2nd International Conference and Exhibition
Sustainable Water Supply and Sanitation
(SWSSC 2012)

INDUSTRIAL WASTEWATER MANAGEMENT PROBLEMS IN BORG EL-ARAB NEW INDUSTRIAL CITY.

*Dr. Helaley A.H. Helaley[1], Chemist. Reda A. Awad[2], Dr. Samaa M.Z. Abdel Aziz[3].

[1]Chief of Industrial Drainage, Sludge and Reuse Device;

[2]Manager of Industrial Wastewater Dept.;

[3]Manager of Industrial Wastewater Research Dept.,

Alexandria Sanitary Drainage Company, Alexandria, Egypt

Key words

Industrial wastewater, Management , Borg El-Arab city, complying, survey, online monitoring.

ABSTRACT:

Borg El-Arab is a new industrial city within Alexandria containing around 1200 factory distributed within four industrial zones. Since 2008, the sanitary system including the treatment plant of Borg El-Arab was handed to Alexandria Sanitary Drainage Company (ASDCO) for management.

From the preliminary survey it was found that all factory's effluents were not complying with the limits of Law 93 for year 1962 and its presidential decree 44 for year 2000. They dispose their raw wastewater directly into the sewerage system, which creates a chronic street flooding problems all over the industrial zones. As well as affecting the quality of the old treatment plant influent located at the east of the city and the newly instructed tertiary treatment plant.

These factories did not construct effective industrial effluent treatment systems for their wastes, which were supposed to be constructed before getting the permission to start the industrial activity and production. Another problem was the lack of effective industrial effluent inspection, monitoring, and weakness of the legal power and action against non-complying industries. Finally, there was no technical assistance system.

Alexandria Sanitary Drainage Company carried out a Management system to solve these problems through: 1) Industrial survey for technical assistance to apply pollution prevention concepts; 2) Periodical sampling and monitoring program based on severity of the industry; 3) Compliance evaluation to take step by step action for non-complying factories after re-assisting non-complying factories to reconcile their situation, this system applies for already existing industries. For new industries it is essential to apply an additional step which is that the Municipality should get our permission before giving license to industries to start practicing their activity.; 4) Applying a cost recovery program. According to applying these steps problems have decreased and number of complying industries has increased.

Under these circumstances we would like to stress on the importance of applying On-line Monitoring systems to assure effective control of industrial effluent quality 24/7.

1. INTRODUCTION:

Alexandria is considered one of the most economically important coastal governorates in Egypt; it fosters 40% of the Egyptian Industries which represents serious negative impacts on the environment, the integrity and life expectancy of the ASDCO's infrastructure as well as operation and maintenance of the treatment facilities.

Borg El-Arab city was established by the presidential decree (506/1979). It lies 60 km west of Alexandria city, 7 km from the Mediterranean seashore. It is characterized by its elevated area. New Borg El Arab is a major industrial city over 6.3 thousand feddans. Industrial activities includes: food, plastics, paper, weaving, building materials, chemical, pharmaceutical and various industries….etc.[1]

In most industries, wastewater effluents result from the following water uses: 1) Sanitary wastewater (from washing, drinking, etc.); 2) Cooling (from disposing of excess heat to the environment); 3) Process wastewater (including both water used for making and washing products and for removal and transport of waste and by-products); and 4) Cleaning (including wastewater from cleaning and maintenance of industrial areas) (Abdulrzzak Alturkmani)

Therefore, the use of water by industry can significantly affect the water quality of receiving waters. The level of wastewater loading from industrial sources varies markedly with the water quality objectives enforced by the regulatory agencies

Thus, it was necessary to establish a well designed and managed industrial waste management program to minimize sewerage system problems, reduce ASDCO's operation and maintenance cost, recover the actual cost of O&M and protection of public health and the environment by eliminating organic load and reducing toxic industrial waste materials. Thus, enable sustainable economic growth in Alexandria.

2. MATERIALS AND METHODS:

The wastewater treatment plant of Borg El-Arab industrial city was handed to Alexandria Sanitary Drainage Company (ASDCO) for management, operation and maintenance since 2008. The sector of Industrial wastewater, Sludge and Reuse took the responsibility of inspecting, monitoring and management of the effluents of the industrial activities within the city which is divided into four industrial zones.

