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THE COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION (CDR)

ENVIRONMENTAL AND SOCIAL SAFEGUARD STUDIES FOR LAKE QARAOUN POLLUTION PREVENTION PROJECT

COMPREHENSIVE PERFORMANCE AND ENVIRONMENTAL AUDIT OF AITANIT WASTEWATER TREATMENT PLANT

AUDIT REPORT

August 7, 2015

ELARD LEBANON			
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ENVIRONMENTAL AND SOCIAL SAFEGUARD STUDIES FOR LAKE QARAOUN POLLUTION PREVENTION PROJECT **COMPREHENSIVE PERFORMANCE AND ENVIRONMENTAL AUDIT OF AITANIT WASTEWATER TREATMENT PLANT**		**No. of Pages:**	**53**
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LIST OF ACRONYMS

AWTP	Aitanit Wastewater Treatment Plant
BOD	Biological Oxygen Demand
BOD5	Biological Oxygen Demand Over 5-day period
$CaCO_3$	Calcium Carbonate
CDR	Council for Development and Reconstruction
CFU	Colony Forming Unit
Cl^-	Chloride ions
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EA	Environmental Audit
ELARD	Earth Link and Advanced Resources Development
HSE	Health, Safety and Environment
HSE	Health, Safety, Environment
ISO	International Organization for Standardization
LRA	Litani River Authority
MSDS	Material Safety Data Sheet
N	Organic Nitrogen
NH3-N	Ammonia-Nitrogen
NO_3^-	Nitrate
PO_4^{3-}	Ortho-phosphate
PPE	Personal Protective Equipment
S^{2-}	Sulfides
SCADA	Sensing, alarm, response, Control, and Data Acquisition system
SO_4^{2-}	Sulfates
SPCC	Spill Prevention, Control, and Countermeasure
SPM	Spill Management Plan
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphate
TSS	Total Suspended Solids
USAID	United States Agency for International Development
WWTP	WasteWater Treatment Plant

1. INTRODUCTION

1.1 BACKGROUND

Earth Link and Advanced Resources Development s.a.l. (ELARD) has been appointed by the Council for Development and Reconstruction (CDR) to prepare the environmental and social safeguard studies for the Lake Qaraoun Pollution Prevention Project. This project aims at implementing certain components of the Business Plan to Combat Pollution at the Qaraoun Lake that was prepared by the Ministry of Environment. As a result of this plan, a follow-up Committee led by the Litani River Authority (LRA) was assigned by the government to follow-up implementation of the plan. The government has requested financial assistance from the World Bank, which is supporting the implementation of the following components:

- Component 1- Improve the collection of municipal sewage
- Component 2- Increase the adoption of Integrated Pest Management (IPM) practices
- Component 3- Technical Studies in Solid Waste Management and Capacity Building and Project Management

This audit of the Aitanit Wastewater Treatment Plant (AWTP) is related to Package 3 of Component 1, which aims to increase the utilization of Aitanit WWTP, designed and implemented by the United States Agency for International Development (USAID), by maximizing its sewage network coverage.

1.2 OBJECTIVES

This audit report mainly focuses on assessing the performance of Aitanit WWTP and its operational environmental impacts. The objectives of the audit are:

- Verification of compliance with design criteria and national regulations;
- Evaluation of the WWTP site;
- Review process and construction documentation;
- Assessment of the WWTP operation status;
- Assessment of treatment efficiency;
- Identification and assessment of environmental management practices; and
- Provision of recommendations with opportunities to improve the WWTP operation.

1.3 AUDIT TIME FRAME

ELARD audit team comprised experts in the fields of mechanical, environment engineering and environmental sciences Mr. Joseph Eid (Senior Wastewater Expert), Mrs. Wiam Khashba (Environmental Engineer) and Ms. Imtithal Sheet (Environmental Specialist)). A pre-audit

meeting was conducted during a normal operation day with the operator of the Aitanit WWTP on the 27th of June, 2014. A comprehensive inspection tour of the plant was completed afterwards.

2. GENERAL DESCRIPTION OF AITANIT WWTP

2.1 BACKGROUND

Sewage generated by the villages of Baaloul, Qaraoun, Aitanit and Machghara contribute to the Aitanit Treatment Plant. The villages of Machghara and Aitanit lie to the west of the Qaraoun Lake whereas the villages of Qaraoun and Baaloul lie to its east. The Aitanit wastewater treatment plant (WWTP) is located within the cadastral area of the village of Aitanit at approximately 400 meters south of the Qaraoun Dam on the Litani River.

2.2 DESCRIPTION OF THE FACILITY AND SURROUNDING ENVIRONMENT

Aitanit WWTP is operated by the Union of Municipalities of the Lake who covers the operation expenses that reach about 100,000 USD per year according to Table 2-1 below.

Table 2-1 Aitanit WWTP Yearly Expenses (source: Union of Lake Municipalities)

Item	Quantity	Expenses (USD)
Staff	3	30,000
Diesel	5000 L/month	50,000
Electricity	--	20,000

Aitanit wastewater treatment plant is designed to provide secondary treatment level to the wastewater originated from Baaloul, Qaraoun, Aitanit and Machghara. The plant was designed to treat an average daily flows of 5000 m^3/day and allow a peak of 7440 m^3/d to pass through the plant. Currently the WWTP treats 800 m^3/d of domestic wastewater, the maximum flows that reached the plant during its operation period were 1200 m3/d. Therefore, the plant has sufficient spare capacity to treat additional flows conveyed by the new sewerage lines connected through the project. In fact, increased wastewater flows to be treated to bring it to half of the plant design flows will Increase the plant operation efficiency and will improve the treatment process stability as the diurnal flow variations will be attenuated by larger connected community.

The plant consists of the following units:

- Manual Bar Screen: one screen, bar opening is 45 mm. Maximum flow: 7440 m^3/ day.
- Static Screen: two screens where clear opening space is 2.5 mm. Maximum flow: 3,750 m^3/day (each).
- Primary Clarifiers: three rectangle clarifiers (3 ×12×3) m.
- Trickling Filters: two plastic media filters (Ø18.7 ×H 6.1) m.

- Final Clarifiers: three rectangular clarifiers (3 ×18×3) m.
- Chlorine Contact Basin: one basin (43.3×1.1×1.1) m.
- Anaerobic Digesters: four square digesters (9×9×5) m.
- Sludge Drying Ponds: 6 Units; the area per bed is 1,200 m^2 and each bed's dimensions are (60×20) m.
- Septic Haulers Receiving Station: One screen where clear opening space is 20 mm.

Figure 2-1 presents the process flow diagram of Aitanit WWTP.

