identify and compare the potential environmental impacts, including the positive and negative, and direct and indirect impacts of the recommended alternatives
3. Propose mitigation and monitoring measures for minimizing the potential adverse impacts of the project on the affected environment

2 Regulatory Framework

This chapter describes the applicable regulatory framework in Jordan, including relevant standards, laws, and regulations.

2.1 Laws

2.1.1 Environment Protection Law (No. 52 of 2006)

In 2006, the Jordanian Law for Protection of the Environment was decreed. Article 5 of this law states that the MoEnv, in cooperation and coordination with the authorities concerned with environmental affairs at the local, Arab and international levels, shall be responsible for the protection of the environment elements and components from pollution. A set of complementary regulations and instructions were issued pursuant to the Law.

According to Article 13 of the law, companies, establishments or entities that conduct activities which negatively impact the environment should prepare an EIA report for their projects and submit such report to the MoEnv to take the appropriate decision in its regard. The MoEnv is in the process of updating the Law and will issue notice of its final availability as appropriate.

2.1.2 Public Health Law (No. 47 of 2008)

The Ministry of Health (MOH) is the entity responsible for applying the Public Health Law in Jordan. The Ministry is also authorized to take all necessary measures to protect public health. Article 47 considers activities that affect human health or cause a health nuisance by releasing solid or liquid waste or emitting gases. Article 48 states that entities responsible for creating health nuisance are given seven days' notice to apply corrective measures. If nothing is done, the Ministry of Health will carry out the required actions at the expense of the activity owner.

2.1.3 Archaeology Law (No. 21 of 1988)

Issued by the Ministry of Tourism / Department of Antiquities (DOA), the law details the main responsibilities of the DOA. These include but are not limited to determining the archaeological sites along with their importance, carrying out archaeological excavations, and maintenance, preservation and restoration of archaeological sites. Article 13 of this law bans construction of any structure within a distance of 5 to 25 meters from an archaeological site.

Article 15 states that any chance finds should be reported to DOA or the Public Security Directorate within 10 days. Article 27 sets the penalties for failing to report chance finds.

2.1.4 Water Authority Law (No. 19 of 1988)

The Water Authority Law and its amendments established the Water Authority of Jordan (WAJ) as an autonomous agency responsible for all water and wastewater issues in the country. WAJ's mandate includes connecting the public to the water and sewer networks, as well as maintaining, operating, and managing these networks.

WAJ's mandate also includes the management of wastewater treatment plants (WWTPs), and thus it is concluded that WAJ's mandate also encompasses any product of WWTPs.

2.1.5 Agriculture Law (No. 44 of 2002)

This law identifies the responsibilities of the Ministry of Agriculture (MOA) in regulating and developing the agricultural sector, in cooperation with the relevant authorities. In addition, Article 57 governs the protection of wild animals and birds and prevents the hunting, killing or capture of birds useful for agriculture as well as birds and animals of prey. The types and species subject to this regulation are specified by the Minister. The Law further governs the protection of agricultural land and pastures.

2.1.6 Law of Planning of Towns and Villages and Buildings (No. 79 of 1966)

By virtue of this law the Higher Planning Council is responsible for regional planning and planning zones. This law applies to all kinds of land uses including buildings and any construction works undertaken. It also applies to any reconstruction conducted by any governmental or local authority, public or private institution. The law provides many sections that regulate licensing, plans for land distribution, pollution prevention, solid waste disposal and sewage, as well as traffic control.

2.1.7 Labor Law (No. 8 of 2002)

The key component of this Law is stated by Article 56 paragraphs (A) and (B) regarding the right of the laborer to not work more than eight hours per day. Furthermore, Article 73 of this law bans the employment of individuals less than 16 years of age. The Law also outlines that projects shall comply with article 78 related to occupational health and safety, and provide essential precautions and arrangements to protect the workers from the risk of hazards, including the supply of Personal Protective Equipment (PPE).

2.1.8 Municipalities Law No. 14, for the year 2007

The Municipalities Law governs solid waste management in Jordan, and gives the various Municipal Councils the responsibility for cleaning, collecting, transporting and disposing of solid waste from households and commercial areas. It also stipulates that Municipal Councils are responsible for the preparation, implementation and follow-up of plans and programs to achieve sustainable development with the participation of communities, and management of all services, facilities and local projects entrusted to it by itself or through partnership with the private sector and/or civil society institutions.

The law also states that the municipality shall take all precautions and procedures necessary to maintain public health and prevent the spread of epidemics among the people.

2.2 Bylaws and Regulations

2.2.1 Environmental Impact Assessment Regulations (No 37 of 2005)

The EIA regulations were issued to ensure that the anticipated impacts of any development project on the social, economic, and natural environment in Jordan are identified. Their aim is to limit these impacts in order to achieve sustainable development in the country. The regulations apply to all industrial, agricultural, commercial, construction, residential, and tourism projects. The level and type of EIA study is determined by the MoEnv consistent with the lists of Category 1 and Category 2 projects specified in Annex 2 and Annex 3 of the regulation. This regulation also states that the EIA review period for the MoEnv is 45 calendar days. The MoEnv is in the process of updating the EIA regulations and associated guidance materials and will issue for use when finalized.

2.2.2 Solid Waste Management Bylaw (No. 27 of 2005)

The MoEnv is responsible for applying this bylaw which aims to establish a solid waste management system that would protect the environment and the public health.

Under this bylaw, the MoEnv is responsible for designating the appropriate dumping sites along with detailing the requirements of solid waste collection, transport, storage, recycling, treatment and disposal.

2.2.3 Regulation for the Prevention of Health Nuisances (No. 72 of 2009)

The provisions of this regulation prohibit anyone from causing any health nuisances within the municipal areas. It identifies the types of nuisances and the measures to be undertaken to prevent the occurrence of health nuisances.

2.2.4 Regulation for the Protection and Safety of Workers from Machineries and Workplaces (No. 43 of 1998)

The provisions of this regulation obligate any institution to take precautions and procedures to ensure prevention of occupational accidents. It identifies types of safety risks at work sites, including mechanical, chemical and electrical machinery and industrial equipment.

2.2.5 Regulation of Preventive and Therapeutic Medical Care for the Workers in Establishments (No. 42 of 1998)

The provisions of this regulation obligate any institution to provide for the medical capability of workers via preliminary and regular medical examinations.

2.2.6 Air Protection Bylaw (No. 28 of 2005)

This bylaw was issued in accordance with Article 23 of the Environmental Protection Law (No.1, 2003). The aim of the Air Protection Bylaw is to protect public health and the environment from pollution resulting from human activities by controlling air pollutants emitted from stationary and mobile sources. It states that for any facility the leak or emission of air pollutants should not exceed the maximum allowable limits. The MoEnv classifies establishments according to the quality and quantity of air pollutants and contaminants resulting from their activities, and their effects on the environment and public health; this classification is used to determine the appropriate location of the facility. The MoEnv is responsible for detecting any excesses and monitoring the compliance with this bylaw.

2.2.7 Soil Protection Bylaw (No. 25 for 2005)

Article 3-E of this bylaw states that the MoEnv, in coordination with the relevant authorities, is responsible for protecting soil from the harmful effects of industrial dust, solid waste, industrial waste and untreated wastewater. The regulation further states that the Ministry in cooperation with the MOA is responsible for studying the sites of development projects and project impacts on land and natural resources, as well as preparing the necessary programs for the rehabilitation of waste dumping sites and their cultivation with appropriate crops.

2.2.8 Environmental Monitoring and Inspection Regulation (No. 65 of 2009)

This regulation was issued pursuant to the Environmental Protection Law No. 52 of 2006. It categorizes three levels of operational facilities based on their risk to cause environmental pollution. This categorization is reflected in the frequency of environmental inspections stipulated in the regulation. In cases where environmental inspections carried out by the MoEnv reveal violation of stated environmental quality requirements, the MoEnv is

authorized to request an environmental audit from the facility, which under Article 9 of the regulation is obliged to submit its audit reports to the MoEnv.

2.2.9 Regulation for Protecting the Environment from Pollution in Emergency Situations (No. 26 of 2005)

This regulation sets out the plan for "protecting the environment and controlling pollution in emergency situations and the methods of implementation thereof, subject to the specific international and regional protocols in this regard to which the Kingdom is party". In addition, MoEnv is responsible for managing the emergency plan and following up on its execution, as well as identifying the necessary resources and conducting the required surveys and studies.

2.2.10 Groundwater Control Regulation (No. 85 of 2002)

This regulation was issued pursuant to Articles 6 and 32 of the Water Authority Law No. 18 of 1988. It governs groundwater extraction and designates groundwater as exclusive government property. The regulation additionally controls the drilling of wells and the licensing thereof, as well as quality and pollution control and remediation. Furthermore, Criminal Law No. 16 of 1960 stipulates the protection of water resources and sets out the penalties in the case of violations.

2.2.11 Water Protection Regulation of 2004

This regulation aims at protecting water sources from pollution. It stipulates that the Ministry of Water and Irrigation (MWI) is to set the environmental conditions to be fulfilled if permission and authorization are to be given for the development projects covered by the environmental impact assessment regulation.

Additionally, Article 6 of the regulation states that no waste dump sites can be constructed without the MWI's authorization and states that MWI in coordination with the concerned entities should set the environmental criteria, conditions and requirements for such a facility. Article 11 further highlights the role of MWI and other concerned entities in setting the environmental conditions for the collection, storage and transportation of all liquid and solid waste in order to prevent the pollution of water sources.

2.2.12 Regulation of Land Use of 2007

This regulation applies to all land uses, including buildings and any construction works undertaken. It designates that the Higher Planning Council is responsible for regional planning and for establishing planning zones. It sets outs the different land use categories and defines the relevant allowable activities.

2.2.13 Hazardous Materials and Wastes Management, Transfer and Circulation Regulation (No. 24 of 2005)

This regulation prohibits dealing with hazardous waste or dangerous substances unless a permit is obtained from MoEnv. Per this regulation, the Ministry should form a committee that classifies hazardous waste or dangerous substances, and prepare instructions to determine the basis and conditions for the handling, collection, storage, treatment and disposal of hazardous waste and dangerous substances.

2.2.14 Regulation for the Formation of Committees and Moderators of Occupational Safety and Health (No 7 of 1998)

The provisions of this regulation obligate any institution that has more than 20 employees to form a functionally specialized committee for the occupational safety and health of the employees. The size of the committee so formed should be commensurate with the size of the institution. The regulation also specifies the responsibilities of this committee.

2.2.15 Regulation for the Prevention of Waste Dumping and Waste Collection Fees in the Municipalities 1/ 1978

This regulation was issued pursuant to Article (41) of the Municipalities Law No. 29 of 1955. It prohibits any inappropriate waste dumping within the municipalities' borders. It also provides the legal basis for the health inspectors to access any institute during daytime. It also specifies the annual fee for waste collection, transfer, treatment and disposal.

2.3 Instructions and Decisions

2.3.1 Instructions for the Protection of Workers and Institutions from Workplace Risks and Hazards of 1998

These instructions specify mitigation measures that should be taken within trades, industries and crafts to ensure the occupational safety and health of workers and reduce risk factors in facilities.

2.3.2 Instructions for Preliminary Medical Testing of Workers of 1998

These instructions designate types of industries in which workers should be subject to a preliminary medical examination to check their capability to perform their assigned work.

2.3.3 Instructions for Regular Medical Testing of Workers of 1998

These instructions designate types of industries in which workers should be subject to certain medical examinations regularly.

2.3.4 Instruction for the Management and Handling of Consumed Oil of 2003

These instructions identify the oils that are refined from crude oil or synthetic oils and those that have been used and have become contaminated waste and therefore must be disposed of or treated to be reused. These instructions prohibit the discharge of these oils into sewage systems, septic tanks, surface water sources, groundwater, or to the environment, and specify all the requirements for the proper handling and disposal of these oils.

2.3.5 Instruction for Management and Handling of Hazardous Waste of 2003

These instructions identify all types of hazardous wastes and prohibit the discharge of these wastes into sewage systems, surface water, groundwater, or to the environment. They also specify all the requirements and steps for proper handling, storage, transportation and disposal of these wastes.

2.3.6 Instructions for the Fees of Hazardous Waste Treatment and Final Disposal of 2004

These instructions identify the fees for the disposal and treatment of all types of hazardous wastes.

2.3.7 Instructions for Noise Prevention of 2003

These instructions address ambient noise. Article 6 of the instructions specifies the maximum allowable level of noise for the different types of areas, both during the daytime and at night.

According to the Instructions for Controlling and Preventing Noise, construction works that use noisy equipment like mixers and shakers and any other similar equipment between 8 pm and 6 am are prohibited except for cases approved by the Ministry.

Table 2-1 displays the allowable maximum limit of the equivalent volume level (dB A) per area.

Table 2-1: Maximum Allowable Noise Levels

Area	Maximum limit for equivalent sound level (decibel A)	
	Day	Night
Residential areas in cities	60	50
Residential areas in suburbs	55	45
Residential areas in villages	50	40
Residential areas that have some workshops or simple vocations or business and commercial and administrative areas and downtown	65	55
Industrial areas (heavy industrial)	75	65
Tuition, worshipping and treatment places and hospitals	45	35

2.3.8 Instructions for Discharge of Industrial and Commercial Wastewater in the Sewage Network of 1998

These instructions detail the detrimental characteristics of industrial and commercial wastewater that make it illegal to discharge into the sewage network. The instructions denote the maximum allowable limits for a number of wastewater pollutants (Table 2-2), and also provide instructions on applying these limits for sewage connections. Discharge to the sewerage network of wastewater that exceeds these limits is prohibited.

Table 2-2: Pre-Treatment Standards for Industrial Wastewater Discharge to Domestic Wastewater Collection Systems

Parameter		Limit	
Hydrogen Ion Concentration	pH	5.5 to 9.5	Range
Temperature	T	65^{o} C	Maximum
Fat, Oil, Grease, Wax	FOG	100 mg/L	Maximum
Hydrocyanic acid-forming compounds	HCN	1.0 mg/L	Maximum
Phenolic compounds (as Phenol)	Phenols	10 mg/L	Maximum
Sulfides (as hydrogen sulfide [H_2S])	Sulfides	10 mg/L	Maximum
Methylene Blue Active Substances	MBAS	40 mg/L	Maximum
Chromium*	Cr	5.0* mg/L	Maximum
Copper*	Cu	4.5* mg/L	Maximum
Tin	Sn	10 mg/L	Maximum
Beryllium	Be	5.0 mg/L	Maximum
Nickel*	Ni	4.0* mg/L	Maximum

Parameter		Limit	
Cadmium*	Cd	1.0* mg/L	Maximum
Arsenic	As	5.0 mg/L	Maximum
Barium	Ba	10 mg/L	Maximum
Lead*	Pb	0.6* mg/L	Maximum
Manganese	Mn	10 mg/L	Maximum
Silver*	Ag	1.0* mg/L	Maximum
Boron	B	5.0 mg/L	Maximum
Mercury*	Hg	0.5* mg/L	Maximum
Iron	Fe	50 mg/L	Maximum
Zinc	Zn	15 mg/L	Maximum
Cobalt*	Co	0.05* mg/L	Maximum
Selenium*	Se	0.05* mg/L	Maximum
Lithium	Li	5.0 mg/L	Maximum
Vanadium*	V	0.1* mg/L	Maximum
Aluminum	Al	5.0 mg/L	Maximum

Notes:* Provided the combined total of these elements together does not exceed 10 milligrams per liter.
mg/L indicates milligrams per liter.

2.4 Standards

2.4.1 Ambient Air Quality Standards (Jordan Standard [JS] 1140 of 2006)

These standards designate ambient air pollutants and the maximum allowable concentration for each of those pollutants in the atmosphere, in addition to approved methods of measurement. Table 2-3 shows the maximum allowable limits for some of the ambient air pollutants listed in JS 1140/2006. The project should comply with these limits during construction and during operations.

Table 2-3: Allowable Limits for Air Pollutants

Pollutant	Averaging Period	Maximum Limit	Number of Times Limit is Allowed to be Exceeded
Sulfur Dioxide (SO_2)	1 hour	0.3 ppm*	3 times in any 12-month period
	24 hours	0.14 ppm	Once a year
	Annual	0.04 ppm	-
Carbon Monoxide (CO)	1 hour	26 ppm	3 times in any 12-month period
	8 hours	9 ppm	3 times in any 12-month period
Nitrogen Dioxide (NO_2)	1 hour	0.21 ppm	3 times in any 12-month period
	24 hours	0.08 ppm	3 times in any 12-month period
	Annual	0.05 ppm	-
Ozone (O_3)	1 hour	0.12 ppm	-
	8 hours	0.08 ppm	-
Particulate Matter 10 (PM_{10})	24 hours	120 µg/m3 **	3 times in any 12-month period
	Annual	70 µg/m3	-
Particulate Matter	24 hours	65 µg/m3	3 times in any 12-month period

2.5 ($PM_{2.5}$)	Annual	15 µg/m3	-
Total Suspended Particulates (TSP)	24 hours	260 µg/m3	3 times in any 12-month period
	Annual	75 µg/m3 (geometric average)	-
Lead (Pb)	Seasonally	1 µg/m3	-
	Annual	0.5 µg/m3	-
Phosphates (P_2O_5)	24 Hours	100 µg/m3	3 times within any 12 months
	Annual	40 µg/m3	-
Cadmium (Cd)	Annual	0.005 µg/m3	-

*ppm: parts per million **µg/m^3: microgram per cubic meter
Reference: Jordan Ambient Air Quality Standards (JS 1140/2006)

2.4.2 Air Emissions from Stationary Sources (JS 1189 for 2006)

These standards provide definitions of stationary sources of air pollutants in addition to the maximum allowable concentration for each of those pollutants in the atmosphere. They also define approved methods of measurement. Furthermore, MoEnv has the legal mandate to oblige entities with an expected risk of exceeding permissible air emission levels to install the required equipment to make air emissions fall within standards. Table 2-4 shows the allowable maximum limits for some of the pollutants listed in JS 1189/2006.

