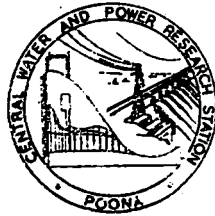


A STUDY ON THE QUALITY OF INDIAN RIVER WATERS

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PREFACE

Very little data was available on the quality of Indian river waters in relation to irrigation and industry. The necessity and importance of collecting such data was pointed out by the Research Committee of the Central Board of Irrigation and Power at its annual meeting in 1949. A systematic study of these waters was taken up by this research station in 1955 for pH, conductivity, salt content and nature of salts. Water samples were collected and analysed every month from various sites of important rivers in India. The data have been collected for five years to get an idea about the monthly, seasonal and annual variations in salt content and their nature at a particular site. The data also reveals the suitability or otherwise of these waters for irrigation and industry.

The authors gratefully acknowledge the co-operation of the Chief Engineers of various states and their staff in procurement of the water samples; help and suggestions rendered by the Ex-directors of the station Sarvashri D.V. Joglekar and M.G. Hiranandani and the present Director Shri C.V. Gole; the keen interest shown by Union Minister for Irrigation and Power, Honourable Dr. K.L. Rao, Ex-Member, Central Water & Power Commission, New Delhi and finally the help rendered by the staff of the Chemistry Division of the Station particularly Sarvashri S.C. Roy and K. Ravindaran.

A STUDY ON THE QUALITY OF INDIAN RIVER WATERS

INTRODUCTION

All natural water used for irrigation contains soluble inorganic salts, the nature of which depends upon the rocks and the soils through which it percolates. The principal dissolved salts usually are bicarbonates, chlorides and sulphates of sodium, calcium and magnesium. Other constituents which may be present are potassium, iron, silicate, carbonate aluminate, borate, fluoride and sulphide. Most of these are present in very small quantities and are not of much importance except borate. Boron concentrations less than 0.4 ppm, however, seldom harm crop plants. The suitability of a water for irrigation purpose is determined by the concentration and proportion of the principal salts. Different views have been expressed by various workers regarding the upper limit of salinity where water is not suitable for irrigation. It is because the quality of water depends upon the nature of the soil, its management and on the crops grown in addition to the total salinity and nature and proportion of the individual ions. Puri (1) derived a general formula for expressing the quality of water and designated the value so obtained as 'Salt Index'.

$$\text{Salt Index} = \text{Total Na} - (\text{Total Ca} - \text{Ca in CaCO}_3) \times 4.85$$

(All quantities in the formula refer to parts per 100,000). The Salt Index is negative for all good waters and positive for waters not suitable for irrigation. Salt Index, according to the formula is -24.5 for distilled water.

Kelley, Brown and Leibig. (2) proposed that quality of water should be determined by the ratio of cations present in addition to the amount of total salts in irrigation water. It was recommended from their study that the ratio of sodium to calcium plus magnesium in irrigation water should not exceed approximately 1:1. The ratio is calculated on the basis of equivalents of each element per million parts of water. The use of this ratio has been further developed by workers at the U.S. Regional Salinity Laboratory [Magistad and Christiansen (3); Richards (4) I]. They suggested the expression in terms of sodium percentage.

$$\text{Sodium percentage} = \frac{\text{Na} \times 100}{\text{Ca} + \text{Mg} + \text{K} + \text{Na}}$$

(Concentrations of all elements are expressed in milli-equivalents per litre).

Magistad and Christiansen (3) divided water into three classes; Class 1 having salts upto 700 ppm and sodium percentage upto 60; Class 2 having salts between 700-2000 ppm and sodium percentage between 60-75 and Class 3 having salt content of 2000 ppm or above and sodium percentage above 75. Wilcox (5) considers the total concentration of dissolved salts, the percentage of sodium and the concentration of boron as the principal criterion for determining quality of water. He divides irrigation waters into five classes on the basis of salt concentration and sodium percentage. In his scheme the effects of high sodium percentage and high salt content are combined into a single rating system, even though the effects of the two factors are

largely independent. While classifying Utah waters, Thorne and Thorne (6) made modifications in Wilcox classification and their categories are designated by the following series:

1A, 1B, 1C, 1D and 1E

2A, 2B, 2C, 2D and 2E

3A, 3B, 3C, 3D and 3E

4A, 4B, 4C, 4D and 4E

5A, 5B, 5C, 5D and 5E

The number refers to the rating with respect to increasing concentration of total salt and the letters to increasing proportion of sodium in the water or to different sodium percentages. The staff of the U.S. Salinity Laboratory (7) introduced a new expression of sodium hazard termed as Sodium Adsorption Ratio (S.A.R) and have proposed a quality diagram for classifying irrigation waters on the basis of conductivity and sodium adsorption ratio. S.A.R is calculated by dividing Na^+ by the square root of half the sum of Ca^{++} and Mg^{++} , where ions are expressed as milliequivalents per litre. Fig.2 has been reproduced from "Irrigated Soils" by Thorne and Peterson p.110. It is a modification of the above referred quality diagram. The lines dividing S.A.R classes are empirical, based upon results of green house and field experiments. The conductivity scale is logarithmic to the base 10. This classification has an advantage over others in that the sodium adsorption ratio combines the effects of both sodium percentage and total salinity. Thus S.A.R is a better indication of the effect of water on soils

than sodium percentage used in other classifications. The negative slope of the S.A.R. lines accounts for the dependence of sodium hazard on conductivity. The conductivity and S.A.R classes may be interpreted as under:

Conductivity Classes

C₁: (0-250 micromhos/cm); Waters in this class have low salinity and they can be used on most soils without endangering the development of salinity. Most crops will tolerate this water.

C₂: (250-750 micromhos/cm): Waters in this class have moderate salinity and can be used on soils of medium permeability. Extremely salt-sensitive plants will not tolerate this water.

C₃: (750-2250 micromhos/cm): Waters in this class have moderate to high salinity and can be used on soils of medium to good permeability. Only plants with moderate to good salt tolerance will grow well with these waters.

C₄: (2250-4000 micromhos/cm): Waters in this class have ^{high} salinity and can be used only on soils having good permeability. Only salt-tolerant crops will grow with these waters.

C₅: (4000-6000 micromhos/cm): Waters in this class have very high salinity and can be used only on soils having high permeability. Only high salt-tolerant crops can grow with these waters.

C₆: (above 6000 micromhos/cm): Waters in this class have excessive salinity and should not be used for irrigation.

S.A.R. Classes

S₁: Waters in this class have low S.A.R and can be used on most soils without endangering alkalisation of the soil.

S₂: Waters in this class have medium S.A.R and can be used on coarse-textured soils with good permeability. Irrigation with this water has tendency towards alkalisation of the soil unless gypsum is present in the soil.

S₃: Waters in this class have high S.A.R and will tend to cause harmful alkalisation in most soils lacking lime. Special care has to be taken for using these waters for irrigation.

S₄: Waters in this class have very high S.A.R and are ordinarily unsuitable for irrigation unless the salinity is low and gypsum or other amendments are feasible.

'Hardness' determines the quality of water for industrial purposes. It is defined as parts per million of calcium plus magnesium expressed as calcium carbonate. Water may be classified as soft, average and hard depending upon the 'Hardness', in accordance with Manual on Industrial Waters(10).

Soft water	'Hardness' less than	100 ppm
Average water	" between	100- 150 ppm
Hard water	" greater than	150 ppm

EXPERIMENTAL

The water samples were collected at mid-stream or at some distance from the bank of the river in polythene bottles from 1955 to 1960 and sent to the research station. The names of the rivers and sites from where water samples have been collected and analysed are given in fig.1. The samples were filtered through Whatman No.42 filter paper to remove the suspended material. The clear filtered samples were analysed for conductivity, pH value, various cations and anions as detailed below:

Conductivity: This was determined by Dionic Water Tester and expressed as micromhos per cm.

pH Value:- This was determined by Beckman pH meter model G using glass electrode and fibre type reference electrode.

Sodium & Potassium:- These were determined by using Beckman flame spectro-photometer Model D.U.

Calcium & Magnesium:- These were volumetrically determined by titration against versenate solution (Ethylene diaminetetra-acetic acid, disodium salt) using murexide and eriochrome as indicators.

Chloride:- This was determined volumetrically by titration against a standard silver nitrate solution using potassium chromate as indicator.

Carbonate & Bicarbonate:- These were determined volumetrically by titration against standard hydrochloric

acid using phenol-phthalein and methyl orange as indicators:

Sulphate:- This was determined gravimetrically by precipitating as barium sulphate after destroying carbonates and bicarbonates with hydrochloric acid in those samples where sum of other anions was considerably less than the sum of the cations.

Boron:- This was determined by quinalizarine method. Some samples from different rivers were analysed and it was observed that none of the samples showed the presence of Boron more than 0.05 ppm.

RESULTS

The analytical data are presented in Statement I. It contains the name of the river and site, year and month of collection, pH value, conductivity, individual cations and anions expressed as parts per million, hardness, sodium percentage, S.A.R and classification as proposed by the staff of the U.S. Salinity Laboratory. In Statement II, are presented the maximum and minimum values for conductivity, pH, individual ions, hardness etc. for any year during the period of study. The rivers have been divided into two groups:

Group I - North Indian Rivers - Ganga, Gandak, Kosi, Brahmaputra and Yamuna.

Group II - Central Indian & South Indian Rivers
Chambal, Narmada, Tapti, Godavari, Krishna & Cauvery.

GROUP I

(a) Ganga:- The river which takes its source in the Himalayas is joined by river Yamuna at Allahabad by river Gomati near Varanasi by rivers Ghaghara and Gandak near Patna and by river Kosi some 60 miles above Farakka and falls into the Bay of Bengal. Its water has been analysed from various sites namely Hardwar, Allahabad, Patna, Bhagalpur and Farakka. It is seen from Statement II that maximum values of conductivity and individual ions etc. are lowest at Hardwar. These values are higher at Allahabad and Patna but decrease slightly at Bhagalpur and Farakka. The decrease at Farakka may be attributed to the river Kosi whose water has low soluble salts, joining Ganga river before Farakka. There is practically no variation in maximum and minimum values from year to year at all the sites. It is also seen that salt concentration of the waters is quite low. Conductivity varies between 122-525 micromhos/cm. pH is always on the alkaline side varying between 7.4-8.9. Other variations are: Na from 0.9-39.5 ppm; K from 1.7-9.8 ppm; Ca from 6.9-44.3 ppm; Mg from 1.0-28.9 ppm; Cl from 1-28 ppm; and HCO_3 from 61-265 ppm. Statement I shows that conductivity is usually maximum during January to April. Magnesium though generally lower than calcium is sometimes higher than calcium in January, February or March. S.A.R. values are very low and all waters fall under C_1S_1 and C_2S_1 classes indicating that they are good for irrigation throughout the year. With regard to hardness, waters are generally either soft or average at all the sites, but at sites other than

Hardwar sometimes these are hard during winter and dry months.

(b) Gandak:- The river takes its source in the Himalayas and joins river Ganga near Patna. The water samples have been analysed only from Hajipur site. Statement II shows that minimum and maximum values from year to year do not vary appreciably. Statement I shows that salts are low, conductivity varying from 175-340 micromhos/cm, maximum being in April. pH is usually on the alkaline side varying from 7.6-8.7. Other variations are: Na from 1.4-7.5 ppm; K from 2.8-8.9 ppm; Ca from 18.9-37.8 ppm; Mg from 5.7-17.0 ppm; Cl from 3-15 ppm and HCO_3 from 95-153 ppm. S.A.R. is quite low and waters are classified as C_1S_1 and C_2S_1 for irrigation purposes indicating that all waters are good. With regard to hardness, waters are generally soft or average.

(c) Kosi:- The river takes its source in the Himalayas and joins river Ganga between Bhagalpur and Farakka at Korsele. Only one years' (1956) complete data is available for study at Chatra site. Salt concentration of the water is very low (Statement I), maximum conductivity being 210 micromhos/cm in April. pH is usually on the alkaline side varying from 7.0-8.5. Other variations are: Na from 2.2-9.1 ppm; K from 1.6-4.3 ppm; Ca from 12.0-24.5 ppm; Mg from 1.5-5.9 ppm; Cl from 6-22 ppm and HCO_3 from 40-105 ppm. S.A.R. is very low and waters fall in C_1S_1 class, indicating that waters are very good for irrigation purposes. With regard to hardness, waters are always soft.

(d) Brahmaputra:- The river takes its source in the Himalayas flows through Tibet and enters India through NEFA and joins river Ganga in East Pakistan. Waters have been analysed from Dibrugarh and Gauhati Sites. It is seen from Statement II that there are practically no variations in maximum and minimum values from year to year at either site. Salt concentration at both the sites is low, maximum conductivity being 280 micromhos/cm, which is observed (Statement I) during February to May. pH is usually on the alkaline side varying from 7.1-8.8. Other variations are: Na from 1.0-8.2 ppm; K from 1.1-7.1 ppm; Ca from 15-38.7 ppm; Mg from 1-16.0 ppm; Cl from 2-14 ppm; and HCO_3 from 61-134 ppm. S.A.R is very low and waters are classed C_1S_1 and C_2S_1 for irrigation and are good throughout the year. With regard to hardness, waters are soft or average.

(e) Yamuna:- The river takes its source in the Himalayas. It forms the eastern boundary of East Punjab, then flows parallel to Ganga and joins it at Allahabad. The water has been analysed from Agra site. Only two years complete data (1956 and 1959) is available. Statement II shows that conductivity goes as high as 1485 micromhos/cm varying from 260-1485 micromhos/cm. pH value is on the alkaline side varying from 7.9-8.9. Statement I shows that maximum conductivity is observed during April, May or June. Other variations are: Na from 7.6-140 ppm; K from 2.3-12.8 ppm; Ca from 12.0-84.3 ppm; Mg from 4.1-50.8 ppm; Cl from 6-314 ppm and HCO_3 from 107-256 ppm. S.A.R is generally low and waters fall in C_1S_1 and C_2S_1 classes and are good for irrigation. Some

waters fall in C_3S_1 class and should be used only for high salt tolerant crops. With regard to hardness, waters are usually hard but during monsoons they are average.

GROUP II

(a) Chambal:- It takes its source in the Abu mountains and flowing north-east joins Yamuna near Katauli about 32 miles below Etawah. Water samples have been analysed from Kota site and indicate (Statement II) that conductivity varies from 170-805 micromhos/cm and minimum and maximum values do not vary appreciably from year to year. Statement I shows that salt concentration is highest during May or June. Monthly variations are large. pH is usually on the alkaline side and vary from 7.4-8.8. Other variations are: Na from 9.1-75.9 ppm; K from 1.1-6.0 ppm; Ca from 6-32.7 ppm; Mg from 3.1-34.6 ppm; Cl from 5-62 ppm and HCO_3 from 93-313 ppm. S.A.R values are not high and waters fall generally in C_1S_1 and C_2S_1 classes except for some samples in dry season which fall in C_3S_1 class. Waters are good for major part of the year for irrigation purposes. With regard to hardness, waters are generally soft or average except in dry months when they are hard.

(b) Narmada:- The river takes its source in the Vindya range, flows westwards and falls in the Gulf of Cambay. Water samples have been analysed from Mortakka and Gardeshwar sites. Statement II shows that waters are similar at both the sites and the minimum and maximum values do not change appreciably from year to year while month to month variations (Statement I) are considerable. Conductivity varies

from 153-575 micromhos/cm and is highest during April, May or June. pH is usually on the alkaline side varying from 7.6-9.0. Other variations are: Na from 3.6-41.4 ppm; K from 0.4-3.7 ppm; Ca from 11.2-38.3 ppm; Mg from 4.1-38.7 ppm; Cl from 4-30 ppm and HCO_3 from 92-311 ppm. S.A.R value is low and waters fall under C_1S_1 and C_2S_1 classes for irrigation purposes showing that waters are good. With regard to hardness, waters are usually hard but in monsoon months they are either soft or average.

(c) Tapti:- The river takes its source in the Satpura range and flows westwards. It falls in the Gulf of Cambay. Water samples have been analysed from Kakrapar site. About one years' data is available for Bhusawal site as well. Statement II shows that salt concentration is not different at the two sites. Maximum and minimum values from year to year do not vary much; but month to month variations (Statement I) are large. Conductivity varies from 195-1125 micromhos/cm, maximum being in April, May or June. pH is on the alkaline side varying from 7.7-9.0. Other variations are: Na from 10.5-125 ppm; K from 1.2-5.9 ppm; Ca from 6.0-41.3 ppm; Mg from 6.2-38.7 ppm; Cl from 7-104 ppm and HCO_3 from 98-368 ppm. S.A.R values are not low and vary from 0.5 to 4.05. Some waters fall in C_3S_1 class and these should only be used on crops with high salt tolerance. Other waters fall in C_1S_1 and C_2S_1 classes and are good for irrigation. With regard to hardness, waters are usually hard but in monsoon months they are either soft or average.

(d) Godavari:- The river takes its source in the Western Ghats and flows eastwards. It falls in the Bay of Bengal. Water samples have been analysed from Nanded Site. Statement II shows that the minimum values do not vary from year to year, but maximum values vary considerably as is evident from conductivity value varying from 920-1500 micromhos/cm. Statement I shows that salt concentration is highest during April or May. Conductivity varies from 225-1800 micromhos/cm. pH is on the alkaline side varying from 7.8-8.9. Other variations are: Na from 1.5-264 ppm; K from 1.3-9.0 ppm; Ca from 12.9-37.8 ppm; Mg from 6.2-48.3 ppm; Cl from 1-174 ppm and HCO_3 from 130-342 ppm. S.A.R value is not very high. Waters generally fall in C_1S_1 , C_2S_1 , C_3S_1 classes, and a few samples fall under C_3S_2 class for irrigation. Waters in dry season falling in C_3S_1 or C_3S_2 class should be used only for salt-tolerant crops and on permeable soils. With regard to hardness, waters are usually hard but in monsoon months they are average and sometimes soft.

