Cairo Univ. Stud. Rev. 27 (2005) : 1 - 25

Effect of Sampling Time and Location on Treated Wastewater Characteristics in an Arid Area .

Magid H.Hashim and Samir G. Al- Solaimani

ABSTRACT

During the sampling period and location , the wastewater discharged from Makkah wastewater treatment plant was partially treated . The high rate of evaporation during summer time has also affected the dissolved salt concentration in the wastewater stream . The results of this investigation showed a serious infringement of the standards set by the Meterology and Environment Protection Agency for the direct discharge of wastewater . Most of the elements analyzed during this study have, howevere, exceeded the compared standards (MEPA, FAO,and MAW). Wastewater samples were colledted at 10 different periods and 5 locations .Results revealed that Wastewater sampling time was significant for some parameters such as BOD, TDS ,EC, Ca , Mg , Na , Zn , Mn, Ni , Pb , and Cr. On the other hand , it was evident that sampling loction possessed mainly significant effect with BOD , SS and total N.

The extent of natural purification along the wastewater stream was little but most noticeable for the BOD and SS. Iron , K, Zn , Cu, Cr and Ni had also shown slight decrease in their concentration along the wastewater stream . The TDS , Mg and Ca , on the other hand , were partially diminishing in their concentrations downstream.

Fac. Of Meterology, Environment and Arid Land Agric ., King Abdul Aziz Univ., Jeddah .

Fresh water resources are creaking under the increasing demand all over this planet , especially in arid and semiarid regions . The recycling or reuse of water resources is now a main objective of planners .Hence , the use of sewage discharge and effluent for irrigation activities is one major part of the blueprint for maximizing the reuse of water resources .

One of the main tragets of the Ministry of Agriculture and Water and some universities of Saudi Arabia is to conduct comprehensive analyses of all forms of usable water resources ,including reuse of waste water from agricultural effluents . All possible alternatives were considered to find the most efficient and economically viable solutions .In this respect , the changes in water quality and its suitability for irrigation as well as its impacts on the environment and public health were also evaluated , including assessment of their capital , annual operation and maintenance costs .

Physical and chemical sewage water characteristics :

Heavy metals are known for their harmful effect on soil , crops , animals , and human beings . Sewage is a major source of heavy metal contamination of crop land . Heavy metals enter sewage as a result of industrial activities . Application of sewage can be beneficial to crop land . Sewage contains many essential plant nutrients , may act as a soil conditioner and increase soil water holding capacity (Bauomy , 1985 ; El-Keily , 1983) . Papadopoulos (1992) reported that suspended solid concentrations were 500 mg /L in sewage and 50 mg/L or less in final effluent .

Chemical composition of sewage sludge vary tremendously , according to the method of waste water treatment and amount of industrial effluents that were discharged into the sanitary sewers (Sammers , 1977).

Wilson (1977) reported that industrial sludge contatined higher levels of Zn, Cd, and Pb as compared to domestic sludge (9240 , 140 and 2900 ppm , and 1920 , 20 and 4550 ppm , respectively). El- Gamal (1980) found that the average means of heavy metals in raw and final effluents for Cd, Co , Cr , Cu, Fe, Mn, Ni , Pb,Sr and Zn were 0.01, 0.03 , 0.06 , 0.04 , 0.63 , 0.15 , 0.08 , 0.10 , 0.35 and 0.15 ppm , respectivaly .

Nitrogen content of the liquid waste may vary considerably according to the source of sludge . It may be as low as essentially zero for some cannery wastes and as high as 700 mg /L for slurries of fresh swine waste (Erickson et.al.,1972).

Pound and Crites (1973) observed that P content of secondary effluent variable varies widely among municipalities . Its concentration ranged from 0.5 to 40.0 mg /L .(Mellbye et .al., 1982) and El- Keily (1983) reported that sewage sludge ash had 13-34% $CaCO_3$ and contained 4.1 –5.8 % P and high levels of trace metals .

Bahri (1988) found that treated wastewater in la Soukra , Tunis , had pH of 7.6 , EC of 2.97 mmoh /cm, T.D. S. of 1.82 g /L and COD of 51 . The following concentrations were found as follows : HCO_3^- : 370 , SO_4^{-2} : 363.0 , Cl^- : 554.0 , Ca^{+2} : 154.5 , Mg^{+2} : 56.5, K^+ : 36.5, Na^+ : 366.0 mg/ L , and SAR 6.4 .

Berrow and Webber (1972) reported that the levels of metals in sewage sludge produced in England and Wales were as high as 5% Zn, 1% Cr and Cu , and 0.5% Ni .

Welson (1977) reported that industrial sludge contained higher levels of Zn and Pb compared with domestic sludge (920 , 140 and 2900 mg /L and 1920 , 20 , 450 mg / L , respectively).

Abdel El- Naim (1988) reported that metal contents did not show any particular trend during the period of study . Moreover , sewage water used was not saline enough to cause problems in sludge and effluent .

El- Nennah et.al.,(1982) , Eid (1984) and Abdel El – Naim (1988) reported that when sewage water was used in irrigating sandy soils , appreciable increases of heavy metals were observed . El-Hassanin et. al . (1992) found that after 67 years of sewage water application in irrigation , total Pb increased 9 times , total Cd 6 times , total Zn 50 times and total B 5 times .

MATERIALS AND METHODS

The disposal site of the treated wastewater from Makkah sewage treatment plant is chosen as a case study . Exploratory trips were made for the general appraisal of the site .

The wastewater effluent from makkah sewage treatment plant is being disposed of in a dry wadi bed , which is a tributary of Wadi Naaman and located to the South of the city . The effucent runs as a natural open channel flow, towards the Red Sea for about 20 km , crossing the road to Taif through a bridge.

Towards the end of the main stream , the flow of wastewater was still relatively high . The stream breaches into several shallower , yet wider channels . The width of the main stream varies from about one half to several meters .

10 trips were made for sampling wastewater . Five wastewater samples were collected in each trip . Sewage wastewater samples were collected at 10 different periods and 5 locations (Table 1 and Fig .1) .

Sampling for chemical and Physical Evaluation of wastewater

4 liters plastic containers were used to collect the wastewater samples for the physical and chemical analysis . The wastewater was taken from 10 cm below the surface of the stream to avoid floating materials .

Table (1) Sample collection times .

