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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 RUSSEIFAH AREAS 1 AND 2 REMEDIATION

June 2015

IMPLEMENTED BY AECOM

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Submitted to:

USAID Jordan

Prepared by:

AECOM

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LIST OF ACRONYMS

C&D	construction and demolition
Cd	cadmium
CO	carbon monoxide
CO_2	carbon dioxide
CSC	Common Services Council
dBA	A-weighted decibel(s)
ECR	environmental considerations report
EIA	environmental impact assessment
EMMP	environmental management and monitoring plan
ET	evapotranspiration
IEE	Initial Environmental Examination
JBC	Jordan Biogas Company
JS	Jordan Standard
LFG	landfill gas
MOA	Ministry of Agriculture
MoEnv	Ministry of Environment
MoMA	Ministry of Municipal Affairs
mSv/yr	millisievert(s) per year
MWI	Ministry of Water and Irrigation
µg/m^3	microgram(s) per cubic meter
NO_2	nitrogen dioxide
NRA	Natural Resources Authority
O_3	ozone
P_2O_5	phosphate
Pb	lead
$PM_{2.5}$	fine particulate matter
PM_{10}	respirable particulate matter
ppm	part(s) per million
SO_2	sulfur dioxide
SWM	solid waste management
TOR	terms of reference
TSP	total suspended particulates
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan
WRECP	Water Reuse and Environmental Conservation Project

1 INTRODUCTION

1.1 Project Background and Need for the Project

The United States Agency for International Development (USAID) Water Reuse and Environmental Conservation Project (WRECP) works throughout Jordan in institutional capacity building, pollution prevention 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

One of the main project components (Task 3) focuses on rehabilitation of historic disposal sites. The Russeifah Site was one of the locations selected for disposal site rehabilitation as part of Task 3. The Russeifah Site is composed of six individual contaminated areas, as described below. The contamination in each area is directly or indirectly the result of the development and operation of the phosphate mining industry, which began in the mid-1930s:

- **Tunnels**. The initial mining began with the hand excavation of exposed seams of phosphate-rich ore. This created a number of abandoned tunnels, called Area 5 (Tunnels).
- **Overburden**. In the mid-1950s, phosphate mining intensified through open pit mining. The material that lay on top of the phosphate-containing geological layers was removed. This material, called “overburden,” was placed in a location now called Area 6 (Overburden Piles).
- **Phosphate Stockpile**. The phosphate ore was then excavated and placed in a large stockpile near the phosphate ore processing plant. Throughout the intervening years, portions of the stockpile were processed and hauled off; however, the bulk of the pile remains and is called Area 3 (Phosphate Stockpile).
- **Landfill**. As a result of the excavation of the phosphate ore, a large and deep open pit remained. In the mid-1980s, the Greater Amman Municipality began using a portion of the open pit as a solid waste landfill. This landfill operation continued until 2003, when the landfill operation was curtailed. The resulting filled area of the open pit is referred to as Area 1 (Landfill).
- **Pit**. The unfilled area of the open pit is referred to as Area 2 (Pit).
- **Lagoon**. During the processing of phosphate, the process wastes were disposed of into a small wadi, which drained to the Zarqa River causing sedimentation and complete blockage of the wadi. As a result, a stormwater drainage lagoon was created, called Area 4 (Lagoon).

With the development of the phosphate mining industry, the City of Russeifah saw rapid population growth. As a result, the residential area is encroaching on Areas 3, 4 and 5, while businesses and industry are pressing on Areas 1, 2 and 6. None of the areas is now in direct use by the phosphate industry. This report assesses the implications of proposed remediation activities at Areas 1 and 2.

The Russeifah Area 1 landfill (Figure 1-1) consists of large partially covered landfill with a partially operational landfill gas (LFG) collection system, limited site drainage controls, and intermittent landfill fires. The Russeifah Area 2 mining pit (Figure 1-2) consists of an abandoned steep sided open pit mine, which is currently being used for disposal of construction and demolition (C&D) debris. Area 2 has no site drainage control or C&D disposal plan. In Jordan, the Russeifah region continues to grow in population. There is a need to remediate each of these areas not only from a public aesthetics prospective but also from that of beneficial use.

Figure 1-1. General View of Area 1 Landfill

Figure 1-2. General View of Area 2 Mining Pit

1.2 Environmental Considerations Report (ECR) 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 Russeifah Areas 1 and 2 remediation. 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) of recommendations made in the feasibility study 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 minimize adverse impacts on human health and the environment for these activities.

The present report is an environmental considerations report (ECR). This ECR was not prepared to be a formal environmental assessment; instead, it was prepared to demonstrate that potential environmental impacts were considered by the design team while making a decision on the recommended plan and during development of the preliminary 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. During implementation of the proposed remediation final design and construction, an environmental impact assessment (EIA) in compliance with Ministry of Environment (MoEnv) regulations and any other funding nation regulations, as appropriate, must be prepared and should incorporate the major results, conclusions, and recommendations of this ECR.

This ECR plays a central role in assessing the social and environmental implications – including water resources implications – of the proposed remediation project and 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.

The ECR describes various components of the environment of the area to be affected by the remediation alternative under consideration. Data and analyses in the ECR are commensurate with significance of the impact. The ECR includes discussions of direct and indirect effects and their significance, polices and controls for the areas concerned, the reuse and conservation potential of the recommended alternative, and mitigation measures. For significant adverse impacts, the mitigation discussions propose measures that would minimize their magnitude and severity.

The main objectives of this ECR for the remediation of Russeifah Areas 1 and 2 are summarized below:

- Determine that the project would not have irreversible negative impacts on the natural and human environments
- Identify and compare the potential environmental impacts, including the positive and negative, and direct and indirect impacts of the recommended alternative
- Evaluate the reasonableness of the alternatives to the recommended alternative and specify those alternatives that should be assessed in the EIA (if required)
- 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 laws, regulations, and standards. If the proposed project is implemented, an EIA would be prepared in accordance with the Jordan EIA Regulations identified in this section and in accordance with the requirements of the lending organization, if applicable.

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.

Article 4 of this law specifies the following responsibilities of MoEnv as related to mining:

> *For the purpose of achieving the goals of environmental protection and the improvement of its various Elements in a sustainable manner the Ministry, in cooperation and coordination with the competent parties, shall carry out the following duties:*
>
> *D- Issuing environmental instructions necessary to protect the Environment and its components and the conditions to establish agricultural, commercial, industrial, housing, mining and other projects and all services relating thereto for compliance therewith and the adoption thereof within preconditions for the licensing or renewal of licensing thereof in accordance with the legal principles in force."*

Article 13 highlights the role of the Ministry in monitoring and supervision to promote compliance with environmental specifications and measurements and the set technical standards. It also highlights the role of the Ministry in monitoring and measuring of environmental components and follow-up through scientific centers. The Environmental Protection Law is currently in the process of being reviewed and any modifications or additions to the law will be announced by the MoEnv. Until such time, the requirements of the existing law should continue to be followed.

2.1.2 Natural Resources Affairs Law (No. 12 of 1968)

The following sections of this law are relevant to and govern mining activities:

Per Clause (b) of Article 57*:*

> *"The* [Natural Resources] *Authority may maintain, operate and otherwise manage any completed or partially completed project until such project is transferred to, and responsibility for maintenance and operation is fully assumed by the village or municipality or any other public body. The Authority shall not remove the control on any project until sufficient assurances are given that the project will be operated and maintained in a manner to ensure maximum useful life of the project."*

Per Article 44 of this law:

> *"The holder of an exploration license or mining right shall not appropriate or take water from any lake, river, source or flow of water or canal bordering or passing*

through licensed land or change its course without the written permission of the President [of the Authority] *after obtaining the agreement of the owners (if any)."*

2.1.3 Public Health Law (No. 47 of 2008)

The Ministry of Health 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.

This law includes information regarding the responsible agency for waste management, the fees that should be collected against the offered service, and the fines that should be paid in case of noncompliance with proper management of municipal solid waste.

2.1.4 Municipalities Law (No. 14 of 2007)

Similar to the *Public Health Law (No. 47 of 2008)*, this law includes information regarding responsible agencies, fees, and fines regarding management of municipal solid waste.

2.1.5 General Framework Draft for Waste Management Law (Under Revision)

This draft law is an effort to issue regulations dealing specifically with solid waste management (SWM) in a comprehensive, efficient and detailed manner. The MoEnv has recently completed the draft for a Waste Management Law that consists of 48 articles and covers all types of wastes, including municipal solid waste. The draft law will be subjected to a national review and discussion by all relevant stakeholders. The framework of the draft law stresses the implementation of waste prevention, minimization, reuse, and recycling. It also lists the waste generator responsibility and puts forth the "Polluter Pays" principle. Furthermore, it lists the responsibilities of different governmental agencies and waste generators. This draft law also covers collection schemes, hauling, final disposal, licensing of waste management facilities, recordkeeping, trans-boundary movement of hazardous wastes, monitoring, auditing, penalties, and ways of achieving compliance.

2.1.6 Archaeology Law (No. 21 of 1988)

Issued by the Ministry of Tourism / Department of Antiquities, this law details the main responsibilities of the department. 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 the Department of Antiquities or the Public Security Directorate within 10 days. Article 27 sets the penalties for failing to report chance finds.

2.1.7 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.

2.1.8 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. This law further governs the protection of agricultural land and pastures.

2.1.9 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. This law provides many sections that regulate licensing, plans for land distribution, pollution prevention, solid waste disposal and sewage, as well as traffic control.

2.1.10 National Privatization Law (No. 21 of 2000)

This law, along with the National Privatization Strategy, calls for the restructuring and privatization of public institutions, increasing private sector investment in infrastructure and attracting foreign technology including SWM.

2.1.11 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. This law also outlines that projects shall comply with article 78 related to occupational health and safety, and provides essential precautions and arrangements to protect the workers from the risk of hazards, including the supply of personal protective equipment.

2.2 Bylaws and Regulations

The following summarizes the bylaws and regulations that are relevant to remediation of Area 3. This summary includes, for some of the bylaws and regulations, a reference to specific language in the bylaws and regulations relevant to the proposed project.

2.2.1 Air Protection Bylaw (No. 28 of 2005)

This bylaw was issued in accordance with Article 23 of the Environmental Protection Law (No.1 of 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; consequently, the appropriate location of the facility is determined. The MoEnv is responsible for detecting any excesses and for monitoring the compliance with this bylaw.

Per Article 4 of this bylaw, the following applies to this project:

> *"The Ministry shall classify the facilities from which Air Pollutants are emitted according to the type and quantity of the emitted pollutants and their effect on the Environment and public health, and shall also determine the areas subject to air pollution and the required monitoring programs, and the necessary procedures to control or prevent environmental damage."*

Per Clause (A) of Article 5, the following applies to this project:

> *"The Minister, upon the recommendation of the Secretary General, shall form a technical committee consisting of experts from the Ministry and concerned entities, that shall identify those Facilities in existence at the time of the coming into force of these Regulations, and that must realign to become in compliance with the provisions*

hereof within the period set by it, provided that such period does not exceed five years."

2.2.2 Soil Protection Bylaw (No. 25 of 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 MoEnv, 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.

Article 3-H of this bylaw states:

"The Ministry, in cooperation with the Ministry of Agriculture and any other entity concerned with soil protection shall carry out the following tasks and authorities:

H- To prepare the necessary programs for rehabilitation of quarries and sand mines, and mining areas the waste dumping sites after their reclamation, exploitation and cultivation with the appropriate crops."

2.2.3 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 currently reviewing the EIA regulations, including the EIA classification system, and will issue any changes to the regulations or additional guidance as appropriate.

2.2.4 Mining Regulation (No. 131 of 1966)

Per this regulation, the following applies to this project:

"A detailed geological, physical and hydrological study should be carried out for the area in which mining shall take place to include the following:

a- Thickness of the mineral to be extracted, its distribution, gradient, distance from the surface and hardness.

b- Vertical cross sections every 200 meters showing the type of rocks, thickness, hardness and gradient over and under the minerals to be extracted.

c- Cracks and folds which may affect the nature of mining in the area.

d- The highest underground water table which may be found in the area and how far from ground surface.

e- Main water course in the area and the highest level to which the water table may rise in these courses calculated on basis that the rate of annual rainfall is 1000mm."

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

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

2.2.6 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 for the prevention of occupational accidents. It identifies types of safety risks at work sites, including mechanical, chemical and electrical machinery and industrial equipment.

2.2.7 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 confirm the medical capability of workers via preliminary and regular medical examinations.

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, which applies to all land uses, including buildings and any construction works undertaken, makes the Higher Planning Council responsible for regional planning. 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. This regulation requires that generated hazardous waste be stored initially at the place of generation, after which it should be labeled and transported to a hazardous waste facility; i.e., in terms of hazardous waste transport and disposal control, the cradle to grave concept is to be applied, and each hazardous waste shipment should be subjected to manifest documentation.

Both industrial and medical wastes are still being disposed at sanitary landfills designed to handle only solid wastes. Liquid industrial wastes (either treated or not treated) and medical wastes (either incinerated or not incinerated) are still being sent to landfill sites in both a legal and an illegal manner. Problems occurring from waste disposal sites can be reduced considerably if this (and the following) regulation is implemented and enforced properly.

2.2.14 Ministry of Health Regulation (No. 1 of 2001)

This regulation deals with the management of medical waste. It defines general medical waste as all solid, liquid and gaseous waste that is generated at different healthcare institutions, medical laboratories, medical research centers, pharmaceutical industries, veterinary clinics and household health care activities.

2.2.15 Solid Waste Regulation (No. 27 of 2005)

This regulation specifies several responsibilities of the MoEnv in relation to SWM, including the following:

- Prepare plans for SWM and develop programs to implement them
- Determine the specifications of the equipment used to manage solid waste and the circumstances of waste collection, sorting, transporting, storage, recycling, treatment and disposal
- Determine methods of rehabilitation upon the closure of landfills
- Conduct studies and gather information on SWM case studies, organize the studies, assess and propose suggestions for each
- Conduct programs for training and public awareness regarding SWM

In addition, this regulation specifies that any party responsible for SWM shall:

- Provide qualified staff to manage solid waste and safety of employees
- Provide the machinery, containers and equipment needed for SWM
- Control solid waste collection and identify the trucks transferring the waste to its allocated disposal sites
- Placement of containers in appropriate places, maintenance and replacement of damaged ones
- Take necessary measures to prevent dumping hazardous waste in solid waste containers

2.2.16 Regulation of Waste Prevention and Collection Fees (1/1978) and its Amendments (30/1983)

This regulation identifies the fees of solid waste services according to municipality category.

2.2.17 Regulation of the Common Services Council (No. 17 of 1983)

This regulation hands the Common Services Council the responsibility of operating and managing landfills.

2.2.18 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. This regulation also specifies the responsibilities of this committee.

2.3 Instructions, Standards and Codes

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 or septic tanks or surface water sources or 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 or surface water or 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 Noise Prevention of 2003

These instructions address ambient noise and were issued by the MoEnv in 2003. 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 MoEnv.

Table 2-1 displays the allowable maximum limit of the equivalent volume level in A-weighted decibels (dBA) per area.

2.3.7 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 2-2 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 2-1. Maximum Allowable Noise Levels

Area	Maximum limit for equivalent sound level (dBA)	
	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

Table 2-2. Allowable Limits of Ambient 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	-
Respirable Particulate Matter (PM_{10})	24 hours	120 µg/m^3 **	3 times in any 12-month period
	Annual	70 µg/m^3	-
Fine Particulate Matter ($PM_{2.5}$)	24 hours	65 µg/m3	3 times in any 12-month period
	Annual	15 µg/m3	-
Total Suspended Particulates (TSP)	24 hours	260 µg/m^3	3 times in any 12-month period
	Annual	75 µg/m^3	-
Lead (Pb)	Seasonally	1 µg/m^3	-
	Annual	0.5 µg/m^3	-
Phosphates (P_2O_5)	24 Hours	100 µg/m^3	3 times in any 12–month period
	Annual	40 µg/m^3	-
Cadmium (Cd)	Annual	0.005 µg/m^3	-

Notes: * ppm indicates part(s) per million.
**µg/m^3 indicates microgram(s) per cubic meter.
Source: Jordan Ambient Air Quality Standards (JS 1140/2006)

2.3.8 Jordanian Building Codes

In 1993, the Government of Jordan issued the Building Code Law No. 7 of 1993, which led to the creation of the Jordan Building Code Commission. The Commission, led by the Ministry of Public Works and Housing, was designated the responsibility of preparing building codes for the country. Since then, the Commission has published 32 building codes regarding the design and construction of buildings in Jordan. For any building design to obtain clearance in Jordan, it has to be approved by the Jordanian Engineers' Association, Civil Defense Directorate, and the Earthquake Commission. These agencies ensure that the design abides by these codes, many of which address environmental, health, and safety issues and are relevant to the building. They are as follows:

- Jordanian Code No. 3: Loads and Forces (Section 4: Earthquake Actions)
- Jordanian Code No. 15: Fire Protection
- Jordanian Code No. 16: Natural Ventilation
- Jordanian Code No. 17: Natural Lighting

- Jordanian Code No. 18: Water Supply for Buildings
- Jordanian Code No. 19: Wastewater for Buildings
- Jordanian Code No. 20: Beautification of the City
- Jordanian Code No. 21: Solid Waste
- Jordanian Code No. 22: Public Safety during Construction
- Jordanian Code No. 23: Electrical Installation
- Jordanian Code No. 27: Fire Alarm Systems
- Jordanian Code No. 32: Building Requirements for the Physically Challenged

2.3.9 Jordanian Code No. 22: Public Safety during Construction

The Code of Public Safety during Construction, Jordanian Code No. 22 of the *Building Code Law No. 7 of 1993*, 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.

3 INSTITUTIONAL FRAMEWORK

This chapter describes the applicable institutional framework in Jordan. Municipal administration is provided by Governorates and Municipalities. Governorates are the executive authority for the implementation of central government policies at the local level and are responsible to the Ministry of Interior for the provision of services outside the municipality areas and some regional planning. Municipalities are responsible to the Ministry of Municipal Affairs (MoMA) for municipal administration and land use planning.

3.1 Zarqa Chamber of Industry

The Zarqa Chamber of Industry serves around 6,000 industrialists from 10 sectors in Zarqa and Mafraq Governorates consisting of small and medium size enterprises (the City of Russeifah is located in the Zarqa Governorate). The chamber also sets trade standards and studies industrial issues.

3.2 Ministry of Environment

The 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. The MoEnv is responsible for the development of environmental legislation, strategies, and policies, including those of relevant to SWM activities.

MoEnv is the entity that would be responsible for reviewing EIA studies and granting the approval for the proposed project, as well as being the entity ensuring and monitoring environmental compliance and protection of environmental components throughout the construction and operation of the proposed project. Furthermore, MoEnv is the entity responsible for handling environmental complaints. The relevant MoEnv laws, regulations, and instructions to be complied with were discussed previously in Section 2.

3.3 Jordanian Natural Resources Authority

In accordance with the provisions of the Natural Resources Affairs Law (No. 12 of 1968), the Natural Resources Authority (NRA) is responsible for "*prospecting, geological and economic studies needed for the natural resources, supervising technically the methods of mining, and exploiting such ….*" From a legal standpoint, the NRA is the responsible body for all that relates to mining. However, with regards to environmental issues, the NRA consults with the MoEnv.

3.4 Ministry of Water and Irrigation, including Water Authority of Jordan and Jordan Valley Authority

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

The jurisdiction of the WAJ encompasses water and wastewater in Jordan, and the authority's objectives include protecting water resources from pollution and depletion, and protecting soils from degradation. The Jordan Valley Authority is responsible for the socioeconomic development of the Jordan Rift Valley, including water resource development and the distribution of irrigation.

3.5 Ministry of Health

The Ministry of Health 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.

3.6 Ministry of Agriculture (MOA)

MOA is the entity responsible for regulating and permitting all agricultural activities in Jordan and has a particular mandate for regulating soil fertilizers and agricultural input material.

Part of MOA's role involves ensuring the sustainability of the agricultural use of natural resources without harming the environment, in addition to creating the suitable atmosphere for investment in the agricultural sector, as well as rural development and increasing the incomes of farmers and improving their lives.