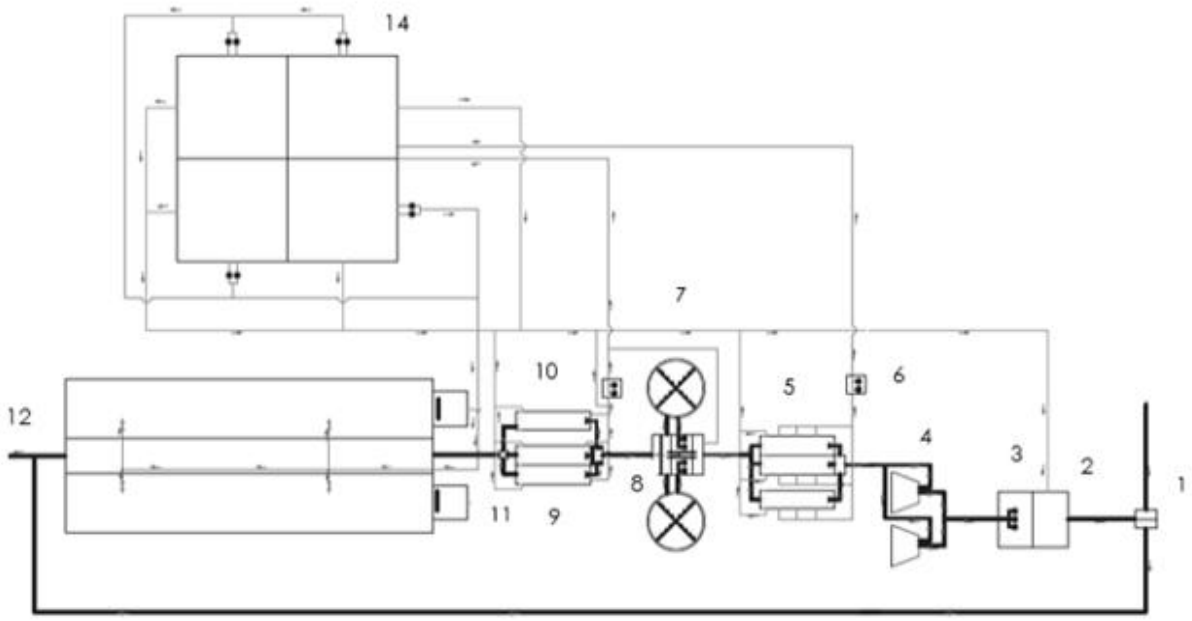

Figure 2-1 Process Flow Diagram of Aitanit WWTP

LEGEND		
ID #	**Description**	**Quantities**
1	Flow Diversion	1
2	Coarse Screen	1
3	Influent pumps	3
4	Fine Screen	2
5	Primary settling tank	3
6	Primary sludge pumps	2
7	Trickling filters	2
8	Trickling filter pumps	4
9	Final Clarifier	3
10	Final Clarifier Pumps	2
11	Chlorine Contact Channel	1
12	Sludge drying ponds	10
13	Digester sludge pumps	8
14	Sludge digester	4

3. AUDIT FINDINGS

The following sections present a description of the audit findings. This audit represents a comprehensive performance evaluation to review and determine whether there are design issues, deficiencies in the operation and maintenance procedures or equipment malfunctions and to propose solutions to overcome identified deficiencies, if any. Plant performance, including its environmental performance were evaluated.

3.1 GENERAL OBSERVATIONS

General observations based on the review of available design documents and the site visits are listed below:

- Aitanit wastewater treated effluent qualities were found in compliances with applicable standards and regulations. It is the best treated effluent between the actually seven operational treatment plants in the Beqaa Valley. As noted below, these effluent qualities can be further ameliorated with minor adjustments to the plant operation (i.e. apply chlorine disinfection, etc…).

- According to the plant operator, some hydraulic overload occurred but was caused by storms and heavy rainfall during winter season.

- Corrosion is noted in some water storage tanks and overflow pipes.

- One of the four digesters was not functioning properly because the pumps were out of service.

- Unpleasant odours can be smelled next to the headwork, mainly the fine screening unit and the drying lagoons and no control measures are detected.

- Some pumps were out of service namely; the influent pumps, the RAS pumps, the trickling filter pump and the digester pumps. These submersible pumps were installed on concrete skid and exposed to sunlight and heavy rainfall without an adequate connection to the cooling media recycle causing operational damages and disturbances (Figure 3-1).

- Rising sludge is observed in the preliminary and secondary settling tanks probably due to the presence of high concentrations of ammonium nitrate in raw wastewater or nitric nitrogen or filamentous bacteria in the final effluent.

- The control panel of the seepage pump station is shaded; however, the control panels of the digester tanks, sludge pumps and primary clarifier pumps are exposed to the sun and rainfall (Figure 3-2).

- An inadequate connection between the outlet of the cooling jacket of the sludge transfer pumps and the plant service water network was observed and may lead to the contamination of the service water by mixing the pumped wastewater with the service water plant inside the pump cooling Jackets.

- Other than the broken sewer pipeline coming from Machghara, no leaking tanks or pipes were detected.

- The structural problem of the Machghara pipeline caused an excess infiltration and accumulation of stones, gravels and grits in the plant's headwork, the treatment units and the pumps. As a result, the performance of the plant was affected especially in the absence of a detritus tank. It's important to note that these particles may end-up in the primary settling tank which will require additional efforts from the plant operators to remove it.

- No evidence of spills or mishandling of chemicals was observed during the site visit between the storage area and the feeding units.

3.2 FLOW INDICATORS

The following points are related to inflows to the plant:

- The plant actual inflow is about 800 m^3/day originating from the villages of Baaloul, Qaraoun, Aitanit and Machghara. The plant is designed to handle peak hydraulic flow of about 7440 m^3/day.

- A hydraulic overload of the plant (flows exceeding maximum plant capacity of 5000 m^3/day) occurs during the rainfall season and is observed through the maximum level float switch. Nevertheless, this system is not very reliable.

- When the influent increases and exceeds the plant's capacity, the flow is manually diverted to the river. As the plant was not provided with any emergency storage ponds, this arrangement minimizes the environmental impacts and health risks that may result from high flows of strongly diluted raw wastewater.

- A flow receiving pit and an interceptor piping system are installed in the plant to balance peak flows. Grits small stones and sand originating from Machghara sewer pipeline are accumulating in the flow receiving pit and are being removed manually by the plant operators every three months according to the characteristics of the wastewater entering the plant.

- Excessive seepage dumping by septic tank pumpers occurs two times per week.

3.3 HEADWORKS

3.3.1 Flow Measurement

Some observations include:

- Flow measurement device is not properly installed

- An in-line type magnetic flow meter is located next to the fine screening unit and installed at the influent pump discharge line (ABB Brand) to measure the plant's influent flows. This flow meter is very sensitive to air bubbles and cannot distinguish entrained air from the process fluid; therefore, air bubbles will cause the meter to read high values (Figure 3-3).

3.3.1.1 Manual Bar Screen

Some observations include:

- The screen is cleaned manually which requires frequent raking by the plant personnel to prevent clogging (increased operational efforts). Manually cleaned screens require little or no equipment maintenance and provide a good alternative for smaller plants with few screening particles.

- There is excessive buildup of large screening particles (stones and gravels) on the screen (Figure 3-4).

- The screen is not provided with a screening storage device such as a basket-type bin rack that can be manually hoisted and cleaned; this also poses operational challenges.

3.3.1.2 Fine Screen

Some observations include:

- The Screening receiving device (e.g. Garbage bin) that is included in the plant is not suitable (Figure 3-4).

- Two Static Sieve type fine screens used to remove solids from primary effluent to reduce clogging problems of the trickling filters are installed. When screened solids reach the bottom of the sieves and pass through a short cone and discharge into plastic bags that are stored next to the screen.

- Screenings are disposed of at Machghara's landfill (once per week).

- Oil and grease are accumulating on the fine screen sieves due to the absence of an oil and grease separator and end-up in the final effluent when not skimmed from the surface of the clarifiers.

3.3.2 Treatment Units

3.3.2.1 Primary Clarifiers (Sedimentation Tanks)

- Flows from the fine screens are equally divided through distribution chambers and diverted to three rectangular primary settling tanks. The flow in the settling tanks is parallel to the tank's length under actual flow conditions. One tank is set offline to maintain sufficient sludge blanket in the other two tanks. The offline tank is typically set online during wet weather events or when the plant's flow reaches its ultimate capacity.

- Wastewater liquids and solids are separated by gravity in the PST. Scum is skimmed from the surface by a hand-operated slotted pipe skimmer and is collected in a scum pit located outside the tank. Part of the grease and oil that float on the surface of the Water in the PST are eliminated by the same skimmer.

- Settled solids are removed from the bottom by two submersible pumps that are installed in a dry pit between the tanks, fully exposed to sunlight and rain water.