Period	Sampling date
1	May 1997
2	July 1997
3	September 1997
4	November 1997
5	January 1998
6	March 1998
7	May 1998
8	July 1998
9	September 1998
10	November 1998

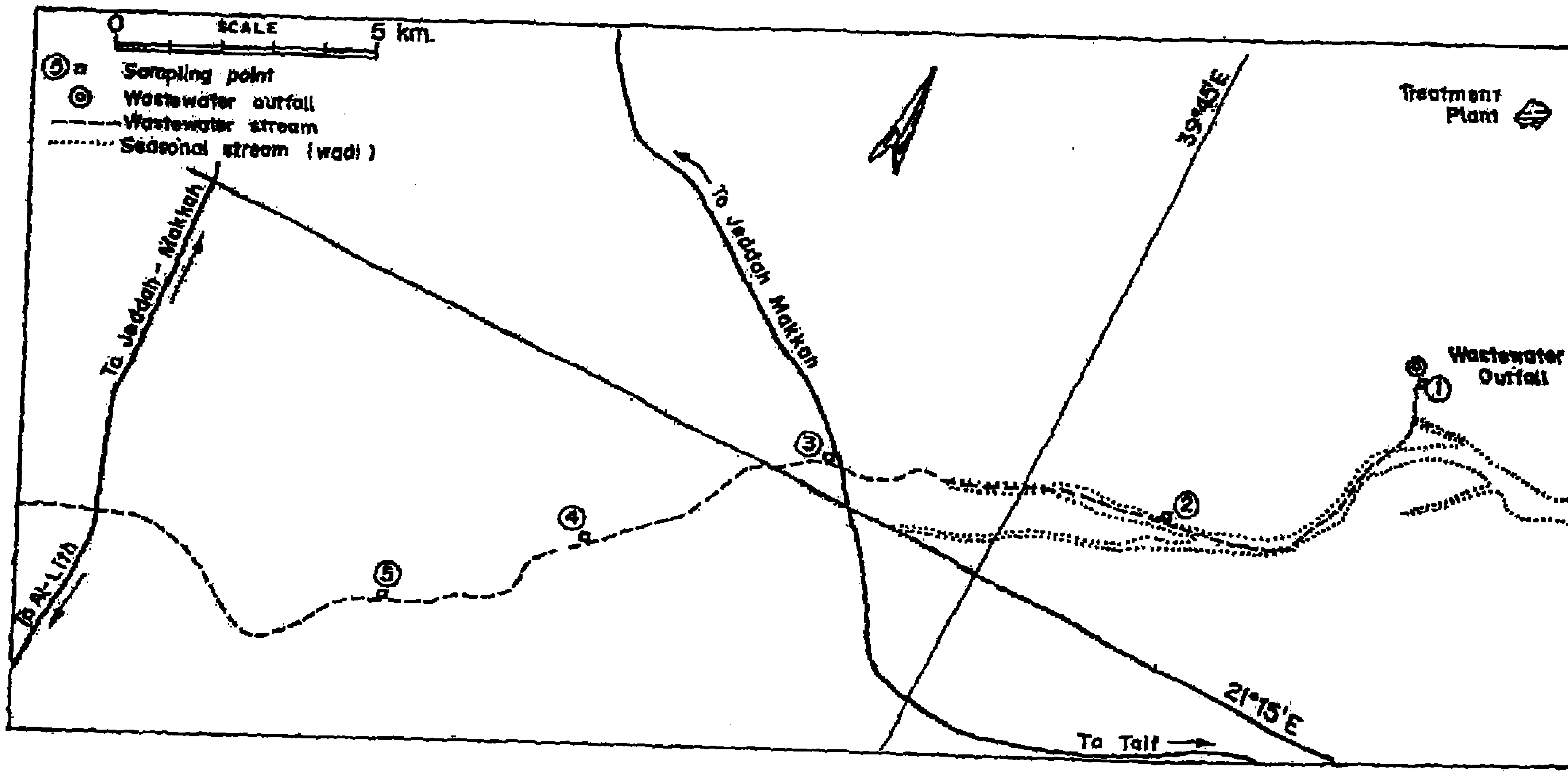

Fig. (1) : A map of the wastewater sampling points along the wastewater stream .

PHYSICAL AND CHEMICAL ANALYSIS OF WATER

- The biochemical oxygen demand (expressed in milligrams per liter) was determined measuring the dissolved oxygen electrode before and after a five day incubation period at 20^5 C.
- The total soluble salts were measured by gravimetric mean . The water samples were filtered through a 0.45 μm membrane filters . The filtrate was then evaporated . The residual salts were weighed and expressed in milligrams per liter .
- The suspended particulate matter measurements were also conducted by a gravimetric mean . The weight of residues on the filter paper was calculated . The SS values were expressed in milligrams per liter .
- The electric conductivities were determined using a self – contained conductivity meter equipped with temperature compensator YSI model 33. The conductivity values are expressed as micromhos / centimeter (μ mhos/ cm).
- The total nitrogen and trace metals analyses were perfomed for waste water .

Fe , Mn , Cr , Pb , Cd , Cu , Ni, Zn , Ca , Mg, K and Na were determined after extraction using the perchloric-nitric digestion procedure of Shelton & Harper (1941) . The concentration of these elements were measured by a Perkin – Elmer 5000 AAS. The procedure of determining the total nitrogen involves the digestion and distillation steps according to the kjeldahl method (Jackson , 1973) using kjeltec auto 1030 analyzer .

RESULTS AND DISCUSION

Physical and chemical analysis of wastewater

The summary of Analysis of variance for the physical and chemical parameters of wastewater along the wastewater stream was presented in Table (2) .

The effect of wastewater sampling time was significant for the following wastewater parameters : Biochemical Oxygen Demand (BOD) . Total Dissolved Solids (TDS) , Electric Conductivity (EC) , Calcium (Ca) Magnesium (Mg) , Sodium (Na) , Zinc (Zn) , Manganese (Mn) Nickel (Ni) Lead(Pb) and Chromium (Cr) . However , the effect of wastewater sampling location was significant for the following wastewater parameters (BOD) ,Suspended Solids (SS) and Total Nitrogen (NK) .

a- Effect of sampling time :

Table (3) shows the effect of sampling time on the physical and chemical composition of wastewater during the period of investigation .In the text discussion , all values obtained are compared with the Saudi standards for the discharge of wastewater set by Meterology and Environmental Protection Administration (MEPA, 1989) as well the Ministry of Agriculture and Water (MAW , 1975) and the (F. A. O, 1985) Standards of Irrigation .