An "Industrial waste management program" was prepared by the industrial wastewater, Sludge and Reuse specialists of ASDCO and the field work was applied by the Industrial Waste Management Department under the umbrella of the sector. The Management program was implemented according to the following steps:

2.1 Identification of industrial facilities:

The distribution of industrial activities was investigated to identify type of industry and its location.

[1] www.urban-comm.gov.eg/english/**borg**_econo.asp

2.2 Sanitary survey:

The industrial activities were investigated to define sources of pollution, possible in-plant changes, process modifications, water-saving measures through which industrial wastewater loads can be significantly reduced and final disposal points.

2.3 Technical assistance:

Technical assistance was provided by advising industrial facilities to develop pollution prevention measures and waste minimization plans according to the survey evaluation or even advising to implement suitable treatment units. The focus of pollution prevention is on minimizing the amount of waste generated as opposed to treating and recycling wastes after generation. The pollution prevention aspects were applied as follows: (Industrial Waste Treatment, 1996).

- Pollution should be prevented or reduced at the source whenever feasible.
- Pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible.
- Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible.
- Disposal or release into the environment should be the last resort and should be conducted in an environmentally safe manner.

Pollution prevention generally encompasses process modification, material substitution and product reformulation; Improved process O&M; good operating practices (good housekeeping); and material recycle, reuse and recovery for in-process use. (Industrial Waste Treatment, 1996).

2.4 Implementing Industrial waste Inspection and Monitoring program:

A comprehensive industrial waste inspecting and monitoring program including effluent flow measurements, periodic effluent sample collection (at least twice a year) from each industrial activity producing industrial wastewater according to the Law 93 for year 1962 and its presidential decree 44 for year 2000.

2.5 Compliance Evaluation:

The wastewater samples were analyzed for a number of standard physico-chemical properties, including pH, temperature, chemical oxygen demand (COD), total suspended solids (TSS), biochemical oxygen demand (BOD), Sulphides, Grease and Oil (G&O), Total Nitrogen (TN), Total Phosphorus (TP) and settleable solids. All experiments were carried out on the basis of "standard methods for water and wastewater tests" (APHA, 2005). The main parameters that will be discussed in this research for measuring the pollution strength are BOD, COD and TSS which are the most effective parameters on the function of the wastewater treatment plants.

When sampling results showed that the wastewater was not complying with the permitted limits of Law 93 and its presidential decree, polluting facilities were advised to reconcile their

situation by providing them with the appropriate technical assistance, then confirmation samples were taken.

Finally, when non-complying industries refused to reconcile their situation after the technical assistance and the time limit provided to them has passed (6 months), legal steps were taken against the violating facilities.

2.6 Cost Recovery system:

A follow-up and updating surcharge program was conducted to recover the actual cost of operation and maintenance (O&M) from the industrial customers, the cost incurred for additional treatment provided for industrial wastewater containing excessive BOD and TSS.

The third industrial zone was selected as a scope for this paper as it contains around 26% of the industries in New Borg El-Arab industrial city in addition it has quite an adequate distribution of all the industrial activities within the city. The main parameters of concern in this work are BOD, COD and TSS.

3. RESULTS AND DISCUSSION:

Data presented in this work was done in the period from 2008 till June 2011. Records showed that the existing industrial activities within the city are around 1200 facility. The actual working is 700. The investigation, so far, showed that the existing industrial activities within the city which dispose industrial wastewater into the sewerage system were around 321 waste producing factories belonging to different industrial sectors. These sectors included Food, Chemicals, Construction, Metal, Textile and Pulp & paper industries. The distribution of industries is represented in figure (1).

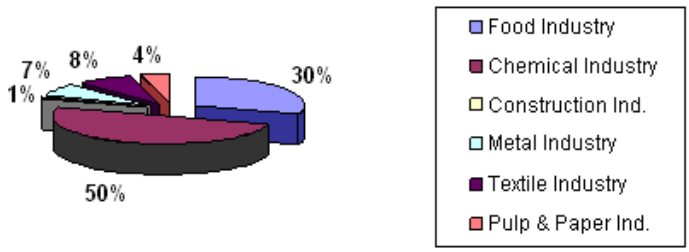

Figure (1): Industrial Activities in New Borg El-Arab Industrial city.

