Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2014/03/jls.htm
2014 Vol. 4 (S3), pp. 830-837/Keyvan and Azam
Research Article

THE IMPACT OF INDUSTRIAL ESTATES WASTEWATER ON THE GROUND WATER POLLUTION BY QUALITATIVE INDEXES (CASE STUDY: MASHHAD TOOS INDUSTRIAL ESTATE)

***Saeb Keyvan[1] and Farhadi Azam[2]**
[1]Department of Environment Group in Islamic Azad University of Tonekabon
[2]Department of Environment Pollutions Major, Islamic Azad University of Tonekabon
**Author for Correspondence*

ABSTRACT
Many plains such as Mashhad plain depends on ground waters. People's life would be in danger if there is any loss in these resources. Ground waters are at risk of pollution due to the increasing growth of population and increase in urban, industrial and agricultural activities. Then, it is necessary to establish a network of sampling points and a stable supervision system in vulnerable areas. Toos industrial estate is located in 18th kilometer of Mashhad-Chenaran road (North West of Mashhad). It has a total area of 425 hectares. The most polluting industries inside it are: Food, chemical, metal and non-metal minerals. Vast majority of its wastewaters are entered into Kashafrood River, so farmlands around it become polluted. Electrical conductivity level of the wastewaters has shown a high salinity. Also, high levels of BOD, COD, TDS and TSS are issues to be considered in the area as they are potential polluters for water and soil. In present study, we've investigated and tested 15 wells, taking ground waters current direction, geological establishments and area's aquifer into account. The analyses were done using Chemistry software and RockWork14. The results have shown that hydro chemical properties of water sample taken from the wells have corresponded to that of industrial wastewaters. So, the intense pollution in a part of the plain was because of the effect of industrial wastewaters on groundwater resources.

Keywords: *Toos Industrial Estate, Wastewater, Groundwater Pollution, Qualitative Indexes*

INTRODUCTION
Groundwater is the main resource for meeting the needed water in Iran as it is so all around the world, too. In recent decades, factors such as: population growth and social industrial activities have important roles not only in groundwater pollution but also in other environment problems. Non-standard industrial waste disposal is one of the most important sources of pollution. So, it is necessary to control it according to principles. Used waters and waste waters produced during industrial processes have lost their first quality and sometimes they would become unusable. Even their disposal to receptive waters is polluting and decreasing water quality (Mostafapour, 1995). Other outcomes of non-standard disposal of industrial wastes are surface water' pollution, change in hydrolic direction of aquifer, soil subsidence, earthquake and mineral's pollution (Soliman *et al.*, 1998). Groundwater' polluters are divided into two groups geometrically: point sources and non-point sources. Point ones are derived from a source placed in one point, but its pollution are extended in line with its path (Todd, 2005). In this study, we've investigated the impact of Mashhad Toos industrial estate on groundwater pollution based on point sources and according to qualitative indices.

Geographical Situation, Geology, Area's Climate
Toos industrial estate is one of the biggest production centers in Razavi Khorasan. Its coordinates are 59̊24'39" E and 36̊26'3" N. It has three phases (figure 1). The third one has not yet been implemented. Toos industrial estate is located in 18th kilometer of Mashhad-Chenaran road (North West of Mashhad). It has a total area of 425 hectares. It is adjacent to the technical science Park, Saamen sport complex and North East technical estate of food and biotechnological industries. The area is part of Mashhad plain and is located in Kashafrood River's catchment. This catchment is one of thirteenth sub catchments of Ghara Ghom (Kashafrood). It has an area of 9909.4 km^2; 3351 km^2 is the plain and the rest 6558 km^2 is mountain (Akbari and colleagues, 2009).

Research Article

Figure 1: Location industrial park birch

The direction of the slope of surface is North-west to Sough-east. The area is located on an alluvial forth era plain which is located between Binalood mountains (south west) and Hezar Masjed mountains (north east). The alluvium forming this plain is consisted of two foresaid mountains. Its water enters into Kashafrood River. The climate of the region is variant. It has warm summers and rather cold winters. Mashhad plain has a cold dry climate. Its rainfalls are different in highlands and plains but its average is 250mm annually. Overall direction of surface and ground flows are Northwest to Southeast. Surface waters output is through Kashafrood (Razavi Khorasan regional water authority, 2013). Available industries in Toos industrial estate are including: Food, loom, chemicals, and cellulose, Metal and non-metal minerals, electronic and service. They are 768 units out of which 180 units are food, 30 units are loom, 151 units are chemicals, 35 units are cellulose, 20 units are non-metal minerals, 243 units are metal minerals, 49 units are electronic and the rest are service. The most polluting industries inside Toos industrial estate are: Food, chemical, metal and non-metal minerals (Razavi Khorasan regional water authority).

