



Environmental and Social Impact Assessment (ESIA) Study

**Jordan India Fertilizer Company
(JIFCO)**

VOLUME (II)

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

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1. INTRODUCTION

An environmental management plan (EMP) including mitigation measures and a monitoring program (MP) is presented in this document. The EMP outlines the environmental impact management procedures that shall be taken by the Jordan India Fertilizer Company (JIFCO) to protect the environment during all phases of the project.

2. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

2.1 Introduction

The environmental management plan document outlines the necessary mitigation measures identified in the ESIA study. Responsibilities for proper environmental management are outlined.

2.2 Responsibilities

The responsibility for the EMP within the JIFCO will be with the JIFCO Project Manager, who may choose to delegate responsibility within the organization. This responsibility includes implementing the mitigation measures and monitoring the performance of these measures, establishing environmental policy, executing the monitoring programs and controlling the operation of all environmental protection activities.

2.3 Permitting Requirements

Table (1) summarizes the permits needed for the project in accordance to their timing.

2.4 Proposed Mitigation Measures

The environmental management plan covers the issues related to the following environmental components:

- Water resources.
- Biodiversity.
- Public health.
- Archeology.
- Socio-economic conditions.
- Occupational health and safety.
- Marine environment.

Table (1): Summary of permitting requirements of major relevant regulatory authorities

Authority	Responsibility
Ministry of Environment	• Permitting prior to construction (ESIA report is required). • Inspection during operation.
Aqaba Special Economic Zone Authority	• Permitting prior to construction in Aqaba zone (ESIA report is required). • Inspection during operation.
Ministry of Labor	• Permitting prior to operation (after occupational health and safety measures). • Inspection during operation.
Water Authority of Jordan	• Supplying water needs during project phases. • Water quality monitoring during project life.
Ministry of Health	• Inspection during operation.
Department of Antiquities	• Permitting in case of existence of archaeological remains.
Civil Defense	• Approval for construction plans. • Permitting prior to operation.
Ministry of Housing and Public Works	• Inspection of the heavy trucks loads during operation

2.4.1 Water resources

Following are the necessary mitigation measures:

Disposal of the industrial wastewater

- The guard pond shall be designed and lined by using high density polyethylene material in a proper method to prevent any possible occurrence of the infiltration of the industrial wastewater into the groundwater table. The lining material shall be inspected regularly.
- The phosphoric acid storage tanks in Aqaba area shall be designed according to the local and international codes against the seismic hazard. In addition, the tank should be provided with a properly lined containment area capable of holding the largest tank volume and 10% of its volume. During the operation phase, emergency handling and cleaning program in case of accidents shall be included in the design of the site facility. The storage tanks should be inspected on a regular basis.
- It is recommended to establish a monitoring program to monitor infiltration through soil sampling through shallow boreholes located downstream of the guard pond and the gypsum staking area.

Disposal of waste oil and leakage of oil storage tanks

- Fuel oil/diesel storage tank should be designed according to international standard codes. In addition, the tank should be provided with a properly lined containment area capable of holding the tank volume.
- The waste oil generated from the spillage, leakage of oil storage tanks, and the spent lubricating oil of equipment and vehicles should be collected in special containers and transported in a safe manner to Jordan Petroleum Refinery Company or sold to the licensed collector of used oil.

Handling and disposal of domestic wastewater

- During the construction phase, the domestic wastewater should be collected in an impermeable reinforced (sealed) tank and should be disposed to the nearest municipal wastewater treatment plant using licensed vacuum tanks and following the appropriate environmental regulations.
- During the operation phase, the treated domestic wastewater resulting from the treatment unit shall be complying with the regulations before it can be used for irrigation.
- The dismantling of the domestic wastewater treatment unit during the decommissioning phase should be done in an environmentally safe manner. The wastewater should be emptied before by using vacuum vehicles. The wastewater should be disposed to the nearest domestic treatment unit.

Impact of the industrial solid wastes

- The spent vanadium pentoxide catalyst (V_2O_5) should be sealed in steel or plastic drums and stocked in designated area and then it shall be returned to the supplier.
- The floor of the gypsum stacking area shall be constructed and compacted in a proper way using proper material to obtain the soil permeability not larger than 1×10^{-6} m/sec. The stacking area shall be contained by dike in all sides to prevent seepage of the wastes out the containment area.

Impact of the surface runoff

During the construction phase, the company shall consider constructing gabions along the side of the wadi near to the storage tanks in Aqaba to minimize the flood impact on the tanks. The company shall also work on protecting the drainage pattern of this wadi from the construction activities.

Considering an alternative water resources

Further studies shall be commenced by all industries in Eshidiya area to find alternative resources to compensate for the deficit between the available and required quantities. The company should use the excess amount of the treated domestic wastewater from the project as well as to study in future the possibility to reuse the treated domestic wastewater from Ma'an municipal treatment unit and the planned treatment unit of Ma'an industrial zone. The company shall comply with the rules of the Ministry of Water and Irrigation regarding water resources protection zones.

2.4.2 Biodiversity

Following are the recommended mitigation measures to be implemented to reduce the negative impacts:

Construction Phase

Flora

- Disposal of debris on flora: The proposed sites for the plants and the storage tanks are suffering from very high levels of deterioration and the expected accumulative impact of the debris disposal is minimal and reversible.

Mitigation Measure

Disposal of debris should avoid the shallow depressions in the area that have some vegetation cover.

