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Al-EKEDER
INDUSTRIAL WASTEWATER MANAGEMENT ASSESSMENT

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Draft Final Report

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I. EXECUTIVE SUMMARY

The task undertaken was to evaluate the disposal of industrial wastewater (IWW) at the Al Ekeder landfill in Irbid, identify/propose most viable, sustainable management practices for disposal of the liquid waste, and outline a plan for site decontamination. The task imparts lessons learned that makes full use of environmentally advantageous technologies. This is to say technologies that utilize resources as efficiently as possible and minimize environmental harm while increasing industrial productivity and improving quality of life. The report provides a broad coverage of tools and recommendations that can help concerned parties to make environmentally responsible decisions. As such the report serves as an implementation reference for the Ministry of Environment (MOE) staff to complement existing programs, informs others (e.g., at Ministry of Municipal Affairs) about actions they can take to address waste management issues in their jurisdictions, and cleanup of contaminated sites**.**

Field visits, review of documentation, meetings, and discussions took place with stakeholders during the course of this project and report development. All information sources point to the need for an environmentally responsible decision to streamline the practices for management of industrial wastewaters, to ensure protection of the Jordanian environment and conservation of the quality of its groundwater resources.

The report offers a largely broad-brush, qualitative assessment of the IWW treatment alternatives based on field observations and documentation of findings. It identifies a set of options for proper treatment of the IWW, and recommends a central IWW treatment system at the point of generation to eliminate to the extent feasible trucking liquid waste, while banning its disposal in land units at Al Ekeder (and any such facility). The report further advocates adoption of a set of universal waste management principles including the 'polluters pay' principle and polluters' liability for the cleaning up of environmental contamination. The report concludes with an outline of basic corrective actions necessary for site restoration (cleanup of contamination). The corrective actions plan is a cleanup plan designed to ensure the *remediation (decontamination)* of the hot spots. Appendices to the report provide supplementary information and data.

This qualitative assessment provides opportunities for subsequent actions including a feasibility study to scope out the cost effectiveness and feasibility of various treatment options. Successful implementation of an IWW management alternative is a function of selecting appropriate treatment processes, design/operation parameters, construction, and overall management to meet and comply with the applicable regulatory environmental standards and other requirements.

It should be noted while this effort focuses on the IWW, the *solid waste management* issues are being separately addressed in a gap analysis investigation conducted by Dr. Hani Abu Qdais of Jordan University for Science and Technology.

II. INTRODUCTION

The Al Ekeder landfill (LF) owned and operated by the Services Council, is located in Northern Jordan, at 27 km East of Irbid in Mafraq Governorate, and at 1 km from the international border with Syria as shown in figure 1. It is the only "dump" site for northern Jordan, serving 62 towns and villages, and is considered the second largest LF in Jordan. In addition to the municipal solid waste and seasonal wastes from olive mill operations, the LF receives large volumes of liquid wastewaters "AKA blue water" from textile enterprises. All waste streams are disposed in specially constructed unlined ponds as shown in figures 2, 3, and 4, below[1]. The closest community to the LF is Al Ekeder Village at about 2 km southwest of the site.

Managing liquid waste in land management units, such as surface impoundments, is unacceptable waste management or disposal practice as it poses imminent and substantial endangerment to the surrounding communities' health, the site work force and the environment. Such practice was banned in many countries including US since the early 1980s because it was found to cause significant environmental damage as well as present hazards to public health.

Of major concern at Al Ekeder, is the potential contamination of groundwater extracted by private wells for unknown use(s) and located within the vicinity of the LF. The Royal Scientific Society (RSS)[2] tested and found some wells to contain elevated levels of turbidity, total dissolved solids, hardness, arsenic and total microbial contaminants, with some in excess of maximum allowable limits of national standards JS 286/2001. Table 1 below shows RSS' results of sampling and analysis during 2004-2005, two periods in 2006 vs. the 1998-99 water quality analysis by the University of Science and Technology. For the tested parameters, there is general increase with the highest reported for Arsenic.

Of significant concern are the dikes established at the surface impoundment (ponds). They are in a critical condition of disrepair, and could potentially breach causing a repeat of the year 2000 incident where the wastewater topped over, flooding Syrian lands and farms. The risk of a dike failure occurrence is greater with the Al Ekeder multiple impoundments due to more dike length, which contributes to greater environmental damage(s). All these concerns point to the urgent need for response to serious health and environmental problems (ticking bomb) at Al-Ekeder. The situation may be reaching criticality, and requires that concerted effort of all concerned parties to agree on an accelerated solution.

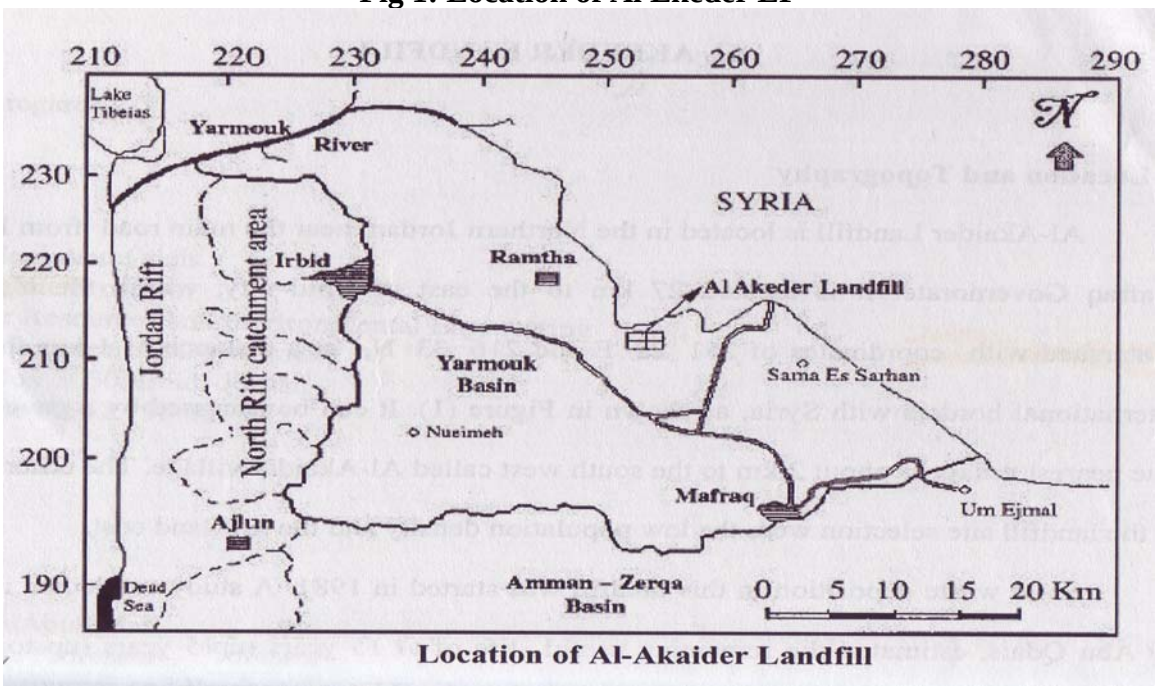
Definition of the Problem

Since 1999, the LF has continued to receive large volumes of uncharacterized blue wastewaters produced by the apparel enterprises at Al Hassan Industrial Estate and other facilities in, and out of Irbid. The blue water however is the largest stream of wastewater.

[1] April 2006, background summary documentation by Dr. Hani Abu Qdais, JUST
[2] RSS April 2006 Analysis report

It results from wet processing of finished cloth before fabricating into a variety of apparel by cutting and sewing. An estimated 1200 m^3/day of uncharacterized and commingled IWW are discharged from trucks at A-Ekeder surface impoundments. The truck drivers are allowed to discharge their loads directly into the head pond as shown in Figure 4. Many areas of the site soils are tainted with the blue color as a result of spills and leaks during discharge/delivery of the IWW. Soil contaminants must be characterized and cleanup alternatives examined to fashion the most cost effective alternative to decontaminating the soil hot spots.

Fig 1: Location of Al Ekeder LF



Appendix 1 describes the site geology and hydrology including a schematic presentation of the disposal units, and outlines the field visit findings/observations. A few of the 1998-99 METAP study field investigations, however, are of general interest to note here, and were reported as follows:

(i) The Rijam Formation (B4), representing the Shallow Aquifer System in the western or northwester part of the disposal site, shows the direction of the major joints coincides with that present in the Muwaqqar Formation[3]. This coincidence of the joints directions of both Rijam and Muwaqqar Formations help in the formation of the drainage system (both surface and underground) occurring in the study area, as most of the major Wadi directions are similar to the joints direction in both formations.

[3] § 2.1.5, p.2-6 & 2-7 and §

(ii) Monitoring wells may be needed downstream of the disposal site in the wadis draining the study area. The main purpose of these wells would be to indicate any lateral/vertical movements of the wastewater from the ponds and to define the water quality, which may accumulate in the uppermost part of the alluvial sediments in the wadi courses. With respect to monitoring changes in water quality upstream, the study recommended a new monitoring well be drilled

(iii) The permeability of the natural ground ranges from $5x10^{-5}$m/s for the first two meters depts., decreasing successively to about $5x10^{-7}$m/s at a depth of 14m. Further indicating that the foundation quality is not completely satisfactory for a landfill and a base sealing system is recommended.