Toos Industrial Estate Wastewater Treatment Plant

The treatment plant has an area of 4Hectares. It has the ability to receive toos industrial estate wastewater (1^{st} and 2^{nd} phases) with an average discharge rate of 6000m^3 per day. Wastewater produced in the estate, were entered into waste network and then directed to the treatment plant. The plant system is a biologic one consisted of screen unit, equalizer unit, aerobic (coherent growth and suspended growth) and anaerobic treatment unit, chlorine tank, sand filter, wastewater storage tank, sludge digestion tank and drying beds. Its best efficiency is in decreasing COD in equalizer unit. Treated wastewater was entered into storage tank, some of which is used in irrigation of green spaces of estate and technical science park. The rest were directed to faze three in order to use in its constructions (Toos Industrial Estate' Treatment Plant Office, 2013). But the vast majority of stored wastewater was entered into Kashafrood. So, its adjacent farmlands were irrigated by this polluted water. Farmers of Parkand Abad, Hasan Shahb and Kooshk Mehdi, have used that polluted water for their agricultural activities. In fact, they've set up pumps to use this flowing polluted water for irrigation. So, the treatment plant of the estate should reach to the

desired efficiency and make the wastewaters corresponded to standards. Otherwise, its non-standard wastewater keeps polluting the environment and makes the life dangerous for inhabitants, herbs and animals of the region. As a result, it is necessary to study and investigate the industries with respect to their polluters' levels in order to be certain about the right application of the treatment plant and to solve its possible problems.

MATERIALS AND METHODS

Methodology

We've first collected and studied scientific applicable sources such as: topographic maps, water resources maps, geologic map, depth-to-water table counter maps, Iso-Cl maps, Iso-EC maps of plain's wells in order to identify the level of water sources, groundwater's direction, geographic situation of the region and to recognize the up streams and down streams, water flow' direction and resources transmittal to determine the sampling points. Sampling was done in winter and spring (February and May). The samples were taken to the labs in less than 1 hour for the following tests: BOD, COD, TDS and turbidity.

In next step, sampling was done in 7 deep wells (used for agriculture and irrigation) located in downstream lands in the passage of wastewaters by determining the up streams and down streams. In less than one week, sampling was done in 3 deep wells in the estate and 5 ones in upstream lands. After determining the sampling points, we've identified their geographic situation using GPS. We've done usual EC, PH, along with Total Dissolved Solid (TDS), Total Hardness (TH), Calcium, Magnesium, Sodium, Potassium, B carbonate, Chlorine, Sulfate analyses.

RESULTS AND DISCUSSION

Table 1 shows the results of samples' analyses for determination of pollution indices, based on their time of sampling. As it's been shown in the table, measured electrical conductance level in samples, shows high salinity; high levels of solved salt. BOD and COD parameters show high level of organic solutions in samples. These two are of most important indices determining the wastewater's pollution. Optimal treatment is necessary to minimize their level. Total Dissolved Solid (TDS) and Total Suspended Solid (TSS) are high in the samples. Their high turbidity is also related to high levels of TDS and TSS. According to the table and comparison the results to the standards, it is clear that the pollution of output wastewater is higher than the standards. So, it doesn't have the required standards for agriculture use.