Table 2-4: Maximum Allowable Limits Set by JS 1189/2006

Pollutant	Maximum Limit mg/ m^3
Sulfur Dioxide (SO_2):	
Combustion of petroleum products	6500
Non-ferrous metal industries	3000
Sulfuric acid industries	1500
Sulfur trioxide (SO_3), Sulfur Dioxide particulates	150
Nitrogen Dioxide (NO_2):	
Combustion processes under 1200^o C	200
Combustion processes above 1200^o C	1500
Non–combustion Industrial processes	300
Volatile organic compounds	20
Lead (Pb)	0.5
Lead compounds	20
Cadmium (Cd)	0.05
Cadmium compounds	10
Chlorine (Cl_2)	30
Hydrogen Chloride (HCl)	10
Hydrogen Fluoride (HF)	15
Copper (Cu)	1
Nickel (Ni)	2
Fluorine (F_2)	5

Ammonia	50
Dioxin	1x 10^{-6}

2.4.3 Water-Industrial Reclaimed Wastewater Standard (JS 202/2007)

This standard outlines maximum allowable concentrations of various chemical and biological parameters in treated industrial wastewater effluent. Criteria are established for various uses of the treated effluent, including wadi discharge, irrigation of certain crops, and other uses. These criteria are shown in Table 2-5.

Table 2-5: JS 202/2007- Effluent Limits for Reclaimed Industrial Wastewater

Parameter	Unit	I. Cooked vegetables, parks, playgrounds sides of roads within city limits	II. Fruit trees, sides of roads outside city limits, and landscape	III. Field crops, industrial crops and forest trees	Cut Flowers	Wadi Discharge
Category A						
Biological Oxygen Demand (BOD)	mg/L	30	200	300	15	60
Chemical Oxygen Demand (COD)	mg/L	100	500	500	50	150
Dissolved Oxygen (DO)	mg/L	>2	-	-	>2	>2
Total Suspended Solids (TSS)	mg/L	50	200	300	15	60
pH	pH unit	6-9	6-9	6-9	6-9	6-9
Turbidity	NTU	10	N/A	N/A	5	15
Nitrate	mg/L	30	45	70	45	80
Ammonium	mg/L	-	-	-	-	5
TN	mg-N/L	45	70	100	70	70
E coli	/100mL	100	1000	-	<1.1	1000
Helminthes	/L	≤1	≤1	≤1	<1	<0.1
Fat Oil and Grease (FOG)	mg/L	8	8	8	2	8
Category B						
Phenol	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
Total Dissolved Solids (TDS)	mg/L	2000	2000	2000	2000	2000
Methyl Blue Active Substances (detergents) (MBAS)	mg/L	100	100	100	100	25
Total Phosphate	mg/L	30	30	30	30	15
Chloride	mg/L	400	400	400	400	350
Sulfate	mg/L	500	500	500	500	300
Bicarbonate	mg/L	400	400	400	400	400
Sodium	mg/L	230	230	230	230	-
Magnesium	mg/L	100	100	100	100	-

Parameter	Unit	I. Cooked vegetables, parks, playgrounds sides of roads within city limits	II. Fruit trees, sides of roads outside city limits, and landscape	III. Field crops, industrial crops and forest trees	Cut Flowers	Wadi Discharge
Calcium	mg/L	230	230	230	230	-
Aluminum	mg/L	5	5	5	5	2
Arsenic	mg/L	0.1	0.1	0.1	0.1	0.05
Beryllium	mg/L	0.1	0.1	0.1	0.1	0.1
Copper	mg/L	0.2	0.2	0.2	0.2	1.5
Fluoride	mg/L	2	2	2	2	2
Iron	mg/L	5	5	5	5	5
Lithium	mg/L	0.075	0.075 (2.5 for citrus trees)	0.075	0.075	2.5
Manganese	mg/L	0.2	0.2	0.2	0.2	0.2
Molybdenum	mg/L	0.01	0.01	0.01	0.01	0.01
Nickel	mg/L	0.2	0.2	0.2	0.2	0.2
Lead	mg/L	0.2	0.2	0.2	0.2	0.2
Selenium	mg/L	0.05	0.05	0.05	0.05	0.05
Cadmium	mg/L	0.01	0.01	0.01	0.01	0.01
Zinc	mg/L	5	5	5	5	5
Boron	mg/L	1	1	1	1	1
Chromium	mg/L	0.1	0.1	0.1	0.1	0.1
Mercury	mg/L	0.002	0.002	0.002	0.002	0.002
Vanadium	mg/L	0.1	0.1	0.1	0.1	0.1
Cobalt	mg/L	0.05	0.05	0.05	0.05	0.05
Cyanide	mg/L	0.1	0.1	0.1	0.1	0.05
Sodium Adsorption Ratio (SAR)	-	9	9	9	9	9
Color	cobalt unit	-	-	-	-	15
Temp change	°C	-	-	-	-	6

Notes: °C indicates degrees Celsius;

mg/L indicates milligrams per liter;
Mg-N/L indicates milligrams nitrogen per liter;
NTU indicates Nephelometric Turbidity Unit;
/100mL indicates per 100 milliliters;
/L indicates per liter.

Reference: Jordan Water-Industrial Reclaimed Wastewater Standard (JS 202/2007).

2.4.4 Uses of Treated Sludge and Sludge Disposal Standard (JS 1145/2006)

This standard outlines the maximum allowable concentrations of various chemical and biological parameters in treated sludge (Table 2-4). It also outlines the allowed uses and proper methods of disposal of treated sludge. Three classes of sludge quality are described depending on the content of heavy metals and level of treatment to reduce the pathogen content, as follows:

- Class I – may be used for agricultural purposes and soil improvement
- Class II – may be used for soil improvement purposes or disposed of at waste disposal sites
- Class III – may only be disposed of at waste disposal sites

Table 2-6: JS 1145/2006 - Sludge Characteristics by Class

Parameters	Concentration by Sludge Class (milligrams per kilogram, except as noted)		
	Class I	Class II	Class III
Arsenic, As	41	75	75
Cadmium, Cd	40	40	85
Chromium, Cr	900	900	3000
Copper, Cu	1500	3000	4300
Mercury, Hg	17	57	57
Molybdenum, Mo	75	75	75
Nickel, Ni	300	400	420
Selenium, Se	100	100	100
Lead, Pb	100	840	840
Zinc, Zn	2800	4000	7500
Moisture Content (max.)	10%	50%	97%
Fecal Coliform (total), MPN/g	1000	2,000,000	-
Salmonella	3/4 g dry	-	-
Nematode Eggs	1/4 g dry	-	-
Intestinal Virus	1/g dry	-	-

2.4.5 Jordanian Code No. 22: Public Safety during Construction

The Code of Public Safety during Construction describes the required measures to be taken in order to safeguard the work environment during construction works. This includes sanitation, toilet facilities, drinking water, medical services, protection from fires, lighting, ventilation, noise, gasses, electrical wiring, openings and edges, transporting workers, solid waste collection and disposal, and insects and harmful animals. For example, noise levels and exposure periods permitted for workers are set forth under this code.

2.5 International Treaties

There are numerous international and regional treaties of some relevance to the ECR for this project to which Jordan is a signatory or upon which Jordan has reached agreement with other entities. These are listed in Table 2-7.

Table 2-7: Relevant Treaties, Conventions and International Agreements Ratified by Jordan

Treaties, Conventions, and International Agreements	Year (in force)	Description
Convention on Wetlands of International Importance Especially as Waterfall Habitat (Ramsar Convention)	1971	- Protects all characteristic flora and fauna, with emphasis on protection of the waterfall habitats.
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1979	- Regulates export and import of listed Endangered species of fauna and flora. - Additionally allows Parties to give protection to selected species of flora and fauna within their jurisdiction.
The United Nations Convention on Biological Diversity (Bonn)	1993	- Calls for identification and monitoring of biodiversity components. - Calls for establishment of protected areas and emergency response plans.
Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	1994	- Calls for combating desertification. - Calls for mitigating the effects of drought.
The United Nations Framework Convention on Climate Change	1994	- Calls for stabilization of greenhouse gas emissions, and requires Parties to prepare greenhouse gas inventories.

3 Institutional Framework

Several parties are involved in governing Al-Ekeder Disposal Facility: the Greater Irbid Municipality, Ramtha Municipality, Yarmouk University, the Water Authority of Jordan, and the Joint Service Council for Irbid Governorate. The Joint Service Council for Irbid Governorate operates the Disposal Facility as an individual authority directed by a chairman who is nominated by the Ministry of Municipal Affairs (MOMA) and administratively related to them.

Ownership of the Disposal Facility is shared by the Greater Irbid Municipality, Ramtha Municipality, Yarmouk University, Water Authority of Jordan and the Joint Services Council for Irbid Governorate.

No single entity had assumed responsibility for the remediation of Al-Ekeder Disposal Facility until early 2014. At that time, with USAID support; the MoEnv elevated the issue to the Prime Minister's Cabinet. A steering committee was formed to force decisions across agencies, including the MoEnv, WAJ, MOMA and Irbid Joint Services Council. In July 2014, the MoEnv prepared a comprehensive plan to implement the decisions made by the Ministerial steering committee, detailing the inter-related projects and identifying the agencies in charge of each.

3.1 Ministry of Environment (MoEnv)

MoEnv is the entity accountable for protecting various environmental components across the Kingdom, in addition to being responsible for environmental compliance. It aims to improve the environment, conserve Jordan's natural resources and achieve sustainable development. MoEnv is the entity that would be responsible for reviewing EIA studies and granting the approval for the project, as well as being the entity ensuring and monitoring environmental compliance and protection of environmental components throughout the construction and operation of the Project. Furthermore, MoEnv is the entity responsible for handling environmental complaints.

The MoEnv is the responsible entity for regulating and monitoring industrial wastewater (including the Zibar) management practices; its role is to supervise rather than implement.

MoEnv is the responsible entity for monitoring Al-Ekeder facility; however, currently, the MoEnv capacity for conducting monitoring programs is limited and, therefore, routine monitoring of Al-Ekeder Disposal Facility is not performed. The MoEnv only steps in when complaints are received, or when there is a clear and unusual problem. However, the MoEnv is the responsible entity for determining how the site should be remediated.

The MoEnv intends to supervise the implementation phase of the work. The scope of work includes training for MoEnv staff on remediation work oversight and long-term monitoring, with emphasis on identifying and mitigating risks to the environment during remediation activities.

3.2 Ministry of Water and Irrigation and Water Authority of Jordan (WAJ)

MWI and its respective authorities are specifically responsible for the protection of water resources. The main objective of MWI is to maintain sustainable water resources with the purpose of achieving national water security and meeting the Ministry's development objectives.

WAJ is the entity that assumes all authority pertaining to water and wastewater in Jordan including the management of WWTPs. The Authority's role further involves the improvement of the relevant infrastructure for the purposes of preserving public health and the environment.

In addition, WAJ is responsible for controlling the quality of biosolids and sludge produced and subsequently influences the appropriate final disposal method. WAJ is responsible for ensuring the proper disposal of biosolids and sludge.

WAJ and MoEnv are both responsible for providing enforcement of industrial waste water treatment regulations so as to require industries to install the necessary pretreatment facilities at the point of the wastewater generation.

3.3 Ministry of Health (MOH)

MOH is the entity accountable and responsible for public health and safety monitoring and control and assumes the responsibility for all health affairs across the Kingdom.

Of particular relevance to the project are the Occupational Health Directorate and the Environmental Health Directorate. The Occupational Health Directorate is responsible for ensuring the safety of the work environment from pollutants and occupational hazards, in addition to the evaluation of the work environment. The Environmental Health Directorate is responsible for ensuring compliance with environmental health requirements and implementing the provisions of the Public Health Law through the relevant monitoring programs developed.

3.4 Ministry of Agriculture (MOA)

MOA is the entity responsible for regulating and permitting all agricultural activities in Jordan and has the responsibility for licensing of olive mills and ensuring proper storage of Zibar within the grounds of the mill itself. However, MOA's mandate ceases at the boundaries of the olive mills[1].

3.5 Ministry of Municipal Affairs (MOMA)

MOMA's mandate includes a responsibility for public health and safety monitoring and control via the management and operation of solid waste collection and disposal. It carries out its duties through its implementing arms: the municipalities and the Joint Services Councils (JSCs). For this Project, the relevant municipality and implementing arm of MOMA would be the Greater Irbid Municipality, Ramtha Municipality, and the Joint Service Council for Irbid Governorate. Within their area of jurisdiction (which includes the project area), these municipalities are authorized to undertake the needed measures to prevent the occurrence of health nuisances.

3.6 Ministry Of Labor (MOL)

MOL is the entity responsible for occupational health and safety, as well as providing the indoor air quality requirements that need to be complied with.

[1]USAID/Jordan Institutional Support & Strengthening Program (ISSP), Olive Mill Wastewater (Zibar) Study- Final Report, Oct. 2013

3.7 Royal Rangers

Currently “Royal Rangers,” who are administratively under the authority of the Ministry of Interior, support the MoEnv on environmental compliance and enforcement efforts in the field.

The Royal Rangers is the responsible entity for taking legal and administrative actions against the perpetrators and controlling the entry and handling of the hazardous materials according to the relevant instructions.

3.8 The General Directorate of Jordan Civil Defense

The general directorate of Civil Defense in Zarqa is the entity to be contacted in the case of fires or accidents.

3.9 Jordanian Standard and Metrology Organization (JSMO)

JSMO is the entity responsible for the issuance of specifications and technical regulations, their adoption and revision, and the monitoring of their implementation for all services and products. However, despite being legally authorized to oversee implementation of specifications and technical regulations, JSMO delegates the responsibility of overseeing their implementation to the relevant ministries. This includes the technical regulations and standard concerning biosolids and sludge disposal, as elaborated previously in Section 2.

3.10 The Royal Society for the Conservation of Nature (RSCN)

RSCN is a non-profit, non-governmental organization which aims to conserve the Kingdom’s natural resources.

4 Description of the Proposed Project

4.1 Project Location

Al-Ekeder Disposal Facility is the second largest Disposal Facility in Jordan, serving around 100 towns and villages in the northern region of the country. As shown in Figure 4-1, the site is located in the Mafraq Governorate in Northern Jordan, approximately 27 km east of the City of Irbid and 1 km south of the Syrian border.

The nearest village to the Disposal Facility is called Al-Ekeder. It is situated about 2 km to the southwest of the site boundaries. The site covers 806,000 square meters.

Figure 4-1: General Location of Al-Ekeder Disposal Facility

4.2 Project Objectives

The designation of Al-Ekeder Disposal Facility as an environmental “hotspot”, and the huge environmental threat that the facility has posed, required immediate environmentally sustainable changes to be implemented. These changes are designed to allow an efficient use of the site, accommodate the growing supply of waste as a result of the introduction of new industries and population growth, and prevent any further environmental degradation.

The MoEnv has ordered the phasing out of the liquid waste lagoons by June 2015 in order to begin preparations for the rehabilitation process. In response to this decision, the project prepared a comprehensive Remediation Master Plan for Al-Ekeder Disposal Facility to allow for safe utilization of the Disposal Facility and to mitigate, if not eliminate, future environmental and safety issues.

4.3 Project Components

As shown in Figure 4-2, Al-Ekeder facility currently has 14 unlined and one lined liquid industrial wastewater lagoons, in addition to a municipal solid waste landfill. Municipal

wastewater liquid sludge, olive oil wastewater (Zibar) and wastewater from various industries are discharged into the earthen lagoons on site, allowing the aqueous fraction to evaporate. Almost all liquid wastes are discharged together in the earthen lagoons throughout the site; Zibar, alone, is disposed of separately.

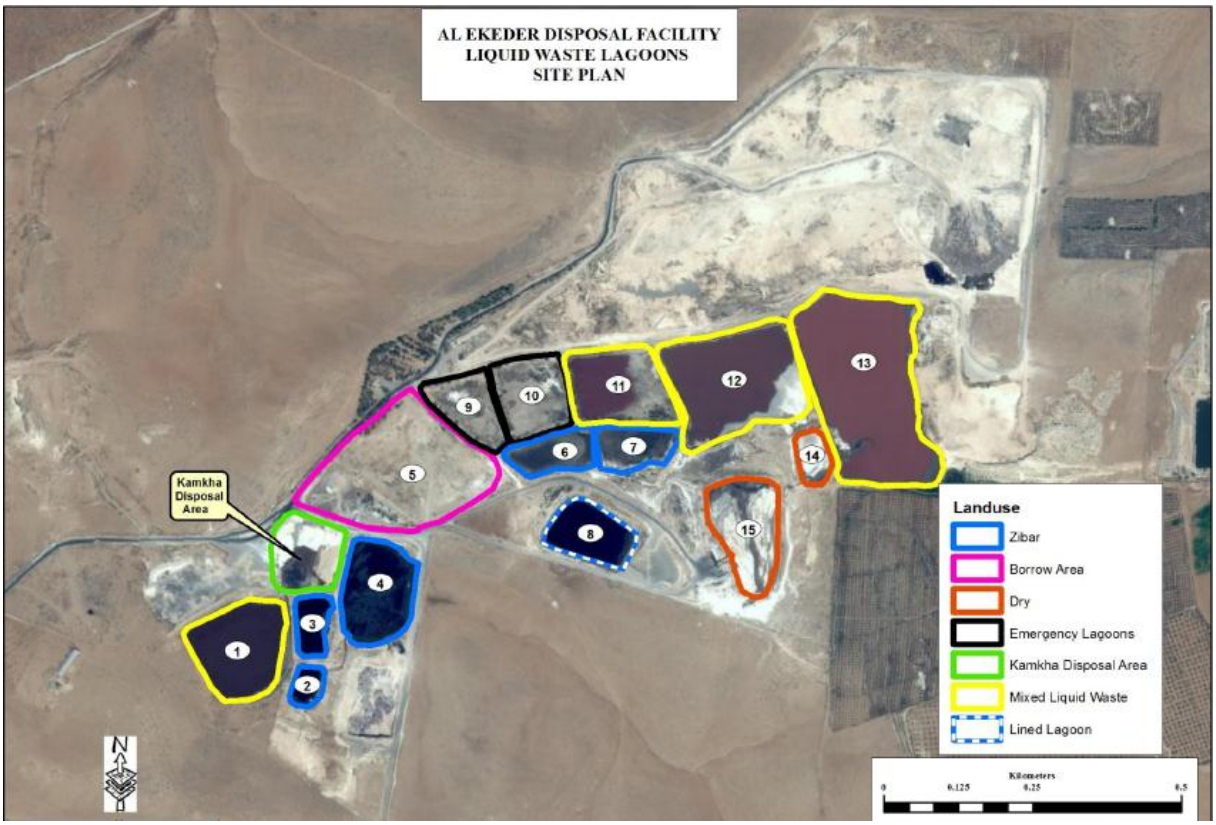


Figure 4-2: Liquid Waste Disposal Lagoons at Al-Ekeder Disposal Facility

The overall approach to future solid waste disposal operations focuses on expansion through land acquisition and lagoon replacement as can be seen in Figure 4-3, and the adoption of more sustainable treatment options. In order to achieve this result, some of the lagoons will be replaced with landfill cells and others will be strategically closed to facilitate the start of the project which will include more sustainable liquid waste treatment.

