WATER QUALITY INDICES FOR TIGRIS RIVER IN BAGHDAD CITY

PROF.Dr RAFA H. SH. AL Suhaili
Environmental Engineering Dep
Engineering University of Baghdad

NAWAR O.A. NASSER
Civil Engineering Dept. College of
College of Engineering University of Baghdad

ABSTRACT

Due to the deterioration of water quality within the last few years because of the increase of water consumption and the waste water production and disposal into the river The water quality in both surface and ground water resources was negatively affected .The concept of water quality index is used as a tool for water quality classification in Tigris River within Baghdad City .Twenty two parameters of pollution were selected to measure the water quality indices of Tigris river within Baghdad city .Those parameters were measured during (2000-2004)as average monthly values ,three water treatment plants were selected out of the eight water treatment plants that exist along the river.Al Kharkh water treatment plant to reflect the water quality north of Baghdad ,Al Wathba water treatment plant to reflect water quality at the center and Al Rasheed water treatment plant located south of Baghdad to reflect the water quality at this area .The estimated water quality indices indicated that the river quality deteriorate south of Baghdad and the geological and hydrological conditions played the prime role relative to the agricultural and industrial activities within the catchments on the quality of Tigris river .Furthermore ,due to the continuous decrease of flow and the simultaneous increase in agricultural and industrial development with time ,the river showed a general deterioration in quality while the worst years were 2002,2003 due to the significant decrease in the amount of flow .

الخلاصه

نتيجة لتردي نوعية المياه خلال السنوات الاخيره بسبب زيادة استهلاك الماء وكذلك زيادة تصريف مياه المخلفات الى النهر ادى ذلك الى تردي نوعية المياه السطحيه والجوفيه .لذلك تم استخدام مؤشر نوعية المياه كوسيله لتصنيف نوعية مياه نهر دجله في مدينة بغداد ,فقد تم اختيار اثنين وعشرين عنصر من عناصر التلوث وقياس معدل تراكيزها الشهريه خلال السنوات 2000-2004 فقد تم اختيار ثلاث محطات معالجه من اصل ثمانيه محطات معالجه على امتداد نهر دجله وهم مشروع الكرخ شمال مدينة بغداد ومشروع الوثبه في مركز مدينة بغداد ومشروع الرشيد جنوب مدينة بغداد .مؤشر نوعية المياه الذي تم حسابه اشار الى ان نوعية

مياه نهر دجله تتردى جنوب مدينة بغداد بسبب الظروف الجيولوجيه والهيدرولوجيه للمنطقه بالاضافه الى تطور النشاطات الزراعيه والصناعيه وتناقص تصريف النهر,وخصوصا في السنوات 2002, 2003

KEY WORDS:
water quality, pollution index, Tigris River.

INTRODUCTION

Developing countries are undergoing a transition period from a largely agrarian economy to intense industrial activity. People and establishment congregate at certain areas and their activities produce external effects ,whether beneficial or adverse, on the environment that support them. One of the most vital components of the environment is the water. Because of a growing global awareness in the maintenance of "clean world", public and private agencies have come to realize the importance of surface water to a nation's economy. Knowledge of water quality thus plays a significant role in the development of water quality control and management strategies.

The use of numerical index as a tool in water quality assessment is necessary. An index is a number , usually dimensionless, which expresses the relative magnitude of some complex phenomenon or condition.(Lohani,1990)

A water quality index also is a communication tool for transfer of water quality data ,and is obtained by aggregating several water quality measurement in to a single number .Index refers to simplified expressions of a complex set of variables They have proved to be very efficient in communicating water quality information to decision makers and to the public. Water quality indices and classifications should not be the only method used for analyzing and reporting data from water quality monitoring system ,because it my be not possible to determine less obvious trends in water quality and some water quality variables may change without affecting the overall classification.(Lohani,1990)

The system for defining water quality in terms of index numbers offers promise as a useful tool in the administration of water pollution abatement The promise lies in the opportunity to improve techniques evaluating water quality conditions and for describing water quality in terms of comparative values