New Borg El-Arab Industrial City is divided into four industrial zones; the distribution of industries within the four zones is shown in figure (2). All the domestic sewage as well as the industrial wastewater is treated at an oxidation pond treatment plant located east of the city and the plant effluent is used in irrigation of silviculture areas.

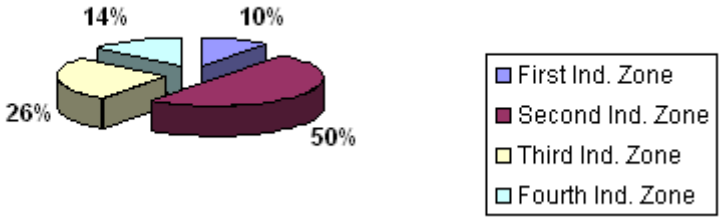

Figure (2): Industrial zones in New Borg El-Arab Industrial city.

The investigation within the four industrial zones showed that the first, second, third and fourth industrial zones were occupied by 33, 158, 84 and 44 running factories respectively discharging industrial wastewater into the sewerage system; the distribution of the industrial activities within the four zones is shown in figure (3).

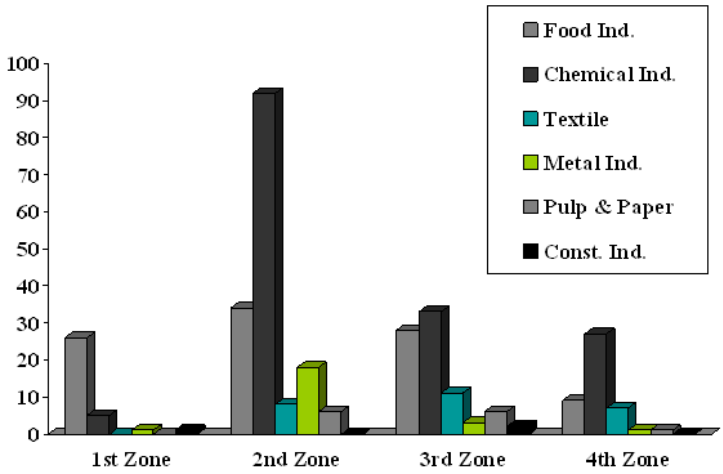

Figure (3): Distribution of industrial activities within the Industrial zones.

From the four investigated zones the third industrial zone had a distribution of all kinds of industrial activates; as shown in figure (4). Thus, it was selected to be the main study area within this research work. The investigation revealed that 85 factories out of 231 were discharging industrial wastewater. They could be classified into 9 textile, 3 fabricated metals, 6 paper and pulp, 34 chemicals, 31 food industries, and 2 building materials facilities (construction).

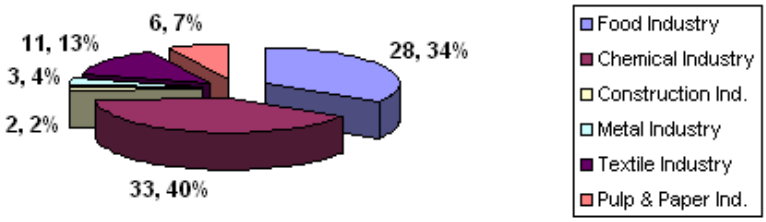

Figure (4): Distribution of industrial activities within the third Industrial zone.

The inspection and monitoring process revealed that out of the 85 wastewater-generating industrial plants in the city, 28 were violating the law 93/62 and its presidential decree for the wastewater discharge into the sewerage system for one parameter or more. These were 3 textile companies, 1 fabricated metal company, 4 paper and pulp facilities, 10 chemical companies, and 11 food processing companies.

