WATER REUSE AND ENVIRONMENTAL CONSERVATION PROJECT

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

Assessment of WWTPs in Industrial Developments in Jordan

May 2015

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ASSESSMENT OF WWTPS IN INDUSTRIAL DEVELOPMENTS IN JORDAN
MAY 2015

Submitted to:

USAID Jordan

Prepared by:

AECOM

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LIST OF ACRONYMS

ASEZA	Aqaba Special Economic Zone Authority
ASU	Arizona State University
AWWARF	American Water Works Association Research Foundation
BMEP	Best Management Environmental Practice
CBO	Community-based organization
CBIWDM	Community Based Initiative for Water Demand Management
CEE	Central and Eastern Europe
C&D	Construction and Demolition
C&I	Commercial and Industrial
CMC	Construction Management Consultant
CO	Contracting Officer
COI	Chamber of Industries
CQA	Construction Quality Assurance
DFZC	Development and Free Zones Commission
ECD	Enterprise Compliance Database
EIA, EIS, EIR	Environmental Impact Assessment, Statement, Report
EMS	Environmental Management System
EPA	Environmental Protection Agency
ESIP	Environmental Strategy Implementation Plan
EU	European Union
FS	Feasibility study
FY	Fiscal Year
GAM	Greater Amman Municipality
GDA	Global Development Alliances
GIS	Geographic Information System
GOJ, GoJ	Government of Jordan
HFDB	Hashemite Fund for the Development of Jordan Badia
IDARA	USAID Water Management Project
IKC	Industrial Knowledge Center
IR	Intermediate results
ISO	International Standards Organization
IEC	International Electrotechnical Commission
ISSP	Institutional Support and Strengthening Program
IT	Information Technology
IWW	Industrial Wastewater
IWTP	Industrial Wastewater Treatment Plant
JAS	Jordanian Accreditation Society
JCI	Jordan Chambers of Commerce
JEF	Jordan Environmental Fund
JIB	Jordan Investment Board
JIEC	Jordan Industrial Estates Corporation
JoDRA	Jordan Desalination and Reuse Association
JUST	Jordan University of Science and Technology
JVA	Jordan Valley Authority
MoEnv	Ministry of Environment
Ministry of Health	MOH
MoIT	Ministry of Industry and Trade
MOU	Memorandum of Understanding
MSW	Municipal Solid Waste
MU	Measurement Uncertainty
MWI	Ministry of Water and Irrigation
NETWORK	The Network for Jordanian Sustainability
NGO	Non-Governmental Organization

O&M	Operation and maintenance
PAP	Public Action in Water, energy, and Environment Project
P2	Pollution Prevention
P2Rx	Pollution Prevention Resources Exchange Program
PEER	Public Entity Environmental Management Systems Resource Center
PIR	Project intermediate results
PPP	Private-public partnership
PSD	Public Security Directorate
QA/QC	Quality Assurance/Quality Control
QMS	Quality Management System
QIZ	Qualifying Industrial Zone
RCRA	Resource Conservation and Recovery Act
REC	Regional Environmental Center
RIAL	Reuse for Industry, Agriculture, and Landscaping project
RKC	Reuse Knowledge Center
RSCN	Royal Society for the Conservation of Nature
RSS	Royal Scientific Society
SABEQ	Jordan Economic Development Project
SEMP	Strategic Environmental Management Plan
T3	Train the Trainer
ToR	Terms of Reference
UNDP	United Nations Development Programme
USEPA	United States Environmental Protection Agency
UNICEF	United Nations Children's Fund
WAJ	Water Authority of Jordan
WEF	Water Environment Federation
WW	Wastewater
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

The USAID Water Reuse and Environmental Conservation Project (WRECP) works throughout Jordan in institutional capacity building, pollution prevention for industries, solid waste and wastewater management, and water reuse. The project goal is to protect and conserve scarce resources through regulation, education, and coordination with industry, local communities and the private sector. The project is implemented by AECOM and a team of international and Jordanian partner firms. This five-year project has four primary tasks:

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

Under Sub-task 2.3b, Design and Engineering Services for Industrial Wastewater Treatment Plants (WWTP), the project team reviewed the operations of five WWTP located within Industrial Estates and Development Areas, to assess the need for upgrading the systems to allow more effective treatment of mixed industrial and domestic. This report summarizes the findings of the site visits and personnel interviews and recommends the best candidate for receiving an upgrade to its WWTP.

A list of 22 potential sites was prepared by the project in 2011 and was presented in a previous deliverable, *Assessment of Priority Industry Sectors for Participation in Industry Surveys*, submitted to USAID on 26 October 2011. In the WWTP assessment that is the subject of the current report, the original list of 22 sites was reduced to a short list of five: Hussein Bin Abdullah II Industrial Estate, Al Hassan Industrial Estate, Muwaqar Industrial Estate, King Hussein Bin Talal Development Area, Ma'an Development Area Industrial Park, and King Abdullah II Industrial Estate.

The project team visited 4 of the 5 wastewater facilities at the short-listed sites and obtained information on the fifth without a site visit, as explained later in this report. The objective was to assess their current condition and operation as well as to collect further information by interviewing personnel. See Appendix A for the site visit reports. The site visits collected information such as:

- Total Area of Development
- Area currently developed
- Type of industries within development
- Ratio of industrial wastewater to domestic wastewater being generated
- Development water resources
- System information
    - Construction date
    - System operational
    - Treated water usage
    - Design loading
    - Operational loading
    - System components
- Performance of wastewater treatment system
- Available space for system upgrades

After reviewing the information collected, the Al Hussan Industrial Estate was selected as the best candidate site to receive upgrades to allow more effective treatment of industrial wastewater. Section 5 explains how the selection was made.

This report concludes by recommending that a project be undertaken to upgrade the Al Hussan Industrial Estate's WWTP and outlining the next steps that should be taken to develop a proposed scope for such a project. The potential project would be similar in scope to the current work being performed by the WRECP at the King Abdullah II Industrial Estate (Sahab) and would include the following activities:

- Feasibility Study
- Environmental Consideration Report
- Preliminary Design of WWTP Upgrade
- Development of Performance Specification and Bid Documents for Design-Build tendering.

2 Background

2.1 Water Reuse in Jordan

Jordan is one of the four countries in the world in which water is scarcest. Water resources consist primarily of surface and groundwater resources, with treated wastewater being used on an increasing scale for irrigation. Jordan's increasing population and growing economy is resulting in increased demands on the country's already scarce water resources. There exists significant evidence that the limited water resources available are exposed to pollution, due in part to ineffective wastewater treatment and management.

Industrial Estates in Jordan offer cost-effective land and factory buildings, a reasonable cost of utilities (including power and water), a comprehensive network of roads and infrastructure, the availability of a wide range of ancillary services and an effective "One Stop Service" capacity. Projects in industrial estates are granted a two-year exemption of income and social services tax, total exemptions from buildings and land tax, exemptions or reduction on most municipality fees, in addition to other exemptions according to Investment Promotion Law (JIB Website, http://www.jib.jo/BusinessandInvestment/WheretoInvest/IndustrialZones/tabid/269/language/en-US/Default.aspx).

The project team gathered data from five industrial estates and development areas in Jordan during their site visits in order to identify, evaluate, and select a candidate WWTP to receive upgrades that would allow it to treat a mix of industrial and domestic wastewater more effectively. All five estates are either wholly or partially managed by the Jordan Industrial Estate Corporation (JIEC). Wastewater treatment requirements in Jordan and in Industrial Estates are governed by several key pieces of legislation as summarized in the next section.

2.1.1 Existing Regulatory Requirements

Environmental laws, standards, and instructions that relate to the environmental management of industrial estates are listed below:

- Jordan Industrial Estates Cooperation Law No. 59 for the year 1985
- Environment Protection Law No. 52 for the year 2006
- Jordanian Standard No. 1140/2006, Environment – Air quality – Ambient air quality standards

- Jordanian Standard No. 1189/2006, Environment – Pollutants – Maximum allowable limits of air pollutants emitted from stationary sources
- Wastewater specification issued by the Jordan Industrial Estates Cooperation (W 1095-3)
- Instructions for Discharging Industrial and Commercial Wastewater into the Wastewater Sewer and its Amendments for the Year 1998
- Jordanian Standard No. 202/2007, Water – Industrial Reclaimed Wastewater
- Jordanian Standard No. 1145/2006, Water– Sludge–Uses of Treated Sludge and Sludge Disposal

Of particular importance to treatment and disposal practices in connection with dedicated industrial wastewater are: JIEC Instruction No. W1095-3; Specification for Discharging Industrial and Commercial Wastewater into the Wastewater Sewer; and Jordanian Standard No. 202/2007. The Jordanian Standard No. 1145/2006, which governs sludge management – albeit in the context of domestic wastewater treatment facilities - is also highly relevant. This subsection includes an overview of these requirements.

2.1.2 JIEC Specification W1095-3

The Jordan Industrial Estate Corporation requires the owners/operators of industrial process facilities to comply with certain specifications that limit both the quantity and pollutant characteristics of the discharge to sewage networks and treatment systems under the jurisdiction of the JIEC.

Under Specification No. W1095-3, the JIEC has established requirements for industrial wastewater being conveyed to biological treatment systems where the effluent will be used for restricted agricultural use. These specifications are summarized in Table 2-1.

Table 2-1: JIEC Specification W1095-3

Parameter	Abbreviation	Maximum Limit
Flow	Q	50 m^3/day
Temperature	T	45°C
Biochemical Oxygen Demand	BOD_5	500 mg/L
Chemical Oxygen Demand	COD	1,000 mg/L
Total Dissolved Solids	TDS	2,000 mg/L
Total Suspended Solids	TSS	300 mg/L
Hydrogen Ion Concentration	pH	6.5 to 9
Fat Oil and Grease	FOG	50 mg/L
Methylene Blue Active Substances	MBAS	26 mg/L
Sodium	Na	400 mg/L
Aluminum	Al	5 mg/L
Arsenic	As	0.1 mg/L
Chrome	Cr	0.3 mg/L
Copper	Cu	2.0 mg/L
Iron	Fe	5.0 mg/L
Nickel	Ni	0.2 mg/L
Lead	Pb	1.0 mg/L
Cadmium	Cd	0.07 mg/L
Zinc	Zn	15 mg/L
Cyanide	CN	0.3 mg/L
Mercury	Hg	0.001 mg/L
Phosphorus	P	50 mg/L
Chloride	Cl	500 mg/L
Boron	B	1.0 mg/L
Phenol	Phenol	0.002 mg/L

Table 2-1: JIEC Specification W1095-3

Parameter	Abbreviation	Maximum Limit
Fluorine	F	2.0 mg/L
Bicarbonate	HCO_3	400 mg/L
Sodium Adsorption Rate	SAR	9.0

Additional general requirements include:

- Industrial wastewater shall be separated from domestic wastewater
- Rainwater shall not be disposed to the sewage network
- Concentrated saline solution resulting from saline regeneration of water softener shall not be disposed to the sewage network
- Wastewater resulting from industry activities and cleaning yards of loading and discharging shall not be disposed to rainwater drainage channels
- The industrial plant shall incur the costs of any violation it commits, whether the resulting damages are operational and affect the treatment plant, sewage network or rainwater drainage channels
- The industrial plant shall incur the costs of analyzing non-conforming samples disposed to the sewage network/rainwater drainage channels as per the rates regulation approved by the Corporation
- A special treatment unit shall be provided according to the type of industry within the plant premises in order to abide by the quality of water discharged to the sewage network
- Industrial wastewater containing the following materials shall not be discharged to the sewage network:
    - Petroleum materials and their derivatives; materials containing oils, greases, waxes or dyes; materials that can precipitate or freeze at a temperature ranging between 0 and 40°C; or materials that cannot be processed or reduced during the treatment process
    - Any liquids or waters containing heavy metals, phenol compounds, chloride organic solvents, sulfate compounds, color removal materials, insecticides, rodenticides, and microorganisms
    - Any materials with corrosion feature or concentrated acidic or alkaline materials
    - Any solid or viscous materials that obstruct flowing or hinder treatment process, such as sand, ash, wood, feather, hair, metals, plastic, sawdust, garbage, meats, paper, or cardboard

For further information, the complete text of JIEC Instruction No. W1095-3 is provided in Appendix B.

It should be noted that this instruction is treated as an interim standard, and the regulatory framework for the treatment and disposal of industrial wastewater is evolving. Due to capacity limitations in the area of environmental enforcement, there is no basis for expecting that industrial dischargers can be made to comply with the pretreatment limits mentioned above.

2.1.3 Jordanian Standard 202/2007

This Standard includes requirements for the discharge of industrial WWTP effluent to surface waters – wadis, streams, and water bodies and for irrigation.

Pollutant limits for industrial wastewater discharge to surface waters are summarized in Table 2-2.

Table 2-2: JS 202/2007 Effluent Limits for Reclaimed Industrial Wastewater Discharges to Surface Waters

Parameter		Maximum Limit	
Physical and Chemical			
Biochemical Oxygen Demand	BOD_5	60	mg/L
Chemical Oxygen Demand	COD	150	mg/L
Dissolved Oxygen	DO	not less than 2.0	mg/L
Total Suspended Solids	TSS	60	mg/L
Hydrogen Ion Concentration	pH	6 to 9	SU
Nitrate	NO_3	80	mg/L
Total Nitrogen	T-N	70	mg/L
Change in Temperature of Receiving Water	T	6	^oC
Color	C	15	-
Turbidity	NTU	15	NTU
Fat Oil and Grease	FOG	8	mg/L
Phenol	Phenol	< 0.002	mg/L
Sodium Methylene Blue Active Substances	MBAS	25	mg/L
Total Dissolved Solids	TDS	2,000	mg/L
Phosphate as P	PO_4-P	15	mg/L
Chloride	Cl	350	mg/L
Sulfate	SO_4	300	mg/L
Ammonium	NH_4	5	mg/L
Bicarbonate	HCO_3	400	mg/L
Sodium Adsorption Rate	SAR	9	--
Total Organic Carbon	TOC	55	mg/L
Microbiological			
Escherichia Coli	E-coli	1,000	MPN/100 mL
Intestinal Helminths	--	≤ 1	Egg/L
Heavy Metals			
Cyanide	CN	0.05	mg/L
Barium	Ba	1.0	mg/L
Aluminum	Al	2	mg/L
Arsenic	As	0.05	mg/L
Beryllium	Be	0.1	mg/L
Copper	Cu	1.5	mg/L
Fluorine	F	2	mg/L
Iron	Fe	5.0	mg/L
Lithium	Li	2.5	mg/L
Manganese	Mn	0.2	mg/L
Molybdenum	Mo	0.01	mg/L
Nickel	Ni	0.2	mg/L
Lead	Pb	0.2	mg/L
Selenium	Se	0.05	mg/L
Cadmium	Cd	0.01	mg/L
Zinc	Zn	5	mg/L
Chrome	Cr	0.1	mg/L
Mercury	Hg	0.002	mg/L
Vanadium	V	0.1	mg/L
Cobalt	Co	0.05	mg/L
Boron	B	1.0	mg/L
Silver	Ag	0.1	mg/L

Pollutant limits for reclaimed industrial wastewater used for irrigation are summarized in Table 2-3.

Table 2-3: JS 202/2007 Effluent Limits for Reclaimed Industrial Wastewater Used for Irrigation

		Cooked Vegetables, Parks, Playgrounds and Sides of Roads Within City Limits	Fruit Trees, Sides of Roads Outside City Limits, and Landscaping	Field Crops, Industrial Crops, and Forest Trees	Cut Flowers
		I	II	III	--
Parameter		**Maximum Limits**			
Physical and Chemical					
BOD_5	mg/L	30	200	300	15
COD	mg/L	100	500	500	50
DO	mg/L	> 2	-	-	> 2
TSS	mg/L	50	200	300	15
Physical and Chemical					
pH	--	6 to 9	6 to 9	6 to 9	6 to 9
Turbidity	NTU	10	-	-	5
NO_3	mg/L	30	45	70	45
T-N	mg/L	45	70	100	70
Microbiological					
Escherichia Coli	MPN/100 mL	100	1,000	-	< 1.1
Intestinal Helminths	Egg/L	≤ 1	≤ 1	≤ 1	≤ 1
FOG	mg/L	8	8	8	2
Phenol	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
MBAS	mg/L	100	100	100	100
TDS	mg/L	2,000	2,000	2,000	2,000
PO_4-P	mg/L	30	30	30	30
Cl	mg/L	400	400	400	400
SO_4	mg/L	500	500	500	500
HCO_3	mg/L	400	400	400	400
Na	mg/L	230	230	230	230
Mg	mg/L	100	100	100	100
Ca	mg/L	230	230	230	230
SAR	--	9.0	9.0	9.0	9.0
Heavy Metals					
Al	mg/L	5	5	5	5
As	mg/L	0.1	0.1	0.1	0.1
Be	mg/L	0.1	0.1	0.1	0.1
Cu	mg/L	0.2	0.2	0.2	0.2
F	mg/L	2	2	2	2
Fe	mg/L	5.0	5.0	5.0	5.0
Li	mg/L	0.075	0.075 (for citrus 2.5)	0.075	0.075
Mn	mg/L	0.2	0.2	0.2	0.2
Mo	mg/L	0.01	0.01	0.01	0.01
Ni	mg/L	0.2	0.2	0.2	0.2
Pb	mg/L	0.2	0.2	0.2	0.2
Se	mg/L	0.05	0.05	0.05	0.05

Table 2-3: JS 202/2007 Effluent Limits for Reclaimed Industrial Wastewater Used for Irrigation

		Cooked Vegetables, Parks, Playgrounds and Sides of Roads Within City Limits	Fruit Trees, Sides of Roads Outside City Limits, and Landscaping	Field Crops, Industrial Crops, and Forest Trees	Cut Flowers
		I	II	III	--
Parameter		**Maximum Limits**			
Cd	mg/L	0.01	0.01	0.01	0.01
Zn	mg/L	5.0	5.0	5.0	5.0
Cr	mg/L	0.1	0.1	0.1	0.1
Heavy Metals					
Hg	mg/L	0.002	0.002	0.002	0.002
V	mg/L	0.1	0.1	0.1	0.1
Co	mg/L	0.05	0.05	0.05	0.05
B	mg/L	1.0	1.0	1.0	1.0
CN	mg/L	0.1	0.1	0.1	0.1

For further information, the complete text of Jordanian Standard 202/2007 is provided in Appendix C.

3 Overview of Wastewater Treatment Plants in Industrial Estates and Development Zones

3.1 Initial Site List

The initial list of 22 sites was developed and presented in a previous *deliverable Assessment of Priority Industry sectors for Participation in Industry Surveys*, 26 October 2011. Table 3-1 summarizes basic information about the 22 sites. This list was used as the starting point for identifying candidate sites that are currently accepting mixed domestic and industrial wastewater. As shown in Table 3-2, five sites were selected for further investigation based on the following criteria:

- Industrial facilities are located within the Estate
- The Estate has an installed Wastewater Treatment Plant (WWTP)
- The WWTP receives or has the potential to receive a mix of industrial and domestic wastewater

Table 3-1: Initial List of Potential Sites

ID No.	Name	Governate/ Location	Managing Organization	Status	Meets Criteria for Further Analysis
1	King Abdulah II Industrial Estate	Sahab	JIEC	USAID design and delivered tender documents for upgrades to the IWTP	X
2	Al Hassan Industrial Estate	Irbid	JIEC	Phase I - abandoned Phase II - in operation, receiving 30 to 70% industrial wastewater, shock loads adversely affect the WWTP Phase III - in place, not in operation	✓
3	Al Hussein Bin Abudullah II Industrial Estate	Karak	JIEC	WWTP operating well, receives 25% industrial wastewater, WWTP can become overwhelmed with Oil and Grease	✓
4	Aqaba International Industrial Estate	Aqaba		No centralized IWTP here. Sanitary WW is sent to a treatment plant in North Aqaba	X
5	Al Muwaqar Industrial Estate	Amman	JIEC	WWTP built, contractor has not handed it over to the estate, in arbitration and is expected to be resolved in 2 to 3 months	✓
6	Al Zarqa Industrial Estate	Zarqa		USAID is designing a centralized IWTP	X
7	Ad Dulayl Industrial Park		Ad Dulayl Industrial Park & Real Estate Co.	No centralized IWTP here, disposal via - wastewater is either trucked or disposed of via septic tank	X
8	Al Tajamouat Industrial City		Specialized Investment Compounds Company (Plc.)	Industrial wastewater is pre-treated and discharged off site via tanker truck	X
9	Cyber City		CyberCity	Web site reports that a sewer system will be built as part of the infrastructure, including grease traps. Implies that the system is not in place yet. (Source: http://www.cybercity.com.jo/)	X
10	Hallabat Industrial Park	Zarqa	JIEC	Infrastructure does not include WW services	X
11	Al-Quastal QIZ	Amman		Private QIZ, located within Item (14)	X
12	Zarqa Free Zones	Zarqa		Located within Item (6)	X
13	Sahab Free Zone	Sahab		Located within Item (1)	X

Table 3-1: Initial List of Potential Sites

ID No.	Name	Governate/ Location	Managing Organization	Status	Meets Criteria for Further Analysis
14	Queen Alia International Airport Free Zone	Amman		Infrastructure does not include WW services	X
15	Al Karak - Free Zone	Karak		Located within Item (3)	X
16	Al Karama - Free Zone	Mafraq		Primarily warehouses, Located 360 km east of Amman on the Jordan/ Iraq border	X
17	King Hussein Bin Talal Development Area (KHBTDA)	Mafraq	DFZC	WWTP plant is not started up yet due to lack of wastewater.	✓
18	Irbid Development Area	Irbid		Early stages of development, still in the planning stage.	X
19	Ma'an Development Area (MDA)	Ma'an	DFZC	Treatment plant is ten years old, not started up yet due to lack of wastewater.	✓
20	Aqaba Special Economic Zone (ASEZ)	Aqaba		Light industry, located within Item (4), no centralized WWTP here.	X
21	Dead Sea Development Zone	Madaba	Dead Sea Development Company	Focused on tourism, not industry	X
22	Jabal Ajloun Development Zone	Ajloun	Jordan Development Zones Company	Focused on tourism and retail, not industry	X

X – denotes criteria not met
✓ - denotes criteria met

References: JIB Website: http://www.jib.jo/BusinessandInvestment/WheretoInvest/IndustrialZones/tabid/269/language/en-US/Default.aspx, accessed April 2015
MEED Website: http://www.meed.com/supplements/2013/meed-guide-to-economic-zones/jordan-economic-zones/3183327.article#X-201308221007014, accessed April 2015

3.2 Selection of Sites for Further Assessment

Table 3-2 shows the sites selected for further assessment. All of these sites have a WWTP on-site and industrial activities are conducted within the Estate. WRECP staff visited all of these sites except the Ma'an Development Area because of a USAID travel ban to this part of Jordan. A project representative was able to meet with members of the Ma'an Development Area in their offices in Amman to obtain information about the current operation of its WWTP.