- Direct damage of the flora at both sites of the project: As observed and studied during the baseline; both proposed sites of the project have very low species flora diversity as well as the absence of any critical or conservation important plant species. Therefore, the expected impact is considered insignificant and does not threaten the absence of similar species in the surrounding area.

Mitigation Measure

At the proposed site for the plants, construction should avoid shallow depressions that have vegetation as much as possible.

- Collecting wood by workers: This impact on the vegetation is of low magnitude level due to the lack of woods in both sites, but some shrubs might be used by workers in the construction.

Mitigation Measure

To prohibit workers from collecting wood.

- Habitats destruction: Due to random access dirt road to the construction site, it is expected to have a low magnitude impact on the vegetation that found in the site.

Mitigation Measure

To limit construction activities within the plants site.

- Solid and liquid wastes: This impact might be significant of medium level especially on the surrounding area to the proposed sites of the project like the wadi systems. Hazard liquid wastes from machineries used in the construction might affect the seasonal wetlands formed in the flood seasons.

Mitigation Measure

To collect all wastes in sealed containers and to be disposed properly according to the regulations of the Ministry of Environment.

Fauna

- Disposal of debris on fauna: This impact is very limited to insignificant level due to the high disturbance levels in the project sites that made the fauna diversity restrict mainly to the micro levels of small reptiles and rodents that are not considered critical or conservation important species.

Mitigation Measure

Disposal should avoid the shallow depressions in the area that have some vegetation cover that might have rodents or reptiles borrows.

- Direct damage of the fauna at both sites of the project: The kind of expected damage is restricted to the disturbance during the construction phase. The proposed sites have low fauna diversity. However, this impact may be of more significance at night time and during the migration seasons of birds during spring and autumn.

Mitigation Measure

Any killed mammal or rodent species should be reported to the Ministry of Environment for recording its status.

- Animals and birds hunting by workers: This impact is of low magnitude level due to the low abundance of game species in the proposed sites of the project.

Mitigation Measure

To prohibit workers from hunting.

- Accidental killing of animals and birds: Accidents of animal killing due to the movements of the vehicle and machineries is expected especially during the night time. This impact is of low magnitude level.

Mitigation Measure

To report any accident and inform the Ministry of Environment.

- Solid and liquid wastes: Domestic wastes might attract some animals species to the site which might initially threat the workers in the site and also threat the animals if it contaminated with hazard wastes produced by the construction activities. This impact is of medium magnitude level.

Mitigation Measure

To collect all wastes in sealed containers and to be disposed properly according to the regulations of the Ministry of Environment.

Operational Phase

Flora

- Disposal of gypsum and possibilities of reuse: The proposed area for the gypsum disposal has very low vegetation coverage of shrubs that are on no conservation importance in away make this impact negligible. In addition to that, the gypsum disposed will have moisture that will harden the residues when its dry in a way minimize the weathering impact on the vegetation cover surrounding the project site.

Mitigation Measure

Restrict gypsum disposal in the proposed site only.

- Soil contamination due to disposal of used oil: This impact has significant levels on the soil although the vegetation cover is very poor in the project area and the surroundings. The extent of this impact can last beyond the project life where the soil will not be able to support regeneration of plant species after the project in the area.

Mitigation Measure

All disposed oil should be collected and management according to the regulations of the Ministry of Environment.

Fauna

- Guard pond impact on the migratory birds: The project area is on the fly way of the migratory birds especially the raptors which can be attracted to the pond that will have harmful liquid (acid). The impact of this pond on the migratory birds is very significant.

Mitigation Measure

Guard pond should not be in direct interaction (contact) with migratory birds. Therefore, strict mitigation measures should be placed such as covering the pond with pale color mesh (sand color) in order to avoid having birds attracted to the pond. The pond should also be fenced to protect the wild animals from falling in it.

- Disposal of gypsum and the possibility of reuse: This impact is very limited to the micro level habitats of reptiles and rodents, as the disposal of gypsum might cover the borrow areas that are mainly restricted to the areas of vegetation cover. This impact is of low significance since there is no conservation important reptile or rodent species found in the area, and the proposed area for gypsum disposal is almost empty of vegetation cover.

Mitigation Measure

Avoid disposal in depression areas with vegetation cover as much as possible.

- Hunting by workers: This impact is expected to be of low magnitude level due to the mild interaction of workers during the operational phase with the surrounding environment during night time.

Mitigation Measure

To prohibit workers from hunting.

- Accidental killing: Due to the heavy transportation activities, road killing for animals is expected especially during the night time due to the nocturnal activities for the animals in the area. This impact is of low magnitude level.

Mitigation Measure

To report any accident and inform the Ministry of Environment.

Decommissioning Phase

Flora

- Random disassembling: This impact is limited to destruction of habitats at the surrounding area during the decommissioning activities by using it as temporary storage or parking sites for machineries.

Mitigation Measure

Disassembling should be restricted within the project boundaries.

Fauna

- Random disassembling: This impact limited to the disturbance that may occur in the area during this phase which may affect fauna species, especially if these activities take place during the night time or during the migration seasons of birds.

Mitigation Measure

Disassembling should be restricted within the project boundaries and during day time as much as possible.

2.4.3 Public health

Air pollution

Construction Phase

- Dust resulting from the construction activities should be minimized as much as possible. Following are some examples that could be taken: water slightly all active construction areas to reduce dust generation, cover all trucks hauling soil, sand, and other loose materials, cover stockpiled soils, sand and cement, and try to remove them promptly and strictly limit truck speed on unpaved roads.
- In addition, it is recommended to apply some other measures such as turning off the vehicles and machinery when not used for extended periods, scheduling the deliveries of the construction materials during off-peak hours and using the minimum number of vehicles.
- To reduce vehicular emissions to limits within national and international standards, it is necessary to regularly monitor these emissions, test the opacity and conduct periodical maintenance of vehicles and machinery that will be used in all phases.