3.7 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. The MoMA oversees all activities of municipalities, including collection and disposal of municipal waste in Jordan. MoMA is responsible for seeing that the action of each municipality is consistent with current legislation. For this proposed project, the relevant municipality and implementing arm of MoMA would be Russeifah Municipality. Within its area of jurisdiction (which includes the project area), Russeifah Municipality is authorized to undertake the needed measures to prevent the occurrence of health nuisances.

The key responsibility of the MoMA concerning SWM is providing municipalities with funding or low interest loans for maintenance of SWM infrastructure and equipment. For SWM cost recovery, partial costs are obtained through a flat charge per month on households. A SWM fee is added to the electrical bill. The SWM fee covers only part of the direct cost of operating waste collection, transport and disposal. The rest is made up from either local municipal revenues or transfers from government. SWM cost recovery is covered by Regulation No.88 of 1998, which introduced the solid waste fees and imposed the mechanism of collection through the electric bill.

In an attempt to reduce operational costs, several municipalities have implemented inter-municipal agreements through the Common Services Councils (CSC) to manage waste disposal sites. In several areas of Jordan, the operation and management of landfill sites is the responsibility of the local CSC, with each serving a group of municipalities. In some areas, the CSC is responsible for waste collection in addition to disposal. Both the CSC and the municipalities are monitored by the MoMA.

3.8 Ministry of Labor

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

3.9 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.

3.10 The Royal Society for the Conservation of Nature

The Royal Society for the Conservation of Nature is a non-profit, non-governmental organization that aims to conserve the Kingdom's natural resources.

4 DESCRIPTION OF THE PROPOSED PROJECT

This chapter describes the project location, objectives, and recommended design alternative for the Remediation of Russeifah Areas 1 and 2.

4.1 Project Location

The City of Russeifah is located in the Zarqa Governorate, 15 kilometers northeast Amman, situated in the middle of Jordan and north of the highway which connects Amman and Zarqa. The city is approximately 665 m above sea level, with an approximate latitude and longitude of 30.0167°N and 36.05°E. The general location of the area can be seen in Figure 4-1.

Figure 4-1. General Site Location

The phosphate mining area within Russeifah was one of the largest mining areas in Jordan. The Jordan Phosphate Mines Company was established in 1952 and was granted a concession area of approximately 13,478 donum (1,348 hectares). The southern part of the concession area, approximately 10,355 donum (1,036 hectares), lies within the border of the Greater Amman Municipality. The remaining 3,123 donum (312 hectares) are within the borders of Russeifah Municipality. Of the total concession area, approximately 2,720 donum (272 hectares) have been abandoned and require rehabilitation and/or redevelopment (RSS, 1995); it is divided into the following six areas:

- Area 1: Russeifah landfill
- Area 2: Mining pit
- Area 3: Phosphate ore pile
- Area 4: Lagoon
- Area 5: Tunnels
- Area 6: Overburden piles

For reference, each of these areas is shown in Figure 4-2. The primary purpose of this report is to assess the social and environmental implications of the proposed remediation project for Areas 1 and 2. The implications of the remediation project proposed for Area 3 are presented in a separate ECR. Detailed descriptions of Areas 1 and 2 are presented below.

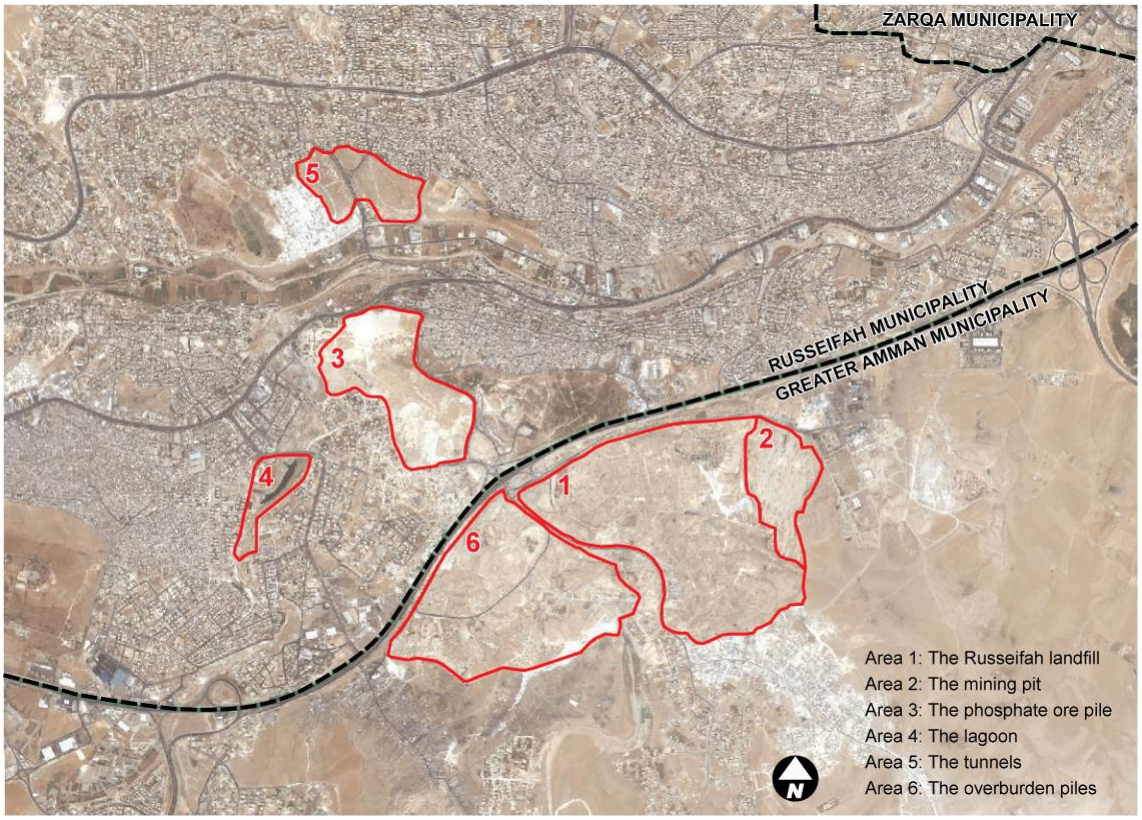


Figure 4-2. Russeifah Site Areas

Area 1 (Landfill), as defined in this report, is approximately 1,128 donum (113 hectares). The area used for municipal waste disposal covers almost 828 donum (83 hectares), while the remaining area has been used for random disposal of excess earth material. Access to the site is somewhat controlled by a gated entrance to the Landfill Biogas Plant. The Area 1 landfill is closed, although illegal dumping of predominantly C&D waste continues to occur.

The Area 2 mining pit resulted from the extraction of phosphate ore by the Jordan Phosphate Mining Company through the process of "open pit mining." The pit lies immediately adjacent to the eastern border of the landfill and is currently used by the Greater Amman Municipality as a C&D debris landfill. *Kamkha* (liquid waste produced from stone and marble cutting) and other potential unacceptable or non-inert wastes are currently being disposed of within Area 2. According to a recent topographic survey, the pit has an approximate area of 350 donum (35 hectares) and a volume of 5,670,000 cubic meters if it were filled to match the elevation of the surrounding natural ground. While the upper portion of Area 2 is accessible from the Amman-Zarqa Highway, there is no access road leading to the base of the pit.

4.2 Project Objectives

The objectives of the proposed Russeifah Areas 1 and 2 remediation project are to improve the quality of the area surrounding the project through the development of Area 1 (Landfill) into a properly closed landfill and the development of Area 2 (Pit) into a properly operating C&D landfill site.

The remediation design was prepared in general accordance with the United States Environmental Protection Agency, Subtitle D requirements for solid waste landfills. The design strategy was based on achieving the following objectives:

- Reduce the amount of infiltration of stormwater through the landfilled waste in Area 1 by:
  - Re-shaping the currently random landfill surface into a surface that will drain water away from the waste
  - Capping the landfill surface with an evapotranspiration (ET) cover
  - Installing a surface water management system consisting of open channels, chutes, culverts, and a lagoon
- Minimize potential landfill fires and control landfill gas (LFG) migration by installing additional LFG wells and collection pipes in capped Area 1
- Contain leachate produced in the unfilled areas of Area 2 by installing a liner and leachate collection system
- Reduce the amount of infiltration of stormwater through Area 2 by capping the landfill surface with an ET cover, and by installing a surface water management system consisting of open channels, chutes, culverts, and a lagoon

4.3 Project Components

This Design Report for Russeifah landfill final closure (Area 1) and the C&D landfill at the Russeifah pit (Area 2) was submitted to USAID and the Government of Jordan and addressed the following components:

- Access control for the site
- Regrading of the landfill site to correct settled areas and to allow surface water drainage for Area 1
- Final cap and stormwater management system for Area 1 and 2
- Landfill Gas Management System for Area 1
- Liner Design and Leachate System for Russeifah the new C&D landfill in Area 2

These five main project components are described in more detail below.

4.3.1 Access Control

There are currently minimal access restrictions at the site. A gated entrance to the Landfill Biogas Plant controls vehicle access to the plant from the adjacent public road. There are fence posts in some areas of the facility, but many are broken. Access controls that would be

implemented to eliminate unauthorized access to the facility would consist of perimeter fencing and signage.

4.3.1.1 Security and Fencing

Access to the site would be controlled by installing a boundary wall surrounding the entire site with a security gate to be closed and locked when the landfill is not operating in order to prevent the entry of unauthorized people and livestock. For the C&D landfill (Area 2), a proper office which cannot be bypassed (i.e. perimeter control fencing, walls, gates, etc. are also required) is to be built at the entrance, and waste entering is to be assessed by the staff and records maintained. An adequate number of well-trained staff must be available onsite when the facility is open and the entrance shall be closed and locked during non-operation hours.

4.3.1.2 Signage

A sign must be permanently posted at the site entrance stating the name and purpose of the facility as well as the contact information for the responsible Owner/Operator. The sign must also include the hours of operation and a list of wastes not allowed to be received or handled in the facility. Appropriate signage should also be placed around the C&D landfill perimeter. Additional guidance signage may be necessary at the segregation pad, listing prohibited waste for the C&D landfill (Area 2).

4.3.2 Regrading Russeifah Landfill (Area 1)

The first step of the Landfill Cap design is to regrade and re-slope the surface of the site to eliminate depressions (settled areas) and to provide a smooth surface suitable for cover installation that is capable of draining stormwater into a system of engineered drainage structures. Historically, waste was randomly placed in the landfill with inconsistent compaction efforts and with no planned final grade. Original grading of the landfill surface is vastly irregular and random, thus making regrading necessary. To prepare the landfill surface for capping, waste and topsoil would be relocated and reconsolidated within the landfill to promote positive drainage to engineered surface water management controls. Surficial soils would be removed within the proposed disturbance limit and segregated for reuse. Waste would be relocated and compacted to fill depressions and to provide the revised slope configuration/grading. The regrading has been designed to support and sustain efficient and controlled stormwater runoff in addition to incorporating the access roads in such a way that their slopes are uniform, easily traversed by landfill traffic, and of sufficient minimum slope and width to accommodate drainage ditches.

4.3.3 Final Landfill Cap and Stormwater Management System

4.3.3.1 Final Landfill Cap

A final landfill cap is proposed for both Area 1 and Area 2. The existing landfill cover for Area 1 is composed of randomly graded porous materials, primarily construction waste, and illegal dumping of predominantly C&D waste continues to occur. The existing limited soil cover allows both LFG to escape into the atmosphere and air to enter into the landfill. In addition, stormwater infiltrates readily through the cover into the waste mass as a result of the lack of engineered slopes for drainage.

The main purposes of a final landfill cap design are to:

- provide long-term minimization or elimination of stormwater infiltration into the waste
- reduce direct exposure to the waste
- minimize air intrusion into the landfill
- help minimize fugitive LFG emissions from the landfill

4.3.3.2 Stormwater Management System

Surface water catchment areas from within the site (runoff) and from outside the site draining into it (run-on) were identified in order to determine the volume and flow rate of surface water that must be managed. Based on the evaluation of these catchments, all runoff has been designed to drain into the access road ditches, which would direct surface water through drop inlets (where appropriate), chutes, and culverts into a surface water basin at the low point on the eastern side of the facility.

The surface water basin would be located at the low point along the eastern side of the site and would ultimately receive runoff from Areas 1 and 2, in addition to runoff from an outside wadi. Based on meteorological data obtained from the years 2001 through 2010 and calculations for rainfall, runoff, and evaporation rates, it was determined that a basin volume of 200,000 cubic meters would be needed to manage surface water from the facility.

4.3.4 Landfill Gas Management System

4.3.4.1 Design Strategy

The LFG Management System at the Russeifah Landfill (Area 1) site has been designed to control the release of LFG to the atmosphere onsite and to prevent the migration of LFG away from the site. As the primary means of disposal, a connection would be provided to transfer extracted and collected LFG to the Jordan Biogas Company (JBC) biogas plant, located near the southwest boundary of Area 1 and adjacent to the landfill, and LFG also would be flared as a backup disposal measure. The LFG management system is designed in accordance with United States Environmental Protection Agency, Subtitle D specifications.

The proposed LFG management system would consist of approximately 222 vertical extraction wells, condensate collection and handling facilities, a blower to draw the LFG from the wells and a flare to reduce atmospheric emissions. There is an existing LFG system in place over a portion of Area 1; however, not all of the LFG wells are currently producing gas. Only about one third of the existing wells are active and the rest have been closed because the methane content was too low to produce electricity. There are anecdotal reports that waste in the north half of Area 1 was burned, reducing its residual organic content. Proper measures would be undertaken for the abandonment of existing LFG wells which cannot be incorporated into the final LFG collection system.

As described previously, uneven settlement in Area 1 has also limited the effectiveness of LFG laterals and header piping as condensate collects in low points within the system and must be periodically manually drained. Therefore, the existing LFG piping and condensate drains would be replaced with trenched piping and self-draining condensate traps.

The design strategy undertaken was to design a new LFG management system to be installed and to abandon the majority of the current system. This strategy was adopted due to the following reasons:

- It is too costly to conduct reliability tests for the existing wells and most are expected to fail.

- The existing landfill soil cover is not representative of a true landfill closure cap nor was it properly graded for drainage control when it was installed. Cracks and fissures randomly cross portions of the landfill thus allowing LFG to emit directly into the atmosphere.

- As the LFG secondary (laterals) and main collection pipes lie directly on the landfill cover soil, they follow the undulations in the improperly graded topography and resultant grades from uneven differential settlement.

- The efficiency of the LFG collection system is further reduced by condensate collecting in the low points of the pipes and the need for it to be manually drained.

- The waste mass is subjected to a partial vacuum by the blower which pulls the LFG through the wells and pipes. This vacuum currently pulls air into the landfill through the cracks and fissures which slows down the anaerobic process producing methane and also increases the risk of spontaneous combustion landfill fires.

Given the above limitations, it was recommended that close coordination with the JBC occur prior to and during construction of the proposed LFG collection system to determine whether any of the existing LFG wells can be incorporated into the final LFG collection system.

4.3.4.2 LFG Management System Description

As mentioned previously above, the existing LFG wells would be abandoned. A new LFG Management System was designed for efficient extraction and transmission of landfill gas from all portions of the landfill.

The layout configuration employed has approximately 41 meters of equilateral spacing between wells such that their zones of influence overlap. The well spacing is based on "typical" North American municipal solid waste industry LFG well spacing of about 2.5 wells per hectare. The radius of influence used for the design is around 25 meters. The well depth varies but falls within the range of 21 to 30 meters with most wells having a depth of 30 meters. Wells are drilled to maximum depth of 3,000 millimeters (3 meters) above the landfill base. The LFG laterals and header piping would be installed within a compacted backfill layer with a minimum of 150 millimeters of compacted backfill above and below each pipe. This provides structural support to the pipe. A minimum 600 millimeter (0.6 meter) thick layer of general backfill with an embedded utility identification tape would be installed above the compacted backfill, followed by the final cover soil.

The LFG header pipe system would facilitate efficient LFG control by employing a looped piping system to provide an even distribution of blower vacuum to the vertical extraction wells. All LFG header pipes are designed with positive gravity flow to the condensate knockouts. Gas conveyance piping was designed to the appropriate minimum diameter that would convey flow at no greater than the selected maximum velocities for concurrent and countercurrent flow.

4.3.5 Liner and Leachate Collection System for Area 2

4.3.5.1 Design Strategy

Area 2 (Pit) is currently being used as a dump site for C&D waste and would be operated going forward as an engineered C&D landfill. According to United States Resource Conservation and Recovery Act, C&D wastes are a component of solid wastes. However, C&D landfills generally have less stringent landfill design requirements due to the inert nature of the waste deposited and therefore have a lower likelihood of adverse impacts to the community and to the environment. Thus, C&D landfills may be exempt from some or all of the requirements for liners and leachate control, if the applicant demonstrates that no significant threat to the environment would result from the exemption. However, as the groundwater aquifer is near to the bottom of the waste level in Area 2, and as *kamkha* and other potential unacceptable or non-inert wastes are currently being disposed of within

Area 2, it is recommended that a liner be installed to reduce potential groundwater contamination risks.

Based on site surveying done by Al Mehwar Survey Office in October 2011, the remaining capacity of the Area 2 C&D Landfill is approximately 5,670,000 cubic meters. Depending upon the review and approval time-frame for the Design Report and the extent of filling at the time of approval, the remainder of Area 2 (Pit) may be graded and a portion of it may be covered with a liner and equipped with a leachate system.

4.3.5.2 Description of the Liner Design and Leachate System

The liner and leachate system are to be placed at the lowest level of Area 2 (pending actual filling status at the time of acceptance of the design and forecasted construction date) as the rest of the area has either been filled with C&D waste or is high and would thus drain into the lowest point. The current profile and configuration of the bottom of the landfill are such that gravitational flow is towards the low point. It is proposed that the base of the pit would be graded at a minimum slope of 1 percent with leachate collection piping installed perpendicular to the main flow line to promote rapid conveyance of collected leachate to the sump area.

The proposed composite liner system would consist of a 1.5-millimeter HDPE geomembrane liner and overlying 1,080 gram per square meter nonwoven geotextile cushion placed on top of 1,000 millimeter (1 meter) thick compacted low permeability soil layer. If the low permeability soil layer cannot be constructed due to the arid climate, a geosynthetic clay liner may be substituted for the 1000 millimeter thick compacted low permeability soil layer in the composite liner. A 300 millimeter (minimum) thick granular drainage layer with a hydraulic conductivity of at least 1×10^{-1}cm/s would be installed on top of the nonwoven geotextile cushion and would be covered by a geotextile filter. Two leachate collection pipes would be installed within granular drainage layer to intercept the leachate flow and convey it rapidly to the sump location for removal. The two perforated leachate collection pipes would terminate at the low point of the leachate collection system at a sump with a slide slope riser. A submersible discharge pipe would be placed in the sump. The pump discharge for the leachate collection system would be connected through the riser termination to a leachate holding tank.

4.4 Project Alternatives

4.4.1 Landfill Cover Alternatives for Area 1

The following five landfill cover alternatives were identified and evaluated for Area 1:

- Alternative 1: Linear low density polyethylene liner plus top soil and grass
- Alternative 2: Closure turf
- Alternative 3: Linear low density polyethylene liner plus aggregate erosion layer
- Alternative 4: Evapotranspiration (ET) layer plus grass
- Alternative 5: ET layer plus aggregate erosion layer

Based on a feasibility study comparing five alternatives for the Landfill Cap, Alternative 5 was selected as the preferred alternative. A monolithic ET cover would be installed using the overburden soil piles from a nearby location in Russeifah referred to as Area 6. The ET cover was chosen due to its proven suitability in arid and semi-arid areas, its limited long-term maintenance requirements, as well as its economic feasibility. The surface of the ET cover would then be covered with an aggregate layer for erosion control.

4.4.2 Landfill Cover Alternatives for Area 2

The following two landfill cover alternatives were identified and evaluated for Area 2:

- Alternative 1: ET layer plus grass
- Alternative 2: ET layer plus aggregate erosion layer

Alternative 2 was selected as the preferred alternative for the same reasons identified above for Area 1.

5 DESCRIPTION OF THE STUDY AREA

This chapter details the existing environmental conditions for the project area.