Table 3-2: Selected Sites for Further Assessment

ID No.	Name	Governate/ Location	Managing Organization
2	Al Hassan Industrial Estate	Irbid	JIEC
3	Al Hussein Bin Abudullah II Industrial Estate	Karak	JIEC
5	Al Muwaqar Industrial Estate	Amman	JIEC
17	King Hussein Bin Talal Development Area (KHBTDA)	Mafraq	DFZC
19	Ma'an Development Area (MDA)	Ma'an	DFZC

4 Selected Wastewater Treatment Plants – Collected Information

Three project staff visited five WWTPs located within industrial estates on March 24 through 29 March 2015. The general location of these sites is shown on Figure 4-1. Each of these estates has a WWTP designed to treat domestic wastewater, but they are either currently treating a mix of industrial and domestic wastewater or have the potential to do so in the future. Some of these industrial estates are fully developed and have had difficulties in treating the wastewater because the WWTPs were designed to treat domestic wastewater and were not designed for the high BOD, COD, and oil and grease loadings of industrial wastewater. Other industrial estates are in earlier stages of development and have not yet started up their WWTPs. The purpose of site visits and personnel interviews was to obtain information about the WWTP operations and to assess the potential need to upgrade the systems to adequately treat the mix of domestic and industrial wastewater that is characteristic to their site.

Figure 4-1: Candidate Sites Location Plan

4.1 Ma'an Development Area

USAID has imposed a travel ban to the governorate of Ma'an, therefore, a USAID representative visited the Ma'an Development Company in Amman on February 11, 2015. In addition, USAID received information and photographs from the site on March 15, 2015. The following summary is based on information obtained from this meeting and the documents provided.

General
The Ma'an Development Area is located approximately 220 km south of Amman to the east of Ma'an City (See Figure 4-2). The Development Area is being developed by the Development and Free Zones Commission (DFZC). It is a gated industrial park that covers an area of approximately 7,500,000 m² (750 ha). The estate is equipped with complete infrastructure including a WWTP with a capacity of 700 m³/day. The estate has eight (8) working facilities that employ approximately 100 persons primarily from the local community. The industry sectors include the following:

- Construction related materials (glass coating, adhesives)
- Tanning (dry)
- Chemical fertilizer

The estate plans to add food grade phosphoric acid and float glass factories in the future.

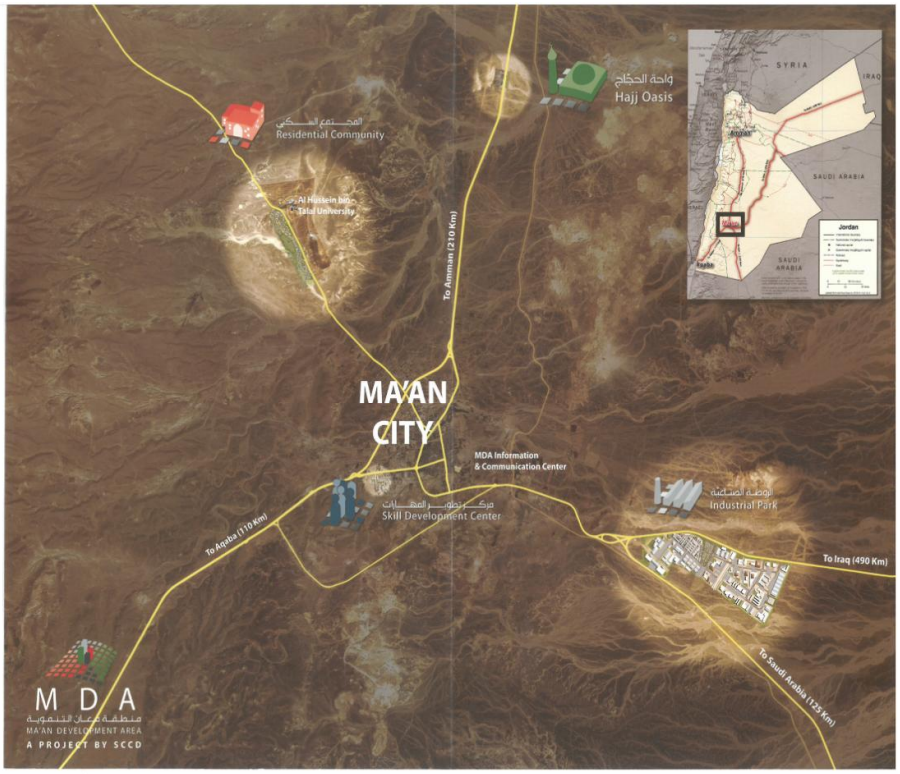


Figure 4-2: Ma'an Development Area Location Plan

Status of WWTP Operation

The WWTP was built in 2005 but has not been commissioned because of a lack of wastewater to sustain operations. See Figure 4-3 for the WWTP layout. The system consists of the following unit operations and was designed for a hydraulic loading of 700 m³/day and an organic loading of 900 mg/L BOD.

- Bar screens
- Lift station
- Splitter box
- Grit Removal
- Oil Water Separation
- Aerated SBR
- Sludge Thickener
- Mechanical Dewatering
- Chlorine contact basin
- Treated Water Basin

Water Supply

The industrial facilities in the industrial park are served by a ground water well with a 25 m³/hr water supply. Mr. Mohannad Tarawneh, Acting CEO, indicated that it is difficult to attract industry to this area, and that an ample water supply would be an attribute. One example is the tanning industry which currently operates a dry process within the estate. In the presence

of good water supply and efficient wastewater treatment, the tanning industry might consider investing in a facility to process fresh material.

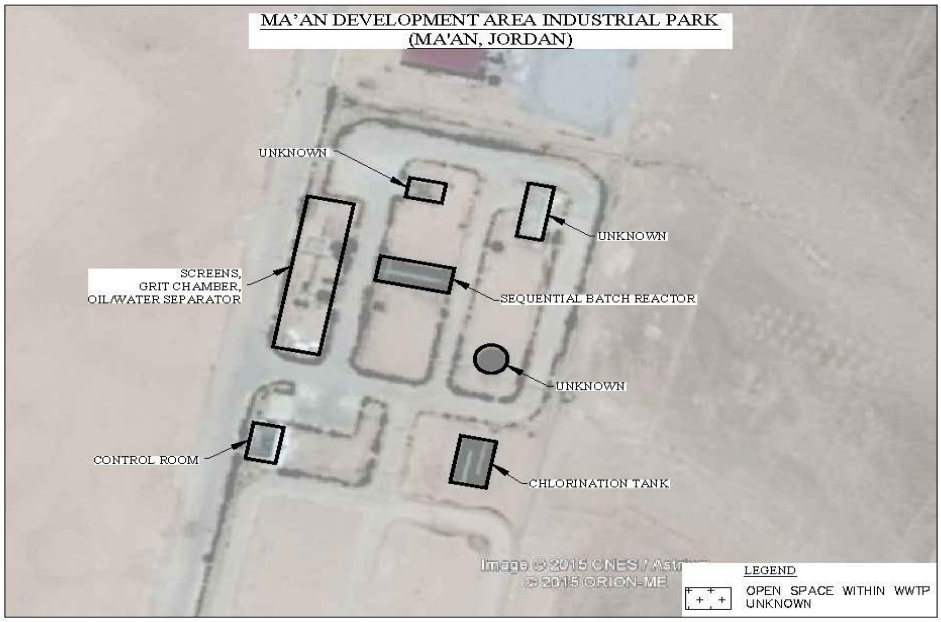


Figure 4-3: Ma'an Development Area WWTP Layout

4.2 Al Muwaqar Industrial Estate

General

This industrial estate was established in 2011 and has a total area of 2,500,000 m² (250 ha). It is located approximately 40 km northeast of Amman (See Figure 4-4). The estate has been designed with a Phased Approach, with Phase 1 now being implemented. Phase 1 is reported to be 72% developed, with approximately 49 facilities under construction or in the design phase. Approximately 26 facilities are reported to be working.

The Director of the Estate reported that NIKE is building a dormitory to house approximately 3,000 workers to work in a ready wear clothing manufacturing facility. The dormitory is expected to be completed in the next six months. Another textile facility that manufactures carpet is also expected to move into the estate in the near future. See Table 4-1 for further information on planned facilities.

Table 4-1: Planned Industrial Sectors in Al-Muwaqar Industrial Estate

Industrial Sector	Notes
Electronics	----------
Medical	----------
Food & beverage	15 factories
Engineering & Electrical	10 factories
Textile & Garment	Nike ready wear, carpet making
Metal & Wood	----------
Chemical	----------
Iron & Steel industries	1 factory

Figure 4-4: Al Muwaqar Industrial Estate Entrance

Status of WWTP Operation

The WWTP is not operational because of difficulties in final negotiations for handing over the plant from the contractor to the owner. It is reported that there is an arbitration committee helping both sides to resolve the issues. Because of this, no staff has been hired to operate the system. The estate is anxious to start the WWTP and begin processing wastewater, especially with the new dormitory expected to be completed within the next 6 months. The estate reports that very little wastewater is currently being generated because most of the facilities are still in the construction phase. Any wastewater that is generated is likely being trucked off –site.

The infrastructure for this estate includes the phased design of a domestic WWTP with Phase 1 capacity of 1,500 m^3/day and a BOD loading of 1,160 mg/L. A second and third phase has been designed, with equivalent capacities, but is not yet constructed. The treatment plant includes the conventional activated sludge process. Water reuse is expected to include off-site agricultural irrigation.

The WWTP is designed to receive and treat domestic wastewater. The high BOD loading is conservative and is characteristic of domestic wastewater in Jordan. The system has an oil/water separator and an equalization tank prior to the aeration system, but does not have pH adjustment or chemical addition which is often required to treat industrial wastewater. The estate did report that it would require all industrial users to pretreat their wastewater prior to discharging into the sewer system.

Water Supply

The estate reports that they have two groundwater wells. Only one is in use for the anticipated phase 1 needs, and the second is on standby. The facility also has access to the public water supply. The estate reports that it has storage for 4,000 m³ of fresh water. See Figures 4-5 through 4-8 for more information on the estate.

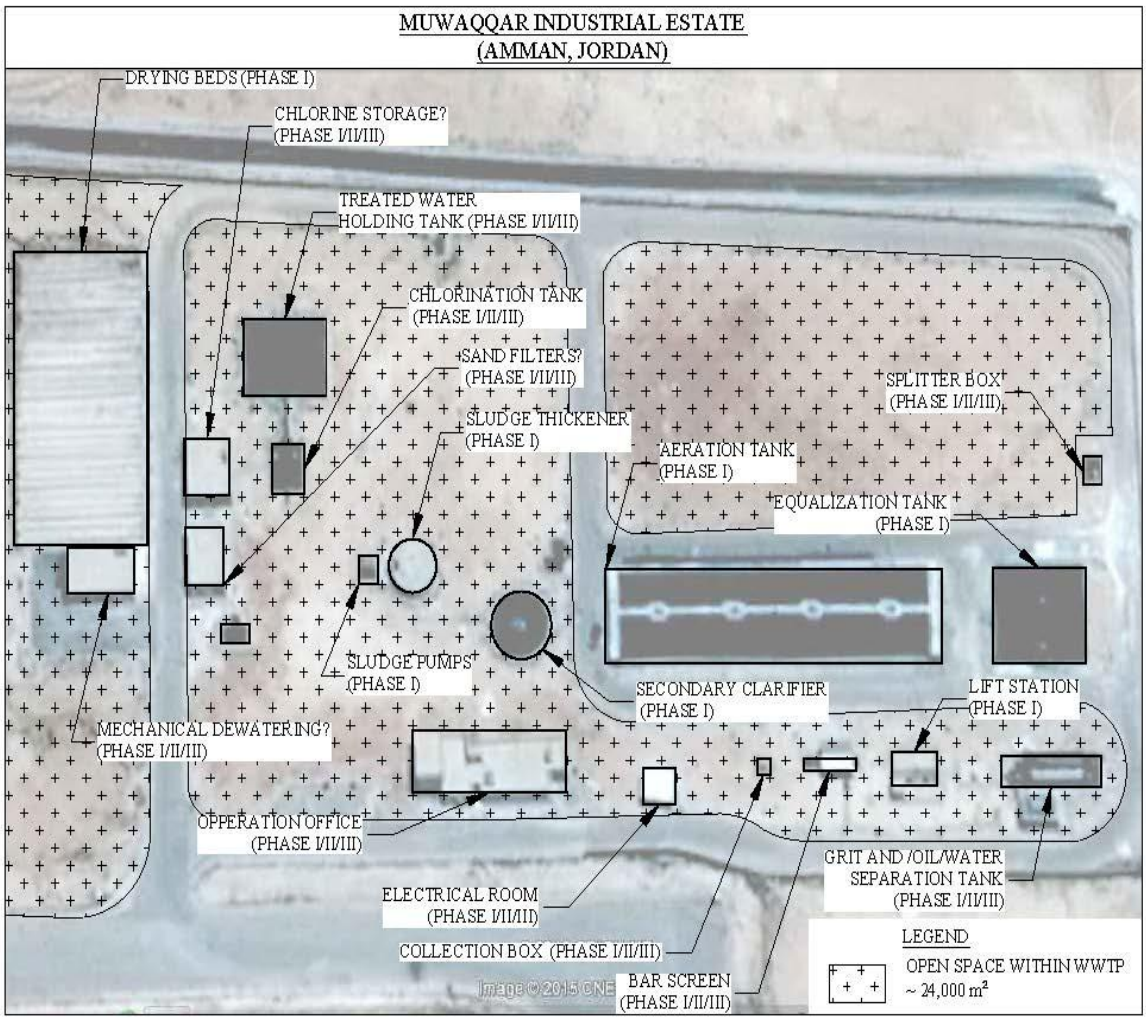


Figure 4-5: Muwaqar Industrial Estate WWTP Site Plan

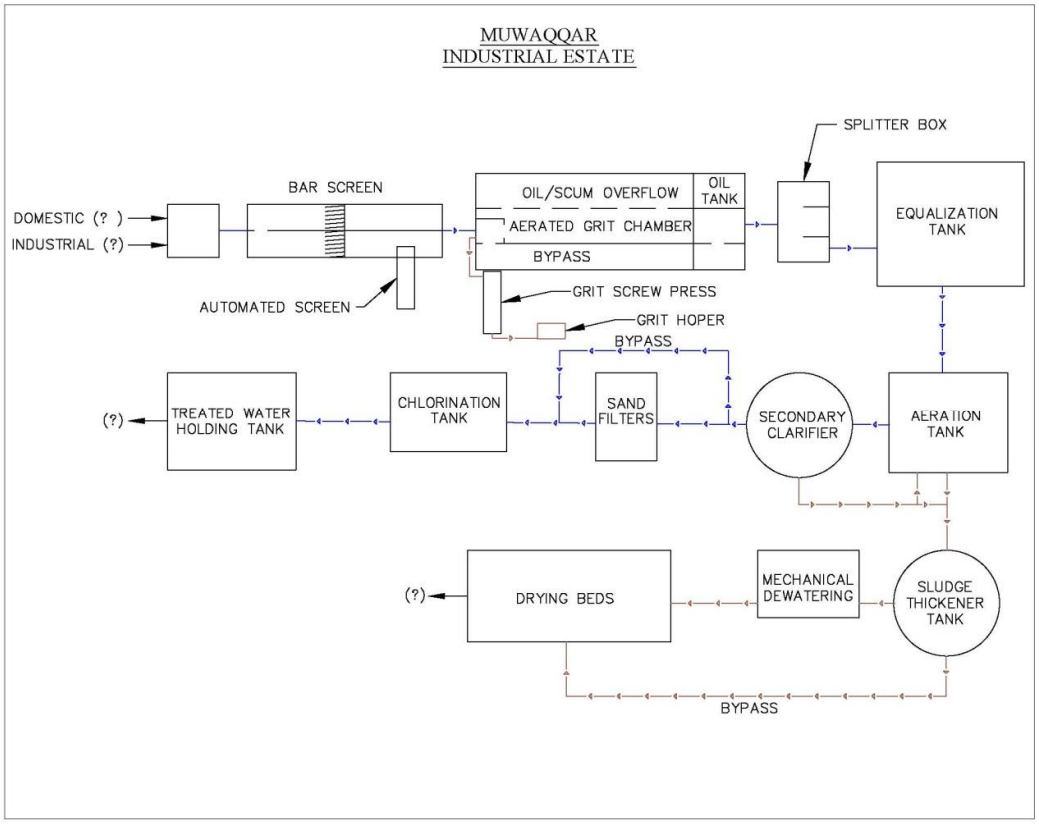


Figure 4-6: Al Muwaqar Industrial Estate WWTP Block Flow Diagram

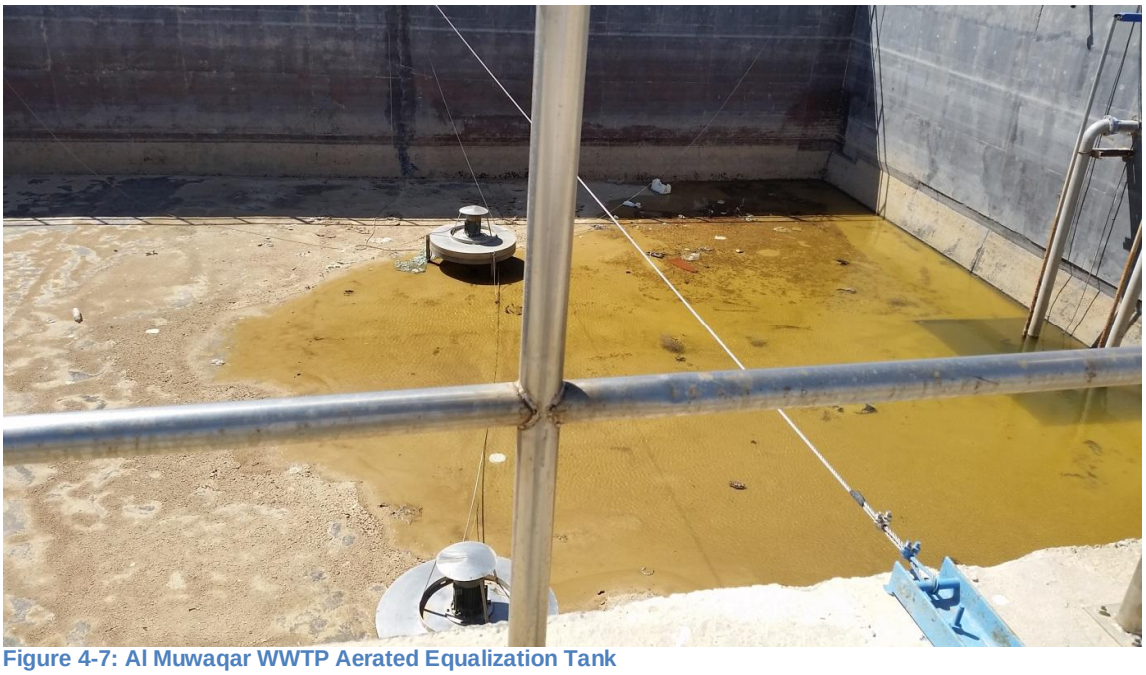


Figure 4-7: Al Muwaqar WWTP Aerated Equalization Tank

Figure 4-8: Al Muwaqar WWTP Aeration Basin

4.3 King Hussein Bin Talal Development Area (KHBTDA)

General

The Mafraq Development Corporation established this industrial estate in 2012. The estate is located approximately 60 km northeast of Amman in the Governorate of Mafraq. The estate size is approximately 21 km² (2,100 ha). Approximately 4.5 km² (450 ha) have been developed, and the Jordan Industrial Estate Company (JIEC) is developing 1.8 km². There is a 1.0 km² free zone, and a 3.0 km² area allocated for solar energy.

The estate has installed infrastructure including sewer, water, and electric utilities to be provided to all facilities. The sewer infrastructure includes gravity sewer collection and two pump stations to collect all the wastewater and transfer it to the wastewater treatment plant (WWTP) located at the far southeastern edge of the estate. The WWTP is currently not operating due to lack of available wastewater.

The estate has approximately 12 facilities that are either working or under construction as summarized in Table 4-2. Currently, these companies are trucking all wastewater off-site for disposal at the Al Ekeder lagoon, which is a few kilometers from the site. There are no dormitories or residences on site at this time, but the estate plan includes provisions for low, medium, and high end housing.