Operation Phase

- The suitable type of de-dusting system that is reliable and of high efficiency shall be installed in all dust emission points such as the phosphate rock discharge point to the ball mill.
- It is important, not only to install de-dusting systems such as cyclones and bag filters i.e. at the stack of phosphate rock ball mill, but also apply regular maintenance and check of the performance of the installed dust protection equipments. In addition, this will ensure meeting the dust emission concentration to the Jordanian Standards limit of 50 mg/Nm^3 . For example, the regular maintenance and performance check of the bag filters should be done at least once every six months and spare bag filters should always be available at the company.
- To reduce the dust emission from material storage areas, the phosphate rock and sulphur stockyards walls should be high enough and built against the prevailing wind direction. This means that the outdoor phase of the stockyards wall should be against the northern and western winds. Moreover, during material transportation, conveyor belts in enclosed galleries (covered conveyor belts) are necessary to carry all materials that can cause pollution such as sulphur granules.
- Cover well all the trucks that will haul the sulphur granules from Aqaba to Eshidiya to prevent the sulphur spillage during transportation and the possibility of grinding it by the vehicles. The company shall import the granular sulphur not the fine one.
- The installation of on-line continuous SO_2 gas analyzer at the sulphuric acid final absorption stack will be so helpful to assist the plant control on air quality and the efficiency of the SO_2 to SO_3 converter. By this system, appropriate corrective action i.e. in case of vanadium oxide malfunction can be taken in earlier times.
- During the operation phase, on-line continuous monitoring of dust emissions from the ball mill stack is also recommended.
- The radioactivity of phosphoric acid and phospho-gypsum should be measured from time to another in order to take the required actions in case of high level of radioactivity and to have baseline data for the existing situation.
- To reduce the possible dispersion of phosphate rock and sulphur dust by wind, good housekeeping measures such as frequently cleaning/sweeping the plant grounds could be applied.
- Build green belt around the area of the proposed project to provide a barrier between the project site and the surrounding area. The green belt helps to capture the fugitive emissions generated in the project activities.
- The unplanned stoppages should be prevented as possible, since they could generate more air pollution emissions than at the normal operation,

- such as the emissions of SO₂, CO and NO_x from the start-up boiler and more SO₂ emissions from the sulphuric acid plant.
- The loading of sulphur and phosphate rock from the trucks to the stores shall be managed well to avoid dust emissions, such as applying the most appropriate angle of loading.
 - Apply water spray on the gypsum stacks during the southern windy days to reduce the generation of dust.
 - The sulphuric acid absorption unit as well as the hydrogen fluoride scrubbing unit should have sufficient capacities to handle the sudden load increase of gaseous pollutants (SO₃ and HF).

Noise

- Equipment and vehicles shall be maintained in line with manufacturer's recommendations to meet relevant standards.
- Vehicles and machines shall be used responsibly, e.g. machines will not be left idling for long periods if they are not in use.
- During the operation phase, the heavy equipment shall be selected, properly operated for the right purpose, inspected and maintained regularly to keep them up to the established standard to reduce their potential generated noise.
- During the operation phase, strict speed limits and safety signs shall be posted along the roads. Drivers shall be trained on defensive driving to reduce potential increase in noise, accidents and dust emissions.
- During the operation phase, a periodical maintenance to all transportation and heavy vehicles shall be done. The vehicles shall be replaced after the mentioned operational life time.
- During operation phase regular checks on the effectiveness of operational systems and noise should be done.

Wastes

- All types of wastes (domestic and hazardous) resulting from construction, operation and decommissioning activities at both sites shall be managed in an environmentally safe manner and according to related regulations. All domestic solid wastes to be disposed of shall be collected in compatible closed containers and then transferred to the authorized waste disposal site with prior coordination with the relevant authorities or the company shall contract a private company to manage this issue. All hazardous waste (oils and others) shall be collected and managed according to the regulation of hazardous waste management and handling issued by the Ministry of Environment. Waste oils shall be

collected and sent to the Jordan Petroleum Refinery Company or sold to a licensed collector of the used oil. The management of used oils shall be according to the regulations of management and handling of used oil issued by the Ministry of Environment.

- The spent catalyst (vanadium pentoxide) shall be sent back to the supplier.
- Gypsum will be piled in a prepared adjacent area east of the plant area.
- Sulphur filter cake will be piled in the gypsum disposal area.
- During the construction phase, toilettes shall be available to be used by the workers. The generated domestic wastewater shall be collected in a container or sealed pit and transported to the nearest wastewater treatment plant. Certain control system shall be in place to ensure collection and transportation of the wastewater in an environmental safe manner.
- Domestic wastewater generated by workers during operation phase will be treated in an activated sludge treatment plant which will be constructed in Eshidiya site. The treated wastewater will be used to irrigate the green belt which will be planted around the Eshidiya site. The excess sludge produced shall be disposed of according to the local standards.
- For Aqaba site, the company shall establish a treatment unit or a sealed pit to handle the domestic wastewater generated during construction and operation phase in order to ensure zero discharge. Approval from local authority (ASEZA) is necessary.
- The quantity of produced by-product (fluosilicic acid) shall be registered and the amount send to JPMC shall be also registered. If there is any surplus amount, the related authorities such as Ministry of Environment shall be informed.