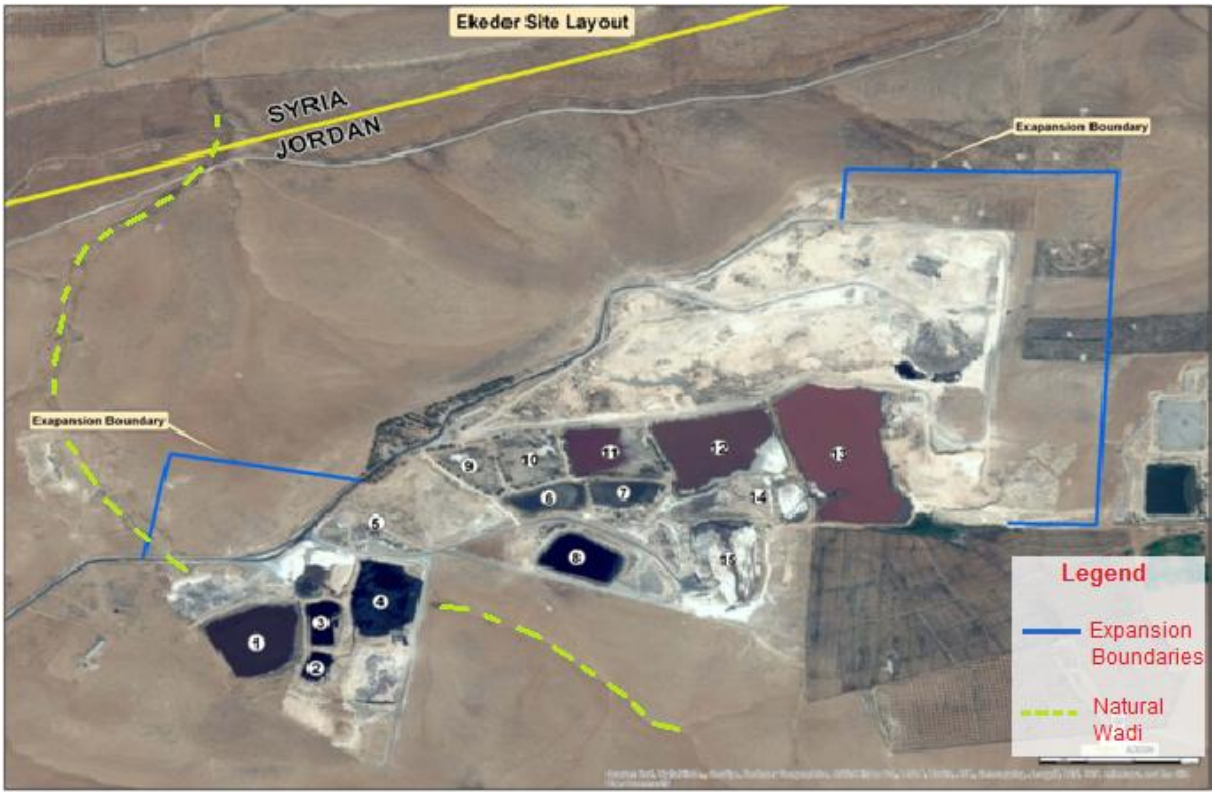


Figure 4-3: Al-Ekeder Expansion Boundaries

The Al-Ekeder Master Plan breaks down into nine main engineering components:

1. **Waste-fill and intermediate cover installation**

This component involves the application of waste-fill materials to reduce side slopes to a maximum 3H:1V on all of the exterior slopes of the existing landfill. These engineered side slopes will support the addition of intermediate cover materials to isolate waste, reduce infiltration and prevent the escape of landfill gases, and provide the base grade for installation of either the ET cover or slope cap liner system (discussed below).

2. **Sanitary landfill cell construction**

Initially, two additional landfill cells (Cells 1 and 1A) are to be constructed on adjacent land recently acquired by the facility. The construction of these additional cells will provide a minimum of 5 years of waste disposal capacity. The proposed strategy will also enable the construction of additional future cells upon the closure of liquid waste lagoons.

3. **Slope cap construction**

The addition of a liner system over the existing landfill will provide an impermeable barrier, sloped to the new expansion cells for leachate collection, that will isolate future waste disposal within a secure landfill for environmental protection.

4. **Final cap phasing**

A proposed earthen evapotranspiration (ET) cap is to be added as a final layer of cover materials as final waste grades are reached. Final cover systems are installed at landfills to control infiltration and percolation of precipitation, promote surface water runoff, minimize erosion, and control gas emissions and disease vectors – while safeguarding aesthetics and public health. ET cover systems rely on water balance and ecosystem components to reduce percolation and are typically less costly to construct than conventional cover systems that include a geosynthetic liner component (United States Environmental Protection Agency, 2003). Installation is contingent upon the soil balance of the site or other local soil availability.

5. Infrastructure construction

Incorporation of environmental protection into landfill operations at Al-Ekeder Disposal Facility requires the construction of the following:

- **Access Plan:** As shown in Figure 5-14, Existing Roads A and E will continue to be used. The north to south portion of Road E will remain active until slope filling along the eastern limit of the existing landfill is complete. Prior to Cell 2 construction, a short segment of Road E will be removed and temporarily relocated westwards. Prior to Cell 3 construction, Road C will be extended around the southern property edge from the current Roads B&C termination at Pond 1 for construction access.
- **Scale Facilities and Office:** The existing scale equipment and building will be relocated westwards along the access road leading to Al-Ekeder Disposal Facility to eliminate traffic congestion/conflicts in the vicinity of the proposed Zibar lagoons and to minimize potential odor nuisance exposure to scale facility personnel. A new administration office will be constructed near the southeast corner of existing lagoon 15.
- **Gas Management Facilities:** Landfill gas utilization/re-use equipment and a backup landfill gas flare station will be constructed within the infrastructure area to the east of existing lagoon 13.
- **Equipment Maintenance Area:** The liquid waste unloading area at lagoon 15 could serve as the new equipment storage/maintenance area once liquid waste has completely stopped and this receiving area is no longer needed.
- **Materials Recovery Facility (MRF) and Refuse Derived Fuel (RDF) Facility:** An enclosed Materials Recovery Facility (MRF) is proposed in the Northern part of the newly acquired land. The MRF will generally consist of an enclosed building with a concrete tipping floor of sufficient size to accommodate hauling vehicles, wheeled loader, materials handling/sorting equipment, storage area(s), and a load-out area.
- **Leachate Collection and Evaporation Lagoons:** Leachate collection sumps will be constructed at the low point of each new lined disposal cell to allow for pumping leachate to new storage/evaporation lagoon(s). A leachate force main will be constructed within a utility corridor on the new perimeter berm to convey leachate from each cell to the evaporation lagoon(s). The lagoon(s) will be constructed in the proposed infrastructure area east of existing lagoon 13 to contain pumped leachate from the proposed slope-cap-lined areas and new lined disposal cells. Only passive/natural evaporation from exposure of the contained water surface to solar radiation and wind is proposed. The leachate lagoon(s) will be lined with a geosynthetic liner system.
- **Erosion and Sedimentation Control and Stormwater Management:** A lined drainage channel will be incorporated into the design of the proposed perimeter berm to convey runoff from the developing landfill final grades as well as the perimeter access road to one of several stormwater management basins/areas.
- **Borrow Area and Stockpiling:** Lagoons 5, 6, 9 and 10 located at the western side of the facility will be remediated and used for soil borrow and stockpiling activities. In the event that emergency storage of liquid waste is required, all or portions of the footprint encompassed by this area may be used for temporary unlined liquid waste storage. Recently acquired properties along the eastern edge of the facility will be excavated for borrow soils to be used for construction of Landfill Cells and other infrastructure facilities.

6. Phased liquid waste lagoon closure

Successful diversion of most liquid sludge by dewatering at the treatment plants and diversion of industrial liquid wastes (with the exception of seasonal Zibar) to treatment facilities would enable the closure of several existing liquid waste disposal evaporation

lagoons. Closing and rehabilitating existing lagoons would enable the reclamation of land for solid waste disposal.

7. New Zibar lagoon construction

The construction of an additional Zibar lagoon is proposed on recently acquired land in the Western portion of the Facility and is currently in the tendering phase. The proposed lagoon will increase Zibar intake capacity and will also allow for phased closure of other unlined Zibar lagoons and their replacement with standard lined evaporation ponds.

8. Zibar Lagoon cleaning and lining of existing lagoons

The clean-up and rehabilitation of lagoons 2, 3, 6 and 7 are currently underway. The remaining unlined Zibar lagoon (lagoon 4) is to undergo similar processes. Each will be retrofitted/replaced with a standard lined lagoon.

9. Borrow area development

Borrow pits are to be developed in several portions of the Disposal Facility, where appropriate, to serve as a source of needed soil (earthen) cover materials.

4.4 Project Alternatives

As described below, several remediation alternatives were proposed and assessed for Al-Ekeder Disposal Facility.

Alternative 1: No Action

This alternative assumes that there will be no changes from the current method of managing incoming sludge and liquids delivered to Al-Ekeder Disposal Facility. Under continued operation (no action), wastes would continue to be commingled in the lagoons with collected solids, requiring periodic removal for disposal at the landfill. This process would permit a continued system of storage/evaporation and infiltration. There would be continued direct access by workers and customers, as well as unrestricted access for the general public, all of which potentially presents a risk to human health. With continued use as an impoundment system, surface water ponding and charging of the sludge/sediment would occur, along with potential leaching of contaminants to subsurface water. Incidental surface water discharge would also continue during high rainfall periods or when adequate maintenance of lagoon solids has not been performed. Lack of maintenance could lead to the eventual overtopping of the lagoons. Consequently there would be continued risk to the environment.

Alternative 2: Diversions of Prohibited Wastes / Abandonment in current conditions

This alternative is identical to Alternative 1, except that, under continued operation, the incoming waste identified as “hazardous” would be diverted from the facility. Similar to the conditions in Alternative 1, water ponding and charging of the sludge/sediment would occur and any leaching of contaminants to the subsurface would continue if this alternative is employed. Surface water overflow would also continue during high rainfall periods or when adequate maintenance of solids has not been performed. Lack of maintenance could eventually lead to overtopping of the ponds. Consequently, as with Alternative 1, there would be continued risk to human health and the environment from existing sludge/sediment.

Alternative 3: Complete Diversions of Waste (Excluding Zibar) / Abandonment in current conditions

This alternative assumes that acceptance of all incoming wastes (with the exception of Zibar as noted above) will cease. The site lagoons would be left in an as-is condition for the foreseeable future. Under this alternative, all historical wastes would remain onsite and all future non Zibar liquid wastes would be diverted from the site.

In the current state, the lagoons are configured as impoundments and continue to detain precipitation as well as the aqueous fraction of the discharged wastewater. Similar to the conditions in Alternative 1, water ponding and charging of the sludge/sediment would occur, and any leaching of contaminants to the subsurface would continue. Surface water overflow would also continue during high rainfall periods. Subsequently, when adequate maintenance of solids has not been performed, over-topping of the ponds may occur. Thus, there will be continued risk to human health and the environment from existing sludge/sediment.

Alternative 4: Complete Diversion of Waste (Excluding Zibar) / Abandonment by Geosynthetic Reinforcement / Backfill / Capping

This alternative assumes that the sludge/sediment is of a thixotropic nature: the sludge will desiccate (dewater) over time and gain enough strength to permit geosynthetic reinforcement material to be placed on top to help support backfill and capping operations.

No treatment of the accumulated sludge/sediment is assumed as part of this alternative. The geosynthetic fabric would be used only where needed to increase the load bearing capacity of the sludge/sediment so as to permit backfilling of soil to grade and allow the construction of a low permeability cover.

The goal of this remedial alternative is to provide a positive discharge of surface water from the covered lagoons, thereby minimizing percolation of water into the untreated sludge/sediment. Capping would also reduce the potential exposure of humans and the environment to the hazardous constituents in sludge/sediment. Under this alternative, it is assumed that acceptance of all liquid wastewater would cease (with the exception of the Zibar liquid wastes as noted above). Therefore, management/disposal alternatives to the ongoing method of liquid waste stream management must be available, including management at the individual points of generation. This alternative could be implemented in phases so that the entire facility need not be taken offline at one time. With portions of the pond system offline, however, there would be a diminished capacity to handle incoming liquid waste streams.

Alternative 5: Complete Diversion of Wastes (Excluding Zibar) / Stabilization of Sludge and Reuse as Landfill Cover Material / Backfill

This alternative includes treating affected media using stabilization/solidification technology. The materials would be removed using conventional earth-moving equipment, treated in situ prior to removal or treated ex situ after removal, then stockpiled for ongoing use as cover material for the adjacent landfill. The stabilization process would be applied to immobilize constituents of concern within their “host” medium (e.g., soil, sand and/or miscellaneous fill materials) and to prevent the constituents from leaching into groundwater.
As a result, the treated materials would be relatively inert and would provide beneficial reuse options for ongoing landfill operation and new cell development.

The goal of this remedial alternative is to eliminate the human or ecological exposure pathway to all historical sediment/sludge. It would provide treatment for existing in-place sludge/sediment to reduce contaminant load to the environment and potentially render the material useful for ongoing landfill needs.

Under this alternative, it is assumed that acceptance of all ongoing liquid waste would cease (with the exception of the Zibar liquid wastes as previously noted). Therefore, management/disposal alternatives of the diverted liquid waste stream must be available. This alternative could be implemented in phases so that the entire facility need not be taken off line at once; however, with portions of the pond system off-line, there would be a diminished capacity to handle incoming liquid waste streams.

Recommended and Approved Remediation Alternative

A detailed evaluation was conducted for each potential remedial action alternative using the following USEPA National Contingency Plan criteria typically employed at Superfund sites:

1. Overall protection of human health and the environment
2. Compliance with environmental legislation
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost Effectiveness

Based on these screening criteria, Alternatives 4 and 5 were the only alternatives considered viable. Alternative 5 allows for future use of the remediated lagoon area as future landfill cells and meets the desire of Al-Ekeder operators, the Joint Services Council for the North, and the MoEnv. Therefore, this alternative was selected and is the basis of this report.

5 Description of the Study Area

5.1 Climate

Mafraq is situated in the subtropical desert scrub biome. The climate of the site is best characterized by records from the Ramtha Meteorological Station – the closest weather station to Al-Ekeder Disposal Facility. Available climate measurements taken between 2003 and 2013 have been averaged and presented in Table 5-1.

Table 5-1: Average Data from Ramtha Meteorological Station

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Mean Air Temp (ºC)	9.2	10.0	13.0	16.8	21.1	24.0	26.0	26.3	24.2	21.0	15.2	10.5	18.1
Mean Max. Air Temp (ºC)	14.1	15.0	19.3	24.1	28.9	31.9	33.5	33.7	31.4	27.8	21.4	16.0	24.8
Mean Min. Air Temp (ºC)	4.2	4.9	6.7	9.6	13.2	16.0	18.5	18.8	17.0	14.0	9.0	5.0	11.4
Total Rainfall (mm)	54.2	63.8	26.5	12.1	2.1	0.3	0.0	0.0	0.2	9.1	20.8	37.3	226
Mean Relative Humidity (%)	73.3	73.1	64.1	58.9	51.7	52.3	56.7	60.2	59.6	56.5	62.1	66.1	61.2
Mean Wind Speed (Knot)	5.5	6.2	6.1	5.8	5.9	6.7	7.4	6.8	5.6	4.1	4.1	4.5	5.7
Total Evaporation, Class 'A' Pan (mm)	62.3	67.1	118.7	167.3	263.6	309.8	334.4	305.4	243.2	179.5	97.0	68.8	187
Prevailing Wind Direction (Degrees from True North) *	171.4	204.1	273.4	245.0	286.6	286.0	293.6	258.6	292.4	288.0	199.4	177.9	248

Reference: Jordan Annual Climate Bulletin, Jordan Meteorological Department (2003-2013)
Note *: The Prevailing Wind Direction Data is averaged from 2006-2012 because of data availability

5.2 Geology

The sequence of the exposed geological formations in the area is characterized by the following main formations (from top to bottom): recent deposits (consists of thin, alluvial – less than 2m); Rijam formation (consists of limestone, chalky limestone, and chalk, alternating with brown to black chert – 15-20m); and Muwaqqar formation (consists of chalk, marl, chalky limestone, thin beds of chert, phosphate, bituminous chalk and nodules and concretions of limestone – 320m). The Rijam formation is considered an aquifer in many places in Jordan; however, at this site, this formation is not categorized as an aquifer because of the discontinuity of the formation. The Muwaqqar formation, which underlies the ponds at depth, is considered an aquiclude and provides a confining formation for the underlying aquifer system. The Amman Formation is considered the main aquifer in the Yarmouk River Basin and exists at depths exceeding 300m below the Muwaqqar formation aquiclude.

A geotechnical investigation of Al-Ekeder Disposal Facility was prepared in January 2012 and contains information relevant to the landfill (Triple Corporation Consultants and Engineers 2012). The following layered subsurface materials (starting from the top surface) were encountered during the geotechnical investigation:

1. **Fill materials** composed of very weak marl with gravel, cobbles and boulders of chert and chalky marly limestone.
2. Brown, moist, stiff to very stiff **silty clay** with some gravel and cobbles of chert.
3. Pale yellow, moist very weak **marl** with fragments of chalky marly limestone.
4. Creamy, very weak **chalky marl** with fragments of chalky marly limestone.
5. Creamy, to light rosy, highly fractured, highly weathered, weak to moderately weak **chalky marly limestone** with marl filling the fractures and intercalated with thin layers of dark brown chert.
6. Creamy, fractured, weathered, moderately strong **silicified limestone**.
7. Dark brown, highly fractured strong **chert**.

No caves or cavities were encountered in any of the boreholes to depths drilled or in any excavated tests pits. Generally, the area is mostly stable. No faults or other geological features were observed at the site and surrounding areas.

5.3 Topography

The area of the site is 806 Donums. The site slopes towards the west. The topography of the landfill may be characterized as hilly to semi-flat, about 650 meters above mean sea level (MSL). The site is located within a natural wadi, with a gradient of approximately 2% flowing from East to West. The natural course of the wadi has been totally altered by the construction of roads, ponds, and stockpiles of excavated material. The land on both sides of the wadi rises at a gradient of more than 12%. After leaving the site, the wadi turns towards the north, entering Syria.