Table 4-2: Current Industrial Sectors in KHBTDA

Industrial Sector	Status	Number of factories	Number of Employees
Food	Working	1	26
Paper	Working	1	99
Engineering	Working	3	247
Steel Forming	Working	1	67
Pharmaceutical	Equipment Testing and commissioning	1	8
Fertilizer	Under Construction	1	2
Plastic Forming	Working	1	45
Detergents	Working	1	39
Aluminum Forming	Under construction	2	4

Status of WWTP Operation

The system was commissioned by the contractor with clean water, but has not operated due to lack of available wastewater. The pumps, blowers, and aeration diffusers have been removed and are in storage. All piping is stainless steel and is in good condition. The system has a hydraulic capacity of 1,500 m^3/day, with a minimum hydraulic requirement of 600 m^3/day and BOD loading of 500 mg/L. The development authority has an agreement with the contractor to start up the WWTP within 10 years of construction (2012) and for operation for one year. After that one year, the estate will take over operation.

The WWTP is designed to receive and treat domestic wastewater. The design utilizes common walls to minimize footprint. The low BOD loading is of concern due the typical high BOD loading that is characteristic of domestic wastewater in Jordan. The system has an oil/water separator and an equalization tank prior to the aeration system, as well as pH adjustment. The system does not include chemical addition which is often required to treat industrial wastewater. The estate indicated that it is willing to consider investing in modifications to the system to process higher BOD loads, if necessary. The estate also indicated that it wishes to install a treated water tank for holding treated water before discharging off-site for irrigation purposes.

The estate reports that all industrial users will need to pre-treat their wastewater before discharging to the sewer system. None of the industries on-site are currently pretreating their wastewater; therefore, every facility would have to invest time and money into installing a pretreatment system before discharging to the estate's sewer system.

The estate is willing to consider interim options to treat wastewater at intermediate locations within the facility. The estate is still in the construction phase and could easily modify its infrastructure to collect and treat wastewater at key locations within the facility. The estate expressed interest in using skid mounted/temporary systems to treat wastewater on a smaller scale until it is fully developed and can bring its WWTP on-line. See Figures 4-9 through 4-11 for more details on the WWTP.

Water Supply

The facility has five wells from which it draws water and a forced water main. There is a holding tank with a capacity of 4,000 m^3 and an elevated storage tank with a capacity of 375 m^3.

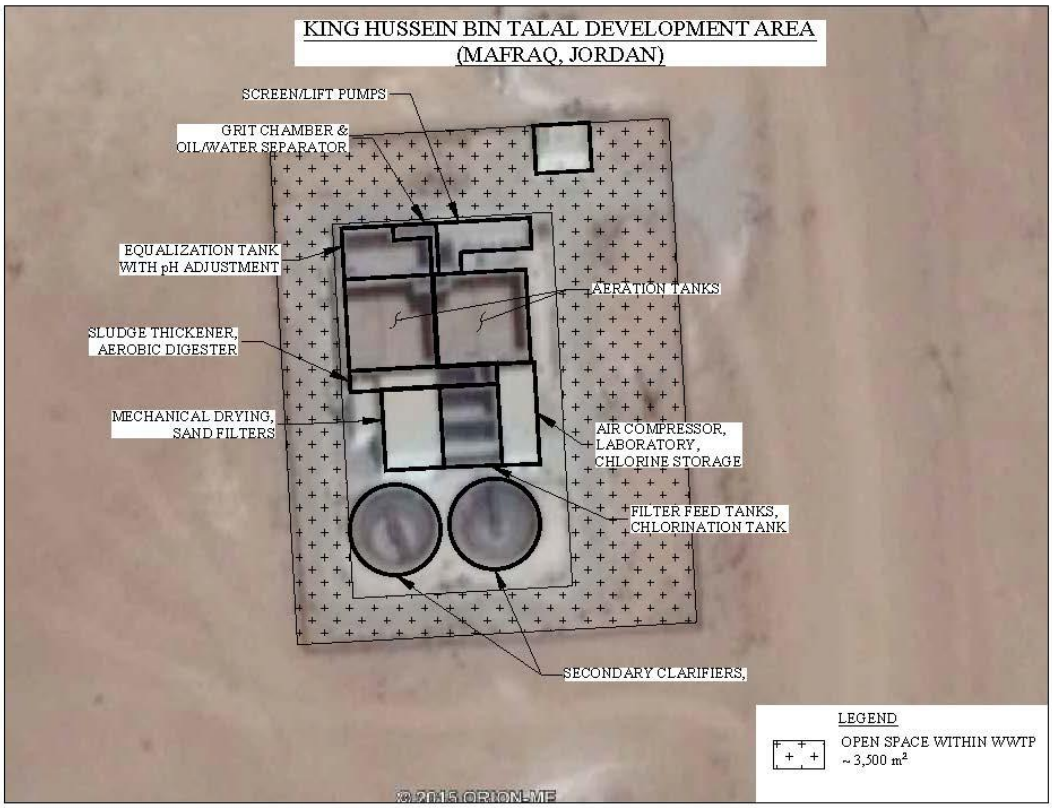


Figure 4-9: King Hussein Bin Talal Development Area WWTP Site Plan

Figure 4-10: KHBTDA WWTP Aerated Grit Chamber

Figure 4-11: KHBTDA WWTP Aeration Tank

4.4 King Hussein Bin Abdullah II Industrial Estate

General

The King Hussein Bin Abdullah II Industrial Estate is located approximately 118 km south of Amman, and 11 km east of Karak City in the Governorate of Karak (See Figure 4-12). The industrial estate currently has 18 companies in operation employing approximately 2,532 workers. The existing wastewater treatment plant (WWTP) services the entire facility receiving approximately 400 to 500 m^3/day of wastewater. Of this, approximately 60% is attributed to the dormitory and cafeteria that houses approximately 2,000 workers. The remaining wastewater is attributed to the industrial activity which is primarily light textiles. The wastewater mix is estimated to be 75% domestic and 25% industrial. No wastewater is trucked in from external sites.

The WWTP consists of an activated sludge extended aeration system that was planned for three phases of construction (Phase 1, Phase 2, and Phase 3). The current system is built to support Phase 1, with a hydraulic capacity of 670 m^3/day and an average BOD of 300 mg/L. The headworks and primary clarifier were built to handle the full phase 3 hydraulic capacity of 2,100 m^3/day, while the remaining unit operations were built for Phase 1 hydraulic capacity. The piping infrastructure is also designed to handle the full phase 3 capacity of 2,100 m^3/day to receive wastewater.

Figure 4-12: King Hussein Bin Abdullah II Industrial Estate

Status of WWTP Operations

The current system appears to be operating well and meets the treatment objective for treating wastewater suitable irrigation. The site provided typical results for influent and effluent quality as summarized in Table 4-3. See Figure 4-13 for the Hussein Bin Abdullah II Industrial Estate WWTP Site Plan.

Table 4-3: Typical Results for King Hussein Bin Abdullah II Industrial Estate

Parameter	Influent	Effluent
pH	7.78	7.68
TDS	1,388 (mg/L)	1,261 (mg/L)
TSS	220 (mg/L)	17.3 (mg/L)
BOD5	225 (mg/L)	12 (mg/L)
COD	1,328 (mg/L)	28 (mg/L)

The WWTP does not have an Oil/Water Separator, pH adjustment, or chemical addition. The primary clarifier has a skimmer that removes a portion of the oil and grease, but is sometimes overwhelmed by oil and grease from the dormitory food preparation facility. The WWTP does have flow equalization ahead of the aeration system.

The WWTP supervisor noted that the discharge from all industrial facilities are sampled every one to two days and analyzed in their own internal laboratory. When a problem is discovered, the industry is notified and given some time to resolve the issue. In some cases, the industry must truck out waste that is off specification – this has happened occasionally for the food preparation facility (dormitory) when the grease trap was overloaded. All new industries are required to obtain a license which requires the submittal of a wastewater characterization. This allows the WWTP to screen the industry before granting permission to establish operations within the industrial estate.

The system has three operators that work one shift per day, seven days per week. The WWTP operates on automatic controls during the evening and overnight hours. Treated wastewater is reused on-site for irrigation and off-site for a fodder irrigation project.

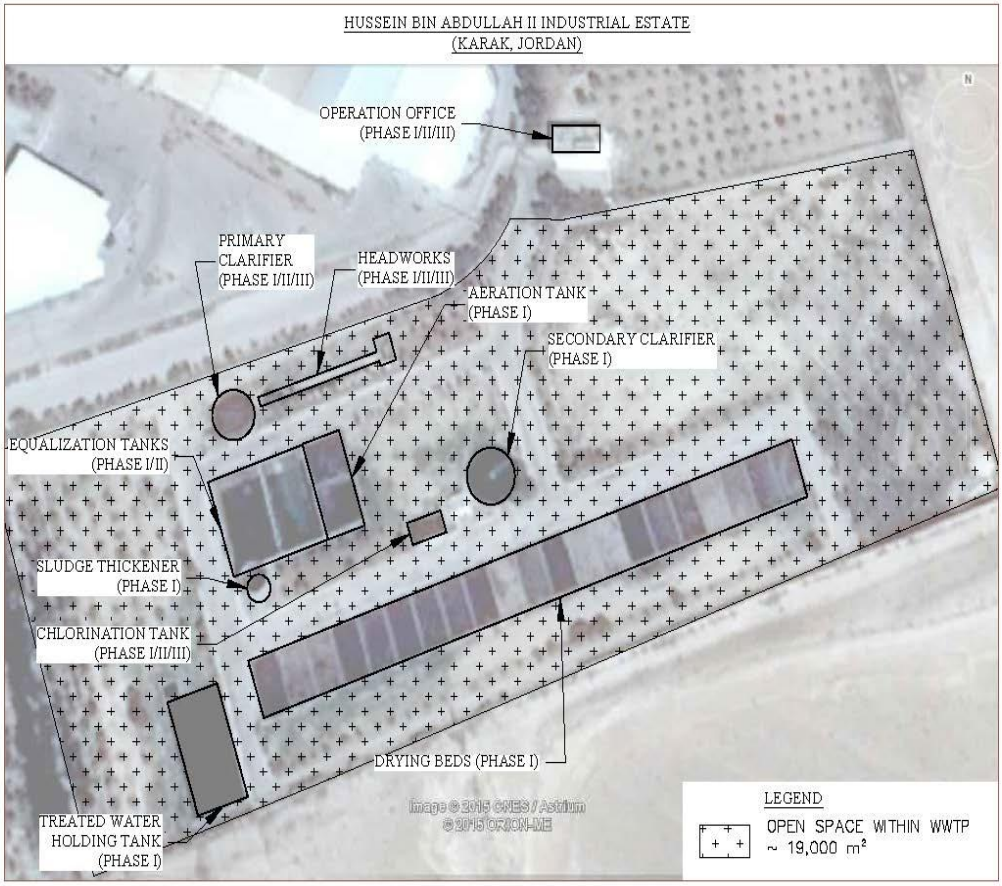


Figure 4-13: Hussein Bin Abdullah II Industrial Estate WWTP Site Plan

Water Source

The source of water for the estate is an on-site well that supplies water via an elevated water tank. The well has a capacity of 55 m³/hr and is sufficient for the needs of the estate.

Noted Issues/ Problems

See Figures 4-14 and 4-15 for images on some of the issues at the facility.

1. Oil and grease loading can sometimes overwhelm the system. The supervisor has to periodically remind the food preparation facility to maintain its grease trap. The system does not have an oil/water separator and relies on the primary clarifier to skim off any floating materials.
2. Threads from the textile industry are difficult to remove and cause problems with the pumps. The plant has installed an additional, finer set of screens but has still had difficulties removing all threads.
3. The primary clarifier is oversized (sized for Phases 1, 2, and 3) and can sometimes develop an unpleasant smell.

4. The current ultrasonic flow meter is not working properly. The flow meter only provides actual flow, but does not provide totalized flow. The WWTP staff is currently taking hourly readings during regular working hours to estimate total flow.
5. There is often a discrepancy with analytical data provided by the on-site laboratory and the data provided by the Royal Society, especially for nitrogen. The samples taken by the Royal Society have shown high nitrogen content, but the samples analyzed on-site do not.
6. The EQ tanks and the aeration tanks do not have drains making it difficult to empty them for maintenance.
7. All control panels are outside and show signs of weathering and corrosion. A control room to house the panels would be preferable.
8. There are no provisions for sludge digestion, so when it rains the sludge can develop a bad smell. Also, the sludge drying beds are not very effective in the winter season when it rains. The site would prefer any future upgrades to include a mechanical sludge dewatering system.

Figure 4-14: Hussein Bin Abdullah II WWTP Flume (Note: oil and grease entering)

Figure 4-15: Outdoor Panels Showing Corrosion

4.5 Al Hassan Industrial Estate

General

Al Hassan Industrial Estate was established in 1991 and is located approximately 75 km north of Amman in the Governorate of Irbid. It has a total area of 1,180,000 m² (118 ha) of industrial space. This Industrial Estate was the first Qualifying Industrial Estate Zone (QIZ) in Jordan as authorized by the US Congress and can directly access US markets without tariff or quota restrictions.

The Industrial Estate contains approximately 125 companies employing more than 25,000 workers. The existing wastewater treatment plant is operating at an average flow rate of approximately 1,200 m³/day and has the capability of expanding to up to 2,100 m³/day. The wastewater mix of industrial and domestic varies day to day and is reported to vary from 35% to 65% domestic waste. Of the industrial wastewater, approximately 60% is from the textile industry. A breakdown of the industry was provided by the estate, as summarized in Table 4-4.

Table 4-4: Summary of Industries Operating at the All Hussain Industrial Estate

Industrial Sector	Labor	No. of Companies
Garment	16,165	36
Engineering	275	20
Plastic & rubber	49	13
Pharmaceutical	346	15
Chemical	130	8
Furniture	17	2
Food	378	21
Leather	57	3
Construction	10	1
Packaging	10	3
Other	56	2
Total	**17,493**	**124**

The estate is nearly fully developed, but some textile facilities are expected to increase operations. In addition, the estate expects to service additional housing for immigrant workers. The estate reports that the wastewater treatment plant will begin receiving wastewater for up to 10,000 more workers in the next few years due to the development of additional housing outside the estate that does not have adequate domestic waste treatment.

Status of WWTP Operations

The estate provided the data in Tables 4-5 and 4-6 for average influent concentrations and effluent concentrations for the month of February 2015. As shown, COD loading is significantly higher than BOD indicating a significant contribution from industrial facilities. The treated effluent is adequate for class III irrigation. Note that the effluent is not analyzed for oil and grease; however, the operators note that the oil water separator is not working well, and the treated effluent had visual oil sheen on the day of the site visit.

Table 4-5: Average Influent Conditions (February 2015)

Parameter	Value
pH	7.2
TDS	1,379 mg/l
TSS	255 mg/l
COD	1,817 mg/l
BOD	349 mg/l
NH_4	4.4 mg/l
NO_3	3.4 mg/l

Table 4-6: Average Effluent Conditions (February 2015)

Parameter	Value
Temp.	16 ^{o}C
pH	7.5
TDS	1,375 mg/l
R-Cl_2	0.00 mg/l
TSS	37 mg/l
COD	207 mg/l
BOD	47 mg/l
NH_4	1.4 mg/l
NO_3	1.0 mg/l
T.H	330 mg/l
Ca	44 mg/l
Mg	54 mg/l
Na	263 mg/l
Cl	405 mg/l
SAR	8.7 mg/l
Turbidity	39 mg/l
Al	0.005 mg/l
CN	0.003 mg/l
Zn	0.04 mg/l
Mn	0.06 mg/l
Fe	0.05 mg/l
L.A.S	0.1 mg/l
SO_4	173 mg/l

The old treatment system is not currently operated. An inspection of the system showed extensive deterioration of the concrete and steel indicating that a significant upgrade would be required for future use, or the system should be demolished.

The new WWTP was commissioned in 2008 and is referred to as Phase 2 and 3 (Phase 1 is the old, decommissioned plant). The system was designed and built to allow a phased approach to start-up and operations. Currently, only phase 2 (1,050 m3/day capacity) is in operation, but the phase 3 (an additional 1,050 m³/day capacity) part of the plant has been installed and can easily be incorporated in to operations. The headworks, including the pumps, grit chamber, and oil water separator have been sized for the full Phase 2 and Phase 3 flow. The equalization tanks, aerators, clarifiers, chlorine contact basin, and sludge drying beds have been sized and installed in two parallel trains to handle the flow of each phase.

The new system is operated by a supervisory control and data acquisition (SCADA) system located in the operations building. The SCADA offers the ability to monitor and control the facility from a computer interface. The operator provided a demonstration of the SCADA screens for the system. See Figure 4-16 for a site plan.

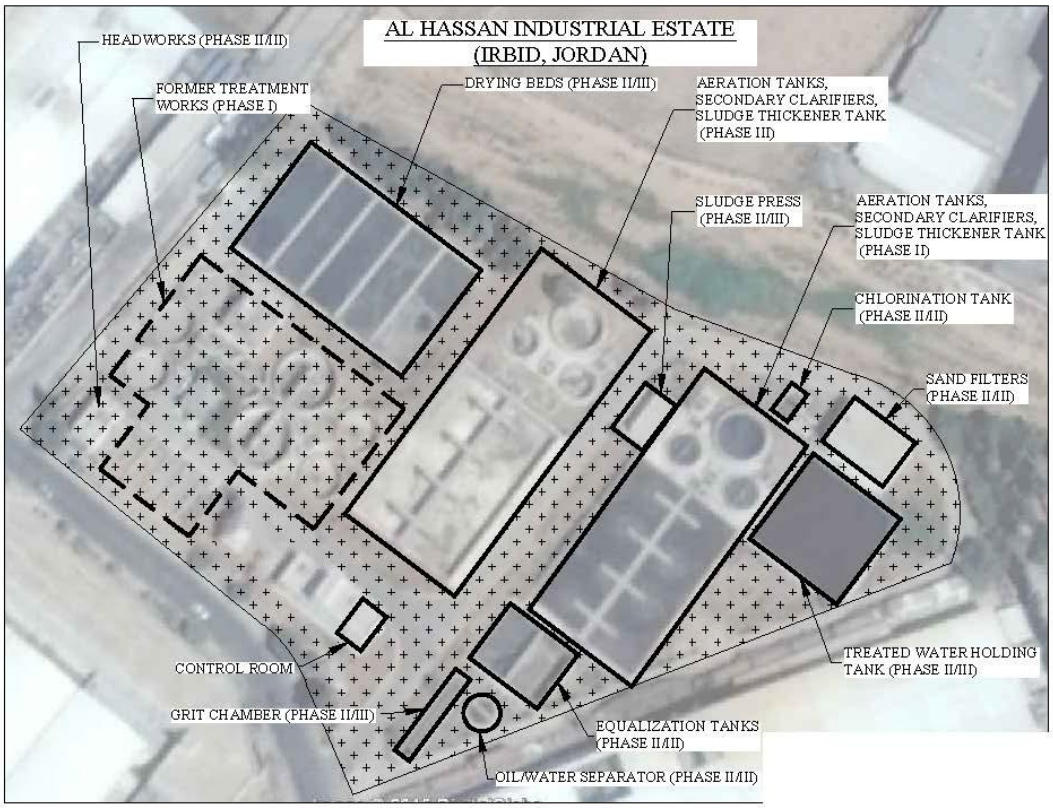


Figure 4-16: Al Hassan Industrial Estate WWTP Site Plan

Noted Issues/Problems

1. The industries in the estate discharge industrial waste without pretreatment. The uncontrolled discharges cause problems in the WWTP that can take weeks or months to overcome. During one site visit, the WWTP had received a slug of red wastewater.

2. The existing WWTP is not equipped to handle slug loads of industrial wastewater. The system would require modification to respond and treat industrial wastewater.
3. The WWTP does not have sufficient trained staff. The staff prefers not to utilize its sand filter due to issues associated with maintenance and backwashing. The staff prefers not to use the belt press also due to the excessive maintenance required.
4. The estate reports that it is treating 1,200 m^3/day of mixed industrial and domestic wastewater, but the Phase 2 hydraulic design capacity is only 1,050 m^3/day. This indicates that the system is operating above its hydraulic design capacity, and the estate may need to bring the Phase 3 treatment train on-line.
5. The WWTP Oil/water separator is not operating and was observed to allow pass through of all oil and grease entering. The separator requires modification or replacement.
6. The analysis of the treated effluent should include Oil and Grease in order to ensure that the treated wastewater is meeting treatment requirements for use as off-site irrigation water.
7. The secondary clarifiers cannot be isolated for maintenance. This can cause excessive sludge buildup causing septic conditions and sludge rising in the secondary clarifiers.
8. The estate is being viewed unfavorably by the public due to recent housing developments outside of the estate to house immigrant workers that work inside the estate. These housing complexes have been either discharging or selling untreated domestic wastewater causing the neighbors to complain. To counteract this problem, the estate is considering collecting the domestic waste from these housing complexes and treating it in its own WWTP, increasing the flow to the system. The increased flow can be accommodated with the start-up of Phase 3 of the WWTP.
9. The old treatment system has experienced significant deterioration. It is not suitable for operation in its current condition and options for removal or restoration should be considered. The condition of the system also poses a safety hazard. The area occupied by the old system could be considered as available space for future modifications to the treatment plant to receive industrial wastewater.

See Figures 4-17 and 4-18 for images of some of the issues at the plant.

Figure 4-17: Hassan City WWTP Secondary Clarifier (Note: floating sludge exiting)

Figure 4-18: Hassan City Oil Water Separator (Red Water Slug)

Blue Water Treatment System (Privately owned)

In addition to the WWTP operated by the estate, there is a private industrial wastewater treatment system located inside the estate. This privately owned system accepts wastewater from the garment industry including blue water and towel water. The treatment design capacity of this blue water treatment system is reported to be 2,000 m^3/day, however, it is currently only treating 700 to 1,000 m^3/day. The treated effluent is provided to farmers outside the facility for irrigation of fodder crops. The owner reports that they take samples to ensure that the water quality is adequate for this use. This private treatment plant reports that it may be forced to shut down because not enough users are sending their wastewater to the facility and the operating and maintenance costs exceed the income generated from its operation.