(e) Krishna:- The river takes its source in the Western Ghats and flowing eastwards falls in the Bay of Bengal. Water samples have been analysed for Karikal and Nagarjunasagar Dam Sites. Statement II shows that the minimum and maximum values from year to year vary considerably. Values at Karikal site are higher than the values at N.J.S.D. Site. Statement I shows that conductivity is highest during April or May, varying from 135-2000 micromhos/cm. pH is always on the alkaline side varying from 7.3-9.0. Other variations are: Na from 5.3-197 ppm; K from 0.7-7.3 ppm; Ca from 10.3-41.3 ppm; Mg from 3.6-50.3 ppm; Cl from 6-254 ppm and HCO_3 from 70-250 ppm. S.A.R values are low and waters fall

in C_1S_1 , C_2S_1 and C_3S_1 classes, but a few samples fall in C_3S_2 class. Waters are usually good for irrigation, but those falling under C_3S_1 and C_3S_2 classes should be used for more salt-tolerant crops and on permeable soils. With regard to hardness, waters are mostly average except during dry periods when they are definitely hard.

(f) Cauvery:- The river takes its source in the Western Ghats and flows eastwards. It falls in the Bay of Bengal. Water samples have been analysed from Bhawani site. Statement II shows that salts are moderate with less variations in minimum and maximum values from year to year. Statement I shows that month to month variations are not considerable. Conductivity varies from 100-390 micromhos/cm, maximum being in May-June and pH is on the alkaline side varying from 7.4-9.2. Other variations are: Na from 5.2-34.6 ppm; K from 1.4-3.6 ppm; Ca from 12.0-25.8 ppm; Mg from 1.8-18.5 ppm; Cl from 8-27 ppm and HCO_3 from 58-201 ppm. S.A.R is low and waters fall in C_1S_1 and C_2S_1 classes for irrigation and are good throughout the year. With regard to hardness, waters are generally soft or average but sometimes hard during dry months.

General Discussion:

The rivers of India have been divided into two groups, group I includes North Indian Rivers (Ganga, Gandak, Kosi,

Brahmaputra and Yamuna) which are fed by the melting of snow during dry periods and Group II includes Central Indian and South Indian Rivers (Chambal, Narmada, Tapti, Godavari, Krishna and Cauvery) which are usually fed by regeneration water during dry periods.

Group I river waters contain low soluble salts and salt concentration does not increase appreciably during dry periods. River Yamuna at Agra is an exception probably because most of the Yamuna discharge is taken away by canals before Agra and during dry season the discharge at Agra may be regeneration water.

Group II river waters show appreciable increase in salt concentration during dry periods. This is because the discharge during that period is very low and is regeneration water. Cauvery is an exception. The water of Cauvery does not show appreciable increase in salinity during dry periods. It is because the river is fed by both the monsoons.

Sodium percentage values for Group I waters are generally less than 40. Yamuna, however, shows some values during dry periods going as high as 65. Group II waters have sodium percentage more than 50 and sometimes as high as 70 during dry periods. Values for Cauvery river are usually between 30-40.

fig.3 Conductivity of water samples mainly depends upon
fig.4 the concentration and nature of salts present in them. Fig.3
 and fig.4 give the relation of conductivity with salt

concentration expressed as ppm and with salt concentration expressed as meq/litre respectively. It is seen from fig.3 that for Indian river waters, conductivity of 1000 micromhos/cm should be taken to mean about 760 ppm, which is higher than the usual value of about 640 ppm. It is due to the presence of high bicarbonate content in the waters. Fig.3 shows that the ratio of conductivity to meq/litre is 100:1 approximately. This agrees with the usual value.

Conductivity does not give any idea about the amount of salts carried by a river at a site during any period. For this, discharge data at the site is required. Some conductivity values alongwith discharge data are given below:

Ganga at Hardwar (1958)			Narmada at Mortakka (1958)	
Month	Conductivity micromhos/cm	Discharge in cusecs	Conductivity micromhos/cm	Discharge in cusecs.
1	2	3	4	5
January	230	8083	450	2884
February	-	-	425	2321
March	275	6508	445	2189
April	175	9825	520	1254
May	220	11048	525	910
June	170	18873	460	2865
July	220	62103	225	56966
August	180	79129	202	101509
September	168	48004	230	132771
October	160	34359	210	55448
November	188	14186	320	16234
December	-	-	360	6374

It will be seen from above that when the discharge increases even 100 times, conductivity does not fall even one third, indicating that the amount of salts carried by the river during monsoon periods are large as compared to the salts carried by it during dry periods.

Group I river waters have low to moderate salinity with less variations from month to month, whereas Group II river waters show high salt concentration when discharge is low during dry periods. As most of the discharge in Group II rivers is during monsoon periods when the salinity of water is low, the water stored (as in reservoirs) will have a salinity almost similar to that in monsoon periods and will be quite low.

Group I river waters have low S.A.R value which never exceeds 2. Group II river waters have slightly higher values during dry periods and sometimes shoot upto 7. A few samples fall in S_2 class and should only be used on permeable soils. However, as pointed before, the water stored in a reservoir will show a very low value for S.A.R.

In classifying waters with regard to S.A.R and conductivity, no consideration is given to the presence of carbonates and bicarbonates. Eaton (8) however, stressed the importance of carbonates and bicarbonates in irrigation waters. In his opinion possible sodium percentage and residual sodium carbonate should be considered for defining the quality of irrigation water. These are calculated as below:

$$\text{Possible Na\%} = \frac{100 \times \text{Na}}{(\text{Ca} + \text{Mg} + \text{Na}) - (\text{CO}_3 + \text{HCO}_3)} \quad \text{where}$$

$(\text{CO}_3 + \text{HCO}_3)$ does not exceed $(\text{Ca} + \text{Mg})$.

$$\text{Residual Sodium Carbonate} = (\text{CO}_3 + \text{HCO}_3) - (\text{Ca} + \text{Mg})$$

(All values are expressed as meq/litre)

Thorne and Thorne (9) applied irrigation waters containing carbonates and bicarbonates under average farm conditions on different soil sites and did not find any significant increase in sodium percentage or lime accumulation. On the basis of laboratory experiments and using the residual sodium carbonate concept of Eaton, the staff of the U.S. Salinity Laboratory have concluded that waters with more than 2.5 meq/litre residual sodium carbonate, are not suitable for irrigation purposes. Waters containing 1.25-2.5 meq/litre are marginal and those containing less than 1.25 meq/litre residual sodium carbonate are probably safe. These conclusions are tentative as they are based on limited data.

Indian river waters contain carbonates and bicarbonates which sometimes amount to about 80 per cent of the total anions. Residual sodium carbonate has been calculated for all the samples. It is seen that waters of Ganga, Gandak, Kosi, Brahmaputra, Cauvery, Krishna and Yamuna have residual sodium carbonate less than 1.25. Residual sodium carbonate for other rivers i.e Narmada, Tapti, Godavari and Chambal is usually less than 1.25 during monsoon period, but in winter and dry periods it lies between 1.25-2.5. A few samples of river Tapti,

Chambal and Godavari show residual sodium carbonate more than 2.5.

With regard to hardness, most of the waters for Group I rivers are generally soft or average. Ganga waters at sites other than Hardwar and Yamuna waters at Agra are hard during winter or dry periods, hardness going as high as 200 to 300. Waters of Group II rivers are usually hard except in monsoon months when they are usually average and sometimes soft. Cauvery waters are mostly soft to average throughout the year.

Chemical analysis of some of the U.S. river waters (12) is given in Statement III. On comparison with Indian river waters, it may be said that these waters differ from Indian river waters in their individual salt content. Waters of rivers Ohio, Beaver and White which have low salinity and do not show much variation in the monthly data may be classed similar to Group I river waters. In river Ohio, bicarbonate is almost negligible, magnesium is quite low and sulphate is abundant. In Beaver river, bicarbonate and magnesium are low and sulphate is abundant. In White river, magnesium and sulphate are low and bicarbonate is high. Group I Indian river waters usually contain high bicarbonate, appreciable magnesium and negligible sulphate. Waters of river Arkansas show considerable variations in the salinity, conductivity varying from 406-1320 micromhos/cm and may be classed similar to Group II Indian river waters. Arkansas river waters have low magnesium and

bicarbonate but high chloride, whereas Indian river water in this group have high bicarbonate and appreciable chloride and magnesium.

Chemical analysis of some Indian river waters as presented by Kobayashi (13) is given in Statement IV. It appears that the results are the analysis of a single sample for a river taken on a particular date. It is seen from the results that the values obtained by him for individual ions and conductivity invariably lie in the range given in Statement II except for the pH values which are slightly on the lower side.

SUMMARY AND CONCLUSIONS

A systematic study on the quality of Indian river waters has been made. Waters collected from different sites for various rivers every month have been analysed during 1955-1960 for conductivity, pH and various cations and anions. The rivers have been divided into two groups as:

Group I:- North Indian rivers (Ganga, Gandak, Kosi, Brahmaputra except Yamuna) have the following salient features:

- (1) Salinity is low throughout the year
- (2) Monthly variations and yearly variations are low
- (3) Waters are mostly alkaline
- (4) Calcium and bicarbonate are the predominant ions.
- (5) Sodium percentage and S.A.R values are low. Waters usually fall in C_1S_1 and C_2S_1 classes for irrigation.
- (6) Waters are usually either soft or average.

Group II:- Central Indian and South Indian rivers (Chambal, Narmada, Tapti, Godavari, Krishna except Cauvery have the following salient features:

- (1) Salinity is low only during monsoon period
- (2) Monthly variations are large and yearly variations are appreciable.
- (3) Waters are mostly alkaline
- (4) Sodium and bicarbonate are the predominant ions. However, during dry months, chlorides and sulphates are appreciable.
- (5) Sodium percentage and S.A.R values are appreciable and sometimes above 60 and 5, respectively. Waters usually fall in C_2S_1 and C_3S_1 classes and sometimes in C_3S_2 class for irrigation.
- (6) Waters are usually hard during dry period and they are either soft or average during monsoon period.

Yamuna and Cauvery are exceptions. The former has the characteristics of Group II and the latter have the characteristics of Group I.

The present study shows that Group I Indian river waters are good throughout the year for irrigation purpose. The Group II river waters are also good during monsoon period. During dry season however, the total salinity, sodium percentage and S.A.R value are quite high for Group II river waters. Such waters should be used for irrigation cautiously and only on pervious soils.

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STATEMENT I
Chemical Analysis of River Water Samples (Group I)

Name of river and (site)	Year and month of collection	Conductivity micro-mhos/cm	pH	Parts per million of							Hardness No.	Na %age	SAR	Classification	
				Na	K	Ca	Mg	Cl	CO ₂	HCO ₃					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
(a) Ganga (Hardwar)	1955 10	278	7.9	11.6	9.8	24.9	10.3	26	...	70	105	17.7	.49	C2 S1	
	11	158	7.5	2.7	2.0	23.2	5.7	6	...	98	82	6.5	.13	C1 S1	
	12	165	8.0	3.4	2.2	23.2	14.4	5	...	107	117	5.9	.14	C1 S1	
1956	1	168	7.9	3.6	2.1	24.1	6.4	7	...	106	94	7.5	.17	C1 S1	
	2	192	8.2	5.0	2.5	28.0	9.5	12	6	116	109	8.8	.21	C1 S1	
	4	230	7.7	2.3	2.4	22.4	6.7	10	...	99	84	5.5	.11	C1 S1	
	5	180	8.5	0.9	3.5	28.6	6.3	8	...	92	97	1.9	.04	C1 S1	
	6	143	8.7	1.2	1.7	18.8	7.2	6	6	76	77	3.1	.06	C1 S1	
	8	122	8.2	1.5	2.7	18.5	3.1	7	...	67	59	5.1	.08	C1 S1	
	9	135	7.8	1.7	2.9	19.8	4.4	7	...	70	67	4.9	.08	C1 S1	
	10	150	8.0	2.1	1.9	21.1	4.9	6	...	79	73	5.7	.10	C1 S1	
	11	198	8.1	2.7	2.7	25.8	9.8	12	4	98	105	5.2	.12	C1 S1	
	1957	1	200	8.6	4.2	1.8	27.1	10.1	8	20	73	110	7.5	.17	C1 S1
		2	200	8.7	4.2	2.5	27.1	17.3	7	4	102	140	6.0	.15	C1 S1
8		135	8.1	1.6	1.7	19.8	3.6	14	...	73	62	5.0	.08	C1 S1	
9		167	7.8	2.4	2.0	23.2	5.4	9	3	79	81	5.7	.11	C1 S1	
10		160	8.0	2.6	1.8	21.1	7.0	11	...	73	82	6.2	.12	C1 S1	
11		185	8.2	3.2	2.0	26.7	7.2	10	...	116	97	6.5	.14	C1 S1	
12		200	8.1	3.6	2.1	30.1	6.2	12	...	146	101	6.9	.15	C1 S1	
1958	1	230	7.5	3.6	2.0	39.1	14.3	5	3	159	157	3.0	.13	C1 S1	
	3	275	7.6	4.6	2.3	29.2	8.3	8	...	98	107	7.9	.19	C2 S1	
	4	175	7.4	2.3	1.8	24.1	4.4	8	...	61	79	5.3	.11	C1 S1	
	5	220	8.3	3.2	2.0	25.8	5.2	6	...	85	86	7.0	.15	C1 S1	
	6	170	8.0	2.5	1.7	19.8	5.7	8	18	61	73	6.9	.13	C1 S1	
	7	220	8.0	2.4	3.7	25.8	6.2	6	6	85	90	5.0	.11	C1 S1	
	8	180	7.9	1.8	2.1	21.5	5.7	6	6	73	78	5.2	.09	C1 S1	
	9	168	8.2	1.9	1.8	17.2	6.4	6	6	73	71	5.2	.09	C1 S1	
	10	160	8.3	3.9	2.4	18.9	8.3	8	3	82	82	9.1	.18	C1 S1	
	11	188	8.5	3.6	1.9	20.6	9.3	6	6	85	90	8.0	.16	C1 S1	
	1959	1	275	7.9	4.9	2.4	28.4	10.8	15	12	110	116	8.1	.19	C2 S1
3		240	8.2	4.2	3.2	22.4	9.3	6	6	95	95	8.4	.19	C1 S1	
4		230	8.1	3.3	2.1	22.8	6.2	4	3	83	83	7.6	.15	C1 S1	
6		175	8.2	2.2	2.8	23.2	4.4	3	2	79	76	5.5	.10	C1 S1	
7		140	8.0	1.6	3.5	15.4	4.1	1	...	70	56	5.6	.09	C1 S1	
8		150	8.6	1.8	1.8	21.5	4.6	1	...	76	73	7.0	.09	C1 S1	
11		195	8.4	3.3	1.8	24.9	7.2	4	...	98	92	6.9	.14	C1 S1	
12		210	8.6	3.7	1.9	23.2	10.6	4	...	101	102	7.1	.15	C1 S1	