The water quality index is based on the understanding that water quality and pollution are relative terms, a concept that although recognized in theory ,is not always so readily recognized in practice.(Lohani,1990)

The interrelationships between the variables themselves are usually ignored. Physical and chemical processes that occur in water are so complex and interdependent that a stress on one variable frequently affects the other variables as well. When only one or two variables are considered at a time ,the overall relationship between combinations to over come these limitations is the use of water quality index.(Lohani,1990)

Theoretically, any number of characteristics could go into the makeup of a quality index . However ,too large a number would make the index unwieldy .Therefore, it appears practical to use only those characteristics that are of greatest significance Also to permit comparison of water quality from one area to another ,it seems desirable to select characteristics that are generally significant in most parts of the capital (Al Saffar,2001)

DESCRIPTION OF TIGRIS RIVER

Tigris River originates in Torous mountains in southern Turkey and enters Iraq at Phaish-Khabur on the Iraqi –Turkish border.

The length of the river is about 1900 kilometers .About 1418 kilometers of the river is located in Iraq from Phaish-Khabur till it joins the Euphrates river at Qurna.
Five tributaries feed Tigris river in Iraq these are :

*Al-Khabur river joins Tigris river at Phaish-Khabur.
** Greater Zab joins Tigris river at allocation 70 kilometers down stream of Mousl city.
*** Lesser Zab river joins Tigris river at a location 30 kilometers north of Fatha site.
**** Al Adaim river joins Tigris river down stream of Sammara just few kilometers north of Balad city.
***** Diyala river joins Tigris river at a location 32 kilometers south of the center of Baghdad city .

Tigris River drains an area about 340500 square kilometers .Most of the catchments is covered by sedimentary rocks while small areas confined to the north and north eastern parts of the catchments are covered by igneous and metamorphic rocks.
The climate of the Tigris basin is considered as arid and semi-arid .The annual precipitation exceeds 1000mm/year in the north while it decrease to less than 50mm/year toward the south (Al-Ansari et al.,1981)

Baghdad is the capital of Iraq ,is heavily populated about 5423964 capita (Annual Abstract Of Statistics,2001) and Tigris river is the only water resource for the city.