The biochemical oxygen demand (BOD) s did not show a specific trend with time . A rough increase with the time can be seen from figure (2) and Table (3) . This indicates degradation in the treatment efficiency of the treatment plant due to increased and limited capacity of treatmant . The overall means of BOD during the period of investigation (52.82 mg/ L) is more than twice that for the disposal of

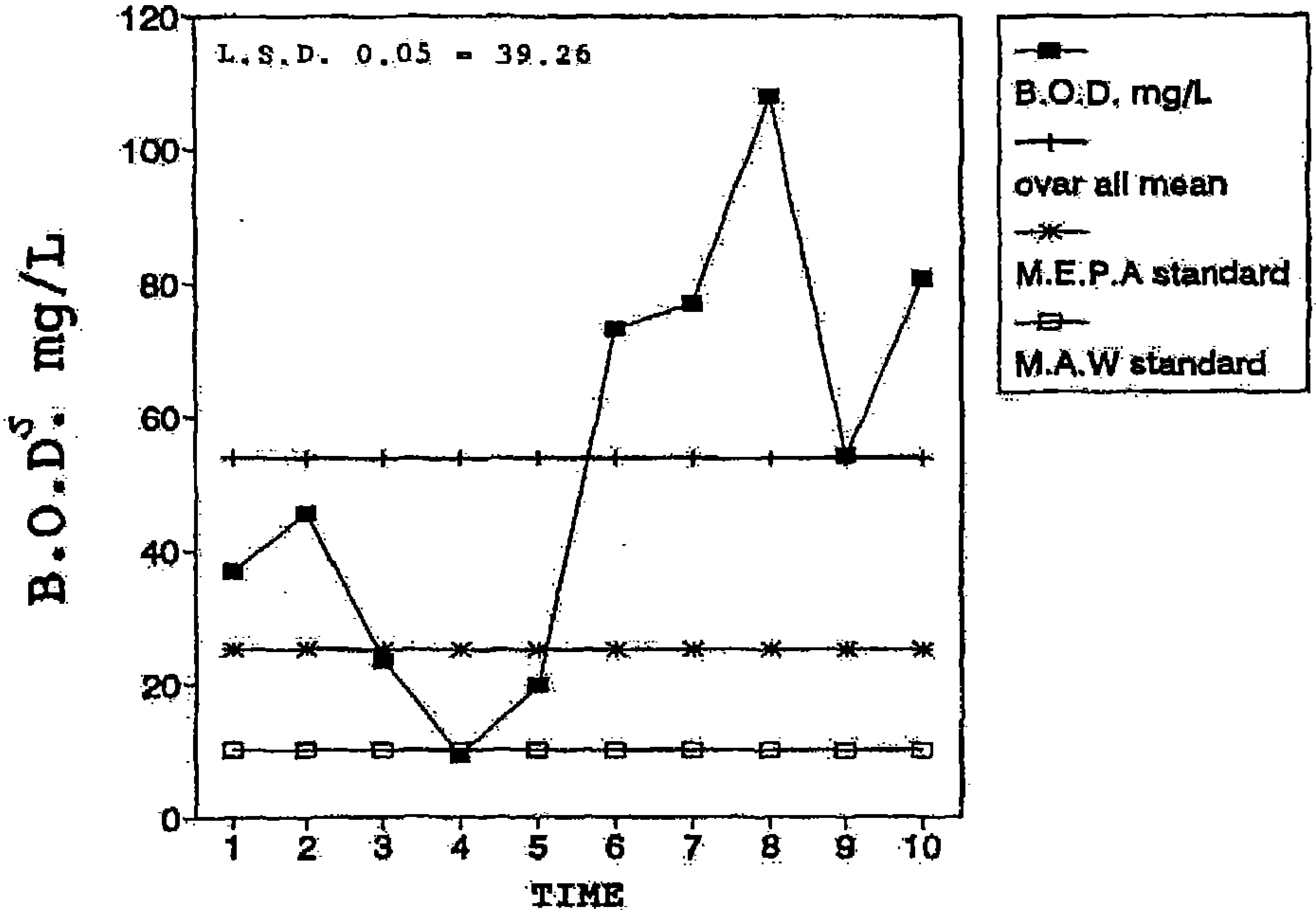

Fig (2): The mean values of (BOD) in the stream of wastewater at the ten sampling time intervales.