5.4 Soils

As shown in Figure 5-1, recent deposits occur in the form of thin alluvial deposits of consolidated gravels of chert and coarse limestone. The gravels are mostly consolidated and covered by a thin layer of soil. The thickness of the soil layer varies from a few centimeters where bedrock is exposed to more than 2 m.

Figure 5-1: Soil cover at Al-Ekeder Disposal Facility

Soil samples were taken from the surface of the land to the east and west of the landfill site in which the organic content measures about 5 - 6%. Table 5-2 shows the concentration of several heavy metals in these soils. The final column shows the heavy metals in a silty, clayey soil sample representative of the eastern part of the site. Note that the data shown are only from surface soil samples taken at three points (one to the east of the landfill, one at the landfill, and one to the west).

Table 5-2: Heavy Metals Measured in Surface Soils near the Site

Parameter	West (mg/L)	East (mg/L)	Landfill (mg/L)
Mercury	65 x 10-3	35 x 10-3	28 x 10-3
Lead	60	66.5	46
Cadmium	0.6	0.8	0.6
Arsenic	12.5	12	15.5

Note: mg/L indicates milligrams per liter.

A geotechnical analysis of the sample collected from the landfill site was made to see whether it would be suitable for use in a liner system as the low permeability layer. The soil is of low to medium plasticity, with a plasticity index of 18.5%, with 34% passing the No. 200 sieve. In the unified soil classification system, this material would be classified as CL, comprising inorganic clays of low to medium plasticity.

5.5 Surface Water

The site is located within a natural wadi as shown in Figure 4-3. After leaving the site, the wadi turns towards the north, entering the Syrian city of Dera'a approximately 2km away. Due to the extent of activities at the site, it is not possible at present to determine the quantity of water flow emanating solely from the wadi. The wadi extends from east to west along the Jordanian-Syrian border and continues into Syrian territory. A branch of the wadi crosses the

Al-Ekeder site at Pond 4. This section of the wadi allows rainfall to accumulate and flow to the ponds, where evaporation occurs.

Within the site, there is no engineered storm water drainage system. Storm water drains by gravity to the ponds from nearby roads and areas. During periods of high rainfall, water can potentially overtop the pond berms and flow uncontrolled across the site and potentially discharge across the Syrian border.

The Al-Ekeder site is in an area where the soil and rock cover above the A7/B2 aquifer system (explained below) is highly protective. Flooding of the wadi and uncontrolled release of polluted water down gradient present a risk of surface water contamination.

5.6 Groundwater

As shown in Figure 5-22, Al-Ekeder Disposal Facility is located within the Yarmouk Basin.

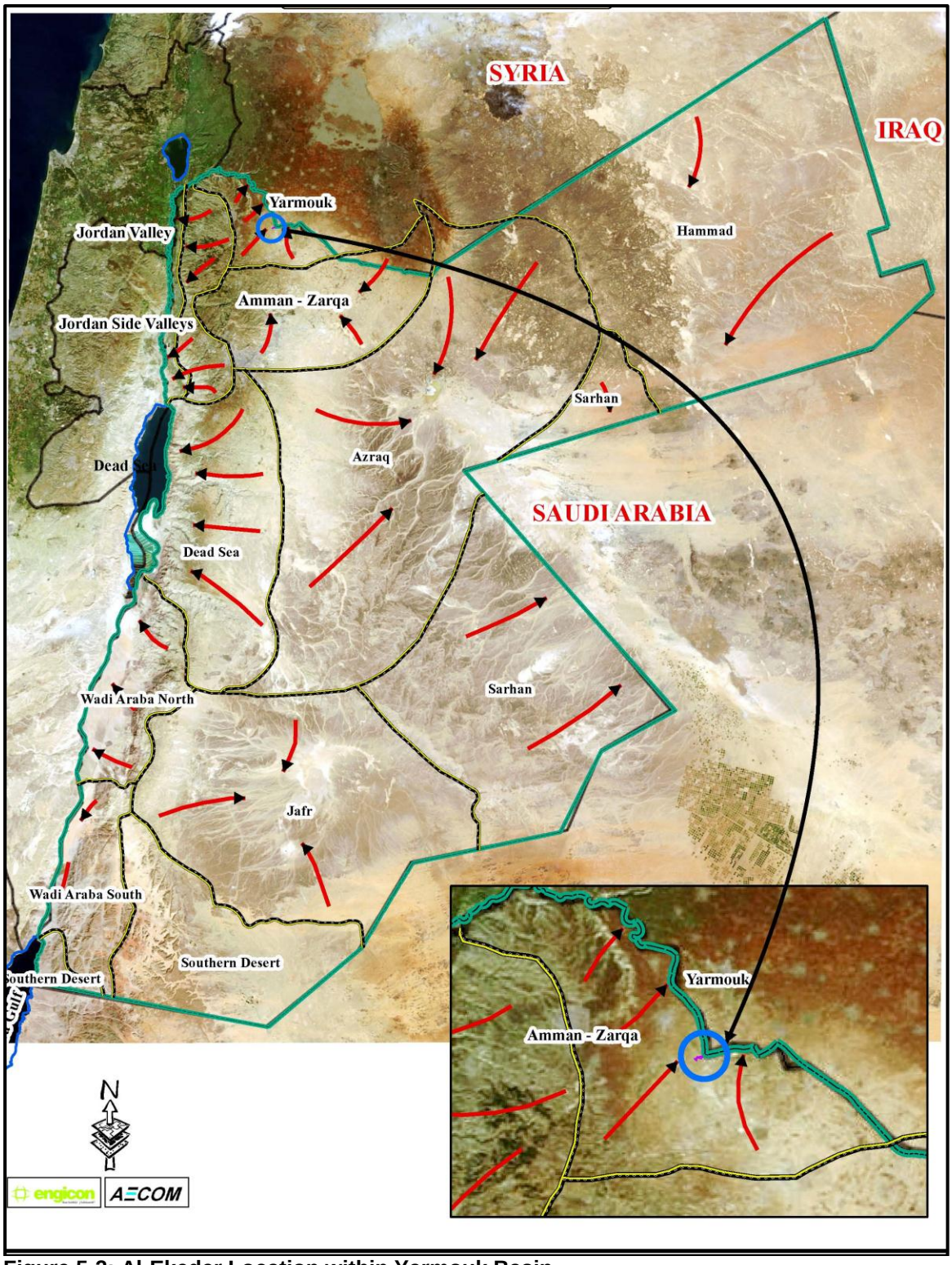


Figure 5-2: Al-Ekeder Location within Yarmouk Basin

Groundwater in the north-east of Jordan is present in three aquifer complexes termed the shallow, middle and deep aquifers. The aquifer systems in the region (Yarmouk Basin) are either related to the Ajloun or Belga Groupslui. The sequence of these formations can be summarized (from top to bottom) as: Rijam Formation (B4), Muwaqqar Formation (B3), Amman Formation (B2), Umm Ghudran Formation (B1), Wadi Sir Formation (A7), Shueib Formation (A5/A6), and Hummar Formation (A4).

The Rijam Formation (B4) is considered an aquifer in many places in Jordan; however, at the site, this formation is not categorized as an aquifer. This is due to its isolated nature, very thin permeable beds and the discontinuity of the formation across the site.

The Muwaqqar Formation (B3), which represents the area's vast exposed rock unit, is composed of chalk and marl. From a hydrogeological view point, it is considered an aquiclude. However, due to its low vertical permeability, and its relatively large thickness, this formation is considered a confining formation for the underlying aquifer system.

Generally, the (B2/A7) Aquifer System represents the Upper Aquifer System in the area and the main aquifer in the Yarmouk Basin (Figure 5-3) and is recharged from three sources: the rock out-crops of the Ajlun Mountains, the inflow from the North-Eastern desert, and the Yarmouk catchment area located in the adjacent Syrian territory.

Because of the geological location of the Amman-Wadi As Sir (B2/A7) Formations, the aquifer system at the Al-Ekeder site is considered to be confined because it is located between two aquicludes (B3 and A5/6).

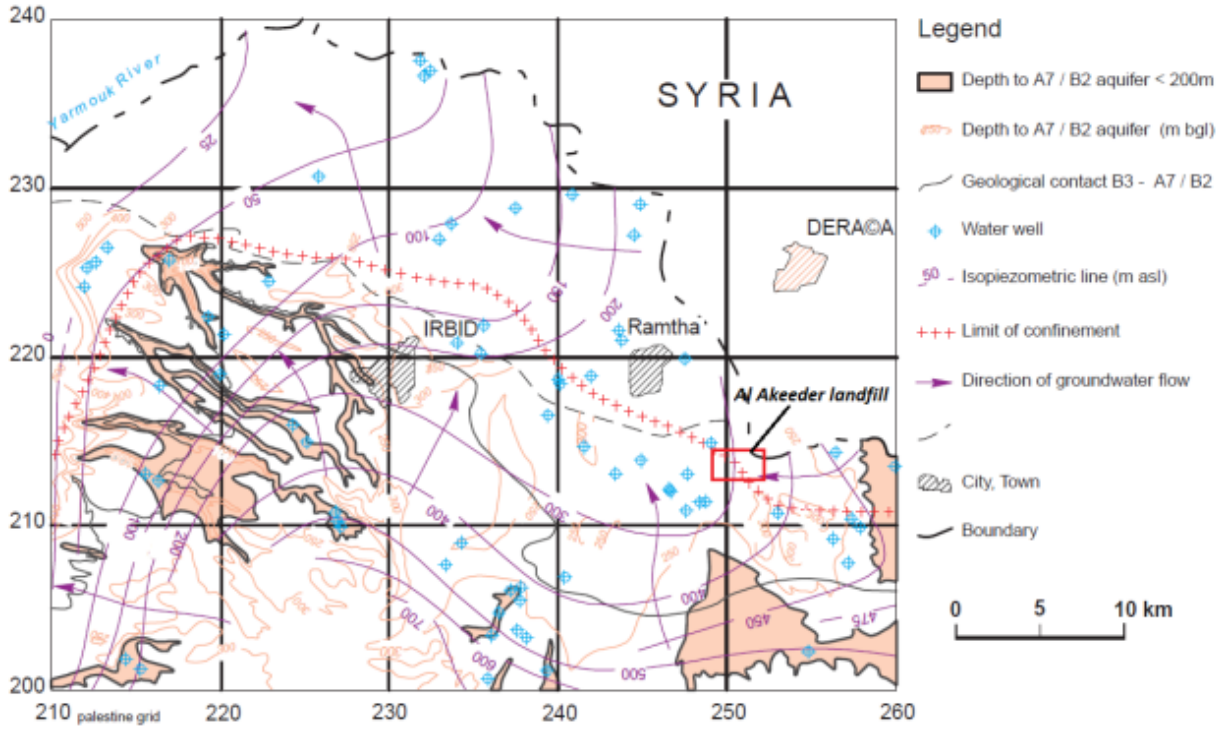


Figure 5-3: Regional Groundwater Flow Pattern in B2/A7 Aquifer System

The groundwater flow direction beneath the Disposal Facility is from east to west as indicated in Figure 5-4.

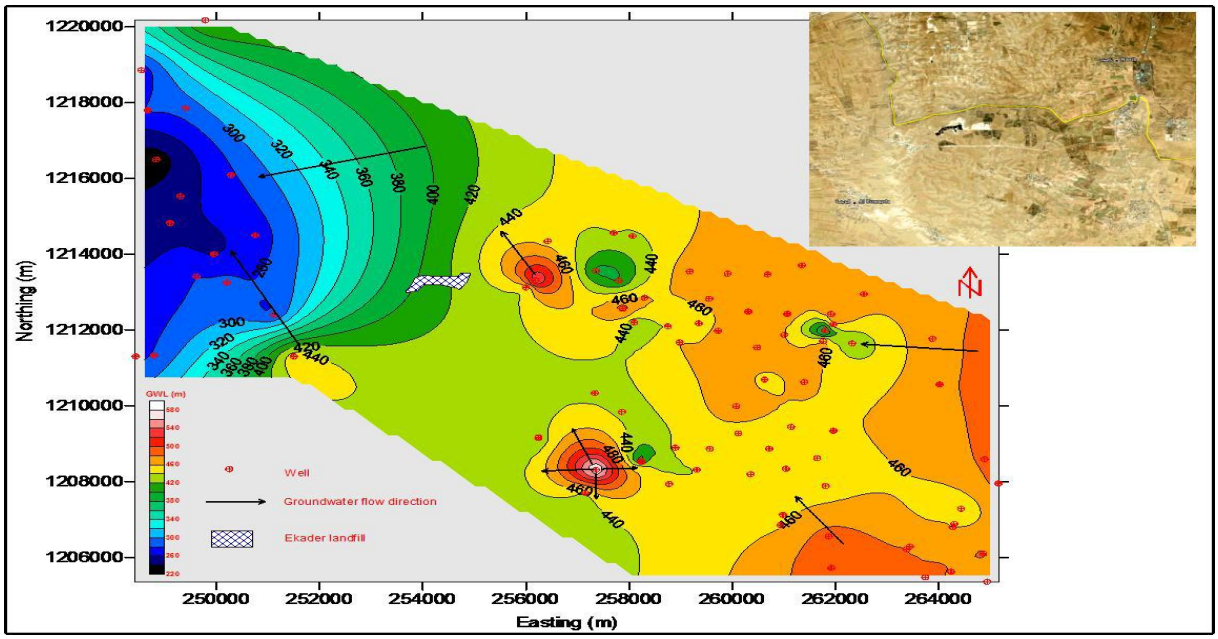


Figure 5-4: Groundwater Flow Map beneath the Al Ekeder Disposal Facility

Figure 5-5 shows the spatial distribution of groundwater wells drilled in the vicinity of the Al-Ekeder site. The piezometric head of the groundwater under Al-Ekeder Disposal Facility is about 400 meter above MSL, or about 100 meter above the B3 base. As a result, productive groundwater wells need to penetrate the (B2/A7) Formations. Therefore the depth of the groundwater wells in the area often exceeds 500m.

The vertical permeability of the B3 Formation is very low, showing a value of about $1x10^{-9}$ m/s, in many studies (Azraq Oasis Project, 1996; JEC, 1997; WAJ/BGR, 1997). Due to this low permeability, and the lack of major structures in the study area, pollutant mobility from the Al-Ekeder site to the aquifer system is anticipated to be very limited.

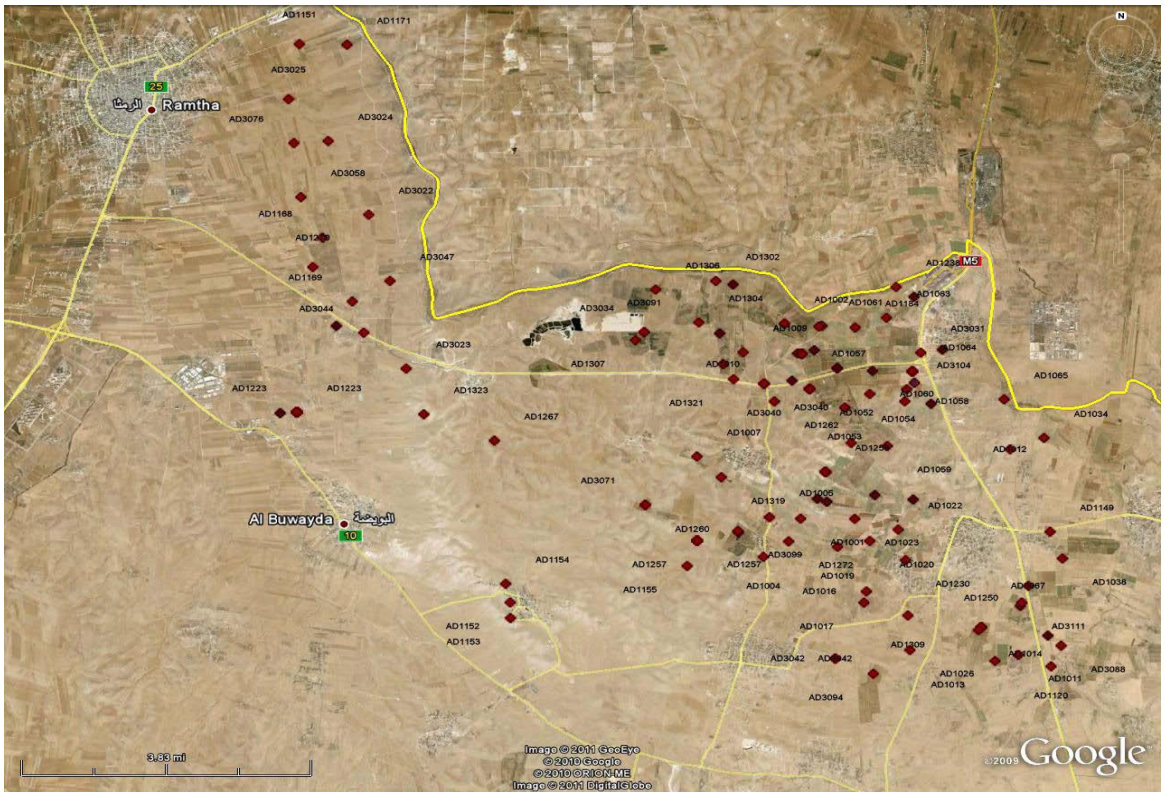


Figure 5-5: Spatial Distribution of Groundwater Wells Drilled In The Vicinity Of Al Ekeder Disposal Facility

Many previously completed studies on groundwater profile were assessed to determine the chemical and biological parameters representative of the groundwater quality in the Al-Ekeder area. A number of privately owned groundwater extraction wells are located within the vicinity of the disposal site; although the use of water extracted from these wells is unknown. The Royal Scientific Society (RSS, 2006) tested a number of these wells and found some to contain elevated levels of turbidity, total dissolved solids, hardness, arsenic and total microbial contaminants. Reportedly some of these results were in excess of maximum allowable limits of national standards in accordance with JS 286/2001.

In another study, Majdalawi *et al.* (2013) collected and analyzed groundwater samples from the productive wells in the surroundings of Al-Ekeder facility. The study shows that there are small changes in the electrical conductivity/TDS values and in some hydrochemical parameters, such as NO_3, of the groundwater resources at the western side of the facility. The authors concluded that there is potential for contamination of groundwater extracted by private wells for irrigation and drinking purposes and located adjacent to the landfill. However, no serious increases in heavy metals were reported.

Abu-Rukah and El-Aloosy (1997) indicated that there is a migration of metal ions to the deep layers, and another similar study indicates that the Al-Ekeder landfill leachates constitute a serious threat to the local aquifers.