The blue water is pumped from the influent collection tank to an equalization tank and then to the top of the elevated treatment system where poly aluminum chloride (PAC) coagulant is added in a rapid mix tank. The wastewater overflows to an inclined plate lamella clarifier and then to an aeration tank using diffused aerators. The towel water is pumped directly to the first aeration tank, where it is mixed with the blue water that is exiting the first settling tank. The effluent from the aerator overflows to a second clarifier and then to a larger aeration tank. The effluent of the second aeration tank enters a chlorination tank where hypochlorite is added, and then a third clarifier before overflowing to a clarified water tank. The owner reports that there are aeration blowers to promote treatment, but are not currently used because of the high cost of electricity. The water in the clarified water tank is pumped through a sand filter and carbon filter and then off site for use as irrigation for fodder crops and trees. The owner reports that he does not sell the treated water, but gives it away.

Sludge is removed from the bottom of the three clarifiers and is sent to a sludge tank and dewatered using a sludge drying bed. There is a filter press located at the facility, but the owner reports that it is too expensive to operate; therefore, they built their own sludge drying bed. The dried sludge is collected in bags, but the owner reports that it is difficult to find a place for disposal of the sludge.

The general condition of the system was difficult to assess. The access stairs and platform have experienced considerable corrosion appear unsafe. The condition of the aeration tanks and clarifiers could not be assessed easily as they were covered.

The owner of this system is disgruntled and frustrated because he is not receiving enough wastewater to make the system profitable. He has received several inquiries from outside industries that have relied on the Al-Ekeder disposal site for disposal of their wastewater. With the imminent closing of this site, these industries are looking for alternatives for disposal of their wastewater. Of specific concern are the wastewaters from the yeast and yogurt industry that is very high in TDS. The owner reports that the existing blue water treatment system cannot accept these wastes due to the high BOD/COD and TDS, unless the system was upgraded to include a DAF and a reverse osmosis unit. The owner reports that he would require financial assistance to make these upgrades. See Figure 4-19 through 4-21.

Figure 4-19: Al Hassan Industrial Estate Blue Water Treatment Plant Site Location Plan

Figure 4-20: Hassan City Blue Water Treatment Collection Tank

Figure 4-21: Hassan City Blue Water Treatment - Treated Effluent

5 Selection Criteria for Candidate WWTP Upgrade

This section describes the evaluation of the sites described in **Section 3** with the goal of selecting one candidate site to receive an upgrade to its WWTP allowing treatment of mixed industrial and domestic wastewater. The considerations used in selecting and evaluating the five sites included the following:

- Status of WWTP
- Number of industries contributing wastewater
- Number of employees working within the Estate
- Size of Estate (area)
- Space Available for Potential Upgrades
- Economic Growth Potential of the Estate
- Environmental and public impact of wastewater discharges

The weighting and scoring procedure developed for a previous deliverable (*Sites Selection of Centralized Industrial Wastewater Treatment Plants in Jordan*, 08 November 2011) was used to evaluate the five sites identified for this report. The criteria in the list above were prioritized and weighted to facilitate the selection of the candidate site and are shown in Table 5-1. High priority criteria were assigned with a higher weightage, and those with lesser importance for the decision were given a lower weight.

Table 5-1: Weighting of Categories

Priority	Weight
1	40%
2	30%
3	20%
4	10%

The team developed a scheme to score the criteria for each site. The scoring scheme is summarized in Table 5-2. Each of the criteria were assigned a score from 1 to 10 points. For example, high score criteria includes scores 8, 9, and 10 while low score criteria includes scores 1, 2, 3, and 4. The objective of the scoring scheme was to quantify any qualitative information using best professional judgment to determine an overall score for each site. The overall score was calculated by multiplying each score with the corresponding weightage factor and summing the scores for the site. A higher overall score indicates a more preferable site to receive upgrades.

Table 5-2: Scoring Scheme

Selection Criteria	Scoring Scheme		
	Low (1,2,3,4)	**Medium (5,6,7)**	**High (8,9,10)**
Status of WWTP	Dry	Operational within 1 year	Operational
Performance of WWTP	Dry	Adequate	Poor/Challenged
Adverse environmental and public health impact, Adverse public perception	Low	Potential	High
Number of employees working in the Estate	0 to 100	100 - 10,000	>10,000
Size of Estate (area) (ha)	<200	<1,000	>1,000
Available Space for Upgrades	Challenging	Adequate	More than Adequate
Economic Growth Potential	Low	Medium	High
Number of industries contributing wastewater	0-20	21-50	>50

The outcome of the scoring activity is shown in Table 5-3. Based on the scoring results, the recommended candidate site is the Al Hassan Industrial Estate. This site has an operating WWTP that is challenged on a regular basis to adequately treat the incoming wastewater due to insufficient staffing and due to the high BOD and COD loads it receives from industrial dischargers. The industrial estate is fully developed and anticipates an increase in the number of workers over the next few years.

Three of the estates' scores were very similar, having either dry WWTPs that may come on-line within the next year, or a WWTP that was operating fairly well. The Ma'an Development Area scored the lowest because of its small size, lack of wastewater, and low economic development potential.

Table 5-3: Overall Site Selection Matrix

Selection Criteria	Priority	Weight	Ma'an Development Area		Muwaqar Industrial Estate		King Hussein Bin Talal Development Area		Hussein Bin Abdullah II Industrial Estate		Al Hassan Industrial Estate	
			Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
Status of WWTP	1	0.4	L	1	M	7	M	5	H	9	H	10
Performance of WWTP	1	0.4	L	1	L	3	L	2	M	7	H	9
Env. And public impact	2	0.3	L	2	L	3	L	2	M	5	H	8
Number of employees	2	0.3	100	3	3000	6	537	5	2000	6	25,000	10
Size of Estate (ha)	3	0.2	750	5	250	5	2100	9	187	3	118	3
Available Space for Upgrades	3	0.2	H	9	H	8	H	9	H	8	H	8
Economic Growth Potential	3	0.2	L	3	H	8	H	8	M	5	M	7
Number of Industries	4	0.1	8	1	26	6	12	2	18	4	124	9
Overall Score			5.8		11.5		10.3		13.3		17.5	
Rank			5		3		4		2		1	

6 Conclusions and Recommendations

Based on the scoring results provided in Section 5, the recommended candidate site is the Al Hassan Industrial Estate. This estate is fully developed and receives a mix of industrial and domestic wastewater that frequently adversely affects the performance of the existing WWTP. The site is understaffed, and would benefit from additional funding to adequately staff the facility and to install upgrades that will enhance its ability to treat a mix of industrial and domestic wastewater.

It is recommended that a project be undertaken to study and design appropriate upgrades to the WWTP. The next phase would include:

- Feasibility Study
- Environmental Impact Assessment (EIA)
- Preparation of Technical Specifications and Bid Documents
- Review and Implementation of Environmental Regulations

6.1 Feasibility Study

The Feasibility Study would entail several parts:

1. Assessment of Existing Conditions
2. Development of Design Basis
3. Development and Evaluation of Alternatives

Two optional activities should be considered for inclusion in the feasibility study – the evaluation of the privately owned Blue Water Treatment Plant and the distribution of an Industry Survey. The goal of the feasibility study would be to establish baseline conditions and a design basis for preparing the technical specifications and design drawings for any recommended upgrades.

6.1.1 Assessment of Existing Conditions

The first part of the Feasibility Study, Assessment of the Existing WWTP, would entail a detailed review and assessment of the existing collection system, treatment units (operational assessment), architectural and structural assessment of existing building and structures, electrical assessment, and mechanical assessment of existing treatment units. The goal of this part of the feasibility study would be to inform the design team of the condition of the plant to allow the development of proper design specifications for the upgrade.

In addition to a review of the operation and condition of the existing treatment plant, an assessment of the abandoned WWTP should be performed. This system was originally designed for a hydraulic flow of 500 m^3/hr and was abandoned in place. The condition of the system is poor and poses a safety hazard. The assessment should include a review of the structural and mechanical condition of the unit processes to determine whether any units can be salvaged, or whether they should be demolished. The resulting available space could be assessed for suitability for the location of any upgrades to the existing WWTP system.

6.1.2 Privately Owned Blue Water Treatment Plant (optional)

It is recommended that the scope of the Feasibility Study include an evaluation of the privately owned Blue Water Treatment Plant located on-site to determine if this facility could be used as part of the overall approach for the Estate to adequately treat industrial wastewater. To evaluate the Blue Water Treatment System, a separate review and assessment of the existing facilities (collection system, architectural, structural, electrical, and mechanical) should be performed, as well as a separate characterization of the incoming wastewater (flow and pollutant loading).

6.1.3 Industry Survey (optional)

The Feasibility Study could include a request for information from each of the industries discharging to the treatment system, to be obtained by means of a questionnaire. The intent would be to obtain information such as current operations, planned expansion or changes to operations, types of industrial processes conducted at the site, chemicals used on-site, existing pre-treatment, number of employees, hours of operation. A sample industry survey form is provided in Appendix D.

6.1.4 Development of Design Basis

This aspect of the Feasibility Study would be conducted to establish the basis of design for the upgraded/modified treatment system. This would require a detailed study of the current and anticipated flow rates and characteristics of the wastewater to be treated in the WWTP. To develop a basis of design the following types of information should be obtained and reviewed:

- WWTP flow data, influent and effluent, for the past three years
- WWTP pollutant loading for the past three years
- WWTP performance data for the past three years
- WWTP reported average and maximum flow rates
- WWTP reported seasonal variations in flow and/or pollutant loading

To confirm the information gathered from the WWTP, confirmatory sampling of the WWTP influent and effluent should be performed for at least one month.

Finally, the reuse and recycle goals for the treated effluent and the corresponding treatment requirements should be confirmed. The potential treatment goals will likely include reuse in industrial processes, reuse for irrigation, or discharge to surface water.

After completing the data review phase and confirmatory sampling, a design basis of average and maximum conditions (flow and pollutant loading) as well as treatment objectives should be developed. It is possible that more than one Basis of Design would be developed, dependent upon varying treatment objectives. This basis would be used to develop treatment alternatives.

6.1.5 Development and Evaluation of Alternatives

6.1.5.1 Development of Alternatives

In this phase, the Basis of Design would be used to develop potential alternatives to successfully treat the mixed industrial and domestic wastewater. The approach for developing alternatives will include:

- Identification of technologies to achieve the treatment objective outlined in the basis of design(s)
- Preparation of process description including modifications to the existing system and sparing philosophy for each option
- Preparation of a process sketch for each option
- Preparation of preliminary material balance for each option
- Development of preliminary plot plan
- Development of budget estimates (preliminary) for capital and operating costs

The materials prepared would be the basis for evaluating each of the alternatives.

6.1.5.2 Evaluation of Alternatives

A comparative assessment of all alternatives would be conducted with the goal of selecting an alternative and moving ahead to the design phase. The comparative assessment would include a review of the following:

- Environmental, Health and Safety Considerations
    - Water Reuse Potential
    - Regulatory Compliance Risks
    - Health and Safety Risks to Workers
    - Odor Control
    - Sustainability
    - Land Area Requirements
- Technical Considerations
    - Operator Experience and Familiarity
    - Operational Flexibility
    - System Complexity
    - Ease of Maintenance
- Ease of Construction
    - Future Expansion
    - Simplicity of Construction
- Economic Considerations
    - Capital Investment Costs
    - Operating Costs

A summary of advantages and disadvantages for each assessment would be prepared, resulting in the selection of a recommended alternative.

An Interim Report would be delivered for review and comment. The interim report would allow JIEC to review the project goals and ensure agreement on the recommended alternative. Following review and comment, a final report would be issued.

6.2 Environmental Impact Assessment (EIA)

After the alternative has been selected, an EIA will need to be prepared. Jordan's Ministry of Environment (MoEnv) requires that all projects submit an application to the MoEnv, to obtain Environmental Approval. The application must be prepared in accordance with the requirements outlined in Environmental Assessment Regulation No. 37. The regulation requires that all projects be classified into one of three categories; the category determines the requirements of the submittal. The goal of the EIA is to identify environmental and social

impacts in the early stages of a project and to identify the means to mitigate the identified impacts.

6.3 Preparation of Technical Specifications and Bid Documents

The next phase would include the preparation of Technical Specifications and Bid Documents for the selected alternative. The preparation of these documents would be dependent upon the project delivery method. The previous projects executed for the facilities in Sahab and Zarqa used a “Design-Build” approach. The typical Design-Build delivery process includes:

- Procurement of Owner’s Representative Services required to assist the Owner in project implementation
- Preparation of Tender Documents
- Prequalification process for Design-Build Contractor
- Procurement of the services for Design-Build Construction

6.4 Review and Implementation of Environmental Regulations

In addition to the above scope of work, it is recommended that a review of the existing environmental regulations applicable to the site and their enforcement be conducted. In order for any project to be successful and sustainable, adequate enforcement of environmental regulations by the Ministry of Environment and other local regulatory agencies is required, to ensure that all industrial wastewaters in the estate are properly collected, transported, and disposed of in compliance with existing requirements. It is recommended that a monitoring program be developed and enforcement authority be granted to the estate and WWTP staff.

7 References

JS202:2007 (2007) *Jordanian Technical Regulation – Water – Industrial Reclaimed Wastewater, JS202:2007*, Jordan Institution for Standards and Meteorology, Amman, Jordan.

RIAL (2011) *Assessment of Priority Industry Sectors for Participation in Industry Surveys*, October 26, 2011, Project Task 2, USAID Jordan.

MoE Website: http://www.moenv.gov.jo/En/LegislationAndPolicies/Legislation/Systems/Pages/EnvironmentalAssessmentSystem.aspx, accessed April 2015

JIB Website: http://www.jib.jo/BusinessandInvestment/WheretoInvest/IndustrialZones/tabid/269/language/en-US/Default.aspx, accessed April 2015

MEED Website: http://www.meed.com/supplements/2013/meed-guide-to-economic-zones/jordan-economic-zones/3183327.article#X-201308221007014, accessed April 2015

JIEC Website: http://www.jiec.com/JIEC/JSP_/other_files/Waste_Water_e.jspm, accessed April 2015

Appendix A. Site Visit Reports

Memorandum

To:	Karl Boyer, Deputy Chief of Party	Page 1 of 24
CC:	Charles Darnell, Chief of Party	
Subject:	Site Visit Reports – Industrial WWTPs in Industrial Estates in Jordan	
From:	Joyce O'Donnell, Randy Twiss	
Date:	02 April 2015	

Purpose

Summarize information obtained and observations made during the site visits to the Industrial Estates to investigate industrial wastewater discharges to existing domestic wastewater treatment plants (WWTPs).

Summary

Joyce O'Donnell (AECOM), Randy Twiss (AECOM) and Fateh Rawan (Engicon) visited five WWTPs located within industrial estates on March 24 through March 29. These estates each have a WWTP designed to treat domestic wastewater, but are either currently treating a mix of industrial and domestic wastewater or anticipate the need to do so in the future. Some of these industrial estates are fully developed and have had difficulties in treating the wastewater because the WWTP was not designed for the shock loads and high loadings of BOD, COD, and oil and grease of industrial wastewater. Other industrial estates are in earlier stages of development and have not yet started up their WWTPs. The site visits and personnel interviews were aimed at obtaining information about how the WWTPs were operating and to assess the potential need to upgrade the system in order to adequately treat the mix of domestic and industrial wastewater characteristic to their site.

Photographs were taken during each of these site visits and are stored on CDs.

Details

The attached site visit reports provide a summary of the information gathered and observations made during site visits to the following sites:

- Ma'an Development Area (Ma'an) (Site not visited due to USAID Travel Ban)
- Muwaqqar Industial Estate (Amman); March 26, 2015
- King Hussein Bin Talal Development Area (Mafraq); March 29, 2015
- King Hussein Bin Abdullah II Industrial Estate (Karak); March 24, 2015
- Al Hassan Industrial Estate (Irbid); March 25, 2015
- King Abdullah II Industrial Estate (Sahab); March 30, 2015

A site visit report is not included for Sahab, as this site is currently in the design phase for upgrading its WWTP to treat industrial wastewater, but was visited to allow comparison to the other sites.

We are available to answer questions by email at joyce.odonnell@aecom.com and randy.twiss@aecom.com.

Joyce O'Donnell
Senior Process Engineer
AECOM

Randy Twiss
Civil Engineer
AECOM

Summary Memo

March 29, 2015
Site: Ma'an Development Area
Attendees: Fateh Rawan, Engicon

USAID has imposed a travel ban to the governate of Ma'an, therefore, Fateh visited the Ma'an Development Company in Amman on February 11, 2015. In addition, Fateh received information and photographs from the site on March 15, 2015. This summary is based on information obtained from this meeting and the documents provided.

General

The Ma'an Development Area is being developed by the Development and Free Zones Commission (DFZC). It is a gated industrial park that covers an area of approximately 7,500,000 m2 (750 ha). The estate is equipped with complete infrastructure including a WWTP with a capacity of 700 m3/day.

The estate has eight (8) working facilities that employ approximately 100 persons primarily from the local community. The industry sectors include the following:

- Construction related materials (glass coating, adhesives)
- Tanning (dry)
- Chemical fertilizer

The estate plans to add food grade phosphoric acid and float glass factories.

The Ma'an Development area includes other facilities to attract workers and investors into the area including the following:

- Al Hussein bin Talal University and Residential community – female student flats that house 1100 students located at Al Hussein bin Talal university. These facilities generate domestic waste that is treated by the university.
- Hajj Oasis - currently under construction, provides a religious center
- Skill Development Center – this training center is located within the City of Ma'an and can accommodate 3000 students. The center includes vocational training services and dormitory facilities for students.

Description of Process

The Ma'an Development Center WWTP consists of an activated sludge system utilizing a sequential batch reactor (SBR). The system was built in 2005 and is sized for a hydraulic loading of 700 m3/day and an organic loading of 900 mg/L of BOD. The wastewater is processed through the following unit operations:

- Bar screens
- Lift station
- Splitter box
- Grit Removal
- Oil Water Separation
- Aerated SBR
- Sludge Thickener
- Mechanical Dewatering
- Chlorine contact basin
- Treated Water Basin

A sequencing batch reactor (SBR) is a fill and draw activated sludge system. The reactor containing activated sludge is filled with wastewater, allowed to process, and then drained - operating in a batch mode. The advantage of this type of system is that equalization, primary clarification, biological treatment, and secondary clarification can be achieved in a single reactor vessel. The SBR is a good option for applications with high fluctuation of incoming flow rates and loadings. Additional reactors can be added to the system to increase capacity.

Following the SBR, the water enters a chlorine contact basin and is stored in a treated water storage tank. The destination of the treated water is unknown, but is expected to be used on-site for irrigation. Sludge is further processed in a sludge thickener and mechanical dewatering.

Status of Operation

The WWTP was built in 2005 but has not been commissioned because of a lack of wastewater to sustain operations.

Water Supply

The industries in the industrial park are served by a ground water well with a 25 m3/hr water supply. Mr Mohannad Tarawneh, Acting CEO, indicated that it is difficult to attract industry to this area, and that an ample water supply would help. One example is the Tanning industry which currently operates a dry process within the estate. In the presence of good water supply and efficient wastewater treatment, the tanning industry might consider investing in a facility to process fresh material.

Site Visit Notes

March 26, 2015
Site: Muwaqqar Industrial Estate (Amman)
AECOM/Engicon Attendees: Joyce O'Donnell, Randy Twiss, Fateh Rawan

General

This industrial estate was established in 2011 and has a total area of 2,500,000 m2 (250 ha). The estate has been designed with a Phased Approach, with Phase 1 now being implemented. Phase 1 is reported to be 72% developed, with approximately 49 facilities under construction or in the design phase. Approximately 26 facilities are reported to be working. The table below summarizes the facilities currently operating and planned within the estate.

The general observation during the site visit was that these companies are more "heavy industry" facilities. The director reported that NIKE is building a dormitory to house approximately 3000 workers to work in a ready wear clothing manufacturing facility. The dormitory is expected to be completed in the next six months. Another textile facility that manufactures carpet is also expected to move into the estate in the near future.

Table (1): Planned Industrial Sectors in Al-Muwaqqar Industrial Estate.

Industrial Sector	Notes
Electronics	----------
Medical	----------
Food & beverage	15 factories
Engineering & Electrical	10 factories
Textile & Garment	Nike ready wear, carpet making
Metal & Wood	----------
Chemical	----------
Iron & Steel industries	1 factory

The infrastructure for this estate includes the phased design of a domestic WWTP with Phase 1 capacity of 1500 m3/day and a BOD loading of 1160 mg/L. A second and third phase has been designed, with equivalent capacities, but is not yet constructed. The treatment plant includes conventional activated sludge process. Water reuse is expected to include off-site agricultural irrigation.

The WWTP is not operational because the contractor has not yet handed over the plant to the estate. There is currently an arbitration committee working with both the owner and operator to negotiate the final terms of handing the facility over. It was reported during the site visit that the contractor has not completely fulfilled their obligation in constructing the facility.

Description of Process

The WWTP is located at the far end of the estate and receives all wastewater flow via gravity. The wastewater passes through a bar screen and an automated screen, then flows to a pump wet well. Three pumps transfer the wastewater to an aerated grit chamber equipped with an overflow weir for oil/scum removal. There is a bypass channel as well. The grit is removed to a hopper and screw conveyor. The effluent from the grit chamber flows via gravity to a splitter box. The splitter box is built to split the flow between the three treatment trains (Phase 1, 2, and 3).

From the splitter box, the wastewater flows via gravity to an Equalization Tank, where it is pumped to the aeration basin. The EQ tank has two floating mechanical aerators. The aeration tank has four fixed mechanical aerators. The effluent from the aeration tank overflows the effluent weir into the secondary clarifier. The water is then pumped to the sand filters and the chlorine contactor. The sand filters can be bypassed, if desired. From the chlorine contactor, the water flows to the treated water tank.