Table 1: Analyses of GW samples taken from private wells in vicinity of the LF
Note: Numbers represent average of 4 quarterly readings for all years, and only 2 reading in Feb & April 2006

Parameters	Dec1998-Feb1999			2004-2005			2006			JS 286/2001 for drinking water
	1	2	3	1	2	3	1	2	3	
Turbidity NTU	-	-	-	4.02	0.75	-	0.40 0.45	3.20 2.10	2.9 4.9	≤1
Hardness ($CaCO_3$) mg/l	0	0	0	311	272	-	322 315	319 337	426 395	<300
Arsenic mg/l	<0.005	<0.005	<0.005	0.006	0.006	-	2.4 5	8.1 2	0.33 <0.1	<0.01
E. Coli MPN/100ml	0	0	0	<1.8	1.8	<1.8	<1.8 <1.8	2.0 2	<1.8 7.8	<1.1
Total bacteria count TCC MPN/100ml	0	0	0	<2	13	<1.8	<1.8 2	<1.8 4.5	<1.8 17	<1
Total Dissolved Solids mg/l	532	539	648	496	505	629	528 489	502 502	656 643	<500

1: Al Ghazawi **Upstream/Gradient** (AD1307) Total depth 523 m
2: Abu Kishek Downstream/Gradient (AD 1324) Total depth 730m
3: Al Tabaa Downstream/Gradient (AD 1170) Total depth 412 m
4. The three wells are all within the same A7/B2 aquifer zone

Much of what is the METAP study recorded/observed points to the potential of contaminants from the LF migrating to the ground water at some level in undetermined quantities. The leachate forms from the millions of gallons of liquid industrial wastes disposed over the years at Al Ekeder, is not controlled and may contaminated the soil, surface water as well as the ground water.

Figure 2: One of a series of waste lagoons showing what is known as blue wastewater in the ponds.

Figure 3: One of the lagoons where sludge is accumulated and left unmanaged in the foreground.

Figure 4:Tanker truck discharging waste to the distributor head

[These 3 pictures are courtesy of Dr. Hani Abu Qdais at JUST]

III. WASTE MANAGEMENT PRINCIPLES OF REVELENCE

Sustainable governance of environmental management is aided by the incorporation into the regulatory schemes some key principles to support the decision-making process. These principles appear in many sources and contexts, both international and domestic (e.g. US and EU regulatory schemes). Of particular relevance are four international principles established at the 1992 United Nations Conference on Environment and Development (UNCED)[4]. In discussing these principles, this report identifies their functional relevance to waste management practices. These principles can, and should be used to guide the development of sectoral environmental standards and policies.

1. Polluter pays principle
2. Precautionary principle
3. Intergenerational equity principle
4. User pays principle (or resource pricing principle)

- ✓ "**Polluters Pay principle**" - is one of the most important and commonly encountered concepts of international and domestic environmental laws. It requires that the **polluters** have to bear the cost of complying with environmental standards, which are predetermined by public authorities. If the polluters have to pay the cost of any pollution they cause, market forces will then encourage them to change their activities either by introducing new pollution control technologies or by switching to more efficient production process. The goal should be to identify the responsible parties and ensure that they pay these costs.

- ✓ The **Precautionary Principle** - also referred to at the "precautionary approach" – means that where there are threats of serious or irreversible damage to environment, as potentially the case at Al-Ekeder, lack of scientific certainty should not be used for postponing cost effective measures to prevent, or mitigate, further environmental degradation. Effectively, this principle is seeking present assurance to address or ease environmental stress before conclusive evidence of damage exists and adopts policy when raw evidence is available. In essence, corrective actions must be implemented without further delay.

- ✓ The **Intergenerational Equity Principle** (also known as users pay principle and complements polluter pay principle) is the primary element of sustainability and states that the beneficiaries should pay for the full cost of using the resources and its related service; the full cost included the cost of losses for future generations. Both the polluter pays principle and the users pay principle considered as equitable and both offer the prospect of achieving efficiency.

- ✓ The **Integrated Principle** is the central principle in the definition of sustainable development. The concept of sustainability means that *development efforts* including those aimed at protecting health and the environment should be

[4] UN General Assembly, Rio Declaration on Environment and Development, Agenda 21: Earth Action Plan (1992).

undertaken in a manner that "meets the needs of the present without compromising the ability of future generations to meet their own needs.[5]" This principle makes it clear that policies and activities in various spheres, including environmental protection, must be *integrated* in order to achieve sustainable development. That is to say, integration efforts should encompass economic, environmental and social objectives, as the three elements are interdependent and underlie sustainable development.

In this context, these principles c/should be phased in to influence and help introduce a new paradigm for environmental management, in general. Complementing these principles are some enabling policies fundamental to achieving a cohesive framework for addressing waste management and cleanup issues at large, and at Al-Ekeder, in particular. Such policies are designed to promote the following.

1) **Responsibility** - Waste generators are "**Responsible Parties**" for the cleanup of contamination **on-, and off-site** caused by improper management and poor handling of wastes generated at their facilities. Generators including facilities' owners, operators and investors, who dispose their waste at Al-Ekeder, should be held responsible and accountable for the cleanup costs, with potential punitive damages from public health exposures and environmental hazards or degradation.

2) **Liability** – In its most basic form, generators – joint and several – could forever or within statutory limits be held liable if found to be Responsible Parties (during and after termination of operation) for the waste created at their facility, regardless whether the waste was mishandled or improperly disposed by a third party and without their knowledge or control. See appendix 5 for standard definition of joint and several liabilities.

3) **Stakeholders Involvement** - All parties (stakeholders) who are or will be affected by decisions should be identified and involved early in the process of selecting and evaluating proposed corrective actions strategy and voluntary agree to implementation timeline. Adequate consultation increases the likelihood that regulatory policies will be successfully designed, implemented, and enforced. (Stakeholders analysis)

4) **Coordination across and between Governments** – At the national level, coordination among ministries and involvement of key constituents, including governorates and municipalities, industry and civic groups or non-governmental organizations, is critical to minimize gaps, conflicting polices and unnecessary overlaps. Furthermore, environmental priorities and concerns must be incorporated into Jordan's National Agenda goals, in coordination with the concerned ministries and governorates or departments.

The sustainability of chosen strategy at Al-Ekeder should be supported by sound regulatory framework inclusive of environmental standards, policies/ directive and

[5] Our Common Future: The World Commission on Environment and Development (The Bruntland Report)

technical guidance, enhanced by comprehensive compliance monitoring and consistent enforcement measures, and aided by deterrent penalties.

IV. LIQUID WASTE MANAGEMENT OPTIONS

While there are many controls and treatment methods available, the near and long term improvements of IWW treatment at Al-Ekeder, needs to be rooted in the selection of the most feasible, cost effective, socially acceptable and environmentally protective solution. Selection of any waste treatment system should assure delivery of the technology-based effluent limits. The proposed solution recommended herein, is determined by the comparison of three feasible waste treatment/management options described as follows.

- **Option 1** – This calls for the construction of a Regional IWW facility, centrally located in Jordan's northern region, which could sufficiently and effectively serve industries in and within reasonable transportation range to Al Hassan and other QIZs. Such facility could be owned and operated by an organized consortium of public and private partnership. The capital investment and buy into a regional system may present insurmountable jurisdictional and financial problems. Transportation of IWW, also, remains a major draw back to this option and the continued potential for road accidents and spillage of waste on land increases the risks of environmental contamination and injury to the public. Not to mention the added the costs of transportation and liability concerns make this option least preferred and potentially more costly than other feasible options.

- **Option 2** –

  2a) This option requires construction and operation of a centralized[6] treatment system at Al Hassan, dedicated to receiving and treating all the IWW generated on site and producing effluents meeting regulatory standards or limitation, acceptable for reuse and/or recycle within the Estate. Implementation of this option would confine the waste generation, treatment and management responsibilities to the Estate. It would also confine any potential spills or accidents to Al Hassan.

  Option 2, provides improved management controls over the waste including use and recycle of treated effluents within Al Hassan. It eliminates waste transported out of the Industrial Estate, while minimizing the distance for waste transported to Al Hassan, from Cyber City and Ad Dulayl QIZs. Minimizing waste transport also minimizes the potential hazards associated with road accidents and/or illegal dumping. Among other advantages, this option provides opportunities for significant cost savings to participating industries resulting from elimination of cost of transportation and opportunities for recycling treated effluent in the industrial process. Implementation of this option, however, would require solid

[6] A system consisting of collection sewers and single treatment plant used to collect and treat wastewater from an entire service area.

financial commitments from all stakeholders including current and future industries.

2b) Alternately, each industrial facility at Al Hassan and other QIZs could assume responsibilities for the pretreatment their wastewater streams to prescribed treatment limits, which would permit the discharge of their effluents to domestic wastewater treatment systems at Al Hassan. The goal of IWW pretreatment is to protect municipal wastewater treatment plant from damage that may occur when hazardous, toxic, or other wastes are discharged into the sewer system, and to protect the quality of sludge generated by the plant.

While this is a viable option, its cost effectiveness and sustainability may be called into question with regard to each facility's technical capability to construct, sustainably operate and maintain an individualized pre-treatment unit to consistently meet pre-treatment limits. Like option 2a, this option does not completely eliminate the need for transportation. It may further increase the potential for spills and other hazards to go undetected.

Either option 2a or 2b, present the most practical alternatives to managing the IWW disposal at Al-Ekeder. The cost effectiveness of either may have to be determined by a value engineering assessment which beyond the scope of this effort.

- **Option 3 -** Construction of a plant at Al-Ekeder for treatment of transported IWW, is least cost effective and continues to present environmental and public health hazards associated with waste transportation. Furthermore, the site should be limited to landfilling of municipal solid waste, composting organic food waste, and gas recovery operations.

Proposed/Preferred IWW Management Option:

In light of the above brief discussion of alternatives, Option 2 a, the construction of a centralized plant for Al Hassan is proposed as the most feasible alternative for providing sound treatment and management of the IWW. A schematic presentation of an effluent treatment system is shown in Appendix 2, including a listing of treatment processes.