Additional Required Mitigation Measures for Other Issues

Safety measures are the most important factors that shall be implemented so as to reduce the probability of accidents impact on public and the surrounding environment. These measures include, but not limited to, the following:

- During all phases of the project, environmental, occupational health and safety, operation and monitoring plans shall be established according to the applicable standards and regulations to protect workers, public health and environment.
- An emergency response plan shall be prepared for all emergency cases, such as earthquakes, leak from phosphoric acid storage tanks in Aqaba

or from the pipeline connecting the storage tanks with the jetty. The pipeline shall be protected against collisions.

- The storage tanks in Aqaba and Eshidiya shall be constructed according to the international codes and standards and in coordination with the civil defense to apply its regulations.
- The vehicles drivers shall have good skills in driving transport trucks and well trained to handle with any oil or chemical spillage. There shall be limits for trip duration to avoid drivers' overtiredness. Also, the vehicles shall be frequently maintained to avoid any spillage of such materials. The transport vehicles shall be placarded.
- Wind breakers shall be constructed around the site to reduce dust dispersion especially from the storage areas of sulphur and phosphate.
- The potential of reuse of gypsum (e.g. in cement industry, leveling the roads) and the rehabilitation of the mining sites in Eshidiya shall be explored by the company during the operation phase and revised frequently with the related institutions.
- Before and during decommissioning phase of any site, prior coordination with relevant authorities shall be established to define site rehabilitation requirements according to the applicable established codes, standards, and regulations at the time.
- During the decommissioning phase, strict decommissioning operation plan shall be established to include environmental and occupational health and safety procedures according to established codes, standards, and regulations that are applicable at the time of decommissioning to protect health and environment.

2.4.4 Archeology

- During the construction phase, it is essential to provide strict instructions to the contractor to pause construction work and excavations in case of discovering any antiquities or archeological items. Such discoveries should be reported to the Director of Department of Antiquities or to the nearest Public Security Center. The Department of Antiquities may in such cases recommend certain measures to protect the found items.

2.4.5 Socio-economic conditions

Following are the mitigation measure to minimize the negative impacts and to enhance the positive ones.

- Employment

- The project is expected to create temporary jobs for both skilled and non-skilled employees during construction and operation phase. So, it is highly recommended that JIFCO give a priority for local community (Al-Jafer and Ma'an area). This can be done in cooperation with the labor directorate in Ma'an governorate.
 - In order to make the local employment more successful, it is recommended that JIFCO arranges with the vocational training center in Ma'an governorate to build and upgrade the capacity of the potential local workers, having basic qualification, on the skills jobs needed by the project.
 - The company shall follow the Jordanian/ International regulations regarding child labor.
 - The employment procedure should be established according to an approved criterion (such as the qualification is one of the main criteria).
 - In case of project decommissioning, it is recommended to help terminated employees to find new jobs and to pay them fair compensation.
- Business prosperity
 - The company should get supplies, food, spare parts (if available having requisite quality and competitive price) from local stores during both construction and operation phases.
 - The company should give priority for local contractor to provide employees with suitable transportation and other services on competitive rates basis.
 - The company should contribute to social development of local communities (especially remotes ones) that are close to the project site.
- Traffic congestion and accident

To reduce the risk of accidents and traffic jams to a minimum along the roads, the following mitigation measures should be adopted:

 - Strict instructions should be issued for drivers not to overload trucks transferring materials.
 - During construction phase, transportation of material to the project site (where congested public access crossings are used) should be avoided during the Rush hours.
 - During the operation phase, strict speed limits and safety signs shall be posted along the roads and drivers shall be trained on defensive driving to reduce potential increase in accidents.

- During construction activities, warning and traffic signs shall be posted so as to prevent accidents.
 - High qualified and trained drivers should be chosen and directed to follow Jordanian traffic regulations.
 - Well maintained appropriate trucks to transport products should be used.
 - The trips of truck transporting the product should be organized to avoid the probability of traffic congestion caused by the use of large number of trucks at the same time.
- Earthquake impact
Due to the location of the storage tank in high risk seismic zone, it is obligatory to take into consideration the regulation and design codes of the Ministry of Public Works and Housing against earthquakes.
- Visual impact
In order to minimize the negative visual impact, the following mitigation measures should be followed:
 - Manage and dispose the excess soil, debris and all types of waste resulting from construction activity and decommissioning phases to a proper dump site specified by the local municipalities.
 - Plant selected trees appropriate for the area to improve the scenery of the site.
 - Reuse or recycle of the disassembled machines.
- Hazardous materials transportation
JIFCO should follow the Ministry of Transport regulations for year 2003 regarding hazardous materials transportation. Following are those regulations:
 - Truck driver should be trained to handle hazardous materials in proper way.
 - Trucks should design in such a way that no leakage or damage of hazardous materials should happen or end up in an explosion while moving.
 - A printed label on the trucks is necessary to identify the nature of hazardous material.
 - Information about the hazardous materials should be given to the truck driver.
 - It is prohibited to park the hazardous material trucks inside the residential area.

- Trucks should be equipped by all the means of security (such as having fire extinguishers) and should be regularly checked.
- Grievance mechanism
In order to minimize potential negative impact from the project activity and to maximize positive impacts, the company should establish a grievance mechanism as part of the management system to ensure that proper consultation, disclosure and community engagement is included throughout the project life continuously.

A policy or process for addressing complaints cannot be effective if no one knows about it. Company's grievance procedures should be documented, publicized and should be clear to the relevant stakeholder groups. Also, the mechanism should be simple and the people should know where to go and whom to talk to as well as to understand the process for handling this issue. As a general rule, the grievance mechanism should not be complicated to use.