Sludge is removed from the secondary clarifier and pumped to the sludge thickener. Some sludge is returned to the aeration tank, and the remaining is dewatered in the mechanical dewatering building. The filtrate is returned to the headworks, and the sludge is further dewatered in the sludge drying beds.

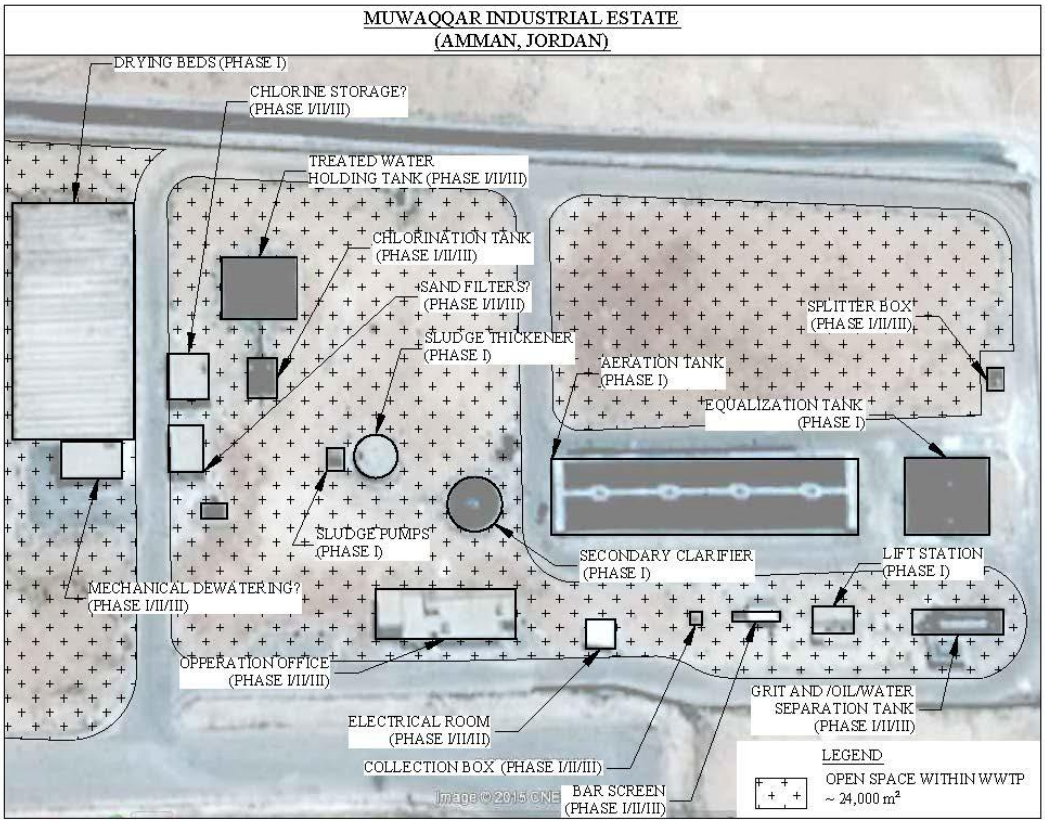
The facility has been designed to process primarily domestic wastewater, not industrial wastewater. The design loading of 1160 mg/L BOD is consistent with typical wastewaters found in Jordan, and the system includes an oil/water separator. No other provisions for receiving industrial wastewater are included in the design. The estate reports that it requires each industry to apply for a license before getting approval to build within the estate. As part of this procedure, the facility must characterize its wastewater. The estate reports that if the wastewater quality is not suitable for treatment in the WWTP, it will require the facility to perform pre-treatment.

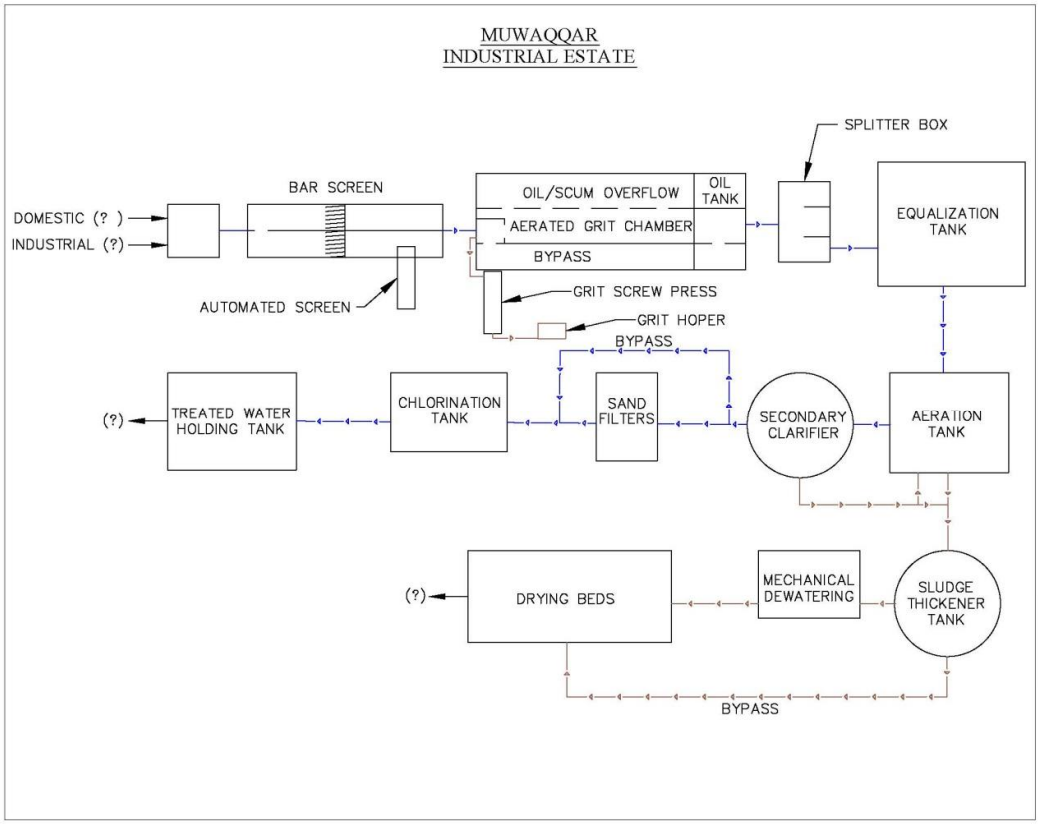
Status of Operation

The facility has not yet been started up because of difficulties in final negotiations in handing over the plant from the contractor to the owner. It is reported that there is an arbitration committee helping both sides to resolve the issues. Because of this, no staff has been hired to operate the system. The estate is anxious to start the WWTP and begin processing wastewater, especially with the new dormitory expected to be completed within the next 6 months. The estate reports that very little wastewater is currently being generated because most of the facilities are still in the construction phase. Any wastewater that is generated is likely being trucked off –site.

Water Supply

The estate reports that they have two groundwater wells. Only one is in use for the anticipated phase 1 needs, and the second is on standby. The facility also has access to the public water supply. The estate reports that it has storage for 4000 m3 of fresh water.


MUWAQQAR INDUSTRIAL ESTATE
(AMMAN, JORDAN)
DRYING BEDS (PHASE I)
CHLORINE STORAGE?
(PHASE I/II/III)
TREATED WATER
HOLDING TANK (PHASE I/II/III)
CHLORINATION TANK
(PHASE I/II/III)
SAND FILTERS?
(PHASE I/II/III)
SLUDGE THICKENER
(PHASE I)
SPLITTER BOX
(PHASE I/II/III)
AERATION TANK
(PHASE I)
EQUALIZATION TANK
(PHASE I)
SLUDGE PUMPS
(PHASE I)
SECONDARY CLARIFIER
(PHASE I)
LIFT STATION
(PHASE I)
MECHANICAL DEWATERING?
(PHASE I/II/III)
OPPERATION OFFICE
(PHASE I/II/III)
GRIT AND /OIL/WATER
SEPARATION TANK
(PHASE I/II/III)
ELECTRICAL ROOM
(PHASE I/II/III)
COLLECTION BOX (PHASE I/II/III)
BAR SCREEN
(PHASE I/II/III)
Image © 2015 CNES
LEGEND
OPEN SPACE WITHIN WWTP
~ 24,000 m²


MUWAQQAR
INDUSTRIAL ESTATE
SPLITTER BOX
BAR SCREEN
OIL/SCUM OVERFLOW
OIL TANK
DOMESTIC (?)
INDUSTRIAL (?)
AERATED GRIT CHAMBER
BYPASS
EQUALIZATION TANK
AUTOMATED SCREEN
GRIT SCREW PRESS
GRIT HOPER
BYPASS
(?)
TREATED WATER HOLDING TANK
CHLORINATION TANK
SAND FILTERS
SECONDARY CLARIFIER
AERATION TANK
(?)
DRYING BEDS
MECHANICAL DEWATERING
SLUDGE THICKENER TANK
BYPASS

Site Visit Notes

March 29, 2015
Site: King Hussein Bin Talal Development Area (KHBTDA) (Mafraq)
AECOM/Engicon Attendees: Joyce O'Donnell, Randy Twiss, Fateh Rawan

General

The Mafraq Development Corporation established this industrial estate in 2012. The estate size is approximately 21 km2 (2100 ha). Approximately 4.5 km2 (450 ha) have been developed, and the Jordan Industrial Estate Company (JIEC) is developing 1.8 km2. There is a 1.0 km2 free zone, and a 3.0 km2 area allocated for solar energy.

The estate has installed infrastructure including sewer, water, and electric utilities to be provided to all facilities. The sewer infrastructure includes gravity sewer collection and two pump stations to collect all the wastewater and transfer it to the wastewater treatment plant (WWTP) located at the far southeastern edge of the estate. The WWTP is currently not operating due to lack of available wastewater.

The estate is strategically located adjacent to the King Hussein Bin Talal Air Base, and there are plans to allow the railroad to pass through the site. The site is located close to the major roadways connecting to Syria, Saudi Arabia, and Iraq. The site is also within 5 km of the Za'atari Syrian Refugee Camp.

The estate has approximately 12 facilities that are either working or under construction as summarized in the table below. Currently, these companies are trucking all wastewater off-site for disposal at the Al Ekeder lagoon, which is only a few kilometers from the site. There are no dormitories or residences on site at this time, but the estate plan includes provisions for low, medium, and high end housing.

Table (1): Current Industrial Sectors in KHBTDA

Industrial Sector	Status	Number of factories	Number of Employees
Food	Working	1	26
Paper	Working	1	99
Engineering	Working	3	247
Steel Forming	Working	1	67
Pharmaceutical	Equipment Testing and commissioning	1	8
Fertilizer	Under Construction	1	2
Plastic Forming	Working	1	45
Detergents	Working	1	39
Aluminum Forming	Under construction	2	4

The estate reports that all industrial users will need to pre-treat their wastewater before discharging to the sewer system. The pretreatment requirements are the same as the basis of design for the WWTP and are summarized in the table below. None of the industries on-site are currently pretreating their wastewater; therefore, every facility would have to invest time and money into installing a pretreatment system before discharging to the estate's sewer system.

Table 2: Design Basis for WWTP, and Pretreatment Requirements for Industrial Users

Parameter	Concentration	Units
BOD5	500	mg/L
COD	1000	mg/L
pH	6 – 9	
Temperature	25 – 30	Degrees C
Chlorides	500 – 1000	mg/L
Sulfates	500 – 1000	mg/L
Dissolved Oxygen	>1	mg/L
TSS	300	mg/L
Settleable Solids	0 – 5	mg/L
TKN	30 – 40	mg/L
Ammonia	20 – 30	mg/L
Phosphorus	3 – 5	mg/L
Surfactants	30 – 40	mg/L
Oil and Grease	30 – 40	mg/L
Phenols	3 - 5	mg/L

Description of Process

The system has a hydraulic capacity of 1500 m3/day, with a minimum hydraulic requirement of 600 m3/day and BOD loading of 500 mg/L. Wastewater is collected throughout the estate via gravity and two pump stations. The headworks consist of two parallel bar screens followed by a lift station transferring the wastewater to a grit chamber and oil water separator. The water flows via gravity to an aerated equalization tank. The water flows under a baffle to a neutralization chamber where the wastewater is adjusted for pH, and is pumped to a splitter box for two aeration tanks. Fine bubble diffusers are used for the aeration tanks.

Overflow from the aeration tanks is processed for solids removal in two secondary clarifiers. The water is then processed through a sand filter and a chlorine contact tank. Currently, there is no treated water storage tank, but the estate would like to install one to allow the water to be reused on-site for landscaping. The current system directs the water by gravity to a small nearby wadi via a 50 m pipeline.

Sludge is removed from the clarifiers via a gravity sludge return line to a sludge collection tank. From here, some sludge is pumped to the activated sludge aeration tanks, and the remaining is transferred to a sludge thickener. The thickened sludge is further processed in a sludge digester and then dewatered with a belt press. A carbon filter is provided for removing odors.

The system design description provides the following characterization for treated wastewater, which is suitable for irrigation.

Table 3: Estimated Treated Water Characterization

Parameter	Concentration	Units
BOD5	<10	mg/L
COD	<120	mg/L
pH	6 – 9	
Temperature	30	Degrees C
Chlorides	Same as inlet	mg/L
Sulfates	Same as inlet	mg/L
Dissolved Oxygen	>2	mg/L
TSS	<15	mg/L
Settleable Solids	-	mg/L
TKN	<12	mg/L
Ammonia	<8	mg/L
Phosphorus	<5	mg/L
Surfactants	<2	mg/L
Oil and Grease	<5	mg/L
Phenols	0.05	mg/L
TDS	Same as inlet	mg/L

Status of Operation

The system was commissioned by the contractor with clean water, but has not operated due to lack of available wastewater. The pumps, blowers, and aeration diffusers have been removed and are in storage. All piping is stainless steel and is in good condition. The development authority has an agreement with the contractor to start up the WWTP within 10 years of construction (2012) and for operation for one year. After that one year, the estate will take over operation.

The estate is investigating alternatives to bring additional wastewater to the facility to allow it to start operating. The estate is willing to accept domestic wastewater from the nearby Za'atari Refugee camp. The Za'atari refugee camp is reported to be generating 1500 m3/day of high BOD waste. Approximately 700 m3/day is reportedly being treated with an MBR and/or trickling filter. The KHBTDA would be willing to accept the remaining waste via truck or via pipeline. Either option would require modification to the treatment plant, which the estate is willing to do. The estate realizes that the high BOD loading may be of concern for the design basis of their WWTP, but is willing to invest in additional process modifications to allow them to accept and treat this domestic wastewater.

The estate is also willing to consider interim options to treat wastewater at intermediate locations within the facility. The estate is still in the construction phase and could easily modify its infrastructure to collect and treat wastewater using skid mounted systems at key locations within the facility. The estate expressed interest in using skid mounted/temporary systems to treat wastewater on a smaller scale.

Water Supply

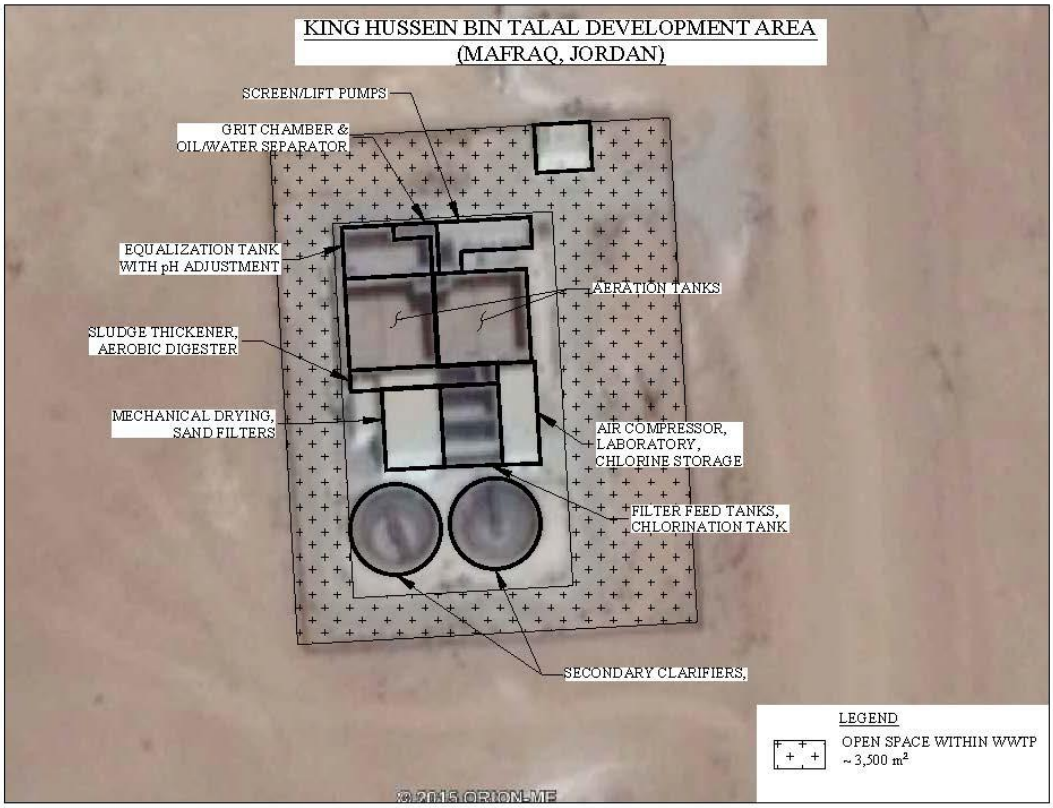
The facility has five wells from which it draws water and a forced water main (municipal source?). There is a holding tank with a capacity of 4000 m3 and an elevated storage tank with a capacity of 375 m3.

Post Visit Notes

Fateh Rawan (Engicon) contacted UNICEF regarding the MBR and Trickling filters in use at the Za'atari Refugee Camp. UNICEF reported the following capacities:

1750 m3/day trickling filter
1750 m3/day MBR
3500 m3/day total capacity for approximately 100,000 people

The camp is currently generating approximately 2000 m3/day, therefore, they have an excess capacity of 1000 m3/day. This conflicts with the information provided by the staff at the Mawaqqar Estate.



Site Visit Notes

March 24, 2015
Site: Hussein Bin Abdullah II Industrial Estate (Karak)
AECOM/Engicon Attendees: Joyce O'Donnell, Randy Twiss, Fateh Rawan

General

The industrial estate currently has 18 companies in operation employing approximately 2532 workers. The existing wastewater treatment plant (WWTP) services the entire facility receiving approximately 400 to 500 m3/day of wastewater. Of this, approximately 60% of this is attributed to the dormitories and cafeteria housing approximately 2000 workers. The remaining wastewater is attributed to the industrial activity which is primarily light textiles. The estimated overall wastewater is estimated to be 75% domestic and 25% industrial. No wastewater is trucked in from external sites.

The WWTP consists of an activated sludge extended aeration system that was planned for three phases of construction (Phase 1, Phase 2, and Phase 3). The current system is built to support Phase 1, with a hydraulic capacity of 670 m3/day with an average BOD of 300 mg/L. Some portions of the current system are built out to handle the full phase 3 hydraulic capacity of 2100 m3/day, while others will require expansion. The piping infrastructure is also designed to handle the full phase 3 capacity of 2100 m3/day to receive wastewater.

The current system appears to be operating well and meets the treatment objective for treating wastewater suitable irrigation. Engicon provided typical results for influent and effluent quality as summarized in the table below.

Parameter	Influent	Effluent	Limit *
pH	7.78	7.68	6-9
TDS	1388 (mg/L)	1261 (mg/L)	2000 (mg/L)
TSS	220 (mg/L)	17.3 (mg/L)	60 (mg/L)
BOD5	225 (mg/L)	12 (mg/L)	60 (mg/L)
COD	1328 (mg/L0	28 (mg/L)	150 (mg/L)

*Limit for Surface Water Discharge (Jordanian Technical Regulation 202/2007)

As seen above, the treatment system cannot remove TDS, however, the levels are still below the limit required for surface water discharge or irrigation. The WWTP supervisor noted that the discharge from all industrial facilities are sampled every one to two days and analyzed in their own internal laboratory. When a problem is discovered, the industry is notified and given some time to resolve the issue. In some cases, the industry must truck out waste that is off specification – this has happened occasionally for the food preparation site when the grease trap was overloaded. New industries would be required to obtain a license which requires the submittal of a wastewater characterization. This allows the WWTP to screen the industry before granting permission to establish operations within the industrial estate.

Operation

The system has three operators that work one shift per day, seven days per week. The WWTP operates on automatic controls during the evening and overnight hours.

Maintenance

The facility conducts maintenance when something is broken, or requires cleaning. They report having backup pumps if required and sufficient spare parts to perform the required maintenance. They have a budget for conducting maintenance, but not for improvements.

Water Source

The source of water for the estate is an on-site well that supplies water via an elevated water tank. The well has a capacity of 55 m3/hr and is sufficient for the needs of the estate.

End Use of Treated Wastewater

Treated wastewater is reused on-site for irrigation and off-site for a fodder irrigation project.

Future Expansion

The current WWTP has a hydraulic capacity of 670 m3/day and is receiving 400 to 500 m3/day. The site has been designed to be upgraded to 2100 m3/day in phases. Some of the WWTP is already sized for the full Phase 3 flow, while some of the WWTP is not.