The construction, operation and maintenance of such facility could be achieved through a joint public-private partnership, if not entirely funded by the QIZ enterprises' owners, operators and investors. The treatment works could be designed and constructed cost effectively and managed efficiently to handle existing and future expansions or increases in industrial discharges at QIZs. It should have the flexibility to operate on batch process or continuous basis as the demand fluctuates. Furthermore, the chosen treatment should produce treated effluent fit for reuse and recycle in the production processes.

- By invoking the "Polluters Pay Principle," financing of the construction of a treatment facility should be handled through private financing; with operation and maintenance costs covered by realistic users' fees, representative of the supply

- Managing current and future industries and enterprises' capacity needs;
- Facilitating regulatory controls with respect to monitoring the treated effluents quality and compliance with prescribed environmental standards, and tracking waste management and housekeeping practices, in addition to inspecting the treatment plant operation and maintenance on regular basis; and
- Enhancing pollution prevention opportunities and measures by providing for reuse and/or recycle, in-process and/or product changes.

Potential disadvantages of such a system include:

- Upfront significant capital investment and conceivably high O & M costs;
- May require the acquisition of additional land area;
- Enterprises' owners/investors' reluctance to buy in, without some public funding , economic incentives, or regulatory concessions;
- Industries outside Al Hassan may have limited access to the treatment facility's services while continue to transport their wastewaters to the central facility; and
- Risks of transportation remains of concern to public health and the environment.

The approach to implementing the preferred option would require targeted measures and specific considerations as follows. The extent of application of each measure would determine the level of success in achieving the stated goal.

- Disposal of hazardous waste in surface impoundments at Al-Ekeder should be phased out as soon as feasible. However, a new pond could be placed in service to be designed, constructed in accordance with the technical standard specific for management of hazardous waste in surface impoundment, and operated on interim basis until a suitable treatment system is available for handling the industrial wastewaters. See Appendix 3 for complete description of surface impoundment requirements.

- The operation and maintenance of an IWW treatment system(s) at Al Hassan must be permitted (i.e., memorialized in a legally sanctioned document singed by all parties), and be valid for a specific duration (e.g. 3 years) and subject to renewal thereafter. Such document constitutes the Operating Permit by which a facility is allowed to operate consistently with the permit's parameters and conditions. A model US permit application is shown in Appendix 7. In general, the permit details the operating and maintenance parameters including:

    - Industry-specific technology-based environmental standards or limits for each pollutants;

- Prescribed pollutants monitoring requirements (e.g., location, frequency and documentation of readings),
- Procedures or guidelines for sampling and analyzing effluent constituents;
- Reporting the quantitative analytical data identifying the types of pollutants presenting the facility's effluent and other conditions as may be required by the concerned authority (ies), such as penalties for noncompliance or violation of terms of the permit; and
- Other terms related to good housekeeping, workers' health and safety and environmental management.

- The treatment facility should have the flexibility to operate on batch process or continuous basis as the demand fluctuates.

- Proper operation and maintenance of a treatment system requires a qualified personnel to operate the system, use of correct treatment chemicals in appropriate quantities, and operation of the system within the stated design parameters. Therefore, it's strongly recommended that such treatment facility be operated and managed by an independent enterprise with necessary credentials and proven record in the field. Such enterprise should appropriately be bonded, licensed, and accredited with sufficient liability insurance coverage. In the absence of such expertise in Jordan, the task could be outsourced to qualified international (non-Jordanian) candidate(s), as may be needed.

Additional Considerations: The following are additional measure that should enter into the decision making process for general planning and streamlining Al-Ekeder waste management practices.

A. Limiting the landfill site operations to daytime hours – not to exceed 12 hours. This is necessary to avoid human and equipment fatigue and to allow for proper site maintenance.

B. Disposal of liquids – absent the interim availability of an operational IWW treatment facility, and under certain conditions, liquid waste (slurry, sludge, etc.) could be allowed in the landfill ONLY if it has been mixed with a non-biodegradable sorbent (solidification and stabilization) so that free-standing liquid is no longer observed (and preferably containerized). Containerized/solidified waste could be stored onsite until additional treatment/disposal capacity is available. Or disposed of at a properly designed, constructed and operating LF, lined, and fitted with leachate management system such as Al Sewaga hazardous waste LF.

C. Institutionalizing an inspection program, including training and certifying a team of inspectors to conduct inspections of generators' facilities at Al Hassan and other facilities to monitor and take "grab samples" from different points of "influent and effluent" points. Grab samples must be

D. Institutionalizing a waste minimization program to require waste generators to characterize their waste, and implement waste reduction program at their facilities. Waste streams to be segregated at source, with emphasis on waste reduction or elimination at the generating facilities. Generators must be encouraged to recycle and reuse their waste to the extent feasible to include water reuse for agriculture, urban or in-plant applications.

E. Enforce the use of a Waste Manifest form to ensure tracking and documentation of the waste received at point of generation and handling through the transportation route until disposal. [A model form used designed by the US Environmental Protection Agency is shown in Appendix 6. Generators and Transporters must be instructed on the use of and compliance with the manifest system. Some of the pre-requisites for such system include:

   - Generators and transporters of any hazardous waste to have assigned identification numbers, and the disposed wastes are codified (each industrial stream is assigned a national number or code), and generators must characterize their wastes to identify pollutants that may end up in the effluent discharge, in-process recycle/reuse, etc.

   - Generators are instructed on method for identifying the physical and chemical parameters to be sampled and analyzed.

   - Generators are instructed on proper waste handling before shipment (packaging, labeling, marking), in accordance with prescribed official system established by the governing authority (ies).

   - Waste handling (either for treatment, disposal or storage) facilities be required to have a Contingency plan (in case of emergency)

V. CORRECTIVE ACTIONS

The disposal of IWW at Al-Ekeder resulted in spills at the discharge points and uncontrolled releases of unknown hazardous constituents into soil, and potentially ground water and air. A corrective actions process is necessary to restore (cleanup) the site, mitigate further contamination, and protect the environment. Generally, the corrective actions process is structured around elements common to cleanups and includes measures for initial site assessment, followed by a more extensive characterization of the extent of

contamination, and then scoping and evaluating cleanup alternatives, and lastly selecting and implementing the most feasible, cost-effective cleanup alternative. Implementation of some of the cleanup measures may have await the closure of the LF, while others could be applied during site operations; i.e., before LF closure.

Corrective actions must be designed and selected to provide measures most protective of human health and the environment during the operation of the LF. Outlined below are basic corrective actions recommended for the implementing authorities or site O/O, to consider. They could be implemented in any order, and not every component is necessary to determine that no further action is required (i.e.; that the corrective action process has been completed.) Some are proposed for immediate or near term (range weeks-months), mid or interim term (months-year), and long term (a year or more). They all, however, would require integrated effort, balanced collaboration and focused long-term planning and budgeting.

Near or Immediate Term

(1) Al-Ekeder site manager, Eng. Nawaf Al –Jammal, developed an action plan addressing immediate site needs (see Appendix 4).

(2) The action plan in number 1 above should incorporate reinforcement of Al-Ekeder site fence, access controls, and security watch and monitors. Post signs around the site to prohibit trespassing and clearly mark entry and exit ways, and traffic directions.

(3) MOE jointly with Ministry of Municipal Affairs need to formulate a strategy to ban the disposal of liquid waste in the landfill (land disposal units). Such strategy should also formulate a national policy or directive on proper management and best practices of industrial waste in Jordan. Such policy should be widely disseminated to the regulated community and addressing all waste generation, collection, treatment and disposal. The content and effective date of such policy must promptly be communicated to the regulated community.

(4) Retrofit the surface impoundments to meet acceptable design, operating and maintenance standards (see Appendix 3 for described engineering standards) while phasing out the disposal of hazardous wastes; and prepare a plan for closure of the disposal units.

(5) Initiate an outreach program to include the media (newspaper, radio, TV, and electronic means, etc.) for educating the general public about hazardous waste issues. This is intended to invite public participation and opinion in the decision making process

(6) Establish a hotline manned 24 hours for reporting of illegal dumping and other such illegal activities.

(7) Characterize the stockpiled sludge from the olive oil waste and examine feasible disposal alternatives. Disposal alternatives should examine use of the sludge as fuel source (if contains high BTU) and/or stabilization and disposal in the LF if contains high level of metals.

(8) Initiate a limited site assessment (SA) to supplement existing information and data on environmental conditions at the site including potential releases[7], and release pathways (e.g., air, soil, or groundwater through which contamination might possibly travel). Review historical and existing hydrogeological information of the G-water direction under the landfill relative to the Yarmouk River watershed to the north and Jordan River to the west. Refer to existing formation and data reported in the METAP study and other such documentations.

Mid or Interim Term

1. Install 'dedicated' monitoring well(s) to detect contamination in the aquifer nearest the ground surface. Well(s) should be installed in the right places to accurately represent the ground water activity under the site. The wells should be lined or cased to prevent the collapse of monitoring well boreholes. This should include taking appropriate samples for making release determinations, updating dated information and collecting new data necessary to select and implement site cleanup alternatives.

2. In the event that ground water is found to be contaminated, identify private well uses and provide alternate clean water supply or source, if deemed necessary. Initiate an expanded sampling and analysis program to define the GW contamination plume, characterize the nature & level of contaminants, and select a feasible treatment technology to restore the groundwater quality.

3. Establish air-monitoring stations strategically located to monitor air emissions from and around the site. This should be supplemented by an analysis of the potential exposure pathways and assessment of environmental hazards emanating from the site contamination.