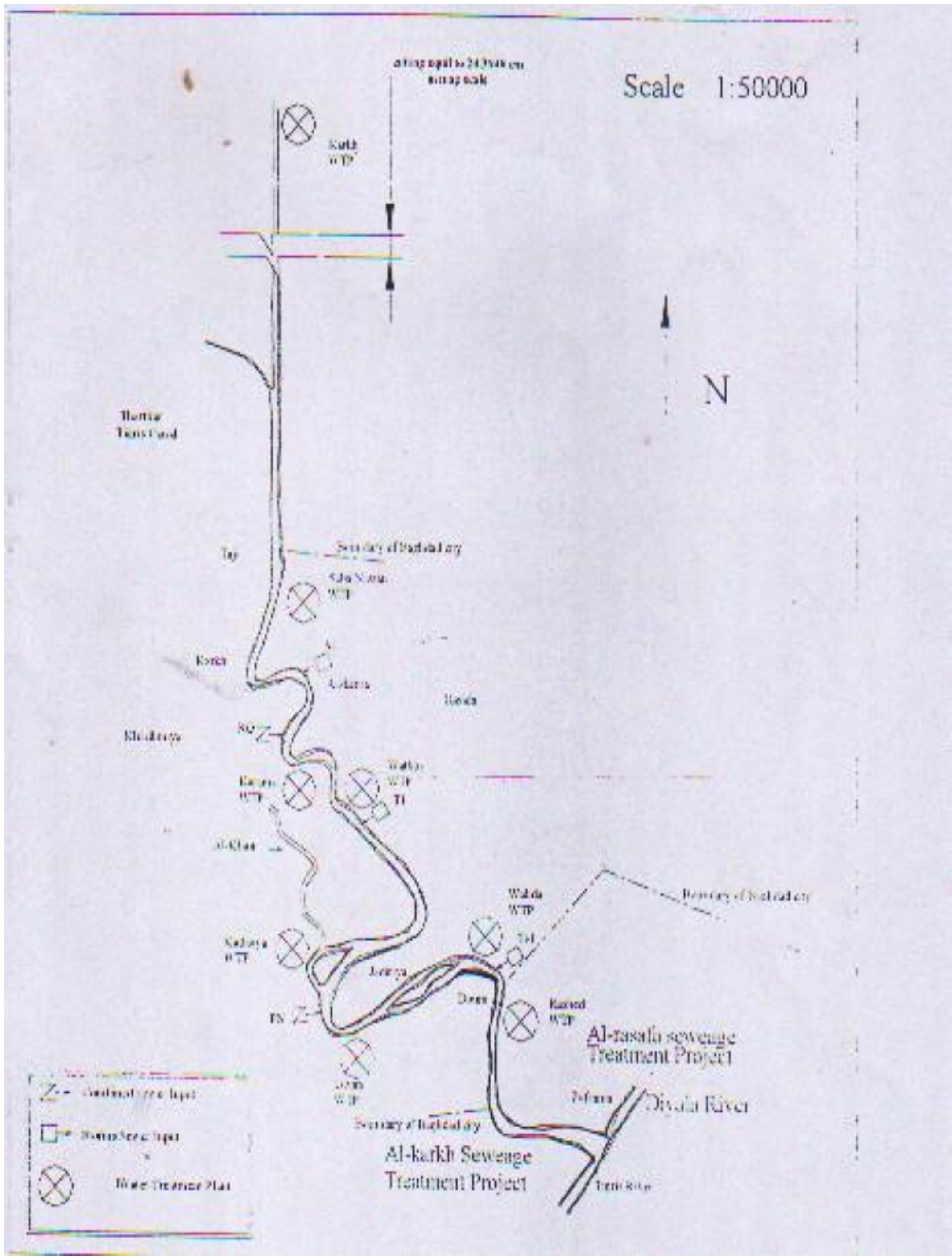
At Baghdad city there are seven water treatment plants located along Tigris river starting from Al Kharkh water treatment plant to the north of Baghdad till Al Rasheed water treatment plant to the south of Baghdad ,these plants supply the people in Baghdad with potable water. Fig(1) shows the locations of the plants in the reach of the river under consideration and table (1) shows the distance of each plant from the reference point and the distance of each plant from the other.(Nasser,2001)

Water is abstracted from Tigris river to be used as raw water for potable water supply and industrial purposes. The river water is also used for irrigation ,fishing,tourism and other beneficial uses.

Besides the river receives wastes from domestic consumers and from industries through outfalls distributed along its banks.In addition ,Tigris river acts as a drainage channel for transporting surplus water to the Arab Gulf.(Al Saffar,2001), fig (2)

showing the flow diagram of Tigris river with industrial, agriculture and domestic deposal

KARKH WTP



Fig(1) the locations of the plants in the reach of the river reach of Tigris river