Unit/Location	Design Phase	Design Flow (m^3/day)	Comment
Headworks (bar screens, grit chamber, flow monitoring)	3	2100	
Primary Clarifier	3	2100	
Equalization Tanks	1, 2	670 x 2	The system has two equalization tanks in place, but only one is used.
Transfer Pumps	1		
Aeration Basin	1	670	
Secondary Clarifier	1	670	
Sludge Pump(s)	1		
Chlorination Tank	1	670	
Treated Water Tank	3	2100	
Sludge Thickener and Transfer Pump	1		
Sludge Drying Beds (21)	1	670	

Site Walk Notes

Inspection of the headworks showed significant amount of oil and grease entering the system. The supervisor indicated that this was from the dormitory cafeteria that was washing dishes from the morning meal.

The screens are cleaned manually. A third set of screens was added with a finer opening to try to reduce the quantity of “threads” that are passing through the system. The presence of these threads from the textile industries is problematic to the system, especially if they enter the pumps. The grit chambers are manually cleaned periodically.

The primary clarifier is sized for the full phase 3 flow. The clarifier does have a scum skimmer and tank, but it has periodically become overwhelmed when a slug of oil and grease enters the system. The clarifier can also develop an unpleasant smell because of the large retention time (it is oversized for the current flow).

The overflow from the primary clarifier enters one of two equalization (EQ) tanks with a capacity of 1100 m3 each. The equalization tanks are not connected to each other hydraulically, which can be troublesome when one tank needs to be cleaned. The second EQ tank is only used during high storm events, or when the first tank needs maintenance. The first tank is aerated with fine bubble aeration

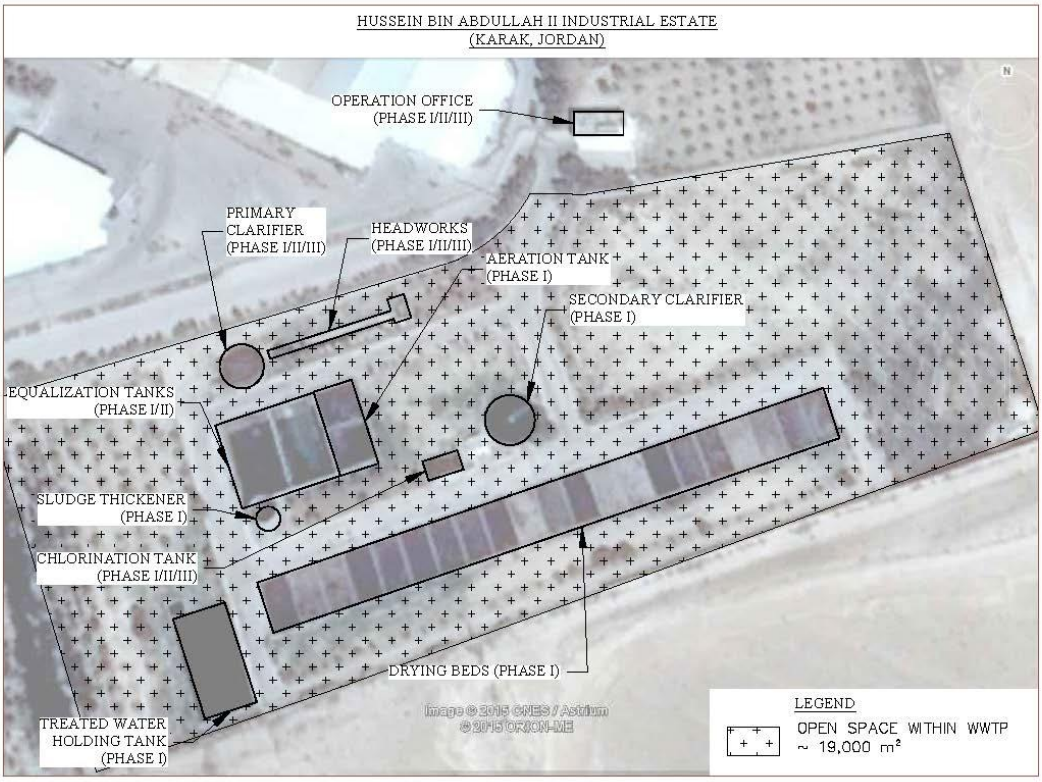
pipes from two blowers that are controlled by the dissolved content of the wastewater. During maintenance, it has been noted that there is very little sludge that accumulates in the EQ tank. The contents of the EQ tank are pumped to a single aeration tank with two submersible pumps. Both pumps operate during the day when the system is receiving peak flow. The pumps are on a timer for alternating start mode during the evening and overnight hours. The aeration tank utilizes jet-type aeration pumps arranged to provide a circular flow of wastewater through the tank and adequate oxygen. The overflow enters the secondary clarifiers via gravity. Upon exiting the secondary clarifier, the wastewater flows through the chlorine contactor and to the treated water tank.

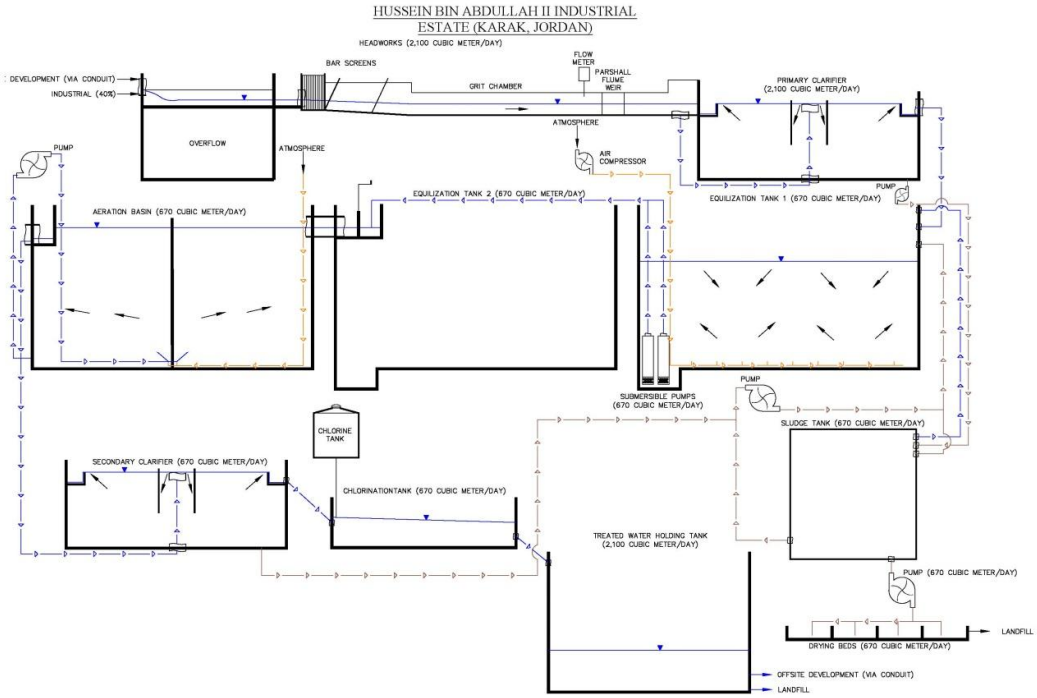
Sludge is withdrawn from the primary and secondary clarifiers and stored in the sludge thickener. The overflow from the thickener flows to the equalization tank. Some sludge from the secondary clarifier is returned to the aeration tank to maintain an optimum F:M ratio. Thickened sludge is pumped to the drying beds for final dewatering. Each time the thickener is emptied, it utilizes three of the 21 drying beds. The dried sludge is collected manually and landfilled. The underflow is returned to the equalization tank. The drying beds operate fairly well during the summer months, but do not perform well during the rainy season (winter).

All control panels were noted to be located outside and showing signs of corrosion, except for the timer for the EQ tank blowers that are located in the administration building. There is no control room.

Noted Issues/ Problems

1. Oil and grease loading can sometimes overwhelm the system. The supervisor has to periodically remind the food preparation facility to maintain its grease trap.
2. Threads from the textile industry are difficult to remove and cause problems with the pumps. The plant has installed an additional, finer set of screens but has still had difficulties removing all threads.
3. The primary clarifier is oversized and can sometimes develop an unpleasant smell
4. The current ultrasonic flow meter is not working properly. The flow meter only provides actual flow, but does not provide totalized flow. The WWTP staff is currently taking hourly readings during regular working hours to estimate flow.
5. There is often a discrepancy with analytical data provided by the on-site laboratory and the data provided by the Royal Society, especially for nitrogen. The samples taken by the Royal Society has showed high nitrogen content, but the samples analyzed on-site do not.
6. The EQ tanks and the aeration tanks do not have drains on them making it difficult to empty them for maintenance.
7. All control panels are outside and show signs of weathering and corrosion. A control room to house the panels would be preferable.
8. There are no provisions for sludge digestion, so when it rains the sludge can develop a bad smell. Also, the sludge dryers are not very effective in the winter season when it rains. The site would prefer any future upgrades to include a filter type sludge dewatering system.


HUSSEIN BIN ABDULLAH II INDUSTRIAL ESTATE
(KARAK, JORDAN)
OPERATION OFFICE
(PHASE I/II/III)
PRIMARY
CLARIFIER
(PHASE I/II/III)
HEADWORKS
(PHASE I/II/III)
AERATION TANK
(PHASE I)
SECONDARY CLARIFIER
(PHASE I)
EQUALIZATION TANKS
(PHASE I/II)
SLUDGE THICKENER
(PHASE I)
CHLORINATION TANK
(PHASE I/II/III)
DRYING BEDS (PHASE I)
TREATED WATER
HOLDING TANK
(PHASE I)
Image © 2015 CNES / Astrium
© 2015 ORION-ME
LEGEND
OPEN SPACE WITHIN WWTP
~ 19,000 m²


HUSSEIN BIN ABDULLAH II INDUSTRIAL
ESTATE (KARAK, JORDAN)
HEADWORKS (2,100 CUBIC METER/DAY)
DEVELOPMENT (VIA CONDUIT)
INDUSTRIAL (40%)
BAR SCREENS
GRIT CHAMBER
FLOW METER
PARSHALL FLUME WEIR
PRIMARY CLARIFIER (2,100 CUBIC METER/DAY)
ATMOSPHERE
OVERFLOW
PUMP
AIR COMPRESSOR
EQUILIZATION TANK 2 (670 CUBIC METER/DAY)
EQUILIZATION TANK 1 (670 CUBIC METER/DAY)
AERATION BASIN (670 CUBIC METER/DAY)
SUBMERSIBLE PUMPS (670 CUBIC METER/DAY)
SLUDGE TANK (670 CUBIC METER/DAY)
CHLORINE TANK
SECONDARY CLARIFIER (670 CUBIC METER/DAY)
CHLORINATIONTANK (670 CUBIC METER/DAY)
TREATED WATER HOLDING TANK (2,100 CUBIC METER/DAY)
PUMP (670 CUBIC METER/DAY)
LANDFILL
DRYING BEDS (670 CUBIC METER/DAY)
OFFSITE DEVELOPMENT (VIA CONDUIT)
LANDFILL

Site Visit Notes

March 25, 2015
Site: Al Hassan Industrial Estate (Irbid)
AECOM/Engicon Attendees: Joyce O'Donnell, Randy Twiss, Fateh Rawan

General

Al Hassan Industrial Estate was established in 1991. It has a total area of 1,180,000 m2 (118 ha) of industrial space. This Industrial Estate was the first Qualifying Industrial Estate Zone (QIZ) in Jordan as authorized by the US Congress and can directly access US markets without tariff or quota restrictions.

The Industrial Estate contains approximately 125 companies employing more than 25,000 employees. The existing wastewater treatment plant (WWTP) is operating at an average flow rate of approximately 1200 m3/day and has the capability of expanding to up to 2100 m3/day. In addition, an older treatment system is still in place that was abandoned when the new system was built. The capacity of the old system is 500 m3/day. The wastewater mix of industrial and domestic varies day to day and is reported to vary from 35% to 65% domestic waste. Of the industrial waste, approximately 60% is from the textile industry. A breakdown of the industry was provided by Engicon and is summarized in the table below. The WWTP is not designed to accept and treat industrial waste, and is reported to experience upsets when it receives slug loads from the industry that can take weeks or months to recover from.

Summary of Industries Operating at the Estate

Industrial Sector	Labor	No. of Companies
Garment	16,165	36
Engineering	275	20
Plastic & rubber	49	13
Pharmaceutical	346	15
Chemical	130	8
Furniture	17	2
Food	378	21
Leather	57	3
Construction	10	1
Packaging	10	3
Other	56	2
Total	17,493	124

The industrial estate is essentially full, and does not expect to add additional industry. However, the estate does expect to service additional housing for immigrant workers. The director of the estate estimates that the wastewater treatment plant will be servicing up to 10,000 more workers in the next few years due to the development of additional housing outside the estate that does not have adequate domestic waste treatment.

In addition to the WWTP operated by the estate, there is a private industrial wastewater treatment system located within the estate. This privately owned system accepts wastewater from the garment industry including blue water and towel water. The treatment capacity of this blue water treatment system is reported to be 2000 m3/day, however, it is currently only treating 700 to 1000 m3/day. The treated effluent is provided to farmers outside the facility for irrigation of trees and fodder crops. The owner reports that they take samples to ensure that the water quality is adequate for this use. This private treatment plant reports that it may be forced to shut down because not enough users are sending their wastewater to the facility and the operating and maintenance costs exceed the income generated from its operation.

WWTP Performance

Engicon obtained data from the WWTP operators for average influent concentrations and effluent concentrations and is summarized in the tables below. As shown, COD loading is significantly higher than BOD indicating additional loading by industrial facilities. The treated effluent is adequate for class III irrigation. Note that the effluent is not analyzed for oil and grease; however, the operators note that the oil water separator is not working well, and the treated effluent had visual oil sheen.

Average Influent Conditions (February 2015)

Parameter	Value
pH	7.2
TDS	1379 mg/l
TSS	255 mg/l
COD	1817 mg/l
BOD	349 mg/l
NH_4	4.4 mg/l
NO_3	3.4 mg/l

Average Effluent Characteristics

Parameter	Value
Temp.	16 ^{o}C
pH	7.5
TDS	1375 mg/l
R-Cl_2	0.00 mg/l
TSS	37 mg/l
COD	207 mg/l
BOD	47 mg/l
NH_4	1.4 mg/l

Parameter	Value
NO_3	1.0 mg/l
T.H	330 mg/l
Ca	44 mg/l
Mg	54 mg/l
Na	263 mg/l
Cl	405 mg/l
SAR	8.7 mg/l
Turbidity	39 mg/l
Al	0.005 mg/l
CN	0.003 mg/l
Zn	0.04 mg/l
Mn	0.06 mg/l
Fe	0.05 mg/l
L.A.S	0.1 mg/l
SO_4	173 mg/l

Site Visit Notes

Headworks

The existing headworks includes an automated bar screen that is currently not operating. The screens are cleaned manually. The lift station is very deep, by design, to accept gravity flow of wastewater from the entire estate. Three lift pumps are used to transfer the inflow to the grit chamber. The discharge from the lift pumps can be valved to allow transfer of wastewater to the old treatment system, but this is only considered during an emergency or upset situation. A flow meter is installed on the pump discharge to both the new wastewater treatment system and the old system.

Old Treatment System

The old treatment system is not currently operated. An inspection of the system showed significant deterioration of the concrete and steel indicating that a significant upgrade would be required for future use, or the system should be demolished. The system includes the following unit processes:

- Bar screens
- Oil water separator

- Circular equalization tank
- Two circular aeration tanks with a single surface aerator
- Two circular secondary clarifiers
- Chlorination tank
- Sludge thickening tank
- Two treated water holding tanks

New System

The new WWT system was commissioned in 2008 and is referred to as Phase 2 and 3 (Phase 1 is the old, decommissioned plant). The system was designed and built to allow a phased approach to start-up and operations. Currently, only phase 2 (1050 m3/day capacity) is in operation, but the phase 3 (an additional 1050 m3/day capacity) part of the plant has been installed and can easily be incorporated in to operations. The headworks, including the pumps, grit chamber, and oil water separator have been sized for the full flow of Phase 2 and Phase 3. The equalization tanks, aerators, clarifiers, chlorine contact basin, and sludge drying beds have been sized and installed in two parallel trains to handle the flow of each phase.

The new system is operated by a SCADA system located in the operations building. The SCADA offers the ability to monitor and control the facility from a computer interface. The operator provided a demonstration of the SCADA screens for the system.

The grit removal consists of two parallel channels with isolation gate valves. The channels are cleaned manually. The oil water separator consists of a circular tank with a skimmer. Currently the system is not working, and appears to have been modified allowing short circuiting. The skimmer was observed to be too high to allow any skimmed grease and oil to overflow, and the effluent pipe was at the same level as the influent, allowing all wastewater entering to flow directly out. A retrofit that would include a submerged outlet for the effluent and balancing of the elevation of the influent and skimmer would likely improve operation.

The effluent from the OWS flows via gravity to the Equalization Tank. The tank includes aeration using blowers and bubble diffusers controlled by the dissolved oxygen content of the water. The discharge from the sludge thickener is returned to the equalization tank. The wastewater is pumped to the aeration tank which includes four jet pumps in each of two chambers. The overflow from the aeration tank enters two secondary clarifiers operated in parallel. The previous site visit by Engicon noted that these clarifiers cannot be isolated making it difficult to clean and can adversely affect operations. The previous site visit observed floating sludge likely due to septic conditions in the bottom of the clarifier.

The overflow from the secondary clarifiers enters the chlorine contactor and is then pumped to the treated water tank. The site has a sand filter that is not currently used due to issues with backwashing. Observation of the water entering the chlorination contactor showed signs of grease and oil, and some suspended solids. Treated water is pumped off-site for use as irrigation of fodder plants.

Sludge is removed from the secondary clarifiers and pumped to a sludge thickener. The thickened sludge is dried in drying beds. The WWTP has a belt press that is currently not in use because of difficulties with operation and maintenance. The facility prefers to use sludge drying beds.

Blue Water Treatment System (Privately owned)

The blue water treatment system receives blue water and towel water from two textile facilities. The facility is reported to have a design capacity of 2000 m3/day and a BOD load of 755 kg/day, but is

currently being operated at 700 - 1000 m3/day. The system consists of a partitioned receiving tank for each of the two streams. The operator reported that the wastewater is treated separately in each of two parallel treatment trains (one for blue water and one for towel water), but visual observation indicates that the streams are mixed within the system. The owner provided a copy of a report that he authored detailing the design and operation of the blue water treatment plant. The following description is based primarily on this report, and not solely on the interviews conducted during the site visit because they were contradictory.

The blue water is pumped from the influent collection tank to an equalization tank and then to the top of the elevated treatment system where poly aluminum chloride (PAC) coagulant is added in a rapid mix tank. The wastewater overflows to an inclined plate lamella clarifier and then to an aeration tank using diffused aerators. The towel water is pumped directly to the first aeration tank, where it is mixed with the blue water that is exiting the first settling tank. The effluent from the aerator overflows to a second clarifier and then to a larger aeration tank. The effluent of the second aeration tank enters a chlorination tank where hypochlorite is added, and then a third clarifier before overflowing to a clarified water tank. The owner reports that the aeration tanks have been operated in the past with aeration blowers to promote treatment, but are not currently used because of the high cost of electricity. The water in the clarified water tank is pumped through a sand filter and carbon filter and then off site for use as irrigation for fodder crops and trees. The owner reports that he does not sell the treated water, but gives it away.

Sludge is removed from the bottom of the three clarifiers and is sent to a sludge tank and dewatered using a sludge drying bed. There is a filter press located at the facility, but the owner reports that it is too expensive to operate; therefore, they built their own sludge drying bed. The dried sludge is collected in bags, but the owner reports that it is difficult to find a place for disposal of the sludge. The general condition of the system was good, except for the access stairs and platform that have undergone considerable corrosion and may be unsafe. The condition of the aeration tanks and clarifiers could not be assessed easily as they were covered.

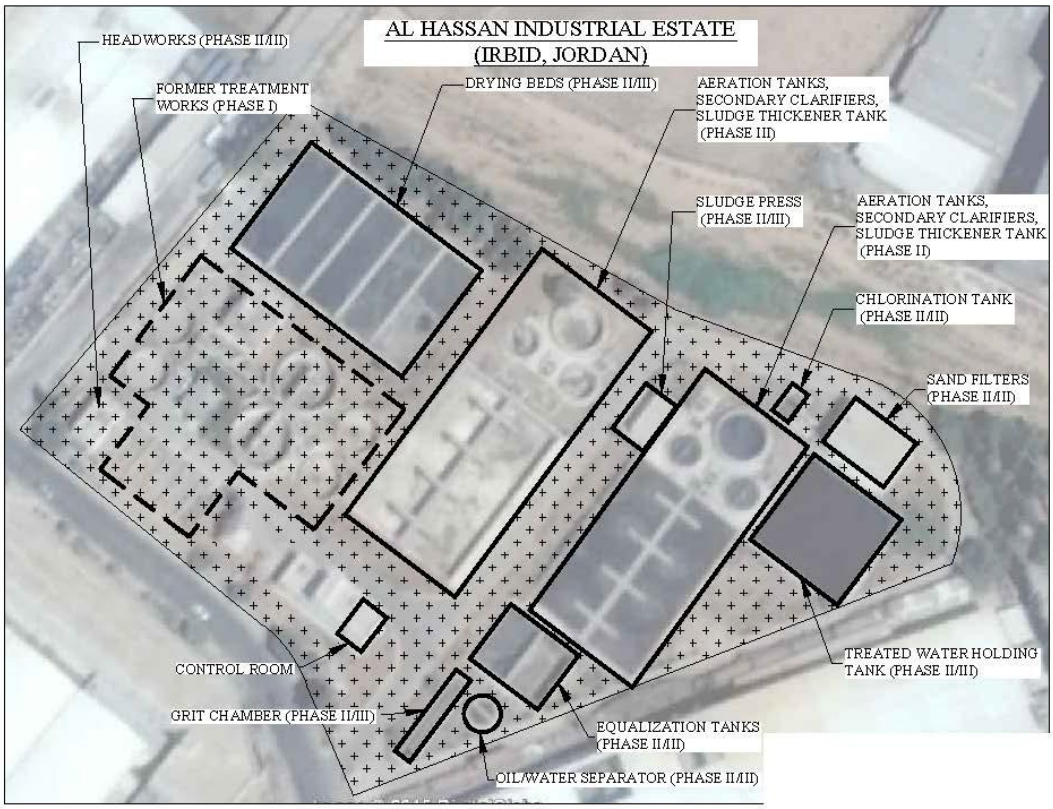
The owner if this system is disgruntled and frustrated because he is not receiving enough wastewater to make the system profitable. He has received several inquiries from industries that have relied on the Al-Ekeder disposal site for disposal of their wastewater. With the imminent closing of this site, these industries are looking for alternatives for disposal of their wastewater. Of specific concern are the wastewaters from the yeast and yogurt industry that is very high in TDS. The owner believes that the lack of options for these facilities may result in an increase in illegal dumping of wastewater. The owner reports that the existing blue water treatment system cannot accept these wastes due to the high BOD/COD and TDS, unless the system was upgraded to include something like a DAF and a reverse osmosis unit.