4. Institutionalize a program for training of transporters of hazardous waste including industrial wastewater. Require transporters to be trained, licensed, insured/bonded, and certificated by a credible organization or institution.

5. Issue directive for Olive Mills to compost their olive pomace by addition of bulking agents to the waste, which could turn into organic-rich fertilizer. This organic-rich fertilizer applied to olive trees plantations, which are often planted in soil deficient in organic matter creating a suitable amendment with waste, is a desirable practice.

[7] See Appendix 5 for definition of "Release"

6. Engage a cadre of legally trained professionals and multidisciplinary technical specialists (or certified inspectors) to monitor compliance with prescribed environmental regulations, issue notice of violations, enforce administrative orders, and pursue civil or criminal proceedings when necessary.

7. Plan for full-scale site characterization to ascertain the nature and extent of contamination at the site. The investigation should be tailored to the site-specific conditions using existing information whenever possible, and should focus on the disposal units, releases, and pathways of concern. Review and validate the existing hydrogeology and geological information specifically to ascertain potential movement of LF contaminants to the Yarmouk River watershed to the north, and b) Jordan River to the west. Refer to relevant formation and data noted in the METAP study and its references.

8. Devise a plan for analyzing representative samples from industrial sources prior to accepting disposal or receipt of their IWW and other hazardous wastes.

9. If necessary, newly constructed surface impoundments could be constructed and utilized for limited treatment, storage, or disposal (separate ponds for different hazardous streams) and MUST be properly engineered.[8]

10. Newly constructed surface impoundments, if required, can be used, as a limited treatment, storage, or disposal unit (each stream into a separate pond) and MUST be properly engineered.[9]

Long Term

(1) Institutionalize segregation/minimization/recycling of waste streams at source (where it is generated).

(2) Review and validate the existing hydrogeology and geological information specifically to ascertain the relationship of the groundwater under the LF to the Yarmouk watershed to the north and Jordan River to the west. Refer to relevant formation and data noted in the METAP study and other such documentation.

(3) Establish a baseline assessment of public health risk to the community (ies) that may have been exposed to or impacted by site contamination and environmental

[8] Although surface impoundments are constructed primarily of earthen materials, they often can have components made of synthetic materials, such as liners and leak detection systems. Synthetic materials that are most often used in the construction of liners include high-density polyethylene, chlorinated polyethylene, and polyvinyl chloride. Leak detection and leachate collection systems can be constructed from a number of geosynthetic textile materials, including polyethylene, polypropylene, and polyester. Surface impoundments may be equipped with a variety of high-strength polymer plastic piping (e.g. polyvinyl chloride) to aid in removal of liquids that have accumulated in leachate collections systems, a component of the leak detection system. See Appendix 3, figure 2 for cross section of surface impoundment unit, and description of the technical standards and inspection requirements.

releases (ambient air and indoor environment, ground- or drinking water sources and any surface water used for recreational activities, and residential, agriculture, etc.)

(4) Initiate a community relation plan to reach out to the public with information about the site and QIZs operations and measures to control and mitigate any potential outbreak of disease or disaster (explosion or fire) at the site

(5) Strengthen the existing enforcement rules to ensure industrial facilities compliance with the industry-specific treatment standards for direct discharge in wadi, or pretreatment limitation for discharging to a municipal sewerage network

(6) Design, develop and administer a permitting system for wastewater generators, to include comprehensive monitoring, reporting, record keeping requirements and a scheme of pre-determined penalties for violations and noncompliance with required environmental standards. The permit should include a penalty scheme for violations and noncompliance with required environmental standards rule, and acceptable waste management practices.

(7) Develop or streamline (as may be necessary) the regulations governing the treatment standards for textile industry dischargers who could treat their waste stream for discharge directly into surface water body or recycle and reuse the treated effluent. Similarly, strengthen the pre-treatment environmental limitations, which must be designed to prevent the discharge of any pollutant into domestic treatment works which pollutant interferes with, passes through untreated, or otherwise is incompatible with such works.

(8) Issue and implement the final decision (selected option) for the wastewater treatment plan to include detailed design, construction, operation, maintenance, and monitoring of the chosen course of action.

TABLUTED CORRECTIVE ACTIONS, STAKEHOLDERS & MILESTONES

Near Term	Proposed Corrective Action(s)	By whom	when
	1. Al-Ekeder site manager developed an action plan addressing immediate site needs (see **Appendix 4**).	Al-Ekeder Owner/ Operator	W/in 4 mons
	2. Reinforcement of Al-Ekeder site fence, access controls, and security watch and monitors.	Al Ekeder O/O	W/in 3 mons
	3. Develop and disseminate national policy or directive regarding characterization and management of hazardous waste including IWW generation, collection, treatment and disposal. The directive and its effective date must promptly be communicated to the regulated community with timeline(s) for meeting required actions.	MOE in collaboration w/ M. of Municipalities (MOM)	ASAP
	4. Formulate a strategy/program for banning the disposal of liquid waste at landfill operations and penalizing violators.	MOE & MOM	ASAP
	5. Retrofit the surface impoundments (SI) to meet acceptable design, operating and maintenance standards OR construct a new SI while phasing out the disposal of hazardous wastes; and prepare a plan for closure of all liquid waste SI units. See **Appendix 3** for surface impoundments technical standards.	Local firm supervised by L/F O/O, & MOE's oversight	Within 6-mons Before winter '07
	6. Initiate an outreach program to include the media (newspaper, radio, TV, and electronic means, etc.) for educating the general public about hazardous waste issues. This is intended to invite public participation and inputs in the national/local decision-making process.	USAID may fund a workshop to MOE & MoM staff	Within 1-3 mons.
	7. Establish a hotline manned 24 hours for reporting of illegal dumping and other such illegal activities. The newly established environmental police corps may be in charge of this operation, and work in collaboration with MOE – Monitoring &Inspection Dir.	MOE in coordination w/ Environ. Police Corps	ASAP

TABLUTED CORRECTIVE ACTIONS, STAKEHOLDERS & MILESTONES

Near Term	Propose Corrective action	By whom	When
	8. Determine the BTU value of the stockpiled sludge from the oil mills waste for use as fuel source (if registers high BTU value) and/or stabilization and disposal in the L/F if contains high level of metals. For use as fuel source, cement kiln operators should be given the first consideration for the sludge utilization. Alternately, oil mill operators should be next in line to use it if they're willing to retrofit their generators to accommodate such use.	Al Ekeder O/O to advertise and nego-tiate with interested parties	ASAP - Within FY-06 or FY-07
	9. Initiate Site Assessment (SA) to compile existing information on environmental conditions at the LF including actual or potential release[10] and exposure pathways through which contamination might possibly travel. This should include taking appropriate samples for confirming release determinations, and collecting new data necessary to update information, scoping site cleanup alternatives. Selected alternative should focus on realistic remedies tailored to the nature and extent of contamination.	Donors' supervised & funded **Estimated $200,000**	Within 6 mons
	10. Explore possibility of public-private partnership for waste composting and gas recovery operations at the L/F. A combined feasibility study (FS) could address options for both operations.	USAID or USTDA may fund limited FS	Within FY-07 **Est. $50K**
Sit Assess-ment (SA)	The SA should <u>update</u> the METAP study with respect to: a) Site description & history of surrounding geography, jurisdictions, and topography; b) Physical description detailing ecologic conditions, soil types & depths, flora, fauna, terrain, surface-, & groundwater hydrology; c) Onsite conditions, e.g., pits, ponds, standing water, bldgs. wells, etc.; d) climatological conditions: regional & site-specific parameters; e) demographics and surrounding land use; f) Description of onsite wastes, disposal practices and material handling ; g) Present/prior complaints concerning L/F; h) Prior sampling & data analysis on or near the site; j)Prior accidents (explosion, fire, etc.), remedial activities at L/F; k)Documentation of workers' safety & health practices. To list a few.		

[10] See **Appendix 5** for definition of "Release"

CORRECTIVE ACTIONS ELEMENTS, STAKEHOLDERS & MILESTONES (cont.)

Mid Term	Proposed Corrective Actions	By Whom	When
	1. In the event of ground water is found to be polluted, identify impacted wells and uses, and provide alternate clean water supply or source, if deemed necessary. Construct alternate wells for water supply and GW monitoring system estimated costs in 1989 (USEPA). Ideally four wells are required, one located hydraulically upgradient of the LF, and three downgradient. Initiate an expanded sampling and analysis program to define the GW contamination plume, characterize the nature & level of contaminants, contaminant migration rate, and determine the most cost-effective, feasible cleanup treatment for restoring the GW quality.	JIEC and the polluters (industries) should bear the cost of this task **Est. $90/ft x 200ft averg, $18,000/wel first yr., and 600/well thereafter**	ASAP
	2. Establish air-monitoring stations strategically located to monitor air emissions (fugitive dust) from the site. This should activity should include an analysis of the potential exposure pathways and assessment of environmental hazards emanating from the site contamination or operation.	Site O/O in contract with JUST **Est. cost $125k/unit**	
	3. Institutionalize a program for training transporters on hazardous waste handling including industrial wastewater. Establish a licensing program for transporters, and ensure they're insured/bonded, and certificated by a credible organization or institution.	MoM in coordinatn with MOE **Est. cost $ 40K**	
	4. Institutionalize the UNDP program for management of olive mills wastes, and provide guidance on implementation to municipalities.	MOE Provided as Tech Assist.	Within 9 mons
	5. Engage (hire) a cadre of legally trained professionals and multi-disciplinary technical specialists (or certified inspectors) to inspect & monitor compliance with prescribed environmental regulations, issue notice of violations, and undertake enforcement actions. if necessary.	MOE w/ USAID for Study Tour/ seminar for new staff	Within FY-07
	6. Devise and implement a scheme for analyzing representative samples from industrial sources prior to accepting disposal or receipt of their IWW and other hazardous wastes.	MoM w/ assistant fromJUST	Within 9mons /soon
	7. Institutionalize a national program for segregation/minimization/recycling of waste stream at source (where it is generated).	MOE w/ MoM	Within 9 mons
	8. 4-6 Weeks Study tour for MOE and MoM waste management specialists	Donor's funded	

CORRECTIVE ACTIONS ELEMENTS, STAKEHOLDERS & MILESTONES (cont.)