5.1 Climate

The climate of Jordan in general is of East Mediterranean type, characterized by warm, dry summers and mild, wet winters. Since 2003, annual average temperatures at the Amman Airport (meteorological station near the study area) have ranged from 8.9 to 27.1 degrees Celsius (°C), peaking in the month of August. Annual rainfall varies widely throughout the year within the Amman area; with precipitation occurring during the winter months (October to May), while the summer months are essentially dry. The average annual precipitation is about 236.5 millimeters per year, and the area is classified as an arid region (USAID, December 2014). The prevailing wind direction at Amman Airport is westerly and the majority of the winds are within +/- 22.5 degrees (USAID, May 2013).

Available climate measurements recorded between 2003 and 2013 at the Amman Airport meteorological station were averaged and are presented in Table 5-1. Daily precipitation values from 2003 to 2013 were analyzed to calculate the mean monthly precipitation, shown in Figure 5-1 (USAID, December 2014).

5.2 Geology

The geology of the project area has been studied and reported by a number of investigators. Previous investigations were compiled and updated by the NRA in 2004. For the purpose of this assessment, the maps developed by the NRA were used as the basis of the geological study. A geological inspection was also conducted during site visits to the Russeifah Phosphate Mining Area. A general geological map of the project area is presented in Figure 5-2, and a generalized vertical section describing the soil layers is presented in Figure 5-3.

In July 2011, project staff conducted a field investigation of each of the Russeifah areas. Additionally, the project team obtained two 1:50,000 NRA geological maps/reports covering the Russeifah area, including Al Zarqa 3254 III (2001) and Sahab 3253 IV (1988). Based upon the field investigation and review of both maps/reports, the stratigraphy characteristics of the earth sequence were identified. The earth layers described in this text follow the nomenclature used in the 1:50,000 National Geologic Mapping Project for Jordan. The sequence of the exposed geological formations in the area is characterized by the following principal formations, in descending order:

- Recent (Pleistocene) Deposits
- Al-Hisa Phosphorite Formation
- Amman Silicified Limestone
- Wadi Umm Ghudran Formation

5.2.1 Recent Deposits

The Pleistocene gravels consist of poorly sorted pebbles and cobbles angular to surrounded clasts of cherty phosphate, and limestone covered Al-Hisa Phosphorite Formation. The alluvial and alluvium are deposits in the wadi and associated floodplains. Clasts of cherty phosphate, limestone and chert are in the range of sand to cobble size. They are sub-rounded to sub-angular and vary in composition, depending on the local bedrock.

Table 5-1. Average data from Amman Airport Meteorological Station: E 35 59', N 31 59', Elevation 780 meters (2003-2013)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Mean Air Temperature (ºC)	8.9	9.9	13.1	17.4	21.9	25.3	27.0	27.1	24.8	21.5	15.4	10.4	18.6
Mean Maximum Air Temperature (ºC)	13.2	14.4	18.4	23.4	28.3	31.4	32.9	33.1	30.9	27.3	20.7	15.1	24.1
Mean Minimum Air Temperature (ºC)	4.5	5.4	7.8	11.3	15.4	19.1	21.2	21.1	18.7	15.6	10.1	5.7	13.0
Total Rainfall (millimeters)	62.8	73.5	25.4	10.7	2.1	0.0	0.0	0.0	0.1	4.0	18.5	39.4	236.5
Mean Relative Humidity (%)	69.0	69.1	59.2	49.1	40.5	38.4	40.4	43.7	49.9	51.9	57.1	63.4	52.6
Mean Wind Speed (Knot)	4.8	5.7	5.5	5.8	5.9	6.3	6.7	5.6	4.6	3.5	3.1	3.9	5.1
Total Evaporation, Class "A" Pan (mm)	52.7	63.9	110.6	166.5	245.5	301.3	326.1	289.4	224.3	159.4	87.7	59.8	173.9

Source: Amman Airport Meteorological Station (2003-2013)

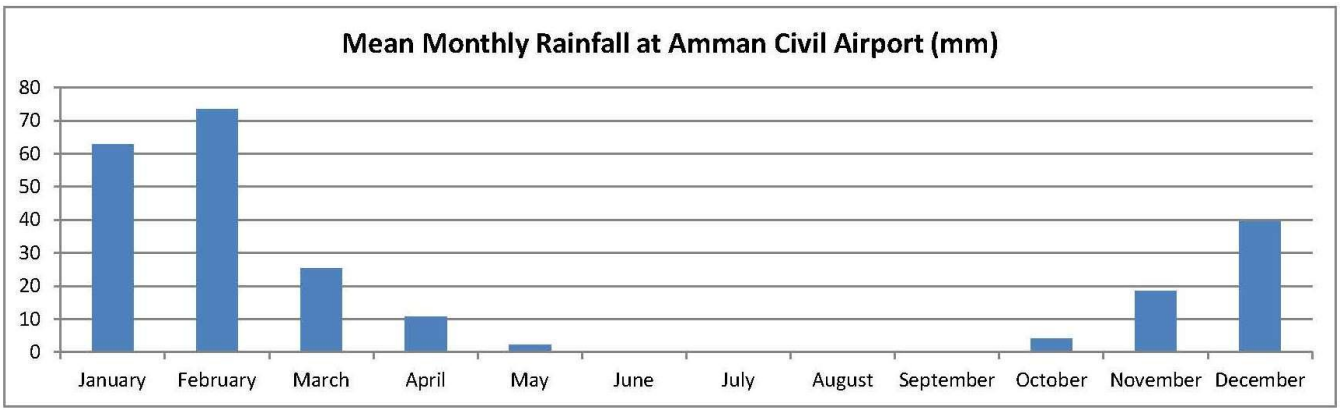


Figure 5-1. Mean monthly precipitation in the study area (2003-2013)

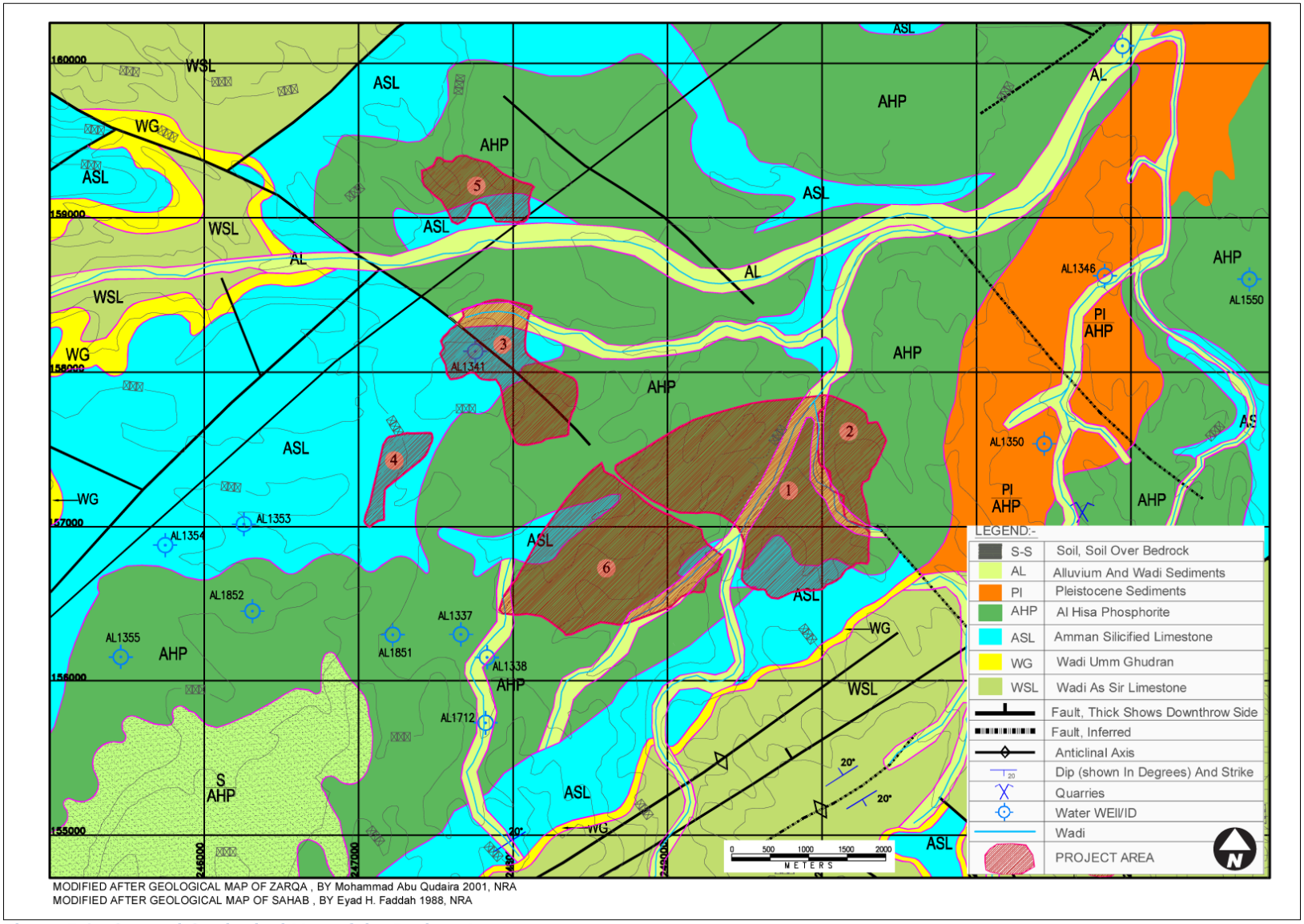


Figure 5-2. General Geological Map of the Project Area

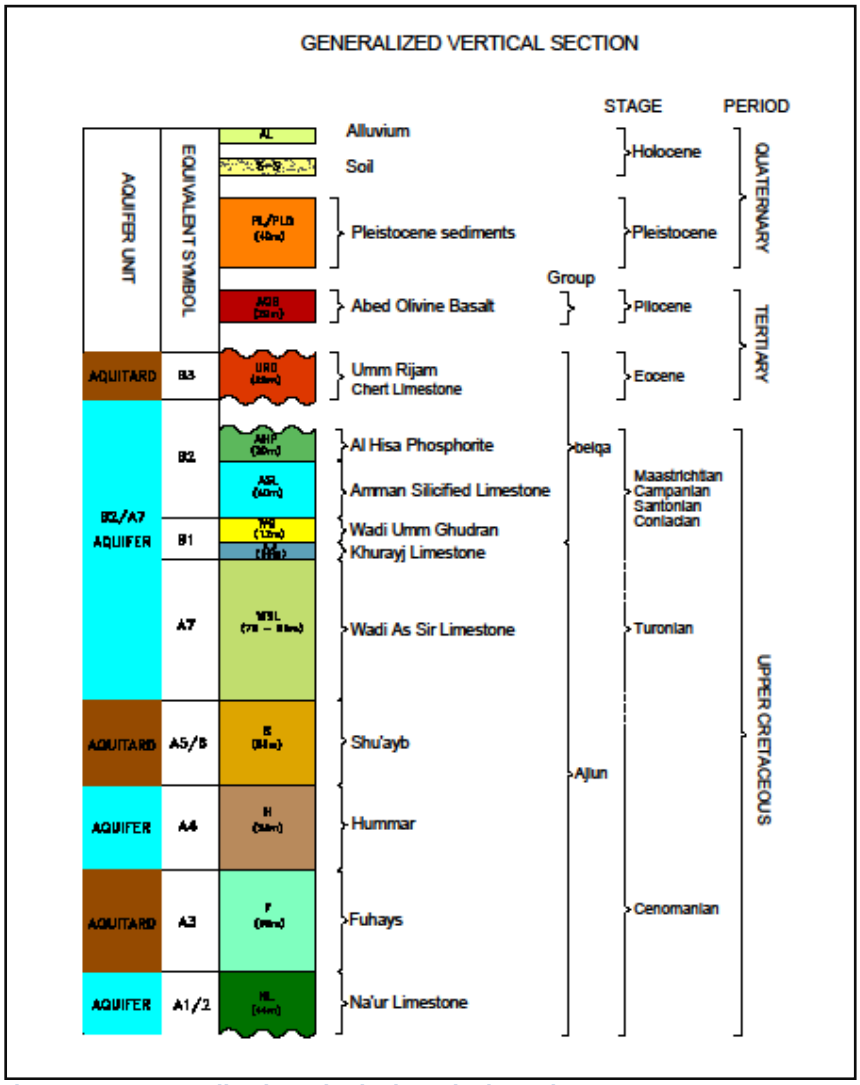


Figure 5-3. Generalized Geological Vertical Section

5.2.2 Al-Hisa Phosphorite Formation

This formation consists of thin to medium bedded chert, white to yellowish marl, chalky marl, cherty phosphate and locally dolomitized microcrystalline limestone. Al-Hisa formation is equivalent to the upper part of the Amman formation (B2), but it was mapped as a separate unit from the underlying formation by the 1961-1966 German Geological Mission (as cited by USAID, January 2012) and Bender (1974). The top of this formation is marked by the change from phosphate, cherty phosphate, and limestone to soft chalk of the overlying Muwaqqar Chalk Marl formation. The formation is close to the Campanion–Maastication boundary, and the thickness of the exposed formation in the area ranges from 5 to 20 meters.

5.2.3 Amman Silicified Limestone

The Amman Formation was named first by Masri (1963, as cited by USAID, January 2012). MacDonald and partners (1965, as cited by USAID, January 2012) used the term “(B2)” which includes both this formation and the overlying Al-Hisa Phosphorite Formation. The lower part of this formation is dominated by thin to medium bedded, partly brecciated chert beds, silicified limestone, and in the upper part of the formation cherty phosphate alternates with thin beds of phosphate. The formation is characterized by its sedimentary undulation, produced by tectonic processes and by the presence of Tripoli in many horizons within this

formation. The base of this formation is characterized by the presence of dark weather chert beds overlying coquina beds of the underlying Wadi Umm Ghudran Formation, while the top is marked by the increasing of phosphate and decreasing of chert. The formation is Campanian in age.

5.2.4 Wadi Umm Ghudran Formation

This formation is considered the basal unit of the Balqa Group and consists of thinly bedded chalky limestone in the lower part overlaid by white chalk pinkish to yellowish, medium hard, thin bedded and white chalk below coquina bed which represent the top of this formation. The base of this formation is indicated by the change from thick bedded, massive limestone of the underlying Wadi As Sir Formation to thinly bedded white chalk and chalky limestone, while the top is marked by the presence of thick brecciated chert beds of the overlying Amman Silicified limestone. The age of this formation is Santonian (USAID, January 2012).

5.3 Topography

Topography within Areas 1 and 2 is varied and has been heavily influenced by past activities at the site. Elevations range from approximately 611 meters above sea level, in the deepest portions of the Area 2 pit, to approximately 678 meters above sea level in other portions of the site (Figure 5-4) (USAID, January 2012).

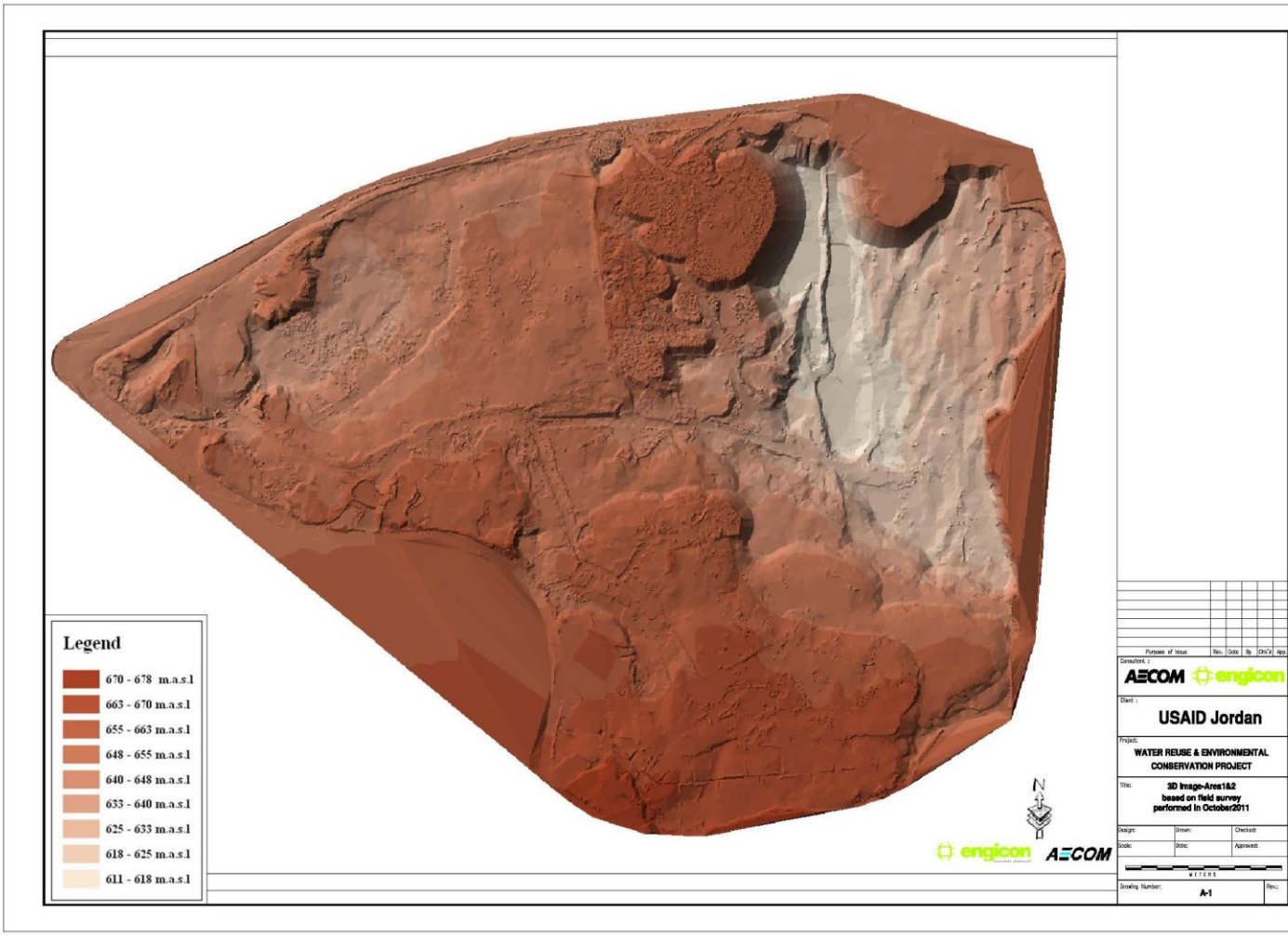


Figure 5-4. 3D Topography of Areas 1 & 2

5.4 Soils

The soil deposits in the general area are formed by the dissolution of Cretaceous bedrock and consist of three parts: upper, middle, and lower. The upper part of the soil is dark to grayish brown, soft to stiff silty clay and contains gravel, cobbles, and boulders of chert and silicified limestone. The middle part of the soil is brown, soft to firm silt. The lower layer is reddish brown, soft to firm silty clay containing angular gravel, cobbles, and boulders of chert. Native soils at Areas 1 and 2 have been heavily disturbed due to landfill and open pit mining, respectively (USAID, March 2014).

5.5 Surface Water

The Zarqa River is located approximately 0.7 kilometers north of Areas 1 and 2. The river generally flows to the north before heading west and finally discharging into the Jordan River at an elevation of 1,090 meters lower than its origin. The river's summer base flow is approximately 2 to 3 million cubic meters per month and rises to 5 to 8 million cubic meters per month during the winter. The river is dry most of the year, but when flowing the major direct water uses are crop and grazing land irrigation, in addition to livestock watering. The total basin area of the river is 3,900 square kilometers, and the basin is the largest watershed in Jordan (Figure 5-5) (USAID, March 2014).