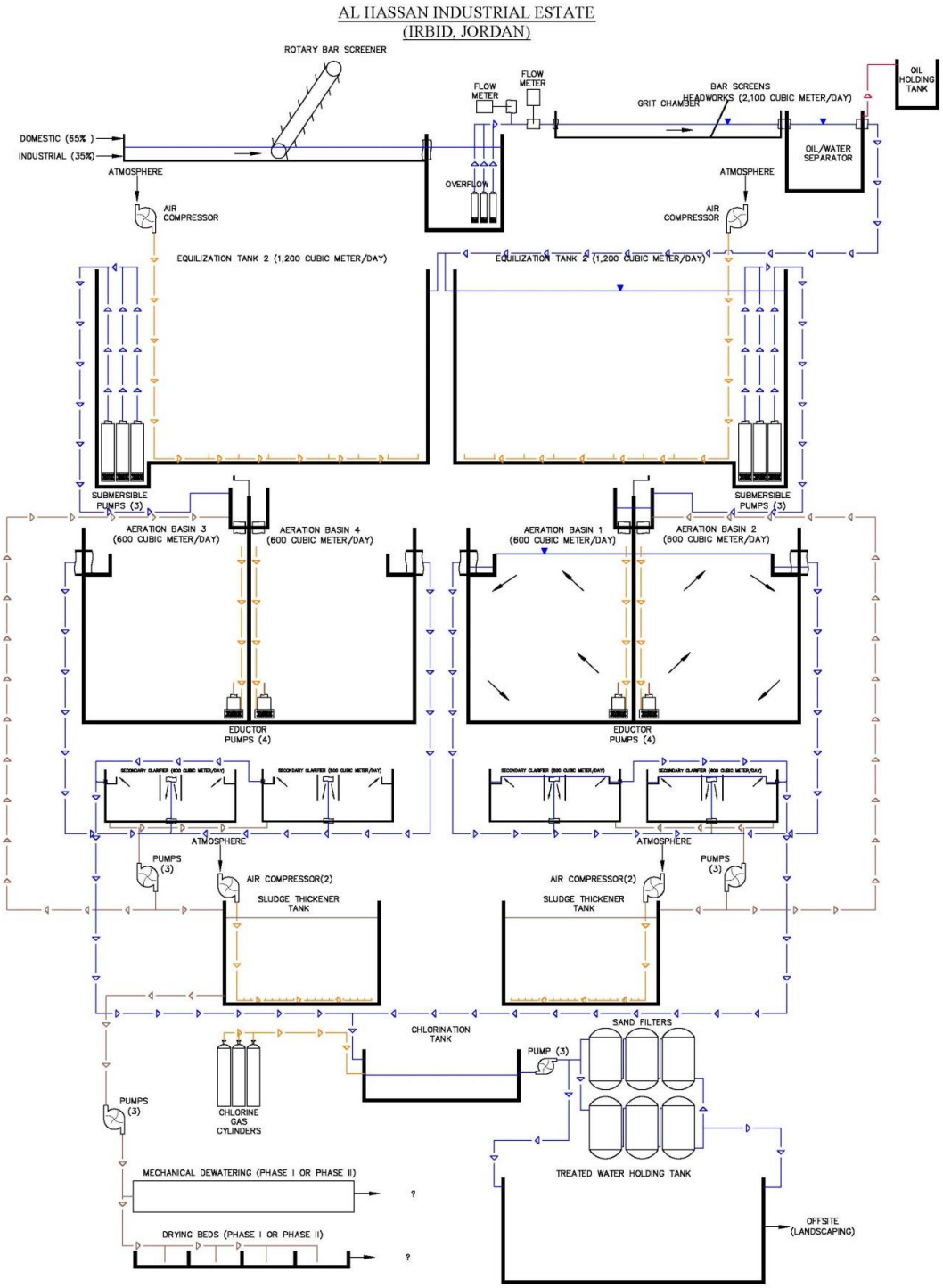
Noted Issues/Problems

1. The industries in the estate are allowed to discharge industrial waste without pretreatment, and the wastewater treatment operators have no authority to change this. The uncontrolled discharges cause problems in the WWTP that can take weeks or months to overcome. During the Engicon site visit, the WWTP had received a slug of red wastewater.
2. The existing WWTP is not equipped to handle slug loads of industrial wastewater. The system would require modification to respond to industrial waste.
3. The WWTP Oil/water separator is not operating. Some minor modifications including a submerged effluent pipe and balanced hydraulic levels of the skimmer may improve the operations.
4. The secondary clarifiers cannot be isolated for maintenance
5. The estate is being viewed unfavorably by the public due to recent housing developments outside of the estate to house immigrant workers for the estate. These housing complexes have been discharging untreated domestic waste causing the neighbors to complain. To

counteract this problem, the estate may start collecting the domestic waste from these housing complexes and treat it in its own WWTP, increasing the flow to the system. The increased flow will not cause an issue since the facility can easily start up the Phase 3 portion of the treatment system, but the unfavorable publicity is of concern.

6. The old treatment system has experienced significant deterioration. It is not suitable for operation in its current condition and options for removal or restoration should be considered. The area occupied by the old system could be considered as available space for future modifications to the treatment plant to receive industrial wastewater.


AL HASSAN INDUSTRIAL ESTATE
(IRBID, JORDAN)
HEADWORKS (PHASE II/III)
FORMER TREATMENT WORKS (PHASE I)
DRYING BEDS (PHASE II/III)
AERATION TANKS, SECONDARY CLARIFIERS, SLUDGE THICKENER TANK (PHASE III)
SLUDGE PRESS (PHASE II/III)
AERATION TANKS, SECONDARY CLARIFIERS, SLUDGE THICKENER TANK (PHASE II)
CHLORINATION TANK (PHASE II/III)
SAND FILTERS (PHASE II/III)
TREATED WATER HOLDING TANK (PHASE II/III)
CONTROL ROOM
GRIT CHAMBER (PHASE II/III)
EQUALIZATION TANKS (PHASE II/III)
OIL/WATER SEPARATOR (PHASE II/III)


AL HASSAN INDUSTRIAL ESTATE
(IRBID, JORDAN)
ROTARY BAR SCREENER
FLOW METER
FLOW METER
BAR SCREENS
HEADWORKS (2,100 CUBIC METER/DAY)
GRIT CHAMBER
OIL HOLDING TANK
DOMESTIC (65%)
INDUSTRIAL (35%)
ATMOSPHERE
OVERFLOW
OIL/WATER SEPARATOR
ATMOSPHERE
AIR COMPRESSOR
AIR COMPRESSOR
EQUILIZATION TANK 2 (1,200 CUBIC METER/DAY)
EQUILIZATION TANK 2 (1,200 CUBIC METER/DAY)
SUBMERSIBLE PUMPS (3)
SUBMERSIBLE PUMPS (3)
AERATION BASIN 3 (600 CUBIC METER/DAY)
AERATION BASIN 4 (600 CUBIC METER/DAY)
AERATION BASIN 1 (600 CUBIC METER/DAY)
AERATION BASIN 2 (600 CUBIC METER/DAY)
EDUCTOR PUMPS (4)
EDUCTOR PUMPS (4)
ATMOSPHERE
ATMOSPHERE
PUMPS (3)
PUMPS (3)
AIR COMPRESSOR(2)
AIR COMPRESSOR(2)
SLUDGE THICKENER TANK
SLUDGE THICKENER TANK
CHLORINATION TANK
SAND FILTERS
PUMP (3)
PUMPS (3)
CHLORINE GAS CYLINDERS
TREATED WATER HOLDING TANK
MECHANICAL DEWATERING (PHASE I OR PHASE II)
?
DRYING BEDS (PHASE I OR PHASE II)
?
OFFSITE (LANDSCAPING)

Appendix B. JIEC Document No. W1095-3, Waste Water Specifications

Instruction	Jordan Industrial Estate Corporation
Page : 1 / 4	Document No : W1095 – 3
Version: 1 / 4 Date: 25 / 4 / 2010	Approved by administration representative :
	Subject : Waste Water Specifications

1. Scope

This specification is based on determination of conditions, requirements and limitations related to disposal of industrial wastewater resulting from plants to sewage networks, then to treatment stations in order to be biologically treated and to reuse such waters for restricted agricultural purposes.

2. Definition

- Industrial Wastewater:

The wastewater resulting from use of waters whether in manufacturing, cleaning, cooling and others.

- Treated Industrial Wastewater :

The industrial wastewater initially treated by a plant prior to disposal to the sewage network, which complies with the sanitation instructions issued by the Corporation.

3. General Requirements

- The quantity of wastewater disposed to the sewage network shall not be more than (50 m3/per day).
- The industrial wastewater shall be separated from Domestic wastewater.
- Rainwater shall not be disposed to the sewage network.
- Concentrated saline solution resulting from saline regeneration of water softener shall not be disposed to the sewage network.
- Wastewater resulting from industry activities and cleaning yards of loading and discharging shall not be disposed to rainwater drainage channels.
- The plant shall incur the costs of any violation it commits, whether the resulting damages are operational and affect the treatment station, sewage network or rainwater drainage channels.
- The plant shall incur the costs of analyzing non-conforming samples disposed to the sewage network/rainwater drainage channels as per the rates regulation approved by the Corporation.
- A special treatment unit shall be provided according to the type of industry within the plant premises in order to abide by the quality of water disposed to the sewage network.
- Industrial wastewater containing the following materials shall not be disposed to the sewage network:

A- Petroleum materials and their derivatives, materials containing oils, greases, waxes or dyes , materials that can precipitate or freeze at a temperature ranging between 0 and 40°C or materials that cannot be processed or reduced during the treatment process.

B- Any liquids or waters containing heavy metals, phenol compounds, chloride organic solvents, sulfate compounds, color removal materials, insecticides, rodenticides and micro organism.

C- Any materials with corrosion feature or concentrated acidic or alkaline materials

D- Any solid or viscous materials that obstruct flowing or hinder treatment process such as sand, ash, wood, feather, hair, metals, plastic, sawdust, garbage, meats, paper, cardboard..etc.

E- The temperature of industrial wastewater shall not be more than 45°C.

4. The industrial wastewater shall be disposed to the sewage network, provided that the quality of wastewater matches with the characteristics included in the below table:

Parameter	Symbols	Unit	Total Accepted Amount
Biochemical oxygen demand	BOD	Mg/L	500
Chemical oxygen demand	COD	Mg/L	1000
Total dissolved solids	TDS	Mg/L	2000
Total suspended solids	TSS	Mg/L	300
Hydrogen-ion concentration	PH	Su	9.0-6.5

Fat oil and grease	FOG	Mg/L	50
Methylene blue active substances	MBAS	Mg/L	26
Sodium	Na	Mg/L	400
Aluminum	AL	Mg/L	5
Arsenic	As	Mg/L	0.1
Chrome	Cr	Mg/L	0.3
Cupper	Cu	Mg/L	2.0
Iron	Fe	Mg/L	5.0
Nikel	Ni	Mg/L	0.2
Lead	Pb	Mg/L	1.0
Cadmium	Cd	Mg/L	0.07
Zinc	Zn	Mg/L	15
Cyanide	CN	Mg/L	0.3
Mercury	Hg	Mg/L	0.001
Phosphor	P	Mg/L	50
Chloride	Cl	Mg/L	500
Boron	B	Mg/L	1.0
Phenol	Phenol	Mg/L	0.002
Fluorine	F	Mg/L	2.0
Bicarbonate	HCO3	Mg/L	400
Sodium Adsorption Ratio	SAR	-	9.0

Back

Appendix C. Jordanian Technical Standard 202/2007, Industrial Reclaimed Wastewater

Jordanian Technical Regulation 202/2007

Water – Industrial Reclaimed Wastewater

1. Scope

This Jordanian standard specification sets the terms, conditions, requirements and constraints imposed on releasing industrial wastewater resulting from industrial establishments or their treatment plants into streams, valleys or wetlands, or utilizing it for irrigation purposes, or any other uses as stipulated by this Jordanian Standard Specification.

2. Standardization References

The following reference documents are indispensable in implementing this document. In case of dated referral, the edition referred to shall be implemented. In case of an undated referral, the latest edition of the reference document mentioned hereunder (including any amendments) shall be implemented, noting that the Institution of Standards and Metrology library comprises indexes of the current standards.

- Manual on "Standard Methods for Inspecting Water and Wastewater", issued by the American Society for Public Health and the American Society for Water, and its amendments.
- Disposal of Industrial and Commercial Wastewater into the Wastewater Sewer, issued on the basis of the Water Authority Law Number 18 for the Year 1988, in accordance with the Wastewater Regulation Number 66 for the Year 1994.
- US Environmental Protection Agency Standard.

3. Terms, Definitions, Codes and Acronyms

3-1 Terms and Definitions

For purposes of this Standard, the following terms and definitions shall be used.

3-1-1 Industrial Establishments

Establishments licensed by relevant authorities to carry out specific industrial activities in accordance with the license granted.

3-1-2 Reclaimed Industrial Wastewater

Water resulting or flowing from the use of water in all or part of the processing, cleaning, cooling or other stages, whether it is treated or not (such as ice manufacturing), which are compatible with this Jordanian standard specification.

3-1-3 Hazardous Waste

Any natural or processed simple or compound material, mixture or refuse, resulting from industrial activities or utilization processes, that have hazardous specifications, such as organic solvents, dyes, paints and others, that represent a hazard to the environment or any of its elements.

3-1-4 Solid Waste
Solid and semi-solid waste material resulting from any activities such as fermentation, combustion, or storage that represent a hazard to the environment, such as sludge, debris or other.

3-1-5 Hazardous Materials
Materials that are considered hazardous and cannot be disposed of in pubic disposal sites or wastewater disposal networks because of their effect on public health and the environment, or those that have combustible or explosive characteristics and require special procedures to deal with them or dispose of them.

3-1-6 Establishment Premises
The area on which the establishment is constructed, and surroundings that are considered part of the establishment.

3-1-7 Reuse Licensing Party
The official party concerned with licensing the reuse of reclaimed industrial wastewater for various uses according to item 4-3 of this Jordanian standard (Ministry of Environment).

3-2 Codes and Acronyms

For purposes of this Jordanian standard, the following acronyms shall carry the codes mentioned in Table (1):

Table (1): Codes and Acronyms

Code	Acronym
Al	Aluminum
As	Arsenic
Be	Beryllium
HCO3	Bicarbonate
BOD5	Biochemical Oxygen Demand (Five Day)
B	Boron
Cd	Cadmium
Ca	Calcium
COD	Chemical Oxygen Demand
Cl	Chloride
Cr	Chromium
Co	Cobalt
CFU	Colony Forming Unit
CU	Copper
CN	Cyanide
DO	Dissolved Oxygen
E. Coli	Escherichia Coli
FOG	Fat, Oil and Grease
F	Fluoride
Fe	Iron
Pb	Lead
Li	Lithium

Table (1): Codes and Acronyms

Code	Acronym
Mg	Magnesium
Mn	Manganese
Hg	Mercury
MBAS	Methylene Blue Active Substance
Mo	Molybdenum
MPN	Most Probable Number
pH	Negative Logarithm of H+ Concentration
NTU	Neuflumetric Morbidity Unit
Ni	Nicket
NO3	Nitrate
Se	Selenium
Na	Sodium
SAR	Sodium Adsorption Ratio
SO4	Sulphate
TDS	Total Dissolved Solids
T-N	Total Nitrogen
TOC	Total Organic Carbon
PO4-P	Phosphate
TSS	Total Suspended Solids
V	Vanadium
Zn	Zinc

4. General Conditions

The following general conditions should exist in reclaimed industrial wastewater:

4-1 Each industrial establishment that intends to reuse industrial wastewater shall obtain a special permit for the intended use from the relevant authority (Ministry of Environment).

4-2 The relevant authority shall receive the request for the reuse of reclaimed industrial wastewater, with the following information attached with it:

- Maps and geographical description of the area showing the location assigned for the establishment.
- Types of products
- Production Methods
- Quality Control Requirements
- Principles and requirements for reducing various waste
- Plan to manage various types of waste
- Plan to manage liquid and solid waste
- Plan for storage of materials and manner of dealing and using them
- Number of employees and operating shift system
- Quantity of water used monthly (within a year)
- Water output per month (during one year) and times of flow
- Location for utilizing reclaimed industrial water and its area

- A list of materials used in the industry including production inputs, cleaning, disinfections and others, as well as materials stored in the establishment.
- Quality of water flowing out, regarding specifications required, according to type of industry and relevant constraints, as pointed out in item 6
- Indication of treatment available at all stages in order to comply with the requirements of this Jordanian standard.
- Indication of alternatives for disposing of industrial wastewater in case it was not possible to reuse it.
- Any information considered by relevant authorities as necessary.

4-3 Based on data obtained from item 4-2 above, the relevant authority shall classify the industry and specify the standards to be followed and adhered to in accordance with conditions indicated in item 7, according to the final use planned.

4-4 Water flowing out of industrial establishments (whether treated or not), should adhere to characteristics set in tables 1 to 7 of this Jordanian Standard, according to the final use planned to prevent imbalance in various environmental elements.

4-5 The official authority may, in some cases, permit the reuse of reclaimed industrial wastewater for irrigation purposes despite the violation of some standards that are not connected to public health considerations, provided the requesting party presents the technical studies indicating that such water does not affect environmental elements in the area where it is used. The exemption shall include concentrating control and monitoring of water types by the relevant authorities in accordance with the requirements of this Jordanian standard.

4-6 Industrial wastewater may be released into the sewage network provided its quality complies with the requirements for releasing industrial and commercial wastewater into the sewage network issued by the Water Authority and with a written permit from the Authority.

4-7 Hazardous waste and refuse shall not be mixed with normal waste.

4-8 Industrial establishments must adopt technologies for combating pollution in all industries.

4-9 Industrial establishments must adopt a trend towards clean production within environmental management.

4-10 Treated and untreated industrial wastewater must be transported in tank trucks with a gray color to areas licensed to receive them.

5. General Requirements

The following general requirements must be available in industrial establishments:

5-1 All licensed industrial establishments must provide a sewage network for industrial water that is separate from the domestic sewage network. This requirement may be waived if the establishment owner showed that mixing water will improve the treatment effectiveness, provided the relevant party approves the permit.

5-2 Pre-licensed industrial establishments which mix domestic sewage water with industrial water shall separate sewage during any upgrading process of the establishment, or shall do this before 2010, whichever is first. During this period, the water flowing from the establishment should have a similar standard as domestic or industrial water, whichever is more stringent.

5-3 Water should not be reused for irrigation purposes in areas of close proximity that affect negatively the quality of ground water.

5-4 In case the owner of the industrial establishment requested the use of reclaimed water for purposes other than those mentioned in this Jordanian standard (such as cooling or fire-fighting), the relevant official authority shall be referred to to specify the standards and specifications to be adhered to in order to guarantee that it does not affect environmental elements and natural, chemical and vital balances.

5-5 The establishment owner shall maintain special records of the quality of water flowing from the establishment for a minimum period of five years and to present them to the relevant authorities upon their request.

5-6 Characteristics and qualities shall be tested according to the "Standard Methods for Testing Water and Wastewater" manual issued by the US Public Health Department and US Water Association, and any amendments, in addition to any other approved methods if they are not available in the reference cited.

6. Restrictions

6-1 Treated (reclaimed) industrial wastewater may not be transported in tank trucks and dumped in areas allocated for domestic wastewater, streams or valleys until after obtaining the permission of the relevant authorities.

6-2 Reclaimed industrial wastewater may not be disposed of in the Gulf of Aqaba or the valleys within its area and leading to it under any circumstances.

6-3 Reclaimed treated industrial wastewater may not be used outside the premises of the establishment, or by a second party until a permit is obtained from the relevant authorities trusted with licensing. Both parties must commit to the conditions mentioned in this Jordanian standard specification and present agreements between the user and the water producer to the relevant authorities upon request.

6-4 Reclaimed Industrial wastewater flowing from industrial establishments may not be mixed with fresh water for the purpose of diluting it to comply with the conditions stipulated in this Jordanian standard specification.

6-5 Workers at the industrial establishment may not be exposed to reclaimed industrial wastewater unless public safety requirements are available, such as gloves, masks, body, face and eyes protection.

6-6 Reclaimed industrial wastewater may not be used to irrigate vegetables and fruits that are consumed uncooked.

6-7 Reclaimed industrial wastewater my not be used for irrigation within the water resources catchment area.

7. Standard Conditions

7-1 Reclaimed industrial wastewater is divided into three sections according to its final use:

- Water dumped in streams, valleys and wetlands.
- Water reused for irrigation purposes.
- Water recycled in the industrial establishment.