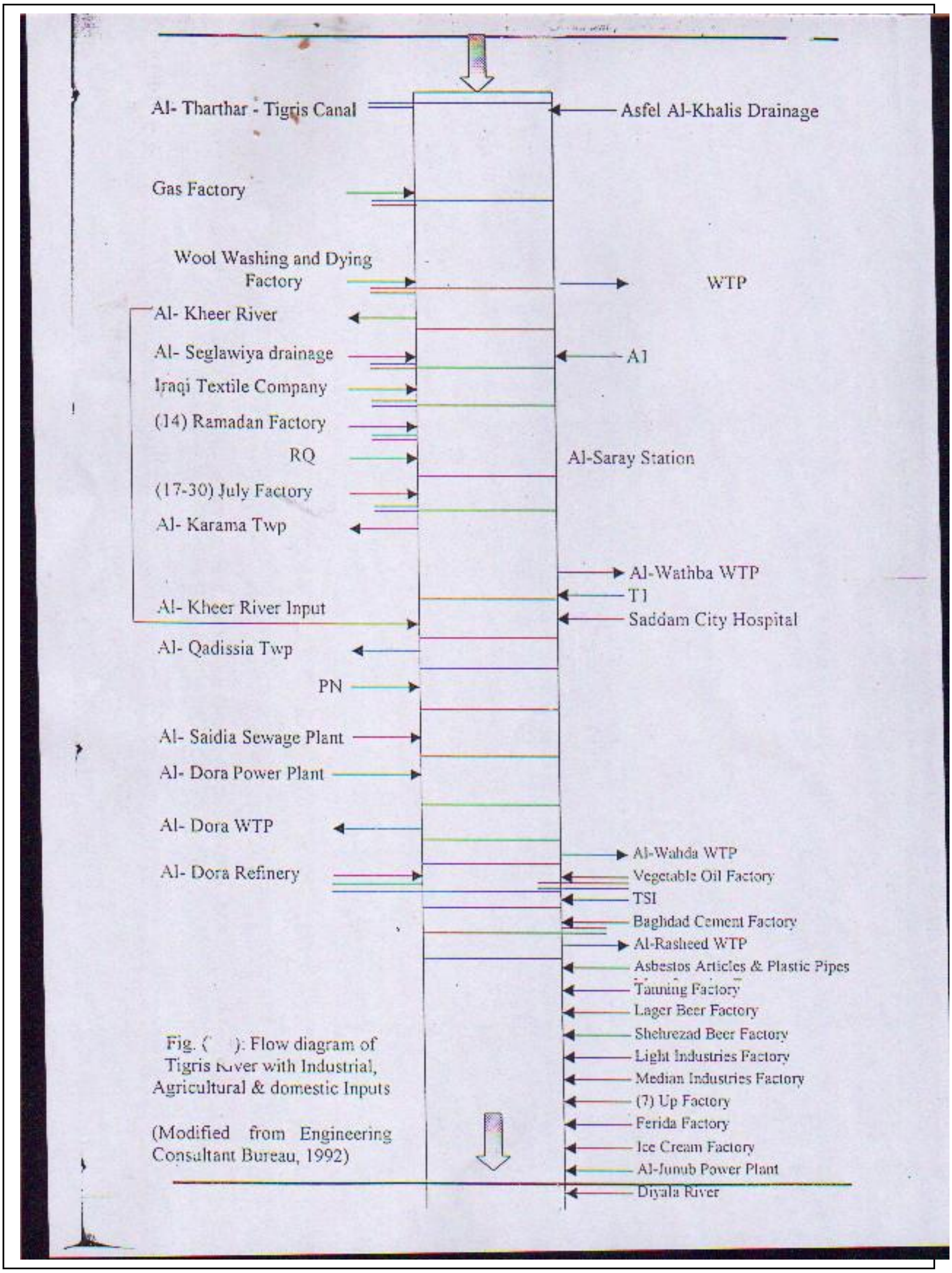


Fig (2) the flow diagram of Tigris river with industrial, agriculture and domestic deposal (Nasser,2001).

Table (1) the locations of the plants in the reach of the river

water treatment plant	Distance from reference point(Km)	Distance from each others(Km)
Al Kharkh wtp	0	0
Sharq dejla wtp	30	30
Al Karama wtp	40.76	10.76
Al Wathba wtp	43.47	2.71
Al Qadissia wtp	55.02	11.55
Al Dora wtp	58.78	3.76
Al Rasheed wtp	67.09	8.31

BASIC CONSIDERATION FOR THE POLLUTION INDEX

The pollution index can be defined as a truly relative term. The permissible pollutant level at allocation of a water use is recommended here as standard value for the index .

