Chemical analysis of drinking water

Report for chemical analysis of water represents data collected for Asia Urbs by EMS from Auroville area (Auroville area - water source from Auroville community and 5 villages which are located around Auroville) and data collected by EMS for ICEF project (India-Canada Environment Facility). ICEF project EMS lab involved science 1999 year, duration 5 years. The work EMS is doing for ICEF closely related to the scope of Asia Urbs in part for quality of water for Auroville bioregion. Data from ICEF project included with kindly permission of the Director of ICEF project Mr. Jurgen Putz.

From Auroville area water were analyzed from 85 source (1615 tests).
From bioregion water were analyzed from 139 source (1907 tests).

Tests were done and results were analyzed on the base of the Indian Standard: Drinking water – Specification IS : 10500 : 1991.
The standard categories various characteristics as essential or desirable. The standard also mentions the desirable limit, permissible limit in the absence of alternate source and indicates their background. All the essential characteristics should be examined in routine. Besides, all desirable characteristics should be examined ever when a doubt arises or the potability of water from a new source is to be established.

Short description of meaning and significance for the health and environmental the measured parameters:

Odour
Odour is recognized as a quality factor affecting acceptability of drinking water and food prepared from it, tainting of fish and other aquatic organisms and aesthetics of recreational waters. Most organic and some inorganic chemicals contribute taste or odour. These chemicals may originate from municipal and industrial waste discharges, natural sources, such as decomposition of vegetable matter or from associated microbial activity.

Turbidity
The Turbidity in water is the reduction of transparency due to the presence of particulate matter such as clay or silt, finely divided organic matter, plankton or other microscopic organisms. These cause light to be scattered and absorbed rather than transmitted in straight lines through the sample. The colloidal material exerts turbidity provides adsorption sites for chemicals that may be harmful or cause undesirable tastes and odors. Desinfection of turbid water is difficult because of the adsorptive characteristics of some colloids and because the solids may partly shield organisms from desinfectant. In natural water

bodies, turbidity may impart a brown or other colour to water and may interfere with light penetration and photosynthetic reaction in streams and lakes.

pH value

pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. In water solution, variations in pH value from 7 are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa. Dissolved gases such as carbon di oxide, hydrogen sulphide and ammonia also affect the pH of water. The overall pH range of natural water is generally between 6 and 8. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity of water. pH lower than 4 will produce sour taste and higher value above 8.5 bitter taste. Higher value of pH hasten the scale formation in water heating apparatus and reduce the germicidal potential of chlorine. pH below 6.5 starts corrosion in pipes, thereby releasing toxic metals such as Zn, Pb, Cd, Cu etc.

Total Hardness

Hardness of water is caused by the presence of multivalent metallic cations and is largely due to calcium, Ca^{++}, and magnesium, Mg^{++} ions. Hardness is reported in terms of $CaCO_3$. Hardness is the measure of capacity of water to react with soap, hard water requiring considerably more soap to produce a lather. It is not caused by single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations.
The low and high value of Hardness has advantages and disadvantages. Absolutely soft water are tasteless. On the other hand, hardness upto 600 mg/L can be relished if got acclimatized to. Moderately hard water is preferred to soft water for irrigation purposes. Absolutely soft water are corrosive and dissolve the metals. More cases of cardiovascular diseases are reported in soft water areas. Hard water is useful to growth of children due to presence of calcium.

Iron

Anaerobic ground waters may contain iron II at concentrations up to several milligrams per liter without discoloration or turbidity in the water when directly pumped from a well. Taste is not usually noticeable at iron concentrations below 0.3 mg/l, although turbidity and colour may develop in piped systems at levels above 0.05 to 0.1 mg/l. Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, physiological status, sex and iron bio-availability and range from about 10 to 50 mg/day. Although iron has got little concern as a health hazard but is still considered as a nuisance in excessive quantities. Long time consumption of drinking water with a high concentration of iron can lead to liver diseases (hemosiderosis). Iron also promotes the growth of iron-bacteria. This gives a rusty appearance to the waters. Colonies of these bacteria may also form a slime which causes problems in water closets, pipes, pumps and distribution

system. High concentration of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items. Water with high concentration of the iron when used in preparation of tea and coffee, interacts with tanning giving a black inky appearance with a metallic taste. Coffee may even become unpalatable at concentration of iron more than 1 mg/L.