Long-term	Proposed Corrective Actions	By Whom	When
	1. Establish a baseline assessment of public health risk to the community (ies) that may be exposed to site contaminations and environmental releases (ambient air and indoor environment, ground- or drinking water sources and any surface water used for recreational activities, and residential, agriculture, etc.)	Ministry of Health, Ministry of Water, MoM, and MOE	ASAP
	2. Initiate a community relation plan to reach out to the public with information about the site and QIZs operations and measures to prevent and mitigate any potential contamination, outbreak of disease or disaster (explosion or fire) at the LF site operations.	Council Services	ASAP
	3. Strengthen the existing enforcement rules to ensure industrial facilities compliance with the industry-specific treatment standards for direct discharge, or pretreatment limitation for facilities discharging to a municipal sewerage network.	MOE thru Amended legislation regulation or policy	ASAP
	4. Based on the waste characteristics which affect the fate and transport of contaminants, toxicology of the waste, environmental features of the site, and physical hazards, health hazards, an appropriate health and safety plan should be implemented for site workers' protection from potential risks at the LF. The health and safety hazards plan is comprised of four basic parts to worker protection: (i) site management procedures to control access and minimize exposure;(ii) engineering safeguards to contain the waste and isolate workers form hazardous areas; (iii) personal protective clothing and equipment to minimize direct contact and inhalation; and (iv) decontamination procedures and practices to remove and control the spread of contamination. Each of these facets should be addressed fully in the site contingency plan and all of the necessary equipment and personal safety gear should be available and accessible at all times at the site.	Site owner and/or operator; i.e. MoM/ Irbid Council	ASAP

VI. CONCLUSION

Given the extent of problems resulting from wastewater disposal, there is clearly a paramount need for the stakeholders (Ministries/local authorities, NGOs, and industries/QIZ) to coalesce and to develop concrete measures for improving hazardous and non-hazardous waste management practices. Disposing of liquid wastes on land should be banned at Al Ekeder and at any other disposal facility. Safe waste management and cleanup are the critical foundation to protect human health and the environment.

As authorized by the law, it is the role for MOE to set national goals for management of waste including hazardous waste, to monitor compliance with, and enforcement of the relevant national environmental standards and requirements. Empowered by the legal authorities, MOE is to provide leadership and technical assistance, and develop guidance and educational materials to aid the regulatory community in understanding and learn their environmental responsibilities. The MOE should also provide information through policy and directives to empower local authorities/governorates, business and industry, as well as individuals to make better decisions in dealing with hazardous, as well as non hazardous waste management. Participation of concerned communities should also be an integral part to the decision-making process. There is a dire need for a rational strategy to solve Jordan's waste management problems, facilitate industries' acceptance of environmental reforms, and reward good environmental performance.

To achieve all of the above there is a need for genuine efforts to: (1) Create enabling rules and administrative environment, and (2). Allocate the required financial resources and build the national capacity in the area of industrial and hazardous waste management.

APPENDIX 1: SITE BACKGROUND AND FINDINGS

Site Background

I. The Al-Ekeder Landfill (LF) site is located in Irbid, 72 kilometers north of Amman, in Mafriq Governorate, and has been operating since 1980. The facility is owned and operated by the Municipality of Rural Affairs, which is overseen by the Government of Irbid of Common Services Council. The nearest village is called Al Ekeder, lies about 2 km to the southwest.

II. The site is located within a natural wadi with an approximate gradient of 2-3% slopping from east to west and to the northwest. After leaving the site, the wadi turns towards the north, enters Syria and eventually meets the Yarmouk River. The nature of site soil is silty soil with sand, with the saturated zone of the ground water aquifer (believed to be confined) at an estimated depth of 350-450m below the ground surface. The climate is mostly dry and hot summer and cool in winter, with an average rainfall of 150-200mm.

III. The facility operates 24/7, and receives municipal solid waste (MSW) and hazardous industrial wastewater (IWW) predominantly from textile apparel enterprises[11] mainly at Al Hassan Industrial Estate, Cyber City and Ad Dulayl, and others. The WW received from textile factories (blue water), is commingled with other wastewaters from car cleaning stations, marble and flags factories. Separate seasonal effluents from olive presses and the IWW are discharged into a series of 'unlined' ponds[12] separated by earth berms, located in the southern section of the landfill. A layout[13] of the disposal units is shown in Figure 5, below. There is no evidence that sub grade preparation or installation of a liner system took place prior to the discharge of IWW.

IV. An estimated 1200 m^3/day of IWW, are delivered and disposed of at Al-Ekeder. The tankers discharge in the reception "high level" pond no.1 (AKA distributor header) from where it is directed into one of the other "lower" ponds. Table 2 below shows a snapshot of the solid and liquid wastes received at the LF. In the high level ponds and in some of the lower ponds, anaerobic conditions generally prevail with resulting methane generation. There is no treatment in place to provide effective management of IWW received.

Site Geology: The METAP EIA report, section 2.1.5 noted that there was no detailed geological information available on Al Ekeder. However, a field survey revealed the nature of the outcropped formations. It further characterized the Al Ekeder hydrogeology

[11] As reported by the landfill, 90% of the IWW is generated by the textile enterprises at the QIZs
[12] Environmental Impact Study, Draft Final Report, Northern Region Solid Waste Management Study, March 1999, for The Hashemite Kingdom of Jordan, General Corporation fro Environmental Protection, under the Mediterranean Environmental Technical Assistance Program (METAP)
[13] Power Point presentation by Eng. Nawaf Al-Jammal, Irbid, Common Services Council, April 2006

and the surrounding vicinity to be composed of the following geologic succession (from top to bottom):

- Rijam Formation (B4) – In the METAP study areas, the thickness of this formation is shown to vary from 5 to 15 meter, due to erosion. The rocks of this formation consist of limestone, chalky limestone, chalk, and brown to black chert. This formation represents the Shallow Aquifer System such as the western or north western part of the disposal site.

- Muwaqqar Formation (B3) -At Al Ekeder, the estimated thickness of this formation is about 320 meters, and is dominated by the presence of chalky limestone, thin beds of chert, phosphate, bituminous chalk and nodules of micro crystalline limestone. The direction measured for the factures and joints present in this formation were found to be 120 NW/SE and 30 NE/SW.

- Recent Deposits – These deposits occur in the form of alluvial debris and are noted to be generally of small thickness in the wadis draining the area. In most of the METAP study area, these deposits were found consolidated and covered by a thing layer of soil.

Site Hydrology: In 1998-99, the METAP study identified the first aquifer system B2/B7 to be located at a depth of more than 300 m from the ground surface and separated from the surface by an aquiclude of low vertical permeability. Due to the geological position of the Amman-Wadi Seer Formations, B2/A7 is generally represents the upper aquifer system in the study area (i.e., Al Ekeder LF).

The groundwater piezometric map of the B2/A7 aquifer was constructed from the hydraulic parameters of the drilled wells in the surroundings of Al Ekeder LF, confirmed the groundwater flow direction from east to west beneath the site. The piezometric head of the GW under the site was calculated at 400 m.s.l. or about 100 m above the B3 base. The study further notes that productive GW wells need to penetrate the B2/A7 Formation and therefore the depth of the GW wells in the area often exceeds 500m.

Site Visit Findings: A site visit was conducted on or about April 27, 2006

1. **Lack of strict site security and access at Al-Ekeder** – provide opportunities for unauthorized access and potential illegal disposal of wastes (solid/liquid). This may also contribute to inappropriate disposal of waste at or dumping at undisclosed/undetermined locations especially at night when skeleton staff may be on duty.

2. **Site location within close proximity to grazing and farm lands**, where livestock may graze or crops are cultivated. Fugitive dust from the site is likely to deposit onto the land and enter the food chains from grazing livestock and local farms and gardens. This constitutes direct and indirect exposure risks to the general public and surrounding communities in particular where fugitive

contaminated dust may contaminate the indoor environment of homes and buildings.

3. **Site operates 24/7** – the facility operates 24 hours a day, 365 days a year, which exacerbates the contamination and undermines controls over the disposal activities. Long operating hours contribute to workers fatigue (poor performance) and equipment overloading (frequent breakdown, inadequate maintenance).

4. **IWW delivered to the site lacks substantive shipment tracking information**. The system is deficient in the checks and balances necessary to assure the waste generators delivery or disposition of their waste to the final destination; and to prevent improper disposal of the hazardous materials.

5. **Absence of written safety procedures and emergency response and preparedness plan.** The facility is ill prepared to respond to emergency situation involving hazardous waste accident or spill.

6. **Absence of dedicated monitoring wells established and properly located down gradient from the disposal units at the perimeter of the site to monitor the GW quality** and to detect contamination. Unsuitable private drinking water wells located some distance from the site were sampled in 2003 and 2005 show the presence of some pollutants such as Arsenic, in detectable concentrations.