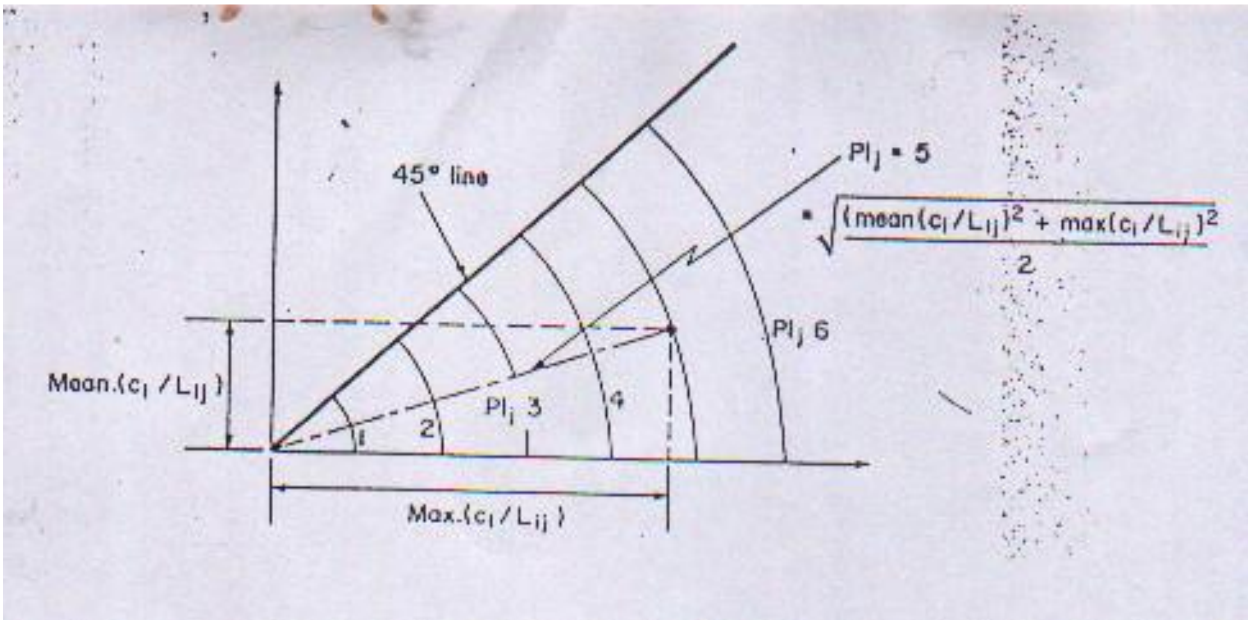
When the multiple items of water qualities are expressed as Ci s and the permissible levels of the respective items for a use are expressed as Lij s, the pollution index for the use j ,PIj may expressed as a function of the relative values (Ci/Lij).Here, i is the number of the i-th item of water quality ,and j is the number of the j-th use(Nemerow,1974)

PIj= A function of [(Ci/Lij)s] (1)

The index may be expressed by the relative value (Ci/Lij) s as shown in relation (1). Each value of (Ci/Lij) shows the relative pollution contributed by the single item .A value of 1.0 is the critical value for each (Ci/Lij).Values greater than 1.0 indicate that the water requires some treatment prior to use for specific purpose .Likewise, when combining the individual values of (Ci/Lij)s in to a common index ,values over 1.0 signify a critical condition under which a proper treatment is necessary for the water use,we propose a reasonable method for an over all expression of pollution .The average value of all the calculated (Ci/Lij)values may be recommended as one of the most important parameters for the PIj
The index may be expressed using the maximum and mean values of the (Ci/Lij)values as shown in the next relation(Nemerow,1974)

PIj=f(max.of(Ci/Lij)s and mean of(Ci/Lij)s) (2)

The general quality expression of pollution for use j is related to the length of a line between the origin and each point .The length is determined by the two values of the maximum and mean of (Ci/Lij) values , we propose to neglect the effect of angle θ in fig (3) .The pollution index for use j ,PIj is measured by the length of the radii of the cocentric circles ,therefore relation (2) is expressed as follows:



Fig(3) Relationship between mean and maximum ratios of contaminant concentration and allowable concentration.