Ganga (Allahabad)	1960	1	310	8.4	5.4	2.8	29.7	8.3	5	...	122	108	9.3	-22	C1 S1
	1955	10	180	8.2	7.5	3.3	24.9	6.7	7	...	128	90	14.8	-33	C1 S1
		11	250	7.6	12.9	3.9	33.1	4.1	13	6	98	100	21.2	-58	C1 S1
		12	275	8.1	13.6	3.3	37.0	11.4	16	8	181	139	17.1	-50	C2 S1
	1956	1	350	8.5	22.2	3.8	23.7	28.6	14	11	239	177	21.0	-72	C2 S1
		2	340	8.3	24.8	4.2	34.0	16.5	23	...	212	153	25.4	-87	C2 S1
		3	370	8.2	29.6	4.8	40.9	18.1	23	20	235	167	26.1	-96	C2 S1
		4	350	8.4	26.6	5.2	37.1	15.0	20	3	215	154	26.5	-93	C2 S1
		5	360	8.6	39.5	7.8	16.7	11.1	26	9	181	88	46.9	1.82	C2 S1
		6	230	8.3	7.6	3.6	25.7	8.5	10	...	134	100	13.8	-33	C1 S1
		7	178	8.0	4.6	2.8	22.8	5.9	8	...	102	81	10.6	-22	C1 S1
8		170	8.5	5.3	2.0	24.1	4.1	12	...	107	78	12.6	-26	C1 S1	
9		198	8.1	7.0	2.0	36.1	1.0	11	...	116	95	13.5	-40	C1 S1	
10		215	8.0	9.0	3.5	28.4	6.7	12	...	134	99	15.9	-39	C1 S1	
11		280	8.1	13.0	3.1	38.7	9.8	15	...	165	137	16.7	-49	C2 S1	
1957	1	380	8.4	20.2	5.0	44.3	15.7	19	20	199	176	25.7	-66	C2 S1	
	2	360	8.4	19.2	4.4	40.0	25.5	14	...	216	206	20.2	-58	C2 S1	
	3	300	8.8	24.9	4.2	23.7	17.8	14	20	112	133	28.2	-93	C2 S1	
	4	380	8.9	30.8	5.3	38.3	19.1	15	28	181	175	27.0	1.01	C2 S1	
	5	380	8.8	32.8	5.3	33.5	20.1	16	12	216	168	29.2	1.11	C2 S1	
	7	263	8.4	14.6	3.2	24.1	11.4	12	...	145	108	22.2	-59	C2 S1	
	8	186	8.1	5.8	2.8	24.5	5.4	8	...	109	84	12.6	-35	C1 S1	
	9	190	8.1	7.7	3.4	24.1	4.6	11	3	98	80	16.4	-37	C1 S1	
	Ganga (Patna)	1955	12	300	8.2	16.9	4.3	34.0	10.8	15	12	197	130	21.4	-64
1956		1	325	8.0	24.8	2.3	25.4	24.5	16	10	265	164	24.4	-97	C2 S1
		2	340	8.4	26.6	4.1	33.5	12.5	22	9	209	137	28.9	-99	C2 S1
		3	300	8.4	24.0	3.9	28.4	16.8	22	11	212	140	26.5	-92	C2 S1
		4	350	8.0	26.4	5.5	37.8	18.1	28	17	220	169	22.6	-88	C2 S1
		5	310	8.6	16.4	4.6	31.0	9.3	15	13	165	116	22.5	-66	C2 S1
		6	275	8.5	13.6	3.9	28.9	11.1	16	9	137	118	19.4	-54	C2 S1
		7	200	8.4	5.7	2.4	25.7	5.7	11	6	108	88	12.1	-26	C1 S1
		8	210	8.5	3.3	1.8	37.8	4.1	9	6	128	111	5.9	-13	C1 S1
		9	170	8.5	4.9	2.0	26.7	3.9	9	...	110	83	10.7	-23	C1 S1
		11	256	8.1	11.6	3.6	35.7	7.0	12	...	149	118	17.1	-46	C2 S1
	1958	10	132	8.1	10.2	2.7	6.9	5.7	12	3	67	41	33.3	-69	C1 S1
11		305	8.5	15.2	3.2	18.1	21.2	14	12	165	133	19.4	-65	C2 S1	
12		325	8.6	15.2	3.7	37.8	12.4	13	12	183	146	18.0	-54	C2 S1	
1959	1	490	8.5	22.4	3.6	43.0	15.0	17	27	214	170	21.8	-74	C2 S1	
	2	380	8.5	23.3	3.5	16.3	28.9	16	24	207	161	23.4	-80	C2 S1	
	3	475	8.4	22.0	4.0	23.2	26.3	14	15	214	168	21.8	-78	C2 S1	
	4	525	8.4	25.0	4.2	37.0	16.5	17	15	225	161	24.5	-85	C2 S1	
	5	430	8.5	24.5	3.1	32.7	15.2	16	12	201	145	26.5	-88	C2 S1	
	6	340	8.4	22.0	4.2	31.0	11.8	13	3	180	127	26.5	-85	C2 S1	
	7	190	8.2	7.7	3.5	24.9	4.6	7	2	116	82	16.0	-36	C1 S1	
	8	160	8.1	6.5	1.8	19.8	4.6	4	2	92	69	16.5	-35	C1 S1	
	9	210	8.2	12.7	2.7	26.3	5.4	6	2	122	82	23.1	-58	C1 S1	
	12	305	8.6	14.5	3.2	21.5	23.2	10	2	201	149	16.9	-52	C2 S1	

Name of river and (site)	Year and month of collection	Conductivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classifi- cation		
				Na	K	Ca	Mg	Cl	CO ₂	HCO ₃						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Ganga (Bhagalpur)	1960	2	500	8.4	23.4	3.5	39.6	16.0	13	5	220	165	23.1	.79	C2 S1	
		3	395	8.6	24.8	3.7	38.3	15.7	17	...	238	176	24.4	.85	C2 S1	
		4	420	8.5	22.4	4.4	36.6	13.2	15	...	232	146	24.2	.80	C2 S1	
		1958	10	232	8.6	10.2	3.0	21.5	10.8	12	12	122	99	17.7	.44	C1 S1
			11	305	8.3	13.2	3.6	20.6	19.1	14	12	177	131	17.4	.50	C2 S1
			12	320	8.4	13.2	3.9	35.7	12.6	13	12	177	142	16.3	.48	C2 S1
		1959	1	425	7.6	16.8	3.2	39.6	14.5	20	27	183	159	18.3	.57	C2 S1
			2	405	8.5	18.7	3.8	18.1	26.6	16	18	189	156	20.1	.64	C2 S1
			3	450	8.5	21.3	4.0	15.5	28.9	12	15	201	159	21.9	.73	C2 S1
			4	475	8.4	19.2	4.0	31.8	17.0	13	18	195	151	21.2	.68	C2 S1
			5	375	8.5	16.0	2.9	31.4	13.2	12	12	171	133	21.0	.63	C2 S1
			6	290	8.4	12.6	4.3	31.0	8.8	8	2	150	114	18.5	.52	C2 S1
		7	230	8.1	12.6	3.4	26.2	5.9	7	...	110	90	22.5	.57	C2 S1	
		8	165	8.1	4.7	2.2	21.5	2.6	3	2	98	65	12.9	.24	C1 S1	
		9	175	8.1	6.9	2.2	20.2	5.4	6	2	104	73	16.5	.35	C1 S1	
		12	315	8.4	12.4	3.2	18.5	24.5	10	...	198	148	15.0	.44	C2 S1	
	1960	1	405	8.4	16.1	3.2	39.1	11.9	9	...	204	147	18.8	.57	C2 S1	
		2	490	8.7	17.3	3.5	17.6	18.8	12	5	128	122	22.7	.68	C2 S1	
		3	390	8.6	20.6	4.5	38.3	11.1	14	...	214	142	23.3	.75	C2 S1	
Ganga (Farakka)		1955	8	145	7.7	5.0	2.9	21.5	5.4	7	...	89	76	11.9	.25	C1 S1
			10	182	7.7	7.3	3.5	26.7	5.7	8	...	140	90	14.6	.34	C1 S1
			11	231	8.0	9.8	3.5	30.5	9.3	11	6	153	114	15.2	.40	C1 S1
			12	263	8.0	11.9	3.6	19.4	20.4	13	10	178	133	15.9	.45	C2 S1
		1956	2	265	8.3	16.8	4.3	29.2	12.6	18	14	162	125	21.9	.66	C2 S1
			3	280	8.3	16.2	3.7	34.4	13.7	16	9	186	142	19.3	.60	C2 S1
			4	280	8.2	17.2	4.2	35.7	14.2	18	14	180	148	19.7	.62	C2 S1
			5	425	8.1	17.3	4.9	34.4	12.9	18	6	186	139	20.1	.63	C2 S1
			6	225	8.1	9.8	4.0	24.5	8.8	13	...	121	98	17.3	.44	C2 S1
			7	198	8.0	6.4	3.4	22.8	5.7	9	...	113	81	14.2	.31	C1 S1
		1957	1	280	8.6	12.3	4.1	36.1	9.8	14	12	150	131	16.4	.47	C2 S1
			2	330	8.1	15.5	4.2	37.8	12.1	20	8	187	145	18.4	.56	C2 S1
			3	285	8.7	18.2	2.9	28.0	16.5	14	20	134	139	21.9	.67	C2 S1
			4	330	8.8	18.2	3.9	37.8	18.8	14	4	203	173	18.3	.60	C2 S1
			5	295	8.5	16.4	4.6	33.1	14.7	16	...	181	144	19.3	.60	C2 S1
			6	260	8.6	14.3	4.0	31.8	13.4	13	4	161	135	18.2	.53	C2 S1
			7	182	8.1	5.5	2.5	23.6	4.4	8	...	104	77	12.9	.31	C1 S1
			8	179	8.2	5.5	2.5	23.2	4.1	7	...	104	75	13.2	.27	C1 S1
		9	179	8.4	6.0	2.8	24.9	5.3	18	3	128	84	12.9	.20	C1 S1	
		10	220	8.4	8.0	3.2	21.5	11.4	16	3	116	101	14.6	.35	C1 S1	
		11	300	8.5	10.5	3.4	34.4	8.3	11	...	171	121	15.4	.42	C2 S1	
		12	350	8.6	11.8	3.4	35.3	11.4	12	6	171	136	15.4	.44	C2 S1	

1958	1	380	8-0	13-3	3-4	37-8	11-9	13	6	183	144	16-3	-48	C2 S1	
	2	325	7-8	16-1	3-5	27-5	21-7	15	3	192	159	17-4	-55	C2 S1	
	3	420	8-0	17-8	3-7	22-4	22-7	16	6	159	151	19-9	-63	C2 S1	
	4	375	7-8	18-6	4-6	24-1	17-0	14	6	122	131	22-6	-68	C2 S1	
	5	350	8-0	13-4	3-9	22-8	17-5	14	6	159	130	17-7	-51	C2 S1	
	6	295	8-3	13-2	4-7	27-5	11-4	16	6	146	116	19-0	-52	C2 S1	
	7	262	7-8	11-9	3-3	23-2	8-3	16	...	110	92	21-3	-54	C2 S1	
	8	190	8-2	4-2	2-3	20-6	6-5	8	6	98	79	10-0	-20	C1 S1	
	9	235	8-4	5-8	3-5	25-8	8-3	10	6	110	99	10-8	-25	C1 S1	
	10	220	8-3	9-8	2-9	23-2	8-3	8	6	131	93	18-3	-44	C1 S1	
	11	212	8-4	12-0	3-2	16-3	10-3	13	6	110	84	22-8	-56	C1 S1	
	12	305	8-0	12-8	3-5	23-2	19-1	14	9	168	138	16-5	-48	C2 S1	
1959	1	380	8-2	14-8	3-1	36-1	13-9	18	18	183	148	17-3	-54	C2 S1	
	2	350	8-5	17-0	3-7	16-3	26-3	14	18	180	151	19-3	-61	C2 S1	
	3	365	8-4	16-8	4-0	24-9	20-6	14	15	189	148	19-2	-60	C2 S1	
	4	415	8-3	17-3	4-5	19-8	22-7	12	12	183	144	20-1	-62	C2 S1	
	5	440	8-8	17-3	4-7	33-5	12-1	12	18	171	134	21-1	-73	C2 S1	
	6	225	8-4	11-2	4-0	24-5	6-7	7	2	113	89	20-4	-52	C1 S1	
	7	210	8-3	8-9	4-0	22-4	7-0	6	...	107	85	17-5	-46	C1 S1	
	8	180	8-6	5-3	2-4	22-8	4-6	4	2	104	76	12-6	-23	C1 S1	
	9	195	8-6	6-1	2-6	24-9	5-7	6	3	107	85	12-7	-32	C1 S1	
	10	215	7-9	7-1	3-0	23-7	7-2	4	...	128	89	14-3	-35	C1 S1	
	11	230	8-7	10-2	2-7	29-7	7-0	9	2	140	103	17-1	-44	C1 S1	
	12	280	8-5	11-4	3-0	28-0	4-2	9	2	168	87	21-1	-52	C2 S1	
1960	1	500	8-3	12-6	4-6	37-0	10-6	10	...	180	136	16-2	-47	C2 S1	
	2	395	8-4	15-9	3-6	36-1	13-2	11	3	186	145	18-7	-57	C2 S1	
	3	380	8-7	17-1	3-8	36-5	10-1	13	...	198	133	16-6	-65	C2 S1	
	4	350	8-7	26-4	4-9	34-8	9-6	14	3	201	126	29-6	1-11	C2 S1	
(b) Gandak (Hajipur)	1955	12	226	8-1	1-9	4-5	34-0	9-6	10	3	153	124	3-1	-07	C1 S1
	1956	1	240	8-0	4-6	3-7	35-7	9-6	12	15	133	129	6-9	-18	C1 S1
		2	240	8-3	5-1	3-9	37-8	10-1	13	11	130	136	7-2	-18	C1 S1
		3	230	8-2	5-9	8-9	37-8	10-8	15	6	145	137	8-3	-22	C1 S1
		4	260	8-0	7-3	5-3	36-1	9-5	10	6	119	129	10-5	-27	C2 S1
		5	250	8-6	2-9	4-2	36-3	8-3	11	6	130	125	4-7	-11	C1 S1
		6	242	8-5	3-1	5-3	33-7	6-7	12	6	105	112	2-5	-13	C1 S1
		7	210	8-5	1-4	4-0	31-8	5-7	14	6	118	103	2-7	-06	C1 S1
	1958	10	175	8-4	3-9	3-7	18-9	8-3	6	6	95	82	8-9	-17	C1 S1
		11	225	8-2	4-0	3-5	25-6	10-8	8	6	122	110	6-9	-16	C1 S1
		12	232	8-5	4-3	3-9	29-7	16-8	10	12	128	144	6-0	-15	C1 S1
	1959	1	305	7-6	5-4	3-4	27-5	13-9	14	12	143	127	8-0	-20	C2 S1
		2	315	8-4	5-0	3-5	20-6	16-5	10	12	134	120	8-0	-20	C2 S1
		3	320	8-5	5-8	3-6	23-2	17-0	8	12	134	129	8-6	-22	C2 S1
		4	325	8-6	6-5	3-7	29-7	7-2	10	6	125	104	11-4	-27	C2 S1

Name of river and (site)	Year and month of collection	Conductivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classifi- cation		
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
(c) Kosi (Chatra)	1959	5	270	7.9	3.5	2.8	26.3	9.6	7	3	122	105	6.4	-14	C2 S1	
		6	220	8.2	3.3	4.3	28.4	7.2	3	2	107	101	6.2	-14	C1 S1	
		7	210	8.2	2.3	3.7	30.5	5.7	4	3	107	100	4.6	-10	C1 S1	
		8	205	8.2	2.3	3.3	30.5	5.7	3	2	116	100	4.6	-10	C1 S1	
		9	210	8.1	4.3	3.4	26.2	6.5	4	...	122	92	8.9	-18	C1 S1	
		1960	2	340	8.7	7.5	3.9	18.0	13.9	7	3	122	103	13.2	-32	C2 S1
			3	290	8.6	6.3	3.9	32.3	6.7	8	...	134	109	10.5	-25	C2 S1
			4	290	8.4	4.4	3.8	30.5	7.0	8	...	122	80	10.0	-21	C2 S1
		1955	9	190	7.8	2.6	2.6	14.6	1.5	7	...	61	43	10.8	-16	C1 S1
			10	80	8.0	2.2	1.6	12.0	2.3	6	...	58	40	10.2	-16	C1 S1
			11	110	7.0	4.1	2.1	15.5	8.0	7	...	40	72	10.8	-21	C1 S1
			12	121	7.6	6.0	3.7	15.1	3.6	8	...	38	53	18.5	-36	C1 S1
		1956	1	115	7.6	6.2	2.5	14.6	3.9	10	...	45	53	19.5	-37	C1 S1
			2	120	7.5	5.9	2.2	15.5	5.2	18	...	76	60	16.7	-33	C1 S1
			3	208	7.8	8.8	2.4	19.8	4.1	12	...	98	66	21.6	-46	C1 S1
			4	210	8.5	9.1	4.3	24.5	5.9	13	6	105	85	17.7	-42	C1 S1
			5	138	8.3	2.6	3.8	18.4	3.6	8	...	83	61	17.7	-14	C1 S1
			6	124	8.1	4.6	2.6	15.1	3.1	10	...	73	51	15.7	-28	C1 S1
			7	132	8.0	4.0	3.4	15.5	3.6	11	...	76	54	12.7	-23	C1 S1
			8	126	8.4	4.1	3.4	17.2	2.6	8	...	76	54	13.3	-27	C1 S1
		9	130	8.1	2.2	3.4	21.5	2.3	8	...	82	64	6.6	-12	C1 S1	
		10	114	7.3	3.9	2.8	17.2	5.2	11	...	52	45	14.8	-21	C1 S1	
		11	135	7.7	3.8	3.6	19.8	4.1	22	...	90	67	10.4	-21	C1 S1	
		12	134	8.0	3.4	3.1	15.9	4.1	13	...	69	57	10.9	-19	C1 S1	
	1957	1	135	8.1	4.2	3.5	16.3	3.4	10	...	73	55	13.2	-25	C1 S1	
(d) Brahmaputra (Dibrugarh)	1955	9	135	7.7	3.0	3.8	20.6	3.1	4	...	87	64	8.7	-21	C1 S1	
		10	137	8.1	2.4	3.0	22.4	4.1	6	...	95	73	6.4	-11	C1 S1	
			11	152	7.6	2.4	2.9	24.9	4.4	7	...	98	80	5.8	-10	C1 S1
			12	165	7.7	3.8	4.5	24.5	7.0	7	...	106	90	7.9	-17	C1 S1
		1956	3	140	7.6	3.2	4.1	23.7	3.4	8	...	93	73	8.1	-16	C1 S1
			4	190	7.8	2.1	2.4	21.1	3.4	10	...	87	67	6.2	-11	C1 S1
			5	168	8.5	1.9	5.3	26.1	3.6	8	9	86	80	4.4	-09	C1 S1
			6	182	8.1	1.0	5.7	29.8	3.4	11	...	111	89	2.0	-04	C1 S1
			7	158	8.1	1.6	4.0	21.6	6.2	13	...	95	80	4.0	-08	C1 S1
			8	125	8.5	1.5	3.0	19.8	2.3	4	...	73	59	4.9	-07	C1 S1
			9	142	7.9	1.7	3.7	23.2	3.1	8	...	82	71	4.7	-08	C1 S1
			10	148	7.8	2.1	4.5	25.8	2.6	10	...	85	71	5.6	-10	C1 S1
			11	158	7.9	2.6	4.5	24.9	3.4	8	...	85	77	6.6	-12	C1 S1
			12	179	8.0	3.2	4.4	24.5	4.9	8	...	96	82	7.4	-15	C1 S1