7. **Potential contamination of groundwater aquifer** resulting from the disposal of untreated IWW directly on the land, which is allowed to infiltrate (soak down through) the soil and subsoil or bedrock into the groundwater. This creates the potential to generate HW leachate that can carry hazardous contaminants into the environment posing a serious threat to ground water resources, resulting in the formation of a pollution plume of pollutants. The contaminated GW may be, or is used as a source of water for household uses, agriculture, and industry. In addition, groundwater may be discharging into Yarmouk watershed, and reaching the surface through natural pathways such as springs and rivers (Zarqa/Jordan River?).

8. **Uncharacterized IWW and sludge** from various industrial sources are disposed in unlined **Surface impoundments are not fitted with leachate** collection handling system (to detect and collect leachate for treatment or recycle). Some of the wastewater streams may contain toxic elements at levels harmful to public health and/or environment.

9. **The IWW is disposed in a series of earthen surface impoundments** used for settling/volume reduction by evaporation and infiltration – i.e., treatment by default. Otherwise there is no treatment capability for IWW management on site. Overloading earth ponds with increased volumes of IWW threatens the collapse of the earth dams.

10. **IWW streams are commingled (**i.e. no hazardous waste classification system is use or implemented) with disregard to the toxicity, reactivity, ignitability, and corrosivity of their constituents. Incompatible waste streams have the potential of causing fire/explosion and compound the adverse environmental impacts and endanger the public.

11. **Contaminated soil** (colored blue) observed on site and around the disposal areas. Spills or leaks may have occurred during discharges of IWW from the delivery trucks. Contaminants in the soil can adversely impact the health of humans when they ingest, inhale, or touch contaminated soil, or when they eat plants or animals that have they been affected by soil contamination. Contamination may end up in the GW.

12. **Accumulated sludge from seasonal wastewaters from olive oil mills** left exposed in separate earthen ponds. This waste has high level organic loading (high biological oxygen demand) and contains polyphenols, which have foul odor. The Ministry of Environment in cooperation with the UNDP is implementing an EU-funded project to introduce the elements of an integrated olive oil waste management system which is expected to introduce cleaner production options to the olive oil pressing industries in Jordan, Lebanon and Syria.

13. **Un-containerized, unlabeled IWW** is delivered to the site by tanker trucks driven by commercial drivers who are untrained and unqualified and most likely unlicensed to handle hazardous waste or hazardous materials. This situation may expose the site owner/operator to liability claims in case of drivers' and/or public injury resulting from IWW delivery truck accidents. [Many reported accident during the hauling of the wastes to the site, by inappropriate tankers and vehicles.]

14. **Residual waste –** unmanaged, accumulated sludge poses human health hazards on- and off-site, and is a source of air contamination, uncontrolled release of fugitive dust. In indoor environments (where people live or work), contaminated fugitive dust is known to cause health ailments such as asthma. Airborne contaminants are also known to travel distances across boundaries depositing in surface water bodies or on farmlands where they are uptaken by plants, crops/ grazing plants and ultimately entering the food chain.

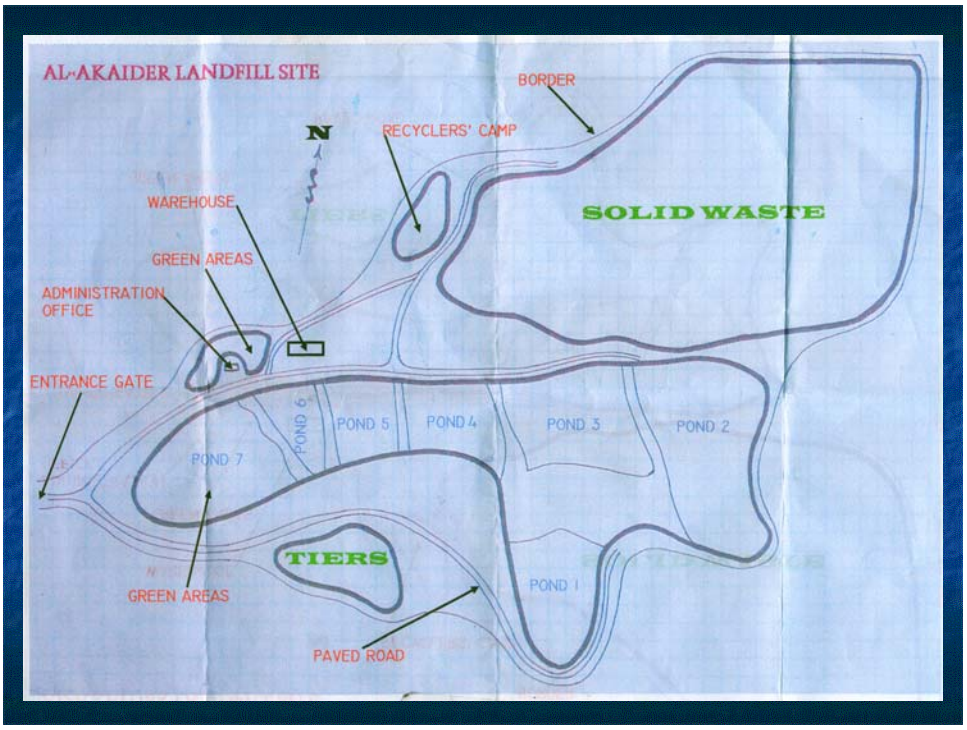


Fig 5: Al-Ekeder Landfill Layout

Table 2[14]: Snapshot of Solid Wastes and Blue Waters Disposed at the LF

Representative Solid Waste Stream Composition (approx.)			**Representative Blue Wastewater Monthly Loading (approx.)**	
Component	Kg	%		
Food Waste	980	74.9		
Gard Waste	25	1.6	Sary Company	3641 m^3
Plastics	140	7.1	Al-Joud Company	5299 m^3
Papers	60	6.3	Classic Company	9025m^3
Wood	8	1.2	Azer Company	30 m^3
Cloth	64	4.2	Ayam maleban	1966 m^3
Glass	15	0.9	Jordash Company	14595m^3
Metals	16	1.4	Al-bander Company	28m^3
Others	30	2.3	Total	34,564m^3
Total	1338	100	Average/day	1152 m^3

Other waste includes: sludge 3750m^3, 675m^3 slaughterhouse, and 3300m^3 Flags Stalactite.

[14] Presentation by Eng. Nawaf Al-Jammal, Mayor, Common Services Council, Irbid, April 2006

APPENDIX 2

WASTEWATER TREATMENT SYSTEM MODULE

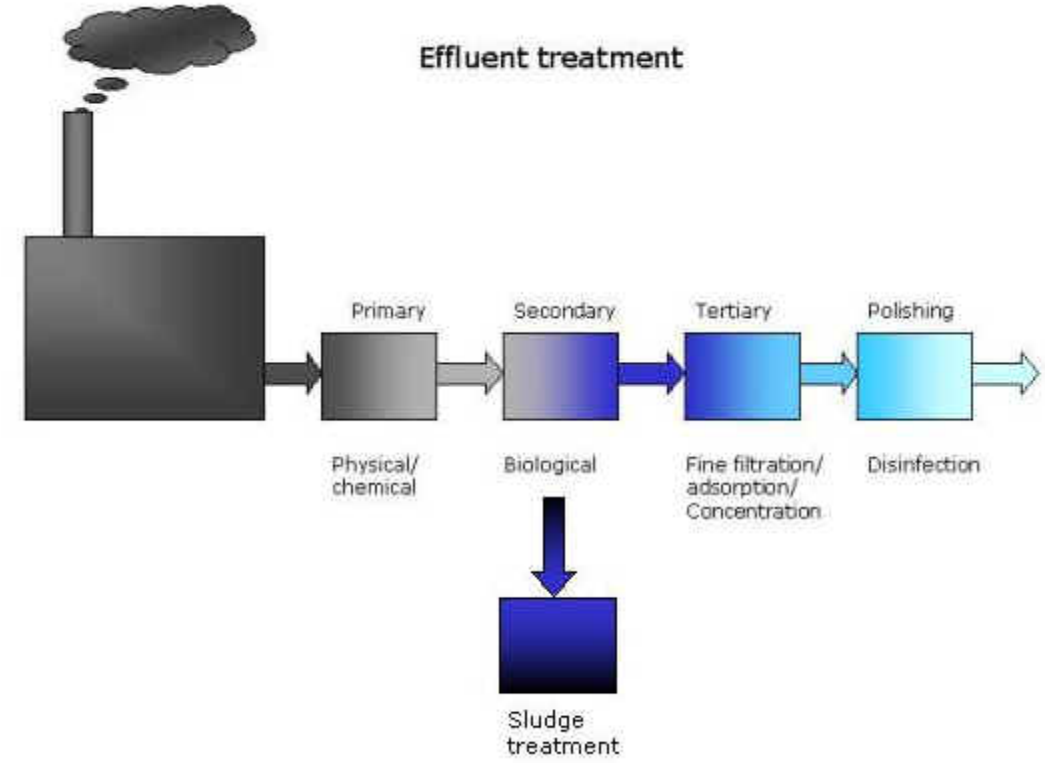


Figure 6: This is a general schematic of industrial wastewater treatment components. For each treatment component there may be a number of applicable treatment techniques that should be examined/selected based on process knowledge, treatability study or bench-sale testing of representative samples of IWW effluents.

Textile industry wastewater[15] is characterized primarily by measurement of BOD; COD; color; heavy metals; total dissolved and suspended solids. Color and turbidity both cause real hazard to the environment. The real hazards of color and solids are dye toxicity and the ability of coloring agent to interfere with transmission of light through water. Heavy metals, typically chromium and copper are very hazards to human and aquatic life at relatively low concentrations. They are introduced into the wastewater of textile operation thru the use of pre-metalized dyes and heavy metals after washes, which are used to increase the light fastness of the finished product.