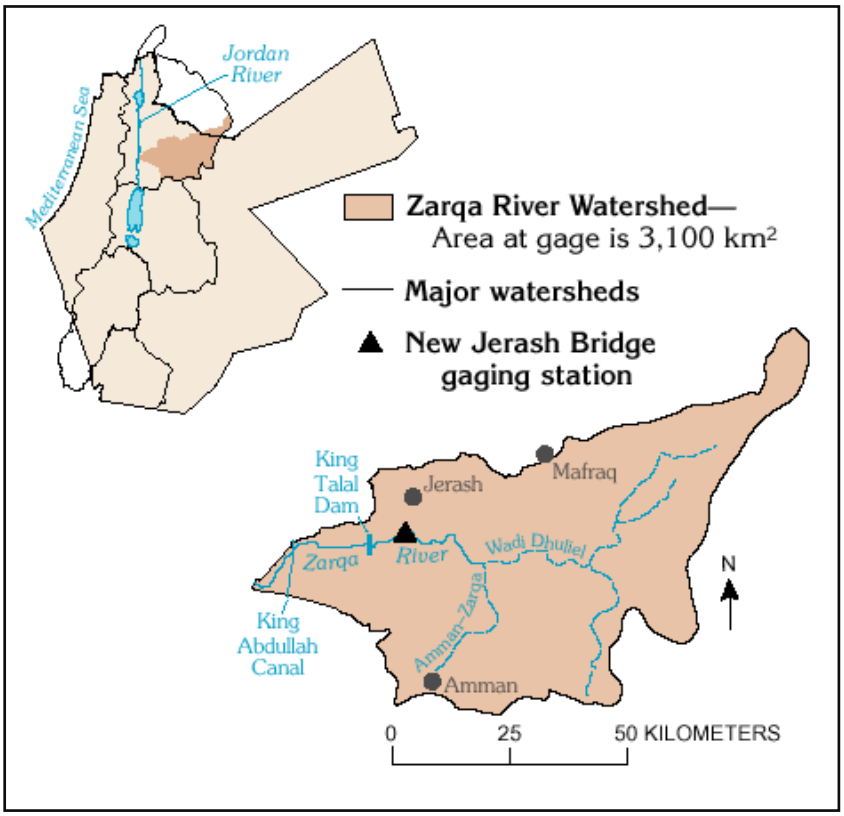


Figure 5-5. Zarqa River Watershed
(Adopted from Executive Action Team (EXACT), Multilateral Working Group on Water Resources)

No wadis or streams traverse Areas 1 and 2, although a small wadi does drain into Area 2 at a low point along the eastern side of the site. Seasonal flow from the wadi and runoff from Areas 1 and 2 result in temporary ponding in isolated depressions on Area 2 during the winter.

5.6 Groundwater

5.6.1 Hydrogeology of Jordan

The groundwater aquifers in Jordan are classified into three main categories: the deep aquifer complexes, middle aquifer complexes, and shallow aquifer complexes. The latter is considered the most exploited (MoEnv, March 2006). In Jordan, a total of 12 groundwater basins were identified, based on the configuration of renewable groundwater divides. Figure 5-6 shows these groundwater basins. The arrows represent the direction of flow of the main renewable groundwater in the upper aquifer system (USAID, March 2014).

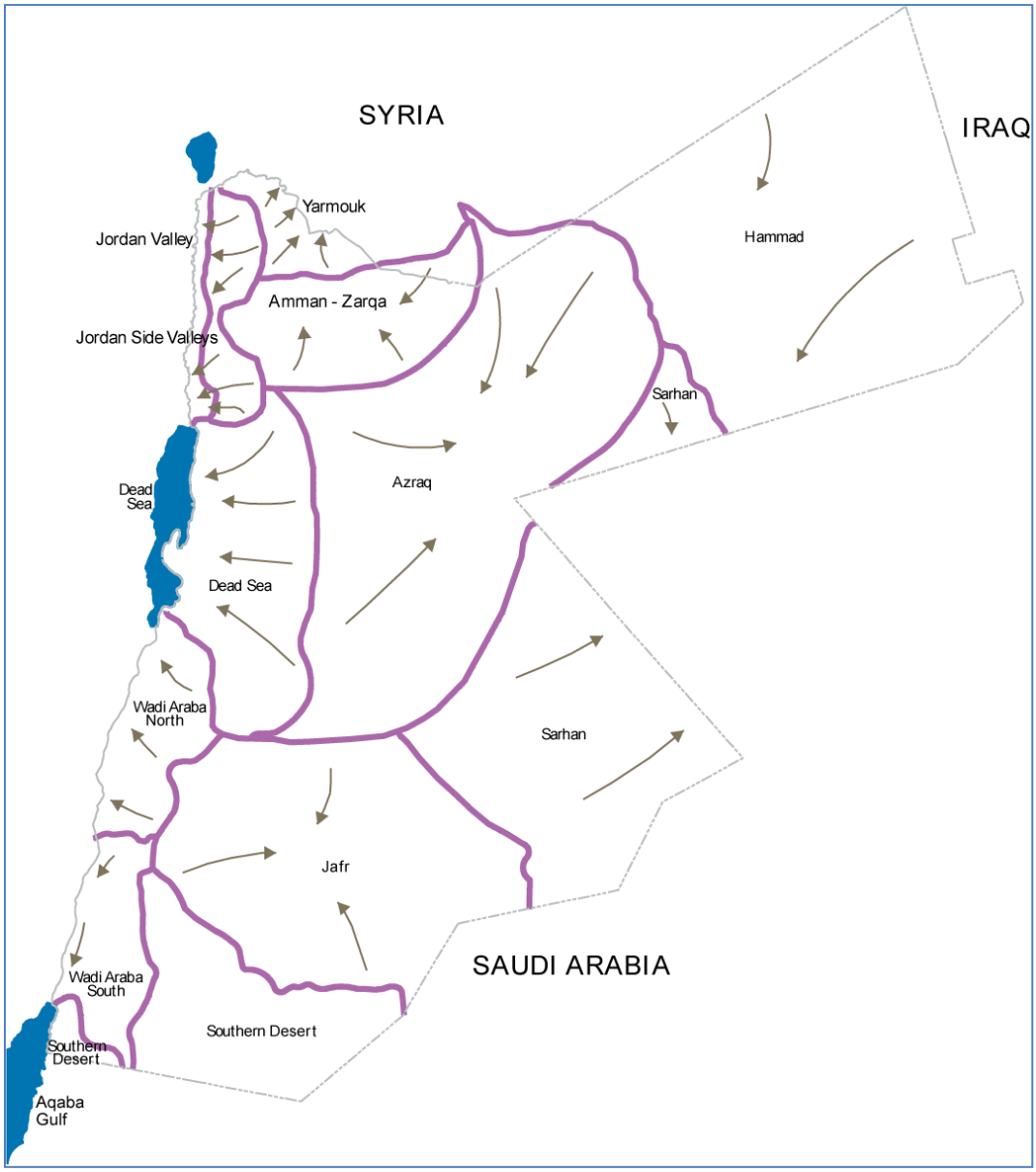


Figure 5-6. Groundwater Basins in Jordan

Within the 12 identified groundwater basins, only the southern aquifer in the Disi area is considered nonrenewable, while the remaining 11 are considered renewable aquifers. A groundwater resource is termed nonrenewable if the present-day aquifer replenishment is very limited, but aquifer storage is very large (Foster and Loucks, 2006). According to the 2006 National Water Master Plan of Jordan (as cited in USAID, March 2014), the primary

over-exploited aquifers include Amman-Zarqa, Yarmouk, Dead Sea, Jordan Valley, Jafr, and Azraq Basins.

5.6.2 Hydrogeology of the Study Area

The project area falls within the Amman-Zarqa Groundwater Basin. The basin is considered one of the most renewable groundwater basins in Jordan. Its extent is large and continuous, with a relatively high permeability. The two main aquifers in the Amman-Zarqa basin are the Amman/Wadi Sir Formation (B2/A7), known as the Upper Aquifer, and the Hummar Formation (A4) to the west of Amman, known as the Lower Aquifer. Figure 5-7 and Table 5-2 summarize the geological and hydrological classifications of rock units in the Amman-Zarqa area.

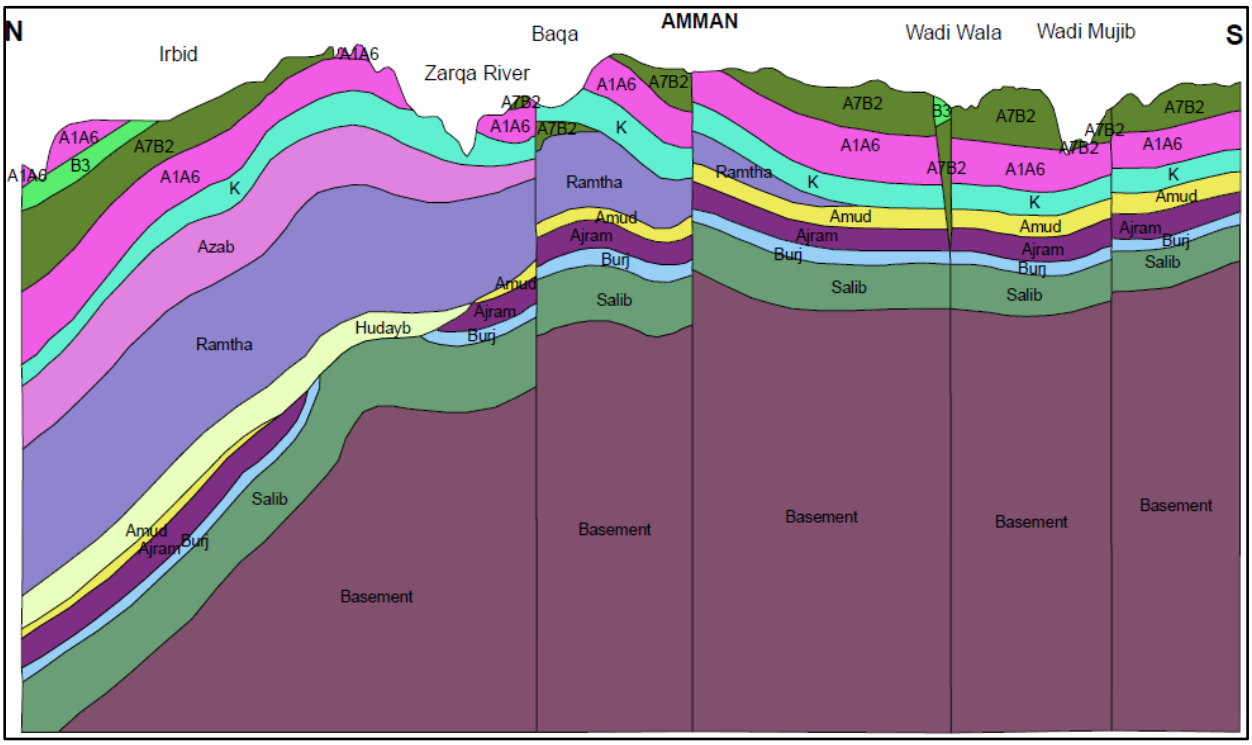


Figure 5-7. Geological Cross Section Covering Amman–Zarqa Area
(Adapted from WAJ and Millennium Challenge Corporation, 2010)

Recharge of the B2/A7 aquifer occurs in the western highlands. Its main outcrop areas generally coincide with the area of high precipitation, which is the main recharge source for the aquifer. Rainfall reaches 400 millimeters per year to the west of Amman, whereas it rarely exceeds 150 millimeters per year in the study area. The regional groundwater flow in the B2/A7 is influenced by the recharge/discharge areas, the topography, and the structural characteristics in the region. A main recharge mound exists a few kilometers to the west of Amman and on the southwestern side of the project area. A portion of the groundwater flows towards the west and increases the discharge level of the springs in the Wadi Sir area. The remainder of the groundwater flows northeastward down the Amman-Zarqa syncline, recharging the upper aquifer and/or flowing further to the east, as illustrated in Figure 5-8.

Table 5-2. Geological and Hydrogeological Classification of the Rock Units in Amman-Zarqa Area

Epoch	Age	Group	Formation	Symbol	Rock Type	Thickness (meters)	Aquifer Potentiality	Permeability (meters per second)
Upper Cretaceous	Holocene	Balqa	Alluvium	Qal	Soil, sand and gravel	10-40	Good	$2.4x10^{-7}$
	Pleistocene		Basalt	V	Basalt	0-50	Good	-
	Mastrichtain		Muwaqqar	B3	Chalk, marl and chalky limestone	60-70	Poor	-
	Campanian		Amman	B2	Chert, limestone with phosphate	80-120	Excellent	10^{-5} to 3×10^{-4}
	Santonian		Um Ghudran	B1	Chalk, marl and marly limestone	15-20	Poor	-
	Turonian	Ajlun	Wadi As Sir	A7	Hard crystalline limestone. dolomitic and some chert	90-110	Excellent	$1x10^{-7}$ to $1x10^{-4}$
	Cenomanian		Shueib	A5-6	Light grey limestone interbedded with marls and Marly limestone	75-100	Fair to poor	$6.3 x10^{-5}$ to $7.2 x10^{-4}$
			Hummar	A4	Hard dense limestone and dolomitic limestone	40-60	Good	8.1×10^{-7} to $7.6 x10^{-4}$
			Fuheis	A3	Gary and olive green soft marl. Marly limestone and limestone	60-80	Poor	5.3×10^{-7} to 1.7×10^{-5}
			Na'ur	A1-2	Limestone interbedded with a thick sequence of marl and marly limestone	150-220	Poor	2×10^{-8} to 3.1×10^{-5}
Lower cretaceous	Albian–Aptian		Kurnub	K	Massive white and multicolored sandstone with layers of reddish silt and shale	300	Good	6.9×10^{-3} to 5.2×10^{-2}

Source: El-Naqa et al, 2006, as cited in USAID, December 2011

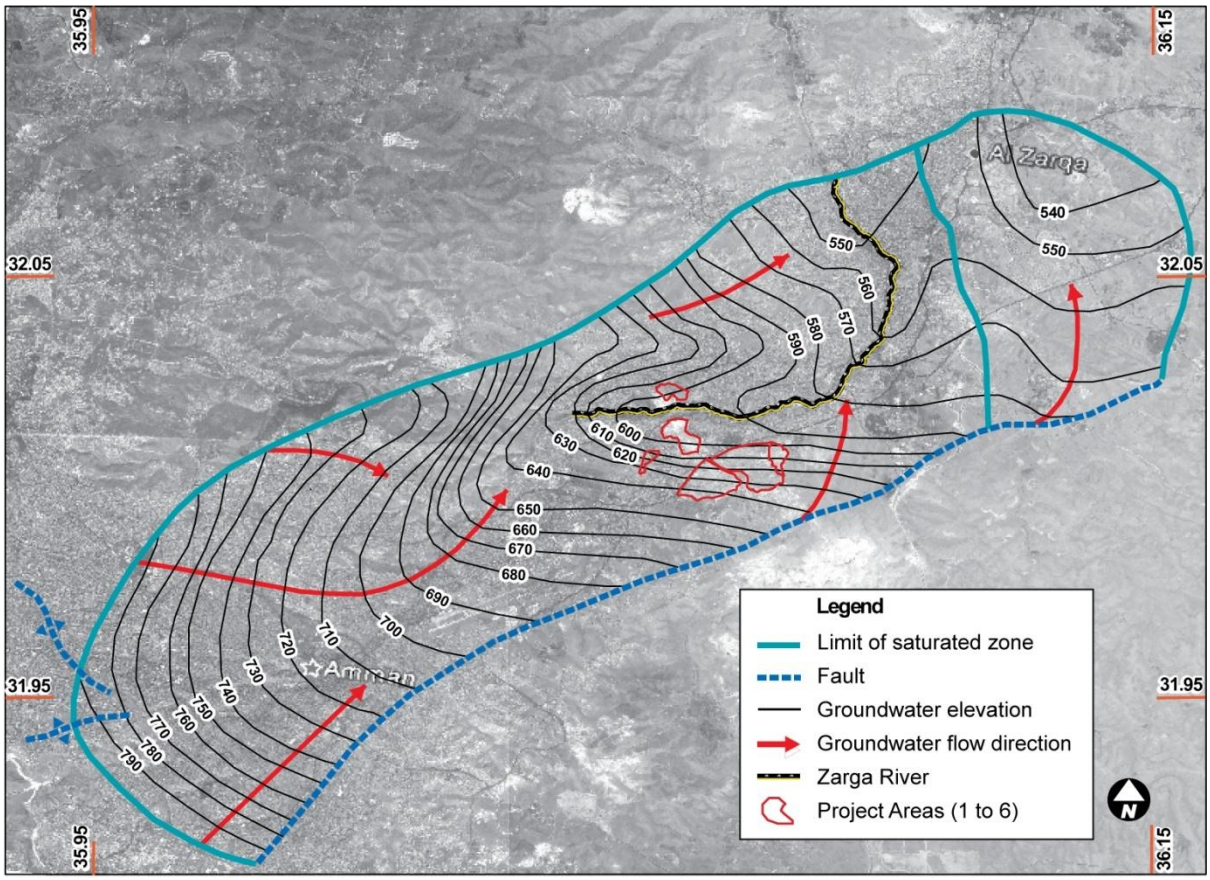


Figure 5-8. Regional Groundwater Contour Map of the (B2/A7) Aquifer (Kuisi, 1992)

The Amman-Zarqa Basin includes the fastest growing region in Jordan, in terms of both industry and population. Groundwater is the primary water supply source in the basin. The 2006 National Water Master Plan estimated the safe yield of the basin to be in the range of 60 to 70 million cubic meters per year. This calculation was based on the estimated recharge and base flow depletion, as summarized in Table 5-3.

Table 5-3. Calculation of Safe Yield for Amman-Zarqa Groundwater Basin

Item	Volume (million cubic meters per year)
Recharge from Rainfall	72
Inflow from Syria	+30
Base flow	−40
Estimated safe yield	=62
Range of safe yield	60 to 70

Source: 2006 National Water Master Plan, as cited in USAID, March 2014

Groundwater well extraction reached its peak in the year 1996, at approximately 161 million cubic meters per year. It decreased by 15 percent in year 2001 to 138 million cubic meters per year. This extraction rate is twice as high as the safe yield (2006 National Water Master Plan, as cited in USAID, March 2014). As a result, the MWI has developed a stepped reduction strategy for groundwater extraction in order to reach the safe yield by the year 2020.

Using pump test data obtained from the MWI databank (El-Naqa et al., 2006), the hydraulic parameters of some groundwater wells near the Russeifah landfill were calculated. The locations of the groundwater wells near the Russeifah landfill are shown in Figure 5-9 and the results are shown in Table 5-4.

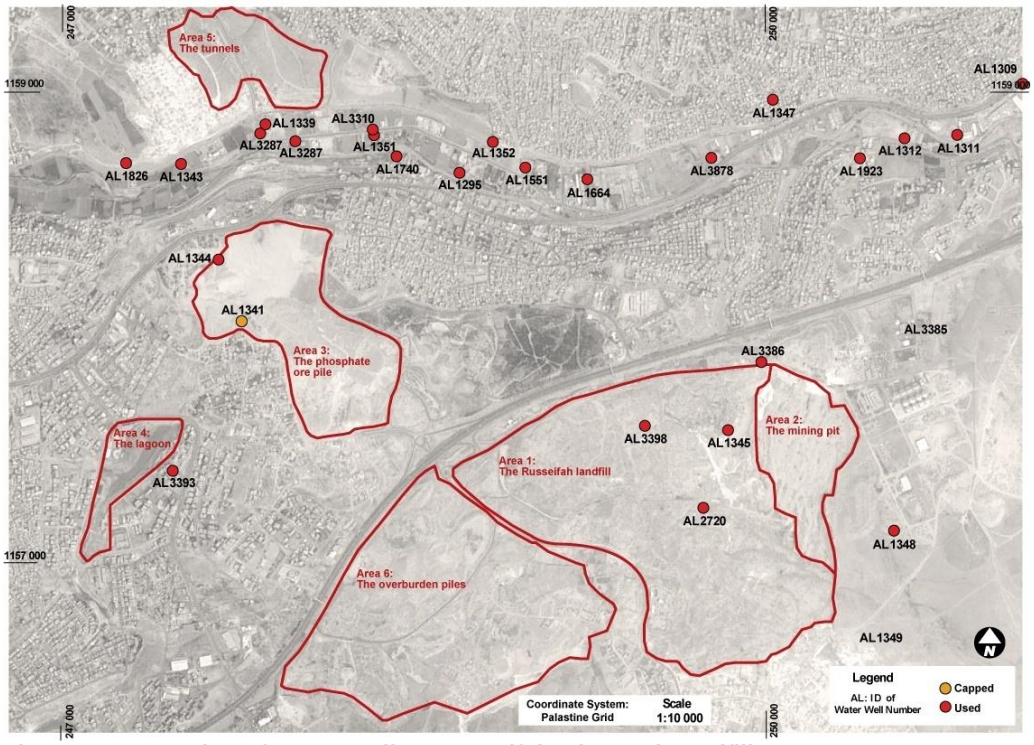


Figure 5-9. Location of Water Wells – Russeifah Mine and Landfill

The transmissivity value of the B2/A7 aquifer system ranges from 33.9 to 409 square meters per day. Hydraulic conductivity ranges from 0.38 to 5.18 meters per day. The hydraulic gradient of the area, calculated based on difference in head of three groundwater monitoring wells inside the landfill, is approximately 2.0 x 10-3. Assuming an aquifer porosity of 0.35, the groundwater velocity was calculated (based on estimated hydraulic conductivity and hydraulic gradient) at 0.029 meters per day.