Table 1: Results of samples analysis

The measured parameter	**Measurement scale**	**The standard limit**			**The results of the first turn (February)**	**The results of the second turn (May)**
		The surface water	**The absorb well**	**The agricultural consumption**		
COD	Mg/L	100	100	200	470	500
BOD5	Mg/L	50	50	100	200	350
PH	-	8.5	9	8.5	7.8	7.52
EC	µs/ cm	-	-	-	7130	7320
TU	NTU	50	--	50	**53**	**60**
T.S.S	Mg/L	60	--	100	**150**	**210**

Second phase results first phase results standard level units of measurement
Agriculture use absorption well surface water

Table 2: The results of the analysis of well water samples

The symbol	The sampling place name	X	Y	PH	EC (electronic automation) in terms of micro mohes on centimeter	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{2-}	TH	T.D.S
						In terms of mg								
w1	Parkand Abad	728403	4031395	7.2	10170	450	316.8	11.4	11.7	530.7	1882.5	1684.5	2499	4222
w2	Hassan shahab	733018	4030540	7.4	8220	520	647.4	460	23.4	622.6	1633	1449.9	4050	3874
w3	Yek jofti	729086	4032295	7.6	6150	486	193.2	466.9	11.7	427	887.5	1225	2750	2916.9
w4	Koshk mahdi	729229	4030365	7.3	5790	332	348	782	9.75	579.5	923	1626.8	2600	3584
w5	Down Khalq Abad	736123	4030911	8.1	1980	76	76.8	315.1	9.75	256.2	234.2	411.6	520	1286.8
w6	Khin Arab	734796	4027754	8	2640	96	49.2	282.9	23.4	292.3	213	514.5	470	1663.2
w7	Fath abad	732047	4026430	8.2	1940	104	30	110.4	25.74	250.1	205	313.6	380	850
W8	Industrial Estate, House Construction Company	716911	4034311	7.44	2200	284	171.6	418.6	19.5	286.6	640	619	1200	1995
W9	Industrial Estate, Khosh Govar Company	715745	435120	7.49	1884	236	129.6	349.6	23.4	180	418	563	1090	1897
W10	Industrial Estate, NO. 13 Well	715399	4034386	8.1	1727	228	82.5	200	11.7	155.6	390.5	524	870	1734
w11	Samen Gym (P.E)	714959	4033534	8.2	686	124	31	90	3.9	91.5	106.5	206	420	932
W12	nazerieh	713936	4039689	7.7	1630	168	72	161	11.7	451.4	98	303.8	710	1026.9
W13	asgarieh	713462	4041498	8.3	1967	94	52.8	230	7.8	149	159.7	542	430	1266
W14	KHARABE AMIN	712091	4041219	8.1	862	100	43.2	68	13.65	256	17.5	288	417	652
w15	Souran ands	711631	4037954	8.2	770	58	39.6	149.5	3.9	262	42.6	269	312	716

Table 2 shows the results of wells' water analysis and table 3 shows the statistical evaluation of the results. The amounts show high differences between wells.

Table 3: The statistical parameters of chemical analysis of case well water

SO4 Mg/l	Cl	HCO3	K	Na	Mg	Ca	PH	T.D.S	EC Micro Houmes on centimeter	Parameter
15	15	15	15	15	15	15	15	15	15	**sample**
701.12	502.4	318.4	14.07	345.6	153.9	223.73	7.82	1907.7	3241.1	**Arithmetic mean**
519.09	581.5	165.1	7.24	281.6	175.8	157.76	0.39	1188.9	2917.1	**Standard deviation**
74.04	115.7	51.85	51.46	81.47	114.2	70.51	4.99	62.32	90	**Coefficient of the changes (percentage)**
1684.8	1882	622.2	25.74	1104	674.4	520	8.3	4222	10170	**Maximum**
201.6	14.2	91.5	3.9	66.7	30	58	7.2	652	686	**Minimum**
1483.2	1867	530.7	21.84	1037	644.4	462	1.1	3570	9484	**Changes scope**
250	250	240	200	200	150	200	6.5 - 9.2	1000	1500	**WHO International Standard**