7-2 Reclaimed industrial wastewater may be dumped into streams, valleys and wetlands provided its quality complies with the requirements of this Jordanian standard and the characteristics and standards mentioned in tables 2 to 5.

Table (2): Characteristics of Industrial Wastewater Quality Released in Streams

Characteristics	Code	Maximum Allowed mg / L (With Exceptions)
Organically consumed oxygen	BOD5	60
Chemically consumed Oxygen	COD	150
Dissolved Oxygen	DO	Not Less than 2.0
Total Suspended Solid	TSS	60
Negative Logarithm of H+ Concentration	pH	6-9 (A)
Nitrates	NO3	80
Total Nitrogen	T-N	
Change in received water temperature	T	6 (B)
Color	C	15 (C)
Neuflumetric Turbidity Unit	NTU	15 (D)
(A) Units (B) Degrees Celcius (C) Cobalt Units (D) Neuflumetric Turbidity Unit		

Table (3): Microbiological Characteristics of Reclaimed Industrial Wastewater Released in Streams, Valleys and Wetlands

Characteristics	Code	Measurement Unit	Maximum Allowable Limit
Escherichia Coli	E. Coli	Most probable number or colony unit / 100 ml	1000
Intestinal Helminthes Eggs		Egg / Liter	Less than or equal one

Table (4): Chemical and Physical Characteristics of Reclaimed Industrial Wastewater Released in Streams, Valleys and Wetlands

Characteristics	Code	Maximum Allowable Limit mg / L
Fat, Oil and Grease	FOG	8
Phenol	Phenol	> 0.002
Methylene Blue Active Substance	MBAS	25
Totally Dissolved Substances	TDS	2000
Phosphates	PO4-P	15
Chlorides	Cl	350
Sulphates	SO4	300
Ammonium	NH4	5
Bicarbonate	HCO3	400
Sodium Adsorption Ratio	SAR	9
Total Organic Carbon	TOC	55

Table (5): Maximum Level of Heavy Metals and Traces in Reclaimed Industrial Wastewater Released in Streams, Valleys and Wetlands

Mineral	Code	Maximum Allowable Limit mg / L
Cyanide	Cn	0.05
Barium	Ba	1.0
Aluminum	Al	2
Arsenic	As	0.05
Beryllium	Be	0.1
Copper	Cu	1.5
Fluoride	F	2
Iron	Fe	5.0
Lithium	Li	2.5
Manganese	Mn	0.2
Molybdenum	Mo	0.01
Nickel	Ni	0.2
Lead	Pb	0.2
Selenium	Se	0.05
Cadmium	Cd	0.01
Zinc	Zn	5
Chromium	Cr	0.1
Mercury	Hg	0.002
Vanadium	V	0.1
Cobalt	Co	0.05
Boron	B	1.0
Silver	Ag	0.1

7-3 Reclaimed Industrial wastewater may be used for various irrigation purposes provided its quality complies with the characteristics mentioned in tables 6, 7 and 8 hereunder.

Table (6): Treatment Level and Microbiological Indicators in Reclaimed Industrial Wastewater Permitted for Use in Irrigation

Standards and Characteristics	Maximum Allowable Limits According to Type of Use Mg / L (with exceptions)			
	Cooked Vegetables, Parks, Playgrounds, Roadsides inside cities	Fruit Trees, roadsides outside cities, green areas	Field crops, industrial crops and forest trees	Cut flowers
	I	**II**	**III**	
Organically Consumed Oxygen	30	200	300	15

Table (6): Treatment Level and Microbiological Indicators in Reclaimed Industrial Wastewater Permitted for Use in Irrigation

Standards and Characteristics	I	II	III	I
Chemically Consumed Oxygen	100	500	500	50
Dissolved Oxygen	>2	-	-	>2
Totally Dissolved Substances	50	200	300	15
pH	6-9 (A)	6-9 (A)	6-9 (A)	6-9 (A)
Turbidity Level	10 (B)	-	-	5 (B)
Nitrates	30	45	70	45
Total Nitrogen	45	70	100	70
Escherichia Coli	100 (C)	1000 (C)	-	> 1.1 (C)
Intestinal Worm Larvae	<_ 1 (D)	<_ 1 (D)	<_ 1 (D)	<_ 1 (D)
Fat, Oil and Grease	8	8	8	2

A) Unit
B) Nifilometer
C) The most likely number or the colony formation unit / 100 ml
D) Egg per liter

Table (7): Chemical and Physical Characteristics of Reclaimed Industrial Wastewater Permitted in Irrigation

Characteristics	Code	Maximum Allowable Limit mg/L
Fat, Oil and Grease	FOG	8.0
Phenol	Phenol	< 0.002
Methylene Blue Active Substance	MBAS	100
Total Dissolved Solids	TDS	2000
Phosphates	PO4-P	30
Chloride	Cl	400
Bicarbonate	HCO3	400
Sodium	Na	230
Magnesium	Mg	100
Calcium	Ca	230
Sodium Adsorption Rate	SAR	9.0

Table (8): Permissible Level of Heavy Metals Concentration and Traces Concentration in Reclaimed Industrial Wastewater Permitted for Use in Irrigation

Element	Code	Maximum Allowable Limit mg/L
Aluminum	Al	5
Arsenic	As	0.1
Beryllium	Be	0.1
Copper	Cu	0.2
Fluoride	F	2
Iron	Fe	5.0
Lithium	Li	0.075 (2.5 for Citrus)
Manganese	Mn	0.2
Molybdenum	Mo	0.01
Nickel	Ni	0.2
Lead	Pb	0.2
Selenium	Se	0.05
Cadmium	Cd	0.01
Zinc	Zn	5.0
Chromium	Cr	0.1
Mercury	Hg	0.002
Vanadium	V	0.1
Cobalt	Co	0.05
Boron	B	1.0
Cyanide	CN	0.1

7-4 If it became evident that industrial production inputs contain toxic chemicals, water output from treatment plants shall be inspected for these materials so that standards and values do not exceed standards and values in international specifications. If they are not available, a special study is performed and submitted to the relevant authorities.

7-5 Sprinkle irrigation only is permitted to irrigate golf courts. Irrigation shall take place at night between 6pm and 1am. Mobile sprinklers that are not subject to day use must be utilized.

7-6 When using reclaimed industrial wastewater for irrigating crops permitted, irrigation shall stop two weeks prior to harvesting.

7-7 When using reclaimed industrial wastewater for irrigating fruit trees and vegetables, fruits that had fallen to the ground shall be disposed of and not sold on the market.

7-8 Reclaimed industrial wastewater may be recycled within the factory in order to reuse it in the same or other operations. Specifications of water that is recycled differ according to the requirements of the plant regarding water type, as long as the safety of workers and their well-being at the plant is observed as indicated hereunder. (Water recycling inside the industrial plants is preferable as an effective measure in rationalizing water consumption and preserving it).

7-8-1 Water should flow through closed pipes that prevent worker exposure to it.

7-8-2 Quantities of recycled water should be less than the plant's full capacity.

7-8-3 The owner of the industrial plant must set a plan for draining wastewater in emergencies that prevent the recycling of water within the establishment.

7-9 Monitoring parties should carry out environmental audits of the plant once every three months to assure that the plant complies with the above conditions.

8. Quality Control

8-1 The mechanism for monitoring reclaimed industrial wastewater drained into streams, valleys and wetlands depends on the quantity of water flowing out of the establishment (less than 100 cubic meters of water daily). The frequency of collecting samples and analyzing them by those operating the industrial establishment shall be as follows:

Table (9): Frequency of Sample-Taking by the Industrial Establishment to Monitor Quality of Reclaimed Industrial Wastewater Released in Streams, Valleys and Wetlands

Industry (A)	Frequency of Sample-Taking							
	Table 2 Applied		Table 3 Applied		Table 4 Applied		Table 5 Applied	
	<100 m^3 / day	≥100 m^3 / day	<100 m^3 / day	≥ 100 m^3 / day	<100 m^3 / day	≥ 100 m^3 / day	<100 m^3 / day	≥ 100 m^3 / day
Packaging, Paper and Cardboard and Office Supplies Industries	Monthly	15 Days	Monthly	15 Days	Monthly	15 Days	Quarterly	Monthly
Food, agricultural and animal wealth industries	Monthly	15 Days	15 Days	Weekly	Monthly	15 Days	Quarterly	Monthly
Leather and Textile Industries	Monthly	15 Days	15 Days	Weekly	Monthly	15 Days	Quarterly	Monthly
Chemical Industries and cosmetics	Monthly	15 Days	15 Days	Weekly	Monthly	15 Days	Quarterly	Monthly
Treatment and Medical Products	Monthly	15 Days	15 Days	Weekly	Quarterly	Monthly	Quarterly	Monthly
Mining Industries	3 Months	3 Months	15 Days	Weekly	Quarterly	Monthly	Quarterly	Monthly
Engineering, Electric and Information Technology Industries	Monthly	Monthly	15 Days	Weekly	Quarterly	Monthly	Quarterly	Monthly
Plastic and Rubber Industries	Monthly	Monthly	15 Days	Weekly	Quarterly	Quarterly	Quarterly	Monthly
See Annex (A)								

8-2 Monitoring and Quality Control

Monitoring and Quality Control operations by the industrial establishment over reclaimed industrial wastewater that will be used for irrigation shall be as is shown in Table (10):

Table (10): Frequency of Sample-Taking by the Industrial Establishment to Monitor Quality of Reclaimed Industrial Wastewater Permitted in Irrigation

Type of Agriculture	Frequency of Agricultural Use					
	Table 6 to be Applied		Table 7 to be Applied		Table 8 to be Applied	
	<100 m^3 /Day	≥100 m^3/ Day	<100 m^3/Day	≥100 m^3/ Day	<100 m^3/Day	≥100 m^3/ Day
I. Cooked vegetables, parks, playgrounds, sides of streets inside industrial establishment.	Monthly	15 Days	Quarterly	Monthly	Every 6 Months	Quarterly
II. Fruit Trees and green areas	Monthly	Monthly	Every 6 Months	Quarterly	Every 6 Months	Quarterly
III. Field crops, industrial crops and forest trees	Every 6 months	Monthly	Every 6 Months	Quarterly	Every 6 Months	Quarterly

8-3 Quality Monitoring Mechanism

8-3-1 Official monitoring authorities shall take samples of reclaimed industrial wastewater that is dumped in streams, valleys and wetlands according to the frequency referred to in Table 11:

Table (11): Frequency of Sample-Taking by Official Authorities to Monitor Quality of Reclaimed Industrial Wastewater Released in Streams, Valleys and Wetlands

Industry Title	Frequency of Taking Sample							
	Table 1 to be Applied		Table 2 to be Applied		Table 3 to be Applied		Table 4 to be Applied	
	<100 m^3/Day	≥100 m^3/ Day	<100 m^3/Day	≥100 m^3/ Day	<100 m^3/Day	≥100 m^3/ Day	<100 m^3/Day	≥100 m^3/ Day
Packaging, Paper and Cardboard and Office Supplies Industries	Monthly	15 Days	Monthly	Every 15 Days	Monthly	Every 15 Days	Quarterly	Monthly
Food, agricultural and animal wealth industries	Monthly	15 Days	15 Days	Weekly	Monthly	15 Days	Quarterly	Monthly
Leather and Textile Industries	Monthly	15 Days	15 Days	Weekly	Monthly	15 Days	Quarterly	Monthly
Chemical Industries and cosmetics	Monthly	15 Days	Monthly	Every 15 Days	Monthly	Every 15 Days	Quarterly	Monthly
Treatment and Medical Products	Monthly	15 Days	15 Days	Weekly	Monthly	15 Days	Quarterly	Monthly
Mining Industries	3 Months	3 Months	15 Days	Weekly	Quarterly	Monthly	Quarterly	Monthly
Engineering, Electric and Information Technology Industries	Monthly	Monthly	15 Days	Weekly	Quarterly	Monthly	Quarterly	Monthly
Plastic and Rubber Industries	Monthly	Monthly	15 Days	Weekly	Quarterly	Quarterly	Quarterly	Monthly

8-3-2 Official monitoring authorities shall take samples from the reclaimed industrial wastewater that is utilized for irrigation purposes according to frequencies mentioned in Table 12.

Table 12: Frequency of Sample-Taking by Official Authorities to Monitor Quality of Reclaimed Industrial Wastewater Utilized in Irrigation

Type of agriculture	Frequency of Agricultural Use					
	Table 6 Applied		Table 7 Applied		Table 8 Applied	
	< 100 m^3/Day	≥ 100 m^3/Day	< 100 m^3/Day	≥100 m^3/Day	<100 m^3/Day	≥ 100 m^3/Day
I. Cooked vegetables, parks, playgrounds, sides of streets inside industrial establishment.	Monthly	15 Days	Quarterly	Monthly	Every 6 Months	Quarterly
II. Fruit Trees and green areas	Monthly	Monthly	Every 6 Months	Quarterly	Every 6 Months	Quarterly
III. Field crops, industrial crops and forest trees	Every 6 Months	Monthly	Every 6 Months	Quarterly	Every 6 Months	Quarterly

8-3-3 The industrial establishment's owner should make sure that the water complies with approved specifications according to the final use. It should carry out the necessary lab tests and start official records to document the test results and present them to the official monitoring authorities when requested to do so according to the frequency rates in Tables 9 and 10.

8-3-4 Samples shall be taken, preserved, transported and analyzed in specialized laboratories, according to the manual on "Standard Methods for Testing Water and Wastewater" published by the US Association for Public Health and the US Federal Association for Water Research and Monitoring its Pollution and its amendments, as well as any approved analysis methods not mentioned in these references.

8-3-5 Regarding mechanical treatment plants that contain purification ponds and natural treatment plants, Biochemical Oxygen Demand (BOD3) is calculated after the filtration process.

8-3-6 The engineering average method is used to calculate the results of the E. Coli thermotolerant coliforms particles when evaluating water quality.

8-3-7 Regarding the evaluation of the Nitrogen content in the reclaimed industrial wastewater, the mathematical average method is used, provided a minimum number of five samples is used.

8-3-8 The results of the E. Coli thermotolerant coliforms tests are taken into consideration when the technical capabilities necessary for testing them are not available.

8-3-9 In cases of epidemics, monitoring and operating agencies are required to investigate and test for intestinal microbes that may be present in water.

8-4 Evaluation Mechanism

8-4-1 Time periods indicated in Tables 9 and 10, for the purpose of evaluating industrial wastewater reclaimed by the industrial establishment, as well as the monitoring agency are to be adopted as indicated in Tables 11 and 12, and as used by the methods utilized in this Jordanian standard.

8-4-2 In case of any violation in any of the special standards for dumping reclaimed industrial wastewater in streams, valleys and wetlands, an additional sample of the reclaimed industrial wastewater is taken. If lab tests indicated a violation in both samples, the relevant party is notified of the need to rectify the situation within a maximum of one month.

8-4-3 In case of a violation in any of the standards for reusing reclaimed industrial wastewater, an additional sample is obtained. If lab results indicated a violation in both samples, the relevant party is notified and requested to rectify the situation. If the violation persisted for a period exceeding three months, reclaimed industrial wastewater reuse is stopped in the area of the use where the violation occurred until the water quality is stabilized.

8-4-4 In case there are no standard values for certain standards that may occur in industrial water, the US Environmental Protection Agency standard, or any relevant European standard is consulted.

Annex (A)
(Normative)

Industrial Sectors

Industries are classified according to industrial sectors mentioned in Table A-1

Table A-1: Industries by Industrial Sector

No.	Industrial Sector	Industry
1	Leather and Textile Industries	- Natural textile fabrics - Yarn - Textiles (cloth material) - Ready textile versions (except garments) - Rugs and carpets - Tricot and its products - Garments - Furs - Textile accessories and supplies - Natural and industrial leather - Bags and suitcases - Shoes - Shoe supplies - Any other similar industries within this sector
2	Treatment and medical industries	- Natural and treatment materials - Pharmaceuticals - Natural medical materials and formulae - Medical and treatment disinfectants - Laboratory solvents and medical equipment and supplies - Visual and audio equipment - Dental equipment and supplies - Medical consumables - Any other similar industries within this sector
3	Chemical industries and cosmetics	- Glue - Refined petroleum products - Organic Chemical materials - Inorganic chemical materials - Paints, pastes and other leather industry and dyeing supplies - Fertilizers and insecticides - Intermediary Petrochemical materials - Soaps and detergents - Aromatics, aromatic bases and beauty supplies - Glues and adhesives - Matches - Explosives and fireworks - Inks - Other chemical products - Any other similar industries within this sector

4	Plastics and Rubber Industries	- Tires - Rubber industries products - Yarn and special plastic textiles - Plastic pipes and tubes - Plastic sheets and plates and their products - Plastic containers - Fiberglass and its products - Sponge products - Plastic toys and dolls - Plastic accessories - Plastic equipment for industrial use - Any other similar industries within this sector
5	Engineering and Electrical Industries and Information Technology	- Electric power - Basic steel industries - Basic metal industries except steel - Construction metal products - Domestic metal tools and supplies - Cutting tools and equipment - Wires, nails and bolts - Sheet metal, forging and lathing industries - Domestic electrical tools and supplies - Central heating and solar heaters - Metal equipment and supplies for agricultural use - Electric equipment, lighting supplies and electric wires - Electronic equipment - Primary compounds and cells - Receiving and radio and television broadcasting equipment and recording - Vehicles and transport equipment - Jewelry - Metal machinery and equipment - Pumps, cranes, ladders and elevators - Cooling, heating and firefighting equipment and supplies - Equipment, machinery and tools for the preparation of construction materials - Measurement and weighing equipment - Equipment for food and water processing - Clocks and alarms - Information technology and communications industries - Any other similar industries within this sector
6	Wood and Furniture Industries	- Processed wood - Carpentry and decorative works - Cork and straw products - Glass and packaging domestic products - Glass and ceramic domestic products - Metal and wood domestic and office furniture

		- Kitchens - Specialized furniture - Furniture components - Other furniture products - Furniture services - Any other similar industries within this sector
7	Construction Industries	- Building stone, crushers and sand - Construction insulation materials - Sanitary installations and supplies - Tiles - Glass sheets - Thermal construction products - Cement construction products - Reinforcing steel and metal structures - Decoration and construction works - Any other similar industries within this sector
8	Food and Agricultural Industries and Animal Wealth	- Agricultural and gardening products - Livestock - Animal products - Red and white meats and their products - Vegetables, fruits and nuts - Fruits and vegetables juices - Animal and vegetable oils and fats and sesame paste (Tahini). - Milk and dairy products - Grain mills products - Fodder - Flour products - Cocoa and sweets products - Coffee beans, tea, spices and food salt - Yeasts - Beverages - Tobacco and its products - Other food products - Any other similar industries within this sector
9	Packing and packaging industries, paper, cardboard and office supplies	- Paper paste and paper - Paper products (except paper) - Printing - Stationery - Printing and packaging services - Film production and engineering design - Packaging and filling products - Any other similar industries within this sector
10	Mining Industries	- Stone and sand extraction - Chemical metals - Cement

TERMS

The following terms shall carry the corresponding meaning in Arabic for the purposes of this standard:

Item No.	Arabic Term	English Term
Table 1	أكسجين ذائب	Dissolved Oxygen (DO)
Table 1	أكسجين مستهلك حيوياً	Biochemical Oxygen Demand (BOD)
Table 1	أكسجين مستهلك كيميائيّاً	Chemical Oxygen Demand (COD)
Table 2	عدد أكثر احتمالاً	Most Probable Number (MPN)
Tables 9, 3, 6	عصيّات القولون المقاومة للحرارة	Thermotolerant Coliforms
Table 3	كربون عضوي كلّي	Total Organic Carbon (TOC)
Table 3	مواد صلبة ذائبة كليّة	Total Dissolved Solids (TDS)
Table 1	مواد صلبة عالقة كلية	Total Suspended Solids (TSS)
Table 1	نيتروجين كلّي	Total Nitrogen (T-N)
Table 1	وحدة عكارة نيفيلومترية	Neuflumetric Turbidity Unit (NTU)

References

- Standards Methods for the Examination of Water and Wastewater, APHA, 1998
- Irrigation with Reclaimed Municipal Wastewater, A Guidance Manual, Suart Pettygrove et al., 1984
- Reuse of Effluents, Methods of Wastewater Treatments and Health Safeguards, WHO, 1989
- www.deqp.go.th/english/greendata/env-standard/12421.html
- www.sunsite.nus.edu.sg/apcel/dbase/vietnam/regs/virwin.html
- www.infrastech.com/index.html

Appendix D. Sample Industry Survey Questionnaire

INDUSTRY QUESTIONNAIRE

1 Industry Name _____
2 Industry Location _____
3 Contact Information (Name, telephone, email) _____

4 Number of employees _____
5 Approximately size of building (m2, or ft2) _____
6 Describe operations conducted at the facility _____

7 Describe the major raw materials used _____

8 Operating hours (hours per day, days per week) _____

9 Does the facility anticipate any major expansions in the future? _____
10 Describe any variations in production _____

11 Describe the source(s) of process water currently used. _____
12 How much water is used (daily, weekly, annually)? _____

13 Is stormwater collected? Is it reused? Is it treated? _____

14 Does incoming water undergo any pretreatment? _____

15 Describe major manufacturing processes that generate wastewater. Are they continuous, batch, both? _____

16 How much wastewater is generated? _____
17 How much is process related? How much is sanitary related? Is it mixed? _____

18 Are there major losses of water in the facility? (cooling tower evaporation, water in product, once through cooling water)

19 How does the facility currently handle the wastewater that is generated.

20 Describe any pretreatment that is conducted.

21 What are the characteristics of the treated wastewater? (pH, metals content, TDS, temperature, BOD, COD, TSS, oil and grease, volatile organics)

22 Does the facility re-use or recycle any process water or wastewater? Describe.

23 Does the facility hold a discharge permit or have treatment requirements that it must meet? Is the discharge monitored on a regular basis?