The static water levels recorded in 2006 at various groundwater wells near the Russeifah landfill site ranged between 30 and 60 meters. Recent static water level data ranging from 30 to 50 meters was obtained from the WAJ for the Amman-Zarqa basin (USAID, March 2014).

Table 5-4. Hydraulic Parameters of Selected Groundwater Wells in the Study Area

Code	Name	Surface Water Level (meters)	Drawdown (meters)	Specific Capacity (cubic meters per hour per meter)	Groundwater Level (meters)	Yield (cubic meters per hour)	Transmissivity (square meters per day)	Hydraulic Conductivity (meters per day)
AL1295	Ain El-Russeifah	NA	NA	NA	NA	NA	NA	NA
AL1345	Phosphate No. 7	42.6	4.6	16.96	595.4	78	247	2.47
AL1346	Phosphate No. 8	46	4.1	14.63	573.0	66		
AL1350	Phosphate No. 10	14.8	40	NA	644.2	NA	33.9	0.38
AL1352	Russeifah Municipality	24	4.0	31.5	598	NA	NA	NA
AL2720	Waste Disposal	29.6	1.63	40.5	590.4	NA	409	5.18
AL3287	Russeifah Deep	96.3	101.2	0.86	503.7	NA	NA	NA
AL1551	Russeifah Municipality	20.9	0.84	142.86	-	120	247	NA
A 105	-	NA	NA	NA	574	NA	1673.2	53.12
A 73	-	NA	NA	NA	598	NA	2.88	0.21
A 83	-	NA	NA	NA	585	NA	NA	NA
AL3385	Russeifah Landfill monitoring well No.2	62.9	NA	NA	592.1	NA	NA	NA
AL3386	Russeifah Monitoring well No.3	31.1	NA	NA	623.9	NA	NA	NA

Source: El-Naqa et al, 2006, as cited in USAID, December 2011

5.7 Air Quality

The Jordan Ministry of Environment (MoEnv) has established 12 air monitoring stations in the Amman, Zarqa, and Irbid governorates to monitor air quality and measure concentrations of gas and dust emissions (The Jordan Times, September 2012). An air monitoring station was established approximately 20 kilometers south of the project area at Sahab and was operated for two years. An additional MoEnv air monitoring station is located near the Jordan Petroleum Refinery Company (JPRC) facility in Al Hashimiyah, northeast of the project area.

Fugitive dust from the phosphate ore stockpile at Russeifah Area 3 (north of Areas 1 and 2) and other nearby sources of dust contribute to diminished air quality in the vicinity of the project site. Some of this dust is radioactive, and radon has also been linked to ore material in the project area (see Section 5.8). Emissions from vehicles on the nearby Amman-Zarqa highway and secondary roads, and from vehicle movements in Area 2 also contribute to diminished air quality in the project vicinity. In addition, LFG with low methane content (less than 38 to 42 percent) is usually not extracted for electricity generation at Area 1 and is left to be emitted to the atmosphere through cracks in the cover layer as the landfill is not capped (USAID, April 2015; USAID, 2012).

5.8 Radiological

One of the prominent issues at Russeifah Area 3 and the general surrounding area is radiation concerns. A radiological field assessment was carried out to provide an initial determination of the range of radiological risks from technologically-enhanced, naturally-occurring radioactive material contained in the phosphate ore stockpiles and wastes present throughout Area 3. Due to the proximity of Areas 1 and 2 to Area 3, which is located approximately 350 meters northwest from Area 1, the findings of the Area 3 radiological assessment potentially are relevant to conditions on Areas 1 and 2.

The assumptions used in the Area 3 initial radiological field assessment and preliminary risk assessment study were intentionally conservative. The results of the radiological study indicate that the average uranium concentration of the ore material found at Russeifah Area 3 is greater than the International Atomic Energy Agency recommended criteria for exemption from regulatory controls. With the exception of exposures estimated for the nearest residential locations at Area 3, none of the risk levels predicted for each receptor group are considered to be extraordinarily high for the situations represented in the Area 3 radiological assessment, but some are sufficiently high to warrant continued review and potential improvement. Remediation of the Russeifah Area 3 phosphate ore stockpile is proposed and is the subject of a separate ECR.

The most relevant components of the Area 3 radiological study to Areas 1 and 2 are the risks of inhalation of fugitive radioactive airborne dust particles. The complementary air modeling performed to help interpret how typical the measured results might be, compared with other days and wind conditions, led to further prediction of long-term estimates of total exposures to nearby public areas, as well as on-site work areas (USAID, December 2014). The study shows annual uranium 238 inhalation dose predictions for the inhalation of airborne dust in the vicinity of Area 1 (the closest of the two areas discussed in this ECR to Area 3) as an approximate range of 0.1 to 0.4 millisieverts per year (mSv/yr) (Figure 5-10) (USAID, December 2014, Appendix B1, Radiological Assessment of Existing Conditions). This range is below the generally applicable dose limit established by the International Atomic Energy Agency Basic Safety Standards of 1 mSv/yr total effective dose for members of the public and 0.5 mSv/yr for sensitive members, such as children. By comparison, the annual exposure dose prediction for the greatest levels of inhalation of airborne dust at Area 3 (at the eastern end of the phosphate ore pile) is approximately 6 mSv/yr (not including contributions from radon).

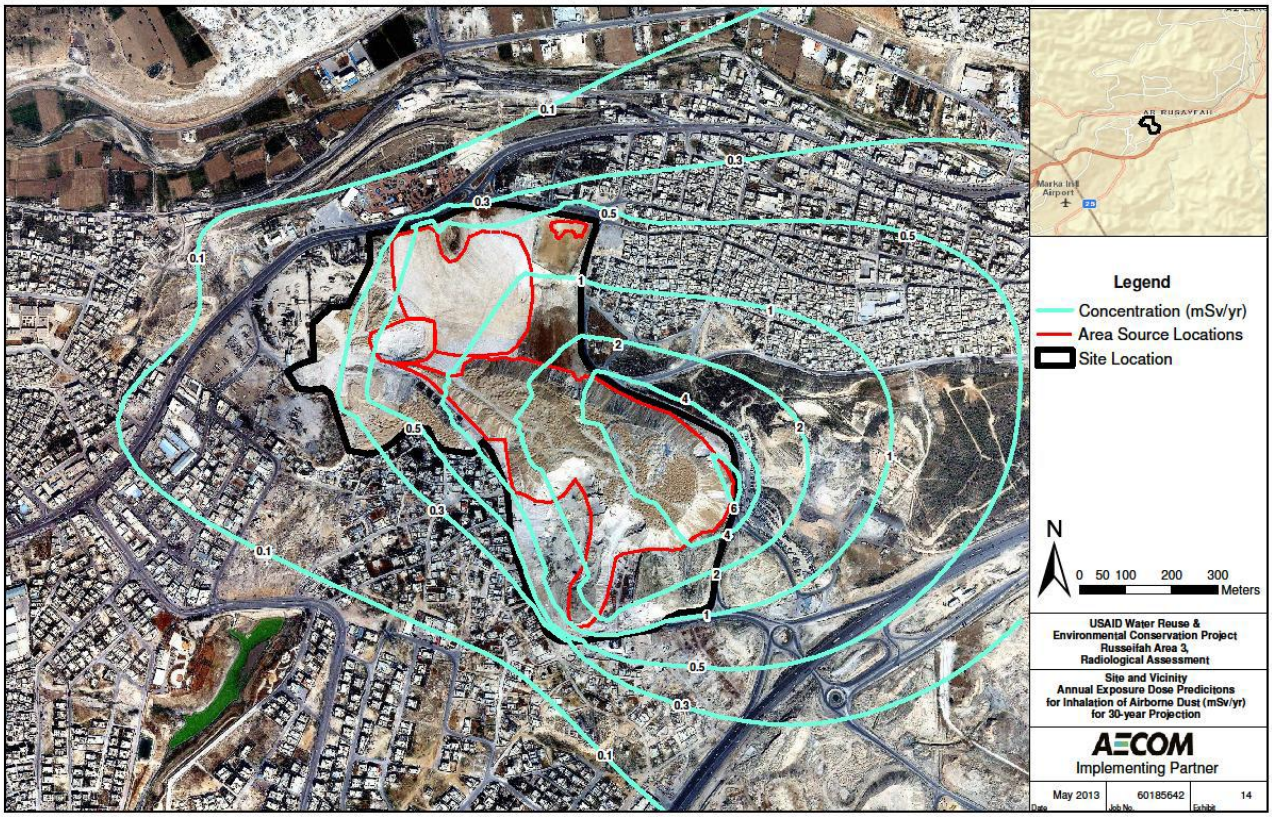


Figure 5-10. Annual U-238 Inhalation Dose Predictions for Area 3 and the Surrounding Area (mSv/yr)

5.9 Noise

Areas 1 and 2 are bounded to the north by a roadway (Al Shaheed), and additional access roads are located on site. Some noise from vehicles utilizing these roadways is expected at the site.

The Area 1 landfill is closed, although illegal dumping of predominantly C&D waste continues to occur. Current legal operations at the landfill consist of LFG collection and electricity production. Noise related to these activities is anticipated at Area 1.

Area 2 is currently used as a landfill for dumping primarily C&D wastes, along with refuse material from nearby projects and liquid waste produced from stone and marble cutting. Area 2 receives an estimated 250 to 300 loads per day and truck use from these activities contributes noise within the project area (USAID, January 2012).

5.10 Flora and Fauna

The project area is located within the Mediterranean realm (Figure 5-11), which is represented by the mountain ranges extending from the north near Irbid, to Ras an Naqb to the south. The Mediterranean realm includes areas of forested vegetation, with an abundance of juniper trees (*Juniperus phoenicea*), white weeping brooms (*Retama raetam*), pistachio trees (*Pistacia atlantica*), pine trees (*Pinus halepensis*), Palestine oak (*Quercus calliprinos*), kermes oak (*Quercus coccifera*), and tabor oak (*Quercus ithaburensis*). Open areas are characterized by high cover of the thorny burnet (*Sarcopoterium spinosum*). However, vegetation in the region near the Russeifah project area is characterized by a very sparse vegetative cover, often composed of plants that can resist hot conditions. The majority of plants are either small shrubs or annual or perennial herbs. This type of sparse vegetation is typically found scattered around the watersheds of small wadis in Jordan.

The mammals of the region around the project area represent most of the mammals found in the Mediterranean Zoogeographic Zone, including the striped hyena (*Hyaena hyaena*) and caracal (*Caracal caracal*). Birds within the general region near the project area include greater sand plover (*Charadrius leschenaultia*), cream-colored courser (*Cursorius cursor*), pin-tailed sandgrouse (*Pteroles alchata)*, common crane (*Grus grus*), lesser short-toed lark (*Calandrella rufescens*), and Temminck's lark (*Eremophila bilopha*) (USAID, May 2015).

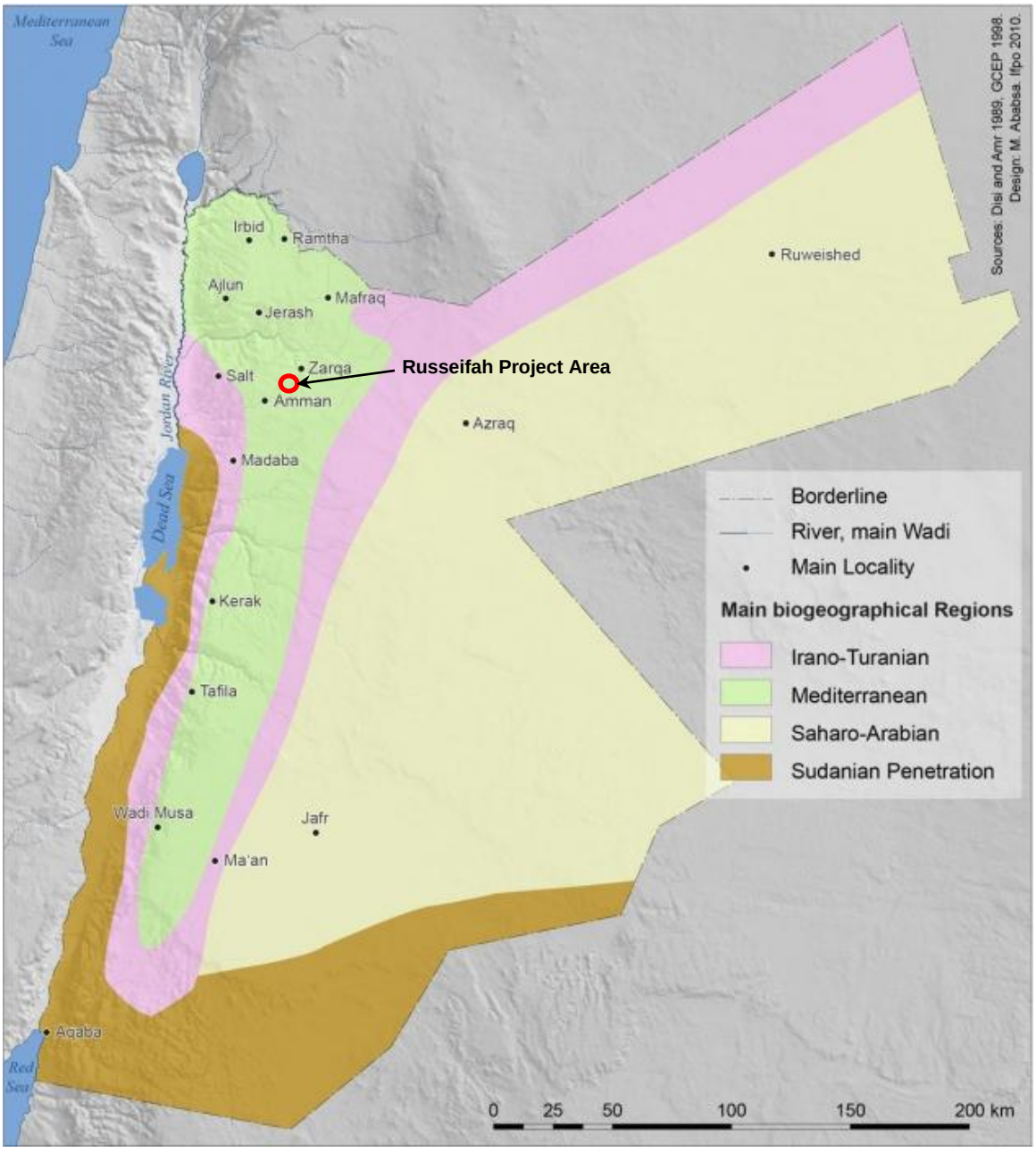
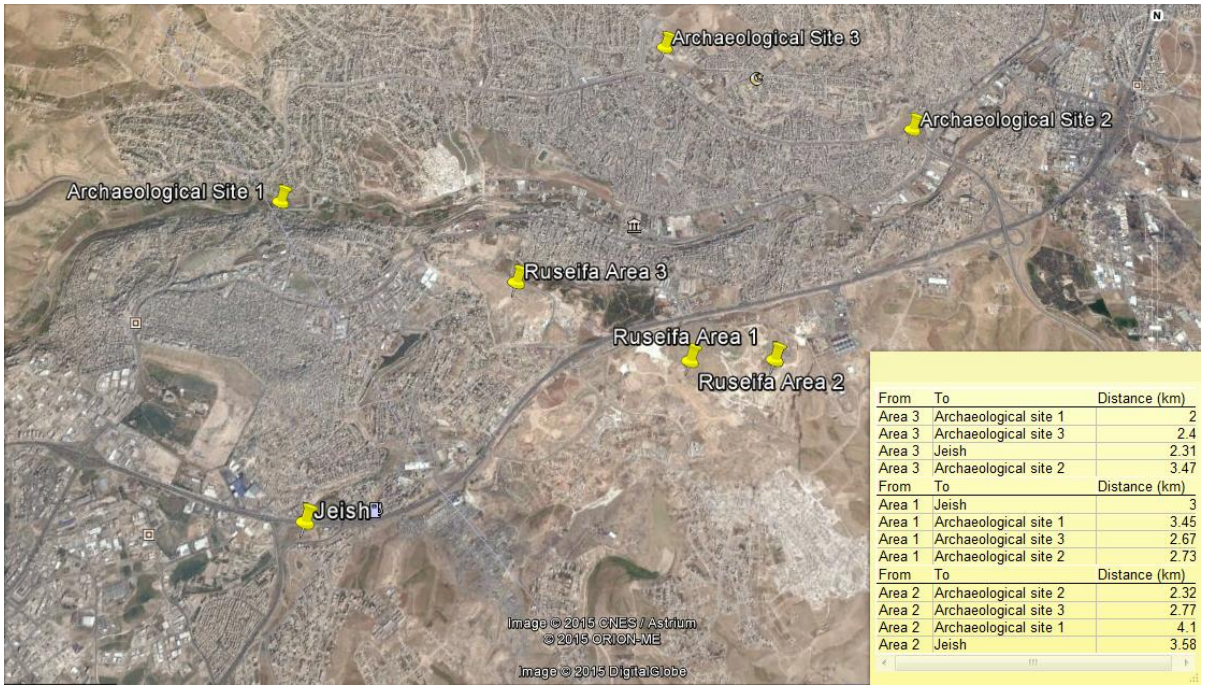


Figure 5-11. The Biological Regions of Jordan Encompassing the Russeifah Project

5.11 Antiquities

Hundreds of archaeological sites are located within the Zarqa Governorate. However, as indicated in Figure 5-12, the closest documented archaeological site to Areas 1 and 2 is over 2 kilometers away (MEGA-Jordan, 2015). Also, the director of the Zarqa Environment Office

and the manager of the Russeifah Municipality Office have confirmed no known archaeological sites are located within the Areas 1 and 2 project area (Majdalawi, 2015).



From	To	Distance (km)
Area 3	Archaeological site 1	2
Area 3	Archaeological site 3	2.4
Area 3	Jeish	2.31
Area 3	Archaeological site 2	3.47
From	To	Distance (km)
Area 1	Jeish	3
Area 1	Archaeological site 1	3.45
Area 1	Archaeological site 3	2.67
Area 1	Archaeological site 2	2.73
From	To	Distance (km)
Area 2	Archaeological site 2	2.32
Area 2	Archaeological site 3	2.77
Area 2	Archaeological site 1	4.1
Area 2	Jeish	3.58

Figure 5-12. Documented Archaeological Sites in Relation to Russeifah Areas 1 and 2

5.12 Land Use

Area 1 is comprised of the Russeifah landfill, which is closed, although illegal dumping of predominantly C&D waste continues to occur. Its current legal operations consist only of LFG collection and electricity production. A landfill biogas plant, operated by JBC, is located south of Area 1, adjacent to the landfill. Area 2 is comprised of a pit that resulted from the extraction of phosphate ore by the Jordan Phosphate Mines Company. This area is currently used by the Greater Amman Municipality as a C&D debris landfill.

The primary surrounding land uses are residential, commercial, and industrial. There is also a small area of agriculture use. Figure 5-13 shows the relationship of the various Russeifah Areas and the existing land uses of their surroundings (USAID, January 2012).

5.13 Population and Major Economic Activities

In terms of population, Zarqa Governorate is the third largest governorate in Jordan, and Russeifah is the second largest city in the Zarqa Governorate (Majdalawi, 2015). Since the mid-1930s, the Russeifah area has seen a significant increase in population, with increases in the number of residences, as well as commercial and light industrial businesses (USAID, January 2012). The city continues to experience rapid population growth. Between 2009 and 2014, Russeifah's population increased 11.6 percent from approximately 312,560 to an estimated 348,870 (Department of Statistics, 2010, 2014, as cited in Majdalawi, 2015).