Not all grievances can be handled in the same manner. Some serious problems require immediate interventions by senior managers. A simple problem could be solved by the JIFCO community liaison officer.

2.4.6 Occupational health and safety

Following are the mitigation measure to minimize the negative impacts and to enhance the positive ones.

- The company shall adopt the following points in order to have a comprehensive occupational health and safety policy:
 - Abide by the relevant laws and regulations and design.
 - Raise the sense of environmental protection and organize an environmental protecting construction.
 - Use qualified materials and dispose wastes in sorts.
 - The disposal of domestic wastewater shall be according to the related regulations.
 - Minimize noise generation to the permissible values.
 - The serious complain of environment would be nil.
 - The death accident would be nil, severe injury rate would be as low as possible.
 - Guarantee the health of the staff in case of occupational disease.
 - Prevent fire and exploding accidents.

All activities that impose unreasonable risks on workers health or safety shall be addressed and mitigated in the occupational health and safety system for either elimination or reduction the risk to an acceptable level and according to established standards and regulations.

The occupational health and safety plan that shall be prepared and available will include:

- Occupational health and safety plan objectives.
 - Standards referred to.
 - Occupational health and safety management system.
 - Management commitments (including responsibilities of company staff).
 - Resource management (including training for the employees).
 - Realization of product.
 - Measurements, analysis and improvement.
 - Control of occupational health and safety management system (including identifying the accidents and documentation procedure, prevent / mitigate the risk, emergency response plan, etc).
-
- The employees shall be provided by the company with information regarding their rights under national labor and employment law.
 - The working conditions shall comply with the national law.
 - The company shall enable means for workers to express their grievances and protect their rights regarding working conditions. The grievance mechanism shall be provided by the company for the workers. Also, the company shall not discourage workers from forming or joining workers organizations of their choosing which will not contradict the local laws and regulations.
 - An emergency response plan shall be prepared by the company to deal with fire, accidents, spillage and any other abnormal conditions. This plan shall be well implemented and reviewed by the management staff frequently. The employees shall be trained on all issues related to the emergency response plan. Also, the drivers shall be part of the plan and well trained.
 - The company should coordinate and involve the concerned authorities in planning and implementing the emergency response plan.
 - Hazard and Operability Analysis (HAZOP) will be prepared to be ready before the operation of the plant.
 - All workers shall have a medical inspection before starting to work in the project.

- The workers shall be provided with all the related issues concerning occupational health and safety.
- Control staff of the company shall visit the work areas frequently to check and be sure that all the occupational health and safety measures are applied.
- Periodic medical inspection shall be done for all workers. If the company proposes to use the existing medical clinic of JPMC, it shall be upgraded to meet the IFC requirements.
- During construction phase, the ground shall be sprayed with water, if required, in order to reduce the dust from vehicle movements and to enable the vehicles drivers to see the workers around. Also on-site trained flag people wearing high-visibility vests shall direct traffic during construction activities. Vehicles shall be outfitted with audible back-up alarms.
- During construction activities, good house-keeping practices should be implemented, such as placing loose construction materials or debris in areas away from foot paths.
- The need for manual transfer of heavy loads should be minimized by good planning of site layout. Lifting devices appropriate to the load shall be used and well maintained.
- Control zones and safety monitoring systems shall be used to warn workers of their proximity to fall hazard zones, as well as securing, marking and labeling covers for openings in floors, roofs or walking surfaces.
- During construction and operation phases, all areas where the equivalent sound level (noise) exceeds 85 dB(A), warning signs will be posted indicating hearing protection is required. Workers will be instructed directly by occupational health and safety responsible person to use the personal hearing-protection equipment. Periodic medical hearing checks should be performed on workers exposed to high noise levels.
- All employees shall have the necessary personal protecting and safety equipment such as dust masks, safety slip retardant shoes, helmet and hearing protection equipment during different phases of the project, which provides additional protection to workers exposed to workplace hazards in conjunction with other facility controls and safety systems. The personal protective equipment shall be maintained frequently and replaced by new ones after the end of its life time.
- Catering with warm and healthy diet for workers (i.e. high carbohydrates fraction and low meat fraction) shall be provided to all workers during construction phase. Cold fresh water shall be available during both construction and operation phases for all employees all the time.

- During construction activities, a medical support including first aid clinic and ambulance shall be made available.
- During operation phase, eye-wash stations and emergency showers shall be provided close to all workstations where immediate flushing with water is the recommended first-aid response.
- Toilettes shall be available to be used by the workers during the construction phase. The generated domestic wastewater shall be collected in tanks and then transported to the nearest wastewater treatment plant in a safe manner. Certain control system shall be in place to ensure transportation of wastewater to the treatment plant.
- During operation phase, the domestic wastewater from the workers will be treated properly using activated sludge technology. The treated wastewater that will be used for irrigation purposes shall comply with the Jordanian standards.
- During construction and operation phases, adequate lavatory facilities shall be available. Toilette facilities shall be provided with adequate supply of hot and cold running water, soap and hand drying devices. Water provided for lavatory facilities shall meet drinking water quality standards.
- Domestic solid waste generated by workers during construction phase shall be collected in closed bags and disposed in a safe manner in closed domestic solid waste containers. The same can be said to solid waste generated from the personnel during operation phase.
- The residence of the workers shall be constructed in a healthy way and provided with all necessary utilities and services.
- Granulated sulphur should be used and not pulverized (fine) one.
- The storage tanks shall be constructed according to the international standards including all the necessary auxiliary tools and equipments related to safety concerns such as vents and alarm systems.
- The company shall apply appropriate measures to maintain air quality within the considered regulations. Air quality control shall be measured and controlled frequently by the company or by a contractor.
- Passages to emergency exits shall be unobstructed at all times. Exits shall be clearly marked to be visible in total darkness. There shall be enough exits at least two for each work area.
- The workplace shall be designed to prevent the start of fires through the implementation of the related codes applicable to industrial settings. Specific worker training in fire prevention or suppression shall be provided.
- Workplaces shall receive natural light as much as possible and supplemented with sufficient artificial illumination. Also, emergency

light shall be activated automatically in case of failure of the artificial light source.