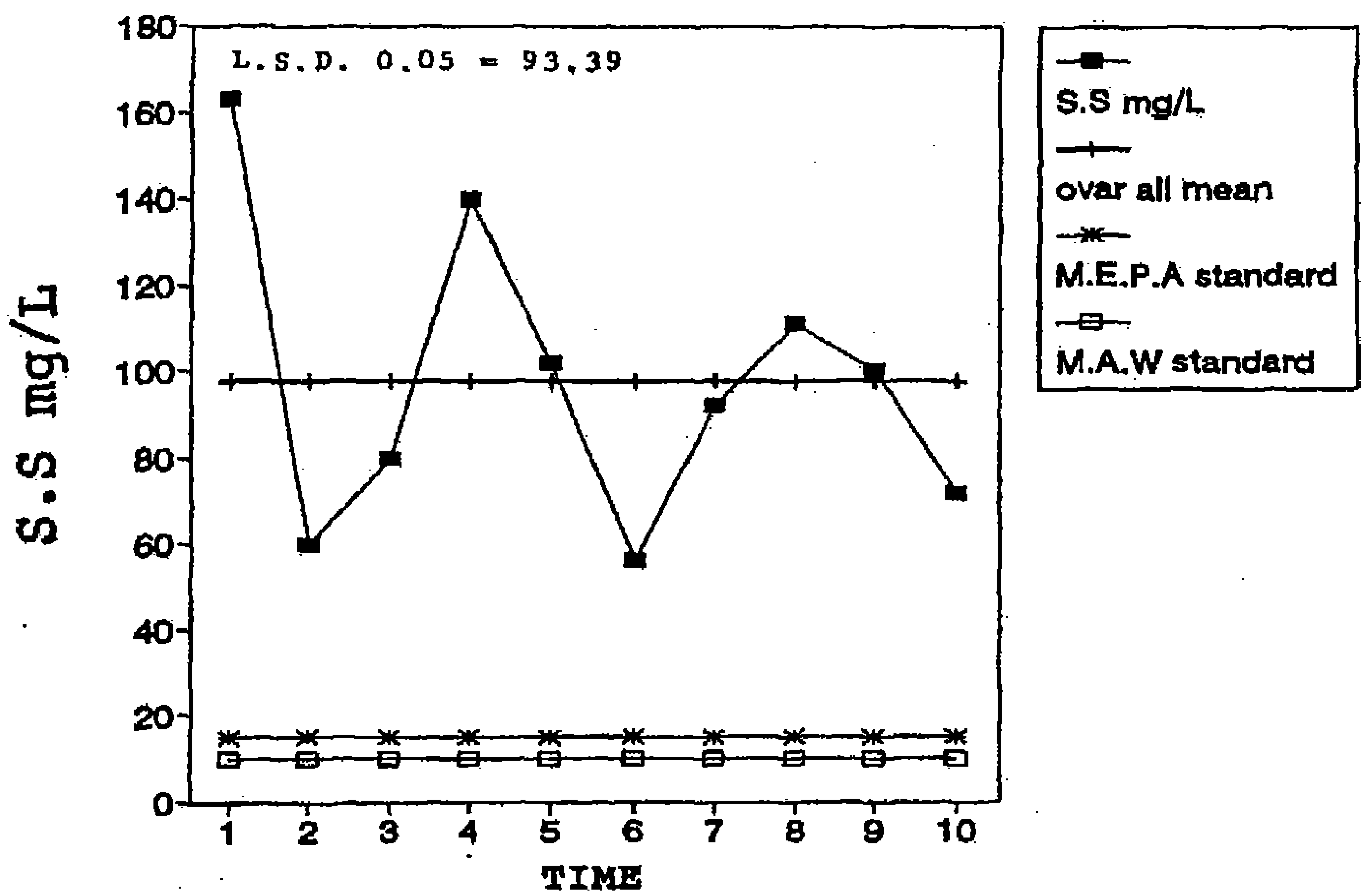

Fig (3): The mean values of suspended solides in the stream of waste-water at the ten sampling time intervales.

wastewater set by MEPA (25 mg/L, MEPA, 1989). High BOD in water leads to lower dissolved oxygen and the production of odors (Fig. 2) .

The overall mean value of suspended solids (SS) was 97.7 mg/L (Table 3) . Compared with the allowed maximum set by MEPA (25.mg/L), this reported value is more than six times higher than MEPA standared (Fig. 3) . No certain trend can be seen during the investigated period . The water curent action and the suspension of bottom sediments may have contributed to the observed irregularity .

Similar to the observation made for BOD and the SS , the total dissolved solids (TDS) showed no consistent trend . There are two high values at the fourth and tenth periods , these periods are in summer time as there is a high rate of evaporation . The overall mean value of TDS (1.172 g/L, Table 3) is an indication to the high salt content of the source water . The desired TDS value for drinking water is less than 0.5 g/L (Clark et.al., 1977) . No TDS standard was set by MEPA for the discharge of wastewater . Gantimurov (1955) mentioned that the continuous use of seawge water in irrigation caused on regular effect on soluble salts and chlorides in soil .

Potassium , calcium and magnesium had shown similar trends during the period of investigation . The variation in these elements concentration (Table 3) may be a result of introducing new water sources . The increased concentration of theses elements indicated inferior water quality . Potassium concentration in drinking water seldom reach 20 mg/L . Calcium and magnesium are the major causing water hardness (APHA, 1985) .

The overall mean value of iron was 4.056 mg/L . This concentration value is below the standard value of FAO and MAW . No standared for irom was made by MEPA . Iron oxide particles sometimes are collected with a water sample as a result of flanking of rust from pipes .

The reported values, however, compared well with the values of iron usually found in secondary treatment wastewater (Arceivala, 1981)

The overall mean value of zinc found during the period of investigation (5.081 mg/ L) was above the allowed values for irrigation sepcified by FAO and MAW and for the direct dischage set by MEPA . The overall trend, however , shows continuous decrease throughout the period of investigation . In the last trip , the value of the mean concentration of zinc was below the maximum allowed by all the reported standards . Zinc most commonly enters the water supply from deterioration of galvanized iron and dezincification of brass . Zinc in water may also result from industrial sources .

Copper overall mean value (0.258 mg/L0 had also exceeded all standards . No specific trend was observed during the period of investigation .

Cadmium on the other hand showed an overall mean concentration value (0.004 mg/L) which is less than all the compared standards

(Table3) , but still no specific trend was observed .

Chromium showed fluctuating value during the investigation period .The overall mean concentration (0.164 Mg/L , Table 3) was above the standards of FAO and MAW for irrigation and MEPA for the direct discharge of wastewater .

Ni standards specified by FAO and MEPA(0.2 mg /L) have been exceeded in all samples collected during this investigation period . The overall mean concentration value was much higher than that of the MAW standards (0.396 mg/L , Table 3) . No certain trend can be detected . Industrial source might be the cause but Nickel concentration in raw domestic wastewater could reach 0.75 mg/L (Forstner anc Wittman , 1981) .

The overall mean concentration of Mn was 0.477 mg/L . Similar to Zn, the concentration decreased with time . In all sampling intervals, the mean value was above the standards of FAW and MAO. No standard for Mn was established by MEPA. Manganese can cause objectionable stains to laundry . The low Mn limits imposed no acceptable water stems from this fact rather than any possible toxicological effect .

Lead in water supply may come from dissolution of old lead plumbing . The overall mean concentration of lead observed during the time of investigation (2.449 mg/L) was above the allowable maximum of MAW and MEPA. All the reported means , however , were below FAO standards.

The overall mean of sodium (454.7 mg/L) obtained during the investigation period is within the range found in natural water (from 1 mg to more than 500 mg /L , APHA , 1985) . It is also below the maximum of FAO .Sodium ranks sixth among the elements in order of abundance . No certain trend can be seen in the Na concentration during the study period . Fluctuation in Na concentration values may be attributed to changes in the water supply sources .

The total nitrogen mean values (130.56 mg / L , Table 3) during the period of investigation were always above the standards of MEPA and FAO (5 mg / L and 30 mg / L , respectively).

The electric conductivity (EC) and sodium adsorption ratio (SAR) (Table 3) of the wastewater are high on third and seven periods, respectively .

Table (2) : Summary of analysis of variance for the physical and chemical parameters of wastewater along the wastewater stream .

	OSL	DF	Biochemical Oxygen Demand	Suspended Solids (S.S)	Total Dissolved Solids (T.D.S)	Electric Conductivity (EC)	Sodium Adsorption ratio (SAR)	Total Nitrogen (N)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
T	OSL	9	0.000**	0.390	0.000**	0.000**	0.103**		0.159	0.003**	0.000**
L	OSL	4	0.028 *	0.023*	0.101			0.000 **		0.228	0.291
EMS		36	369.737	5300.783	0.010	13619.886	3.722	547.930	3667.859	65532.718	235.925

	OSL	DF	Sodium (Na)	Iron (Fe)	Zinc (Zn)	Copper (Cu)	Manganese (Mn)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
T	OSL	9	0.00 **	0.341	0.000 **	0.185	0.033*	0.002**	0.000 *	0.003 **	
L	OSL	4	0.298	-	-	-	-	0.085*	-	-	0.380
EMS		36	12047.934	10.419	2.925	0.007	0.035	0.012	0.201	0.006	0.000

* Significant at 0.05 level
** Significant at 0.01 level

OSL = Observed Statistical level
DF = Degree of freedom
EMS = Error mean sqaure
T = Time of sampling
L = Location of sampling

Table (3) : Effect of sampling time on the physical and chemical composition of wastewater and their tests of significance.