1957	1	182	8-2	2-8	4-1	28-0	5-4	13	6	87	93	5-9	-12	C1 S1	
	3	159	8-7	8-0	3-4	32-7	3-1	14	4	89	95	14-9	-36	C1 S1	
	4	135	8-7	2-6	2-9	21-1	6-5	4	4	65	80	6-3	-12	C1 S1	
	5	215	8-8	3-0	7-1	38-7	5-7	4	19	116	121	4-7	-11	C1 S1	
	7	150	8-1	4-0	4-7	22-8	2-1	5	...	93	66	10-8	-21	C1 S1	
	8	176	8-4	1-0	4-7	29-2	2-3	5	...	124	83	2-4	-04	C1 S1	
	10	170	8-1	2-6	3-8	27-5	2-1	14	3	92	77	6-3	-12	C1 S1	
	1958	2	250	8-0	5-8	4-1	27-1	9-0	7	3	101	105	10-2	-24	C1 S1
		3	230	8-0	3-4	3-3	25-8	5-9	7	...	101	89	7-0	-15	C1 S1
		4	175	7-5	2-6	3-6	20-6	16-0	8	6	73	118	4-0	-12	C1 S1
5		210	7-9	2-4	6-1	30-1	7-2	6	...	104	105	4-3	-09	C1 S1	
7		155	7-8	1-8	2-8	15-1	6-5	6	6	79	65	5-6	-10	C1 S1	
8		190	7-9	1-5	4-2	25-8	4-1	6	6	92	82	3-9	-06	C1 S1	
9		158	8-2	1-8	5-7	19-8	4-1	6	6	73	67	4-9	-09	C1 S1	
10		158	8-4	3-4	3-7	20-6	4-9	4	6	82	72	8-9	-17	C1 S1	
11		175	8-5	3-9	3-7	21-5	6-2	9	6	85	80	9-2	-19	C1 S1	
12		187	8-3	4-7	4-1	19-8	9-3	7	6	110	88	9-7	-21	C1 S1	
1959		1	228	8-2	4-4	3-2	19-8	9-8	12	15	98	90	9-1	-20	C1 S1
		2	280	8-5	4-6	3-3	19-0	10-8	4	12	95	93	9-4	-21	C2 S1
	3	198	8-3	3-5	3-6	21-5	5-2	6	6	88	75	8-6	-17	C1 S1	
	4	240	8-0	3-5	3-5	24-5	2-6	9	15	67	72	9-0	-17	C1 S1	
	5	175	8-4	2-6	3-4	19-5	4-9	3	...	104	69	7-1	-13	C1 S1	
	6	160	8-2	2-1	4-4	21-5	3-4	4	2	88	68	5-8	-11	C1 S1	
	7	130	8-0	2-1	3-6	19-0	2-6	2	2	82	58	6-7	-12	C1 S1	
	8	155	8-0	2-7	4-2	21-1	3-4	2	2	88	67	7-7	-15	C1 S1	
	9	165	8-0	2-7	4-9	22-0	4-1	2	...	101	72	7-1	-14	C1 S1	
	10	185	7-6	5-3	4-9	22-8	4-4	4	...	101	75	12-3	-26	C1 S1	
Brahmaputra (Gauhati)	1955	9	150	7-7	2-6	4-5	25-4	1-3	12	...	84	69	7-2	-13	C1 S1
	10	128	8-2	2-9	2-5	20-2	3-4	5	...	85	65	8-6	-16	C1 S1	
	11	152	7-6	6-1	3-2	23-7	2-8	6	...	95	71	15-0	-32	C1 S1	
1956	1	162	8-2	4-2	3-1	25-8	5-7	7	6	104	88	9-0	-19	C1 S1	
	2	166	8-1	4-6	1-1	29-2	3-9	12	7	93	89	9-6	-21	C1 S1	
	4	180	7-7	2-1	3-5	20-2	3-6	10	3	81	65	6-2	-11	C1 S1	
	6	160	8-4	1-2	3-7	23-3	4-1	6	...	134	75	3-1	-06	C1 S1	
	7	145	8-3	2-0	3-3	22-8	3-4	6	...	85	71	4-8	-11	C1 S1	
	12	188	8-1	4-2	4-0	25-8	5-4	10	...	98	87	9-1	-19	C1 S1	
1957	1	192	8-2	3-8	4-0	27-5	6-2	14	4	94	95	7-7	-16	C1 S1	
	3	135	8-6	3-6	3-1	19-4	5-4	6	4	77	71	9-4	-19	C1 S1	
	7	139	8-1	1-4	2-5	18-5	4-9	6	...	81	67	3-5	-07	C1 S1	
	9	135	8-2	2-3	3-4	19-8	2-8	7	3	67	61	7-1	-13	C1 S1	
	10	175	8-4	3-7	3-3	24-1	5-2	8	...	85	82	8-5	-17	C1 S1	
	11	180	8-8	5-3	3-0	24-1	6-7	8	3	98	88	11-1	-24	C1 S1	
	12	190	8-4	5-0	4-0	25-8	4-6	8	...	110	84	10-9	-24	C1 S1	

Name of river and (site)	Year and month of collection	Conduct- ivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classifi- cation		
				Na	K	Ca	Mg	Cl	CO ₂	HCO ₃						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	1958	1	220	8.5	4.0	3.2	24.9	5.9	10	12	61	87	4.0	-18	C1 S1	
		2	280	7.1	8.2	4.1	29.7	7.5	12	...	112	105	11.4	-35	C2 S1	
		4	200	7.5	3.0	3.3	22.4	7.2	6	6	67	86	6.8	-13	C1 S1	
		5	175	7.8	3.5	3.9	26.7	1.0	8	...	73	109	9.0	-17	C1 S1	
		6	150	7.8	2.4	3.9	19.8	3.6	8	6	61	65	6.7	-12	C1 S1	
		7	142	7.7	1.8	2.8	16.3	4.1	6	...	73	58	6.2	-08	C1 S1	
		8	171	7.9	2.5	3.7	20.6	4.1	6	6	73	68	7.0	-13	C1 S1	
		9	175	8.1	2.8	4.0	20.6	5.2	6	...	85	73	7.1	-14	C1 S1	
		10	154	8.2	3.0	2.9	18.1	5.2	6	3	88	67	8.5	-16	C1 S1	
		12	190	8.4	4.5	3.6	25.8	5.7	9	6	98	88	9.8	-21	C1 S1	
		1959	1	230	7.6	5.0	4.0	25.8	5.7	9	9	101	88	10.6	-23	C1 S1
			2	260	8.4	5.1	3.2	21.5	9.6	7	9	101	94	10.1	-23	C2 S1
		3	218	8.3	4.9	3.5	24.1	5.2	6	6	88	82	10.9	-23	C1 S1	
		4	225	8.6	4.2	4.8	24.9	4.1	5	6	110	80	9.5	-20	C1 S1	
		5	140	8.1	2.1	3.9	19.4	2.6	3	...	76	59	6.6	-11	C1 S1	
		6	170	8.3	2.1	4.3	25.4	3.6	3	2	92	78	5.1	-10	C1 S1	
		7	170	8.1	2.6	4.5	21.1	4.9	2	2	82	73	6.5	-13	C1 S1	
		8	150	8.1	2.6	3.8	22.4	3.4	2	2	82	70	6.8	-13	C1 S1	
		9	165	8.0	2.7	3.7	22.4	4.1	2	...	76	73	7.2	-14	C1 S1	
		10	135	8.1	2.3	2.3	17.6	4.1	3	...	73	61	7.2	-13	C1 S1	
		11	170	8.0	4.4	3.0	23.2	4.1	3	...	95	75	10.7	-22	C1 S1	
		12	190	8.6	4.4	2.8	25.4	4.9	3	...	104	84	9.8	-21	C1 S1	
	1960	1	275	8.5	4.9	3.2	31.8	3.4	5	...	110	94	9.7	-22	C2 S1	
		3	210	8.3	4.4	3.4	24.1	4.1	5	...	88	77	10.4	-21	C1 S1	
		4	190	8.1	3.7	5.6	21.9	0.8	3	...	79	58	10.9	-21	C1 S1	
(e) Yamuna (Agra)	1955	10	260	8.0	8.2	4.8	35.3	6.7	16	...	165	116	12.9	-33	C2 S1	
		11	360	7.5	23.5	8.5	40.4	11.9	24	...	198	150	24.1	-86	C2 S1	
	1956	4	620	8.3	62.7	6.6	36.7	19.1	76	...	219	171	43.3	2.08	C2 S1	
		5	900	8.5	109	12.8	30.4	32.8	145	9	226	211	51.5	3.26	C3 S1	
		6	450	8.4	39.2	7.5	33.5	9.8	57	6	143	124	39.0	1.53	C2 S1	
		8	250	8.3	7.6	2.3	26.7	4.1	18	...	107	84	12.6	-35	C2 S1	
		9	284	8.7	13.8	3.3	35.7	7.5	24	8	128	120	19.5	-54	C2 S1	
		10	350	7.9	27.2	4.5	40.9	7.5	22	...	177	134	29.9	1.01	C2 S1	
		11	360	8.2	19.6	3.9	43.9	5.5	19	...	192	132	23.7	-73	C2 S1	
		12	540	8.4	46.7	4.1	45.6	7.7	48	16	201	146	40.2	1.69	C2 S1	
	1957	2	550	8.1	43.5	7.8	43.4	20.6	44	...	205	189	31.6	1.37	C2 S1	
		4	550	8.8	51.1	5.3	47.2	24.0	60	24	159	218	33.1	1.52	C2 S1	
1958	9	400	8.5	20.6	5.0	22.4	21.7	24	6	134	146	22.7	-74	C2 S1		
	10	330	8.6	25.6	6.9	17.2	25.8	30	18	162	151	25.8	-91	C2 S1		
	12	605	8.2	51.1	6.4	41.3	23.2	58	18	226	200	34.9	1.55	C2 S1		

1959	2	485	8.5	98.2	3.3	21.5	16.5	54	36	256	123	62.7	3.88	C2 S1
	3	430	8.5	19.6	4.2	12.0	31.0	20	18	171	159	20.6	.67	C2 S1
	4	1,100	7.9	86.9	8.0	12.0	49.0	107	18	214	235	43.4	2.47	C3 S1
	5	1,130	8.5	87.6	8.4	44.7	27.1	107	6	256	225	44.7	2.54	C3 S1
	6	1,100	8.3	115	10.4	38.3	33.3	149	3	220	234	50.2	3.26	C3 S1
	7	700	8.5	63.3	10.4	35.3	18.6	73	3	192	166	43.5	2.14	C2 S1
	8	295	8.3	7.5	3.5	44.3	6.7	7	6	153	139	10.3	.28	C2 S1
	10	315	8.3	13.9	4.4	37.8	8.8	10	3	162	131	18.6	.52	C2 S1
	11	390	8.8	22.4	5.6	23.7	23.5	24	2	162	157	22.7	.77	C2 S1
	12	1,485	8.9	140	9.5	84.3	50.8	314	11	223	422	41.2	2.95	C3 S1
1960	1	1,355	8.6	117	7.4	61.5	34.8	172	...	210	299	45.2	2.95	C3 S1
	3	1,160	8.6	102	9.0	28.4	32.5	148	3	122	206	50.4	3.09	C3 S1
	4	1,350	8.6	129	9.6	54.2	34.1	171	3	232	277	49.7	3.37	C3 S1

Chemical Analysis of River Water Samples (Group II)

(a) Chambal (Kota)	1955	8	172	7.8	12.2	4.5	20.2	3.9	14	...	93	66	26.9	.85	C1 S1
		9	228	8.0	11.6	2.6	31.8	6.2	6	...	174	105	18.9	.49	C1 S1
		11	430	8.1	49.1	2.8	28.4	23.2	33	12	268	167	38.9	1.65	C2 S1
		12	475	8.3	57.5	4.2	22.8	24.8	40	15	282	159	43.2	1.98	C2 S1
	1956	3	480	8.5	76.7	3.9	14.2	26.6	44	17	276	145	52.7	2.75	C2 S1
		4	520	8.1	81.1	4.3	17.6	28.9	48	31	278	163	51.2	2.75	C2 S1
		5	800	8.7	79.8	5.2	15.9	28.9	48	37	273	159	51.3	2.75	C3 S1
		6	600	8.8	82.7	5.2	10.2	29.2	49	25	267	145	54.3	2.97	C2 S1
		10	295	8.2	22.8	2.4	33.9	8.3	17	...	177	118	28.9	0.91	C2 S1
		11	390	8.1	35.6	3.5	30.5	16.3	29	...	220	144	34.3	1.29	C2 S1
		12	440	8.3	40.7	4.7	28.8	19.6	40	16	216	154	35.8	1.44	C2 S1
	1957	2	500	8.6	48.3	4.5	23.8	22.7	36	24	230	167	38.0	1.69	C2 S1
		3	450	8.9	57.9	3.2	14.2	26.6	38	28	193	146	45.8	2.08	C2 S1
		4	460	9.0	61.1	3.2	14.6	26.4	38	22	216	147	47.1	2.19	C2 S1
		5	510	9.0	66.7	3.8	20.6	28.1	41	32	211	169	45.7	2.25	C2 S1
		6	550	8.4	75.9	4.8	23.2	27.6	47	...	313	173	48.2	2.50	C2 S1
		7	170	8.2	13.2	1.1	16.8	3.9	12	...	100	58	32.6	.76	C1 S1
		9	190	8.2	9.9	2.1	24.9	3.1	20	...	116	75	21.7	.49	C1 S1
		10	340	8.5	26.4	2.7	24.1	14.2	25	6	171	120	31.8	1.05	C2 S1
		11	450	8.6	33.0	4.0	32.7	12.2	28	9	189	133	34.1	1.25	C2 S1
		12	450	8.4	33.6	3.9	21.5	13.9	24	6	207	112	38.5	.97	C2 S1
	1958	2	450	8.7	41.5	4.1	25.8	16.3	26	7	165	132	39.8	1.57	C2 S1
		3	490	8.0	35.6	3.6	28.4	11.4	26	6	159	118	38.7	1.43	C2 S1
		4	490	7.4	39.1	5.9	25.8	13.4	32	...	171	120	28.3	1.55	C2 S1
		5	525	8.3	39.9	4.1	25.8	20.4	30	18	177	149	36.1	1.41	C2 S1
		6	425	8.1	39.9	3.9	24.1	16.5	30	6	195	129	39.5	1.53	C2 S1
		7	520	8.3	39.5	5.9	28.4	18.8	32	6	207	148	35.6	1.41	C2 S1
		8	240	8.2	9.1	1.8	24.1	7.2	12	6	104	90	17.4	.42	C2 S1
		9	280	8.5	9.8	2.6	19.8	16.0	10	6	159	116	15.0	.40	C2 S1
		10	370	8.6	36.8	3.2	19.8	17.0	26	15	183	120	39.1	1.46	C2 S1
		12	420	8.6	44.3	3.7	18.1	21.7	30	24	201	136	40.8	1.66	C2 S1