- Safe passageways for pedestrians shall be constructed in the complex. Access ways shall be there for all equipment and installations requiring servicing. Railings shall be installed on stairs, fixed ladders, platforms, permanent and interim floor openings and ramps. All openings shall be sealed by gates or removable chains.
- Unauthorized access to dangerous areas shall be prevented by appropriate measures and signage of hazardous areas, installations, materials, safety measures and emergency exits shall be according to international standards and well known to workers.
- All vessels and pipes containing hazardous materials shall be labeled with the content according to national and international standards, also for piping systems with the direction of flow. Also the workers shall be trained how to use the available information such as Materials Safety Data Sheets (MSDS).
- According to Jordanian regulations, asbestos containing materials shall be avoided in construction of the project.

2.4.7 Marine environment

Phosphoric acid

Response when spilled to sea

Phosphoric acid is likely to cause serious risk to the marine environment when spilled. Therefore, mitigation measures are essential in order to allow best handling, storage, loading and unloading processes of the phosphoric acid. So, all fittings shall be properly secured prior to energizing loading/unloading system. Care should be taken to avoid acid contact when disconnecting lines/hoses after unloading. The pipe from the storage yard to the jetty shall be inspected regularly.

Quantity of the acid that dissolves in water depends on salinity and temperature. When phosphoric acid comes into contact with the sea (rapidly dilute the acid concentrations and reduce heat production), the response action on the main cause (tanks, pipes, tankers) shall consider the precautions outlined below:

- a. The accident area will be approached upwind (wind direction behind) equipped with personal protective equipment. The number of responders in the risk area shall be kept to a minimum.

- b. In theory, the action of phosphoric acid could be neutralized in shallow waters and in limited quantities using soda bicarbonate. However, buffering capacity in seawater might help in neutralizing the acid. Furthermore, phosphoric acid was reported to sink into the shallow waters but did not spontaneously mix with the water.

Response actions in the event of spill into a water column

- Measure concentrations
- Regularly monitor the pH and water temperature
- Establish exclusion zones (fishing, water intakes)
- Ecological monitoring of water and sediment chemistry and benthos census

Tank container trucks

Phosphoric acid is transported in liquid form in stainless steel/rubber lined carbon steel tanks. Leak-floors shall be provided underneath vulnerable equipment to prevent contamination of the soil from acid leaks during transportation.

Response actions in case of land spill

- Isolate spill or leak area immediately for at least 25 to 50 m in all directions.
- Keep unauthorized personnel away.
- Contain large spills with dikes and transfer the material to appropriate containers for reclamation.
- Absorb remaining material or small spills with an inert material and then place in a chemical waste container.
- Neutralize washings with a base such as soda ash or lime. Flush residual spill area with large amounts of water.
- Approach release from upwind.
- Stop or control leak using special protective clothing.

Fluosilicic acid

Road transport

The number of locomotives or frequency of trips of trucks transferring fluosilicic acid (H_2SiF_6) will be 6 trucks/day (each truck hold 35 tone) through desert. Management of fluosilicic acid emergencies shall consider the following:

- Tankers shall have bottom discharge nozzles with no provision of compressed air on the tanks utilized for unloading purposes.
- Clean up personnel will need personal protection equipment and respiratory protection.
- Source of water supply and eyewash facilities may also be needed for clean up personnel.
- Bags of neutralizing agent or chemical absorbent will be required for spill.
- A manual tool such as shovel may be required to scoop up neutralized acid/lime/soda ash residue.

Sulphur

Sulphur transportation

The number of locomotives or frequency of trips of trucks transferring sulphur through desert shall be 43 trucks/day and the quantity that will be transported from JPMC to Eshidiya is 1500 ton / day. Mitigation measures that will be implemented during transportation shall include:

- Dust emissions control by the use of water sprays in the event of a dry spell during uploading and downloading of trucks.
- Prevent wind blown sulphur from entering the environment by the use of proper sheltering of material during road transport.

Accidental release

Mitigation measures that will be implemented during accidental release:

- Remove all sources of ignition.
- Evacuate and ventilate the area of spills.
- Wear self-contained breathing apparatus, rubber boots and heavy rubber gloves.
- Wear disposable coveralls and discard them after use.
- Clean up spills in a manner that does not disperse dust into the air and place in closed containers.
- Use non-sparking tools and equipments.
- Reduce dust and prevent scattering by moistening with water.

Sulphur handling at the jetty

The following operational mitigation measures shall be implemented to alleviate potential environmental impacts of sulphur handling to the marine environment:

- Safety personnel will visually monitor and maintain the sulphur conveyance from the jetty to the storage yard.

- Conveyors shall be maintained and properly protected using suitable covers against any loss of powder product.
- Lost particles and dust dispersion on jetty platform shall be collected continuously and timely scheduled.
- Good house-keeping actions shall be followed during handling of the product at both the jetty and storage yard.
- Provision of automatic shut down systems in case of accidents and malfunctions.