Trip	Biochemical Oxygen Demand	Suspended Solids (S.S)	Total Dissolved Solids (T.D.S)	Electric Conductivity (EC)	Sodium Adsorption ratio (SAR)	Total Nitrogen (N)	Potassium (K)	Calcium (Ca)	Mangesium (Mg)
	Mg/L	Mg/L	g/L	mhos/cm		mg/L	mg/L	mg/L	mg/L
1	36.80 CDE	163.20 A	0.932 EF	1250.00 CD	6.710 E	126.400 A	67.10 AB	348.80 CD	168.00 C
2	54.60 BCDE	60.00 B	0.868 F	1290.00 C	7.026 E	126.00 A	73.50 AB	437.60 BCD	155.00 C
3	23.60 DE	80.00 AB	1.732 A	1840.00 A	4.986 A	133.800 A	80.0 AB	536.60 CD	172.00 C
4	9.20 E	140.0 AB	0.970 EF	1390.00 BC	6.648 E	137.400 A	139.90 A	850.80	353.00 AB
5	19.80 DE	102.80 AB	1.256 C	1352.00 BC	8.076 E	138.800 A	88.352 AB	707.10	278.12 BC
6	73.20 ABC	56.00 B	0.992 DEF	940.00 E	5.062 CD	132.200 A	47.50 B	270.00 CD	152.00 C
7	77.20 AB	92.00 AB	1.020 DE	952.00 E	8.285 A	128.800 A	65.0 AB	270.00 CD	151.50 C
8	107.80 A	111.00 AB	1.113D	1131.20 D	7.578 B	129.200 A	55.368 B	245.940 D	156.48 C
9	54.20 BCD	100.00 AB	1.556 B	1442.00 B	6.578 B	127.200 A	50.0 D	235.00 D	142.50 C
10	80.80 AB	72.00 AB	1.280 C	1127.00 B	5.674 D	125.800 A	141.34 A	584.920 ABC	504.56 A
Overall Mean	52.82	97.7	1.172	1271.4	6.699	130.56	80.806	448.676	223.316
LSD	39.257	93.387	0.128	149.694	2.475	30.024	77.683	328.358	168.397

Table (3) : contd ....

Trip	Sodium (Na)	Iron (Fe)	Zinc (Zn)	Copper (Cu)	Manganese (Mn)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	431.60 CD	3.15 B	6.95 C	0.220 BC	0.640 A	0.500 A	3.300 AB	0.150 BCD	0.003 A
2	471.20 BC	5.04 AB	15.50 A	0.300 AB	0.560 BC	0.350 BC	1.700 D	0.064 D	0.002 A
3	366.20 CD	3.10 B	11.60 B	0.250 ABC	0.680 A	0.250 D	0.498 E	0.215 ABC	0.004 A
4	599.20 AB	1.90 B	5.918 CD	0.260 ABC	0.340 BC	0.280 CD	1.805 D	0.130 CD	0.003 A
5	652.02 A	2.58 B	4.644 D	0.170 C	0.500 ABC	0.398 ABC	2.197 CD	0.146 BCD	0.005 A
6	297.000 D	7.30 A	1.565 E	0.230 ABC	0.500 ABC	0.500 A	2.733	0.240 AB	0.004 A
7	486.000 BC	4.40 AB	1.38 E	0.330 A	0.500 ABC	0.500 A	2.950	0.250 A	0.003 A
8	393.000 CD	5.34 AB	1.262 E	0.290 AB	0.400 BC	0.400 AB	2.904	0.073 D	0.005 A
9	385.000 CD	3.65 AB	1.195 E	0.250ABC	0.350 BC	0.400 ABC	2.760 BC	0.175 ABC	0.004 A
10	465.600 BC	4.10 AB	0.796 E	0.280 AB	0.300 C	0.334 BCD	3.586 A	0.200 ABC	0.004 A
Overall Mean	454.682	4.056	5.081	0.258	0.477	2.449	2.449	0.164	0.004
LSD	140.70	4.410	2.194	0.107	0.239	0.575	0.575	0.093	0.004

Trip No.	Time of sampling	Trip No.	Time of sampling
1	9/5/1997	6	14/3/1998
2	10/7/1997	7	10/5/1998
3	9/9/1997	8	13/7/1998
4	9/11/1997	9	29/9/1998
5	12/1/1998	10	12/11/1998

L.S.D = Least significant difference at 5%
A = 1st highest category
B = 2nd highest category
C = 3rd highest category

b-Effect of sampling location :

Changes in the physical and chemical parameters of wastewater along the stream are shown in Table (4) .

BOD values showed a noticeable trend of decrease with location away from the source (Fig .4) Natural purification process is a slow process . Even though the natural purification process was taking place. The overall mean values (52.82 mg/ L , Table 4) was above the standard of both MEPA and MAW .

The suspended solids (Fig . 5) and Table (4) showed a sharp decrease in their concentration from the source (location no .1) location no.3 .The SS value started to increase toward the end of the stream

(location no. 4 and 5) . The nature of the soil cut by the stream may be the reason for the SS increase in these locations . In all locations, however, the values of SS are above the standards set by MEPA and MAW .

The total dissolved solids showed a slight increase towards the end of the wastewater stream .This increase can be attributed to the evaporation of water running in the stream particularly during summer time . The high value of TDS in the stream water (overall mean value of 1.172 mg/ L , Table 4) comes mainly from the water source (secondary treatment does not remove dissolved salts)

Potassium mean concerntrations were similar (about 70 mg / L) at the three locations upstream (Table 4).These concentration values increased sharply towards the end of the wastewater stream (locations no. 4 and 5) . The introduction of new materials like clay minerals by the resuspension of stream bottom sediments due to current actions