Name of river and (site)	Year and month of collection	Conductivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classifi- cation		
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
(b) Narmada (Mortakka)	1959	1	585	8.3	51.5	3.2	26.7	20.9	38	36	207	154	39.6	1.82	C2 S1	
		2	605	8.7	59.6	3.9	12.9	34.3	38	36	247	174	41.8	1.96	C2 S1	
		3	660	8.6	64.3	4.1	6.0	34.6	36	24	256	159	45.9	2.22	C2 S1	
		4	700	8.6	69.4	4.3	8.6	24.8	36	30	244	125	53.7	2.69	C2 S1	
		5	805	8.7	73.6	6.0	18.1	26.1	42	18	281	154	49.8	2.58	C3 S1	
		7	475	8.4	50.7	4.0	21.1	17.3	26	3	210	125	45.9	1.98	C2 S1	
		8	195	8.2	9.2	1.9	24.9	4.9	5	3	113	83	19.0	.44	C1 S1	
		9	230	8.2	10.6	1.9	26.2	6.7	10	2	131	94	19.4	.47	C1 S1	
		10	380	8.4	26.2	2.8	31.8	12.9	20	2	207	133	29.4	.99	C2 S1	
		12	390	8.7	36.2	2.9	22.4	20.4	25	2	217	140	35.2	1.33	C2 S1	
		1960	1	690	8.8	74.8	2.8	25.8	18.6	62	6	159	141	52.7	2.75	C2 S1
			2	495	8.6	38.7	3.4	31.4	15.7	24	5	204	143	36.1	1.40	C2 S1
			3	420	8.7	39.7	4.0	31.8	11.9	28	...	223	128	39.2	1.53	C2 S1
			4	420	8.8	41.1	3.4	16.8	15.5	30	3	198	106	44.6	1.73	C2 S1
		1955	8	130	7.8	4.2	1.7	18.9	4.6	17	...	88	66	11.6	.22	C1 S1
			9	122	8.1	3.6	1.5	18.1	4.6	5	...	92	64	10.7	.20	C1 S1
			10	185	8.3	7.4	1.6	21.1	7.7	8	...	153	85	12.5	.35	C1 S1
		1956	1	340	8.1	23.0	1.7	33.5	20.6	16	4	274	169	22.7	.78	C2 S1
			2	340	8.3	29.2	2.0	29.8	21.7	18	11	255	164	26.3	.99	C2 S1
			9	158	7.8	5.4	1.8	24.1	4.6	13	...	110	80	12.5	.29	C1 S1
			10	175	7.9	6.0	1.8	24.5	6.7	8	...	116	89	11.3	.29	C1 S1
			11	192	7.6	7.3	2.0	25.8	6.2	13	...	131	90	14.6	.34	C1 S1
			12	340	8.1	19.0	2.9	31.8	18.8	12	...	226	167	20.3	.64	C2 S1
		1957	1	350	8.5	22.2	2.4	33.5	19.6	15	20	214	165	22.4	.75	C2 S1
			2	350	8.4	21.4	2.4	31.8	17.6	16	10	209	153	23.0	.75	C2 S1
			3	300	8.6	26.8	1.1	14.6	22.7	13	6	197	131	30.9	1.0	C2 S1
			4	360	8.5	26.9	1.1	27.5	26.8	14	10	244	181	24.5	.87	C2 S1
			5	350	8.6	28.0	1.2	23.7	25.5	14	26	193	165	26.9	.95	C2 S1
			6	380	8.7	34.2	1.2	22.4	27.6	15	26	224	171	30.3	1.13	C2 S1
			7	153	7.9	7.6	1.4	19.4	4.1	6	...	99	66	19.7	.35	C1 S1
			8	154	7.9	4.3	0.4	19.8	5.2	8	...	104	71	11.6	.23	C1 S1
			10	280	8.5	12.0	1.5	12.0	24.8	12	12	147	133	16.1	.45	C1 S1
			11	400	8.4	21.8	2.0	24.1	17.0	16	6	232	131	26.2	.82	C2 S1
			12	480	8.6	21.6	1.8	23.4	20.6	18	12	220	144	24.2	.78	C2 S1
		1958	1	450	8.5	26.2	1.8	18.1	20.1	14	6	256	128	30.1	1.01	C2 S1
			2	425	8.4	28.7	2.1	29.7	22.9	24	4	250	170	26.7	.96	C2 S1
			3	445	8.3	29.5	1.6	24.5	28.1	15	12	229	179	26.2	.96	C2 S1
			4	520	7.6	29.0	2.5	23.2	38.7	16	15	214	220	22.1	.85	C2 S1
			5	525	8.0	32.4	2.5	23.2	26.6	18	18	207	169	29.1	1.08	C2 S1

	6	460	8-4	28-4	2-7	19-4	28-1	20	12	292	166	33-1	-96	C2 S1	
	7	225	7-8	5-0	1-6	31-8	6-7	10	6	134	108	8-8	-21	C1 S1	
	8	202	8-2	5-8	1-5	23-2	6-2	8	6	92	84	12-7	-27	C1 S1	
	9	230	8-5	5-6	1-6	27-5	9-2	12	6	122	108	9-9	-24	C1 S1	
	10	210	8-6	8-4	1-4	24-1	8-3	12	12	116	95	15-7	-36	C1 S1	
	11	320	8-5	16-0	2-3	31-0	16-5	12	24	183	146	18-8	-57	C2 S1	
	12	360	8-7	23-2	2-1	15-5	27-9	16	18	219	155	24-3	-81	C2 S1	
1959	1	450	8-4	26-4	2-0	28-4	22-2	16	24	183	164	25-7	-90	C2 S1	
	2	380	8-7	24-1	2-4	24-9	26-8	12	27	223	174	22-8	-80	C2 S1	
	3	495	8-1	28-3	2-2	23-2	25-3	14	18	232	164	27-0	-96	C2 S1	
	4	530	8-6	30-9	2-5	20-6	27-1	12	15	262	165	28-6	1-05	C2 S1	
	5	400	8-7	35-5	2-4	18-5	28-1	12	12	281	164	31-7	1-21	C2 S1	
	6	475	8-3	40-9	3-7	20-2	28-9	12	2	311	171	33-6	1-37	C2 S1	
	7	180	8-3	4-2	2-0	24-1	4-6	5	2	104	80	10-1	-20	C1 S1	
	9	270	8-3	10-3	1-4	34-4	10-8	6	3	177	131	14-5	-39	C2 S1	
	10	270	7-9	10-3	1-3	29-2	11-4	7	2	171	121	15-6	-41	C2 S1	
	11	310	8-7	21-7	2-0	34-0	16-8	12	3	210	154	22-9	-75	C2 S1	
	12	305	8-8	22-9	1-8	26-7	19-6	11	6	201	147	24-7	-81	C2 S1	
1960	1	435	8-6	22-0	1-7	24-5	19-4	11	...	226	141	25-0	-80	C2 S1	
	2	500	8-4	26-9	1-9	30-5	22-2	11	...	268	168	25-5	-91	C2 S1	
	3	410	8-8	32-0	2-7	29-2	23-0	11	...	277	168	28-8	1-07	C2 S1	
	4	440	8-2	36-2	2-1	28-8	19-9	12	6	262	154	33-2	1-26	C2 S1	
Narmada (Gardeshwar)	1955	9	212	8-2	7-4	2-2	32-3	6-7	8	...	154	109	5-4	-31	C1 S1
		10	205	7-8	9-0	1-6	30-1	6-2	14	...	162	101	16-0	-38	C1 S1
		11	292	8-2	16-9	1-4	33-5	14-4	12	9	214	143	20-3	-61	C2 S1
		12	325	8-0	25-2	2-2	29-2	23-2	12	8	215	169	24-3	-84	C2 S1
	1956	1	350	8-2	26-8	2-1	20-2	20-2	18	14	242	133	30-1	1-00	C2 S1
		2	320	8-3	30-6	2-2	23-2	24-8	26	14	235	160	29-0	1-04	C2 S1
		4	360	8-1	38-0	2-3	20-6	25-0	30	20	249	155	34-5	1-33	C2 S1
		5	550	8-3	37-5	3-4	18-9	27-3	26	6	284	160	33-3	1-30	C2 S1
		6	310	8-7	24-0	3-4	26-9	13-7	20	9	184	124	28-9	-94	C2 S1
		7	261	8-0	10-8	2-2	31-8	9-3	14	...	172	118	16-3	-43	C2 S1
		8	198	8-6	6-8	1-7	28-4	6-7	10	3	134	94	12-8	-29	C1 S1
		10	300	8-1	15-2	2-1	37-8	11-9	12	...	210	143	18-5	-55	C2 S1
1957	3	320	9-0	30-0	1-6	21-9	21-7	14	16	187	145	30-9	-90	C2 S1	
	4	360	8-7	32-0	2-0	24-1	25-5	20	8	248	166	29-4	1-08	C2 S1	
	5	360	8-7	35-2	1-7	18-5	27-3	19	12	236	160	25-5	1-21	C2 S1	
	6	310	8-2	11-6	1-1	38-3	11-6	11	...	217	144	14-8	-41	C2 S1	
	7	184	8-3	4-0	-9	26-2	4-5	14	...	110	84	9-3	-18	C1 S1	
	8	300	8-6	16-2	1-2	26-7	17-0	21	...	153	138	20-2	-59	C2 S1	
	9	320	8-2	20-8	1-7	22-4	19-9	18	3	208	139	24-2	-76	C2 S1	
	10	320	8-0	20-4	1-7	20-6	21-2	18	...	207	140	23-6	-75	C2 S1	

Name of river and (site)	Year and month of collection	Conductivity micro- mhos/cm	pH	Parts per million of								Hardness No.	Na %age	SAR	Classifi- cation	
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
(c) Tapti (Kakrapar)	1958	10	213	8.6	13.8	1.6	11.2	12.6	12	9	128	81	26.7	.67	C1 S1	
		11	350	8.8	22.0	2.0	24.9	20.1	17	24	189	146	24.2	.80	C2 S1	
		12	350	8.5	22.0	2.2	16.3	26.8	14	18	207	153	23.4	.79	C2 S1	
		1	420	8.4	24.8	1.1	24.1	21.2	14	36	180	148	26.5	.88	C2 S1	
		2	425	8.7	29.9	2.1	13.8	28.4	14	30	214	153	29.5	1.05	C2 S1	
		3	490	8.7	32.0	2.5	20.6	26.3	16	18	247	161	29.8	1.09	C2 S1	
		4	575	8.5	40.9	3.0	23.2	25.0	15	24	262	162	34.8	1.09	C2 S1	
		5	515	8.6	41.4	2.2	21.1	24.5	18	12	275	155	36.4	1.16	C2 S1	
		6	430	8.6	41.1	3.5	23.7	21.2	18	6	238	147	37.1	1.48	C2 S1	
		7	170	8.2	3.5	1.7	21.5	4.4	4	..	101	72	9.3	.17	C1 S1	
		8	230	8.6	9.1	1.2	30.1	7.2	7	3	137	105	15.7	.38	C1 S1	
		9	310	8.4	13.3	1.4	37.0	12.6	9	3	207	145	16.5	.48	C2 S1	
		10	305	8.6	14.4	1.5	31.8	12.4	9	6	177	131	19.2	.55	C2 S1	
		11	305	8.8	21.5	1.8	30.5	17.0	12	2	220	146	26.8	.91	C2 S1	
		1960	1	460	8.7	27.6	1.7	21.1	19.6	18	..	229	134	30.6	1.04	C2 S1
			2	515	8.5	34.1	2.2	24.1	23.2	16	5	238	156	31.6	1.18	C2 S1
			3	505	8.8	36.7	2.2	27.5	24.3	19	..	281	169	31.5	1.22	C2 S1
		1955	10	325	7.6	18.7	1.7	42.1	7.8	18	..	262	137	22.3	.75	C2 S1
			11	375	7.5	34.8	1.8	36.1	17.5	30	..	275	162	31.5	1.18	C2 S1
			12	450	8.1	50.3	3.0	24.5	21.4	41	22	254	149	41.7	1.79	C2 S1
		1956	1	480	8.3	59.9	3.1	15.1	32.8	49	21	279	173	42.5	1.96	C2 S1
			2	540	8.2	65.9	3.4	22.8	27.8	60	11	317	171	45.1	2.19	C2 S1
			3	540	8.3	81.5	3.1	23.2	28.6	58	6	308	176	49.7	2.66	C2 S1
			4	600	8.1	94.3	3.9	24.9	29.7	74	20	270	185	52.0	3.01	C2 S1
			5	975	8.3	96.3	4.0	24.9	29.4	86	9	368	183	52.7	3.08	C3 S1
			6	450	8.7	51.1	3.4	31.4	15.2	63	16	197	141	43.4	1.86	C2 S1
			7	205	8.3	10.5	1.7	22.0	6.2	15	..	118	81	21.8	.51	C2 S1
			8	285	8.5	14.2	1.8	29.8	12.9	18	6	168	128	19.3	.54	C2 S1
			9	294	8.3	22.6	2.5	30.9	10.3	18	..	186	120	28.2	.90	C2 S1
			10	200	8.3	22.8	2.4	31.4	9.6	20	..	180	118	29.1	.91	C2 S1
			11	420	8.4	42.7	2.4	30.1	16.7	35	..	234	144	38.7	1.55	C2 S1
			12	320	8.2	35.2	2.4	19.8	11.9	25	..	171	98	43.0	1.54	C2 S1
		1957	1	500	8.7	57.9	3.7	24.1	24.4	51	32	203	149	47.5	1.98	C2 S1
			2	580	8.6	73.5	4.7	19.4	29.2	56	28	252	170	47.8	2.46	C2 S1
			3	720	8.4	107	3.6	20.2	30.4	104	..	313	177	56.3	3.49	C2 S1
			4	640	8.9	90.3	3.8	24.1	28.9	.69	32	268	181	51.0	2.93	C2 S1
			5	700	8.9	99.1	5.3	26.2	32.8	76	32	179	202	51.1	3.01	C2 S1
			6	740	8.7	106	4.6	25.8	34.1	83	8	262	207	52.3	3.20	C2 S1
			7	380	8.3	32.8	2.2	28.8	14.2	32	..	217	131	34.8	1.25	C2 S1

	8	300	8-6	18-2	1-9	36-6	10-1	21	9	171	134	22-5	68	C2 S1	
	9	300	8-5	32-4	2-8	24-5	7-2	32	6	134	91	42-7	1-47	C2 S1	
	10	510	8-6	55-9	3-7	21-5	15-5	40	6	238	118	49-6	2-25	C2 S1	
	11	600	8-6	59-9	3-3	16-3	18-6	42	12	256	118	51-5	2-40	C2 S1	
	12	710	8-7	81-1	3-7	14-6	22-7	50	6	293	152	56-4	3-12	C2 S1	
1958	1	800	8-5	75-9	3-7	28-4	28-6	66	9	298	190	45-9	2-41	C3 S1	
	2	850	8-0	77-5	4-0	18-5	33-5	74	12	317	186	46-9	2-47	C3 S1	
	3	900	8-3	84-7	4-1	13-8	25-3	80	15	244	140	56-1	3-14	C3 S1	
	4	1,075	7-7	106	5-9	12-0	31-5	100	18	299	161	67-5	3-63	C3 S1	
	5	1,060	8-1	105	5-7	30-5	24-5	98	18	268	178	63-7	3-43	C3 S1	
	6	1,100	7-9	112	5-7	24-1	28-4	101	30	298	179	56-8	3-66	C3 S1	
	7	290	8-1	22-4	2-2	19-4	9-0	14	6	109	86	35-4	1-04	C2 S1	
	8	330	8-3	24-0	3-3	23-2	10-8	20	6	140	103	32-7	1-02	C2 S1	
	9	232	7-9	10-5	1-6	19-8	9-8	12	6	98	90	20-0	-48	C1 S1	
	10	340	8-7	36-4	2-2	12-9	16-0	28	18	159	99	43-8	1-59	C2 S1	
	11	450	8-7	45-9	2-9	19-8	21-7	33	30	195	140	40-9	1-71	C2 S1	
	12	375	8-6	38-8	2-8	18-9	18-1	26	18	189	123	40-0	1-51	C2 S1	
1959	1	660	8-4	63-9	2-8	24-9	25-0	47	36	238	167	45-0	2-17	C2 S1	
	2	690	8-7	68-9	3-5	9-5	36-6	52	24	293	176	45-4	2-25	C2 S1	
	3	740	8-7	78-3	4-3	6-0	38-7	60	36	275	176	48-4	2-57	C2 S1	
	4	900	8-7	98-4	4-2	16-8	33-0	72	36	305	180	53-6	3-12	C3 S1	
	5	1,005	8-7	108	3-9	18-9	25-6	74	33	329	167	57-6	3-82	C3 S1	
	6	785	8-6	97	5-2	28-0	25-3	77	6	348	175	53-7	3-19	C3 S1	
	7	210	8-2	10-5	2-3	20-6	7-7	7	2	122	84	20-6	-50	C1 S1	
	8	211	8-2	13-1	1-8	21-5	7-5	9	3	116	85	24-5	-62	C1 S1	
	9	350	8-4	15-0	1-8	42-1	13-7	9	5	214	162	16-5	-51	C2 S1	
	10	460	8-4	30-9	2-4	37-8	18-6	20	...	275	172	27-7	1-03	C2 S1	
	11	420	8-7	43-2	2-3	30-5	19-9	30	3	247	158	36-8	1-50	C2 S1	
	12	550	8-7	61-9	2-8	19-4	30-2	43	3	290	173	43-0	2-05	C2 S1	
1960	1	770	8-7	68-9	3-1	29-2	23-7	50	...	305	171	46-1	2-29	C3 S1	
	2	720	8-8	72-4	3-1	29-2	23-5	50	6	275	170	47-4	2-40	C2 S1	
	3	690	8-9	81-8	3-4	11-6	25-8	62	6	250	135	55-8	3-06	C2 S1	
	4	790	9-0	88-8	3-6	22-4	19-4	67	8	268	136	57-7	3-29	C3 S1	
Tapti (Bhusawal)	1955	9	300	8-3	15-9	1-6	40-4	11-4	11	...	220	148	18-7	-57	C2 S1
		10	195	8-2	14-5	2-3	23-7	6-7	12	...	168	88	26-0	-67	C1 S1
		11	430	8-3	27-7	1-2	41-3	20-6	22	21	232	188	24-1	-87	C2 S1
		12	410	8-0	30-4	1-7	24-1	18-8	27	6	261	138	32-2	1-13	C2 S1
1956	1	325	8-1	31-2	1-1	22-4	18-6	25	8	183	133	33-7	1-18	C2 S1	
	2	580		89-9	3-5	19-8	32-8	64	14	336	185	50-9	2-09	C2 S1	
	3	590	8-5	99-9	3-4	16-3	29-1	76	23	310	161	56-9	3-41	C2 S1	
	4	650	8-2	112	3-9	19-8	31-2	76	37	325	178	57-2	3-63	C2 S1	
	5	1,125	8-3	125	4-9	17-2	32-8	98	37	363	178	59-4	4-05	C3 S1	
	6	325	8-6	35-6	4-0	23-3	10-1	26	16	153	100	42-5	1-55	C2 S1	