Zarqa Governorate is characterized by the presence of heavy industries, such as oil refining, electrical power production, and chemical and steel industries, as well as light industries, such as small-scale food factories and workshops (Majdalawi, 2015). Agricultural activities occur in limited areas within the governorate. The major economic activities in the City of Russeifah are commercial and industrial, with limited agricultural activities.

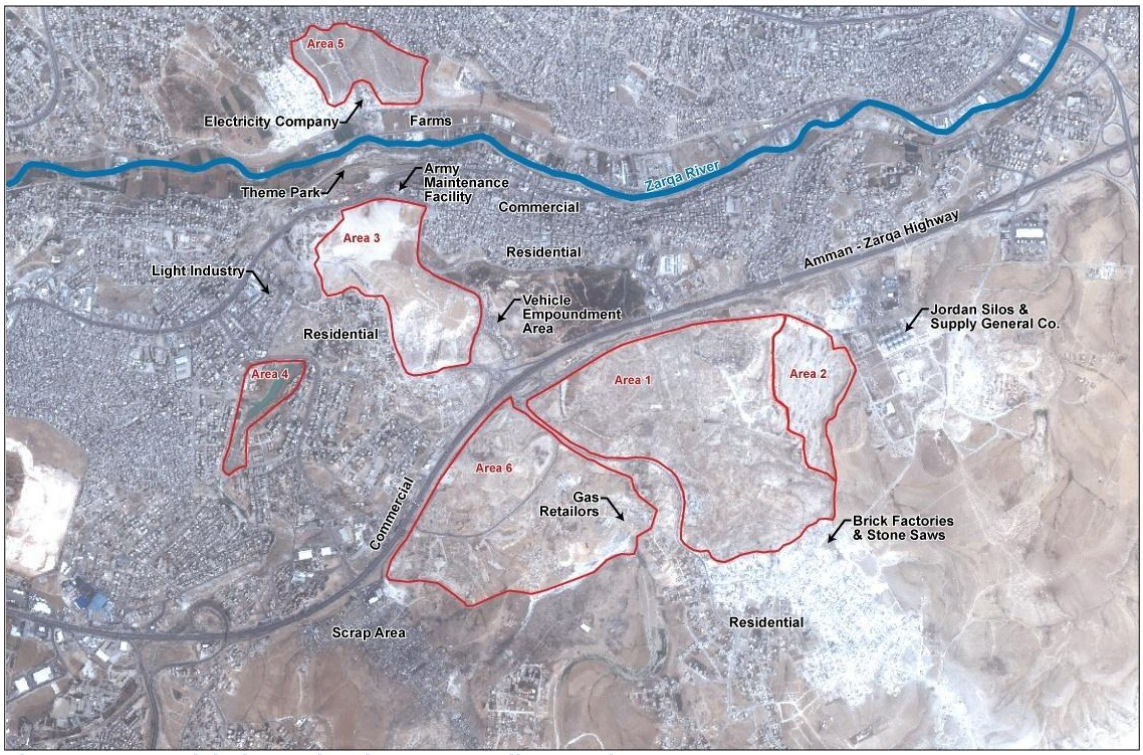


Figure 5-13. Aerial Photo Showing Surrounding Land Uses

Several light and heavy industries are found near the phosphate mining areas (USAID, January 2012). These include the Jordan Silos and Supply General Company, which operates and maintains government grain silos and is located east of Area 2. Brick factories and a gas storage area are located south and west of Area 1. Light industries dedicated to car maintenance and a car impoundment area are located west and south of Area 3, respectively. A livestock market also is located in the vicinity of the phosphate mining area (Majdalawi, 2015) and, during several visits to Area 1, shepherds were observed moving their flocks across the closed Area 1 landfill (USAID, January 2012).

Table 5-5 shows the relative distribution of average monthly household income in Zarqa Governorate and in Russeifah District, based on Department of Statistics 2008 data. Compared to the governorate overall, larger proportions of households in Russeifah had average monthly incomes in the brackets representing incomes equal to or less than 500 Dinars; whereas, a smaller proportion of households in Russeifah had incomes in the greater than 500 Dinars bracket.

Table 5-5. Distribution of Households by Average Income (percent)

Monthly Average Income (Jordan Dinars)	Zarqa Governorate	Russeifah District
Less than 150	1.7	2.9
150 to 199	4.5	4.6
200 to 299	19.2	20.0
300 to 500	36.7	42.4
Greater than 500	37.9	30.1

Source: Department of Statistics, 2008, as cited in Majdalawi, 2015

5.14 Transportation

The road network in the Zarqa Governorate is in generally good condition and connects most cities and villages in the governorate, and connects the governorate with the rest of Jordan. The Amman-Zarqa highway crosses through the Russeifah phosphate mining area. The highway is located north of Areas 1, 2, and 6 and south of Areas 3 and 4. The highway is a primary access route in Jordan. There are also secondary and village roads in the project area. Public transportation, including buses, microbuses, cars, and taxis, are available and used for local trips as well as longer distance travel to Zarqa City and other destinations in Zarqa Governorate and elsewhere in Jordan.

Areas 1 and 2 are accessible from the Amman-Zarqa Highway and from local, secondary roads. The Area 1 landfill perimeter generally is uncontrolled, with access to foot traffic at almost any point (USAID, January 2012). The onsite access road is poorly maintained and use of a 4-wheel-drive vehicle is recommended. Whereas the upper portion of the Area 2 mining pit is accessible from the Amman-Zarqa Highway, there is no access road leading to the base of the pit.

5.15 Water and Electricity Supply

Groundwater is the primary water supply source in the Zarqa basin. The safe yield of the basin is estimated to be in the range of 60 to 70 million cubic meters per year (Table 5-3), and the aquifer is used as a primary source of potable water in the kingdom (Majdalawi, 2015).

The water supply quantity is limited, especially during the summer months when there is little to no precipitation (Table 5-1). During this time, water supply to customers is restricted. In order to maintain their supplies, most residents have rooftop water storage tanks with a typical capacity of 1,000 to 2,000 liters (1 to 2 cubic meters) (Majdalawi, 2015). The groundwater supply is supplemented with water from Zarqa River. The WAJ mixes water from the Zarqa River with groundwater, because the salinity of water in the river is high. In the past, villagers depended on springs for local consumption and irrigation.

The groundwater level in the project area is relatively shallow, at 30 to 50 meters below local ground level (USAID, March 2014). There is a risk of water pollution in this area. As the depth of the landfill waste is 10 to 25 meters, the waste is in close proximity to the top of the groundwater (USAID, September 2014, January 2012).

The Zarqa Governorate receives electricity from the Hussein Thermal Power Station and the Samra Thermal Power Station (Majdalawi, 2015). Electricity is available for all houses and factories in the project area. Currently, the landfill at Area 1 is being utilized by the JBC for LFG collection and electrical generation.

5.16 Solid Waste

5.16.1 Russeifah Landfill (Area 1)

The landfill is closed, although illegal dumping of predominantly C&D waste continues to occur. Its current, legal operations consist only of LFG collection and electricity production. However, the site was used for solid waste disposal by the Greater Amman Municipality from 1986 until its closure in 2003, with an estimated 12 million tons of waste placed at the site during its years of operation. The solid waste dumped at the landfill includes an estimated 56 percent organic, 16 percent paper and paper board, 13 percent plastic, 7 percent glass, 5 percent metal, and 3 percent other (United Nations Framework Convention on Climate Change, 2006, as cited in USAID, January 2012). Solid waste covers almost 82.8 hectares, while the remaining area has been used for disposal of excess earth material (USAID, 2012).

During the operation of the landfill, there was little to no waste compaction, and only a rudimentary final cover was installed. The depth of the buried waste varies from 10 to 25 meters. The site has experienced considerable differential settlement, with cracks and fissures erratically crossing the landfill. As there is no stormwater management system, there is evidence of stormwater infiltrating into the waste mass through these cracks and fissures, thereby exacerbating landfill settlement. Additionally, as there is no landfill bottom liner or leachate collection system, rain water can percolate through the waste mass and infiltrate into the subsurface aquifer as leachate.

5.16.2 Mining Pit (Area 2)

The pit currently is used as a landfill for dumping mostly C&D wastes, along with material from nearby projects and *kamkha* (liquid waste produced from stone and marble cutting). Area 2 receives an estimated 250 to 300 loads of waste per day, comprising approximately 10 cubic meters per load. Approximately 377,000 cubic meters have been dumped to date, leaving a site capacity of approximately 5,670,000 cubic meters.

The Greater Amman Municipality started its operation in April 2010 and plans to continue operation until the site is full. The current method of waste placement is to allow trucks to dump their loads from on top of a steep cliff. This methodology is considered unsafe and requires improvements. The current site waste acceptance criteria is not clear, although it has been observed that, in addition to *kamkha*, the site may accept other unwanted waste material (USAID, January 2012).

5.17 Human Health

The most common ailments in the project area are related to respiratory infections (asthma, allergies, etc.), which are likely related to air pollution issues in the area (Majdalawi, 2015). As discussed in Section 5.7, fugitive dust from the phosphate ore stockpile at Russeifah Area 3 (north of Areas 1 and 2) and other nearby sources of dust contribute to diminished air quality in the vicinity of the project site. Some of this dust is radioactive, and radon has also been linked to ore material in the project area (see Section 5.8). Emissions from vehicles on the nearby Amman-Zarqa highway and secondary roads, and from vehicle movements in Area 2 also contribute to diminished air quality in the project vicinity. In addition, LFG with low methane content (less than 38 to 42 percent) is usually not extracted for electricity generation at Area 1 and is left to be emitted to the atmosphere through cracks in the cover layer as the landfill is not capped (USAID, April 2015; USAID, 2012).

One of the prominent issues at Russeifah Area 3, which is located approximately 350 meters northwest from Area 1, and the general surrounding area is radiation concerns. As described in Section 5.8, a radiological field assessment was carried out to provide an initial determination of the range of radiological risks from technologically-enhanced, naturally-occurring radioactive material contained in the phosphate ore stockpiles and wastes present throughout Area 3.

The most relevant components of the Area 3 radiological study to Areas 1 and 2 are the risks of inhalation of fugitive radioactive airborne dust particles. The complementary air modeling performed to help interpret how typical the measured results might be, compared with other days and wind conditions, led to further prediction of long-term estimates of total exposures to nearby public areas, as well as on-site work areas (USAID, December 2014). The study shows annual uranium 238 inhalation dose predictions for the inhalation of airborne dust in the vicinity of Area 1 (the closest of the two areas discussed in this ECR to Area 3) as an approximate range of 0.1 to 0.4 mSv/yr (Figure 5-10) (USAID, December 2014, Appendix B1, Radiological Assessment of Existing Conditions). This range is below the generally applicable dose limit established by the International Atomic Energy Agency

Basic Safety Standards of 1 mSv/yr total effective dose for members of the public and 0.5 mSv/yr for sensitive members, such as children. By comparison, the annual exposure dose prediction for the greatest levels of inhalation of airborne dust at Area 3 (at the eastern end of the phosphate ore pile) is approximately 6 mSv/yr (not including contributions from radon).

6 INITIAL ASSESSMENT OF ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This chapter addresses the anticipated environmental impacts of the implementation of the proposed Russeifah Areas 1 and 2 Remediation. The analysis is qualitative in nature and is based on professional judgment and experience. Environmental impacts are considered and detailed according to the two project phases:

- Construction phase
- Operations phase

Mitigation measures for these environmental impacts also are recommended.

6.1 Construction Phase

6.1.1 Geology, Topography and Soils

6.1.1.1 Impacts

The surface geology, topography, and soils at Areas 1 and 2 have been significantly modified by past excavation of phosphate ore (both areas) and subsequent landfill and C&D waste dumping (Areas 1 and 2, respectively). During construction at Area 1, surface topography and soils would be modified further by regrading and re-sloping of the surface of the landfill to eliminate areas of settling and to provide a smooth surface suitable for cover installation. To prepare for the cap, surface soils would be removed (where present) within the proposed disturbance limit and segregated for reuse. Waste would be relocated and compacted to fill depressions and to provide the revised slope configuration and grading. The removed soil would then be placed and graded in 30 centimeter (maximum) lifts.

The regraded site at Area 1 would be developed into three distinct peaks with approximate top slopes of 5 percent and would receive an ET cap. Side slopes have been designed to mimic natural terrain and would be established at approximately 5:1 grades (5 units horizontal change to 1 unit vertical change) with limited areas of 6:1 and 4:1 grades. In the future, once the Area 2 landfill is filled to capacity with C&D waste, it would be capped with an ET cap, further modifying existing topography and soils at the site.

As the proposed construction phase would involve active soil work as described above, the increased potential for soil erosion exists during this phase. Additionally, soil contamination may occur as a result of oil and fuel leakage or spills from vehicles or machines, improper disposal of construction materials, or waste from workers.

6.1.1.2 Mitigation

The project area limits of work should be clearly marked and minimized to limit the extent of the affected area. Careful handling of contaminated top soil should be required. The contractor should develop and implement a soil erosion prevention plan and a spill management plan. These plans should specify all the necessary measures, main concerns, actions, and implementation responsibilities to prevent soil erosion and pollution. Solid and liquid wastes should be collected regularly, and disposed of at the closest approved disposal site to prevent soil contamination during construction. If needed, a designated hazardous material storage area should be established on site to avoid and contain soil contamination. The storage area should have an impermeable surface, drip trays, and spill kits and a list of all hazardous chemicals potentially used on site should be posted. Fuel stored on site should be kept in double walled storage tanks or contained within a suitably sized impermeable vessel to avoid leakage. Soil contamination can be avoided by isolating fueling and maintenance areas, as well as vehicles parking areas, on an impermeable surface. Any

leakage or spill incidents should be dealt with immediately by using spill kits and cleaning up and removing the contaminated soil. Such contamination accidents should be documented and reported.

6.1.2 Surface Water

6.1.2.1 Impacts

The construction phase of the project is not anticipated to impact surface water as the nearest body of water, when flowing, is the Zarqa River. The Zarqa River is located approximately 0.7 kilometers north of Areas 1 and 2, beyond the proposed limits of work.

As discussed in Section 5.5, no wadis or streams traverse Areas 1 and 2, although a small wadi does drain into Area 2 at a low point along the eastern side of the site. As this wadi drains into Area 2, construction on the project site would not impact the quantity or quality of seasonal flows in the waterway. Seasonal flow from the wadi and runoff from Areas 1 and 2 that currently result in temporary ponding in isolated depressions on Area 2 would be detained during winter in the proposed surface water basin.

6.1.2.2 Mitigation

As project construction is not anticipated to impact surface water, no mitigation is proposed for surface water.

6.1.3 Groundwater

6.1.3.1 Impacts

At Area 1, the waste is in an unlined landfill approximately 20 to 30 meters above the groundwater table. As the geologic layers under the waste are relatively permeable, leachate from the waste can readily seep into the groundwater. However, earthwork necessary to regrade and cap the landfill during the construction phase is not anticipated to impact groundwater. Similar to Area 1, capping Area 2 also is not anticipated to directly impact groundwater as a result of construction activities.

If large quantities of groundwater are used for dust suppression during construction, the use of this water could further deplete available groundwater. There would likely also be an increase in water demand for the various construction activities and domestic water uses at site offices. In addition, potable water might be used to wash construction equipment and tools.

If the contractor would be trucking water to the site, the contractor should be required to consider the effects on the source supply. Groundwater contamination resulting from construction activities, including the use of hazardous chemicals, is unlikely to happen.

6.1.3.2 Mitigation

The contractor should develop and implement a water resource management plan. In the pre-construction stage, a water source for construction activities should be identified to confirm that use of water by the contractor would not affect the water supply of local community or of others relying on the source supply. The contractor should provide water from tankers rather than using water from the public network. Construction crews should conserve water during all construction activities and handle water efficiently.

The contractor should develop and implement a hazardous material management plan. Hazardous materials should be stored within double-walled tanks to prevent any spills or leaks to the environment. Hazardous materials should be labeled, stored, used, and disposed of properly and according to the plan.

6.1.4 Air Quality

6.1.4.1 Impacts

Fugitive dust generated by grading, capping, and other construction activities at Areas 1 and 2 would contribute to diminished air quality in the vicinity of the project site. Some of this dust could potentially be radioactive. Air quality would likely be temporarily impacted during construction as a result of fugitive dust, as well as construction vehicle and equipment emissions. During construction, LFG with low methane content would continue to be emitted to the atmosphere through cracks in the cover layer.

6.1.4.2 Mitigation

Dust control measures should be implemented to limit resident and worker exposures during construction.

The contractor should develop and implement a fugitive dust management plan. All necessary dust abatement measures should be identified in the plan, including but not limited to:

- Minimizing dust generation during dry and dusty weather, and scheduling dust-generating activities according to the weather conditions
- Suppressing dust using a non-water-dependent dust control product given the scarcity of water in the region
- Covering all stockpiles and trucks transporting soil and other construction materials
- Controlling vehicles movement and speeds on unpaved roads and, as practicable, paving heavily-used roads
- Following good housekeeping within the site and its perimeters
- Providing workers with dust protection equipment
- Undertaking and recording inspections to verify compliance with fugitive dust management plan requirements, daily during periods of high activity or prolonged dry, windy weather and weekly otherwise during construction

To minimize air pollutant emissions, heavy machinery and construction vehicles should be maintained in good working condition and vehicle idling times should be minimized. Spill cleaning equipment should be available at all times. All air quality complaints by residents and on-site workers should be recorded, and the causes should be identified and corrected.

6.1.5 Radiological

6.1.5.1 Impacts

It is expected that fugitive dust that contains traces of naturally occurring radioactivity material from Area 3 may be present within Areas 1 and 2. Construction activities on Areas 1 and 2 may temporarily re-suspend radioactive fugitive dust if present, potentially exposing construction workers and residents in the vicinity to ambient radioactivity during project activities.

6.1.5.2 Mitigation

During construction, dust control is a primary requirement for reducing fugitive radioactive dust that may be located in the work substrate. A proactive dust control and monitoring program, when activated, can reduce the construction-related dust generation by 25 to 75 percent, depending on the practices employed. Pre-treatment of all work areas near the periphery of the site with polymer coating materials and/or water can provide significant benefits to both the workers and the public. A control plan with pre-treatment should be used along with a real-time dust monitoring program to dynamically assess the effectiveness of the control measures being employed. Sub areas should be prioritized and then mitigated generally in priority order to minimize their impact on neighboring areas, while maintaining

flexibility for operational efficiency. Implementation of construction sequencing, dust reduction procedures, air monitoring, and worker protection requirements could effectively mitigate short-term impacts during construction.

6.1.6 Noise

6.1.6.1 Impacts

Noise levels are anticipated to temporarily increase during the construction phase, due to operation of heavy machinery. Noise levels would vary throughout construction according to the activities executed and the combinations of machines and equipment used. Some neighborhoods in close proximity to Areas 1 and 2 may experience a temporary increase in noise levels during construction, although construction workers are anticipated to be the most affected from construction noise.

6.1.6.2 Mitigation

The contractor should comply with the Jordanian Instructions for Controlling and Preventing Noise, prohibiting loud noise-generating construction activities between 8 pm and 6 am. In addition, hearing protection equipment should be provided to workers. Multiple noise-generating activities should be conducted simultaneously to prevent prolonged periods of noise. Heavy machinery should be maintained and greased regularly to minimize unnecessary noise. Motorized equipment should be muffled and, where possible, noise sources should be enclosed.

6.1.7 Flora and Fauna

6.1.7.1 Impacts

As the sites contain very little vegetation in general, vegetation loss as a result of project construction would be minor. If any fauna use Areas 1 and 2 as habitat, this habitat would be lost during re-contouring and capping. Construction activities may also discourage bird usage of the area, although fauna usage in general at the site is anticipated to be minimal.

6.1.7.2 Mitigation

Some habitat loss as a result of construction in Areas 1 and 2 is inevitable and cannot be mitigated. However, the following would avoid or minimize impacts to flora and fauna:

- Construction vehicles should be restricted to using previously disturbed land and roads in order to avoid disturbing and damaging the surrounding habitat.
- Construction activities should be restricted to one area at a time, wherever possible, to allow the movement of fauna species to undisturbed nearby areas.
- Construction workers should not trap or hunt any existing animals or bird species within Areas 1 and 2.
- If capturing of an animal is needed to enable construction, any caught animals should be moved to nearby undisturbed areas.
- Generation of noise and fugitive dust, and chemical and hazardous material spills and discharges should be controlled and minimized as much as possible, to prevent negative impacts on the biodiversity of the area.