In contrast to these studies, Northern Region Solid Waste Management Study, Final Report (1998/1999) concluded that the groundwater quality in the vicinity of Al-Ekeder Disposal Facility does not appear to have been impacted by pollutants. Moreover, there was no evidence that the groundwater is being impacted by either the solid or the liquid wastes operations at the Al-Ekeder site.

5.7 Air Quality

There is no landfill gas collection or flaring system in Al-Ekeder Disposal Facility. During the site visits, project team members experienced blurry vision in the landfill area as a result of gas emissions, and many incidences of landfill fires were seen.

In a study that was conducted by Abu Qdais, F. Abdulla and L. Qrenawi, methane emission from Al-Ekeder landfill was simulated from 1981 to 2055. It was assumed that by the year 2020, the landfill will be reaching its full capacity and will be closed. The peak amount of methane was estimated to be 12 million cubic meters per year in the year 2021 (one year after landfill closure), after which the methane production would start declining.

It is well-known that methane is a flammable greenhouse gas with relatively high heat content. According to the study, methane has 21 times the effect of carbon dioxide in contributing to Global Warming Potential. Table 5-3 presents the GWP Species Emitted from Al-Ekeder Landfill in 2006.

Table 5-3: GWP Species Emitted from Al-Ekeder Landfill in 2006

Species	GWP (tonnes of CO2)
Methane	150000
Carbon Dioxide	23300
1, 1, 1, 2 – Tetrafluorochloroethane	2.88
1, 1, 1 – Trichlorotrifluoroethane	54.3
1 – Chloro – 1, 1 – difluoroethane	155
Chlorodifluoromethane	4570
Chloroform	0.221
Chlorotrifluoromethane	1280
Dichlorodifluoromethane	13600
Dichloromethane	3.77
Trichlorofluromethane	956
Trichlorotrifluoroethane	325
Total	194247

Reference: H. Abu Qdais, F. Abdulla and L. Qrenawi, 2010

In addition to gas emissions, high concentrations of phenolic compounds in Zibar ponds inhibit microbial activity and thus prevent biological treatment or microbial fermentation. As a result, there is a strong and unpleasant odor within the site.

However, there is no operating air quality monitoring station in the project area at the time of preparing this document.

5.8 Noise

During visits to the site, noise levels in the vicinity of Al-Ekeder Disposal Facility were due to the movement of heavy vehicles transporting solid wastes and the excavation and transportation of cover materials from a designated on-site borrow area.

5.9 Flora and Fauna

The project site and surrounding area is classified as part of the Irano-Turanian region, which is characterized by treeless land with mostly shrubs and bushes. Threatened species in the Mafraq region are Verbascum transjordanicum, Biarum eximum and Narcissus tazetta. Table 5-4 presents typical plant species found in the Irano-Turanian region.

Table 5-4: Typical Plant Species found in the Irano-Turanian Region

Species Name	Species Name	Species Name	Species Name
Anabasis syriaca	Texiera glastifolia	Capparis parviflora	Achillea santolina
Noaea mucronata	Cardaria draba	Boissiera squarrosa	Achillea fragrantissima
Salsola vermiculata	Adonis dentata	Crithopsis delileana	Varthemia iphinoides
Salsola inermis	Artemisia herba-alba	Lactuca orientalis	Gypsophila arabica
Hammada eigii	Salvia lanigera	Erucaria pinnata	Matthiola aspera
Crocus moabiticus	Pimpinella eriocarpa	Diplotaxis erucoides	Sisymbrium runcinatum
Tulipa polychroma	Poa bulbosa	Torularia torulosa	Ephedra alte

Reference: Al-Eisawi, D. (1996) Vegetation of Jordan. UNESCO – Cairo Office

As shown in Figure 5-6, during the team's site visits to the facility, a few batches of Forest Trees that are distributed randomly in the areas surrounding Al-Ekeder Facility were noticed.

Figure 5-6: Forest Trees at the Areas Surrounding Al-Ekeder Facility, 21.04.2015

Vegetation in the southern and eastern areas surrounding the Al-Ekeder site is composed mostly of olive trees and other heat tolerant plants, as shown in Figure 5-7 and Figure 5-8.

Figure 5-7: Olive Trees at the Areas Surrounding Al-Ekeder Facility from the South, 21.04.2015

Figure 5-8: Olive Trees and Fleshy Plants at the Areas Surrounding Al-Ekeder Facility from the East, 21.04.2015

Important mammals observed in the Mafraq area include the Marbled Polecat (Vormela peregusna), which is considered a vulnerable species according to the International Union for the Conservation of Nature (IUCN) Red Book. Another mammal observed in the Mafraq area is the five-toed Jerboa, Allactaga euphratica. This Jerboa is restricted to the arid

habitats of Jordan. It is not a species of special concern. Additionally, as shown in Figure 5-9 sheep have been noted to graze in the area surrounding the facility from the east and near the landfill site, in addition to some Canaan dogs.

Figure 5-9: Sheep Grazing at the Areas Surrounding Al-Ekeder Facility from the East, 21.04.2015

Bird species that have been observed in the Mafraq area are listed in Table 5-5. As per the map in Figure 5-10 provided by the Royal Society for the Conservation of Nature (RSCN), Al-Ekeder Facility is located within an Important Bird Area (IBA). The IBA program was developed by BirdLife International with the purpose of identifying and conserving sites that have a global significance for birds based on specific global criteria (The State of Jordan's Birds, 2013). Al-Ekeder area was mainly chosen due to the migrating birds passing through it during spring and autumn migration.

Table 5-5: List of Bird Species Observed in Mafraq Region

Species Name	Common Name	IUCN Red list Classification
Aquila heliaca	Eastern Imperial Eagle	VU (Facing high risk of extension in the wild)
Falco naumanni	Lesser Kestrel	VU (Facing high risk of extension in the wild)
Crex crex	Corncrake	NT (Close to qualify for a threatened category in the near future)
Vanellus gregarius	Sociable Lapwing	CR (Critically endangered: facing extremely high risk of extension in the wild)
Oenanthe finschii	Finsch's Wheatear	LC (Least concern: widespread and abundant)
Serinus syriacus	Syrian Serin	VU (Facing high risk of extension in the wild)

Reference: Evans, M.I. Important Bird Areas in the Middle East. Birdlife International and IUCN Red List of Threatened Species Website (www.iucnredlist.org)

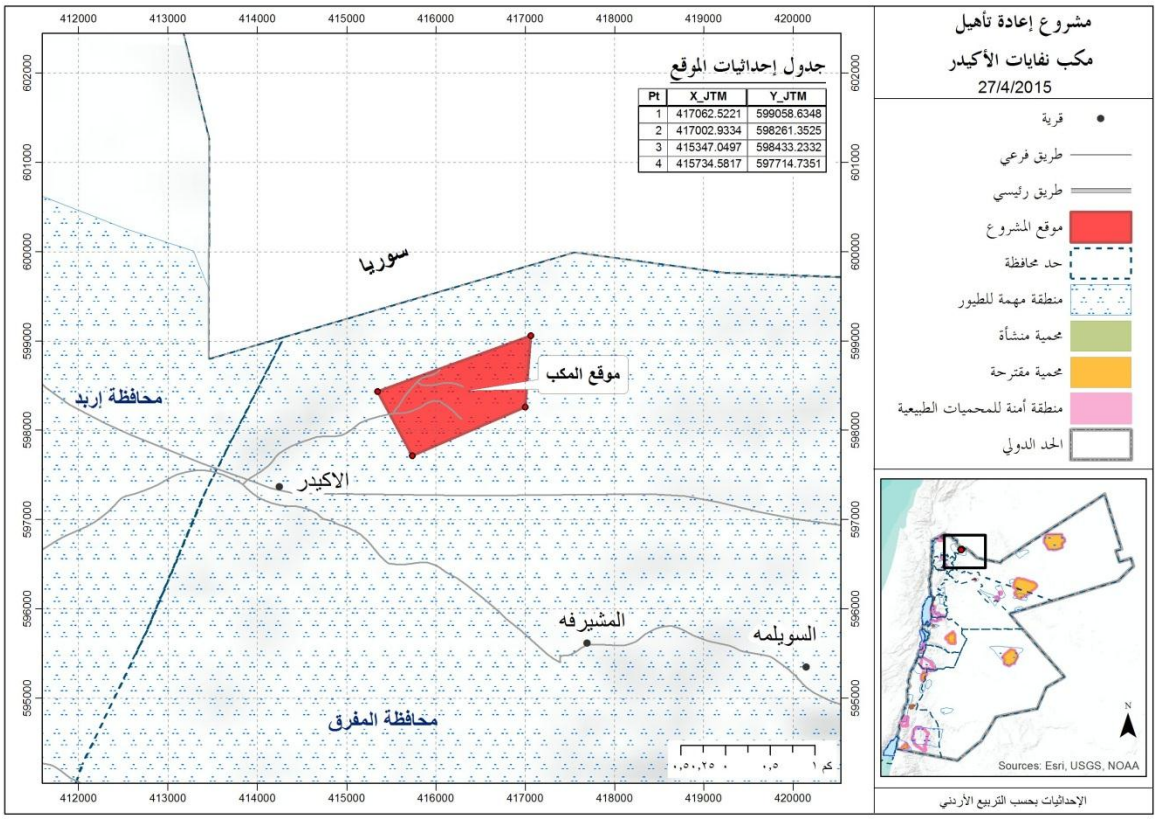


Figure 5-10: The Ekeder Facility as Part of an IBA, RSCN, 2015

As shown in Figure 5-11, the critically endangered Sociable lapwing was observed in Al-Ekeder facility during the team site visit in April 2015.

Figure 5-11: Sociable lapwing at the Al-Ekeder Facility, 21.04.2015

5.10 Antiquities

Archaeological resources and antiquities in the vicinity have been identified through the MEGAJORDAN website which documents details about national heritage archaeological sites around the country. Preliminary research showed that there are five archaeological sites in the disposal facility's surrounding area in addition to Al-Ekeder village, as shown in Figure 5-12. Information on the history and nature of these sites is not available but using the coordinates of the sites the proximity to the project location has been identified. Duhaiyim is the closest site to the landfill expansion site on the eastern side of the Disposal Facility and it is around 2.25 km away. The closest site to the western expansion portion is an unnamed location that is around 2.70 km away.

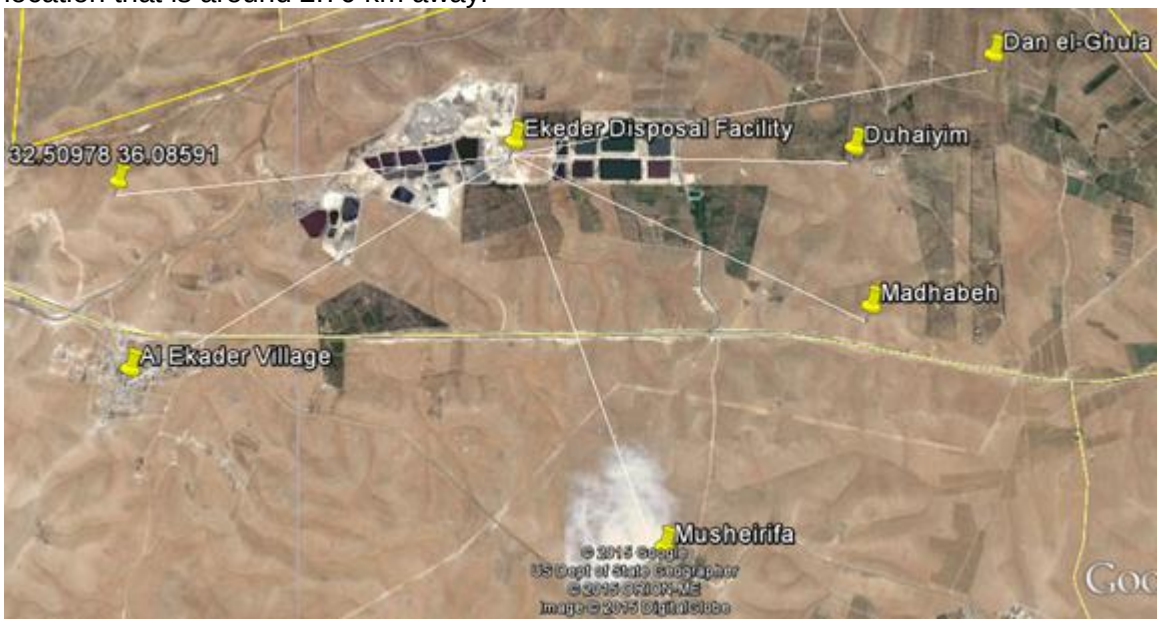


Figure 5-12: Surrounding Archaeological Locations, MEGAJORDAN.org

5.11 Land Use

The nearest village to the Disposal Facility is called Al-Ekeder. It is situated about 2 km to the southwest of the site boundaries. The site covers 806,000 square meters. The land around the Al-Ekeder site is traditionally used as rough pasturage for sheep and goats, with strip cultivation along the banks of the wadis. The low annual rainfall (200 mm) allows the growing of olive trees. Effluent from the adjacent waste water treatment plant is used for irrigation of olive farms adjacent to the site.

Land in the western portion of the facility adjacent to the site entrance was recently acquired by the facility to construct an additional Zibar lagoon. Similarly, adjacent land plots in the eastern portion of the site were acquired for the construction of a landfill expansion cell (Cells 1 and 1A).

It is expected that with the implementation of the proposed Remediation Master Plan, there will be a partial reclamation and increase in land value in the project area.

5.12 Population and Major Economic Activities

The Ekeder Disposal Facility is located 2km northeast of the village of Al-Ekeder which lies in the Hosha sub-district in the Mafraq Governorate (see Figure 5-13). The Mafraq Governorate has a population of 306,900. The Hosha sub-district has a population of 17,820 inhabitants (DOS 2013). At the time of writing, no reliable information on the actual population of the village of Al-Ekeder could be found; however, numbers from unofficial sources indicated approximately 5,000 inhabitants.

At an almost equal distribution of males and females, the Mafraq governorate has a 14.5% unemployment rate and has a noticeable difference in the unemployment rates of both genders where male unemployment is 12.3% and female unemployment rate is much higher at 24.9% (see Table 5-6, DOS 2013).

Figure 5-13: Main Districts in Mafraq Governorate, MoI

Table 5-6: Unemployment Rates by Sex and Governorate, 2013

Governorate	Total	Female	Male
Amman	10.5	19.0	8.7
Balqa	14.4	20.4	12.9
Zarqa	13.1	21.9	12.0
Madaba	16.2	23.2	14.2
Irbid	13.0	26.5	10.4
Mafraq	14.5	24.9	12.3
Jerash	12.3	22.3	10.4
Ajloun	13.5	27.2	9.7
Karak	15.8	25.0	12.5
Tafiela	17.1	28.9	13.0
Ma'an	15.0	19.1	14.1
Aqaba	15.2	21.3	14.1

The Kingdom	12.6	22.2	10.6

Reference: DOS, 2013

Al-Ekeder Disposal Facility is the second largest disposal facility in Jordan, serving around 100 towns and villages in the Northern region of the country. Due to increased waste intake, the facility is expanding its operations and adopting more environmentally sustainable operations. This should provide some temporary construction jobs and a possibility for some permanent jobs. Additionally, it will support Jordanians in different parts of the country because it is one of the few disposal facilities that accept Zibar which can aid in their compliance of environmental regulations.

No clear information about the economic activities taking place in the direct surroundings of the disposal facility was available. There are a number of contracted scavengers who are living in the direct surroundings of the facility. They mostly live in tents and have basic capabilities, but they were seen collecting recyclable materials at the facility during the team's site visits.

5.13 Transportation

Al-Ekeder landfill is located in the northern region of Jordan, near the main road to Mafraq Governorate. It can be reached by a paved road about 7 km to the north of the Irbid/Mafraq highway (Abu Qdais, et al., 2010).

The site is connected to the international road (Jabber Road). Jabber Road runs along the southern boundary of the site and is one of the major roads to the Syrian border from Ramtha City. It connects with the disposal facility access road and presently has sufficient capacity to serve the facility.

Within the site, there are five major access roads (see Figure 5-14):

1. Road A located along the site from the scale area to the solid waste landfill north of the ponds.
2. Road B located along the site from the scale area to the major discharge point at Pond 1.
3. Road C which branches from Road B and progresses along the southern border of the landfill to the discharge point at Pond 1.
4. Road D which branches from Road B and progresses beside Pond 9 to the upper point in the southern part of landfill.
5. Road E which branches off Road A and progresses around the solid waste landfill.

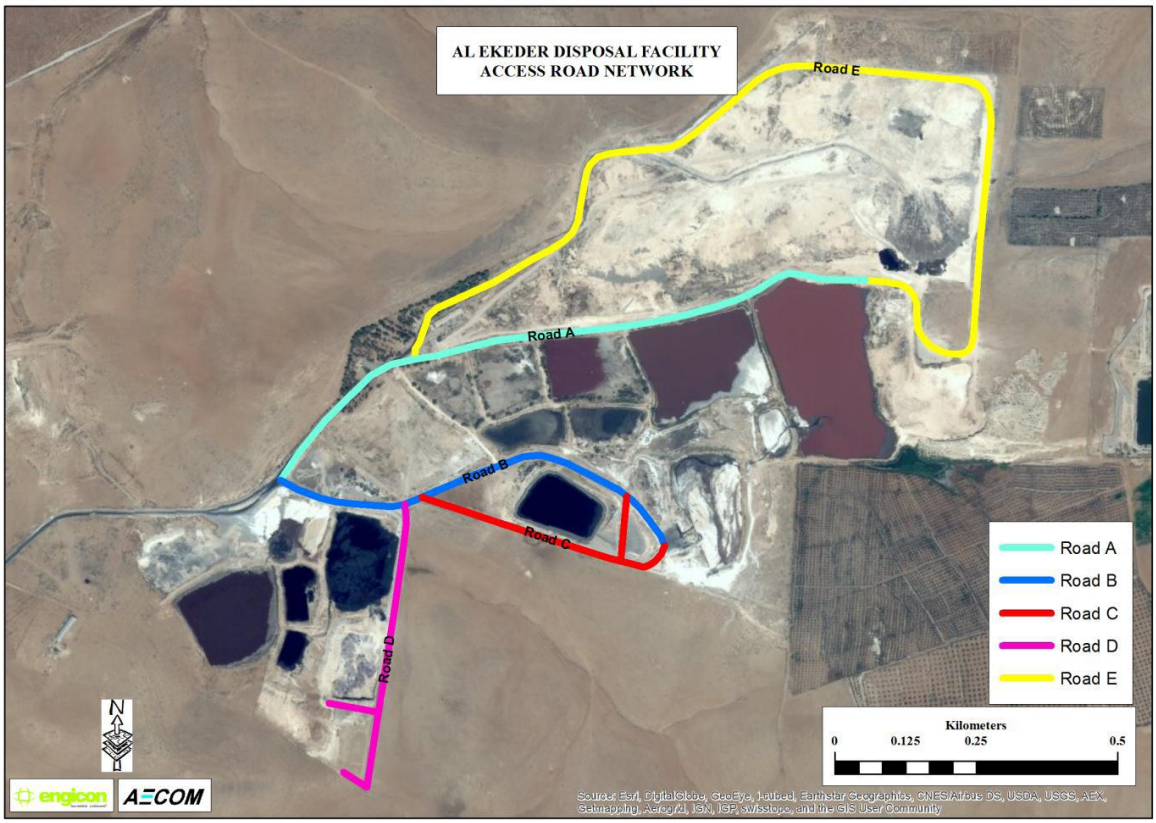


Figure 5-14: Access Road Network at Al-Ekeder Disposal Facility

263 vehicles transported solid wastes in the northern region in 2012 (DOS, 2013). A truck count survey (TCS) of the liquid waste of Al-Ekeder was conducted covering the period of 20 December 2010 to 10 January 2011. The TCS concluded that more than 93.4% of the waste transported to the facility consisted of sludge from WWTP, Zibar, and stone industries waste water (Kamkha).