Name of river and (site)	Year and month of collection	Conduct- ivity micro- mos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classif- ication	
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
(d) Godavri (Nanded)	1955	8	287	7.9	19.9	2.6	32.3	8.5	12	...	191	116	26.7	.81	C2 S1
		9	225	8.1	17.6	1.8	26.0	6.6	8	...	153	92	28.8	-.80	C1 S1
		10	360	7.9	39.2	2.5	32.7	11.1	25	...	232	128	39.5	1.53	C2 S1
		11	500	8.3	59.1	2.6	34.8	14.7	24	18	278	148	46.0	2.06	C2 S1
		12	550	8.2	75.9	4.3	29.2	23.2	44	10	279	169	48.7	2.55	C2 S1
	1956	1	610	8.1	94.3	4.9	26.7	24.3	51	11	282	167	54.3	3.21	C2 S1
		2	690	8.5	104	5.1	28.4	25.5	70	29	244	176	55.3	3.42	C2 S1
		3	780	8.0	117	6.0	30.1	21.9	78	6	302	165	59.6	3.98	C2 S1
		4	920	8.1	148	7.2	31.8	32.0	96	11	307	211	59.4	4.41	C3 S1
		5	850	8.6	120	6.8	27.3	24.7	80	6	261	169	59.5	4.01	C3 S1
		6	550	8.6	73.5	5.3	26.9	14.9	45	9	200	129	54.1	2.93	C3 S1
		7	250	8.5	15.5	1.7	24.9	9.0	16	6	130	100	24.8	-.67	C2 S1
		8	320	8.7	24.8	2.4	33.9	10.3	21	9	163	127	29.3	-.96	C2 S1
		9	340	8.3	32.8	2.4	31.8	10.3	24	...	186	122	36.3	1.31	C2 S1
		10	320	7.9	24.8	2.3	37.4	8.8	18	...	192	129	28.9	-.94	C2 S1
		11	450	8.1	46.7	4.0	33.1	13.4	30	...	223	137	41.7	1.96	C2 S1
		12	570	8.7	67.9	4.2	31.0	20.4	48	30	119	163	53.4	2.32	C2 S1
	1957	1	700	8.6	90.7	4.8	30.5	24.3	68	22	230	178	55.0	2.96	C2 S1
		2	750	8.7	110	4.2	19.4	28.9	76	28	187	169	58.1	3.69	C2 S1
		3	850	8.8	125	5.4	30.5	34.6	85	28	226	221	54.7	3.68	C3 S1
		4	940	8.8	140	6.8	31.8	34.3	102	30	224	223	57.1	4.11	C3 S1
		5	...	8.7	172	8.1	33.1	34.3	116	30	211	226	61.5	5.00	C3 S1
		6	910	8.5	140	7.6	37.8	30.7	116	16	234	222	56.9	4.08	C3 S1
		7	273	8.3	17.9	1.4	27.5	8.0	17	...	154	102	27.3	-.77	C1 S1
		8	265	8.3	22.8	1.4	24.9	7.5	14	...	149	94	34.3	1.02	C2 S1
		9	380	8.1	39.9	2.7	21.5	15.0	28	6	153	117	42.0	1.61	C2 S1
		10	400	8.6	42.3	2.9	14.6	18.6	30	9	153	114	43.9	1.73	C2 S1
		11	800	8.3	87.1	4.2	30.1	24.3	50	9	183	176	51.0	2.87	C3 S1
		12	880	8.5	98.3	4.7	21.5	23.7	54	9	293	152	57.4	3.47	C3 S1
	1958	1	1,000	8.6	118	5.0	15.5	29.4	68	6	268	161	60.1	4.04	C3 S1
		2	1,150	8.3	114	5.3	31.4	27.9	79	18	213	194	55.2	3.56	C3 S1
		3	1,400	8.2	129	6.0	18.1	38.2	100	18	195	204	57.0	3.89	C3 S1
		4	1,650	8.3	160	8.2	35.3	33.0	112	18	231	226	59.6	4.64	C3 S1
		5	1,800	8.5	203	8.5	31.8	42.3	138	18	225	256	62.2	5.52	C3 S2
		6	1,700	8.3	264	5.5	27.1	48.3	174	12	293	254	68.8	7.00	C3 S2
		7	270	8.2	17.6	1.6	21.1	8.0	1	6	134	86	30.3	-.82	C2 S1
		8	325	8.2	18.0	1.5	28.4	10.3	14	6	146	114	25.2	-.73	C2 S1
		9	270	8.6	16.6	4.5	26.7	6.2	10	6	134	93	26.9	-.75	C2 S1
		10	450	8.5	55.9	3.1	19.8	15.0	34	9	186	112	51.2	2.29	C2 S1
		11	610	8.7	75.9	5.4	27.5	20.6	46	24	226	155	50.5	2.66	C2 S1
		12	585	8.6	71.9	3.9	12.9	28.4	40	30	195	151	53.6	2.56	C2 S1

(e) Krishna
(Karikal)

1959	1	910	7-8	99-9	5-3	30-1	25-3	63	24	262	181	59-8	3-24	C3 S1	
	2	1,090	8-6	117	5-3	19-8	27-4	78	48	342	164	59-2	4-00	C3 S1	
	3	1,350	8-7	150	7-2	20-6	39-2	90	18	286	215	59-2	4-46	C3 S1	
	4	1,560	8-6	176	7-7	15-9	47-0	92	30	268	236	61-0	5-00	C3 S1	
	5	1,755	8-8	203	9-0	20-6	40-5	128	21	290	221	66-1	5-94	C3 S2	
	6	470	8-7	52-6	3-7	27-5	9-3	29	3	177	108	50-3	12-21	C2 S1	
	7	315	8-2	28-3	3-2	27-1	7-2	16	2	146	98	37-5	1-25	C2 S1	
	8	260	8-6	20-1	1-3	23-2	7-2	11	3	134	88	32-7	.92	C2 S1	
	9	350	8-6	26-2	2-1	14-6	20-4	14	3	180	122	31-5	1-03	C2 S1	
	10	465	8-2	43-9	3-0	29-7	17-8	23	3	226	148	37-5	.77	C2 S1	
	11	505	8-8	66-6	3-2	28-4	18-8	33	6	220	148	48-3	2-35	C2 S1	
	12	600	8-9	73-6	3-7	30-5	22-2	38	6	250	168	48-0	2-46	C2 S1	
1960	1	985	8-7	104	4-5	26-2	24-5	58	2	259	117	56-6	3-47	C3 S1	
	2	1,150	8-7	127	5-3	28-1	29-7	67	6	275	193	57-8	3-97	C3 S1	
	3	980	8-9	131	5-5	30-5	27-6	71	6	250	190	58-9	4-12	C3 S1	
	4	1,400	8-8	187	8-0	35-7	34-3	106	8	281	230	62-6	5-35	C3 S1	
1955	8	195	7-8	10-2	1-5	25-8	5-2	15	..	115	86	20-1	.48	C1 S1	
	10	198	7-9	8-2	1-3	32-3	5-4	14	..	153	103	14-5	.35	C1 S1	
	11	350	8-3	36-0	2-3	30-1	11-4	40	6	174	122	38-5	1-40	C2 S1	
	12	500	8-1	57-5	2-9	34-4	17-0	70	8	195	156	43-9	2-00	C2 S1	
1956	3	610	7-8	82-7	4-1	30-4	24-2	103	6	186	176	49-9	2-70	C2 S1	
	4	880	7-8	142	5-3	19-8	32-8	149	11	203	185	61-8	4-53	C3 S1	
	5	1,525	8-2	156	6-4	23-7	30-7	198	11	215	186	63-7	4-98	C3 S1	
	6	540	8-5	73-5	4-0	25-5	9-0	80	6	121	100	60-3	3-16	C2 S1	
	7	310	8-5	24-6	2-6	23-7	9-5	35	6	141	99	34-4	1-08	C2 S1	
	8	265	8-1	28-9	1-6	23-7	4-1	21	..	114	78	44-3	1-44	C2 S1	
	9	288	8-5	28-0	1-1	29-7	4-9	28	..	125	92	39-4	1-25	C2 S1	
	10	350	7-7	47-8	2-0	23-2	5-2	40	..	134	79	56-0	2-33	C2 S1	
	11	540	7-9	63-1	2-0	41-3	12-1	70	..	192	152	47-1	2-22	C2 S1	
	12	480	8-4	49-9	4-9	34-0	12-6	55	12	161	138	43-9	1-85	C2 S1	
	1957	2	850	8-6	102	3-9	35-7	25-5	125	18	181	196	52-6	3-18	C3 S1
		3	1,020	8-2	148	4-3	33-5	32-0	152	8	207	217	59-0	4-37	C3 S1
4		1,150	8-5	171	4-7	30-1	43-1	187	18	187	255	59-0	4-64	C3 S1	
5		1,320	8-6	192	5-9	30-1	50-3	193	34	138	285	59-1	4-94	C3 S1	
6		830	8-3	124	1-4	31-4	13-4	123	..	153	134	66-5	4-68	C3 S1	
7		380	7-8	51-1	1-4	29-7	7-7	37	..	151	106	50-8	2-15	C2 S1	
8		200	7-9	15-6	1-0	21-5	17-0	30	3	147	125	21-3	.61	C1 S1	
9		300	8-0	22-2	1-5	16-3	16-8	25	3	148	111	30-2	.91	C2 S1	
10		380	8-0	36-3	1-5	17-6	16-8	43	3	122	114	40-5	1-47	C2 S1	
12		380	8-5	33-0	2-7	27-5	7-7	30	..	146	72	40-7	1-43	C2 S1	
1958		1	630	8-5	57-5	2-1	52-5	5-2	60	..	189	152	44-5	2-03	C2 S1
		2	1,075	7-3	87-9	4-5	34-4	27-4	120	..	189	200	48-2	2-71	C3 S1
	4	1,100	7-3	108	4-9	28-8	33-0	134	6	159	209	52-1	3-25	C3 S1	
	5	750	7-5	67-9	3-7	30-9	15-7	76	6	141	143	50-0	2-47	C2 S1	

(37)

Name of river and (site)	Year and month of collection	Conductivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classifi- cation		
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Krishna (N. J. S. Dam)	1958	6	575	8.3	57.9	2.8	12.9	19.6	46	6	183	114	51.8	2.37	C2 S1	
		7	270	8.1	10.1	1.6	28.4	9.3	14	6	134	110	16.5	.42	C2 S1	
		8	203	7.7	9.7	1.2	19.8	4.1	16	...	98	67	23.6	.52	C1 S1	
		9	174	8.4	7.5	1.3	17.2	5.2	16	6	92	65	22.9	.41	C1 S1	
		10	300	8.0	25.6	1.3	21.5	9.3	30	6	119	92	37.2	1.15	C2 S1	
		11	405	8.5	44.7	2.2	20.6	13.4	53	12	110	108	46.7	1.88	C2 S1	
		12	710	8.5	85.9	2.8	25.8	24.3	116	15	146	166	52.5	2.91	C2 S1	
		1959	1	920	8.0	89.9	2.8	28.4	27.9	114	18	171	187	50.6	2.85	C3 S1
			2	1,070	8.3	95.8	3.7	23.2	30.4	121	36	226	185	52.4	3.08	C3 S1
			3	1,260	8.6	132	4.4	17.2	28.4	144	36	250	161	63.3	4.55	C3 S1
			4	1,410	8.4	159	5.0	21.5	39.2	144	15	189	217	60.8	4.70	C3 S1
			5	2,000	8.6	197	7.3	40.4	50.3	254	9	214	311	57.2	4.86	C3 S2
			6	480	8.1	61.7	3.0	22.4	4.6	46	2	128	75	63.2	3.09	C2 S1
			7	390	8.5	31.8	3.1	33.5	9.0	20	2	168	122	35.6	1.25	C2 S1
			9	135	8.0	6.7	0.7	15.1	3.6	9	...	70	53	21.3	.41	C1 S1
			11	425	8.6	40.9	2.1	29.2	13.9	46	6	98	130	49.3	1.88	C2 S1
			12	325	8.8	39.3	1.8	25.8	5.2	25	...	137	86	49.1	1.83	C2 S1
		1960	1	840	8.4	77.1	2.6	34.4	20.6	83	...	186	171	48.8	2.55	C3 S1
			3	1,125	8.7	152	4.2	24.1	31.7	130	...	192	191	62.5	4.78	C3 S1
			4	1,090	8.6	125	4.3	22.4	27.6	138	2	107	170	60.6	4.17	C3 S1
		1955	8	230	8.1	18.3	1.6	27.9	4.9	15	...	140	90	30.8	.94	C1 S1
			9	300	8.4	38.8	2.0	26.7	4.6	6	6	165	86	48.9	1.83	C2 S1
		1956	5	540	8.6	77.9	3.1	19.9	14.4	69	16	168	109	60.1	3.25	C2 S1
			6	420	8.6	57.9	3.1	22.0	8.5	44	9	140	90	57.3	2.65	C2 S1
			7	160	8.5	5.8	0.7	18.8	14.4	11	6	76	106	10.5	.24	C1 S1
			8	234	8.4	18.4	...	27.5	4.6	19	...	122	88	31.2	.85	C1 S1
			9	300	8.2	23.8	1.4	36.1	6.2	26	...	168	116	30.6	.96	C2 S1
			10	350	8.2	36.7	1.4	33.5	6.7	32	...	171	112	41.3	1.52	C2 S1
			11	410	8.2	51.9	1.4	30.1	9.3	42	...	180	114	49.5	2.13	C2 S1
			12	540	8.5	67.1	3.5	32.3	14.2	59	12	179	140	51.0	1.95	C2 S1
		1957	1	720	8.5	95.9	4.0	27.5	20.9	91	14	191	156	58.1	3.36	C2 S1
			3	680	8.9	97.1	3.0	25.8	21.9	91	28	150	156	57.1	3.40	C2 S1
			4	600	9.0	87.9	2.6	23.2	20.6	83	18	150	144	56.7	3.21	C2 S1
			5	700	8.3	102	2.9	24.1	22.2	101	...	195	151	58.8	3.57	C2 S1
			6	610	8.1	99.9	2.5	25.8	9.6	82	...	183	105	67.0	4.25	C2 S1
			7	298	8.4	26.0	1.4	31.8	8.3	20	...	166	114	33.1	1.06	C2 S1
			9	246	8.1	16.6	1.2	20.6	20.8	21	3	183	97	26.9	.61	C1 S1
			10	480	8.5	58.3	2.1	10.3	21.2	50	3	98	114	52.0	2.38	C2 S1

1958	3	800	7-7	89-5	3-5	23-7	39-0	114	9	116	222	46-3	2-61	C3 S1	
	4	800	8-1	71-9	3-3	25-8	15-2	82	6	134	128	54-3	2-76	C3 S1	
	5	1,300	8-4	124	4-6	28-6	23-6	161	6	153	170	60-3	4-14	C3 S1	
	6	675	8-4	81-5	3-2	17-2	16-5	72	6	159	110	60-4	2-36	C2 S1	
	7	350	8-2	19-6	1-6	30-1	10-3	22	6	146	118	26-1	-79	C2 S1	
	8	280	8-1	24-4	1-3	28-4	5-9	18	6	122	96	35-3	1-11	C2 S1	
	9	270	8-4	15-2	2-0	23-2	8-8	16	6	122	95	25-4	-67	C2 S1	
	10	350	8-5	47-9	2-0	13-8	9-3	34	9	128	73	57-9	2-43	C2 S1	
	11	500	8-7	67-5	2-6	17-2	14-5	51	18	140	103	57-9	2-90	C2 S1	
	12	650	8-6	88-3	3-7	14-6	24-8	80	18	183	140	57-1	3-25	C2 S1	
	1959	1	775	8-2	83-9	3-4	23-6	21-7	79	18	183	148	54-5	2-82	C3 S1
		2	580	8-6	52-6	3-2	22-4	15-5	54	36	134	120	48-0	2-10	C2 S1
3		615	8-5	57-3	2-7	13-8	19-1	60	12	146	114	51-6	2-35	C2 S1	
4		545	8-4	48-8	2-6	22-4	13-2	44	12	153	111	48-2	2-01	C2 S1	
5		500	8-7	80-6	3-0	21-9	12-9	50	3	162	109	60-8	3-36	C2 S1	
7		225	8-3	15-7	2-0	19-7	6-7	15	2	101	77	30-0	-78	C1 S1	
9		210	7-9	14-6	1-4	19-7	4-6	14	..	107	69	31-4	-76	C1 S1	
12		490	8-9	64-3	3-1	22-8	14-5	44	3	190	117	53-5	2-59	C2 S1	
1960		2	620	8-4	62-6	2-3	21-5	12-6	52	..	149	106	55-5	2-64	C2 S1
		3	450	8-3	50-3	1-8	21-5	9-1	42	..	134	91	53-8	2-29	C2 S1
	4	515	8-6	60-3	3-1	19-8	9-0	47	2	107	86	53-8	2-26	C2 S1	
(f) Cauvery (Bhawani)	1955	11	190	7-9	8-1	2-1	17-2	6-5	15	..	131	70	19-7	-42	C1 S1
	12	185	7-8	18-6	2-1	17-2	18-1	16	..	132	118	25-2	-75	C1 S1	
1956	1	212	8-1	21-4	1-8	18-9	12-9	14	7	153	100	31-2	-92	C1 S1	
	4	260	7-9	25-6	2-1	21-5	12-9	22	..	186	107	33-7	1-07	C2 S1	
	5	290	8-7	28-4	3-6	19-2	14-7	25	9	172	108	35-3	1-18	C2 S1	
	7	262	8-0	19-4	2-1	21-2	10-8	18	..	162	98	29-6	-85	C2 S1	
	8	100	8-1	5-2	2-7	12-0	1-8	12	..	58	37	21-7	-37	C1 S1	
	10	168	8-0	15-0	3-4	14-6	5-2	17	..	104	58	34-5	-85	C1 S1	
1957	1	278	8-7	25-6	3-0	21-5	11-1	27	16	126	100	35-0	1-11	C2 S1	
	2	280	8-2	26-0	2-7	21-1	12-4	21	..	163	104	35-1	1-10	C2 S1	
	3	288	8-8	30-0	3-3	21-1	12-4	21	6	159	104	37-7	1-27	C2 S1	
	4	290	8-8	28-8	3-3	22-8	13-4	19	10	163	113	35-0	1-17	C2 S1	
	5	280	8-8	30-0	1-8	20-6	13-7	20	12	163	109	37-2	1-24	C2 S1	
	6	245	8-4	25-4	1-8	19-4	10-1	20	..	159	91	37-4	1-16	C1 S1	
	7	166	8-0	12-7	2-3	12-9	6-2	15	..	101	58	31-4	-72	C1 S1	
	8	155	8-1	12-7	2-3	12-0	6-7	16	..	84	58	31-3	-72	C1 S1	
	9	150	8-2	11-8	1-4	14-2	3-9	14	3	73	52	32-4	-71	C1 S1	
	10	195	8-1	16-0	1-7	14-6	6-7	20	3	104	65	34-4	-87	C1 S1	
	12	265	8-5	25-2	2-7	20-6	9-3	22	9	134	90	36-9	1-15	C2 S1	
	1958	1	280	7-9	24-1	1-6	25-8	9-8	22	..	171	105	32-7	1-01	C2 S1
2		360	7-7	25-6	1-9	23-2	11-3	8	3	153	105	34-2	1-08	C2 S1	
3		375	7-5	25-2	1-8	21-1	13-9	9	6	134	111	32-1	1-04	C2 S1	