Industrial wastewater effluents are usually highly variable, with quantity and quality variations brought about by batch discharges, operation start-ups and shutdowns, working-hour distribution and so on. (Abdulrzzak Alturkmani)

3.1 Food Industry

Food processing can be divided into four major sectors including fruit &vegetables; meat, poultry, and seafood; edible oil production; and dairy operations. All of these sectors consume huge amounts of water for processing food. A considerable part of these waters are potential wastewaters to be treated for safe disposal to the environment. Water is used as an ingredient, an initial and intermediate cleaning source, an efficient transportation conveyor of raw materials, and the principal agent used in sanitizing plant machinery and areas. Although water use will always be a part of the food-processing industry, it has become the principal target for pollution prevention, source reduction practices. (Pollution from food processing factories book).

The primary issues of concern in the food processing wastewater are biochemical oxygen demand (BOD) (soluble and insoluble), total suspended solids (TSS), Grease and Oil (G&O), excessive nutrient loading (namely nitrogen and phosphorus compounds), dissolved solids and salts, pathogenic organisms, residual chlorine and pesticide levels. The food industry is now facing increasing pressure to ensure that their company's activities are environmentally sensitive. (Pollution from food processing factories book).

Results of the food industry, as presented in figure (5), showed that the most polluting factor in the Food industry is the COD as it ranged between 2.4 - 3.8 kg/m^3. While the BOD levels didn't exceed 0.7 kg/m^3 and TSS didn't exceed 1 kg/m^3. The maximum levels of COD were reached at year 2009 were our program was still in the beginning, while after continuous inspection and monitoring together with applying technical assistance aspects with industries we succeeded to gradually decrease the COD levels as it reached its minimum during 2010. However, during 2011 and the revolution of 25th January the companies started again to violate the law this was shown by the increase in the levels. However BOD and TSS were almost within the same range during the 4 years of work.

3.2 Chemical Industry

Chemical industry is one of the largest polluting industries. The activities within the chemical industry vary between pharmaceutical plants, tanning facilities, fertilizers, plastics, detergents and printing facilities. Chemical industrial facilities generate a variety of wastes during manufacturing, maintenance and housekeeping operations. While maintenance and housekeeping activities are similar from one plant to the next, the actual processes used in manufacturing vary widely. Typical waste streams include spent fermentation broths, process liquors, solvents, dyes, acidic and alkaline wastes, equipment washwaters, lubricating oil,

detergents, dirt, impurities, spilled materials, off-spec products, and used processing aids. (ZHANG-Yuan).

Reducing the generation of these wastes at the source, or recycling these wastes, will benefit manufacturers by increasing product yields, reducing raw material needs, reducing disposal costs, and reducing the liabilities associated with hazardous waste management.

Results of the pollution load from the 34 chemical industries, as presented in figure (6), showed that COD is the most polluting factor in this industry, its value ranged between 1.1 - 1.9 kg/m^3. While the BOD levels didn't exceed 0.6 kg/m^3 and TSS didn't exceed 0.8 kg/m^3. The maximum levels of COD were reached at year 2009, after continuous inspection and monitoring together with applying technical assistance aspects with industries we succeeded to gradually decrease the COD levels as it reached its minimum during 2011. Generally, the results show that the chemical industry is in the process of decreasing its pollution loads.

3.3 Construction Industry:

Traditionally materials like clay, sand, calcium carbonate, lime, trace metals, suspended particulate matter and scum are the major components in wastewater. The optimal solution for solid waste management is to minimize the quantity of waste both at generation and disposal stage followed by preventive environmental management action. (Asokan Pappu et al)

Results of the two working Construction facilities, as presented in figure (7), showed that COD is also the most polluting factor in this industry. Levels varied between 2.9 - 5.8 kg/m^3. While the BOD levels didn't exceed 1.3 kg/m^3 and TSS didn't exceed 2.3 kg/m^3. The maximum levels of COD were reached at year 2010. BOD results decreased noticeably as we have advised the company to separate the domestic waste from the industrial, consequently the COD results decreased accordingly. However, they are not responding to apply appropriate treatment to their wastes.