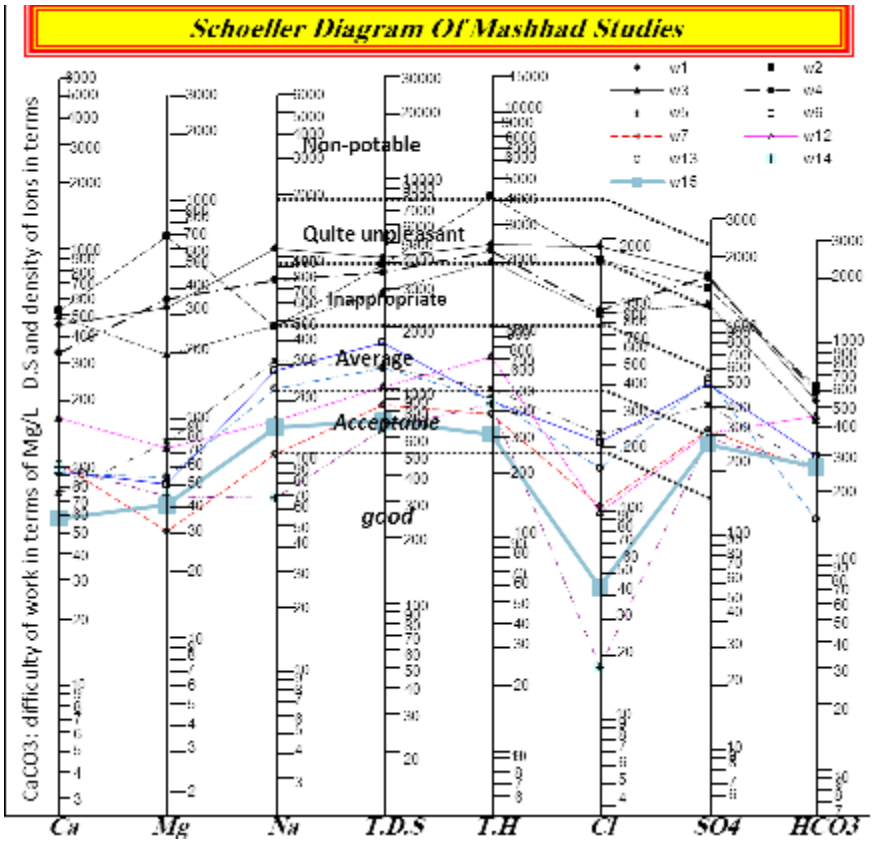

Figure 3: The status of some studied samples on choeller diagram

Overall, the wells have high levels of TDS and high density of Sodium; higher than the standards. Very high salinity of the samples taken from wells of some villages (Parkand Abad, Hasan Shahab, Yek Jofti and Kooshk Mehdi) show that their water can't be used in agriculture and drinking and irrigating. Also, we've seen high levels of calcium, magnesium, sodium and high density of sulfate and chlorine in these four wells compared to the others.