5.14 Water and Electricity Supply

In general, water supply for household municipal purposes in Mafraq governorate was about 21.4 million cubic meters in 2012.

There are no groundwater wells located within the Al-Ekeder site that cover the facility's water supply requirements. The facility's water requirements are provided through external trucking. Water is required mainly for drinking and sanitary purposes.

Electricity services in Mafraq Governorate are gradually improving. Five generators were recently added in the Mafraq area by Irbid District Electricity Company (IDECO) to improve the electricity current and to lower the load on the other generators. Mafraq electricity consumption is 736,036kw/hr., which forms 31.91% of the total generated energy that is provided by IDECO.

It is reported that three-phase power is supplied to the on-site maintenance area. A pole-mounted power transformer 33/0.4 kV provided by the electrical company (IDECO) is located near the existing administrative offices.

5.15 Solid Waste

Al-Ekeder Landfill receives solid waste generated in northern Jordan, which comprises roughly 100 towns and villages in addition to major urban centers. According to the landfill

operator, Al-Ekeder Disposal Facility receives roughly 1300 metric tonnes of solid waste per day (2014 estimate).

Solid waste arrives at the facility by means of individual trucks, which are weighed and source-identified at the scale house located at the main entrance, in the western part of the site. After the weigh-in, solid waste transport trucks are directed towards the working face of the landfill in the northern part of the site. The solid waste is then dumped at the working face, where contracted scavengers (some of whom live near the disposal facility) rummage through the waste to extract recyclable materials.

The remaining waste is then compacted. It is worth noting, however, that the effectiveness of compaction is restricted by the lack of specialized compaction equipment. Subsequently, the available landfill airspace at the site is being consumed very rapidly due to the low compaction of the waste and high waste intake. After compaction, the waste is sometimes covered with excavated materials from a designated on-site borrow area or with residue from evaporated liquid wastes.

Daily per capita generation of municipal solid waste in Irbid was estimated to range from 0.78 to 0.92 kg/capita/day (H. Abu Qdais et al., 2010).

5.16 Human Health

The ongoing practice for the disposal of liquid wastes using land management units in the Al-Ekeder site poses imminent and substantial endangerment to the surrounding communities' health.

Direct access by workers, customers and scavengers, as well as unrestricted access for the general public, presents a potential risk to human health. Toxicity of the individual substances relates to occupational or accidental exposure, as opposed to risk associated with the long-term exposure of the population who live close to the site.

Although the effects of leachate and gas production on health is the main concern in Al-Ekeder Facility, the effect of industrial wastewater disposal in unlined lagoons is another important issue: industrial wastewater can percolate into the soil and can be carried away with the gas generated in the landfill.

There are 12 Comprehensive and Primary Health Centers, and 11 Maternal and Child Health Centers in Ramtha district, which is the closest district to Al-Ekeder Disposal Facility. In addition, there are 10 governmental hospitals in Irbid city and another 3 governmental hospitals in Mafraq city.

6 Initial Assessment of Environmental Impacts and Mitigation Measures

6.1 Construction Phase

6.1.1 Geology, Topography and Soils

Anticipated Impacts

The expansion of the landfill cell is going to occupy land east of the existing facility. In addition, gas and leachate infrastructure, materials recovery facility, new administrative building and a gas flare/recovery system will be built within the site boundaries.

These construction activities can possibly cause soil erosion and soil compaction as a result of the heavy machinery and transport of construction materials. Soil compaction can affect drainage and increase flooding risk.

The existing landfill will be stabilized and graded to a maximum slope of 3H:1V. This will change the topography of the landfill site and increase the stability of waste-piles.

A proposed earthen evapotranspiration (ET) cap is to be added as a final cover layer. This cover will help in minimizing erosion. This cover typically uses locally available soils, so borrow pits are to be developed in several portions of the disposal facility during the construction phase to serve as a source of the needed cover materials. However, it is expected that a long-term soil shortage is likely to occur. It is assumed that on-site excavated soils will cover most soil requirements during the construction phase except for the granular protective cover that would be obtained from off-site sources.

The construction of an additional Zibar lagoon on recently acquired land in the western portion of the Facility is proposed. A natural wadi passes through the expansion boundary and slopes westwards towards the Syrian border. As a result, the natural course of the wadi might be altered by the construction of the new Zibar lagoon.

Additionally, there is a possibility for soil contamination as a result of fuel and liquid leakage from construction vehicles and machinery, and discarded wastes from construction employees.

Proposed Mitigation Measures

The contractor should abide by a Soil Erosion Prevention Plan and Spill Management Plan. These plans should include all the necessary measures to prevent and deal with soil erosion and contamination. The construction of the new Zibar lagoon in the wadi course should be avoided.

Soil compaction can be avoided by reducing the amount of trips made with construction vehicles, avoiding wet soil if possible, and loosening the soil through tilling once construction activities are concluded.

Soil contamination can be avoided by providing a sealed/impermeable floor for parking vehicles and isolating their movement to the expansion grounds where possible. Any leakages should be reported and dealt with immediately by using spill kits, and removing any contaminated top soil to be treated or disposed in a lined landfill cell.

Solid and liquid wastes from construction workers should go into designated containers that are emptied regularly and properly at the site. The liquid wastes may have to be transported to another facility depending on the type of liquid waste Al-Ekeder facility is accepting at the

time of implementation. External sources of soil should be identified in the early phases of the implementation of the proposed Master Plan, to avoid soil shortage and additional on-site excavation.

6.1.2 Surface Water

Anticipated Impacts

The natural course of the wadi might be altered by the construction of the proposed Zibar lagoon, and that presents a risk of flooding and thus surface water contamination. However, the risk of surface water contamination from discharges of construction activities and used hazardous chemicals can be managed and minimized through proper operation and storage of equipment and vehicles.

Proposed Mitigation Measures

A lined drainage channel will be incorporated into the design of the proposed perimeter berm to convey runoff to one of several stormwater management basins/areas and to avoid risk of flooding. Construction workers should be banned from washing their equipment and tools in the wadi course.

A Hazardous Materials Management Plan should be developed and implemented. Hazardous materials should be stored within double-lined tanks to prevent any spills / leaks to the environment.

6.1.3 Groundwater

Anticipated Impacts

The risk of ground water contamination from discharges of construction activities and used hazardous chemicals can be managed through proper operation and storage of equipment and vehicles.

6.1.4 Air Quality

Anticipated Impacts

The main impact on air quality during construction is caused by dust generated from excavation, vehicular movement, and uncovered construction materials. Emissions from heavy construction machinery are another source of air pollution during construction. Although these impacts are temporary, they can cause nuisance and health problems for workers and the surrounding communities.

Proposed Mitigation Measures

A dust management plan should be developed and abided by during the construction phase. All necessary dust abatement measures should be identified in the plan. These measures may include:

- Minimizing dust generating activities during dry and dusty weather.
- Moistening excavation sites by spraying a dust suppressant; alternatives to use of water as a suppressant should be evaluated due to the shortage of water sources.
- Covering all stockpiles and trucks transporting sand and other dust-producing construction materials.
- Spreading gravel on unpaved roads that will be used by construction vehicles.
- Controlling vehicle movement on unpaved roads.
- Providing construction workers with dust protective equipment such as glasses and face masks.
- Undertaking and recording visual on-site and off-site inspections on a daily basis, especially during periods of high activity or prolonged dry, windy weather.

All air quality complaints and potential causes of the complaints should be documented. Heavy machinery should be maintained regularly to minimize released emissions. Spill-cleaning equipment should be available at all times.

6.1.5 Noise

Anticipated Impacts

Noise levels are anticipated to increase during the construction phase, due to excavation activities and operation of heavy machinery. Construction workers will be the most affected by the noise but there is also a possibility for the scavengers to be affected by the noise produced by construction activities since some of them live near the site and they are regularly collecting recyclable items from the landfill.

Proposed Mitigation Measures

The Contractor should abide by the Jordanian Instructions for Controlling and Preventing Noise, such that noisy activities are prevented from 8 pm to 6 am. Furthermore, workers should be provided with noise protection equipment. Several noise generating activities should be scheduled at the same time, to prevent prolonged periods of noise. Heavy machinery should be maintained and greased regularly to minimize unnecessary equipment noise.

6.1.6 Flora and Fauna

Anticipated Impacts

The existing disposal facility area is barren of most kinds of vegetation. However, the landfill expansion site is directly adjacent to the existing landfill, and it is vegetated with natural annual grasses, some scattered trees, and olive trees that will be removed during the construction.

In addition, the construction of the new infrastructure facilities and Zibar lagoons will include removing parts of the vegetative cover at the site and potentially disturbing and polluting the surrounding vegetation through soil erosion and contamination and direct damage to the vegetation.

Construction works might have minimum negative impacts on the fauna species that exist in the project area. No fauna species are anticipated to be affected, except for one small herd of sheep that graze in the area and dogs that should be kept away from the facility boundaries.

Al-Ekeder Facility is recognized as an IBA since it is an important staging and wintering area for a wide assortment of migratory water birds. Therefore, these water birds might be at risk of disturbance due to construction noise, traffic, and presence of people. In addition, the closure of several existing liquid waste disposal evaporation lagoons might affect these water birds and reduce their numbers in the area.

Proposed Mitigation Measures

Some habitat loss is inevitable and cannot be mitigated. However, construction vehicles should be confined to using previously disturbed land and roads from the current facility in order to avoid disturbing and damaging the surrounding habitat. Additionally, any trees removed as a result of the construction activities related to the expansion should be relocated or replanted elsewhere if at all possible.

Construction activities should be restricted to one area at a time wherever possible, to allow the movement of fauna species to undisturbed areas nearby. It is also recommended to avoid construction works during the migratory season (mainly in the winter time) and to conduct multiple noise-generating activities simultaneously so as to reduce the periods of

exposure, as long as total noise levels are controlled. Construction workers should not trap or hunt any existing animal and bird species in the project area. Any captured animals should be moved to nearby undisturbed areas.

Generation of noise, dust, and the spill of chemicals and hazardous materials should be controlled and reduced as much as possible, to prevent the negative impacts on the biodiversity of the area.

6.1.7 Antiquities

Anticipated Impacts

No visible archaeological findings were found in the project site. However, the contractor should take into consideration the possibility of finding and damaging unknown archaeological structures during excavation.

Proposed Mitigation Measures

The Contractor should stop work within the area in the case of any archaeological findings and immediately contact the DOA. Work should not be resumed until further notice from the DOA is given to proceed. Areas close to archaeological findings should be protected during all project phases.

6.1.8 Land Use

Anticipated Impacts

The newly acquired land plots in the eastern portion of the site will be used for the construction of new landfill cells and this includes the removing/cutting of adjacent areas of cultivated olive trees. This will affect land owners and farmers by reducing their income that is generated from olive trees cultivation. The newly acquired land parcel in the western portion of the site will be used for the construction of two additional Zibar lagoons. The expansion area of the site will consume additional lands that were previously not part of the Al-Ekeder site, which accordingly will extend the environmental impacts to the surrounding new areas.

The remediation plan will improve, to an extent, the value of the nearby lands surrounding the Al-Ekeder site. The boundary of the expanded Al-Ekeder site will be closer to the buffer zone of the Jordan-Syrian border. Ownership of the Al-Ekeder site is shared by the Greater Irbid Municipality, Ramtha Municipality, Yarmouk University, Water Authority of Jordan and the Joint Services Council for Irbid Governorate.

Proposed Mitigation Measures

The removal of olive trees and the expansion of the landfill cells and Zibar lagoons should be controlled to minimize the environmental impacts during construction phase. Owners of land adjacent to the expansion areas and farmers should be compensated if any loss, damage or negative impact affects their lands and agricultural practices during construction phase.

6.1.9 Population and Economic Activities

Anticipated Impacts

New job opportunities are expected to be generated for surrounding local communities during the construction phase. This will help in increasing generated income and ultimately enhance the life conditions of the nearby communities. Employment opportunities are mainly for males and can come in the form of construction positions, drivers, or service providers to the workers onsite. This contributes to the livelihood of the neighboring communities and offers a source of income.

6.1.10 Transportation

Anticipated Impacts

Al-Ekeder Disposal Facility is already accessible through five major access roads; however, prior to Cell 2 construction, a short segment of Road E will be removed and temporarily relocated westwards along the eastern edge of Lagoon 13. This temporary road will be taken out of service prior to Cell 3 construction. Road C will be extended around the southern property edge from the current Roads B&C termination at Pond 1 for construction access. Therefore the construction of additional access roads is considered minimal, and can be considered insignificant.

In general, the risk of accidents might increase in the project area as a result of traffic increase due to the presence of construction vehicles and the movement of workers from and to the site. Trucks delivering necessary construction material and conveying construction waste out of the site might generate dust if uncovered, which will result in lower visibility along the road.

Proposed Mitigation Measures

A traffic management plan should be developed and implemented by the contractor . The plan should be suitable for the construction site conditions. Proper and clear signage, in different languages, should be provided along affected access roads in order to indicate the construction activities.

Construction material and soil should be securely packed and covered on trucks to prevent loads from falling off or generating dust.

6.1.11 Water and Electricity Supply

Anticipated Impacts

There will be an increase in water demand for the various construction activities, such as dust control, and domestic water uses at site offices. It is expected that the demand on water will increase by about five times. In addition, potable water might be used to wash construction equipment and tools. If the contractor will be trucking water in, it is expected that there will be no potential impact on the local water supply; however, the total demand on water in the country might be slightly affected.

The demand on electricity will also increase during the construction phase, which will affect the current power supplied to Al-Ekeder Facility.

Proposed Mitigation Measures

In the pre-construction stage a water source for construction activities should be allocated to ensure that use of water by the contractor will not affect the water supply of the local communities. The Contractor should provide water from a sufficient source of water using tankers and ensure that the availability of water in the local community will not be affected. Construction crews should conserve water during all construction activities and handle water resources efficiently.

Increasing the size and capacity of the existing power supplied to the site needs to be discussed with IDECO prior to the construction phase.

6.1.12 Solid Waste

Anticipated Impacts

The main sources of solid waste during the construction phase are excavation and earthworks. Additionally, domestic solid waste is generated by construction workers. The

accumulation of these wastes can be considered a hazard for human health and the surrounding environment.

Proposed Mitigation Measures
Excavated soils should be loaded and hauled to designated stockpile areas (borrow areas) and used as cover material.

Construction wastes should be collected and disposed of regularly. A Waste Management Plan should be prepared and implemented. The plan should identify waste collection schedule, storage locations, qualified carriers, and the final Disposal Facility.

Awareness sessions should be provided to construction workers on solid waste management, focused on minimizing waste generation, reusing and recycling where possible and designating certain areas for waste disposal. Furthermore, a Hazardous Materials Management Plan should specify the procedures for handling, storing, transporting and disposing of hazardous wastes.

6.1.13 Human Health

Anticipated Impacts
The construction of the new landfill cells, Zibar lagoons, and infrastructure, as well as the phased Zibar and liquid waste lagoons closure will require excavation and/or fill activities. Potential injury sources during the construction phase include falls, electrocution, transportation accidents, and excavations and mishandling of machinery.

Construction workers will be working with heavy machinery, which might lead to accidents. In addition, workers might be susceptible to health problems such as respiratory diseases, due to the exposure to leachate leaks, hazardous materials, high levels of dust, and high concentrations of methane, carbon dioxide and chlorofluorocarbons in the vicinity of the Al-Ekeder site. Methane is also a highly flammable gas, which if not controlled properly might lead to an increased risk for fires within the landfill site.

The exposure to high levels of noise might cause hearing impairment. Moreover, the presence of small wadis near the new Zibar lagoon, as well as the change in natural drainage systems, might jeopardize workers' safety: some workers may slip or fall down without adequate safety measures.

The project area is characterized by high temperatures, such that if construction were conducted during summer months direct exposure to the sun might pose heat stress risk for the workers. Heat stress can cause dizziness, weakness, breathlessness, as well as accelerated heartbeats.

Proposed Mitigation Measures
All necessary safety measures should be described in a separate section within the Contractor's Tender Documents. These measures should be provided during the construction phase. They include safety gear and equipment such as harnesses, hearing protection, guardrails, secured ladders and scaffoldings, and trench shields. Proper mitigation measures for noise, dust and traffic should be provided to alleviate construction induced impacts on workers and the nearby communities. The contractor should schedule the work shifts in a way that keeps exposure durations for workers within the acceptable noise limits.

Personal safety gas detectors should be provided to workers to warn them of high levels of methane. Heat stress can be prevented by drinking enough water; potable water should therefore be easily accessed by all workers. In addition, clean cups and water bottles should

be provided. Proper scheduling of work durations and breaks can reduce the incidents of heat stress by reducing individual workload. Hats and shaded areas should also be provided for workers.

Prior to construction activities, a comprehensive Health and Safety Plan (HASP) should be developed to stipulate the contractor's responsibilities regarding health and sanitary needs of workers. These include proper arrangements for dining, bathing, drinking, sanitation, ventilation and light, firefighting, and safe transportation. The HASP should also assign a Health and Safety Officer to ensure its implementation. Moreover, the plan should lay out a procedure for reporting and investigating all accidents to identify responsible individuals and to prevent recurrence.