There are many technologies currently available for treating wastewater from the textile industry included are 1) biological treatment, 2) chemical precipitation, 3) ultra filtration, 4) carbon adsorption, 5) oxidation with ozone, and 6) electrochemical technology.

In treating textile wastewater, the treated effluent should be of high quality to allow for in-process or in-plant reuse and recycle. Textile finishers use vast quantities of waster

[15] USEPA, 1997, Profile of the Textile Industry, EPA/310-R-97-009

often at a high price, which contributes substantially to the overall cost of production. Thus many producers would be interested in the "water reuse" capability in any treatment scheme since this would represent an attractive pay back on their investment. Water quality is crucial to all textile-dyeing operations and each process facility should have its own stringent requirements.

In general, different hazardous waste streams may be treated with one or more technologies. Several treatment technologies or processes exist for rendering hazardous waste less hazardous. Some of the most common ones are listed below.

- **Biological** treatment uses microorganisms to break down hazardous organic compounds in a waste stream and make the waste less toxic.
- **Carbon adsorption** is a chemical process that removes hazardous substances from the waste using specially treated carbon. This method is particularly effective in removing organic compounds from liquid wastes.
- **Dechlorination** removes chlorine from a substance by chemically replacing it with hydrogen or hydroxide ions, making it less toxic.
- **Incineration (or combustion)** destroys waste or makes it less hazardous through burning. Incineration is frequently used to destroy organic wastes.
- **Neutralization** decreases the acidity or alkalinity of a substance by adding to it alkaline or acidic materials, respectively.
- **Oxidation** makes a waste less toxic by combining with oxygen.
- **Precipitation** removes solids from a liquid waste so that the hazardous solid portion can be disposed of safely.
- **Solidification and stabilization** removes wastewater from a waste or change it chemically, making it less likely to be transported by water.
- **Soil washing** uses water or a washing solution in mechanical processes to scrub soils and remove hazardous contaminants.
- **Solvent extraction** separates hazardous constituents from oily wastes, oils, sludges, and sediments to reduce the volume of waste that must be disposed of.
- **Thermal treatment** makes elevated temperatures as the primary means of changing the chemical, physical, or biological character of waste. Examples include wet air oxidations and calcinations.

APPENDIX 3

SURFACE IMPOUNDMENT TECHNICAL STANDARDS[16]

A new unit must be constructed consistent with design standards to minimize the potential for leachate to leak from a surface impoundment. The following design standards (cross section configuration illustrated in Fig.7, should be followed in implementation: double liner; leachate collection and removal system; leak detection system; dikes, berms, and freeboard; and construction quality assurance.

- **Double liner system** has two components: a top liner and a composite bottom liner. The top liner usually a synthetic material that keeps the liquid waste within the unit and prevents migration of hazardous leachate and waste through the liner. **The composite liner, consisting of a synthetic liner (special kind of plastic) on top of three feet (90 cm) of compacted soil or earthen material of low permeability, of no greater than $1x10^{-5}$cm/sec, is designed to prevent any liquid that have leaked through the top liner from reaching underlying soils and ground water.**

- **Leachate collection and removal system** should be installed between the top liner and the bottom composite liner to collect any leachate that may leak through the top liner and to pump it to a collection tank. The system features a pump and drainage layer to slow the flow of the leak, and must be designed with a minimum bottom slope to help drainage, be made of materials that will not chemically react with the wastes placed in the unit, and be able to remove the liquid leachate at a specified minimum rate.

- **Leak detection system**: A lower leachate collection and removal system should be constructed to continually remove small amount of liquid that might seep through the top liner. In the event of larger leaks that can apply strong pressure on the bottom liner, potentially causing it to fail, the leak detection system is installed within the leachate collection and removal system. The detection system must also be able to detect when the flow rate into the leachate collection and removal system is above a normal operating range; hence, signaling the unit owner/operator that the top liner may be leaking.

- **Dikes, berms, and freeboard:** are walls or man-made hills surrounding the unit, designed to prevent the flow of liquids over top of an impoundment, and must be constructed and maintained to ensure minimum distance (freeboard) between the surface of the waste and the top of the surface impoundments to prevent overflow during high winds or rainstorms.

- **Surface Area:** It is one of the most important factors in impoundments used for evaporation such as the case at Al Ekeder. The rate of evaporation must ≥ rate of

[16] USEPA, 1998, Guidance for Managing Hazardous Wastes in Surface Impoundments.

precipitation plus the liquid waste inflow rate. Thus the larger the surface area, the larger the amount of waste liquid that can be accommodated.

- **Construction quality assurance** – the purpose of which is to ensure that the unit meets all the technological requirements. A construction assurance plan identifies how construction materials and their installation should be monitored and tested and how the results should be documented. This plan or program must be developed and implemented under the direction of a registered engineer who must also certify that the construction quality assurance plan has been successfully carried out and that the unit meets all specifications before any waste is placed into the unit.

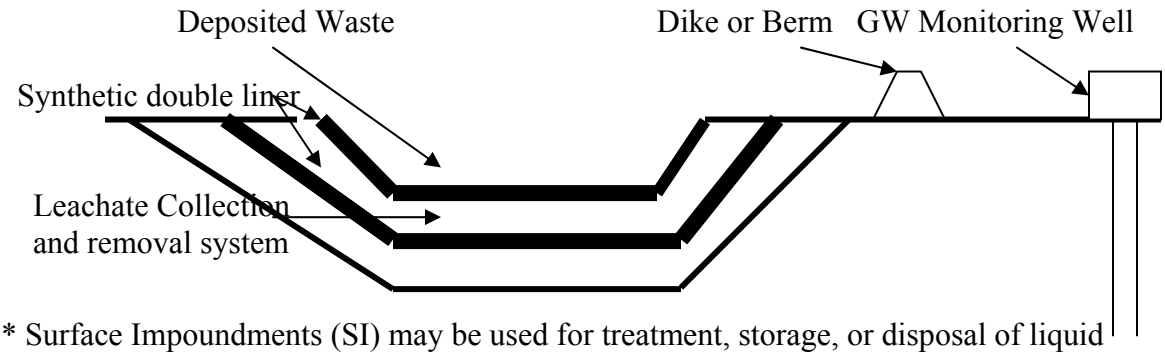
- **Impoundment shape**: The most common and most economical shape for a surface impoundment is rectangular with straight-sloped sides. Other shapes increase the cost of grading, dike construction, and liner installation.

Inspection: To ensure that the liners and leachate collection and removal system are working properly, site owners/operators of surface impoundment unit must:

- ✓ Inspect liners and dikes or berms for any problems after construction or installation, and continue inspections weekly and after storms to monitor for evidence of deterioration, sudden drops in the level of the impoundment contents, and severe erosions of dikes and other containment devices.

- ✓ Monitor leachate collection and removal system pumps at least weekly to measure the amount of liquid in the sump pump and determine whether the upper liner might be leaking. This is designed to verify both the integrity of the liner and the efficiency of the leachate pump. If the level indicates a substantial leak, the owner/operator must take the proper response action; i.e., implement the facility response action plan.

Figure 7: Cross-Section of a surface Impoundment**



** Surface Impoundments (SI) may be used for treatment, storage, or disposal of liquid hazardous wastes in ponds. At Al Ekeder, SI is used for disposal by evaporation.

Construction material requirements, and cost estimates for installation of a double-liner system for surface impoundment[17]

The type of waste disposal units or surface impoundments utilized at Al Ekeder is generically known as non-discharging (evaporation or disposal). Such units generally rely strictly on natural evaporation to maintain liquid level. A comparison of multiple impoundments versus single unit, it was found that four small impoundments would cost nearly twice as much as a single large impoundment. Also, the risk of a dike failure occurrence is greater in multiple impoundments due to more dike length, but greater environmental damage would ensue from dike failure of a single large impoundment. All things considered, it appears that a single large impoundment and multiple small impoundments, constructed to serve the same purpose, are approximately equal in environmental risk. According to the USEPA guidance, the most common and most economical shape for a surface impoundment is rectangular with straight-sloped sides, assuming units with below grade excavation and above-grade dikes. The excavated material can often be used as dike material. Below-grade surface impoundments have the environmental advantage of being less prone to catastrophic failure, since no dike is involved. Above-grade impoundments, on the other hand, could lose all their waste to the surrounding area if the dike were breached. **Table 3 below highlights an *estimated* costs comparison for surface impoundment (with Geomembrane/Composite Liner) with respect to three construction positions: above-grade, below grade, and combination**.

Operation	Above Grade	Below Grade	Combination
Geotechnical Invest.	$13,805	$13,805	$13,805
Excavation	0	40,562	20,602
Foundation Preparation	1,670	3,463	2,708
Berm Construction	41,095	0	18,556
Soil Liner	126,982	123,657	125,734
Sand Drain Layer	26,928	26,170	26,639
Geosynthetic Drain Layer	27,182	28,478	27,432
Geotextile Layer	6,313	5,869	6,175
Primary Geomembrane Liner	18,151	16,873	17,754
Geotextile Layer	6,313	5,869	6,175
Geomembrane in Composite Liner	21,825	20,452	21,397
Leak Detection: Main	421	372	408
Leak Detection: Lateral	1,234	728	1,196
Leak Detection: Riser	0	82	425
Pump	8,955	8,955	8,955
Sump	4,964	4,964	4,964
Riprap	8,186	0	3,314
Level Controller	5,000	5,000	5,000
Total	321,349	307,624	303,564

Note: All impoundments are designed to hold 9,940 m^3 of liquid waste. Construction materials assumed to be the same in all 3 cases. Actual site-specific cost of construction may be grossly different.

