Quality of Groundwater, Proceedings of an International Symposium, Noordwijkerhout, The Netherlands, 23—27 March 1981, W. van Duijvenbooden, P. Glasbergen and H. van Lelyveld (Eds.), *Studies in Environmental Science*, Volume 17

GROUND WATER POLLUTION IN WARANGAL TOWN, ANDHRA PRADESH, INDIA.

KRISHNA RAO NARAM

Chief Engineer, Public Health, Government of Andhra Pradesh and Member Secretary, A.P. State Board for Prevention and Control of Water Pollution, Hyderabad, (India)

ABSTRACT

Until recently relatively little attention has been focussed on ground water pollution in India. The causes of under ground water pollution are numerous and are as diverse as the activities of man. Recognising the growing importance of the problem to the water supply industry, an attempt is made in this paper to bring out different sources of man made pollution of ground water including sources of pollution at ground surface and at sub-surface. Physical, chemical and biological aspects of ground water pollution are discussed along with control methods. Ground water quality survey was conducted in the Warangal Town. The chemical and bacteriological results of the above survey are reported.

INTRODUCTION

Both surface water and ground water are liable to pollution. At present, most of the emphasis is directed towards detection, prevention and amelioration of surface water pollution, widely acknowledged to be due to the ease with which such pollution can be detected by adverse changes in colour, taste, odour or turbidity which are obviously perceptible or detectable in most cases or evidenced at times dramatically by dead aquatic life, oil slicks etc. On the other hand ground water pollution may remain undetected due to removal of colour, odour, turbidity etc. by the soil, subsoil and aquifer materials through which the pollutants are filtered. Nevertheless the hazard of pollution may persist undetected.

While considerable work has been carried out in India on pollution of surface waters (Refs. 1 - 4) very little attention was paid to the subject of ground water pollution. Spreading of untreated industrial wastes on land either for evaporation or for irrigation leads to contamination of ground water. One study (Ref. 5) reported deterioration of well water supply to a town when untreated tannery wastes were discharged on nearby land. Another study (Ref. 6) reported the effect of discharge of waste waters from a group of tanneries in the dry bed of a river. The river had a considerable amount of subsurface flow which was tapped for domestic and irrigation supply. The survey showed that the background concentration of total dissolved solids increased from between 640 & 740 mg/l to 1900 mg/l and chlorides from 88-100 mg/l to 820 mg/l in the area of the tannery effluent outfall. The effect of contamination was observed upto a distance of 8 km. Some information is also available on the travel of pathogenic organisms through geological formations (Refs. 7-9).

With this background, studies reported in this communication were undertaken. The quality of ground water in two areas in Warangal town, Andhra Pradesh, India where untreated tannery and textile mill wastewaters are being discharged

on land, as a method of disposal, was studied over a period of one year and the results obtained are reported.

NATURE AND SOURCES OF POLLUTION OF GROUND WATER

The mechanism of ground water pollution is summarised by Mckee and Wolf (Ref. 10) as follows: "Wastes from municipalities or industries may be discharged into underground water by means of spreading grounds (percolation beds) or recharge wells, provided that such wastes are relatively free of substances that clog the interstices of the soil".

Haphazard Urban Development without adequate attention to sewage and waste disposal is one of the most widespread causes of pollution. Rapid industrialisation without provision of proper treatment and disposal of waste and effluents is another source of pollution of atmosphere, biosphere and hydrosphere. The use of pesticides in improving agricultural productivity and human and animal health has been rapidly increasing, causing increased pollution of surface as well as ground waters.

To summarise, the following are the usual causes of pollution of ground water:

i) Disposal of domestic as well as industrial waste waters and application of pollutants on the surface.
ii) Subsurface waste disposed through pits, mines, wells, septic tanks etc.
iii) Drill holes, oil and gas wells etc. leading to saline water ingress into fresh water aquifers and
iv) Disturbing saline water/fresh water inter-relationships by over-pumping of fresh water aquifers.

The pollutant may enter the ground water from a point source as in the case of injecting it through a well or sink or from a dispersed source as in the case of application of manure or pesticide in an irrigated tract. In the former case, the pollutants may be concentrated and in the latter case, incipient and widespread. The degree and extent of pollution largely depends on the quantity and concentration of the pollutants and the porosity, permeability, hydraulic gradient and storage capacity of the aquifers, besides the time factor. To a certain extent, self-purification occurs during the course of movement of pollutant in the ground, by which undesirable qualities and properties may be removed with or without accompaniment of changes in the properties of the medium, through which the movement takes place. Turbidity may be removed by filtering mechanisms of the soil and aquifer fabric, pollutants may decompose or get diluted, decayed or absorbed and bacteria may die due to change in environment. Caldwell and Parr (Ref. 11) and Dyer and Bhaskaran (Ref. 12) found that in sandy and clayey soils free from fissures, bacteria do not travel more than 3 metres to about 8 metres in the direction of flow when the rate of withdrawal of ground water is not high.

Protection of ground water quality cannot be fully achieved solely by regulation and control of disposal of wastes, or by regulation of the construction and abandonment of wells (Ref. 13). Only through comprehensive, conjunctive management of surface and ground waters can the full benefits of these resources, with adequate protection of quality be achieved.