- The cooling Jacket recycle line of the two submersible pumps is not connected.
- The two submersible pumps are connected to the tanks by UPVC pipes. Due to UV radiation, a change of color of the exposed surface of the pipes was observed.
- The three primary tanks are in a moderate condition.
- The gas bubbles and the floating materials that are observed on the surface of the sedimentation tank resulted either from an improper operation of the scum skimmer, an excessive sludge accumulation in the basin, decomposing organics, and the return of well nitrified activated sludge.
- The floating sludge, the black color of the raw wastewater and the unpleasant odors indicate that settled sludge is being retained for a long period of time in the PST (Figure 3-5).

3.3.2.2 Trickling Filters

- This filter is equipped with an underdrain system that collects the filtrate and solids that are then conveyed to the settling tank. Part of the filtrate is recirculated through the trickling filter by the trickling filter recirculation pumps. Adequate doors for passive ventilation and fans for forced air are provided. Vent doors are shut when the fan is running (Figure 3-6).
- A thin layer of algae is observed on top of the filter.

3.3.2.3 Final Clarifiers

- A secondary settling tank composed of three clarifier tanks (two are in use), each equipped with six manually activated telescopic valves installed in a GRP Channel to draw off the sludge from the bottom hopper of the tank into the GRP are observed (Figure 3-7).
- The solids that settle in the clarifier are discharged directly into a sludge digester or recycled and sent back to the trickling filter by pumping capacity.
- Clarified water flows by gravity to the chlorine contact tank for disinfection prior to disposal into the river through the outfall pipe.
- The GRP channels in Aitanit WWTP were supposed to be built in concrete. These channels showed deformations along the edges.
- Excessive gas bubbles, floating bulks and rising sludge appeared on the surface of the wastewater. This indicates improper settlement of sludge and forming clouds caused by filamentous bacteria and denitrification process inside the clarifier. Tiny floc particles that were moving to the final clarifier weirs increased the turbidity of the effluent.

3.3.2.4 Chlorine Contact Basin

- No evidence of a reliable and applicable method for chlorination is detected.

- No automatic control of the residual chlorine concentration is noted.
- The treated effluent is being discharged in the river without disinfection, even though chlorine dosing pumps are available.
- No disinfecting agent is found in the Chlorine contact tank (Figure 3-8).
- The chlorine feeding room is not equipped with eyewashes.
- The chemical solution tank for the preparation of the chlorine solution is missing. Instead, a 20-L drum is being used for chemical solution preparation.
- No chlorine test kit was available at the time of the visit.
- The chlorine agent was expired at the time of the visit.

3.3.3 Sludge Treatment

3.3.3.1 Anaerobic Digester

- Four digester tanks with an open top used for thickening and sludge ageing as well as decanting pipes on facing surfaces are installed in the plant (Figure 3-9). Those digesters are the source of unpleasant odours in the plant and its surrounding area.
- Decanting pipes are used in the anaerobic digester to ensure the evacuation of the supernatant (excess water) into the primary settling tank.
- In order to mix the digester content and transfer the sludge to the drying ponds two submersible pumps with cooling jackets are installed in a dry pit fully exposed to sunlight and rain water. The cooling Jacket recycle line of these pumps was not connected at the time of the visit. The suction and discharge pipes of the pumps were not adequately positioned to provide a complete mixing of the tank's content.
- The area above the pumps and the control panels is not shaded.

3.3.3.2 Sludge Drying Lagoons

- The supernatant evacuation through the sluice gates is not effective because these open from bottom to top instead of top to bottom to allow supernatant, which accumulates on the top to be released (sludge deposits on the bottom of the ponds and the supernatant remains on the top)(Figure 3-10).
- Ten drying lagoons are available within the Aitanit WWTP. After the digestion process, solid sludge is conveyed to the drying lagoons for dewatering purposes (Figure 3-11). The sludge drying ponds contain sludge during winter and summer which is unsafe especially during rainfall periods.
- Due to the lack of adequate sludge disposal practices the following was detected in the drying lagoons:
    - appearance of poor sludge distribution;

- noxious odours (next to the ponds);
- Presence of snails and vegetations.

3.3.4 Sludge Disposal

- The secondary sludge is being stored for a long period of time in the settling tank and is then being pumped back into the PST.
- The quantity of sludge generated during the first year of the plant's establishment was 50 kg/day; however, after the opening of the Qaraoun valve, the sludge quantity doubled and was kept for three years in the drying beds without being eliminated to a landfill.
- The Seepage delivery is directly diverted to the drying beds without passing through the sewage treatment units.

3.3.5 Treated effluent

- Treated wastewater is discharged into the river through a 1 km outfall. The structural problem in the design of the outfall can be translated into the absence of a Rip rap structure or a diffused outlet into the river to avoid point pollution and disturbance of the aquatic life in the river.
- No regular analysis is conducted for treated effluent or receiving waters by the operator (except for the pH, DO and temperature).

3.3.6 Standby Power and Alarms

- The total power capacity of the generator is 150-250 kV
- The plant (treatment units and headwork) is equipped with local alarms to notify units' failure or loss of power.
- No gas detector equipment is connected to the generator to detect the flammable and toxic gases.
- A noise reduction system is installed to reduce disturbance from the generator.
- Continuous monitoring of unusual excessive heat, noises, vibrations, and burnings is ensured.
- Operators regularly (daily/ weekly/ monthly) conduct maintenance programmes for the generator by controlling and inspecting the generator's voltage, the cycles and engines, the battery, the fuel tank level and the battery chargers.
- The average monthly fuel consumption is 10,000 L/day which corresponds to 4 to 12 hours/ day of average daily operation time. The daily operation time is highly dependent on the electricity supplied by the Government.
- The storage tank is located underground.

- There is no intention to replace high energy consuming equipment with energy efficient equipment.
- Diesel-powered plants and equipment are turned-off while not in use to reduce excessive energy consumption.

3.3.7 General Housekeeping

- Repair tools are available at the workshop area.
- Maintenance and operation manual is available in the plant.
- The plant is generally clean, free from open trash areas.
- No pest control program is initiated in the plant due to the absence of a landscaping area.
- Regular and daily cleaning procedures are carried out for the plant treatment units, the digester, the blowers and the pore systems.
- The treated effluent that reaches the chlorine contact tank is used for cleaning.
- No SPCC Plan (Spill Prevention, Control, and Countermeasure) is set at the plant; however, the employees are well trained to control spills (oil and fuels).
- Spills and leaks that occur in dry areas are directly controlled.
- Storage and labelling requirements of the chemicals are not respected in the plant.
- Some spare parts are maintained in the plant (recommended spare parts are presented in Appendix A).

3.3.8 Safety

- The access to the plant is secured through two gates, one in front of the administrative building and the other by the side of the drying lagoons. The first gate is normally used. Gates are not provided with security alarms.
- All ladders and catwalks were provided with adequate handrails for the safety of the operator (Figure 3-12).
- A list of emergency phone numbers is available at the plant (Figure 3-13).
- Personal Protective Equipment including hard hats, rubber boots and gloves are available at the plant.
- Emergency response plans are accessible at the facility.
- Warning signs (no smoking, non-potable water, danger-fire risk, danger-chlorine and electric shock risk) are available on site in critical area (Figure 3-14).
- Material Safety Data Sheets (MSDS) are available for chemicals.

- First aid kit is available in the plant but most of the medicines are found to be expired (Figure 3-15).

- Fire extinguishers are available at the plant but the expiry dates are passed and the extinguishers have not been renewed (Figure 3-16).

3.3.9 Environmental Monitoring plan

- At earlier stage when the feasibility study was conducted, a general environmental and social impact assessment was conducted for all of the three plants funded by USAID (Fourzol, Ablah, Aitanit). This assessment covered Aitanint environmental impact and was used also to elaborate an environmental monitoring plan to assist the operator in managing and monitoring this plant impacts on the environment. This monitoring plan is included in Appendix D.

3.3.10 Sampling

- The laboratory is equipped with a kitchen sink, cabinet and drawers to store laboratory equipment and instruments.