Chlorides

Chloride is one of the major inorganic anion in water. In potable water, the salty taste is produced by the chloride concentrations is variable and dependent on the chemical composition. There is no known evidence that chlorides constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/l in supplies intended for public use. In many areas of the world where water supplies are scarce, sources containing as much as 2000 mg/l are used for domestic purposes without the development of adverse effect, once the human system becomes adopted to the water.

High chloride content may harm metallic pipes and structures as well as growing plants.

Colour

Colour in water may be due to the inorganic ions, such as iron and manganese, humus and peat materials, plankton, weeds and industrial wastes. The term colour is used to mean the true colour of water from which turbidity has been removed. The term apparent colour includes not only the colour due to substances in solution but also that due to suspended matter. Apparent colour is determined on the original sample without filtration or centrifugation.

Total Dissolved Solids

Total dissolved solids is the term applied to the residue remaining in a weighed dish after the sample has been passed through a standard fibre glass filter and dried to constant mass at 103 – 105^{o}C or 179 – 181 ^{o} C.

Many dissolved substances are undesirable in water. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, taste and odor. Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation, yet others have been identified as carcinogens. Water with higher solids content often has a laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them. High concentration of dissolved solids about 3000 mg/l may also produce distress in livestock.

Calcium

Calcium is a major constituent of various types of rock. It is one of the most common constituents present in natural waters ranging from zero to several hundred milligrams per liter depending on the source and treatment of the water. Calcium is a cause for hardness in water and incrustation in boilers.

Magnesium
Magnesium is a common constituent in natural water. Magnesium salts are important contributors to the hardness to the hardness of water which break down when heated, forming scale in boilers. The magnesium concentration may vary from zero to several hundred milligrams. Chemical softening, reverse osmosis, electro dialysis, or ion exchange reduces the magnesium and associated hardness to acceptable levels.

Copper
Copper is found mainly as a sulphide, oxide, or carbonate in the minerals. Copper enters the water system through mineral dissolution, industrial effluents, because of its use as algicide and insecticide and through corrosion of copper alloy water distribution pipes. It may occur in simple ionic form or in one of many complexes with groups, such as cyanides, chlorides, ammonia or organic ligands. The tests for copper is essential because of dissolved copper salts even in low concentrations are poisonous to some biota. Desirable limit for copper in potable water is 0.05 mg/l maximum which can be relaxed in the absence of better alternate source to 1.5 mg/l

Manganese
The intake of manganese can be high as 20 mg/day without apparent ill effects. It should be noted that manganese may be objectionable to consumers if it is deposited in water mains and causes water discoloration. Although concentrations below 0.1 mg/liter are usually acceptable to consumers, this may vary with local circumstances.

Sulphate
The major physiological effects resulting from the ingestion of large quantities of sulfate are catharsis, dehydration, and gastrointestinal irritation. Water containing magnesium sulfate at levels above 600 mg/l acts as a purgative in humans. The presence of sulfate in drinking water can also result in a noticeable taste, the lowest taste threshold concentration for sulfate is approximately 250 mg/l, as the sodium salt. Sulfate may also contribute to the corrosion of distribution systems.

Nitrate
Nitrates generally occur in trace quantities in surface waters but may attain high levels in some ground waters. Nitrite in water is either due to oxidation of ammonium compounds or due to reduction of nitrate. It can be toxic to certain aquatic organisms even at concentration of 1 mg/l. In excessive limits, it contributes to the illness known as methenoglobinemia in infants.

Fluoride
Traces of fluorides are present in many waters. Higher concentrations are often associated with underground sources. In seawater, a total fluoride concentration of 1.3 mg/l has been reported. In groundwater, fluoride concentrations vary with the type of rock that the water flows through but do not usually exceed 10 mg/l. Presence of large amounts of fluoride is associated with dental and skeletal fluorosis (1.5 mg/l) and inadequate amounts with dental caries (< 1 mg/l).

Zinc
Zinc is an essential and beneficial element in body growth. Concentrations above 5 mg/l may cause a bitter astringement taste and opalescence in alkaline water. Zinc most commonly enters the domestic supply from deterioration of galvanized iron and dezincification of brass. Zinc in water may also come from individual water pollution.

Alkalinity
Alkalinity of water is its quantitative capacity to react with a strong acid to a designated pH. Highly alkaline waters are usually unpalatable. Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields. Alkalinity is significant in many uses and treatments of natural and wastewaters. Alkalinity measurements are used in the interpretation and control of water treatment processes.