[17] USEPA, 1999, Technical Resource Document, EPA/530/SW-91/054

APPENDIX 4

AL-EKEDER ACTION PLAN[18]

- Remove wastewater from two ponds and remove sludge from them to provide capacity for industrial wastewater discharge during WWTP construction, estimated cost: 200,000JD.
- Maintain equipment in the landfill and install air conditioners in trucks and heavy machinery estimated cost: 100,000JD.
- Increase discharge fees to 1JD instead of 0.3JD.
- Train workers in landfill operation and maintenance.
- Provide protective and safety tools to workers and build a health unit in Alakeder village with resident physician.
- Provide incentives to workers.
- Plant trees around the landfill to keep waste and dust inside.
- Install weighbridge at the entrance of the landfill to measure weight of solid and liquid waste.
- Control waste movement between industries and the landfill using a five-page manifest to be signed at every point.
- Request industries to contract with qualified transport companies with qualified personnel to prevent illegal discharge along the route to the LF.

[18] Plan provided by Eng. Nawaf Al-Jammal, Mayor, Common Service Council for Irbid

APPENDIX 5

DEFINITIONS:

Composite Sample: Sample composed of two or more discrete samples. The aggregate sample will reflect the average water quality covering the composting or sample period.

Corrective/Remedial Actions: Remedial actions are long-term actions taken to prevent, minimize, or mitigate exposure and damage to human health or the environment. For the purposes of cost recovery, remedial action is defined as physical on site construction.

Grab Sample: A sample, which is taken from a waste stream on, a one-time basis without consideration of the flow rate of the waste stream and without consideration of time.

Hazardous Waste: It is a waste with properties that make it dangerous or potentially harmful to human health or the environment. Hazardous waste can be liquids, solids, contained gases, or sludges. They can be the byproducts of manufacturing products or simply discarded commercial products, like cleaning fluids or pesticides.

Joint and Several Liabilities: A legal doctrine defining the scope of a defendant's liability. When more than one potentially responsible party (PRP) is involved at a site and the harm is indivisible, the court may impose joint and several liability upon all parties involved at the site. In this instance, each PRP involved at the site may be held individually liable for the cost of the entire response action.

Leachate: Any liquid, including any suspended components in the liquid that has percolated through or drained from waste. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, ground water or soil.

Manifest: Paperwork that accompanies hazardous waste from the point of generation to the point of ultimate treatment, storage, or disposal. Each party involved in the waste's management retains a copy of the manifest, which contains specific information about the waste.

Permitting Authority: The Ministry of Environment (MOE) is authorized by the national legislation to develop and implement a permitting program for effluent discharges from point source [end of pipe industrial (factories) or commercial (dry cleaners), etc.] and non- point sources (runoff from parking lots, agriculture lots, etc.)

Permit – A legal document issued by governing authorities containing a detailed description of the proposed activity and operating procedures as well as appropriate procedures as well appropriate requirements and regulations. The permit process includes provisions for public comments.

Pretreatment: The reduction of the amount of pollutants, the elimination of pollutants, or the alternation of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a municipal treatment system.

Primary Treatment: First stage of wastewater treatment in which solids are removed by screening and settling.

Releases – are an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, releases at the facility to land. Specific releases are defined as follows.

1) Releases to Air (point and fugitive air emissions) include all air emissions from industry activity. Point emissions occur through confined air streams as found in stacks, vents, ducts, or pipes. Fugitive emissions include equipment leaks, evaporative losses from surface impoundments and spills, and releases from building ventilation systems.
2) Releases to Water (Surface Water Discharges) – encompass any releases going directly to streams, rivers, lakes, oceans, or other bodies of water. Releases may also emanate from runoff including storm water runoff.
3) Releases to Land – occur within the boundaries of a facility. Releases to land include disposal of toxic chemicals in landfills, land treatment/application farming, surface impoundments, and other land disposal methods (such as pills, leaks or water piles

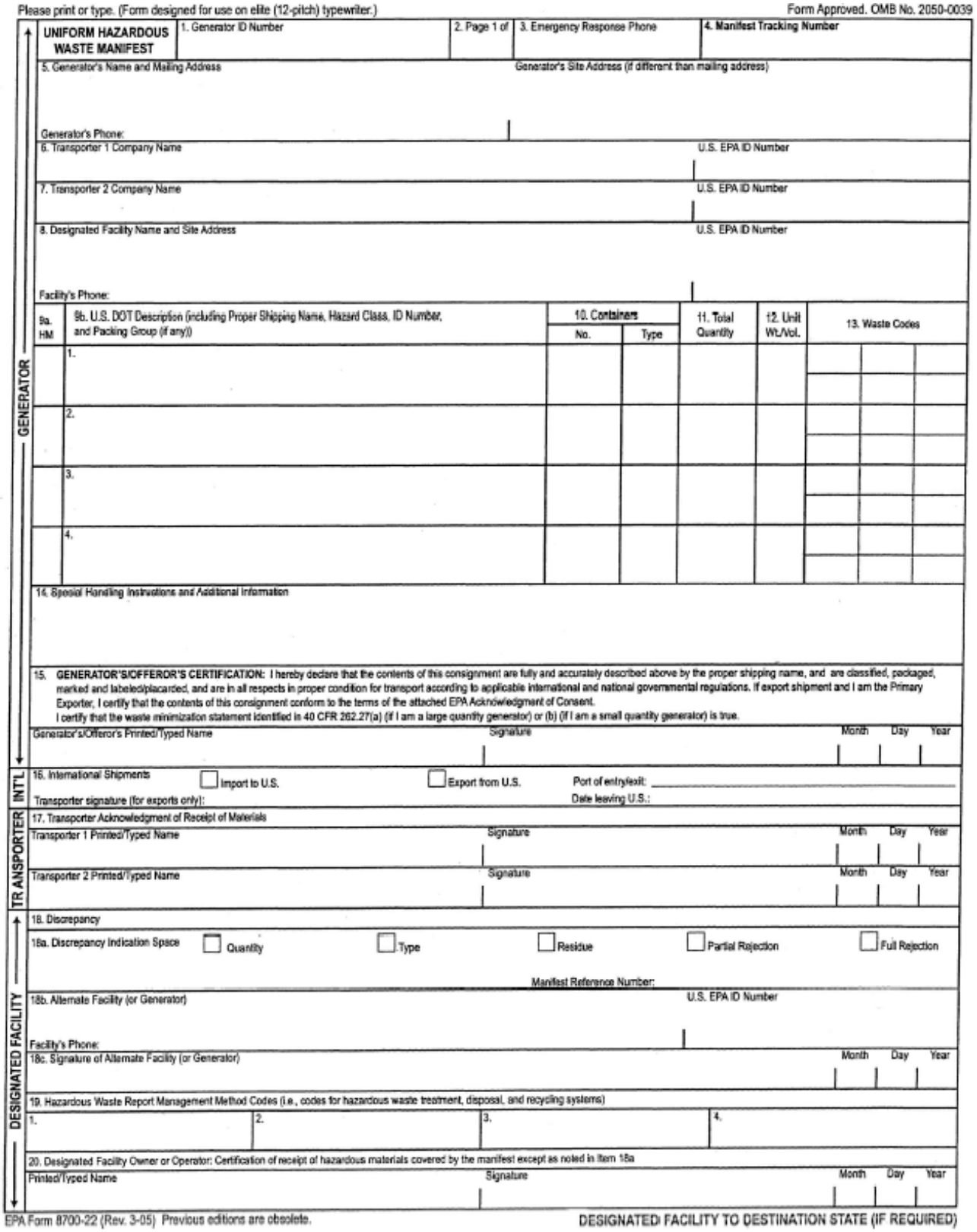
Secondary Treatment: Following primary treatment, the secondary treatment is biological in which bacteria consume the organic parts of the waste. This treatment usually removes about 90% of all solids and oxygen-demanding substances.

Technology-Based Effluent Limit: A regulatory limit for a pollutant that is based on the capability of a treatment method to reduce the pollutant to a certain concentration.

Tertiary Treatment: An enhancement of normal sewage treatment operations to provide water of potable quality (i.e., highest drinking water standards) using further chemical and physical treatment.

Value Engineering (VE): VE is an effective technique for reducing costs, and improving quality. It can be applied to manufacturing; specifications, standards, facilities design and construction. It may be successfully introduced at any point in the life cycle of products, systems, or procedures. VE is a technique directed toward analyzing the functions of an item or process to determine "best value," or the best relationship between worth and cost. In other words, "best value" is represented by an item or process that consistently performs the required basic function and has the lowest total cost. In this context, the application of VE in facilities construction can yield a better value when construction is approached in a manner that incorporates environmentally sound and energy-efficient practices and materials.

APPENDIX 6: Hazardous Waste Manifest – USEPA Model



Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number | 2. Page 1 of | 3. Emergency Response Phone | 4. Manifest Tracking Number

GENERATOR

5. Generator's Name and Mailing Address | Generator's Site Address (if different than mailing address)

Generator's Phone:

6. Transporter 1 Company Name | U.S. EPA ID Number

7. Transporter 2 Company Name | U.S. EPA ID Number

8. Designated Facility Name and Site Address | U.S. EPA ID Number

Facility's Phone:

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1.					
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name | Signature | Month | Day | Year

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit: _____

Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name | Signature | Month | Day | Year

Transporter 2 Printed/Typed Name | Signature | Month | Day | Year

DESIGNATED FACILITY

18. Discrepancy

18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

18b. Alternate Facility (or Generator) | U.S. EPA ID Number

Facility's Phone:

18c. Signature of Alternate Facility (or Generator) | Month | Day | Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1. | 2. | 3. | 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a

Printed/Typed Name | Signature | Month | Day | Year

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

APPENDIX 7