- The only available laboratory instruments and reagents on site are pH meter, DO meter, distilled water bottle and some pH buffer solution. Instruments are not properly calibrated as the reagents and the buffer solutions are expired.

- The sampling and analysis plan and the daily process control sampling are available.

- The available instruments were not sufficient to operate a wastewater treatment plant adequately.
- The DO meter (YSI Brand) was indicating false measurement results due to the non-accuracy of DO sensor.

3.3.11 Records

- A full record of the operational performance of the plant, the equipment maintenance and the reparation procedures is available.

- As-built drawings, shop drawings, site layout, design plans and criteria and construction specifications are available on site.

- Maintenance and reparation records for the wastewater treatment plant units are available.

- A process flow diagram, instructions for the operation of the equipment, warranty information and different record forms (sludge settle ability test forms, sludge handling daily process control data sheet, flow meter testing data collection form and the standby power generator record form) are available.

- Records of previous environmental problems are available.

- There are no records for the daily plant influent or effluent characteristics; however, there is logbook for the daily flow meter reading, DO measurement and pH value.

3.3.12 Treatment efficiency

The treatment efficiency was evaluated by comparing the quality of the inlet wastewater and the outlet treated wastewater as well as comparison with the prevalent standards. Two (2) Twelve hours composite samples were collected from the effluent chamber and the certificates are included in Appendix B.

According to the results, the wastewater treatment efficiency for BOD removal is 97.8% and the efficiency of COD removal is 88.6%;

The wastewater analysis results of the effluent were compared against the proposed Lebanese Wastewater Reuse guidelines (Table 3-1), Water Quality for Irrigation[1] and the Lebanese Maximum Allowable Limits for discharging wastewater into surface water (Table 3-2). Exceedances to the standards are highlighted in bold.

Coliform Bacteria concentrations exceeded the standards for category 1 and 2.

Coliform Bacteria concentrations exceeded the Lebanese standards for maximum allowable limits for receiving surface water bodies as the plant operator was not disinfecting the effluent to reduce his operational cost. The treated water is being used for irrigation purposes and hardly any water is being discharged to the river due to the lack of water in the area. The effluent pipes are currently closed and the farmers are pumping out treated water from chlorine contact tank for irrigation. Therefore, the audit did not find it as incompliance issue. However, the recommendation will be made to properly operate choline addition as designed and level of Coliform Bacteria will be monitored closely.

TDS level in the effluent require slight to moderate restriction on use for irrigation, whereas after disinfection with chlorine it can be discharged to surface water without any restriction.

Total Nitrogen concentrations exceed slightly the reclaimed wastewater reuse guidelines in Lebanon as the plant was designed before the approval and implementation of the Ministry of Environment decision 8/1of the year 2001. De-nitrification was not part of this plant treatment process design while actually partial denitrification is occurring in the secondary settlement tank due to the long retention of sludge inside these tanks. The excess in the total nitrogen above the reuse guidelines will not restrict the possibility of reuse of reclaimed water for irrigation purposes as nitrate will enhance the fertilizing quality of the treated water and don't cause any harm for trees when in Nitrate status.

In addition to wastewater analysis, a sludge sample was collected from the drying ponds on July 16, 2014. The analysis results were compared against the sewage sludge ordinance for Lebanon that respects the local conditions and follows the orientation of the European directive 86/278/EEC. Limit values are based on current recommendations of the European Commission (Table 3-3). If sludge does not meet the above described standard or if the demand of sludge is insufficient then it must either be disposed by incineration or on a sanitary landfill. It is recommended that the operator prepares a sludge management plan in accordance with this ordinance.

[1] Proposition for Lebanese Wastewater Reuse Guidelines- United Nations-Food and Agricultural Organization (FAO) Rome, 2010

According to the results, the sludge concentration of heavy metals and organic compounds are within the limit values for use on land with the exception of the Zinc. The concentration of the AOX exceeded the standards; the AOX is probably formed inside the treatment plant under the anaerobic conditions or resulted from the discharge of the industrial wastewater into the plant.

Table 3-1 Comparison of the Results of Aitanit WWTP Effluent against the proposed Wastewater irrigation Reuse Guidelines

Parameter	Category (Appendix C)			Results of Aitanit WWTP Effluent
	1	2	3	
pH*	6-9	6-9	6-9	8.05
Total Suspended Solids (mg/L)	60	200	200	20.3
BOD_5 (mg/L)	25	100	100	16
COD (mg/L)	125	250	250	90
Faecal Coliforms (in 100mL)	<200	<1,000	None required	**100,000**

* Field measurment

Table 3-2 Comparison of the Results of Wastewater Analysis against the Maximum Allowable Limits for Surface Water and Irrigation Water Quallity

Parameter	Aitanit WWTP Inlet and Outlet		Maximum Allowable Limits For Surface Water (MoE Decision 8/1)	Degree of Restriction on Use		
	Raw wastewater	Treated water		None	Slight to Moderate	Severe
pH	7.88*	8.05*	6-9	6.5 - 8	6.5 - 8	6.5 - 8
Salinity (mg/L)	895*	683*	-	<700	700-3,000	>3,000
Specific Conductivity (µS/cm)	1549*	1202*	-			
TDS (mg/L)	$1.1 * 10^3$*	855*	-	<450	450 - 2,000	>2,000
Temperature (°C)	26.2*	22.2*	30 °C			
BOD (5 day, 20°C) (mg/L)	712	16	25 mg/l			
COD (dichromate) (mg/L)	790	90	125 mg/l			
Total Suspended solids (mg/L)	310	20.3	60 mg/l	<50	50-100	>100
Total solids (mg/L)	1136	872				
Hydroxide Alkalinity (mg/L)	0	0				
Carbonate Alkalinity (mg/L)	0	0				
Bicarbonate Alkalinity (mg/L)	610	259				
Chlorides (mg/L)	839	481	-	<105 (Sprinkler irrigation)	>105 (Sprinkler irrigation)	
				<140 (surface irrigation)	140 - 350(surface irrigation)	>450(surface irrigation)

Ammonia (NH4+) (mg/L)	68	1.5	10 mg/l			
Organic Nitrogen (mg/L)	0.96	3.82				
Total Nitrogen[2] (mg/L)	68.96	5.32	30 mg/l	<5	5 - 30	>30
Nitrate (NO3-) (mg/L)	48	130	90 mg/l			
Total Phosphorus (mg/L)	7.0	3.9	10 mg/l			
Phosphate (PO_4^{3-}) (mg/L)	1.80	0.87	5 mg/l			
Sulphate (SO_4^{2-}) (mg/L)	80	140	1,000 mg/l			
Sulphide (S^{2-}) (mg/L)	3.85	0.003	1 mg/l			
Coliform Bacteria 370 C in 100 ml[3]	$6.6*10^6$	**100,000**	2,000			

[2] Sum of Kjeldahl-N(organic N + NH3),NO3-N, NO2-N
[3] For discharges in close distance to bathing water, a stricter environmental limit value could be necessary