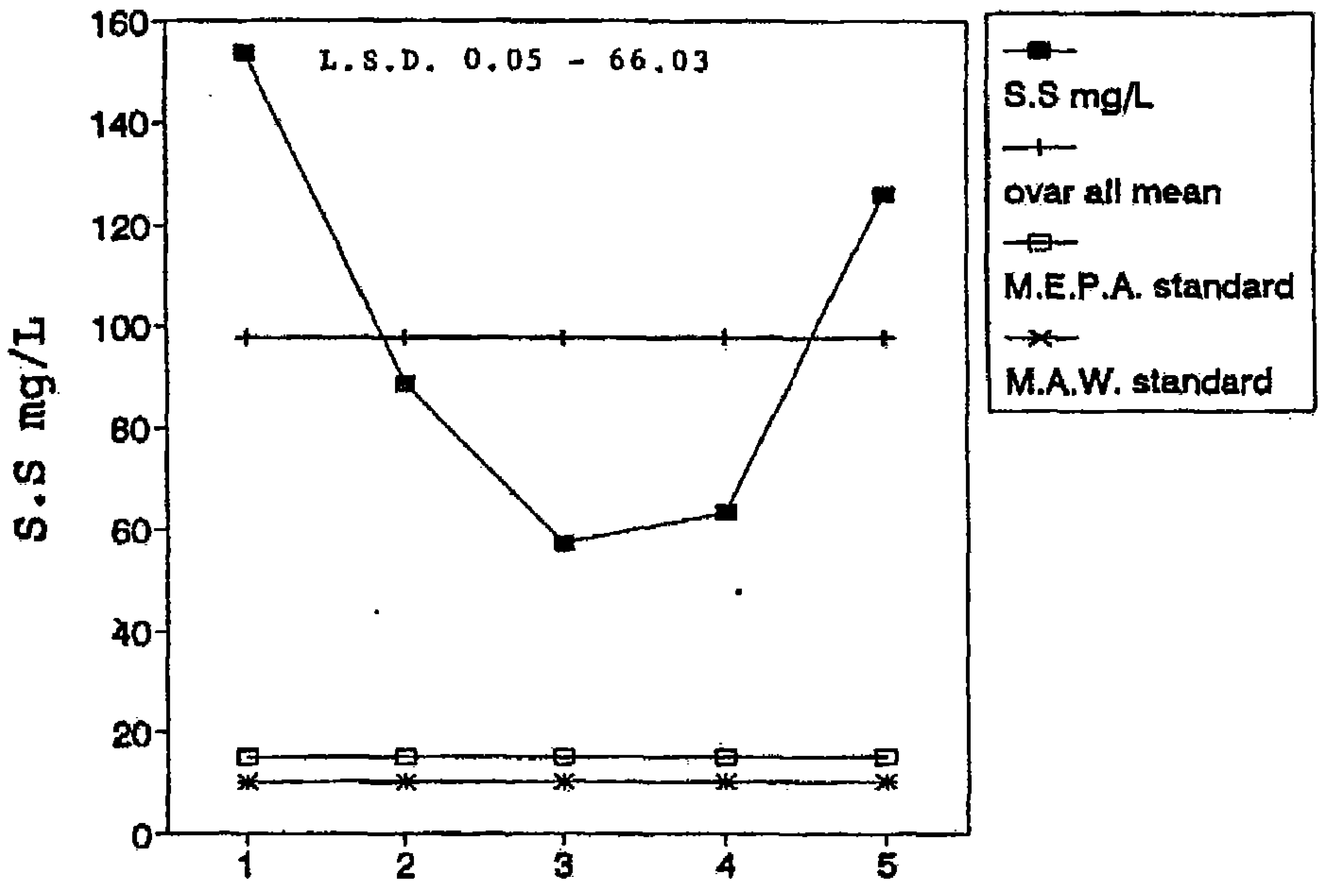

Fig (4): The mean values of (BOD)in the wastewater stream at the five locations during the period of investigation.

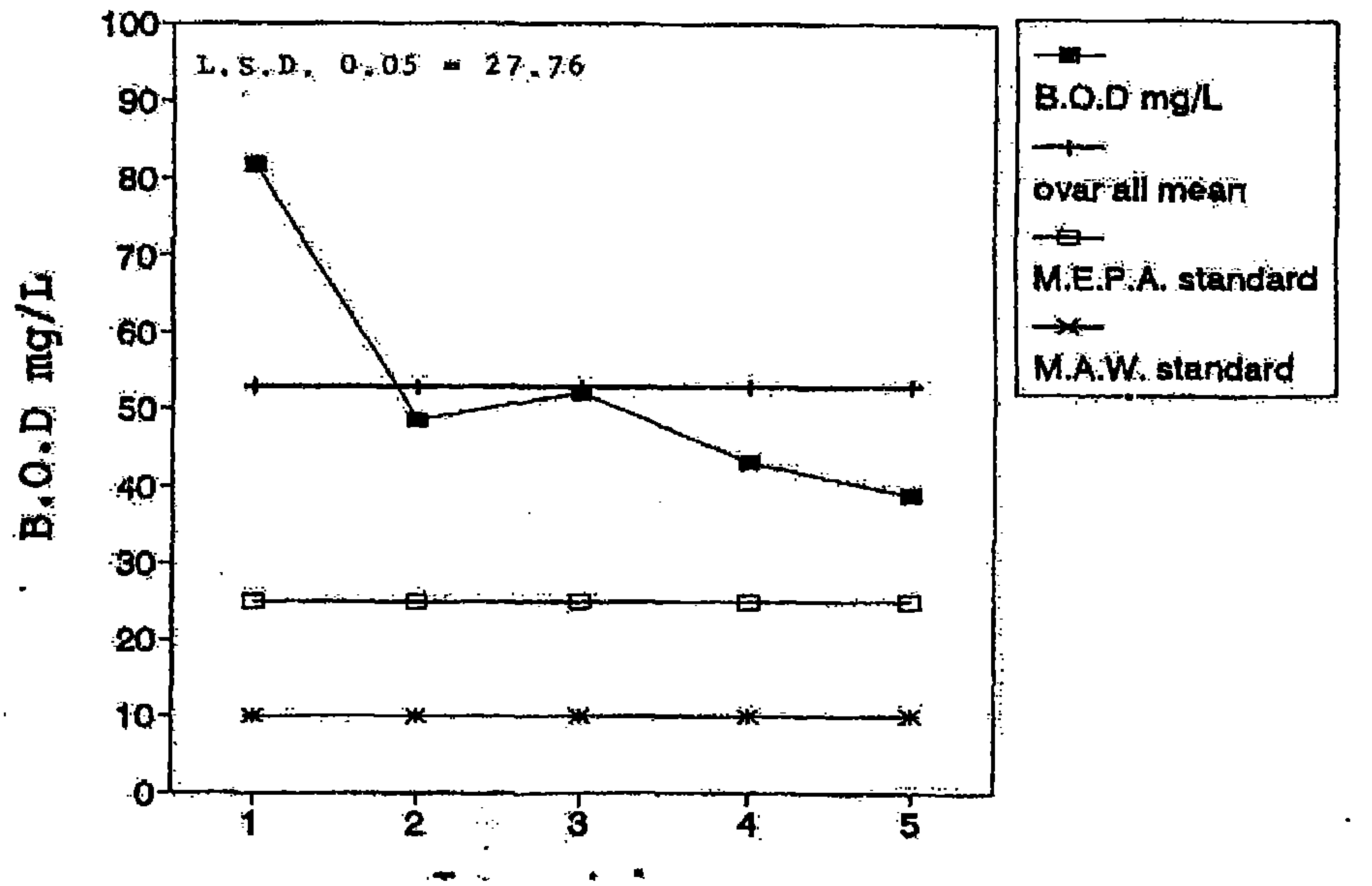

Fig (5): The mean values of suspended solides in the wastewate stream at the five locations during the period of investigation.

may be the cause for such increase in the value of potassium . K is however a common constituent of natual water .