6.1.8 Antiquities

6.1.8.1 Impacts

As no documented archaeological sites are located within the project area and Areas 1 and 2 have been previously disturbed, no impacts to antiquities are anticipated as a result of construction activities.

6.1.8.2 Mitigation

While no impacts are anticipated, a letter should be submitted to the Antiquities Department of Zarqa requesting whether there is reason to believe an undocumented archaeological site may be located within the limits of construction. Construction work should be halted if any artifacts are encountered, and appropriate measures should be carried out in consultation with the Antiquities Department of Zarqa and the Department of Antiquities.

6.1.9 Land Use

6.1.9.1 Impacts

The adjacent land uses would be subject to elevated levels of dust and noise from construction activity, including grading and capping of the landfill and increased truck traffic. These impacts are discussed in Sections 6.1.4.1 and 6.1.6.1.

6.1.9.2 Mitigation

Dust and noise control measures should be implemented to limit impacts to adjacent land uses during construction. See Sections 6.1.4.2 and 6.1.6.2 for details regarding dust and noise control measures.

6.1.10 Population and Economic Activities

6.1.10.1 Impacts

Implementation of the project would result in short-term benefits for the local economy. Construction activities would generate temporary jobs during the construction period and would contribute to local earnings and induced spending.

The number of workers that would be required for project construction has not been estimated. The number of local people hired for project construction would be determined substantially by the availability of local, suitably skilled labor. Those temporary, construction-related jobs that are not filled by people in the local economy would be filled by people not currently residing in the project area. This project construction-related employment would result in a temporary increase to employment and population in the project area overall.

During construction, project personnel who live outside the project area or its vicinity would stay in temporary accommodations or in the home of local residents within acceptable commuting distances of the project site, generating local revenue. Depending on the duration of project construction and the construction-related employment opportunities, dependent family members may accompany the incoming non-local workers. The project personnel and their dependents would contribute to induced spending on goods and services locally and throughout the overall project area.

Project construction would result in economic benefits not only for the project workers, but also for the communities in which the workers live. In addition to the direct positive economic effects on the project workers, indirect positive effects could be expected as a result of the ‘multiplier effect.’ In other words, direct gains in jobs and earnings would be felt further down the line as workers spend much of their money in the local economy on such things as supplies, food, other merchandise, and various services. Because the anticipated economic effects would occur only for the duration of the construction period, no permanent or long-lasting economic effects are anticipated as a result of construction.

6.1.10.2 Mitigation

As no negative demographic or economic impacts are anticipated during construction, no mitigation is recommended. However, the project proponent should require that the contractor promote the hiring of local labor throughout project construction. Specifically, the project proponent could require that the contractor reserve non-skilled employment positions

for local labor and use available, suitably skilled, local labor for semi-skilled and skilled positions.

6.1.11 Transportation

6.1.11.1 Impacts

Project construction at Areas 1 and 2 would lead to an increase in truck and car traffic in the project area. However, the increase in construction-related vehicles would be temporary and at the conclusion of construction vehicle trips and transportation demand levels at Areas 1 and 2 would be similar to current conditions.

6.1.11.2 Mitigation

The contractor should prepare and implement a traffic management plan, suitable for the construction site conditions and, as required, coordinated with ongoing C&D landfill operations at Area 2 during construction.

6.1.12 Water and Electricity Supply

6.1.12.1 Impacts

There would be an increase in water demand for the various construction activities, such as dust control and washing construction equipment and tools. If the contractor trucks in water from another location, it is expected that there would be no impact on the local water supply.

The demand on electricity would also increase during the construction phase, which would result in a temporary increase the amount of power supplied to the project area. However, it is anticipated that a sufficient supply is available and there would be no adverse impact as a result of construction of the project.

6.1.12.2 Mitigation

The contractor should prepare and implement a water management plan. During the pre-construction stage, a water source for construction activities should be identified to confirm that use of water by the contractor would not affect the local water supply. Construction crews should conserve water during all construction activities and handle water efficiently to minimize overall water use.

As project construction is not anticipated to impact the local electrical supply, no mitigation is proposed.

6.1.13 Solid Waste

6.1.13.1 Impacts

As discussed above, the Russeifah Landfill at Area 1 has received large amounts of waste from the Amman and Zarqa areas for 17 years, but was not designed, constructed, or operated as an engineered sanitary landfill. There is no bottom liner, no leachate collection system, little to no waste compaction, a rudimentary final cover, and a considerable amount of differential settlement with cracks and fissures randomly crossing the landfill. The pit at Area 2 is a large excavation left behind after phosphate mining and the pit has been used for the dumping of C&D waste.

The construction phase of the proposed project would improve SWM at Area 1 by regrading and compacting the fill, and then providing a suitable cap, incorporating an ET cover. SWM at Area 2 would also benefit from construction of an ET cover. The ET covers, in conjunction with a stormwater management system at both sites, would help prevent further intrusion of rainwater into the solid waste mass, reducing leachate production at both sites. During construction, some waste would be generated by the construction activities and by construction workers.

6.1.13.2 Mitigation

Construction waste and any municipal waste generated by workers at the site should be collected and disposed of regularly. A waste management plan should be prepared and implemented. The plan should identify a waste collection schedule, storage locations, qualified carriers, and the final disposal facility. During construction, waste management in support of construction should be coordinated with ongoing C&D landfill operations at Area 2.

6.1.14 Human Health

6.1.14.1 Impacts

As discussed in Section 5.17, due to the proximity of the phosphate ore stockpiles and wastes present at Russeifah Area 3, at Areas 1 and 2 there is a potential health risk related to inhalation of fugitive radioactive airborne dust particles. It is expected that fugitive dust that contains traces of naturally occurring radioactivity material from Area 3 may be present within Areas 1 and 2. Construction activities on Areas 1 and 2 may temporarily re-suspend radioactive fugitive dust if present, potentially exposing construction workers and residents in the vicinity to ambient radioactivity during project activities.

Emissions from construction vehicles and equipment would contribute to diminished air quality in the project vicinity, potentially contributing to respiratory ailments, particularly in combination with background vehicle emissions and the ongoing release to the atmosphere of LFG with low methane content.

Project construction would expose the construction workers to the various, typical hazards associated with construction activities, such as falls, accidents involving construction vehicles and equipment, and prolonged exposure to sun, heat, dust, and loud noises. Construction at Russeifah Areas 1 and 2 would present additional risks associated with the steep cliffs that abut the mining pit, potential exposure to leachate and hazardous liquid and solid waste, and the potential for spontaneous combustion landfill fires or fires that result directly from construction activities.

6.1.14.2 Mitigation

During construction, dust control is a primary requirement for reducing fugitive radioactive dust that may be located in the work substrate. A proactive dust control and monitoring program, when activated, can reduce the construction-related dust generation by 25 to 75 percent, depending on the practices employed. Pre-treatment of all work areas near the periphery of the site with polymer coating materials and/or water can provide significant benefits to both the workers and the public. A control plan with pre-treatment should be used along with a real-time dust monitoring program to dynamically assess the effectiveness of the control measures being employed. Sub areas should be prioritized and then mitigated generally in priority order to minimize their impact on neighboring areas, while maintaining flexibility for operational efficiency. Implementation of construction sequencing, dust reduction procedures, air monitoring, and worker protection requirements could effectively mitigate short-term impacts during construction.

The contractor should prepare and implement an occupational health and safety plan, suitable for the construction site conditions and, as required, coordinated with ongoing C&D landfill operations at Area 2 during construction.

6.2 Operations Phase

6.2.1 Geology, Topography and Soils

6.2.1.1 Impacts

The goals of the project include the stabilization of Areas 1 and 2, and to cover the landfill and mining pit with an engineered cap and establish stormwater collection systems at both sites. The permanent impact resulting from the project would be a positive one, as both areas would be properly caped and stabilized. No negative impacts to geology, topography, or soils are anticipated for the project during operation.

6.2.1.2 Mitigation

As no negative impacts are anticipated for geology, topography, or soils following construction, no mitigation is recommended.

6.2.2 Surface Water

6.2.2.1 Impacts

Following the construction of the projects at Areas 1 and 2, both areas would include stormwater management systems consisting of open channels, chutes, and culverts, discharging to a single surface water basin. These systems would help manage stormwater at each site, guiding surface water away from the ET covers. Seasonal flow from the small wadi that drains into Area 2 and runoff from Areas 1 and 2 would be detained during winter in the surface water basin. No existing surface waters would be impacted by the operation of Areas 1 and 2.

6.2.2.2 Mitigation

As no existing surface water bodies are anticipated to be impacted by the proposed project, no surface water mitigation is recommended.

6.2.3 Groundwater

6.2.3.1 Impacts

The post-construction phase of the project would have a positive impact on groundwater in the vicinity of Areas 1 and 2. The ET covers at Areas 1 and 2 would help minimize the amount of stormwater infiltration through the landfill waste, thereby helping to reduce the amount of leachate generated at each site. In addition, with a liner and leachate collection system installed for a portion of Area 2, groundwater would benefit from a further reduction in leachate reaching the aquifer.

6.2.3.2 Mitigation

As no adverse impacts to groundwater are anticipated after construction, post-construction mitigation for groundwater is not recommended for the project.

6.2.4 Air Quality

6.2.4.1 Impacts

As the proposed project would cover the Area 1 landfill and the Area 2 mining pit with ET covers, less fugitive dust would leave the site, resulting in a positive impact to air quality in the vicinity after construction. Likewise, the project would establish four paved roads that would provide access throughout Areas 1 and 2, further reducing disturbance of onsite soils and generation of fugitive dust.

The LFG Management System at Area 1 has been designed to control the release of LFG to the atmosphere on site and to prevent the migration of LFG away from the site. Whereas the LFG extracted and collected from the landfill would be flared as a backup disposal measure,

LFG would be transferred to the JBC biogas plant as the primary means of disposal. No negative impacts to air quality are anticipated for the project following construction.

6.2.4.2 Mitigation

As the project would improve air quality after construction as a result of dust suppression by the engineered caps and improved SWM, no post-construction mitigation is proposed for air quality.

6.2.5 Radiological

6.2.5.1 Impacts

The long-term operation of the project may result in the reduction of fugitive dust in the surrounding project area and a potential decrease in ambient radioactivity, as the Area 1 landfill and Area 2 mining pit would be capped with ET covers. However, if the nearby Area 3 is not remediated, radioactive fugitive dust still could accumulate on Areas 1 and 2, as well as elsewhere in the surrounding area.

6.2.5.2 Mitigation

As the project potentially would decrease ambient radioactivity through dust suppression by the engineered caps, and as no adverse radiological impacts are anticipated after construction, no post-construction mitigation is proposed.

6.2.6 Noise

6.2.6.1 Impacts

The operation of the proposed LFG system at Area 1 could increase noise above current levels at the site. In particular, operation of the proposed blower/flare station, adjacent to the JBC biogas plant near the southwest boundary of Area 1, potentially would be a source of additional noise both on site and in nearby offsite areas. Depending on the resulting noise levels off site, operation of the station could result in adverse noise impacts for offsite occupants, particularly if sensitive receptors are located in the vicinity.

Following the completion of Area 2 remedial landfill capping, the remediated site is not anticipated to generate significant noise. Therefore, no noise impacts are anticipated after construction for Area 2.

6.2.6.2 Mitigation

To minimize the potential adverse impacts generated by the proposed LFG system on Area 1, all machinery and equipment should be maintained in good working condition. In case of elevated noise levels on site, hearing protection equipment should be provided to onsite workers. If offsite, adverse noise impacts are predicted by the noise impact analysis conducted requisite to the EIA that would be prepared if the project is implemented, additional mitigation measures should be specified.

As no noise impacts are anticipated during operation for Area 2, no post-construction noise mitigation is recommended for Area 2.

6.2.7 Flora and Fauna

6.2.7.1 Impacts

The final cap established on the Area 1 landfill, comprising the ET cover with an overlying aggregate layer for erosion control, would provide minimal flora and fauna habitat. C&D disposal operations at Area 2 likewise would generally preclude establishment of vegetation or use of the site as habitat by fauna species, as would the final cap proposed for Area 2, comprising the same cap system as proposed for Area 1. The surface water basin that would receive runoff from the stormwater management systems for Areas 1 and 2, however, may

create intermittent, seasonal habitat for flora and fauna. No adverse impacts to flora and fauna are anticipated during operation.

6.2.7.2 Mitigation

As no adverse impacts to flora and fauna are anticipated during operation, no mitigation is recommended.

6.2.8 Antiquities

6.2.8.1 Impacts

Archaeological resources on the project site would be encountered during the construction phase, if at all. The operations phase is not expected to result in impacts to archaeological resources.

6.2.8.2 Mitigation

As project operation is not anticipated to impact archaeological resources, no mitigation is proposed.

6.2.9 Land Use

6.2.9.1 Impacts

Implementation of the proposed project at Areas 1 and 2 would result in overall improved operations and ultimate proper closure of the landfill, thereby resulting in beneficial impacts to the project site and surrounding land uses. In addition, the LFG Management System at Area 1 site would control the release of LFG to the atmosphere onsite and prevent the migration of LFG away from the site.

6.2.9.2 Mitigation

As project operation is not anticipated to result in adverse impacts to land use, no mitigation is proposed.

6.2.10 Population and Economic Activities

6.2.10.1 Impacts

Implementation of the project would result in neither long-term adverse impacts nor benefits to the local economy. Project operation would not generate permanent jobs and, therefore, would not contribute to local earnings and induced spending. However, by improving the area surrounding the project, developing Area 1 into a properly closed landfill and developing Area 2 into a properly operating C&D landfill site would result in indirect benefits to the local population and economy.

6.2.10.2 Mitigation

As no negative demographic or economic impacts are anticipated during operation, no mitigation is recommended.

6.2.11 Transportation

6.2.11.1 Impacts

The proposed project is not expected to result in an increase in the quantity of waste transported to the Area 2 C&D landfill above the current estimated 250 to 300 loads per day. Consequently, no substantial increase in landfill traffic is anticipated in the project area, or on the Amman-Zarqa Highway or on local, secondary roads. The number of new workers that would be required for project operation has not been estimated. Nonetheless, it is anticipated that the project would not lead to a substantial increase in transportation demand and resulting passenger vehicle trips.

During operation, to prevent the entry of unauthorized people and livestock, access to Areas 1 and 2 would be controlled by a boundary wall surrounding the entire site and a security gate to be closed and locked when the landfill is not operating (USAID, September 2014). The project would establish four paved roads on site. The roads would have uniform slopes, easily traversed by landfill traffic, and would have 10-meter top widths to accommodate two-way traffic. The roads would provide access throughout Areas 1 and 2, including access to the base of the Area 2 mining pit and the proposed surface water basin.

No negative transportation impacts are anticipated during operation.

6.2.11.2 Mitigation

As no negative transportation impacts are anticipated during operation, no mitigation is recommended.

6.2.12 Water and Electricity Supply

6.2.12.1 Impacts

No operational impacts to water are anticipated as a result of the project, as future use of Areas 1 and 2 would be similar to current uses. Ultimately, when the final caps are installed for both landfills and the landfills are abandoned, water demand for Areas 1 and 2 would decrease as activity on the sites would diminish.

Operation of the project is not anticipated to result in an increase in demand of electricity. As previously discussed, a new LFG Management System would be implemented at Area 1 for efficient extraction and transmission of landfill gas from all portions of the landfill. Implementation of this more efficient system would likely result in greater generation of electricity at the adjacent JBC biogas plant.

6.2.12.2 Mitigation

As no adverse impacts to water and electricity supply are anticipated during operation, no mitigation is currently recommended.

6.2.13 Solid Waste

6.2.13.1 Impacts

Operation of the project would have a positive impact on SWM at Areas 1 and 2. Operating Area 2 as an engineered C&D landfill and the ET caps at both Area 1 and Area 2 would help protect the underlying wastes from infiltration of stormwater, reducing leachate in both areas. The operation of the LFG management system would reduce the buildup of landfill gasses from the solid waste at Area 1. If constructed, the liner and leachate collection system at Area 2 would help remove leachate from a portion of Area 2.

6.2.13.2 Mitigation

The purpose of the proposed projects is to improve SWM at Area 1 and Area 2. As no adverse solid waste impacts are anticipated during operation, no mitigation is recommended.

6.2.14 Human Health

6.2.14.1 Impacts

Implementation of the proposed project is anticipated to result in an overall positive impact to human health. The long-term operation of the project may result in the reduction of fugitive dust in the surrounding project area, a potential decrease in ambient radioactivity, and the reduction of LFG emitted to the atmosphere, as the Area 1 landfill and Area 2 mining pit would be capped with ET covers. However, if Area 3 is not remediated, radioactive fugitive dust still could accumulate on Areas 1 and 2, as well as elsewhere in the surrounding area.

6.2.14.2 Mitigation

As the project potentially would decrease ambient air pollution and radioactivity through the LFG Management System and dust suppression by the engineered caps, and as no adverse radiological impacts are anticipated after construction, no post-construction mitigation is proposed.

7 INITIAL ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

The Initial EMMP was developed from the mitigation measures detailed in Chapter 6, Initial Assessment of Environmental Impacts and Mitigation Measures, to address the anticipated environmental and social impacts of the project. The main objectives of the EMMP are the following:

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

The EMMP would assist the project proponent/owner, contractors, and government authorities in undertaking the required mitigation measures throughout the progress of the project, and guiding monitoring activities intended to verify that the mitigation measures are implemented and have the desired effects.

Table 7-1 presents an initial list of recommended environmental mitigation and monitoring measures to implement the project in a safe and environmentally sound manner during project construction. Table 7-2 presents the recommended environmental mitigation and monitoring measures for the operation phase of the project. The recommended mitigation measures address the anticipated environmental and social impacts of the project. They are actions that are not already included in the proposed project evaluated in this ECR and are not integral to the design, construction, and operation of the project. Unless otherwise noted in Table 7-1 or Table 7-2, it is expected that the construction contractor would be responsible for implementing construction phase mitigation and monitoring measures, and the project owner or operator would be responsible for implementing the operation phase measures in accordance with MoEnv requirements.

If the decision is made to implement the proposed project, the project proponent should prepare an EIA in accordance with MoEnv requirements, and the project EIA team should develop a more detailed, binding EMMP. The construction-phase environmental mitigation and monitoring measures specified in that EMMP should be incorporated into the tender documents provided to the construction contractor, and the specified operation-phase measures should be incorporated into the operation manuals for the project facilities.

Table 7-1. Recommended Construction-Phase Environmental Mitigation and Monitoring Measures

Anticipated Impact	Mitigation / Monitoring Measure
Soil erosion	**Mitigation** Develop and implement a soil erosion prevention plan. Restrict construction vehicles to previously disturbed land and roads. Pave roads and parking areas where heavy construction vehicle traffic/use is expected.
	Monitoring Monitor compliance with the soil erosion prevention plan. Inspect soil erosion and sedimentation control measures weekly.
Soil contamination from oil and fuel leakage or spills, or improper disposal or storage of waste and construction materials	**Mitigation** Develop and implement a spill management plan. Develop and implement a waste management plan. Establish designated waste and construction material storage areas on site. Establish designated fueling, and vehicle and equipment maintenance areas on site. Establish designated, paved vehicle parking areas on site. Dispose of waste in approved disposal facilities off site.
	Monitoring Monitor compliance with the spill management plan. Monitor compliance with the waste management plan. Document leaks and spills, and other incidents that may impact soil.
Increased groundwater demand to support construction activities	**Mitigation** Develop and implement a water management plan. Supply water from approved off-site sources.
	Monitoring Monitor compliance with the water management plan. Inspect water management measures weekly.