Table 3-3 Sludge analysis results

Substance	Unit	Aitanit Sludge	Limit Values in sludge for use on land
Dry matter	% (w/w)	95.7	
Organic matter	% (w/w) dm	68.2	
Residue on ignition	% (w/w) dm	31.7	
Fraction < 16 µm	% (w/w) dm	30.8	
Fraction < 2 µm	% (w/w) dm	1.6	
Metals			
Arsenic (As)	mg/kg dm	<5.0	
Cadmium (Cd)	mg/kg dm	1.3	10
Chromium (Cr)	mg/kg dm	39	1000
Copper (Cu)	mg/kg dm	150	1000
Mercury (Hg)	mg/kg dm	2.7	10
Nickel (Ni)	mg/kg dm	25	300
Lead (Pb)	mg/kg dm	220	750
Zinc (Zn)	mg/kg dm	**2900**	2500
Sum Extractable Organic Halogenes			
EOX	mg/kg dm	41	
Polycyclic Aromatic Hydrocarbons, PAH			
Naphtalene	mg/kg dm	0.19	
Acenaphtylene	mg/kg dm	0.042	
Acenaphtene	mg/kg dm	0.043	
Fluorene	mg/kg dm	0.032	
Phenanthrene	mg/kg dm	0.32	
Anthracene	mg/kg dm	0.13	
Fluoranthene	mg/kg dm	0.22	
Pyrene	mg/kg dm	0.22	
Benzo(a)anthracene	mg/kg dm	0.059	
Chrysene	mg/kg dm	0.15	
Benzo(b)fluoranthene	mg/kg dm	0.12	
Benzo(k)fluoranthene	mg/kg dm	0.068	
Benzo(a)pyrene	mg/kg dm	0.37	
Dibenzo(ah)anthracene	mg/kg dm	<0.010	
Benzo(ghi)perylene	mg/kg dm	<0.010	
Indeno(123cd)pyrene	mg/kg dm	0.93	

Substance	Unit	Aitanit Sludge	Limit Values in sludge for use on land
PAH 10 VROM (sum)	mg/kg dm	2.4	6
PAH 16 EPA (sum)	mg/kg dm	2.9	
miscellaneous research			
AOX	mg/kg dm	**840**	500

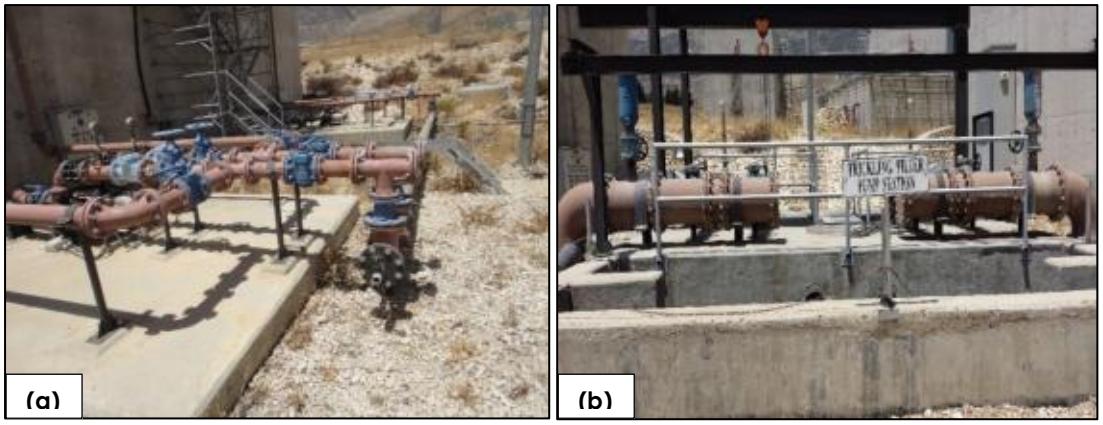

Figure 3-1 Pump stations for digester tanks (a) and Trickling Filter Unit (b)

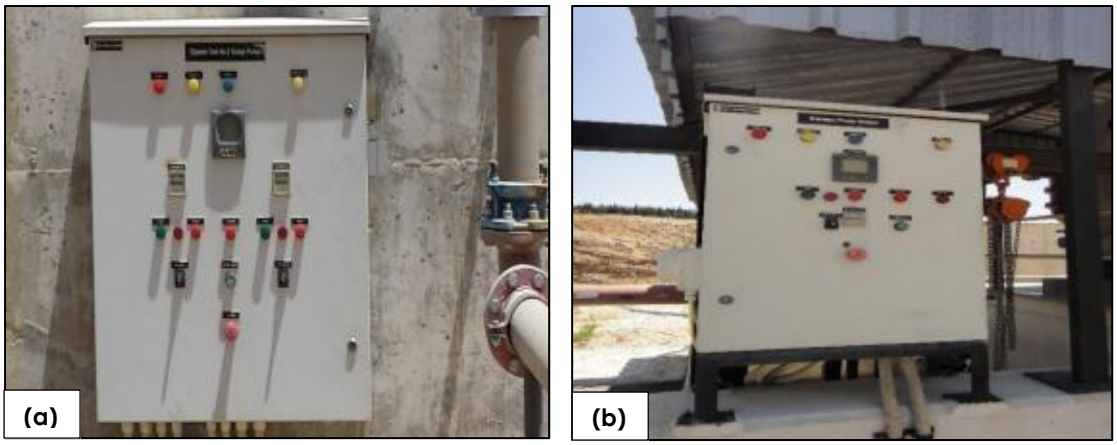

Figure 3-2 Control Panels for seepage pump station (a) and digester tank sludge pump (b)

Figure 3-3 Influent Flow Meter

Figure 3-4 Screening Unit at Aitanit WWTP includes: (a) Bar Screen; (b) Two Static Sieve Type Fine Screen and (c) Fine screen with hand filling plastic bag.

Figure 3-5 Primary Clarifier Unit of Aitanit WWTP

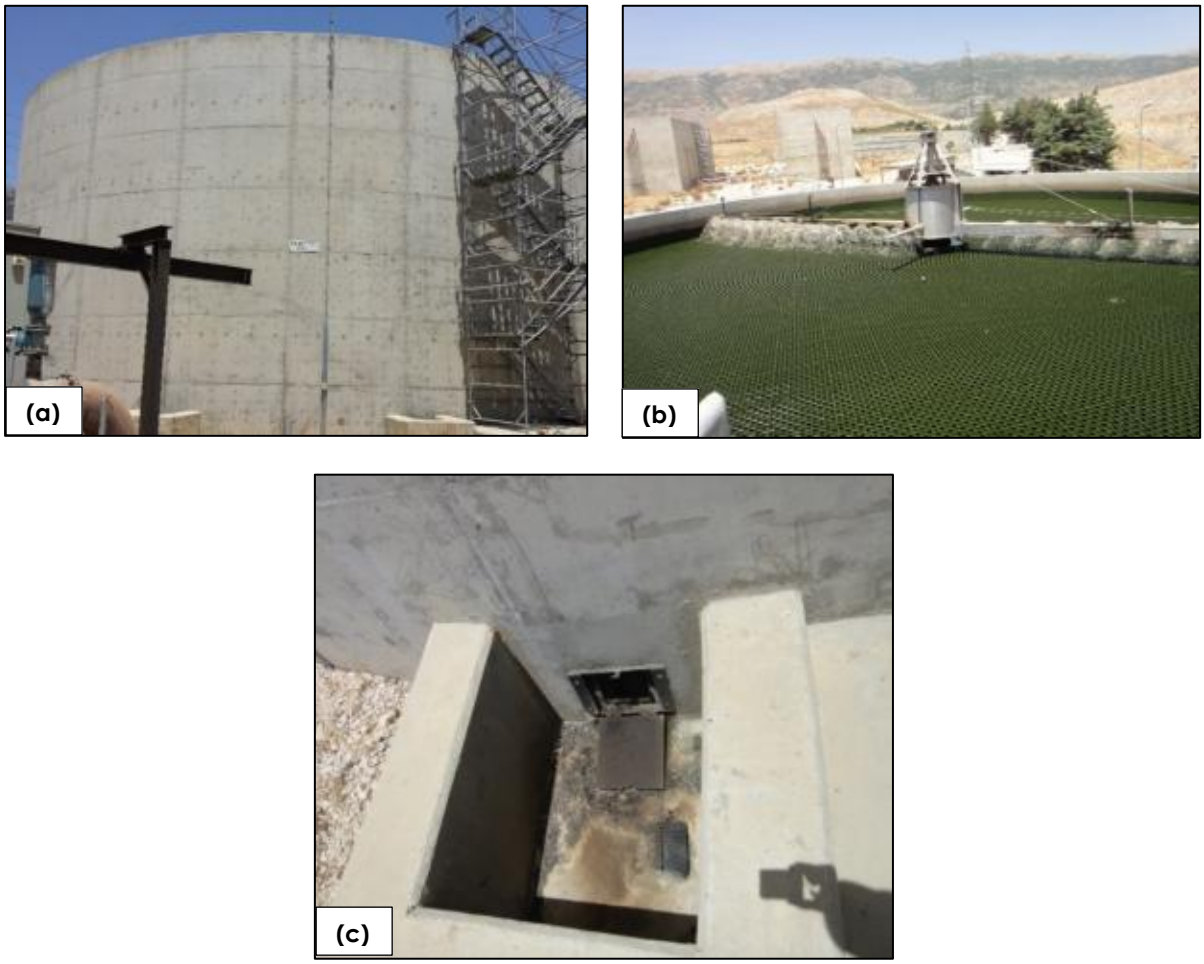

Figure 3-6 Trickling Filter Unit showing the main TF building (a) and the rotation of distribution arms (b) and Ventilation door (c)