Name of river and (site)	Year and month of collection	Conduct- ivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	Classifi- cation	
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	1958	4	390	7.4	27.6	2.2	22.4	18.5	20	6	146	125	32.1	.87	C2 S1
		5	325	7.9	30.0	2.4	18.1	12.9	20	6	153	99	39.0	1.30	C2 S1
		6	350	8.3	30.0	2.3	14.6	14.5	22	6	134	97	39.5	1.31	C2 S1
		7	280	8.1	20.6	2.1	12.9	11.9	18	6	116	82	34.8	.99	C2 S1
		8	160	7.8	6.8	1.4	14.6	4.6	12	6	73	56	20.1	.40	C1 S1
		9	175	8.4	15.6	1.5	17.2	5.2	12	3	101	65	38.3	.85	C1 S1
		10	200	8.7	16.2	1.6	12.9	8.3	14	9	101	67	33.8	.85	C1 S1
		11	198	9.2	17.8	1.9	12.9	8.8	16	24	67	69	35.0	.92	C1 S1
		12	292	8.0	22.4	2.3	14.6	11.9	19	12	128	86	35.3	1.04	C2 S1
	1959	1	350	8.2	26.0	1.8	18.9	11.9	16	24	140	97	36.3	1.14	C2 S1
		2	395	8.6	31.6	1.7	20.6	17.0	20	18	183	123	35.5	1.24	C2 S1
		3	425	8.6	33.9	3.2	22.8	13.4	18	6	201	113	38.6	1.38	C2 S1
		4	460	8.6	33.9	2.4	20.2	16.5	19	18	183	119	37.5	1.32	C2 S1
		5	420	8.6	34.6	2.2	21.1	15.7	20	15	198	118	38.3	1.38	C2 S1

STATEMENT II

Showing maximum and minimum values for individual characteristics (Group I)

Name of river and (site)	Year of collection	Conduct- ivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR		
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃					
1	2	3	4	5	6	7	8	9	10	11	12	13	14		
(a) Ganga (Hardwar)	1956	min	122	7.7	0.9	1.7	18.5	3.1	6	...	67	59	1.9	.04	
		max	230	8.7	5.0	3.5	28.6	9.8	12	6	116	109	8.8	.21	
	1957	min	135	7.8	1.6	1.7	19.8	3.6	7	...	73	62	5.0	.08	
		max	200	8.7	4.2	2.5	30.1	17.3	14	20	146	140	7.5	.17	
	1958	min	160	7.3	1.8	1.7	17.2	4.4	5	...	61	71	3.0	.09	
		max	275	8.5	3.9	3.7	39.1	14.3	8	18	159	157	9.1	.19	
	1959	min	140	7.9	1.6	1.8	15.4	4.1	1	...	70	56	5.5	.09	
		max	275	8.6	4.9	3.5	28.4	10.8	15	12	110	116	8.4	.19	
	Ganga (Allahabad)	1956	min	170	8.0	4.6	2.0	16.7	1.0	8	...	102	81	10.6	.22
			max	370	8.6	39.5	5.2	40.9	28.6	23	20	239	177	46.9	1.82
	1957	min	190	8.1	5.8	2.8	23.7	4.6	8	...	98	80	12.6	.35	
		max	380	8.9	32.8	5.3	44.3	25.5	19	28	216	206	29.2	1.11	
Ganga (Patna)	1956	min	170	8.0	3.3	1.8	25.4	3.9	9	...	108	83	5.9	.13	
		max	350	8.6	26.4	5.5	37.8	24.5	28	17	265	169	28.9	.99	
1959	min	160	8.1	6.5	1.8	16.3	4.6	4	...	92	69	16.0	.35		
	max	525	8.6	25.0	4.2	43.0	28.9	17	27	225	170	26.5	.85		
Ganga (Bhagalpur)	1959	min	165	7.6	4.7	2.2	15.5	2.6	3	...	98	65	12.9	.24	
		max	475	8.5	21.3	4.3	39.6	28.9	20	27	201	159	22.5	.73	
Ganga (Farakka)	1956	min	158	7.8	4.9	2.3	22.4	4.6	9	...	98	75	8.5	.15	
		max	425	8.4	17.3	4.9	35.7	14.2	18	14	186	148	21.9	.66	
	1957	min	179	8.1	5.5	2.5	23.2	4.1	7	...	104	75	12.9	.27	
		max	350	8.7	18.2	4.6	37.8	18.8	20	20	203	173	21.9	.67	
	1958	min	190	7.8	4.2	2.3	16.3	6.5	8	...	98	79	10.0	.20	
		max	420	8.4	18.6	4.6	37.8	22.7	16	9	192	159	22.8	.68	
	1959	min	195	8.2	5.3	2.4	16.3	4.2	4	...	104	76	12.6	.23	
		max	440	8.7	17.3	4.7	36.1	26.3	18	18	189	151	21.1	.73	
	(b) Gandak (Hajipur)	1956	min	210	8.0	1.4	3.7	31.8	5.7	10	...	105	103	2.5	.06
			max	260	8.6	7.3	8.9	37.8	10.8	15	15	145	137	10.5	.27

Name of river and (site)	Year of collection	Conduct- ivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	
				Na	K	Ca	Mg	Cl	CO ₂	HCO ₃				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
(c) Kosi (Chatra)	1959	min	210	7.6	2.3	2.8	20.6	5.7	3	...	107	92	4.6	.10
		max	325	8.6	6.5	4.3	30.5	17.0	14	12	143	129	11.4	.27
	1956	min	114	7.3	2.2	2.2	14.6	2.3	8	...	45	45	6.6	.12
		max	210	8.5	9.1	4.3	24.5	5.9	22	6	105	85	21.6	.46
(d) Brahmaputra (Dibrugarh)	1956	min	140	7.6	1.0	2.4	19.8	2.3	8	...	73	59	2.0	.04
		max	190	8.5	3.2	5.7	29.8	6.2	13	9	111	89	8.1	.16
	1957	min	135	8.1	1.0	2.9	21.1	2.1	4	...	65	66	2.4	.04
		max	215	8.8	8.0	7.1	38.7	6.5	14	19	124	121	14.9	.36
Brahmaputra (Gauhati)	1958	min	158	7.5	1.5	2.8	15.1	4.1	6	...	73	65	3.9	.06
		max	250	8.5	5.8	6.1	30.1	16.0	9	6	104	118	10.2	.24
	1959	min	130	7.6	2.1	3.2	19.0	2.6	2	...	67	58	5.8	.11
		max	280	8.5	5.3	4.9	24.5	10.8	12	15	101	93	12.3	.26
(e) Yamuna (Agra)	1957	min	135	8.1	1.4	2.5	19.4	2.8	6	...	67	61	3.5	.07
		max	192	8.8	5.3	4.0	27.5	6.7	14	4	110	95	10.1	.24
	1958	min	142	7.1	1.8	2.8	16.3	1.0	6	...	61	58	4.0	.08
		max	280	8.5	8.2	4.1	29.7	7.5	12	12	112	109	11.4	.35
(e) Yamuna (Agra)	1959	min	135	8.0	2.1	2.3	17.6	2.6	2	...	73	61	5.1	.10
		max	260	8.6	5.1	4.8	25.4	9.6	9	9	110	94	10.9	.23
	1956	min	250	7.9	7.6	2.3	26.7	4.1	18	...	107	84	12.6	.35
		max	900	8.5	109	12.8	45.6	32.8	145	16	226	211	51.1	3.26
1959	min	295	7.9	7.5	3.3	12.0	6.7	7	...	162	123	10.3	.28	
	max	1,485	8.9	140	10.4	84.3	50.8	314	36	256	422	62.7	3.88	
<i>Group II</i>														
(a) Chambal (Kota)	1956	min	295	8.1	22.8	2.4	10.2	8.3	17	...	177	118	28.9	.91
		max	800	8.8	82.7	5.2	33.9	29.2	49	37	278	163	54.3	2.75
	1957	min	170	8.2	9.9	1.1	14.2	3.1	12	...	100	58	21.7	.49
		max	550	9.0	75.9	4.8	24.9	28.1	47	32	313	173	48.2	2.50
	1958	min	240	7.4	9.1	1.8	18.1	7.2	10	...	104	90	15.0	.40
		max	525	8.6	44.3	5.9	28.4	21.7	32	24	207	149	40.8	1.66

(b) Narmada (Mortakka)	1959	min	195	8.2	9.2	1.9	6.0	4.9	5	2	113	83	19.0	-44
		max	805	8.7	73.6	6.0	31.8	34.6	42	36	281	174	53.7	2.69
	1956	min	158	7.6	5.4	1.8	24.1	4.6	8	...	110	80	11.3	-.29
		max	340	8.3	29.2	2.9	33.5	21.7	18	11	274	169	26.3	-.99
	1957	min	153	7.9	4.3	0.4	12.0	4.1	6	...	99	66	11.6	-.23
		max	480	8.7	34.2	2.4	33.5	26.8	18	26	244	181	30.9	1.13
Narmada (Gardeshwar)	1958	min	202	7.6	5.0	1.5	18.1	6.7	8	4	92	84	8.8	-.21
		max	525	8.7	32.4	2.7	31.0	38.7	20	24	292	220	33.1	1.08
	1959	min	180	7.9	4.2	1.3	18.5	4.6	5	2	104	80	10.1	-.20
		max	530	8.8	40.9	3.7	34.4	28.9	16	27	311	174	33.6	1.37
	1956	min	198	8.1	6.8	1.7	18.9	6.7	10	...	134	94	12.8	-.29
		max	550	8.7	38.0	3.4	37.8	27.3	30	20	284	160	34.5	1.33
(c) Tapti (Kakrapar)	1957	min	184	8.0	4.0	.9	18.5	4.5	11	...	110	84	9.3	-.18
		max	360	9.0	35.2	2.0	38.3	27.3	20	16	248	166	30.9	1.21
	1959	min	170	8.2	3.5	1.1	13.8	4.4	4	...	101	72	9.3	-.17
		max	575	8.8	41.4	3.5	37.0	28.4	18	36	275	162	37.1	1.48
	1956	min	200	8.1	10.5	1.7	15.1	6.2	15	...	118	81	19.3	-.51
		max	975	8.7	96.3	4.0	31.4	32.8	74	21	368	183	52.7	3.08
Tapti (Bhusawal)	1957	min	300	8.3	18.2	1.9	14.6	7.2	21	...	134	91	22.5	-.68
		max	740	8.9	107	5.3	36.6	34.1	104	32	313	207	56.4	3.49
	1958	min	232	7.7	10.5	1.6	12.0	9.0	12	6	98	86	20.0	-.48
		max	1,100	8.7	112	5.7	30.5	33.5	101	30	299	190	67.5	3.66
	1959	min	210	8.2	10.5	1.8	6.0	7.5	7	...	116	84	16.5	-.51
		max	1,005	8.7	108	5.2	42.1	38.7	77	36	348	180	53.7	3.82
(d) Godavri (Nanded)	1956	min	325	8.1	31.2	1.1	16.3	10.1	26	8	153	100	33.7	1.18
		max	1,125	8.6	125	4.9	23.3	32.8	76	37	363	185	57.2	4.05
	1956	min	250	7.9	155	1.7	24.9	8.8	16	...	130	100	28.9	-.67
		max	920	8.7	148	7.2	37.4	32.0	96	30	307	211	59.6	4.41
	1957	min	265	8.1	17.9	1.4	14.6	7.5	14	...	149	94	27.3	-.77
		max	940	8.8	140	8.1	37.8	34.6	116	30	293	226	61.5	5.00
(d) Godavri (Nanded)	1958	min	270	8.2	16.6	1.5	12.9	6.2	1	6	146	86	26.9	-.73
		max	1,800	8.7	264	8.5	35.3	48.3	174	30	268	256	68.8	7.00
	1959	min	260	7.8	20.1	1.3	14.6	7.2	11	2	134	88	31.5	-.77
		max	1,755	8.9	208	9.0	30.5	47.0	128	48	342	236	66.1	5.94

Name of river and (site)	Year of collection	Conduct- ivity micro- mhos/cm	pH	Parts per million of							Hard- ness No.	Na %age	SAR	
				Na	K	Ca	Mg	Cl	CO ₃	HCO ₃				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
(e) Krishna (Karikal)	1956	min	265	7.7	24.6	1.1	19.8	4.1	21	...	114	78	34.4	1.08
		max	1,525	8.5	156	6.4	41.3	32.8	198	12	215	186	63.7	4.98
	1957	min	200	7.8	15.6	1.0	16.3	7.7	25	...	122	72	21.3	.61
		max	1,320	8.6	192	5.9	35.7	50.3	193	34	207	285	66.5	4.94
1958	min	174	7.3	7.5	1.2	12.9	4.1	14	...	92	65	16.5	.41	
	max	1,100	8.5	108	4.9	30.9	33.0	134	15	189	209	52.5	3.25	
1959	min	135	8.0	6.7	0.7	15.1	4.6	9	...	70	53	21.3	.41	
	max	2,000	8.8	197	7.3	40.4	50.3	254	36	250	217	63.3	4.86	
Krishna (N. J. S. D.)	1956	min	160	8.2	5.8	0.7	18.8	6.2	11	...	76	88	10.5	.24
		max	540	8.6	77.9	3.5	36.1	14.4	69	16	180	140	60.1	3.25
	1957	min	246	8.1	16.6	1.2	10.3	8.3	20	...	98	97	26.9	.61
		max	720	9.0	102	4.0	31.8	22.2	101	28	191	156	67.0	4.25
1958	min	280	7.7	15.2	1.3	17.2	5.9	16	6	116	73	26.1	.67	
	max	1,300	8.7	124	4.6	30.1	23.6	161	18	183	222	60.4	4.14	
1959	min	210	7.9	14.6	1.4	13.8	4.6	14	...	101	77	30.0	.76	
	max	775	8.7	83.9	3.4	23.6	21.7	79	36	190	148	60.8	3.36	
(f) Cauvery (Bhawani)	1956	min	100	7.9	5.2	1.8	12.0	1.8	12	...	58	37	21.7	.37
		max	290	8.7	28.4	3.4	21.5	14.7	25	9	136	108	35.3	1.18
	1957	min	150	8.0	11.8	1.4	12.0	3.9	15	...	73	52	31.3	.71
		max	290	8.8	30.0	3.3	22.8	13.7	27	16	163	113	37.7	1.27
1958	min	160	7.4	6.8	1.4	12.9	4.6	8	...	73	56	20.1	.40	
	max	390	9.2	30.0	2.4	25.8	18.8	22	24	171	125	39.5	1.31	

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STATEMENT III
Chemical Analysis of some U. S. rivers