Other mitigation measures

- All generated debris during construction activities shall be disposed to an authorized site after getting approval from ASEZA.
- It is recommended to continue conducting the monitoring program for the marine environment that could help in defining any points of divergence.
- ASEZA is responsible to monitor construction activities to confirm they are functioning as intended.

2.4.8 Training

Trained operators are the key to safe and environmentally sound project activities. Appropriate training programs should be established and implemented for the project employees as relevant to their duties and responsibilities including all activities taken place in the project.

All project employees should undergo professional training on occupational health and safety and on managing environmental issues relevant to their duties and practices.

Procedures should be developed to monitor the effectiveness of the training programs.

3. MONITORING PROGRAM (MP)

Environmental monitoring is an important part of the ESIA study. It is used for protecting and conserving valued environmental components (VECs) and to assess the effectiveness of the mitigation measures.

JIFCO is responsible for ensuring the implementation of the monitoring program. Regulatory authorities such as the Ministry of Environment (MoEnv), Aqaba Special Economic Zone Authority (AESZA), Water Authority of Jordan and Ministry of Health have the mandate to check / inspect that the program is fully and adequately implemented.

3.1 Objectives

The main objectives of the monitoring program with respect to the project activities are as follows:

- To ensure compliance with regulatory authorities requirements.
- To assess effectiveness of the proposed mitigation measures in the ESIA.
- To assure that the objectives of EMP are met.

3.2 Monitoring Targets

To fulfill the above-mentioned objectives, the monitoring program shall cover issues related to valued environmental components as shown in the following sections.

3.3 Water Resources

Desired targets

- The quality of the drinking water shall meet the Jordanian standard for drinking water JS: 286/2001 and IFC regulations.
- The quality of treated domestic wastewater shall meet the Jordanian standard for treated domestic wastewater JS: 893/2006 and IFC regulations.
- Regulations regarding monitoring groundwater (No. 26 for 1977).

Parameters to be measured

- Drinking water: All relevant parameters shown in Table (2) shall be analyzed.

- Treated domestic wastewater: All relevant parameters shown in Table (3) shall be analyzed.
- Groundwater (well):
The following parameters should be measured:
PO₄, F, K, pH, EC, TDS, Mg, Na, SO₄, Fe, Mn.

Method of measurement

- Field instruments shall be used to test the following parameters (pH and EC). For completion of other analysis, samples should be sent to specialized water analysis laboratories or JIFCO's own laboratory.

Time frame

- Frequency: As shown in Table (2) and Table (3) for drinking water and treated domestic wastewater respectively.
- Groundwater analysis should be done at least once a year.

Table (2): Monitored parameters for drinking water

Parameters	Sample Collection and Analysis Frequency	WHO Maximum Levels (WBG/IFC Units)	Jordan Maximum Levels (Jordan Units) JS: 286/2001
pH	Daily	6.5 - 8.0	6.5-8.5
Total residual chlorine	Daily	5 mg/l	0.2-1 mg/l
Total hardness (as CaCO ₃)	Annual	500 mg/l	300-500 mg/l
Sulfate (SO ₄)	Annual	400 mg/l	200-500 mg/l
Total dissolved solids	Annual	1000 mg/l	500-1500 mg/l
Arsenic	Annual	0.01 mg/l	0.01 mg/l
Chromium (total)	Annual	0.05 mg/l	0.05 mg/l
Lead	Annual	0.01 mg/l	0.01 mg/l
Benzene	Annual	0.01 mg/l	0.01 mg/l
<i>E. Coli</i> or thermotolerant Fecal coliform bacteria Most Probable Number (MPN) or plate count (PC)	Weekly	<1 Per 100ml	MPN/100 <1.1 ml

Table (3): Monitored parameters for treated domestic wastewater

Parameters	Sample Collection and Analysis Frequency	WBG/IFC Maximum Levels (WBG/IFC Units)	Jordan Maximum Levels (Jordan Units) JS: 893/2006 (for irrigation purposes)
pH	Daily	6-9	6-9
Biochemical oxygen demand (BOD ₅)	Weekly	30 mg/l	300 mg/l
Chemical oxygen demand (COD)	Weekly	125 mg/l	500 mg/l
Oil and grease	Weekly	10 mg/l	8 mg/l
Total suspended solids (TSS)	Weekly	30 mg/l	300 mg/l
Total dissolved solids (TDS)		1000 mg/l	1500 mg/l
Cadmium	Monthly	0.1 mg/l	0.01 mg/l
Fluoride	Monthly	20 mg/l	2 mg/l
Phosphorus	Monthly	5 mg/l	30 (as PO ₄) mg/l
Nitrogen (total)	Monthly	15 mg/l	100 mg/l
Total coliform bacteria, Most Probable Number (MPN) or plate count (PC)	Monthly	Per ≤400 100ml	- -
Temperature increase	Monthly	3°C	
NO ₃	Weekly		70 mg/l

3.4 Public Health

3.4.1 Air pollution

Desired target

- Air emissions shall not exceed the limits given in the Jordanian Standards (JS: 1189/2006) and IFC regulations for stack emissions.
- The ambient concentration shall not exceed the Jordanian Ambient Air Quality Standards (JS: 1140/2006) and IFC regulations.

Parameters to be measured

- All relevant gaseous pollutants and particulate emissions from the stacks shall be monitored as shown in Table (4).
- All relevant gaseous pollutants and particulate matter concentrations in the ambient air shall be monitored as shown in Table (5).