Conductivity
Specific conductance yields a measure of water's capacity to convey an electric current. This property related to the total concentration of the ionized substances in a water and the temperature at which the measurement is made the nature of the various dissolved substances, their actual and relative concentrations, and the ionic strength of the water sample vitally affect the specific conductance.

Inorganic Phosphorus
Phosphate occurs in traces in many natural waters, and often in appreciable amounts during periods of low biologic productivity. Traces of phosphate increase the tendency of trouble some algae to grow in reservoirs. Waters receiving raw or treated sewage, agricultural drainage, and certain industrial waters normally contain significant concentrations of phosphate. Also phosphate is frequently added to domestic and industrial waters in various forms. Phosphate analyses are made primarily to control chemical dosage, or as a means of tracing flow of contamination.

From Auroville area water were analyzed from period of time 17/06/2002 to 1/4/2003, 85 samples.

Essential characteristics we analyzed in the water from Auroville area are:

1. Colour
2. Odour
3. Turbidity
4. pH value
5. Total hardness
6. Iron
7. Chlorides

Desirable characteristics we analyzed in the water from Auroville area are:

1. Total dissolved solids
2. Calcium
3. Copper
4. Magnesium
5. Manganese
6. Zinc
7. Sulphate
8. Nitrate
9. Fluoride
10. Alkalinity
11. Pesticides

Parameters we analyzed which are not in standard:

1. Conductivity
2. Inorganic phosphorous

Conclusion:
62 sources of water have all analyzed parameters within desirable limit and water can be used for drinking.
23 sources of water have some parameters more than desirable limit but still within permissible limit, water from these sources can be used for drinking purpose in absent of alternate source.
There are not any sources of water with parameters more than permissible level.

From bioregion water were analyzed from period of time 2/01/2002 to 24/06/2003 from 58 villages, 139 samples.

Essential characteristics analyzed in the water from bioregion are:

1. Turbidity
2. pH value
3. Total hardness
4. Chlorides

Desirable characteristics analyzed in the water from bioregion are:

1. Total dissolved solids
2. Calcium
3. Magnesium
4. Sulphate
5. Nitrate
6. Fluoride

Parameters we analyzed which are not in standard:

1. Conductivity
2. Inorganic phosphorous
3. Sodium

Conclusion:
41 sources of water have all analyzed parameters within desirable limit and water can be used for drinking purpose
55 sources of water have some parameters more than desirable limit but still within permissible limit, water from these sources can be used for drinking purpose in absent of alternate source. .
43 sources of water have some parameters more than permissible level and water from these sources can not be used for drinking purpose without special pretreatment.

We analyzed water in Auroville from 31 bore well for residue of pesticides.

The target group of pesticides we analyzed is Organochlorine pesticides. Organochlorine pesticides the most persistent in the environment and have high health hazard due to possibility to be accumulate in body tissue.

List of the pesticides analyzed.

1. Aldrin and Dieldrin
2. Alpha –BHC
3. Beta – BHC
4. Gamma – BHC (Lindan)
5. Endosulfan I and II
6. Endosulfan sulfate

7. Endrin and Endrin Aldehyde
8. Heptachlor and Heptachlor Epoxide
9. Total DDT (4,4-DDT, 4,4-DDD, 4,4-DDE)

Aldrin and Endrin banned in India now but widely used in the past.
Dieldrin, DDT, Gamma – BHC (Lindan) restricted for use in India.
Endosulfan I and II widely used in India.

We detect pesticides residue in 6 bore well.

No	Community	Bore well No	Date	Pesticide name	Concentration
1.	Aurobrindavan	32	30/10/02	Endosulfan I &II	0.009 µg/L
2.	Samasti	178	31/10/02	Gamma – BHC	0.003 µg/L
3.	Silence	196	12/11/02	Endosulfan I &II	0.003 µg/L
4.	Djaima	72	4/12/02	Gamma – BHC	0.002 µg/L
5.	Annapurna	10	16/12/02	Gamma – BHC	0.005µg/L
6.	Annapurna	-	16/12/02	Gamma – BHC	0.003µg/L

Conclusion:
All pesticides in water detected in Auroville area from 6 bore well have concentration less than permissible level and water can be suitable for drinking purpose.