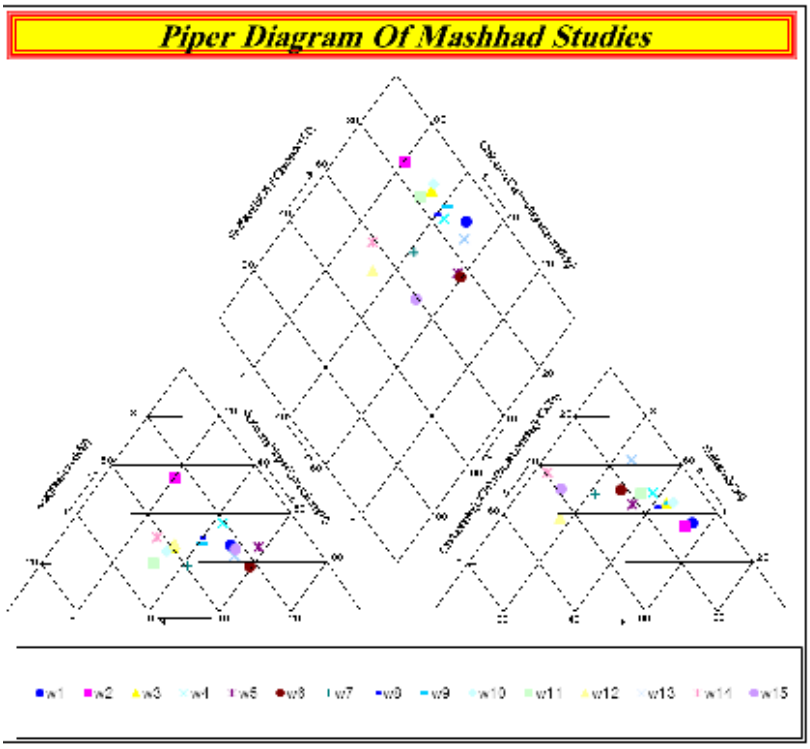

Figure 4: The status of studied samples on Piper diagram

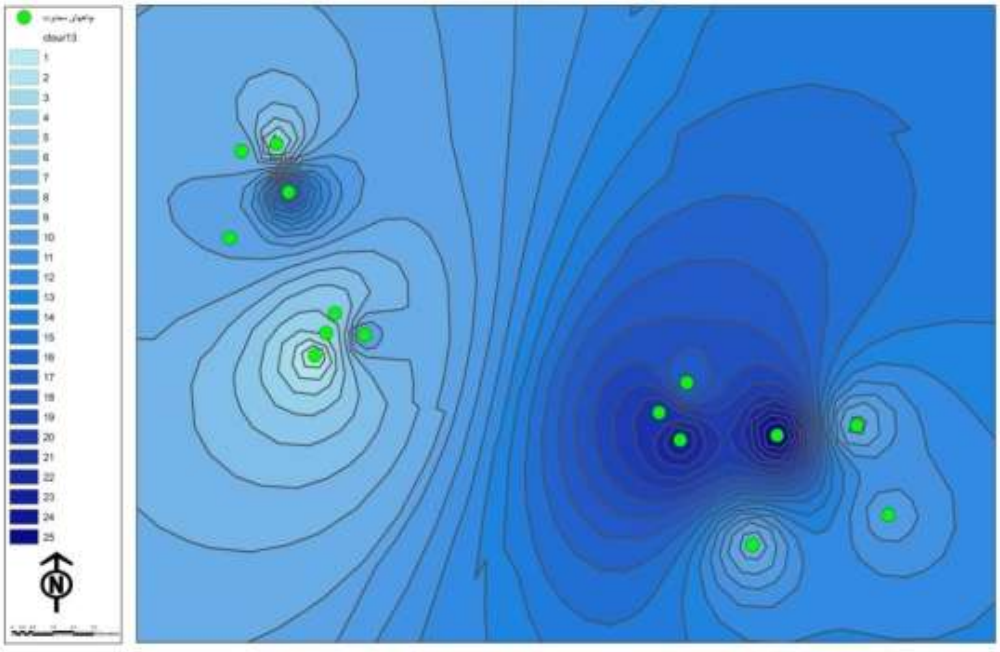

Figure 5: HCO_3 aligned curves

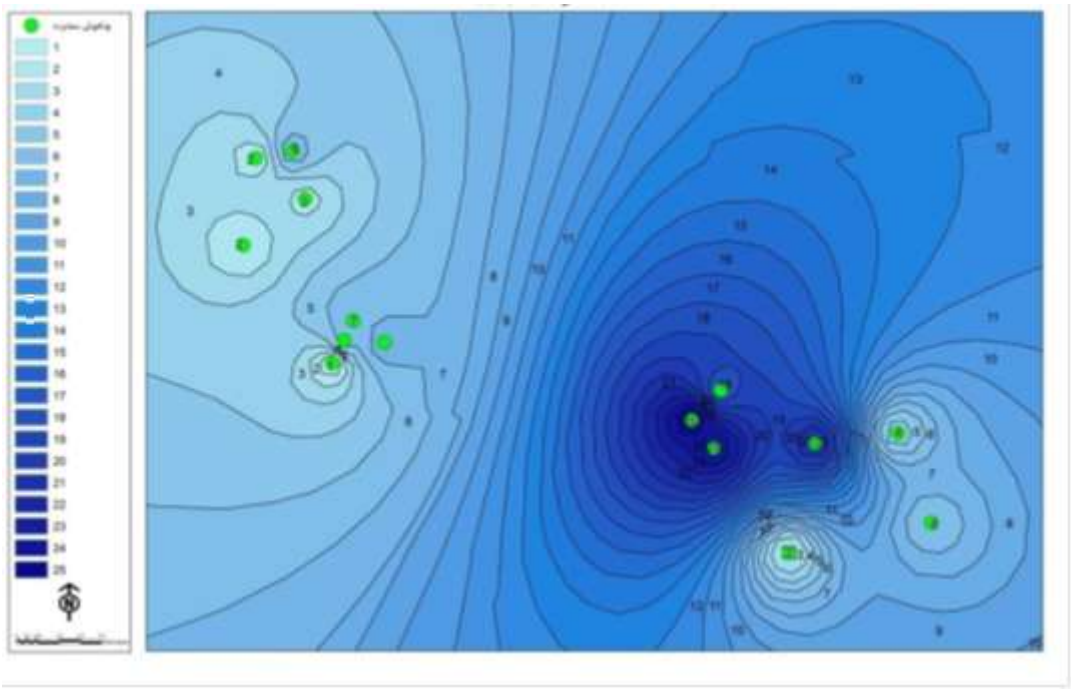

Figure 6: SO_4 aligned curves

Table 4: The percentage of each Wilcox ranking classes for agriculture consumption in whole region