Regular safety awareness sessions and meetings should be held to ensure the proper implementation of the HASP. The location of the closest hospital or medical clinic and the shortest route should be identified. Transportation of workers should be done in vehicles equipped with seats and barriers for their safety. It is not permitted to transport individuals in dump trucks. It is also important to assign a doctor to serve the workers during the construction phase. Workers should be provided with health insurance, and should be subject to regular medical checkups as per the Jordanian instructions.

A Hazardous Materials Management Plan (HMMP) should be developed and abided by. Hazardous materials should be stored within double-lined tanks to prevent any spills/leaks that might cause injuries. Hazardous material should also be labeled, used and disposed of properly and according to the HMMP.

In addition, it is important to avoid dust-generating activities during windy days. The contractor should also apply dust-suppressing measures such as moistening and water spraying of the excavation areas, and any other exposed surfaces.

6.2 Operations Phase

6.2.1 Geology, Topography and Soils

Anticipated Impacts

Al-Ekeder Disposal Facility already experiences frequent truck activity due to the nature of the facility. Unloading, disposal, and landfill covering activities in addition to the movement of heavy machinery may have a negative impact on soil stability, and may cause soil erosion and compaction. This in turn may affect drainage and increase flooding risk.

Many of the roads going through the landfill are not paved which means that some liquid waste from different sources may be discharged onto permeable surfaces with potential damage to the soil. However, a lined drainage channel will be installed for the perimeter berm to convey runoff to one of several stormwater management basins/areas and to avoid risk of flooding.

Soil contamination is another impact of disposal facilities due to possible infiltration of leachate, fuel and vehicle liquid leaks and liquid wastes from workers in the site. However, the addition of a liner system over the existing landfill will provide an impermeable barrier sloped to the new expansion cells for leachate collection and will isolate future waste disposal within a secure landfill for environmental protection, which as a result will reduce soil contamination.

Currently, Al-Ekeder Landfill operates with minimal daily cover because bed rock is so shallow at the site, Therefore the remediation plan considered the reuse of solidified/stabilized sludge as daily cover on the landfill. However, it is expected that within

five years after the construction of Cells 1/1A, Al-Ekeder landfill will experience soil deficits; therefore, soil may need to be obtained from off-site sources.

Soil contamination in the existing site will be reduced through utilizing contaminated soils, compost, or construction demolition debris as landfill daily cover. Contaminated soil will be treated in-situ using stabilization/solidification technology. This will eliminate the direct human exposure pathway to sediment/sludge or ecological exposure to hazardous constituents in sludge/sediment.

In addition, the proposed ET cap, as a final layer of cover material, will control infiltration and percolation of precipitation, promoting surface water runoff and minimizing erosion.

Remediation and replacement of the unlined Zibar lagoons with standard lined lagoons will help in reducing soil contamination during the operation phase. Nonetheless, liner leakage that leads to uncontrolled leachate filtration may occur and that poses a risk of soil contamination. Kamkha residues are already dry, and can also be used for daily cover material, agricultural purposes, stabilization and solidification of lagoon sludge, and the development of low grade cement.

Proposed Mitigation Measures

In general, the remediation plan is designed in a way that minimizes the risk of soil contamination and improves the site topography. Monitoring of soil quality around Al-Ekeder Facility should be performed regularly (every two or three months) during the operation phase to avoid negative impacts on the quality of soil.

Solid waste disposal needs to be confined to the designated landfill cells and proper waste compaction and cover practices need to be enforced, in order to avoid any additional soil and environmental degradation.

A Soil Erosion Prevention Plan and Spill Management Plan should be developed and implemented. These plans should include all the necessary measures, main concerns, required actions, as well as responsibilities to prevent soil erosion and pollution. In order to avoid additional soil compaction, vehicle paths need to be clear and vehicle traffic should be confined to those areas if possible.

Fuelling and maintenance areas should be located on a sealed floor to prevent localized soil contamination. Any leakage incidents should be dealt with immediately by using spill kits and cleaning up and removing the top contaminated soil. Such accidents should be reported. Vehicles should be parked on a site with an impermeable surface.

6.2.2 Surface Water

Anticipated Impacts

If the landfill cell wastes are not compacted correctly and are loose, heavy rainfall events may cause some of the waste to drift with the path of the rain. Since there is a natural wadi sloping to the west of the project site, heavy rainfall events may take some of the trash down the wadi – especially if flooding occurs. In addition, unloading, disposal, and landfill covering activities, as well as the movement of heavy machinery, might impact soil stability and increase flooding risk.

Unlike the ongoing disposal practices, the addition of a liner system over the existing landfill will provide an impermeable barrier sloped to the new expansion cells for leachate collection, isolate future waste disposal within a secure landfill, and prevent the seepage of leachate into the subsurface. Furthermore, a lined drainage channel that will be installed for the

perimeter berm to convey runoff to one of several stormwater management basins/areas and that will lessen the risk of flooding.

Nevertheless, liner leakage that leads to uncontrolled leachate filtration might occur and that poses a risk of surface water contamination.

Flooding and leakage in Zibar lagoons (both the lined and unlined) will lead to surface water contamination, especially since one of the existing Zibar lagoons as well as the new Zibar lagoons are located on the natural wadi course. However, increasing the number of Zibar lagoons will increase Zibar intake capacity and thus reduce the risk of flooding.

There are no permanent water bodies within the area surrounding Al-Ekeder Facility and it is dry most of the year. However, with the presence of the natural wadi course within the facility boundaries, there is a minor risk of surface water contamination if the suggested mitigation measures are not implemented properly.

Proposed Mitigation Measures
The remediation plan includes a storm water drainage system, a leachate collection system, and additional lined Zibar lagoons to prevent seepage of leachates and flooding. Therefore, the design plan will minimize the chances of surface water contamination.

Monitoring of surface water in the surrounding areas should be performed regularly during the operation phase. Proper compaction practices as indicated in the Al-Ekeder Master Plan should also be enforced.

A Spill Management Plan should be developed and implemented. This plan should include all the necessary measures, main concerns, actions, as well as responsibilities to prevent surface water pollution. Vehicle paths need to be clear and vehicle traffic should be confined to those areas as possible.

Fuelling and maintenance areas should be located on a sealed floor to prevent surface water contamination. Any leakage incidents should be dealt with immediately by using spill kits and cleaning up and removing the top contaminated soil. Such accidents should be reported.

6.2.3 Groundwater

Anticipated impacts to groundwater resources are minimal. The installation of waste-fill and intermediate covers will help in controlling the infiltration and percolation of precipitation, and thus prevent groundwater contamination. Uncontrolled leachate filtration might occur and that poses a risk of groundwater pollution.

The replacement of the unlined Zibar lagoons with standard lined lagoons will help in avoiding groundwater contamination during the operation phase. Leakage from the lagoons might lead to uncontrolled leachate filtration and thus poses a risk of groundwater contamination.

Nevertheless, the impact on groundwater is insignificant because the separation distance between the bottom of the ponds and the groundwater is 300 meters and the permeability of the strata between the bottom of the ponds and the water table is very low.

Proposed Mitigation Measures
As mentioned earlier, the remediation plan is designed in a way that minimizes the risk of groundwater contamination. Monitoring of groundwater quality around Al-Ekeder Facility should be performed regularly (every two or three months) during the operation phase to ensure no negative impacts on the quality of water.

Any liquid infiltration as a result of vehicle fuel and oil spills should be controlled by employing spill prevention practices and maintaining the vehicles regularly.

6.2.4 Air Quality

Anticipated Impacts

The decomposition of organic matter in the remaining sludge and in the landfill produces methane (CH_4) and other gases that include carbon dioxide and chlorofluorocarbons and are considered significant sources of pollution. Methane is a toxic and extremely flammable gas that can seep through sludge and other materials, and it has been associated with an increase in fire occurrence in Al-Ekeder Landfill.

Other than the fire hazard some of these gases cause, they are also directly connected to respiratory issues in humans and animals.

In addition to the odor produced in the landfill cells, strong and unpleasant odor is also generated from the Zibar lagoons, which is considered another negative impact. It can affect the surrounding areas in certain weather conditions. Odor can also be caused by leachate, and it can also affect the workers inside the facility as well as the surrounding areas.

It should be noted that the remediation plan includes a gas collection system that is connected to a flare/recovery system, as well as a leachate collection system to prevent such impacts.

However, it is expected that there might be some odor associated with fugitive emissions during the handling and evaporation of the leachate.

Emissions and dust generated by heavy machinery during the unloading process and daily solid waste covering process might also be a source of air pollution; emissions will increase with the increase of vehicles used within the site area. The MRF will have eventually a positive impact on the air quality since it will reduce greenhouse gas emissions that contribute to global warming.

Proposed Mitigation Measures

Part of the remediation plan is to properly line the landfill cell and cover it in order to avoid foul odors and the exposure to harmful gases. The leachate collection system should be maintained regularly to reduce generated odor, and periodic gas monitoring should be conducted to detect any increase in the emissions.

The installed gas collection system should be maintained regularly so that CH_4 doesn't accumulate to explosive levels. In emergency cases, excess amounts of gases should be collected, vented to the atmosphere or flared. An effective ventilation system must be installed and maintained in the surrounding buildings. Regular air quality monitoring that considers the accumulative impact of gas emissions in Al-Ekeder Facility should also be performed.

Fire safety measures resulting from higher concentrations of methane need to be taken into account and signs indicating the higher concentrations of harmful greenhouse gases should be placed around the site. In addition, the HASP should include a procedure for immediate reporting of all fires to local fire-fighting offices. The closest general directorate of Civil Defense is the entity to be contacted in the case of fires or accidents.

Treatment technologies of the Zibar, such as classification by gravity, anaerobic digestion, and up-flow anaerobic treatment, should be studied and implemented in order to reduce the generated odor.

Vehicles used in the project area are expected to regularly undergo any required maintenance in order to ensure they are in good working conditions. A dust management plan should be also developed and abided by during the operation phase. All necessary dust abatement measures should be identified in the plan.

All air quality complaints and identified causes, and any remedial actions taken should be documented.

6.2.5 Noise

Anticipated Impacts

Operational activities in Al-Ekeder Disposal Facilities produce noise as a result of the heavy vehicles unloading Zibar, transporting solid wastes, and excavating and transporting cover materials from the designated on-site borrow areas. The remediation of Al-Ekeder Facility is not likely to cause any additional noise. Additional noise might be generated from the MRF; however, since the facility is enclosed, the additional noise levels are expected to be insignificant. Facility employees are the most affected by noise.

Proposed Mitigation Measures

The operator should abide by the Jordanian Instructions for Controlling and Preventing Noise. Workers should be provided with noise protection equipment. Several noise generating activities should be scheduled at the same time, to prevent prolonged periods of noise. Heavy machinery should be maintained and greased regularly to minimize unnecessary noise.

6.2.6 Flora and Fauna

Anticipated Impacts

As maximum waste elevations are achieved in each landfill cell, an earthen evapotranspiration (ET) cap will be added as the final cover. ET cover systems use one or more vegetated soil layers, allowing vegetation to grow on top.

Sludge and Kamkha residues could therefore theoretically be used as fertilizer for agricultural use if the quality of generated sludge meets Category 1 of Jordanian Standards JS 1145/2006. However, due to the fact that there is no legal basis for the utilization of sludge for agricultural use, the generated sludge can only be used after dewatering as cover material.

The implementation of the master plan will allow for more sanitary conditions, reducing the chance for spreading disease through different medium. Additionally, air quality should improve as a result of the rehabilitation plan and any animals that are exposed to the waste, such as the Canaan dogs, will not encounter the same hazards that they would under current conditions. Nevertheless, Canaan dogs and livestock should be prohibited from grazing inside the facility.

As mentioned earlier, Al-Ekeder Facility is recognized as an IBA since it is an important staging and wintering area for some migratory water birds. Therefore, these water birds might be affected by the closure of several existing liquid waste disposal lagoons.

Proposed Mitigation Measures

Movement of workers, waste transferring and stockpiling and other operation activities should be banned outside the landfill boundaries. Wherever possible, access roads should be minimized to limit the disturbance of biodiversity. Additionally, it is recommended that natural vegetation be planted wherever possible and replace any trees moved from the project area be replaced.

Perimeter security fencing should be maintained regularly to prevent the access of livestock and other animals to the facility. Workers should not trap or hunt any existing fauna species in the project area. Any captured animals should be moved to nearby undisturbed areas.

Proper signs should be provided that emphasize the importance of protecting the natural habitat of the area.

6.2.7 Antiquities

Anticipated Impacts

Any encountered archaeological resources would have turned up during the construction phase, if at all. The operations phase will not have any impact on archaeological resources.

6.2.8 Land Use

There will be no further acquisition of land areas and therefore no impacts on land use during the operation phase.

6.2.9 Population and Economic Activities

Anticipated Impacts

The project is expected to expand on the previous facility and cater to a larger amount of MSW. The changes that are proposed through the project will create a more environmentally sustainable operation method. This may not have any direct effects on the surrounding villages, but it does have a positive effect on the scavengers since they are continuously exposed to the landfill cells. Since this an expansion project, the facility may need more operators and employees on the site in order to properly manage the increased capacity. This outcome can be considered a positive socioeconomic impact when compared to existing conditions and no mitigation should be required. In addition, the new MRF will generate new sources of income, from which scavengers and the local community will benefit. It is also expected that new job opportunities will be created for the daily recovery activities, and the recycling and manufacturing industries.

6.2.10 Transportation

Anticipated Impacts

The capacity of the disposal facility is going to increase which means that traffic will also increase. The facility could see more trucks bringing in their waste. Attention will need to be given to roadway capacity and conditions as the project moves forward.

The increase in traffic due to Zibar trucking would be seasonal (during the Zibar generation season, between mid-October and mid-January).

6.2.11 Water and Electricity Supply

Anticipated Impacts

There will be an increase in water demand for the various operation activities, such as dust control, domestic water uses at site offices, and material recovery activities. In addition, potable water might be used to wash recovery equipment and tools The operator will need to verify source and adequacy of water to be used for various applications.

The demand on electricity will also increase during operation phase, which will affect the current power supplied to Al-Ekeder Facility.

Proposed Mitigation Measures
The operator will need to verify source and adequacy of water supply. Operation employees should attempt to conserve water and handle water resources efficiently.

The size and capacity of the existing power supplied to the site should be increased to cover the demands of the operation phase.

6.2.12 Solid Waste
Operational capacity at Al-Ekeder Facility is increasingly stressed due to the inefficient use of available airspace, and the expansion plan will help to alleviate the current situation. The Al-Ekeder Master Plan involves air space optimization through better cover practices. This means that space will be used more efficiently and the landfill cells will be able to handle more capacity when compared to the current cells. Additionally, the landfill cells will be lined, which means that the solid waste will pose less of an environmental hazard. Since some of the Zibar lagoons are being phased out and transformed into sanitary landfill cells, the amount of solid waste will increase significantly; however, if the recommended compaction and cover practices are employed, there should not be any significant impacts associated with solid waste.

The MRF will also will allow for recyclable materials to be reused/recycled. This will ultimately have a positive impact since it conserves natural resources, reduces and prevents pollution, and facilitate the collection of new raw materials.

6.2.13 Human Health
Anticipated Impacts
High levels of greenhouse gases, waste, Phenol compounds, and heavy vehicle movement are all a cause of concern during the operational phase of the disposal facility. The presence of greenhouse gases including methane, carbon dioxide and chlorofluorocarbons have been documented in the landfill cell. Methane is considered a fire hazard, and each of the gases has detrimental effects on human health and has been proven to cause respiratory illnesses.

The foul odor and insects from waste accumulation, and gas emissions, may also be a cause for concern for workers near the landfill cells. Large accumulations of waste often create a breeding ground for diseases and pathogens.

Additionally, Zibar contains high concentrations of phenol compounds that are toxic and corrosive, and thus pose health risks for workers.

Workers of Al-Ekeder Facility are exposed to other safety risks such as slipping, falling or mishandling machinery, if safety measures are not instituted.

It should be noted that the remediation plan took into consideration the minimization of the size of the active face of the landfill, which minimizes the chances of negative impacts.

Proposed Mitigation Measures
A comprehensive Health and Safety Plan (HASP) should be developed and implemented for the operation phase. It should specify all responsibilities regarding health and sanitary needs including proper arrangements for dining, bathing, drinking, sanitation, ventilation and light, firefighting, and safe transportation. Safety gears and equipment such as face masks should be provided during the operation phase.

The responsibilities of the “Health and Safety Officer” should also be specified within the HASP to ensure its implementation. Moreover, the plan should lay out a procedure for reporting and investigating all accidents so as to identify responsible individuals and to prevent recurrence.

The following are not mitigation measures, but are standard procedures that should be followed as components of proper implementation of the design plan:

- Fire safety measures need to be employed and workers need to be given awareness sessions on the dangers of operating in a waste disposal facility. Proper signage needs to be set in place in order to warn people about methane emissions and the associated potential fire hazard. In addition, smoking and activities that involve fire igniting should be restricted to designated areas in order to avoid any accidents.

- Proper cover practices need to be employed in order to avoid foul odors and to keep insects away. These practices will also control the spreading of disease and decrease the amount of greenhouse gases being emitted into the atmosphere.

- Regular safety awareness sessions and meetings should be held to ensure the proper implementation of the HASP. The location of the closest hospital or medical clinic and the shortest route should be identified. Transportation of workers should be done in vehicles equipped with seats and barriers for their safety. It is not permitted to transport individuals in dump trucks.

- It is also important to assign a doctor to serve the workers during operation phase. Workers should be provided with health insurance, and should be subject to regular medical checkups.

- A Hazardous Materials Management Plan (HMMP) should be developed and implemented. Hazardous materials should be stored within double-lined tanks to prevent any spills/leaks that might cause injuries. Hazardous material should also be labeled, used and disposed of properly and according to the HMMP.

7 Initial Environmental Management and Monitoring Plan

The Environmental and Management and Monitoring Plan (EMMP) was developed based on an understanding of the project conditions and on the findings detailed in Section 6.

The main objectives of the EMMP can be summarized as follows:

- Provide detailed guidance for implementing the mitigation measures.
- Assign responsibilities for implementation.
- Facilitate efficient auditing and monitoring throughout the different project phases.

Table 7-1 and Table 7-2 present recommended mitigation and monitoring measures to implement the project in a safe and environmentally sound manner during the construction and operation phases. The tables also show the roles and responsibilities of various entities that are required to implement these measures.