3.4 Metal Industry

The general processes of metal finishing industry include machining, cleaning (removal of oil, grease and dirt using water and detergent or electolytic and non-electrolytic alkaline cleaning and acid cleaning), surface preparation, plating & coating, anodizing & etching, and chemical milling. Wastewater produced may include oils (free or emulsified), lubricants, detergents, acids, acidic and alkaline solvents, heavy metals (free or complex) such as cadmium, chromium, copper, lead, nickel, zinc, tin, aluminum and Iron. (Industrial Waste Treatment, 1996)

Results of the pollution load from the metal industry, as presented in figure (8), showed that the most polluting factor in this industry is also the COD, its values varied between 2 - 13.3 kg/m^3. The BOD levels didn't exceed 1.8 kg/m^3 and TSS didn't exceed 8 kg/m^3. The maximum levels of COD were reached at year 2009. Results showed that all parameters were decreasing gradually as a result of applying pollution prevention and waste minimization concepts.

3.5 Textile Industry

The textile industry uses vegetable fibers such as cotton, animal fibers such as wool and silk, and a wide range of synthetic materials such as nylon, polyester, and acrylics. Pollutants in wastewater from textile factories vary greatly and depend on the chemicals and treatment processes used. Pollutants that are likely to be present include suspended solids, biodegradable organic matter, toxic organic compounds (e.g. phenols), and heavy metals. This industry has a high importance in terms of its environmental impact, since it consumes considerably high amounts of processed water and produces highly polluted discharge water in large amounts. (Neşe Tüfekci et al, 2007)

The most important parameters in wastewater from textile industry are COD (Chemical Oxygen Demand), BOD_5 (Biological Oxygen Demand), pH, fats, oil, nitrogen, phosphorus, sulphate and SS (suspended solids). (Neşe Tüfekci et al, 2007)

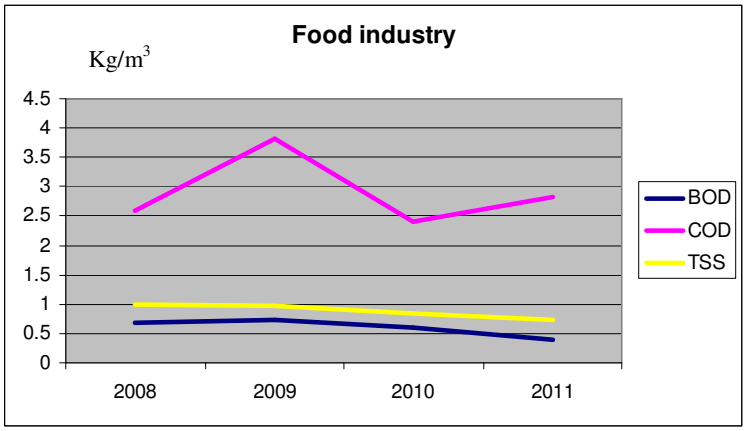

Figure (5): Pollution Load from the Food Industry.

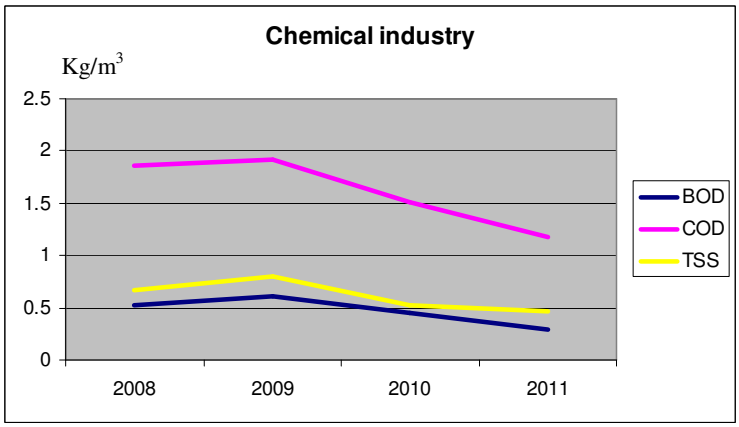

Figure (6): Pollution Load from the Chemical Industry.