The mean values of dissolved calcium were erratic during the investigation period . The overall mean value was 448.7 mg/ L (Table 4) . This is above the FAO standard , calcium is one of the common constituents of natural water . Concentration of this element depends on its concentration in the source raw water .

Magnesium overall mean value was 223.3 mg/ L (Table 4) . The FAO satanard (60 mg/L) is below all the mean values at the locations measured during the investigation period . No obvious trend can be seen for Mg concentration along the wastewater stream .

Iron showed similar trend to that of SS. Iron oxide particles collected with water samples as a result of flaking of rust from pipe as well as the mineralogy of the stream bottom sediment are most likely the cause of such trend , FAO and MAW standards are 5ppm . This value had not been exceeded by the overall mean concentration of dissolved iron in the stream of waste- water .

The average concentration of zine at the five locations did not deviate much from the overall mean values (5.081 Mg/L, Table 4) .No significant removal of Zn by natural purification was above all the compared standards (FAO, MAW and MEPA).

Copper overall mean value (0.258 MG/L, Table 4) was also above all the compared standards . It also can be seen that there was a slight decrease in Cu mean concentrations towards the end of the stream of wastewater . Industrial sources and copper piping can be considered as a potential provider of copper into the steam wastewater .

Cadmiun overall mean concentration (0.004 Mg/L, Table 4) was below the standard of MEPA as well as FAO and MAW. In no location had the value of Cd mean concentration exceeded the compared standards. No appreciable removal of Cd by natural purification along the wastewater stream was observed .

Contrary to cadmium, the overal concentration of chromium (0.164 mg/L, Table 4) was above all three compared standards. Many metals and alloys are plated with chromim particularly those used in making taps, sinks, showers and pipe joints. Corrosion of these utensils may release Cr to the wastewater stream.

Nickel mean concentration at the five locations along the wastewater stream showed similar trend of concentration compared to zinc, copper and chromium. A slight decrease in the concentration of these elements can be seen toward the end of the wastewater stream. Industries are the most likely source of these elements in the studied wastewater. Nickel's overall mean concentration value (0.396 mg/L, Table 4) is far exceeded the maximum set by MEPA for the direct discharge of wastewater.

Manganese mean concentration values are similar at all sampled locations along the wastewater stream except for location no.2. Precipitation of Mn at this locatioin and dissolution at the following locations might be the cause of such deviation. The overall mean concentration (0.477 mg/L, Table 4), however, was more than twice that of FAO and more than twenty orders of nagnitude compared to the maximum allowable by MAW.

Lead overall mean concentration (2.449 mg/L, Table 4) was below the FAO standards but exceeded both the MAW and MEPA standards. The mean concentration in the wastewater stream at the five locations ranged between 2.3 to 2.6 mg/L during the investigation periods .Lead toxicity is very well known. It should be removed from the wastewater before reuse. Industrial sources might be responsible for the presence of lead in the wastewater stream .

Sodium mean concentrations increased slightly towards the end of the wastewater stream (location 1 to Iocation 4), but returned to its original value at location no.5. Evaporation of the wastwater can be attributed to sodium increase in the wastewater stream. The overall mean value of sodium (454.7 mg/L, Table 4) was below the maximum value set by FAO.

Total nitrogen overall mean concentration (130.6 mg/L, Table 4) was above FAO and MEPA standards. Nitrogen and Phosphorus are major nutrients. The presence of this nutrient in a water in high concentration can lead to bad environmental consequences (e.g. algal bloom, eutrophication, odor etc).

Table (4) : Changes in the physical and Chemical parameters of wastewater along the stream and their tests of significance .

Location	Biochemical Oxygen Demand	Suspended Solids (S.S)	Total Dissolved Solids (T.D.S)	Electric Conductivity (EC)	Sodium Adsorption ratio (SAR)	Total Nitrogen (N)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
	mg/L	mg/L		mhos		mg/L	mg/L	mg/L	mg/L
1	81.8 A	153.40 A	1.101 B	1244.50 A	5.909	114.00 CD	68.45 A	517.400	247.500
2	48.50 B	88.70 ABC	1.194 AB	1293.30 A	7.008	138.90 B	68.275 A	335.510	156.310
3	52.0 B	57.30 C	1.17 AB	1300.00 A	6.843	133.40 BC	69.17 A	445.400	194.130
4	43.10 B	63.20 BC	1.173 AB	1280.80 A	7.405 A	165.00 A	86.701 A	372.180	273.200
5	38.70	125.90 AB	1.222 A	1238.60 A	6.330	101.50 D	111.434 A	572.890	245.40
Overall Mean	52.72	97.7	1.172	1271.77	6.699	130.56	80.806	448.676	223.316
LSD	27.759	66.034	9.069	105.849	1.70	21.231	54.292	232.181	119.151

Table (4) : contd ....

Table (4) contd......

Location	Sodium (Na)	Iron (Fe)	Zinc (Zn)	Copper (Cu)	Manganese (Mn)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
	mg/L	mg/L	Mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	428.900	4.345 A	5.512 A	0.280 A	0.490 A	0.450 A	2.458	0.183 A	0.005 A
2	436.330	4.063 A	5.008 A	0.265 A	0.440 A	0.412 AB	2.570	0.160 A	0.003 A
3	453.900	3.473 A	5.395 A	0.270 A	0.485 A	0.425 A	2.305	0.170 A	0.003 A
4	522.580	3.355 A	4.837 A	0.255 A	0.485 A	0.319 B	2.444	1.137 A	0.003 A
5	431.700	5.044 A	4.654 A	0.220 A	0.485 A	0.374 AB	2.649	0.173 A	0.004 A
Overall Mean	454.682	4.056	5.081	0.258	0.477	0.396	2.449	0.164	0.004
LSD	99.55	2.928	1.55A	0.075	0.169	0.0993	0.407	0.070	0.009

LSD = Least Significant difference at 5%
A = 1 st highest category
B = 2 nd highest category
C = 3 rd highest category

REFERENCES

Abdel – Elnaim , E.M. (1988) . Use of sewage water in irrigation. Regional seminar ; wastewater reclamation and reuse . FAO, Cairo , Dec ., 11-16 , 1988 .