Method of measurement

- Online and intermittent stack emission sampling will be conducted to demonstrate compliance with the national standards and IFC regulations.
- Isokinetic dust sampling will be used to measure particulate concentration in stacks to demonstrate compliance with the national standards and IFC regulations.
- Gravimetric by using high volume sampler will be used to measure inhalable particulate matter (PM10 and PM2.5) concentrations in ambient air.
- The ambient air monitoring will be conducted down wind of JIFCO (south to southeast of JIFCO)

Time frame

Stack (intermittent measurement)

- Measurement period: short time measurement during 1 day.
- Frequency: As shown in Table (4).

Ambient

- Measurement period: during 1 week (24 hrs continuous)
- Frequency: As shown in Table (4).

Table (4): Monitored parameters for stack emission

Parameters	Collection Frequency	WBG/IFC Maximum Levels (WBG/IFC Units)		Jordan Maximum Levels (Jordan Units) JS: 1189/2006	
PM	Quarterly	50	mg/Nm ³	50	mg/Nm ³
Nitrogen oxides (as NO ₂)	Quarterly	200	mg/Nm ³	200* 1500**	mg/Nm ³
Sulfur dioxide (SO ₂)	Quarterly	2,000	mg/Nm ³	6500	mg/Nm ³
For sulfuric acid plant, SO ₂	Quarterly	450 2	ppm kg/t acid	1500	mg/Nm ³
For sulfuric acid plant, SO ₃	Quarterly	60 0.075	mg/Nm ³ kg/t acid	150	mg/Nm ³
Fluorides (gaseous) as HF	Quarterly	5	mg/Nm ³	15	mg/Nm ³
F ₂	Quarterly	-	-	5	mg/Nm ³

* : If the combustion temperature is less than 1200 °C.

** : If the combustion temperature is more than 1200 °C.

Table (5): Monitored parameters for ambient air emission

Parameters	Collection Frequency	WBG/IFC Maximum Levels (WBG/IFC Units)	Jordan Maximum Levels (Jordan Units) JS: 1140/2006
Particulate matter (PM10) 1-year 24-hour	Quarterly	70 150 $\mu\text{g}/\text{Nm}^3$	70 120 $\mu\text{g}/\text{Nm}^3$
Particulate matter (PM2.5) 1-year 24-hour	Quarterly	35 75 $\mu\text{g}/\text{Nm}^3$	15 65 $\mu\text{g}/\text{Nm}^3$
Nitrogen dioxide 1-year 1-hour	Quarterly	40 200 $\mu\text{g}/\text{Nm}^3$	0.05 ppm 0.21 ppm
Sulfur dioxide 24-hour 10-minute	Quarterly	125 500 $\mu\text{g}/\text{Nm}^3$	0.14 ppm -
Ozone 8-hour daily maximum	Quarterly	160 $\mu\text{g}/\text{Nm}^3$	ppm 0.08
Hydrogen sulfide 24-hour health effect 30-min sensory effect	Quarterly	150 $\mu\text{g}/\text{Nm}^3$ 7 $\mu\text{g}/\text{Nm}^3$	0.01 ppm -
Fluorides	Quarterly	1 $\mu\text{g}/\text{Nm}^3$	-
P ₂ O ₅			
24 hours	Quarterly	- -	100 $\mu\text{g}/\text{Nm}^3$
yearly		- -	40 $\mu\text{g}/\text{Nm}^3$

3.4.2 Noise

Desired target

- Noise levels shall not exceed the values given in the Jordanian Noise Regulations for 2003 and IFC regulations.

Method of measurement

- Sound level meter will be used during day and night time periods at the measured site that was selected for background noise levels measurements (labor camp). Also, noise measurement shall be conducted at the borders of JIFCO.

Parameter to be measured

- Noise: Day and night equivalent sound pressure level (LAeq).

Time frame

- Measurement period: 24 hours for labor camp and short term measurements at the borders of the project site during day time.
- Frequency: Quarterly.

3.5 Occupational Health***Desired target***

- Workplace air quality parameters shall not exceed the values given in the Jordanian Regulations (Regulation 943/1998) and IFC regulations.

Parameter to be measured

- SO₂, HF, PM, Temp., Noise

Method of measurement

- Electrochemical cells will be used for short term measurements of SO₂, HF.
- Light scattering or gravimetric will be used for short term measurement of PM.
- Sound level meter will be used for measurement of noise in working areas.

Time frame

- Measurement period: 24 hours (short term measurements).
- Frequency: Quarterly.

Table (6): Monitored parameters for workplace

Workplace Monitoring Parameter	Sample Collection and Analysis Frequency	WBG/IFC Maximum Threshold Limit Value (TLV-TWA)¹	Jordan Regulatory Limits and Units Regulation 943/1998
Workplace Respirable Air Concentrations			
SO _x (SO ₂)		13 mg/m ³	5.2 mg/m ³ (2ppm)
HF*			2.6 mg/N m ³ (3 ppm)
Workplace Noise	Quarterly	80 dB(A)	85 dB(A)
Heat Exposure, continuous work	Quarterly		
Moderate work load (walking, standing, use of hand tools)		27.5 °C	

The above monitoring programs and time frames should be subject to revisions and updates as necessary depending on the monitoring results.

3.6 Follow Up Procedure

In addition to the above procedures, follow up procedures shall be in place to ensure implementation of all mitigation measures stated in this document.

¹ TLV-TWA (Threshold Limit Value-Time Weighted Average): The time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek, to which nearly all workers may be exposed, day after day, without adverse effect.