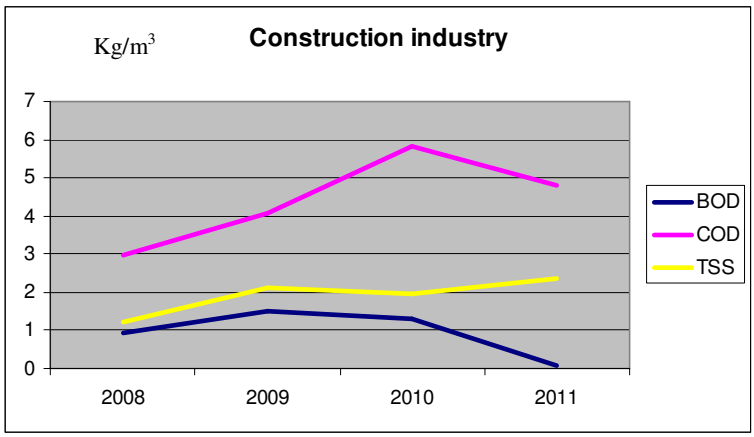

Figure (7): Pollution Load from the Construction Industry.

Results of the nine working textile industries, as shown in figure (9), showed that the most polluting factor in this industry is the COD as varied between 0.5-1 kg/m3. The BOD levels didn't exceed 0.5 kg/m3 and TSS didn't exceed 0.6 kg/m3. The graph showed that the BOD, COD and TSS loads were almost constant during the years 2008 and 2009, while at 2010 there was a considerable reduction in pollution loads after continuous inspection and monitoring together with applying technical assistance aspects with industries we succeeded to gradually decrease the COD levels as they reached their lowest values at 2010.

During 2011 and the revolution of 25th January the companies started again to violate the law this was shown by the increase in the pollution loads, especially the levels of COD. Although BOD and TSS values increased they didn't reach the starting values as the pollution prevention measures affect mainly BOD and TSS while COD values showed increase over the starting values as it requires additional treatment.

3.6 Pulp and Paper Industry

Water is used in the major unit operation in the manufacture of paper (pulping and paper making).The significant environmental impacts of this industry are from the pulping and bleaching processes. In some processes chlorinated and organic compounds, nutrients, and metals are discharged to the wastewaters. (Pulp and Paper Mills, 1998)

Conventional pollutants from mill processes are BOD and TSS and from Mechanical pulping fibers (cellulose), suspended solids, lignin, biodegradable organics, sodium carbonate, sodium hydroxide, sodium sulphate, sulphite and ammonia. From spills, wash and screening operations. From De-inking processes secondary fiber pulping, ink, detergents, solvents, fillers and coating agents. From Bleaching processes washing wastewater contains sodium hydrosulphite, chorine, calcium hypochlorite and chlorine dioxide. Finally, from paper making white water (SS, COD, BOD, Alkalies and carbonates).

Results of the six working paper & pulp industries, as presented in figure (10), showed that the most polluting factor in this industry is the COD as varied between 2.3-7.9 kg/m^3. The BOD levels didn't exceed 1.5 kg/m^3 and TSS didn't exceed 5.7 kg/m^3. The maximum levels of

all parameters were reached at year 2008 were our program work was still in the beginning, while after continuous inspection and monitoring together with applying technical assistance aspects with industries we succeeded to gradually decrease the pollution levels as it reached its minimum during 2009.

During 2010 new factories were newly inspected and the pollution levels started to increase. As we applied technical assistance the levels started to decrease. However, the COD values were still increasing as the pollution prevention measures affect mainly BOD and TSS while COD values requires additional treatment. In addition, the paper fibers are not biodegradable so BOD values are less than COD.

The wastewater from industries varies so greatly in both flow and pollution strength. In general, industrial wastewaters may contain suspended, colloidal and dissolved (mineral and organic) solids. In addition, they may be either excessively acidic or alkaline and may contain high or low concentrations of colored matter. These wastes may contain inert, organic or toxic materials and possibly pathogenic bacteria. These wastes may be discharged into the sewer system and affect the treatment efficiency or have undesirable effects on the sewer system.