American Public Health Association (APHA) ,(1985) . Standard methods for the examination of water and wastewater . 16 th ED . APHA , Washington DC , USA .

Arceivala , S.J. (1981). " Wastewater Treatment and Disposal " , Pollution Engineering & Technology / 15 , Marcel Dekker , New York , P. 892 .

Bahri , A. (1988) . Present and future state of treated waste water and sewage sludge in Tunisia . In FAO Proceeding . Reclamation and Reuse of wastewater for Agriculture, Cairo , 11-16 Dec ., 1988 .

Bauomy , M. B. (1985) . Effect of sewage water on soil properties of the Egyptian soils . Ph .D. Thesis , Fac . of Agric . Menoufyia Univ . 130 p.

Berrow , M.C. and Webber , J. (1972) . Trace elements in sewage sludge . J. Sci . Food Agric ., 23 : 93-100 .

Bouwer , H. and Chanye , R.L. (1974) . Land treatment of wastewater . Adv . in Agron ., 26:133-176.

Clark , J.W. , Viessman Jr . W., and Hammer , M . (1977) . Water supply and pollution control . 3 rd . Harper and Row publisher , New York , N. Y.

Eid , M. A. M . (1984) . Studies on some heavy metals in soils and waters. M. Sc . Thesis , Fac . of Agric . Ain Shams Univ ., 81 p.

El- Gamal , I.M.I . (1980) . Evaluation of Cario sewage sludge applied to soil with special consideration to its heavy metal contents . M. Sc. Thesis ,Fac . of Agric ., Ain Shams Univ . , Cairo , Egypt .

El- Hassanin , A.S., Labib , M. T. and Dobal , A. T. (1992) .Potential Pb , Cd , Zn and B contamination of sandy soils after different irrigation periods with sewage effluent . Water , Air & Soil Pollution . Vol . 66 (3-4) : 239-249 .

El- Keily , O. M. (1983) . Effect of sewage sludge on soil properties and plant growth . Ph . D. Thesis , Fac . of Agric . Alex . Univ . 215 P.

El- Nennah , M., El-Kobbia , T. Shehata ,A. and El- Gamal, I . (1982) . Effect of irrigating loamy sand soil by sewage effluents on its content of some nutrients and heavy metals . Riyadh Univ . (Saudi Arabia) , Coll . of Agric. Plant and Soil , 65 : 289-292 .

Erickson , A. E., Tiedje , J.M. Ellis , B.G. and Hanse, C.M. (1972) .

Proc ., Cornell Agric . Waste Mange . Conf., pp. (405-410 (C. F. Adv. in Agron ., 26-176, 1974).

FAO (1985) . " Water Quality for Agriculture ", FAO Irrigation and Drainage Paper No .29, Rev . 1., Rome, Italy .

Forstner , G. T. and Wittmann , G . T. W. (1981) . " Metal Pollution in the Aquatic Environment ", Second edition , Springer – Verlag , New York , P. 486 .

Gantimurov, I. I. (1955) . The nutrient regime and biological of leached chernozm irrigation with sewage waters . Trudy nivosibirsk . S. Kh. Nst . 9 : 73-90 .

Jackson , M. L. (1973) . Soil Chemical Analysis . New Delhi , India : Perntice Hall of India .

Mellbye , M. E. Hemphill, D.D. and Volk , V. V. (1982) . Sweet corn growth on incinerated sewage sludge amended soil . J. Environ . Qaul . 11: 160-163 .

MEPA (Meteorology and Environmental Protection Administration)

(1989) . " Environmental Standards " Saudi Arabia Document , 1409-10 .

Ministry of Agric . and Water , Riyadh (1975) . City of Riyady : Study for utilization of sewage treatment effluent . Clonsult Ltd ., Riyadh , p 48-49 .

Papadopoulos , I. (1992) . Use of treated wastewater for irrigation . An International Training Course , "WasteWater Reuse " Cairo , 19-30January , 1992 .

Pound , C. E. and R. W . Crites . (1973) . Elemental content of soil sorghum and wheat on sludge injected agricultural land . In

" Recycling Municipal Sludge and Effluents on Land " Agric . Ecosy . and and Environ ., 9 (3) : 49-61 (C. F. Bouwer and Chaney , 1974) .

Sammers , L. E. (1977) . Chemical composition of sewage sludges and analysis of their potential use as Fertilizer . J . Environ . Qual ., 6 : 225-232 .

Shelton , W. R . and Harper , H. J. , (1941) . A rapid method for the determination of total phosphotus in soil and plant material . Iowa State College Journal of Sci ., 15 : 403-413 .

Wilson , D. O. 1977 . Nitrification in soil treated with domestic and industrial sewage sludge . Environ. Pollut ., 12 : 73-82 .

تأثير مدة وموقع أخذ العينات على خصائص مياه الصرف الصحي المعالجة في منطقة جافة

ماجد حسين هاشم وسمير جميل السليماني

كلية الأرصاد والبيئة وزراعة المناطق الجافة ، جامعة الملك عبد العزيز ، جدة .

ملخص

لقد تم معالجة الصرف الصحي في محطة مكة المكرمة أثناء أخذ عينات المياه في فترات مختلفة ومن مواقع مختلفة ، حيث تم أخذ العينات على عشر فترات زمنية ومن خمسة مواقع على امتداد مجرى المياه . ولقد كان لدرجة الحرارة العالية في الصيف تأثيراً شديداً على معدل بخر المياه وفي زيادة تركيز الأملاح الذائبة .

أظهرت النتائج أن وقت أخذ العينة أثر معنوياً على بعض القياسات منها الطلب علي الأكسجين الحيوي (BOD) والمواد الصلبة الكلية الذائبة (TDS) والأملاح الكلية الذائبة (EC) وبعض العناصر مثل الكالسيوم والماغنسيوم والصوديوم والزنك والمنجنيز والنيكل والرصاص والكروميوم. ومن ناحية أخرى أثر الموقع معنوياً على بعض القياسات أهمها BOD والمواد الصلبة المعلقة (SS) والنيتروجين الكلي.

وعموماً كان تأثير معدل تنقية المياه قليلاً ولكنه كان أكثر تأثيراً على BOD و SS أما الحديد والبوتاسيوم والزنك والنحاس والكروميوم والنيكل فقد حدث نقصاً خفيفاً لتركيز هذه العناصر على امتداد مجرى المياه ، وعموماً حدث نقص ملحوظ عند نهاية مجرى المياه في تركيز TDS ، والماغنسيوم والكالسيوم.