$PIj=m \sqrt{max(Ci/Lij)^2+mean(Ci/Lij)^2}$ (3)

Here ,m =the proportionality constant
A critical condition to determine the coefficient m is recommended as follows
:
PIj=1.0,when max Ci/Lij =1.0 and mean Ci/Lij=1.0 (4)

This means that the index for use j is expressed as 1.0 when all items of water qualities are just equal to their respective permissible levels for the use .the relation (3) is as follows under relation (4) :$1.0=m\sqrt{1^2+1^2}$,$m=1/\sqrt{2}$

Therefore, PIj is proposed as follows :$PIj=\sqrt{max(Ci/Lij)^2+mean (Ci/Lij)^2/ 2}$ (Nemerow,1974)

One possible procedure for establishing the overall index PI is that the relative effects are determinable as simple constant numbers in an overall estimation.
Judging from the fact that each PIj values is relative value, nondimentionaol, and that the relative importance of each use may be generally determined as a constant value, the overall index PIj is proposed as aweighted average value of all the PIj s as follows:

$$PI=\sum_{j=1}^{j=n}(wi .PIj) \quad (5)$$

Here wj=Weight coefficient (constant value) ,which is determined by the relative importance's of the water use j in the region or society.

n= Number of water uses

$$\sum_{j=1}^{j=n}(wj)=1$$

and

consideration is given to the practical grouping of water uses (j s)and the reasonable items of water quality (I s) for the practical application of the proposed indices ,grouping of water uses may be possible and facilitate calculation of the pollution indices. The following three groups are recommended for separate index expressions.

1- Human Contact Use (j=1),which includes drinking,swimming,beverage manufacturing.
2- Indirect Contact Use (j=2) ,which includes fishing ,industrial food preparation,agricultural use
3- Remot Contact Use (j=3) ,which includes industrial cooling ,aesthetic,navigation.

The overall permissible levels (Lij s) should be determined for the three grouped uses by applying the permissible contamination levels for each particular use.(Nemerow,1974)

WATER QUALITY INDICES DETERMINATION

The average monthly concentrations of twenty two parameters of pollutants were collected from Baghdad water administration for three water treatment plants along Tigris river, Al Kharkh water treatment plant water to reflect water quality at north of Baghdad ,Al Wathba water treatment plant to reflect water quality at the center and Al Rasheed water treatment plant at the south of Baghdad to reflect water quality at this area ,Table(2) shows the quality items according to the Iraqi specification no.417,2001 .Table (3) shows the water quality indices for the period (2000-2004) for the human contact use .Table(4) shows the water quality indices for the same period but the indirect contact use .Table(5) shows the water quality indices for the remote contact use .The limits used in the calculations are according to the Iraqi specification No.417,2001,and according to EEC,1998.

The relative weight may be determined tentatively according to its important in our society :

w1=0.5, w2=0.3, w3=0.2

therefore

PI=w1*PI1+w2*PI2+w3*PI3

Table(6) shows the overall water quality indices for the same period and table (7)shows the overall water quality indices for the whole period.

Figure(4) shows the bar chart of particular water quality indices for the period 2000-2004 for each plants, and the figures (5)and(6) show the particular water quality indices for the whole period.

TABLE(2) QUALITY ITEMS USED IN WATER QUALITY INDICES DETERMINATION

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Quality item	Limts	Quality item	Limts
C1	color	C12	Total solids
C2	temperature	C13	Magnisum
C3	alkalinity	C14	Suspended solids
C4	Total hardness	C15	Sulfate
C5	calcium	C16	Iron
C6	conductivity	C17	floride
C7	pH	C18	amonia
C8	turbidity	C19	nitrate
C9	silica	C20	nitrite
C10	chloride	C21	coliform
C11	aluminum	C22	Fecal coliform

TABLE(3) WATER QUALITY INDICES FOR the Human Contact Use(j=1)

PI	AL Kharkh WTP	AL Wathba WTP	AL Rasheed WTP
2000	15.476	22.821	26.822
2001	15.472	23.245	27.991
2002	16.280	22.163	37.177
2003	15.900	22.867	35.757
2004	15.569	21.305	25.618