GEOGRAPHICAL AND HISTORICAL FEATURES OF WARANGAL

Warangal town in Andhra Pradesh (India) with a population of 0.25 million has got a protected water supply scheme with Dharmasagar lake as the main source. During the past decade the town had experienced severe drought. In one particular year (1973) the only source got dried up completely forcing the local authorities to search for alternate sources of water supply. Investigations were taken up on the extraction of ground water to meet the demand of water supply during such

exigencies. Several bore wells were sunk all over the town to augument the town water supply. In order to study the quality of the water in these wells, this study was undertaken.

Warangal town is situated on a Latitude of 18° North and Longitude of 79° East at an altitude of about 274.32 meters above mean sea level. The average annual rainfall is about 610 millimeters. It is an elongated city, spread out in a ribbon like fashion, along the main road connecting East and West. The town has no sewerage system and the nightsoil and refuse are dumped at various parts of the town. While part of the liquid waste is used for irrigation, the rest is discharged through open drains into a fresh water lake. In one area ofthe town (Zone I) there are 12 small vegetable tanneries discharging their untreated wastes on nearby land. In another area (Zone II) a textile mill is discharging daily about 0.6 million litres of waste water. This waste water is allowed to flow through open drains which ultimately join a fresh water lake. Sullage from different areas is also discharged into the open drain carrying textile mill waste waters at different points.

MATERIALS AND METHODS[+]

Water samples were collected from a number of wells in Zone I and II where untreated effluent from tanneries and textile mill along with sullage is discharged. Samples for chemical analysis were collected in clean polythene bottles. Samples for bacteriological analysis were collected in clean sterilised glass stoppered bottles, preserved in an ice-box and analysed within 6 hours after collection. Samples were collected at monthly intervals for a period of one year. Data for pH, alkalinity and distance of the well from the polluted areas, were recorded on the spot while collecting the samples. Water samples were analysed for pH, total dissolved solids, alkalinity, chlorides, sulphate, COD, BOD, nitrates and for total count and coliforms. All these tests were carried out as per methods given in Standard Methods (Ref. 14).

RESULTS AND DISCUSSIONS:[+]

The range values of the characteristics of waste water discharged from different tanneries and the textile mill are given in tables 1 and 2.

TABLE 1

Characteristics of Waste Water from Tanneries in Zone I

S.No.	Characteristics	Range Values
1.	pH	8 - 10.5
2.	Alkalinity ($CaCO_3$)	500 - 1200
3.	Suspended Solids	1900 - 6000
4.	BOD_5 at 20°C	2000 - 7500
5.	C.O.D.	3500 - 15000
6.	Chlorides (Cl)	5000 - 7500

All results in mg/l except pH.

[+] Abbreviations used: mg/l = milligrams per litre, BOD = biochemical oxygen demand, SS = suspended solids, TDS = total dissolved solids, COD = chemical oxygen demand, m = metres.

TABLE 2

Characteristics of Waste Water from Textile Mill in Zone II

S.No.	Characteristics	Range Values
1.	pH	7.5 - 11.0
2.	Alkalinity ($CaCO_3$)	500 - 900
3.	Suspended Solids	250 - 600
4.	B.O.D.$_5$ at 20°C	100 - 600
5.	C.O.D.	250 - 900
6.	Chlorides (Cl)	450 - 1200
7.	Sulphates	110 - 400

All results in mg/l except pH.

Information on the quality of bore well waters in Zone I and Zone II are presented in Tables 3 and 4. The effect of depth of the well situated 5 metres away from the area of discharge of tannery waste water on land on the quality of water was studied and the results are shown in Table 5.

TABLE 3

Physical-Chemical and Bacteriological characteristics of water from different wells located in Zone I

Characteristics	Refe-rence Well	Well Nos 1	2	3	4	5	6	7	8
1. Distance from effluent channel (in meters)	500	5	10	20	50	75	100	125	150
2. pH	7.4	8.3	8.3	8.2	8.1	8.1	8.0	7.7	7.4
3. Turbidity	10	12.0	12.0	12.0	11.0	10.0	10.0	10.0	10.0
4. Colour	2	40.0	36.0	30.0	20.0	15	8	2	1
5. BOD_5 at 20°C	2	30.0	25.0	21.0	16.0	12.0	10	5	2
6. C.O.D.	8	80.0	70.0	55.0	40.0	30.0	21	14	10
7. Alkalinity ($CaCO_3$)	120	360.0	320.0	270.0	210.0	190.0	160	140	125
8. Suspended Solids	15	20.0	18.0	16.0	15.0	15.0	15.0	15.0	15.0
9. Chlorides	160	1200.0	860.0	640	510	405	320	180	165
10. Sulphates	60	62	64	56	61	49	71	62	62
11. Nitrates as N	5	6	5	4	5	5	4	5	5
12. Total Dissolved Solids	650	1460	1350	1215	1120	1030	830	680	650
13. Total Count/ml.	40	260	220	170	140	110	90	50	40
14. Coliform MPN/100 ml.	4	20	16	10	10	10	6	4	4