Groundwater contamination from hazardous materials used during construction	**Mitigation** Develop and implement spill management plan. Develop and implement a hazardous material management plan.
	Monitoring Monitor compliance with the spill management plan. Monitor compliance with the hazardous material management plan. Document leaks and spills. Document discharges of hazardous materials.
Fugitive dust	**Mitigation** Develop and implement a fugitive dust management plan. Develop and implement a soil erosion prevention plan. Pave roads and parking areas where heavy construction vehicle traffic/use is expected. Cover stockpiles of and cover vehicles that carry dry spoil and other dust-generating cargo.
	Monitoring Inspect adherence to fugitive dust management plan requirements daily during periods of high activity or prolonged dry, windy weather, and weekly otherwise. Monitor compliance with the soil erosion prevention plan. Inspect soil erosion and sedimentation control measures weekly. Document dust complaints.
Construction machinery and vehicle air pollutant emissions	**Mitigation** Maintain machinery and vehicles in good working condition. Minimize vehicle idling time.
	Monitoring Inspect machinery and vehicles monthly. Document air quality complaints.
Radiological exposure	**Mitigation** Develop and implement a fugitive dust management plan. Develop and implement a soil erosion prevention plan.
	Monitoring Inspect adherence to fugitive dust management plan requirements daily during periods of high activity or prolonged dry, windy weather, and weekly otherwise. Monitor compliance with the soil erosion prevention plan. Inspect soil erosion and sedimentation control measures weekly.

Increased noise	**Mitigation** Prohibit loud noise-generating construction activities between 8 pm and 6 am. Provide hearing protection equipment to construction workers. Conduct multiple noise-generating activities simultaneously. Maintain machinery and vehicles in good working condition.
	Monitoring Monitor compliance with the Instructions for Controlling and Preventing Noise daily. Inspect machinery and vehicles monthly. Document noise complaints.
Flora and fauna impacts	**Mitigation** Develop and implement a soil erosion prevention plan. Restrict construction vehicles to previously disturbed land and roads. Restrict construction activities to one area at a time. Prohibit trapping or hunting. Move captured animals to nearby undisturbed areas. Control and minimize noise and fugitive dust generation, and hazardous material spills and discharges.
	Monitoring Monitor compliance with the soil erosion prevention plan. Inspect soil erosion and sedimentation control measures weekly. Inspect adherence to fugitive dust management plan requirements daily during periods of high activity or prolonged dry, windy weather, and weekly otherwise. Monitor compliance with the Instructions for Controlling and Preventing Noise daily. Document discharges of hazardous materials.

Dust and noise impacts on adjacent land uses	**Mitigation - Dust** Develop and implement a fugitive dust management plan. Develop and implement a soil erosion prevention plan. Pave roads and parking areas where heavy construction vehicle traffic/use is expected. Cover stockpiles of and cover vehicles that carry dry spoil and other dust-generating cargo. **Mitigation - Noise** Prohibit loud noise-generating construction activities between 8 pm and 6 am. Conduct multiple noise-generating activities simultaneously. Maintain machinery and vehicles in good working condition.
	Monitoring - Dust Inspect adherence to fugitive dust management plan requirements daily during periods of high activity or prolonged dry, windy weather, and weekly otherwise. Monitor compliance with the soil erosion prevention plan. Inspect soil erosion and sedimentation control measures weekly. Document dust complaints. **Monitoring - Noise** Monitor compliance with the Instructions for Controlling and Preventing Noise daily. Inspect machinery and vehicles monthly. Document noise complaints.
Construction-related traffic	**Mitigation** Develop and implement traffic management plan.
	Monitoring Monitor compliance with the traffic management plan.
Increased water demand to support construction activities	**Mitigation** Develop and implement a water management plan. Supply water from approved off-site sources.
	Monitoring Monitor compliance with the water management plan. Inspect water management measures weekly.

Solid waste generation	**Mitigation** Develop and implement a waste management plan. Establish designated waste storage areas on site. Dispose of waste in approved disposal facilities off site.
	Monitoring Monitor compliance with the waste management plan.
Health risk from radiological exposure	**Mitigation** Develop and implement a fugitive dust management plan. Develop and implement a soil erosion prevention plan. Develop and implement an occupational health and safety plan.
	Monitoring Inspect adherence to fugitive dust management plan requirements daily during periods of high activity or prolonged dry, windy weather, and weekly otherwise. Monitor compliance with the soil erosion prevention plan. Inspect soil erosion and sedimentation control measures weekly. Monitor compliance with the occupational health and safety plan.

Table 7-2. Recommended Operation-Phase Environmental Mitigation and Monitoring Measures

Anticipated Impact	Mitigation / Monitoring Measure
Increased noise from LFG system	**Mitigation** Provide hearing protection equipment to onsite workers. Maintain machinery and vehicles in good working condition.
	Monitoring Monitor compliance with the maximum allowable noise levels specified by the Instructions for Noise Prevention monthly. Inspect machinery and vehicles monthly. Document noise complaints.

8 PROPOSED ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY AND SCHEDULE

If the decision is made to implement the proposed project, the project proponent should prepare an EIA in accordance with the Jordan Regulations No. (37) of 2005, Environmental Impact Assessment Regulations, and consistent with the requirements of any lending organization that provides financing for the project. The project EIA team should conduct field investigations, desktop research, and consult with experts (when needed) in order to efficiently assess the existing environment, address all the significant environmental and social impacts related to the project, and formulate an EMMP to mitigate the significant negative impacts and define the institutional responsibilities for implementing these measures. The EIA should accomplish the following:

- Specify the project designs, plans, and activities that would be associated with environmental and social conditions
- Identify the environmental and social regulations, standards, policies, and administrative framework
- Describe the environmental and socioeconomic baseline conditions of the project area and the affected communities
- Inform and obtain input from stakeholders (e.g., governmental authorities and the public), and document their relevant issues and concerns
- Assess the environmental and socioeconomic impacts that would result from the project activities during construction, operation, and decommissioning
- Identify mitigation measures to address the impacts identified
- Analyze the different project alternatives according to their environmental and socioeconomic effects, both positive and negative
- Develop an EMMP that sets a comprehensive plan for mitigation measure implementation, including monitoring and institutional management

8.1 Desktop and Field Studies

Desktop research and field studies will need to be undertaken as part of the project EIA. The objectives of the desktop and field studies are to provide a detailed description of the affected environment and establish the environmental and socioeconomic baseline that will be used in impact assessment.

8.1.1 Literature and Data Review

The desktop research studies will entail thorough literature reviews for all of the resource areas covered in the EIA. One of the primary purposes of the desktop review will be to further evaluate data from secondary sources, according to:

- The extent to which available baseline information covers all areas potentially impacted by the project
- Whether the current existing baseline data is still valid and sufficient or should be updated and extended through primary research
- The extent to which baseline data meets requirements to complete an EIA to the applicable standards and guidelines

The EIA team should review all available, relevant data about the project and the project area. This will include review of studies and investigations related to the proposed Russeifah Area 1 and Area 2 remediation, and environmental and socioeconomic conditions on the project site and throughout the surrounding project area. Literature and data review also should include consulting web-based resources. Data will be collected by reviewing several pertinent documents including, but not limited to the following:

- *Russeifah Area 1 (Landfill) and Area 2 (Pit) Remediation Feasibility Study*, USAID WRECP 19 January 2012, including associated appendices
- *Russeifah Site (Areas 1 and 2) Design Report*, USAID WRECP September 2014, including associated appendices
- Data from the Department of Statistics publications
- Jordan Climatological Handbooks and Bulletins, Meteorological Department
- *Handbook of the Geology of Jordan*, Burden 1959
- *Geology of Jordan*, Bender 1974
- *Geology of Jordan*, Abed 2000
- *Jordan Country Study on Biological Diversity*, General Corporation on Environmental Protection 1998
- *Jordan Country Study on Biological Diversity: Jordan Ecology, Ecosystems, and Habitats*, General Corporation on Environmental Protection 2000
- *Jordan Country Study on Biological Diversity: Mammals of Jordan*, General Corporation on Environmental Protection 2000
- *Jordan Country Study on Biological Diversity: Plant Biodiversity and Taxonomy*, General Corporation on Environmental Protection 2000

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

For some resources, desktop studies will be sufficient for the impact analysis. For several resources, however, field studies are expected to be necessary to provide sufficient information for the required level of EIA, as detailed in the following section.

8.1.2 Field Investigations and Analyses

Structured site visits, field surveys, and stakeholder consultations should be undertaken to collect primary data from the site and directly from stakeholders in order to garner their perceptions about the project's predicted impacts. Site visits, field surveys, and stakeholder consultations are expected to contribute to determining the following:

- Environmental and human health baseline and current situation
- Stakeholders' perceptions of the project and the anticipated impacts
- Stakeholders' views and recommendations on the mitigation of predicted negative impacts
- Roles and responsibilities associated with the EMMP

Data should be collected firsthand through several field visits to the project site. Field investigations, including "walkover" surveys, should be conducted during the preparation of the EIA document to acquire a comprehensive understanding of the environmental conditions at the site. During the field investigations, the potential impacts on the project area should be considered and mitigation measures to be implemented during project construction, operation, and decommissioning should be proposed.

8.1.3 Groundwater Assessment

A field survey should be undertaken to verify the characteristics of the main recharge zones in the area. As feasible, water samples from onsite and nearby groundwater resources should be collected, to establish the baseline conditions and the concentrations of contaminants that may be associated with activities on the project site.

The study should also assess water needs for the various construction, operation, and decommission phase project activities and support development of a water management

plan for the project. The study team should consider potential impacts on groundwater quality from project activities, such as waste dumps and leachate, and should recommend mitigation measures to be implemented to protect groundwater resources in the project area.

The EIA should assess the quality, quantity, and importance of groundwater in the project area, together with groundwater use in neighboring areas. This should include assessment of aquifer parameters (quantity, quality, and direction of groundwater flow) for each of the geological units that may be impacted by the proposed project. The assessment should include the following:

- Surveying existing groundwater supply facilities (bores, wells or excavations), including location, pumping parameters, drawdown and recharge at normal pumping rates, and seasonal variations of groundwater levels, to the extent that records exist
- Identifying and monitoring a network of observation points that would satisfactorily monitor groundwater resources before commencement of project operation, and that would continue to be monitored after during operation
- Specifying the major ionic species present in the groundwater, pH, electrical conductivity, and total dissolved solids
- Describing the environmental values of the underground waters of the affected area

The groundwater study should assess the potential project impacts on the identified resources, including identifying any potential wastewater runoff issues. The assessment should define and describe practical measures for protecting groundwater resources and mitigating project impacts, and a program for managing, monitoring, and auditing implementation of those measures and their effectiveness.

8.1.4 Air Quality and Noise Studies

In order to establish a baseline for the concentrations of air pollutants and noise levels, air quality and noise testing should be carried out. Sampling should be conducted for several testing points inside and outside the proposed facility boundaries. Measurements should be performed at the following locations:

- At minimum, one point at the Area 1 site boundary
- At minimum, one point at the Area 2 site boundary
- One point at the Area 1 site boundary near the proposed location of the blower/flare station
- Additional points located where people would be exposed to air emissions and noise during project construction, operation, and decommissioning, including residential areas and sensitive receptors such as schools and hospitals

Air quality samples should be taken and analyzed according to the JS 1140/2006 Ambient Air Quality Standards. Key air quality parameters that should be tested include the following:

- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Hydrogen sulfide (H_2S)
- Ozone (O_3)
- Ammonia (NH_3)
- Carbon dioxide (CO_2)
- Respirable particulate matter (PM_{10})
- Fine particulate matter ($PM_{2.5}$)
- Total suspended particles (TSP)

- Phosphate (P_2O_5)
- Methane (CH_4)

Desktop activities should include developing an inventory of the sources, types, and magnitude of air and noise emissions that would be generated by construction, operation, and decommissioning of the proposed project. Fugitive dust, equipment and vehicle emissions, and noise levels anticipated during the construction and decommissioning phases should be assessed qualitatively. Dust, emissions, and noise levels anticipated during the operation phase should be assessed quantitatively.

8.1.5 Human Health Assessment

The objective of the human health assessment should be to identify, assess, and manage the potential future effects of the proposed project on the health of communities within the project area. The assessment should include the following components:

- Conducting desktop investigations and scoping to identify potential communities that would be affected by the proposed project and key health issues
- Developing a plan to gather additional data needed to conduct the assessment, using both existing information and input from health experts
- Collecting the additional data, as necessary, using interviews with key health experts, health service providers, community organizations, and local leaders
- Assessing the potential health effects of the project
- Developing a management plan for addressing those effects

8.1.6 Ecological Assessment

An ecologist should conduct a site visit in order to evaluate the existing ecological conditions. As the project site is located within an urban area and the site is highly disturbed, a single reconnaissance-level investigation likely would be sufficient, although additional investigations should be programmed if warranted by the initial visit.

The ecological assessment should focus on obtaining baseline data of the biological environment in the project area. This is to support analysis of potential impacts to biological resources that may result from implementation of the proposed project during the construction, operation, and decommissioning phases. If needed, the study should recommend approaches to reduce any potential threats to rare or endangered species, thus bolstering compliance with national and international protection requirements.

8.2 Scoping

If required, scoping gives stakeholders an opportunity to learn about the project, raise concerns, understand the potential effects, and comment on the project. Through scoping, key issues to be investigated and assessed are identified, and the range and extent of the studies to be conducted are determined. The key objectives of scoping are to:

- Identify stakeholders and inform them of the project and the EIA process
- Provide stakeholders with the opportunity to identify any issues and concerns associated with the project
- Identify areas of likely impact and environmental issues that may require further investigation in the EIA
- Determine the need for specialist baseline and impact assessment studies in response to initial stakeholder input

During scoping, desktop analyses, stakeholder interviews, and public meetings should be conducted to ascertain whether additional information is needed to evaluate baseline conditions and potential impacts within the project area. The desktop evaluation should

include reviews of pertinent environmental and social data collected from external sources and previous studies of the project area. The project proponents should meet with stakeholder groups (e.g., local governmental agencies, non-governmental organizations, and representatives of local communities) to discuss the scopes of the proposed studies, including alternatives and the criteria for the impact assessment, and determine if additional baseline data will be required for a comprehensive analysis.

Public consultations should be conducted. This includes a scoping consultation session with the main objective of reviewing the EIA scope of work with stakeholders, and obtaining stakeholders views on the issues that need special attention during the field investigations and the analysis. Additionally, plenary public consultation sessions should be organized after drafting the EIA in order to validate and review the study findings with the relevant stakeholders and groups potentially affected by the project.

The EIA should document the names of participants, the details of the scoping session activities, and the results of the public consultations.

8.3 Environmental Impact Identification and Assessment

During environmental impact identification and assessment, the EIA team should determine the impacts and effects of the proposed project, reasonably practicable alternatives, and a no-action alternative. To assess the potential environmental impacts of the proposed project and its alternatives, the EIA team should undertake the following:

- Provide a detailed description and assessment of the negative and positive potential environmental impacts of the project and its alternatives for all phases of the project (construction, operation, and decommissioning)
- Provide details of the methods/assessment tools used to estimate impacts for each technical parameter, as appropriate
- To the extent practicable, assess the scale or quantity of potential impacts anticipated from all aspects of the project throughout each phase of the project (construction, operation and decommissioning)
- Evaluate the type and magnitude of impact relative to quantitative or qualitative criteria, and any regulatory standards or other performance standards, and determine whether the anticipated impact meets or exceeds the standards or criteria
- Identify which technical parameters have the potential to be significantly affected by the project

Also during environmental impact identification and assessment, the EIA team should develop mitigation measures that would eliminate or reduce adverse impacts that may be caused by the proposed project. Mitigation measures should be developed for each adverse impact anticipated during the construction, operation, and decommissioning phases. The measures selected should:

- Target the impact of concern
- Be feasible to implement and cost effective
- Incorporate best available technology when possible or when mandated by permit approval
- Address cumulative impacts that by themselves would not be considered significant

8.4 Environmental Management and Monitoring Plan Development

The EIA team should prepare an EMMP to manage environmental and social issues during the construction, operation, and decommissioning phases of the project. The EMMP should be developed from the mitigation measures detailed during environmental impact identification and assessment to address the anticipated environmental and social impacts of

the project. The EMMP will assist the project proponent/owner, contractors, and government authorities in ensuring that the required mitigation measures are fully executed and sustained throughout the progress of the project, and that the monitoring activities intended to verify that the mitigation measures are implemented and have the desired effects likewise are fully executed and sustained.

Although the EMMP is an integral part of EIA, in accordance with the Jordan Regulations No. (37) of 2005, Environmental Impact Assessment Regulations, it should be a separate, standalone report from the EIA document. For all phases of the project (construction, operation, and decommissioning), the EMMP should address each project activity to which an environmental limitation or other requirement applies, or for which a mitigation measure will be implemented. For each project phase, the EMMP should:

- Identify the aspect/resource to be monitored
- Identify specific mitigation and monitoring measures
- Provide information on the anticipated effectiveness of the mitigation
- Define the location, period, and frequency of monitoring
- Describe monitoring requirements as commitments
- Identify the responsible party for monitoring
- Describe reporting and record keeping requirements
- Consider anticipated expectations or requirements of other stakeholders who may have involvement once construction or operation begins
- Include reporting frequency and type
- Discuss what will happen if monitoring indicates that impacts are not reduced
- Confirm sufficient resources (funds, staff) are available to conduct monitoring
- Reference applicable Jordanian legislation and/or regulations, or applicable international standards
- Include additional general requirements
- Include a signature by an authorized representative of the project proponent
- Include a statement that the project proponent or owner is required to implement all items stated in the EMMP

The EMMP should be continually updated as needed as the project goes to construction, operation, and long-term monitoring, and must provide sufficient information for the MoEnv Inspection Department to use during the inspection process. The construction-phase environmental mitigation and monitoring measures specified in the EMMP should be incorporated into the tender documents provided to the construction contractor, and the specified operation-phase measures should be incorporated into the operation manuals for the project facilities.

8.5 Approvals

Following review of the Initial EIA, the MoEnv will decide whether to grant the Environmental Approval or, if significant impacts are anticipated, to require further study in a Comprehensive EIA. If a Comprehensive EIA is required, a preliminary terms of reference (TOR) document should be prepared by the project proponent. The TOR document should explain how the EIA will be conducted and should identify potential impacts and proposed mitigation measures for the purposes of discussion at a scoping session.

Using information acquired in the scoping session, in which interested stakeholders participate, the proponent writes a scoping report and finalizes the TOR document. The MoEnv may approve the revised TOR or request modifications. When the TOR is approved, the Proponent conducts the EIA study and prepares the Comprehensive EIA document. The

MoEnv reviews the document and may request modifications. After completing the document review, the MoEnv either issues Environmental Approval or rejects the project.

8.6 Disciplines Required

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

- Environmental Task Leader
- Environmental Specialist
- Groundwater Hydro-geologist
- Air Quality Expert
- Radiologist
- Noise Expert
- Ecologist
- Archaeologist
- Socio-economist
- SWM Engineer
- Health and Safety Specialist

Curricula vitae of involved experts should be provided in the EIA report.

8.7 Proposed EIA Report Outline

The MoEnv recently developed a guidance document for preparing EIA reports. This guidance provides detail on the organization, format, and general level of detail required to be provided in EIA documents. In addition, the MoEnv has prepared individual technical guidance documents to assist project proponents and their consultants conduct some of the more complex analyses required to determine the potential effects of their respective projects. These guidance documents (*Technical Guidance Protocols Annex* to: *Guidance for Preparing Environmental Impact Assessments*, October 2014) are available from the MoEnv.

8.8 Schedule

Figure 8-1 summarizes the anticipated schedule for implementing the EIA for the project.

Activity	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
Literature and Data Review									
Field Investigations and Analyses									
Environmental Impact Identification and Assessment									
EMMP Development									
EIA Final Preparation									

Figure 8-1. Schedule for Implementing the EIA

9 CONCLUSIONS

The existing partially covered landfill and open mining pit that comprise Russeifah Areas 1 and 2 are an aesthetic, environmental, and health concern and pose risks associated with slope stability and landfill fire hazards. Based on the findings of this ECR, although some potentially adverse impacts would be associated with the proposed remediation of Areas 1 and 2, the proposed project is not expected to result in significant adverse environmental or social impacts during construction or operation. The anticipated adverse impacts would be temporary and can be mitigated, providing implementation of the mitigation and monitoring measures outlined in the preceding Initial EMMP.

Overall, the proposed remediation of Areas 1 and 2 (i.e., development of Area 1 into a properly closed landfill and development of Area 2 into a properly operating C&D landfill) is expected to substantially reduce the environmental and human health risks currently associated with the landfill and mining pit, and improve the quality of life for the residents of Russeifah.

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