7.1 Construction Phase

The EMMP during construction should be included in the Tender Documents and be binding on the Contractor. The tender documents should also refer to the ECR. The Contractor should be obligated to assign a Health, Safety and Environmental Officer with relevant experience to prepare a detailed Construction Environmental Management and Monitoring Plan (CMMP). The CMMP should contain, but is not limited to, the following sections:

- Traffic Management Plan
- Soil Erosion Prevention Plan
- Spill Management Plan
- Health and Safety Plan
- Water Resources Management Plan
- Waste Management Plan
- Site-Specific Dust Management Plan

Table 7-1: EMMP during Construction

Impact/Issue	Mitigation Measure	Monitoring Measure	Implementation Responsibility	Supervision Responsibility
Soil erosion and contamination	Prepare and abide by a soil erosion prevention plan	Document any incidents of spills and other incidents that my harm soil health	Contractor / 3rd party assessor	MoEnv
	Prepare and abide by a spill management plan			
	Pave roads where heavy vehicle traffic is expected			
	Reduce the amount of trips made by construction vehicles where possible			
	Provide a paved parking area			
	Designate a refueling and maintenance area			
Contamination of surface water	Prepare and abide by HMMP		Contractor	MoEnv / MWI
	Install lined drainage channel for runoff			
	Prohibit construction workers from washing tools and equipment in the wadi course			
Increased levels of emissions and dust	Prepare and abide by a dust management plan	Daily visual inspections	Contractor /3rd party assessor	MoEnv
	Report and investigate any complaints			
	Ensure regular maintenance of construction vehicles			
Increased noise levels	Confine all construction activities between 8 pm and 6 pm	Daily on-site monitoring	Contractor	MoEnv
	Provide noise protection equipment to workers			
	Several noise generating activities should be scheduled at the same time, but should not exceed safe noise levels			
	Maintain all necessary equipment in minimize unnecessary noise			
Disturbance of biodiversity	Relocate or plant any trees that are removed in the project area		Contractor / RSCN	RSCN MoEnv
	Prohibit construction workers from trapping or hunting any fauna species in the project area			
	Confine vehicle use to project area where possible			
Damage of unknown archeological findings	Stop work within area surrounding any archaeological findings and immediately contact the responsible authority		DOA/ Contractor	MoEnv
Change in land use	Control the removal of olive trees and the expansion of the landfill cells and Zibar lagoons to minimize the environmental impacts		Contractor/ MoEnv	MoEnv
	Compensate owners of adjacent lands if any damage or			

Impact/Issue	Mitigation Measure	Monitoring Measure	Implementation Responsibility	Supervision Responsibility
	negative impact affected their lands			
Increased water and electricity demands	Provide an adequate source of water from available and approved off-site sources		Contractor/ IDECO	MoEnv
	Conserve water use			
	Increase the size and capacity of the existing power supply			
Accumulated waste	Allocate a designated disposal site for construction Waste and borrow areas to store excavated soils		Contractor	MoEnv
	Minimize construction waste by using debris as cover material			
	Hold waste management awareness session for workers			
	Prepare and abide by HMMP			
Traffic disruption	Prepare and abide by a traffic management plan	Document any traffic accidents or issues / Weekly report of traffic related incidents	Contractor	Local Traffic Department / MoEnv
	Provide proper signage in different languages			
	Securely pack and cover trucks with loose material			
	Provide vehicles equipped with seats and barriers for the transportation of workers			
Occupational and public health	Assign a Health, Safety and Environment Officer	Daily inspection by safety officer/ Supervision consultant team	Contractor	MoEnv
	Prepare and abide by HASP and HMMP			
	Noise, dust and sun exposure durations for workers should be within acceptable limits			
	Provide proper safety equipment and enforce use			
	Meet all health and sanitary needs of workers			
	Prepare and abide by a dust management plan			
	Hold safety awareness sessions			
	Report and investigate any incidents and complaints			

7.2 Operations Phase

Table 7-2 presents the EMMP that should be implemented during operation. Since the day-to-day operations activities will be managed by the facility operator, most of the responsibilities in this EMMP are designated to him, in addition to the third party assessor and MWI, and MoEnv.

Table 7-2: EMMP during Operation

Impact/ Issue	Mitigation Measure	Monitoring Measure	Implementation Responsibility	Supervision Responsibility
Soil erosion and contamination	Prepare and abide by a soil erosion prevention plan	Log of soil quality	Operator/Third Party Assessor	MoEnv
	Confine solid waste disposal to the designated landfill cells			
	Enforce proper waste compaction and cover practices			
	Perform regular monitoring of soil quality around Al-Ekeder Facility			
	Prepare and abide by a spill management plan			
	Designate a fuelling and maintenance area			
	Confine vehicle traffic to clear designated paths			
	Provide parking site paved with an impermeable surface			
Contamination of surface water	Monitor surface water in the project area regularly	Log of water quality	Operator/Third Party Assessor	MWI MoEnv
	Prepare and abide by a soil erosion prevention plan			
	Confine solid waste disposal to the designated landfill cells			
	Prepare and abide by a spill management plan			
	Designate a fuelling and maintenance area			
	Provide parking site paved with an impermeable surface			
	Install and maintain run-off draining channel			
	Maintain and monitor the installed leachate collection system and evaporation pond			
	Enforce proper waste compaction and cover practices			
Contamination of groundwater	Monitor groundwater quality in the project area regularly	Log of water quality	Operator/Third Party Assessor	MWI MoEnv
	Prepare and abide by a soil erosion prevention plan			
	confine solid waste disposal to the designated landfill cells			
	Prepare and abide by a spill management plan			
	Designate a fuelling and maintenance area			
	Provide parking site paved with an impermeable surface			
	Install and maintain run-off draining channel			
	Maintain and monitor the installed leachate collection system and evaporation pond			
	Enforce proper waste compaction and cover practices			

Impact/ Issue	Mitigation Measure	Monitoring Measure	Implementation Responsibility	Supervision Responsibility
Increased levels of emissions, odors and dust	Prepare a site specific dust management plan	Monitor levels of GHGs, TSP and PM10 regularly	Operator/ Third Party Assessor	MoEnv
	Maintain and monitor the installed gas collection system and leachate collection system			
	Collect, vent, or incinerate excess amount of gases			
	Immediately report fires to local fire-fighting offices			
	Minimize dust generation during dry and dusty weather			
	Cover stockpiles and vehicles delivering materials			
	Record and keep air quality complaints			
	Implement Zibar Treatment technologies			
Increased levels of noise	Adequately muffle and maintain motorized equipment	Daily on-site monitoring	Operator	MoEnv
	Provide workers with noise protection equipment			
	Schedule several noisy activities to occur at the same time whenever possible, but should not exceed safe noise levels			
Disturbance of biodiversity	Ban workers from trapping or hunting any existing fauna species in the project area		Operator	MoEnv RSCN
	Plant natural vegetation whenever possible and replace any trees moved from the project area			
	Restrict operation activities outside the facility			
	Maintain perimeter security fencing regularly			
Damage of unknown archeological findings	Stop work within area surrounding any archaeological findings and immediately contact the responsible authority.		DOA/ Operator	MoEnv
Increased water and electricity demands	Provide an adequate source of water from available and approved off-site sources		Operator IDECO	MoEnv
	Conserve water use			
	Increase the size and capacity of the existing power supply			
Occupational and public health	Assign a Health, Safety and Environment Officer	Daily inspection by Safety Officer / Consultant	Operator	MoEnv
	Meet all health and sanitary needs of workers			
	Enforce use of safety gears and equipment			
	Noise, dust and sun exposure durations for workers should be within acceptable limits			
	Hold safety awareness sessions			
	Report and investigate any accident			
	Avoid working in dusty weather			
	Prepare and abide by HASP and HMMP			

8 Proposed ESIA Methodology and Schedule

The ESIA will be prepared in compliance with the Jordanian Environmental Impact Assessment Bylaw of 2005, and technical guidance provided by the MoEnv. The contractor should hire a qualified consulting entity to conduct the ESIA study. The consulting entity shall conduct field investigations, desktop research and consult with experts, when required, in order to efficiently assess the existing environment and address all the significant environmental impacts related to this project.

8.1 Data Collection For Existing Environment

The ESIA team shall review all available data about the project area as well as The Al-Ekeder Disposal Facility Master Plan Report. This will include review of studies and investigations related to the existing disposal facility, in addition to all available reports on Al-Ekeder Disposal Facility.

The data may include meteorological data, population, water resources, soil and archeological resources.

8.2 Review of Available Literature

Data will be collected by reviewing several pertinent documents including, but not limited to the following:

- Al-Ekeder Disposal Facility Master Plan
- Al-Ekeder Lagoons Site Remediation Design Report
- Al-Ekeder Liquid Waste Disposal Site Remediation Feasibility Assessment, June 2011
- Data from the Department of Statistics publications
- Jordan Climatological Handbooks and Bulletin
- Handbook of the Geology of Jordan, Burden, 1959
- Geology of Jordan, Abed, 2000
- Geology of Jordan, Bender, 1974
- Jordan Country Study on Biological Diversity, Mammals of Jordan and Plant Biodiversity and Taxonomy

A comprehensive review of the legal requirements and regulatory constraints in Jordan should also be reviewed and described. Relevant environmental laws, by-laws, guidelines and standards should be addressed.

8.3 Field Investigations

The appropriate level of data collection should be confirmed with the MoEnv. The following outlines the appropriate level of data collection if new field data are required.

Data shall be collected first hand through several field visits to the project site. Field investigations, including “walk” surveys, should be conducted during the preparation of the ESIA document to acquire a comprehensive understanding of the environmental conditions at the site. During the investigations, the potential impacts on the project site area should be considered and mitigation measures should be proposed for implementation during the construction and operation phases of the project.

8.3.1 Ecological Assessment

An Ecologist shall conduct several site visits in order to evaluate the existing ecological conditions. The assessment should focus on obtaining baseline data of the biological environment in the project area. This is to highlight any environmental concerns that may arise upon the implementation of the proposed project on the existing biological conditions, during construction and operation phases. Moreover, the study should recommend approaches to reduce any potential threats on endangered species, thus ensuring compliance with national and international protection requirements.

8.3.2 Socio-economic Study

A socio-economic study should be conducted to investigate the socio–economic and demographical characteristics of the project area. Both qualitative and quantitative data collection and analysis should be carried out. The quantitative approach enables the socio-economist to thoroughly analyze the socio-economic conditions of the people in the project area; the qualitative approach will enhance interpretation of the quantitative data.

The study needs to discuss the socio-economic changes influenced by the project. The socio-economist should hold focus discussion groups meetings to survey and assess the perceptions and views of the local community in the project area. In addition, the socio-economic study shall also highlight the influence of the local social norms and socio-economic conditions on the project.

The study should recommend mitigation measures for the adverse impacts. According to the Scoping Session findings, economic equity will be further discussed as one of the main issues.

8.3.3 Surface and Ground Water Assessment

A field survey should be undertaken to verify water resources in the area, including permanent and intermittent surface water flow and groundwater recharge zones in the project area. Where feasible, water samples from nearby surface and ground water sources should be collected to establish the baseline conditions and the concentration of elements which may be associated with project activities.

In addition, routing and direction of groundwater flows should also be assessed in order to evaluate the impacts of the proposed project on the groundwater and to identify any potential wastewater run-off issues.

Moreover, the study should include impacts on surface and ground water quality from project activities, such as waste dumps and leachates, and should recommend mitigation measures to be implemented to protect water resources in the project area.

The study should also assess water needs for the different project activities and develop a “Water Management Plan”.

8.3.4 Air Quality and Noise Baseline Testing for Existing Environment

Dust emissions and noise level during construction period should be assessed qualitatively.

In order to establish a baseline for the concentrations of air pollutants and noise level, an air quality testing shall be carried out. Sampling should be conducted for several testing points inside and outside the disposal facility boundaries. In addition to noise, key parameters that should be tested include:

- Sulphur Dioxide (SO_2);
- Hydrogen Sulfide (H_2S) ;
- Nitrogen Dioxide (NO_2);
- Ozone (O_3);

- Carbon Monoxide (CO);
- Carbon Dioxide (CO_2);
- Ammonia (NH_3); and
- Total Suspended Particles (TSP) and Particulate matter (PM_{10}, $PM_{2.5}$).

Samples should be taken and analyzed according to the JS 1140/2006 Ambient Air Quality Standards (daily and hourly measurements). Odors inside the facility should also be monitored regularly.

8.3.5 Health and Safety

Al-Ekeder Disposal Facility is a potentially dangerous work environment. Health and safety are considered primary issues that need to be assessed prior to the construction phase in order to avoid potential exposure to pathogens and avoid accidents for workers during both the construction and operation phases.

A health and safety specialist should assess the site's existing conditions to establish a baseline for the frequency and type of accidents that occur in the site (such as fires, collapses, flooding, etc.) and create a log to record similar future events.

A "Health and Safety Management Plan" should also be developed and should include appropriate precautionary measures that should be implemented during all project phases.

8.3.6 Cumulative Impact

The ESIA report shall include an assessment of the potential cumulative environmental impacts as a result of the project's multi-activities. In particular, the potential for the project to impact the soil, air quality as well as surface and ground water quality in the project area.

The cumulative impact of the different project's activities should be measured and quantified to ensure compliance with the Jordanian regulations and standards.

8.4 Scoping Session

Project stakeholders and affected communities should be invited to participate in a scoping session as appropriate. Public consultation in early stages of the project can prevent problems that may otherwise arise in more serious forms at later stages in the review process.

The scoping session should identify and discuss environmental issues associated with the project. Names of participants and details of the scoping session's activities should be documented in the ESIA study.

8.5 Environmental Impact Identification and Assessment

The EIA team shall identify and assess the anticipated impacts using the Impacts Description Matrix (IDM). The matrix shall cover the following elements:

- Nature: this indicates whether the impact on the environment is positive or negative
- Significance: the impact should be classified as highly, moderately or mildly significant
- Reversibility: the impact should be classified as reversible, partially reversible, or non-reversible
- Likelihood: the impact should be classified as very likely, likely, or unlikely to occur
- Duration: impact duration should be provided as long-term, short-term or an actual time will be specified

- Geographic extent / location: the geographic extent of the impact should be provided (eg. area, village, and country)

The outcomes of the several investigations and surveys should be incorporated and evaluated in the ESIA report. Consequently, the identified impacts should be thoroughly described and quantified where possible.

8.6 Development of Mitigation Measures

Mitigation measures shall be developed for each impact, aiming at either avoiding or reducing the impact. The measures will be developed for various project stages, including design, construction, operation and decommissioning. The measures selected shall be realistic and fairly easy to implement.

8.7 Development of Environmental and Social Management Plan and Monitoring Plan

A comprehensive ESMP shall be developed to ensure that the required mitigation measures and monitoring activities are implemented and sustained throughout the progress of the project. In order to facilitate the identification of the mitigation measures and monitoring activities, it is better to present the ESMP in a tabular format. It should include the following:

- List of environmental and social objectives
- List of mitigation measures for various phases of the project
- Designation of parties responsible for implementation
- Description of any training needs
- Time schedule for implementing proposed mitigation measures
- Monitoring plan for certain parameters
- Inspection and plan review schedule and methods
- Public reporting
- Proposed corrective actions

8.8 Approvals

Prior to the scoping meeting a draft ToR should be prepared and discussed with the MoEnv. Outcomes of the scoping session should be incorporated within the final ToR and submitted to the MoEnv to obtain approval to start with the ESIA study. Site approval from the DOA should be obtained when necessary.

18 copies of the ESIA Reports should be submitted to the MoEnv, in addition to an Executive Summary that should be provided in Arabic and English. The MoEnv will review the ESIA report and require further information if needed. The reviewing period is 45 days from receipt of the ESIA Report.

8.9 Disciplines Required

The following experts are expected to participate in the preparation of the EIA:

- Environmental Task Leader
- Environmental Specialist
- Socio-economist
- Ecologist
- Archaeologist
- Air Quality Expert
- Health and Safety Specialist

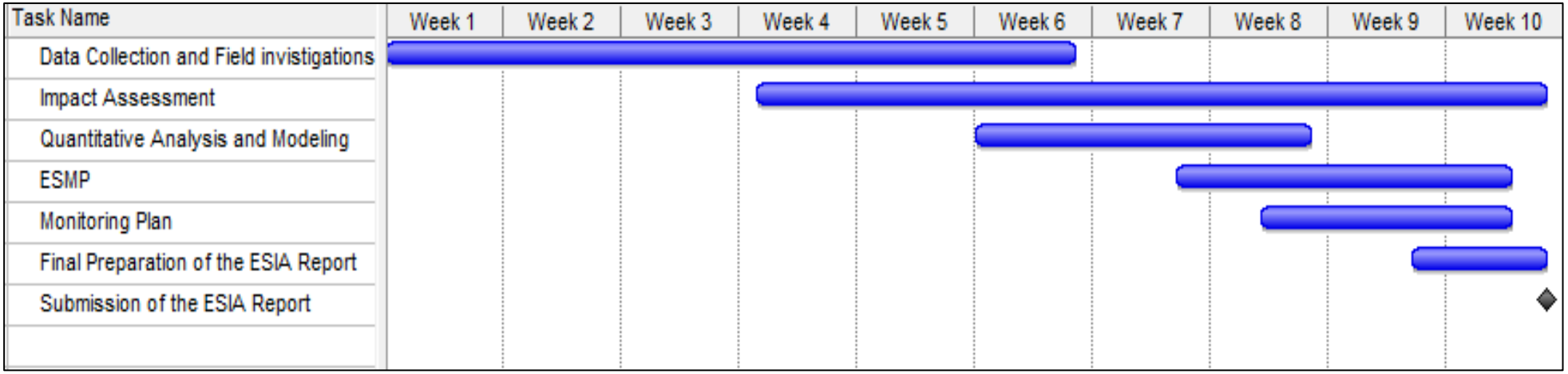
Curricula vitae of involved experts should be provided within the ESIA report.

8.10 Proposed EIA Report Outline

In accordance with EIA Bylaw, the ESIA report should include the following contents:

- Executive Summary
- Background and the Purpose of the Project
- Regulatory Framework
- Alternatives including the Proposed Action
- Affected Environment
- Expected Environmental Impacts
- Environmental Management Plan
- List of Preparers
- Appendices

8.11 Schedule



9 Conclusions

According to the previous discussions and the outcomes of the ECR, it can be concluded that the project is not expected to cause significant adverse environmental or social impacts on the project area during construction or operation as long as recommended design and operational measures are undertaken. In fact, improved environmental conditions are expected as a result of implementation of environmentally friendly solid waste management, Zibar disposal, and recovery and recycling options at Al-Ekeder Disposal Facility.

However; the proper implementation of the EMMP and proper monitoring is essential to minimize negative impacts.

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