TABLE 4

Physico-Chemical and Bacteriological characteristics of water from differentwells in Zone II

Characteristics	Reference Well	Well Nos 1	2	3	4	5	6
1. Distance from effluent in meters.	750	5	10	25	50	75	125
2. pH	7.3	8.4	8.2	7.9	7.7	7.4	7.4
3. Alkalinity ($CaCO_3$)	140	440	370	310	220	160	150
4. Colour	3	45	35	27	18	9	4
5. B.O.D.$_5$ at 20°C	2	33	24	18	11	7	2
6. C.O.D.	7	90	76	61	38	18	10
7. Total Dissolved Solids	750	1380	1210	1080	860	770	750
8. Suspended Solids	10	18	15	12	10	10	10
9. Chlorides	80	100	92	84	80	80	80
10. Total Count/ml	35	2400	1400	500	500	300	30
11. Coliform MPN 100 ml	10	2400	1200	600	400	100	10

TABLE 5

Influence of depth on the quality of well water 5m away from source of pollution in Zone I

S.No.	Characteristics	Depth in meters 0.5	3	6	12
1.	pH	8.3	8.1	7.8	7.1
2.	Alakalinity ($CaCO_3$)	360	300.0	225.0	140
3.	BOD_5 at 20°C	30.0	24.0	16.0	4.0
4.	Chlorides	1200	1050	800	180

From Table 1 it can be seen that the pH of Tannery waste water varied from 8 to 10.5 while BOD and chloride varied from 2000-7500 mg/l and 5000-7500 mg/l respectively.

From table 2 it can be seen that the pH of the textile waste water varied from 7.5 to 11.0 while BOD and SS varied from 100-600 mg/l and 250-600 mg/l.

From table 3 it can be seen that the quality of ground water deteriorated depending upon the distance of the borewell from the point of discharge of tannery waste water. The quality of the water in the well at a distance of 5m from the pollution source was very much affected. The BOD, chloride, TDS of the well water at 5 m distance was 30, 1200, 1460 mg/l respectively. As the distance of the well from pollution source increased the quality of water improved. The effect of pollution could be seen upto 150 meters. The soil in this area is pervious and consists of sandy loams and rocky soil.

From table 4 it can be seen that the ground water quality in Zone II where untreated textile mill waste together with town sullage is discharged in an open

channel showed marked variation in characteristics as the distance from the polluting source increased upto 125 m.

From Table 5, it can be seen that water collected from deeper wells was purer. Ground Water collected at 12 m. depth was the least polluted.

SUMMARY AND CONCLUSIONS

Warangal town has two areas in which untreated waste waters from tanneries and a textile mill are being discharged on land in the area. Studies on the quality of ground water in these areas have been carried out and results obtained are presented.

The physico-chemical and bacteriological characteristics of well waters showed that a number of wells in these areas are highly polluted. Relationship between the pollution of the well water and the distance of the well from the source of pollution and depth of the well has also been studied. Most of these well waters are found to be unfit for drinking and domestic purposes.

Factors including the pollution of ground water were described and the need for control is stressed.

REFERENCES

1 Verma, S.R., and Dalela, R.C., Studies on the Pollution of Kalinadi by industrial wastes near Mansurpur Part I, Acta, Hydrochim Hydr. 3(3-239-257) 1975.
2 Verma S.R., and Mathur R.P., Characteristics and Pollutional effect of Paper Mill wastes on Hindom River, Joint Inst. of Engrs, India, E-4-1-12 (1971).
3 K.L. Saxena, R.N. Chakrabarty, A.R. Khan, S.N. Chattopadhya and Harishchandra, Pollution studies of the River Ganges near Kanpur, Environmental Health, 81,270-85 (1966).
4 Seth G.K. and Bhaskaran T.R. "Effect of Industrial waste disposal on the sanitary condition of the Hooghly river in and around Calcutta, Ind. J. Med. Res. 38,(4) 341-354 (1950).
5 W.H. Taylor, Disposal of Tannery Wastes, Sanitak, 1, 4 24 (1953).
6 A.S. Hariharan "Industrial wastes discharges and pollution ofground and subsurface waters" 12th Indian Standards convention, Bhubaneswar, December 1968.
7 Krome R.B., Orlob G.T. and Hodkinson C. Sew & Ind. waste 30, 18 (1958).
8 Nichols. M.C. J. Amer Wat. Wks. Ass. 47,29(1955).
9 Stiles, C.W. Hyg. Lab. Bull, No. 147 (1927).
10 Mckee, J.E. and Wolf, H.W. Water Quality Criteria, 2nd Edition, California State Water Resources Control Board, Calif., USA.
11 Caldwell, B.L. and Pair, W.P. Jour. Infc. Disease, 61 (1931).
12 Dyer, B.R. and Bhaskaran, T.R., Ind. Jour. Med. Research 33, 1945.
13 H.O. Banks "National Water Commission News Ground water Protection" Wat. & Sew. Wks., 124, 73 (1977).
14 Standard Methods for Examination of Water & Waste Water, 12th Edition, APHA, AWWA, WPCF. New York 1965.