TABLE(4) WATER QUALITY INDICES FOR the Indirect Contact Use(j=2)

PI	AL Kharkh WTP	AL Wathba WTP	AL Rasheed WTP
2000	1.301	1.810	1.801
2001	1.168	1.751	1.537
2002	0.8	1.226	1.244
2003	0.826	1.458	1.305
2004	0.803	1.359	1.177

TABLE(5) WATER QUALITY INDICES FOR the Remote Contact Use(j=3)

PI	AL Kharkh WTP	AL Wathba WTP	AL Rasheed WTP
2000	5.995	5.386	3.078
2001	6.068	5.911	4.135
2002	4.928	4.437	4.080
2003	4.863	6.056	3.594
2004	5.135	6.183	4.627

TABLE(6) THE OVERALL WATER QUALITY INDICES FOR THE SELECTED PLANTS

PI	AL Kharkh WTP	AL Wathba WTP	AL Rasheed WTP
2000	9.327	13.030	14.566
2001	9.3	13.33	15.283
2002	9.365	12.336	19.777
2003	9.17	13.081	18.988
2004	9.052	12.296	14.087

TABLE(7) THE OVERALL WATER QUALITY INDICES FOR THE WHOLE PERIOD

PLANTS	**PI1**	**PI2**	**PI3**	**PI**
ALKharkh WTP	**15.778**	**0.961**	**5.479**	**9.271**
ALWathba WTP	**22.592**	**1.523**	**5.714**	**12.895**
ALRasheed WTP	**26.752**	**1.418**	**3.993**	**14.6**