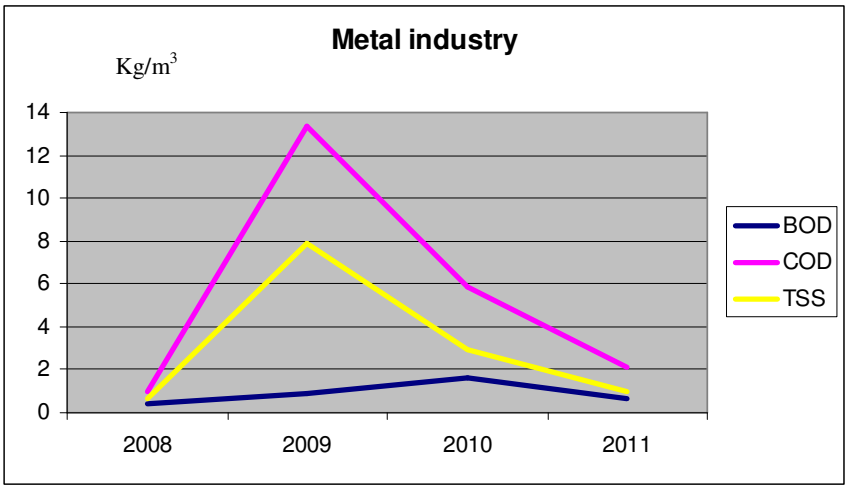

Figure (8): Pollution Load from the Metal Industry.

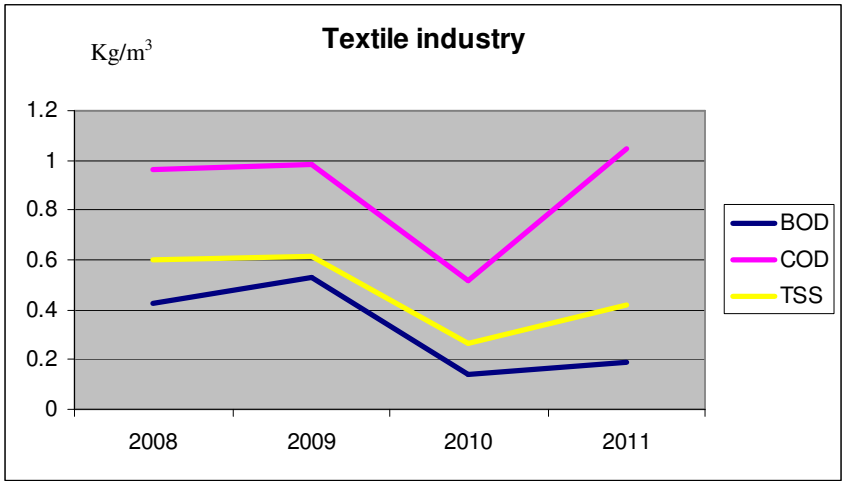

Figure (9): Pollution Load from the Textile Industry.

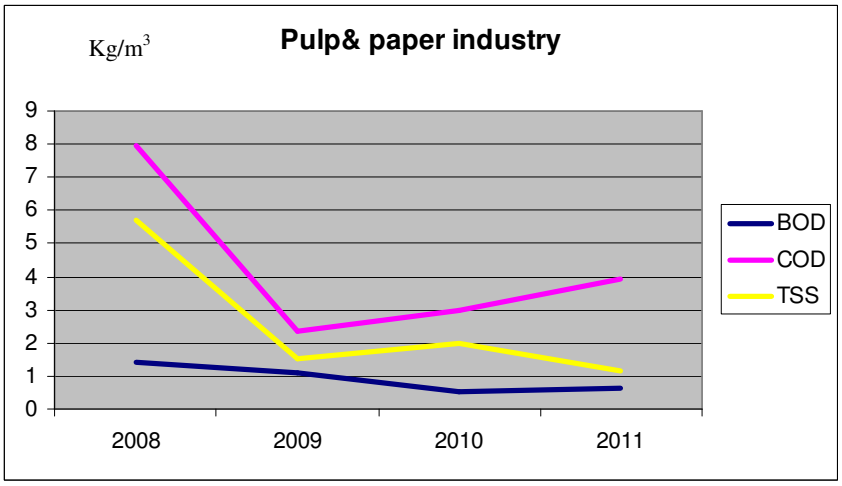

Figure (10): Pollution Load from Pulp and Paper Industry.