Name of river 1	Period of collection 2	Conductivity in micro-mhos/cm 3	pH 4	Parts per million of								Hardness No. 12
				Na 5	K 6	Ca 7	Mg 8	Cl 9	HCO ₃ 10	SO ₄ 11		
Ohio river (South Heights P. A.)	1945											
	Oct.	1-10	219	6.2	10	2.6	20	5.6	8.8	10	70	73
	Nov.	1-10	309	4.8	17	3.2	28	7.6	14	10	106	101
	Dec.	1-10	226	6.2	9.7	2.8	21	6.0	6.3	5	82	77
	1946											
	Jan.	1-10	253	5.8	13	0.8	24	6.8	8.0	7	92	88
	Feb.	1-10	385	4.4	20	1.9	31	10	13	0	144	126
	Mar.	1-10	217	4.9	9.5	1.6	19	5.6	9.1	6	74	70
	Apr.	1-10	289	5.0	13	1.7	25	7.6	17	5	105	94
	May	1-10	402	4.4	23	2.5	35	11	5.9	0	163	147
	Jun.	1-10	208	5.9	8.6	0.8	20	5.3	15	6	76	72
	Jul.	1-10	288	6.0	15	1.7	25	7.3	25	7	98	92
	Aug.	1-10	501	4.2	32	...	44	12	...	0	192	171
Sep.	1-10	602	4.2	39	3.4	49	13	34	0	207	186	
Beaver river (New Brighton P. A.)	1945											
	Oct.	1-10	272	6.8	9.8	3.2	30	7.2	14	40	69	104
	Nov.	1-10	328	6.9	13	3.4	36	7.9	18	43	82	122
	Dec.	1-10	326	7.0	11	3.1	35	8.6	17	43	82	123
	1946											
	Jan.	1-10	244	6.7	7.6	2.7	27	6.4	11	35	66	94
	Feb.	1-10	366	6.9	18	3.7	38	9.9	21	59	85	136
	Mar.	1-10	220	6.8	6.8	2.2	24	6.1	8.8	30	57	85
	Apr.	1-10	388	6.9	16	4.0	41	9.1	22	38	108	140
	May	1-10	510	6.7	22	4.5	56	12	31	41	150	189
	Jun.	1-10	288	7.2	11	3.0	34	7.7	12	52	73	116
	Jul.	1-10	388	6.6	17	4.4	43	8.7	19	52	105	143
	Aug.	1-10	421	6.6	18	5.9	47	9.6	22	46	119	157
Sep.	1-10	454	6.6	18	6.1	51	10	24	44	136	168	
White river (New Port Ark)	1945											
	Oct.	1-10	243	8.3	2.8	1.8	36	15	8.0	145	7.0	146
	Nov.	1-10	300	8.3	2.5	1.7	40	18	6.5	193	4.9	174
	Dec.	1-10	312	7.9	9.6	2.7	36	15	5.0	200	4.2	152

Name of river and (site)	Period of collection	Conductivity micro- mhos/cm	pH	Parts per million of							Hardness No.	
				Na	K	Ca	Mg	Cl	HCO ₃	SO ₄		
1	2	3	4	5	6	7	8	9	10	11	12	
	1946											
	Jan.	1-10	298	...	5.2	1.8	35	14	3.8	177	5.4	145
	Feb.	1-10	252	8.2	4.2	1.5	33	12	3.0	151	4.9	132
	Mar.	1-10	213	8.0	3.5	1.8	26	11	2.8	132	4.7	110
	Apr.	1-10	276	8.3	7.8	1.5	32	13	3.5	170	4.2	133
	May	1-10	224	7.8	5.2	1.6	27	9.7	2.2	134	5.9	107
	Jun.	1-10	210	8.1	2.2	1.7	27	10	2.2	131	3.4	108
	Jul.	1-10	302	8.0	6.0	1.8	36	16	4.0	195	4.0	156
	Aug.	1-10	267	8.0	3.9	2.0	34	16	3.8	184	3.5	151
	Sep.	1-10	292	8.0	4.0	2.1	33	19	3.2	197	4.0	160
	1945											
	Oct.	1-10	449	...	36		38	7	66	105	21	124
	Nov.	1-10	966	...	121		58	13	207	149	43	198
	Dec.	1-10	1320	...	170		67	16	305	154	45	233
	1946											
	Jan.	1-10	1160	...	160		59	8.8	277	126	36	184
	Feb.	1-5	938	...	118		54	13	215	120	44	188
	Mar.	1-10	666	...	77		38	9.1	129	98	34	132
	Apr.	1-10	748	...	70		54	11	146	114	30	180
	May	1-10	421	...	55		27	5.7	90	75	20	91
	Jun.	1-10	406	...	47		31	5.2	73	90	22	99
	Jul.	1, 8-10	1150	...	162		55	11	268	133	44	182
	Aug.	1-3, 8-10	923	...	129		47	12	212	129	39	166
	Sep.	1-5	1220	...	156		70	15	272	168	51	236

STATEMENT IV
Chemical Analysis of some Indian rivers given by Kobayashi (12)

Name of river and (site)	Residue on evaporation ppm.	pH	Parts per million of						
			Na	K	Ca	Mg	Cl	HCO ₃	SO ₄
Brahmaputra (Pandu)	91.3	7.1	2.8	3.29	21.5	3.2	0.1	81.1	...
„ (Panchratra)	100	7.2	3.6	2.76	25.3	3.8	0.6	90.7	...
Ganga (Raiwala)	106	7.2	3.2	1.70	24.0	5.5	0	88.9	...
Ganga (Allahabad)	169.5	7.5	27.1	2.86	39.5	5.4	16.0	211.8	...
Yamuna	209.7	7.1	15.3	4.66	42.8	10.7	6.3	195.4	11
Chambal	...	7.5	33.4	...	34.1	...	20.7	223.8	...
Ganga (Monghyr)	...	7.4	17.6	...	43.7	...	7.2	198.7	...
Kosi	67	7.0	2.4	2.17	14.0	...	0.1	52.9	...
Mahanadi	...	7.0	5.7	1.57	13.8	...	0.8	74.6	...
Godavari	...	7.3	27.4	2.04	24.2	...	8.9	168.2	...
Aganda Cauvery	224.6	7.4	25.6	2.17	21.4	12.2	13.6	153.9	...
Tapi	314.8	7.5	44.6	3.00	36.5	8.7	30.0	280.6	4.0
Narmada	184.7	7.5	18.1	1.93	30.8	8.6	5.2	196.6	2.4
Sabarmati	408.3	7.3	66.9	3.79	44.1	20.3	55.3	312.7	8.4

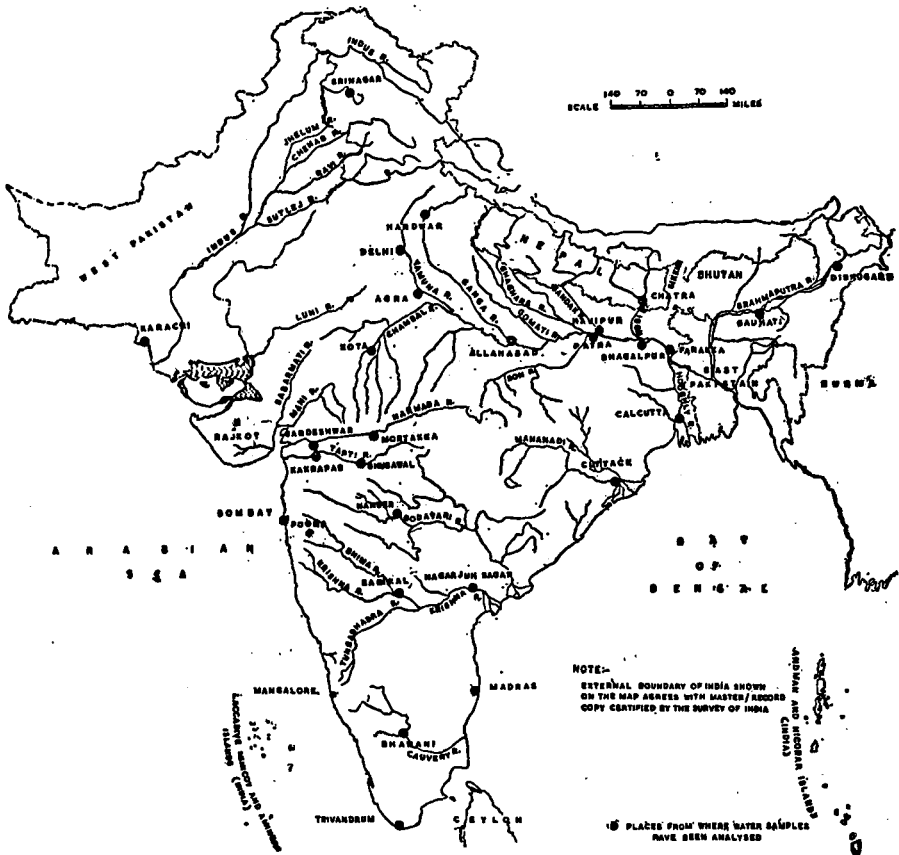


Fig. 1 : Map of India showing the names of rivers and places from where water samples have been analysed

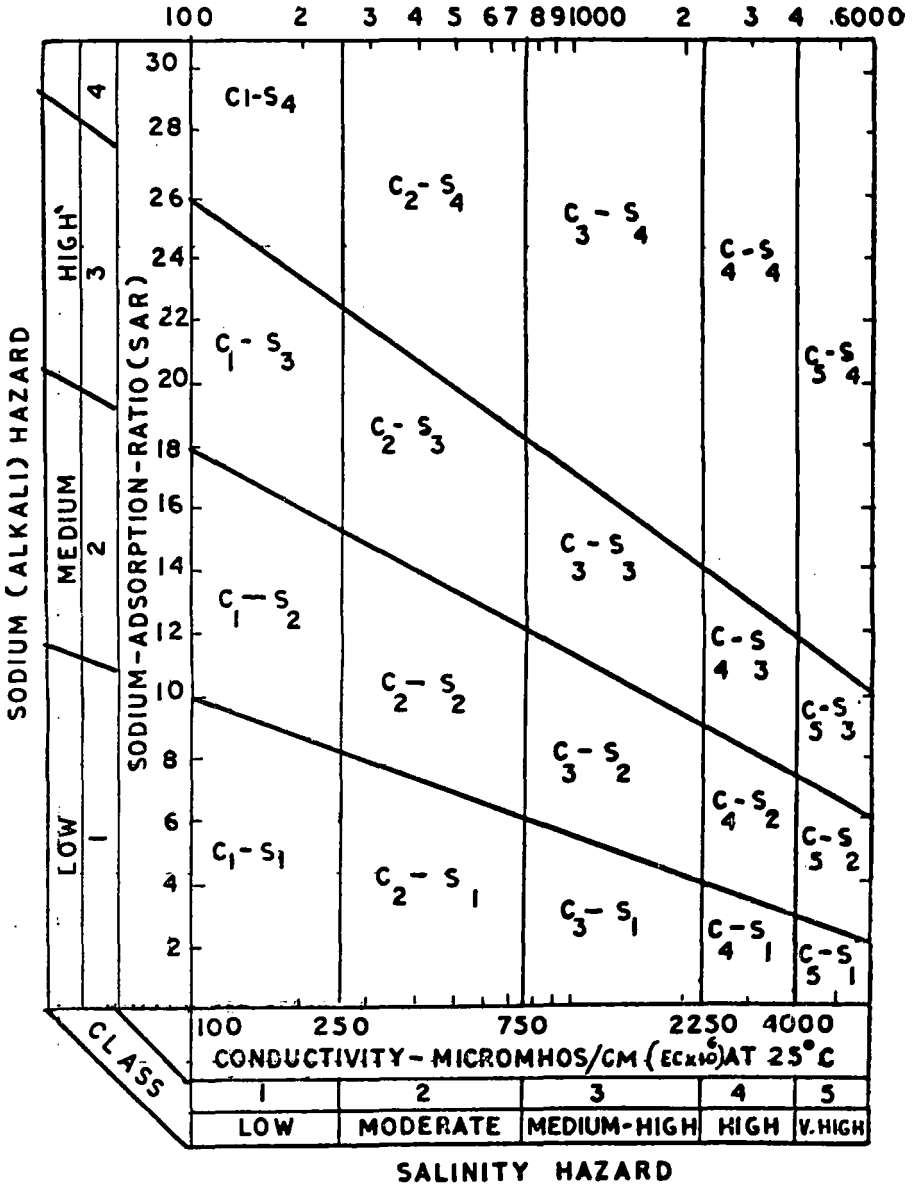
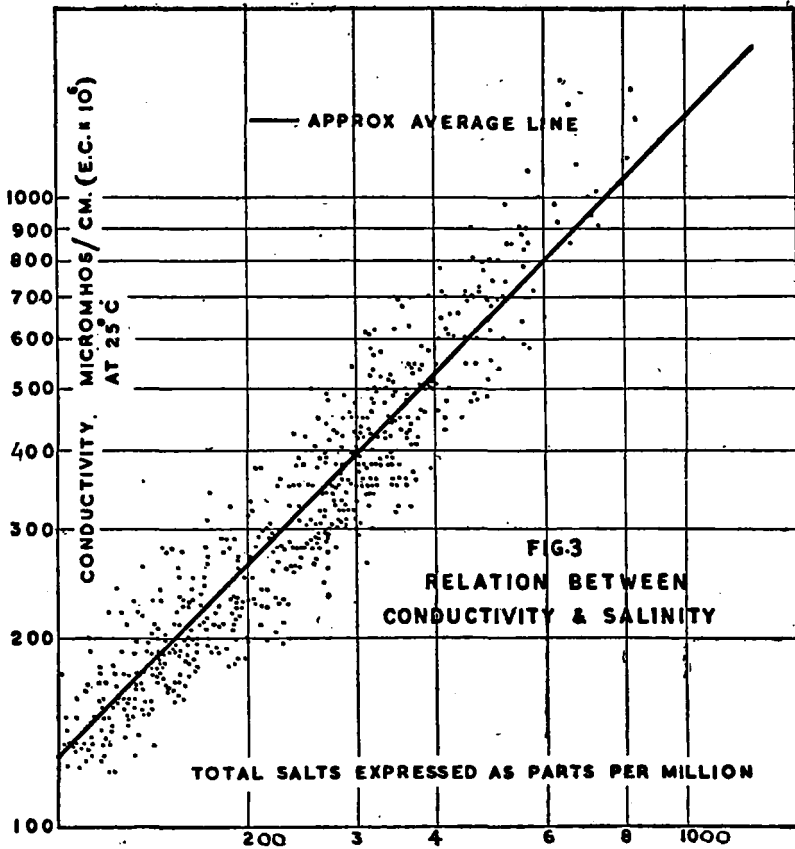
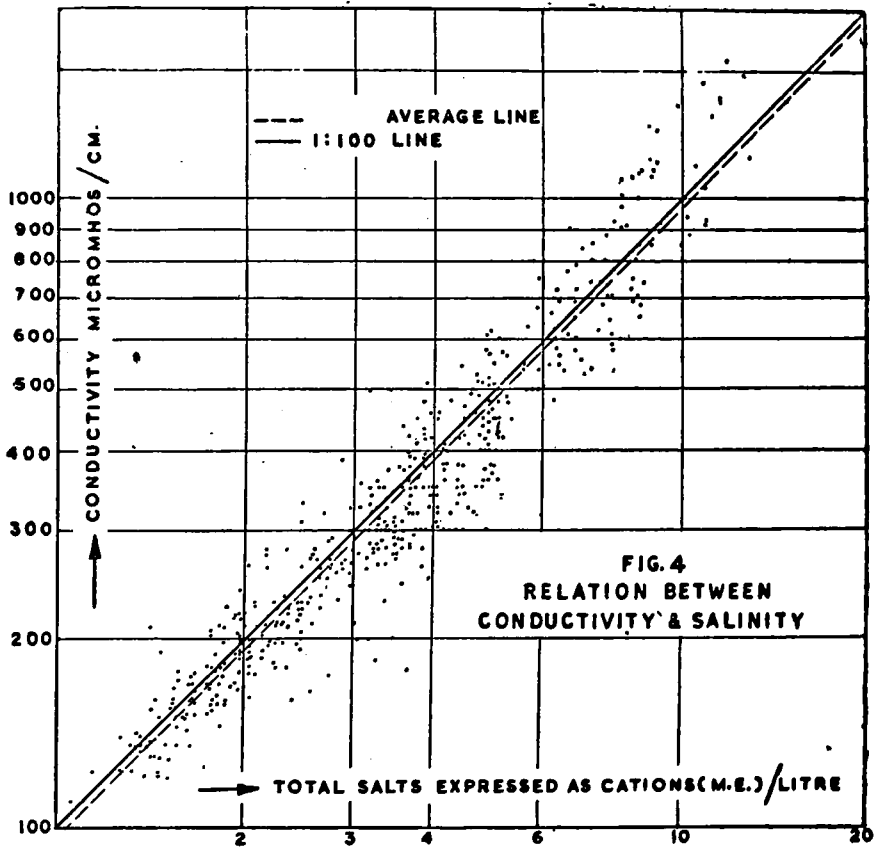


Fig 2 : Diagram for determining the quality rating of an irrigation water from its sodium absorption ratio and electrical conductivity (modified from diagnosis and improvement of saline and alkali soils U. S. Salinity Laboratory Staff 1953.)





CWPRS TECHNICAL MEMORANDUMS

SUBJECT CLASSIFICATION

Subject	Symbol
Water studies & Hydrology	HLO
Rainfall & Runoff	
Regeneration & Losses	
Quantity of Water	
Fluid Mechanics	FLM
Design of Hydraulic Structures	HYD
River Training & Flood Control	HYR
Irrigation, Drainage & Reclamation	IRD
Surface & subsurface irrigation	
Water requirements of crops	
Soil survey and crop pattern	
Drainage	
Reclamation	
Navigation	NAV
Ports, Harbours & Estuaries	
Inland Navigation	
Coastal Erosion	
Ships & Navigation Crafts	
Structural Design	STD
Soil Mechanics & Foundation Engineering	SFE
Investigations	
Stability, deformations & displacements of earth structures	
Foundation studies including geophysical	
Construction Materials & Practices	CMP
Concrete Technology	
Building & other Materials	
Instrumentation	IST
Model and Prototype comparisons	MPC
Other miscellaneous	MIS

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