Figure 3-7 Secondary or Final Clarifier showing sudsy, billowing and bulking sludge

Figure 3-8 Chlorine Contact Tank

Figure 3-9 Digester tank and its pump station

Figure 3-10 Supernatant evacuation system of the sludge: sluice gates

Figure 3-11 Sludge drying lagoons showing sludge cakes and vegetation

Figure 3-12 Safe Catwalk and Ladders

Figure 3-13 List of emergency phone numbers

Figure 3-14 Warning Sign

Figure 3-15 First Aid Kit

Figure 3-16 Fire Extinguishers

4. CONCLUSIONS AND RECOMMENDATIONS

Aitanit WWTP treated effluent is compliant with the MoE applicable standards and regulations and has an additional capacity to treat the additional sewage flows collected through the proposed project.

Although design of the WWTP is in compliance, an issue was found at an operational level that the operator is not properly adding chlorine, which resulted in high level of bacterial coliform. The audit concluded that this is not an incompliance issue as hardly any water is being discharged to the River due to the lack of water in the area. However, considering the possibilities of treated water to be discharged to surface water in the future, the audit recommends the Government to allocate adequate budget for chlorine addition and monitor the level of coliform closely. Implementation of the monitoring plan in Appendix D should be ensured by MoE and BWE.

Also, the operator should prepare a sludge management plan in accordance with the ordinance on the use and disposal of sewage sludge to improve the sludge disposal practices and ensure safe reuse and disposal with regular analysis. The analysis frequency must meet the minimum number of analysis per year stated in the ordinance.

Furthermore, some recommendations were made to enhance the plant's treatment performance whereby a detailed action plan was developed (Table 4-1). The plan included costs (where possible) to assist in budgeting the implementation of these recommendations. It has to be noted that additional processes shall be added to enhance de-nitrification when required (when plant merely reaches its ultimate capacity) as per the plant's feasibility study.

Table 4-1 Recommendations to further enhance plant performance

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
Structural problem occurred in the sewer trunk coming from Machghara (broken) which lead to excess infiltration and accumulation of stones, gravels and grits in to this pipe line.	Influent sewer pipe lines	Technical and structural	B, C	Implement aggressive programs to reduce inflow and infiltration from Machghara broken sewer pipe line or from any unknown sources in order to lower the number of weather-related wastewater treatment plant bypasses and the infiltration of gravels and grits from this pipeline. Replace broken Trunk Sewer lines (PVC pipe Ø 300) installed by the riverside.	110 USD/m
Both bar screen and static screens are cleaned manually which require frequent raking by the plant personnel to prevent clogging.	Manual bar Screen and static screen	Structural/technical	C	• It is recommended to provide the coarse screens with an adequate trash removal that can be manually hoisted and cleaned. • It is recommended to install a belt conveyor and a screening bin for the evacuation of screenings from the fine screen area.	4,800 USD
Improper placement of flow measurement device.	Manual bar screen	Structural	B	Install a Parshal flume and level detecting device for flow measurement and high influent flows detection upstream of coarse screen channel.	10,500 USD
Grease pass through the plant to show up in the final effluent due to the absence of oil and grease removal tank.	Static screen	Structural/technical	D	Add an oil and grease trap upstream of the fine screen and use more frequently the primary clarifier Skimmer to remove free	8,000 USD

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
				floating oil and grease from the water surface and dispose the scums instead of recycling it.	
Sand and grits are settled in the influent chamber and some of pass through to the primary clarifier.	Static screen	Structural/technical	D	Add sands and grits channels with adequate removal mechanism and repair sewer lines in the river.	18,000 – 20,000 USD
The primary clarifiers contain black and odorous wastewater with a scum which indicates improper sludge withdrawal rate or frequency, return of well-Nitrified waste -activated sludge.	Primary clarifier	Operational	C	• The operator must use the water analysis to identify the problems and rectify it. • It's recommended to transfer more of the primary settled sludge to the sludge digesters and decrease the recycling of secondary settled sludge to the Primary clarifier.	NA[4]
Poor scum/ sludge removal, improper operation of scum skimmer and excessive sludge accumulation in the basin.	Primary clarifier	Operational	C	Improve scum/ sludge removal and eliminate co-settling of waste activated sludge.	NA
A rising sludge are noticed in the secondary clarifiers and the fouling is overflowing the weirs; the effluent from the settling tank contains a high	Secondary clarifier	Technical/logistics	B,C	De-nitrification is happening in secondary clarifier due to excess storage of sludge. The bubbles of nitrogen act as a sludge carrier. Remove sludge more frequently from	NA

4 N/A stands for not applicable which means the following:

- The proposed mitigation measure cost is marginal and can't be estimated at this stage as it needs further elaboration situated beyond the scope of this study;
- The cost of the mitigation measure was included within another measure cost; and
- An operational modification to improve the plant work efficiency that is not associated with additional cost.

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
concentration of suspended solids.				Secondary clarifiers to avoid excessive de-nitrification.	
Treated effluent is discharged without disinfection. As a result, the level of Coliform exceeds the maximum allowance to be discharged to surface water.	Chlorine contact basin	Technical/logistics	D	Most of water is being reused for irrigation purposes due to the lack of water in the area, However, it is recommended to apply chlorination to the treated water before discharge it to the river or use it in irrigation. The Actual Operator (Union of Municipalities of the Lake) is required to allocate enough budget for the operator to operate the choline addition system. MoWE/BWE will implement the Environmental Monitoring Plan included in the Amended Environmental Impact Statement Small Village Wastewater Treatment Systems "EIQC – TO818" dated November 2005. Especially more rigorous monitoring is required for Coliform. The operator must ensure that treated effluent meets applicable requirements prior to land application for agricultural uses.	24,000 USD
The anaerobic digesters contain dead areas without any mixing.	Anaerobic digester	Structural/operational	C	Add an adequate mixing technique such as agitator to insure proper mixing in the anaerobic digester and enhance sludge digesting.	15,000 USD

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
The anaerobic digesters are not operating properly.	Anaerobic digester	Operational	C	Improving the load distribution between multiple tanks is required and can be achieved by using two digesters for the primary scum and two for the final scum with the focus on increasing of sludge concentration.	NA
Sludge is stored all the year in liquid form to be dried in summer. No draining is allowed from sludge drying ponds.	Sludge drying ponds	Operational	C	• The operator should develop a sludge management plan in accordance with the Ordinance on the use and disposal of sewage sludge to improve the sludge disposal practices and provide landfills for disposing the sludge with regular analysis. The only existing sanitary landfill is Zahle. There is a planned landfill in Jeb Jannine to be used when fully constructed. • Insure proper operation of the drying ponds sluice gate to allow supernatant evacuation and reduce the time required for drying.	3,000 USD
Dried Sludge is being stored in the sludge drying ponds for the past three years.	Sludge drying ponds	Operational / Logistic	C, D	• The dried sludge should be relayed off the plant to a landfill or to be used in agriculture. In both cases, sludge quality must be tested to ensure safe reuse/disposal in accordance with the ordinance on the use and disposal of sewage sludge (CDR 2003). • It is preferred to apply sludge in agriculture as a fertilizer with suitable	NA