Compatible pollutants can be defined as those pollutants that are normally removed by the publicly owned wastewater treatment plants (WWTPs). Biochemical oxygen demand (BOD), suspended solids (SS), oil and grease, and ammonia are considered compatible pollutants. The WWTPs designed to treat primarily domestic wastewater and the compatible pollutants discharged by industry.(Abdulrzzak Alturkmani)

Non-compatible pollutants are defined as those pollutants which are not normally removed by the WWTPs, may be toxic to a biological industrial wastewater treatment system, and may cause pass-through or interference with the treatment system. Even some biologically degradable wastes such as soluble, synthetic cooling oils may cause interference with the heavy metal removal system by inhibiting floc formation. Other examples of non-compatible pollutants include heavy metals such as copper, nickel, lead, and zinc; organics such as

methylene chloride, 1,1,1-trichloroethylene, methyl ethyl ketone, acetone, and gasoline; and sludges containing toxic organics or metals. (Abdulrzzak Alturkmani)

From the perspective of the WWTPs, conventional pollutants sometimes exhibit the characteristics of non-compatible pollutants, and vice versa. Soluble BOD from a food industry may have some harmful effects on a WWTP's secondary treatment system. The accidental discharge of ammonia by a fertilizer manufacturer may disrupt the nitrification/denitrification or stripping tower processes used by the WWTP to treat ammonia. On the other hand, some of the heavy metals (usually classified as non-compatible pollutants) are used as micronutrients to aid in the production of biological mass and the reduction of BOD. Certain organic chemical wastes such as acetone and isopropanol are biodegradable and, in dilute solutions, are removed by biological action in secondary treatment. (Abdulrzzak Alturkmani)

4. CONCLUSION:

From these results we can conclude that the implementation of the industrial wastewater program management has partially minimized waste loads from the inspected industries. But it is still necessary to apply specific suitable treatment prior to release to the municipal system. By time It is expected that the quality of different industries are going to be improved in terms of the law regulations and the overall national conditions returns to normal.

5. RECOMMENDATIONS:

Borg El Arab industrial city was legally belonging to the city's municipality before 2008. After the sewer system and treatment plant were handed to ASDCO there was difficulty to cooperate. It is highly recommended to apply co-operation with ASDCO in applying the industrial waste management program. The Municipality should get our permission before giving license to industries to start practicing their activity. Also, they should cooperate with ASDCO to enforce industries to comply with the regulations of Law 93/1962 and its presidential decree and to implement suitable treatment for their waste by implementation of the legal proceedings against them in case of violations.

Under these circumstances we would like to stress on the importance of applying On-line Monitoring systems to assure effective control of industrial effluent quality 24/7 to protect the wastewater treatment sewerage system from shock loads and define on spot the violating industries.

REFERENCES:

Abdulrzzak Alturkmani, INDUSTRIAL WASTEWATER .

Asokan Pappu, Mohini Saxena, Shyam R. Asolekar. Solid wastes generation in India and their recycling potential in building materials.

Guides to pollution prevention in pharmaceutical industry. uEPA/625/7-9l/017, October 1991

Industrial Waste Surcharge and Industrial Waste Monitoring program – AGOSD ISPR Project, CH2M HILL International, May 2000.

Industrial Waste Treatment: A field study training programme, US.E.P.A, office of Water programs. Vol. 1, 2nd edition 1996.

M.H. Ramadan, O.D. EL-Sebaie, F.M. EL-Sharkawy, A.H. Mahmoud and R.A. Hussein. Study on Industrial Wastewater Characteristics in New Borg El-Arab City, Alexandria, Egypt. Environmental Heath Department, High Institute of Public Health, Alexandria University.

Nese Tufekci, Nuket Sivri, Ismail Toroz. Pollutants of Textile Industry Wastewater and assessment of its Discharge - Limits by Water Quality Standards. Turkish Journal of Fisheries and Aquatic Sciences 7: 97-103 (2007).

Pollution from Food Processing Factories And Environmental Protection Book.

Pulp and Paper Mills- Pollution Prevention and Abatement Handbook - WORLD BANK GROUP- Effective July 1998.

Standard methods for the examination of water and wastewater, 21st Ed., APHA-AWWA-WEF,. Washington DC, USA. APHA., (2005).

Zhang Yuan, LIU Jiangfan, Yang Yuchuan. Pollution Prevention Countermeasures of Chemical Industry in the Haihe Basin.