C4				C3				C2				C1			
S4	**S3**	**S2**	**S1**	**S4**	**S3**	**S2**	**S1**	**S4**	**S3**	**S2**	**S1**	**S4**	**S3**	**S2**	**S1**
6.67	6.67	20	0	0	0	26.67	33.33	0	0	0	6.67	0	0	0	0

Schoeller and Piper diagrams were drawn to determine the desirability of the waters taken from the sample wells for agriculture and drinking usage (figure 3 and figure 4). The water of the four foresaid wells (the most affected ones by the wastewater) is completely undesirable and inappropriate for drinking. Other wells have acceptable or moderate level of desirability; water quality of the wells near the output wastewater is less than that of the others. Results from Piper diagram show that wells dominant type of the plain is sulfate. The dominant cation is of calcium and sodium; the wells are sodic and calcic. Figures 5 and 6 show the HCO_3^- and SO_4^{2-} counter lines. As can be seen, sulfate and B carbonate density are higher in the beginning of the wastewater way (four foresaid wells). Density increasing happens on short intervals with high differences which show the impact of treatment plant wastewater and entering of a polluted flow into the groundwater aquifer. We should note that foresaid wells are in C4-S4 place in Wilcox ranking. In spite of that, according to table 4 (showing the percentage of each Wilcox ranking classes), most of the region's wells are placed in C3 place which means saline waters applicable in agriculture.

Conclusion

Low quality of water in wells near the output wastewater rather than the others is clear from Schoeler diagram. According to Wilcox diagram, wells placed in C4-S3, C4S2 and C4-S4 places have saline water inappropriate for agriculture.

Totally, the minimum quality of the water taken from 15 wells in plain, belongs to the ones placed in industrial estate and those near to the wastewater passage; these are placed in the end of topographic slope of the region. Annual discharge of the wastewater to the farmlands and surface waters (Kashafrood

River), along with groundwater flow direction (leading to the wells and increasing their solute levels in the end of the slope) makes the pollution inevitable so that many reported features of water quality in those foresaid wells placed in output wastewater passage (Parkand Abad, Hasan Shahab, Yek Jofty and Kooshk Mehdi) and two wells placed in the estate are corresponded to the features of wastewater of the treatment plant. But the high density of chlorine and sodium seen in all the wells, is traced back to the neogene formations and their marl stones.

According to the aligned curves, Sulfate, B carbonate and other chemical parameters density in the beginning of wastewater passage are higher than those of other regions. Density increase in this region shows the impact of treatment plant wastewater and entering of a polluting flow into the groundwater aquifer. This is inevitable because of the continuous discharge of wastewater for irrigation. Keeping going this way is a threat for Mashhad Plain groundwater resources, considering its water scarcity. So, more considerations should be taken to the wastewater discharged into Kashafrood and its farmlands. Also, it is necessary to supervise the wells and wastewater of the treatment plant periodically and regularly in order to prevent the pollution of the groundwater.

REFERENCES

Mostafapoor F (1995). Investigating environmental impacts of Shahid Rejayi powerhouse' wastewater, MA Dissertation of Environment Health Engineering, Tehran Medical Sciences University, Health College.

Razavi Khorasan Industrial Estates Corporation (2013).

Razavi Khorasan regional water authority.

Soliman M, Jargeh M and Madani Sadat H (1998). Investigating groundwater' decrease using GIS systems, case study: Mashhad plain' aquifer, *Water and Soil Protection Research Journal* **16**(4) 220-31.

Todd, David K and Larry W Mays (2005). Groundwater hydrology edition. Wiley, New Jersey.

Toos Industrial Estate Treatment Plant Office (2013).