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
				management measures related to application rates, crop selection and not to use it in areas that are irrigated with the treated effluent to avoid accumulation of contaminants.	
Sludge constituents are not analysed to evaluate the performance of treatment and the ability of use as a fertilizer.	Sludge drying ponds	Operational	C	As the sludge was never moved from drying ponds it was never monitored or tested by the operator. The sludge analysis conducted on collected samples from drying ponds showed results and quality suitable for fertilizing usage. It is recommended to conduct routine analysis for sludge prior to permission of use it in agriculture.	600 USD/test
Future increase of wastewater inflow to the plant will put more pressure on sludge treatment units.	Influent	Operational	C	• The plant has four sludge digesters where only two are used for the time being, increasing inflows may require running all the four digesters and that may increase sludge retention time which will lead to a reduction in sludge production and reduce further its VSS content and will enhance its quality for reuse or disposal.	300 USD/Month
The service pumps are out of service	Pumps	Technical	B	It is recommended to repair the plant water pumps.	800 USD/pump
Frequent damage to the functionality of primary clarifier and trickling filter pumps'	Primary Clarifier and Trickling	Technical	B	The area of related pump skids and its control panels shall be shaded in order to avoid any	12000 USD

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
upon exposure to heavy rainfall and sunlight	Filter unit			unexpected damage upon exposing to sunlight and heavy rainfall.	
The effluent is not clear; suspended solids, turbidity, grease and scum present in the treated water.	Effluent discharge point	Operational	C	It is recommended to conduct routine analysis for treated water prior to permission of use it in agriculture.	500 USD/test
Treated effluent is discharged through the chlorine basin without disinfection. The discharged water are used by the farmers to irrigate the cultivated land of the surrounded area. Small volumes of the treated effluent are used in the plant for miscellaneous purposes.	Effluent discharge point	Technical	D	It is recommended to restrict the reuse of the treated effluent in agriculture for category 1 and 2 considering crops selection, in case disinfection limits were not achieved it can be used for irrigation of category 3 crops without further treatment.	Cost of conveyance of treated water to irrigation areas to be bared by farmers
Treated water discharge structure into the Litani river must be modified to reduce the discharged water impacts on the environment. It encounter some beaks different places and need to be repaired.	Treated water outfall	Operational/ Technical	C	• It is recommended to modify the outfall design and propose a structure to prevent excessive degradation in the discharging point. • Implementation of the Environmental Monitoring Plan included in the Amended Environmental Impact Statement Small Village Wastewater Treatment Systems "EIQC – TO818" dated November 2005.	110 USD/meter + 3,000 USD

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
No adequate measures for odor control are considered or applied in the plant design and construction.	-	Operational	D	• Add a mechanism of Hydrogen Peroxide injection for headwork's odor control. Hydrogen Peroxide typically controls odors and corrosion at the WWTP by direct oxidation of hydrogen sulphide (H2S) within the wastewater. • Implement a green belt to reduce the odor emissions and their spread. • Insure routine relay of the sludge and the screenings out of the plant.	800 USD for setup and 1,750 USD/year
The plant is equipped with a fire alarm system but it is not operational due to its power battery failure.	-	Operational	C	Fix the fire alarm system and put it in service.	250 USD
Fire extinguishers are available in the plant but they are expired.	-	Operational	C	Insure that the fire extinguishers are always filled and not expired.	500 USD
First aid kit is available but most of the medicines are expired.	-	Operational	C	Insure that the first aid kit is always available and medicines are not expired.	150 USD
Power failure influence on treatment efficiency and sludge removal.	-	Operational	B	Aitanit is provided with electricity from Qaraoun Dam, it suffers from power outage only in drought season. The union of municipality is requested to supply enough diesels for the main generator of the plant to cover the power shortage.	2000 USD/ month
No gas detector equipment is connected to the generator to detect the flammable	-	Technical	C	Provide the plant with a gas detection	2,000 USD

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
and toxic gases.				system.	
Only three staffs are working in the plant (operator, operator assistant and guard), which is not adequate for plant operation and securing.	-	Operational	C	• It is required to employee additional personnel for plant operation and maintenance after following training on the O&M manual and analysis procedure. • Subcontract a specialized O&M company to operate, maintain and secure the plant (consumable not included)	148,000 USD 210,000 USD
The available instruments are not sufficient to operate a wastewater treatment plant adequately.	-	Operational	D	• Update the pH meter and supply new sensors for DO meters and provide lab equipment suitable for plant running including the main analysis such as pH, BOD, COD, TSS, bacteriological, TKN, orthophosphate, TP. • Train the operator to use the lab equipment including samples preparing, analysis performing and instrument calibration.	24,000 USD
Poor emergency and management programs	-	Operational / Logistics		• Conduct regular wastewater treatment plant infrastructure and performance reviews with the end goal of achieving good and economical effluent. • Emergency backup power systems should be maintained and be available at all times to avoid any spill or discharges of	3,800 USD/month

Problems/Deficiency	Location	Type	Rating	Recommended Action	Cost
				untreated effluent from the site. Fuel for Genset must be provided. • On-line instrumentations (Dissolved Oxygen, pH, H2S Monitoring, Free residual chlorine, etc…) or at least portable instrumentations to enable monitoring of wastewater treatment operations must be provided.	12,000 USD

***** Rating is marked as following:

A – Excellent: No mitigation measure needed;

B – Minor improvement possible: Identify a level of deficiencies that needs minor action to be rectified; these actions are possible to be done by the actual operator;

C – Minor problems need attention: Identify a level of deficiencies that need attention at plant management level, its associated costs are beyond the operation budget;

D – Structural problems need attention in long run: Identify a level of deficiencies that need major modification in the plant structure and are beyond the capacity of the actual plant management; and

E – No data available: Identify deficiencies of which we could not collect any data.

The priority of mitigation measure shall be given to identify deficiencies ranked form E to A.

5. REFERENCES

National Environmental Auditing Manual (2000). First Edition.

Standard Methods for the examination of water and wastewater, 22nd Edition, 2012.

Ministry of Environment. Decision 8/1/2001. Standards for air pollution & wastewater discharges from industries & drainage water process stations.

APPENDIX A: RECOMMENDED SPARE PARTS

Generator
Filter, coolant
Fuelfilter
Filter
Filter, oil
Sealing ring
Gasket, valve cover
V-belt set
Sealant
Thermostat
V-belt set
Fuse, 1.5A, 250V
Fuse, 3A, 250V fast acting
Fuse, 3A, 250V fast acting
Industrial air cleaner
Lamp, 28V, 4.8W
Sbmersible pumps
Mechnical seal kit
Radial bearing kit
Thrust bearing kit
O-ring kit
Wear ring
Sludge pumps (Primary clarifier pump station)
Mechnical seal kit
Radial bearing kit
Thrust bearing kit
O-ring kit
Submersible pumps (Trickling filter pump station)
Mechnical seal kit
Thrust bearing kit
O-ring kit
Radial bearing kit

Generator
Wear ring
Submersible pumps (Final clarifier return sludge pumps)
Mechnical seal kit
Radial bearing kit
Thrust bearing kit
O-ring kit
Wear ring
Submersible pumps (Final clarifier waste sludge pumps)
Mechnical seal kit
Radial bearing kit
Thrust bearing kit
O-ring kit
Chemical feed pumps
Pepair and preventive maintenance kit
Pump head
Auto-prime valve
Plant water booster
Seal kit + OR sleeve
Gasket (Novus)
Sludge pumps (Anaerobic digester pump station
Mechnical seal kit
Radial bearing kit
Thrust bearing kit
O-ring kit
Wear ring
Sludge pumps (Septage receiving station)
Mechnical seal kit
Radial bearing kit
Thrust bearing kit
O-ring kit
Wear ring