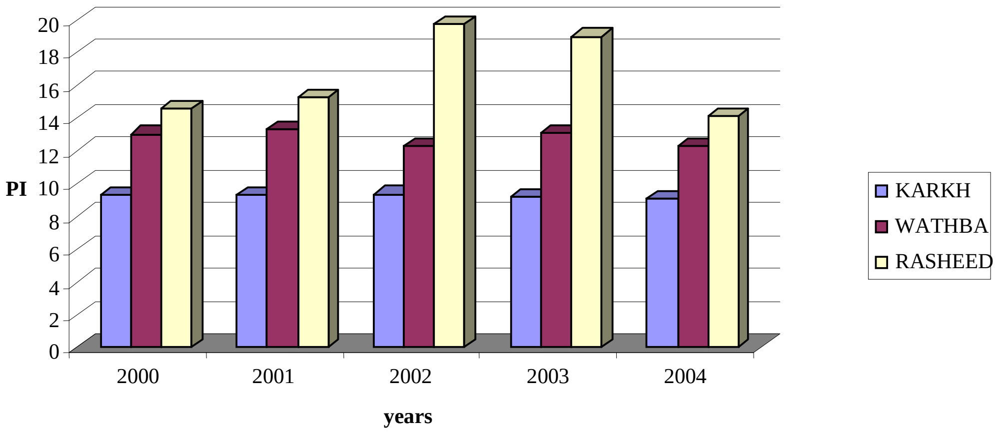

Figure (4)The particular water quality indices

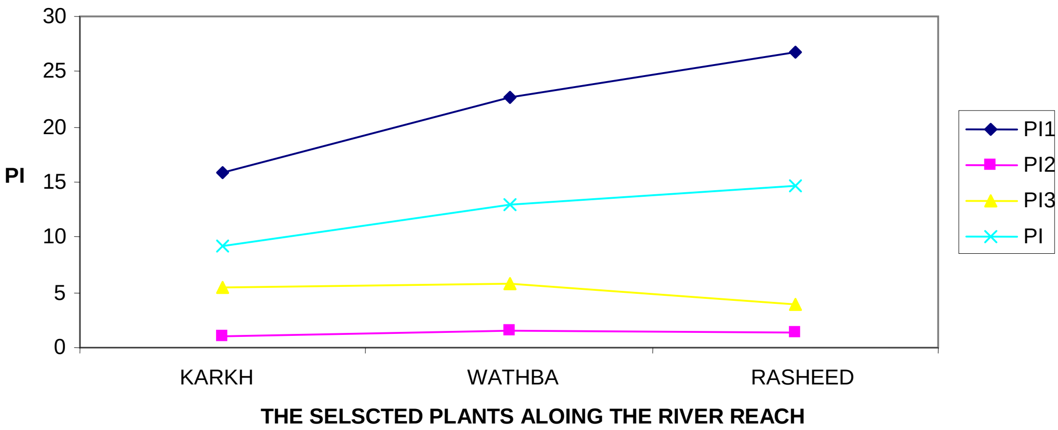

Fig (5)The overall pollution indices for the whole period.

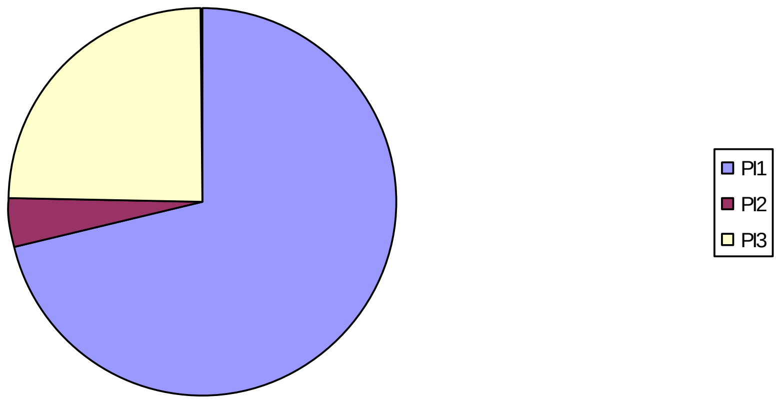

Fig (6) The particular pollution indices for the whole period.

CONCLUSIONS

*-water quality indices for the Al Rasheed WTP were greater than the water quality indices for Al Wathba WTP the indices for Al Wathba WTP were greater than water quality indices for Al Karkh WTP .which indicates that the water quality of Tigris river deteriorate south of Baghdad

*-The deterioration as going down stream the river reflects the cumulative effect of agriculture and industrial activities .Furthermore ,the water quality indices were noticed to be abnormally high during 2002 and 2003 due to the lowest precipitation in those years.

*-The water quality indices for Al Rasheed WTP showed that they were generally deteriorate with time ,this degradation is due to the decrease in the amount of flow coupled with an increase in the agricultural and industrial development within the basin.

*-The relative low water quality indices in year 2004 are due to the dilution caused by high flow and precipitation during the year.

*-The water quality indices for the human contact use are greater than the indices for the indirect contact use and the remote contact use, while the water quality indices for the remote contact use are greater than the indices for the indirect contact use.

*- High water quality indices for the human contact use are due to the high concentrations of coliform and fecal coliform bacteria while the high water quality indices for the remote contact use are due to the high concentrations of turbidity in river water .

REFERNCES:

*Al-Ansari,N.A.,Essaid,H.I. and Salim,Y.N.,"Water Resources in Iraq"Jour.of Geol. Soc. Of Iraq. 14(1),1981

*Annual Abstract Of Statistics, central statistical organization, Planning Ministry,2001

*Al-saffar,A.E.A., "Proposed Water Quality Management For Tigris River" PhD. Thesis ,College of Engineering, University of Bghdad,2001

*Baghdad Water Administration ,"The Annual Reports for the physical ,chemical and biological tests",2004

*EEC,No.464,"Surface water quality for drinking water abstraction",1998

*Iraqi limitations,No.417,Central statistical organization, Planning Ministry,2001

*Lohani,B.N.,"Water quality index in Chao Pharaya river"ASCE,Vol.118,1990

*Nasser,N.O.A.,"Variation of salinity indication parameters of Tigris river in Baghdad city (1990-1999)",M.Sc. Thesis ,College of Engineering, University of Bghdad,2001

*Nemerow,N.L.,"Scientific stream pollution analysis",McGrew-Hill Book Co.,1974