Generator
Portable diaphragm pump
Polyethylene flapper valve
Thermoplastic diaphragm

APPENDIX B: ANALYSIS CERTIFICATES

AUB American University of Beirut
Faculty of Engineering and Architecture
Department of Civil and Enviromental Engineering
كلية الهندسة والعمارة
قسم الهندسة المدنية والبيئية
www.aub.edu.lb

Civil Engineering Service Laboratories | مختبرات الهندسة المدنية

CERTIFICATE OF TEST

Requested by:

ELARD
Lebanon

Date: **22/07/2014**

Your Ref.:

Our Ref.: **R -25632-W**

Nature of Test:

Sample type: Wastewater raw and treated
Date samples received: 16/07/2014

Parameters	Sample IDs			
	Ablah (R)	Ablah (T)	Aitanit (R)	Aitanit (T)
Biological Oxygen Demand (mg/L BOD_5)	985	61	712	16
Total Suspended solids (mg/L)	480	71	310	20.3
Total Solids (mg/L)	1576	984	1136	872
Hydroxide Alkalinity (mg/L as $CaCO_3$)	0	0	0	0
Carbonate Alkalinity (mg/L as $CaCO_3$)	0	0	0	0
Bicarbonate Alkalinity (mg/L as $CaCO_3$)	863	378	610	259
Chlorides (mg/L Cl^-)	844	518	839	481
Ammonia-Nitrogen (mg/L NH_3-N)	79.8	8.1	68	1.5
Organic Nitrogen (mg/L as N)	6.66	1.31	0.96	3.82
Total Kjeldhal Nitrogen (mg/L as N)	86.46	9.41	68.96	5.32
Nitrate (mg/L as NO_3^-)	54.5	64.5	48	130
Total Phosphorous (mg/L as P)	11.0	7.1	7.0	3.9
Ortho-Phosphate (mg/L as PO_4^{3-})	1.02	1.39	1.80	0.87
Sulfates (mg/L SO_4^{2-})	68	124	82	140
Sulfides (mg/L S^{2-})	5.65	0.004	3.85	0.003
Chemical Oxygen Demand (mg/L O_2)	985	112	790	90
Fecal Coliforms (in 100 ml)	TNTC*	~428,000	~6.6 x 10^6	~100,000

*TNTC = Too numerous to count in 0.01 ml of the sample.

All tests are performed in accordance to the "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, 2012 as approved by the American Public Health Association, the American Water Works Association, and the Water Environment Federation unless otherwise noted.

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Professor of Civil & Environmental Engineering

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Certificate of analysis

Your project number	J0086	Certificate number/Version	2014097481/1
Your project name	Qarauon	Start date	08-28-2014
Your order number	Ferzol	Report date	09-15-2014/16:26
		Annex	A,B,C
Sampled by		Page	1/2
Sample matrix	Soil; Sludge, sediment		

	Analysis	Unit	1
	Sample Pre-treatment		
Q	Cryogenic grinding		Executed
	Characteristics		
Q	Dry matter	% (w/w)	87.9
	Organic matter	% (w/w) dm	45.8
Q	Residue on ignition	% (w/w) dm	53.3
Q	Fraction < 16 µm	% (w/w) dm	35.2
Q	Fraction < 2 µm	% (w/w) dm	13.4
	Metals		
Q	Arsenic (As)	mg/kg dm	<5.0
Q	Cadmium (Cd)	mg/kg dm	1.2
Q	Chromium (Cr)	mg/kg dm	55
Q	Copper (Cu)	mg/kg dm	280
Q	Mercury (Hg)	mg/kg dm	3.9
Q	Nickel (Ni)	mg/kg dm	37
Q	Lead (Pb)	mg/kg dm	83
Q	Zinc (Zn)	mg/kg dm	1400
	Sum Extractable Organic Halogenes		
	EOX	mg/kg dm	0.39
	Polycyclic Aromatic Hydrocarbons, PAH		
	Naphtalene	mg/kg dm	<0.010
	Acenaphtylene	mg/kg dm	0.013
	Acenaphtene	mg/kg dm	<0.010
	Fluorene	mg/kg dm	0.015
	Phenanthrene	mg/kg dm	0.11
	Anthracene	mg/kg dm	0.024
	Fluoranthene	mg/kg dm	0.21
	Pyrene	mg/kg dm	0.23
	Benzo(a)anthracene	mg/kg dm	0.071
	Chrysene	mg/kg dm	0.12

No.	Sample description	Date sampling	fins Analytico-#
1	F-Sludge -1+2	28-Aug-2014	8237986

Q: Dutch Accreditation Council (RvA) accredited test
A: AP04 accredited test
S: AS3000 recognized test

Gildeweg 44-46
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BNP Paribas S.A. 227 9245 25
VAT/BTW No. NL 8043.14.883.B01
KvK No. 09088623
IBAN: NL71BNPA0227924525
BIC: BNPANL2A

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TESTING
RvA L010

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Certificate of analysis

Your project number	J0086	Certificate number/Version	2014097481/1
Your project name	Qarauon	Start date	08-28-2014
Your order number	Ferzol	Report date	09-15-2014/16:26
		Annex	A,B,C
Sampled by		Page	2/2
Sample matrix	Soil; Sludge, sediment		

Analysis	Unit	1
Benzo(b)fluoranthene	mg/kg dm	0.13
Benzo(k)fluoranthene	mg/kg dm	0.045
Benzo(a)pyrene	mg/kg dm	0.079
Dibenzo(ah)anthracene	mg/kg dm	<0.010
Benzo(ghi)perylene	mg/kg dm	<0.010
Indeno(123cd)pyrene	mg/kg dm	<0.010
PAH 10 VROM (sum)	mg/kg dm	0.66
PAH 16 EPA (sum)	mg/kg dm	1.0
miscellaneous research		
AOX	mg/kg dm	280 1)

No.	Sample description	Date sampling	›fins Analytico-#
1	F-Sludge -1+2	28-Aug-2014	8237986

Q: Dutch Accreditation Council (RvA) accredited test
A: AP04 accredited test
S: AS3000 recognized test

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KvK No. 09088623
IBAN: NL71BNPA0227924525
BIC: BNPANL2A

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TESTING
RvA L010

APPENDIX C: CATEGORIES EXPLANATIONS

Category 1:

a) Fruit trees and crops that are eaten cooked
b) Parks, public gardens, lawns, golf courses and other areas with direct public exposure
c) In case of stabilisation pounds, the TSS limit value is 100 mg/L

Water treatment expected to meet the criteria: Secondary treatment + filtration + disinfection.

Category 2:

d) Fruit trees
e) Lawns, wooded areas, and other areas with limited public access, road sides outside urban areas
f) Landscape impoundments: ponds, water bodies and ornamental streams, where public contact with water is not allowed

Water treatment expected to meet the criteria: Secondary treatment + filtration + disinfection or Secondary treatment + either storage or well-designed series of maturation ponds or infiltration percolation.

Category 3:

g) Irrigation of cereals and oleaginous seeds, fiber and seed crops
h) Crops for canning industry, industrial crops
i) Fruit trees (except sprinkler-irrigated)
j) Plant nurseries, ornamental nurseries, wooden areas, green areas with no access to the public

Water treatment expected to meet the criteria: Secondary treatment + a few days' storage or Oxidation pond systems.

APPENDIX D: AMENDED ENVIRONMENTAL IMPACT STATEMENT OF SMALL VILLAGE WASTEWATER TREATMENT SYSTEMS "EIQC – TO818": ENVIRONMENTAL MONITORING PLAN