



## **HYDROLOGY–ASSESSMENT OF QUALITY OF WATER FROM NALGONDA DISTRICT**

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### **ABSTRACT**

Complete analysis for the compatibility of water for drinking in Nalgonda district as per the official guidelines were carried out. Water quality is an index of health and well being of a society. Various essential and desirable tests carried out on the water samples collected from various regions of nalgonda district reveals that fluoride, calcium, magnesium and total hardness levels are out of range in many places comparatively.

**Key words:** Water analysis, BIS Guidelines, Physico-chemical studies.

### **INTRODUCTION**

The importance of water can't be overstated when it comes to life on Earth. Safe drinking water and basic sanitation will bring a payback worth many times the investment involved. It will also bring health, dignity and transformed lives to many millions of the world's poorest people. The humanitarian case for action is blindingly apparent<sup>1</sup>.

Drinking water must be 'wholesome' and this is defined in law by standards for a wide range of substances, organisms and properties of water in regulations. The standards are set to be protective of public health and the definition of wholesome reflects the importance of ensuring that water quality is acceptable to consumers. There is good agreement amongst worldwide on the science behind the setting of health based standards for drinking water and this expert evidence is documented by the world health organisation in the guidelines for drinking water quality<sup>2</sup>.

One of the primary goals of WHO and its member states is that "all people, whatever

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their stage of development, social and economic conditions, have the right to have access to an adequate supply of safe drinking water”<sup>3</sup>.

Water is an elixir of life, which contains minerals depending upon natural mineral quality of earth crust. Minerals are good for human health but in appropriate quantity. If minerals are consumed in high or low intake, it may impose life threatening risk to human health. Among all the minerals, fluoride is one of the most important in ground water that prevents the tooth decay and controls the metabolic bone diseases<sup>4</sup>.

While the WHO standards and BIS: 10500-1991 permits only 1.5 mg/L as a safe limit of fluoride in drinking water for human consumption, people in several districts in Rajasthan are consuming water with fluoride concentrations up to 24 mg/L. Fluorosis continues to be an endemic problem. More and more areas are being discovered regularly that are affected by fluorosis in different parts of the country. Children in the age group of 0 to 12 years are most prone to fluorosis as their body tissues are in formative/growth stage during this period. Expectant mothers are also to be protected, as there is growing concern about effects of fluoride on foetus.

Fluorosis, which was considered to be a problem related to teeth only, has now turned up to be a serious health hazard. It seriously affects bones and problems like joint pain, muscular pains etc. are its well known manifestations. It not only affects the body of a person but also renders them socially and culturally crippled<sup>5</sup>.

The present study has been undertaken to estimate the amount of various minerals including fluoride, and also the basic parameters to check the portability of water for use by the local Nalgonda people in the selected localities. Essential tests carried out are: Odour, pH, total hardness, chloride and fluoride. Desirable tests carried out are: Calcium, magnesium, alkalinity, aluminium, total dissolved solids and *E coli*.

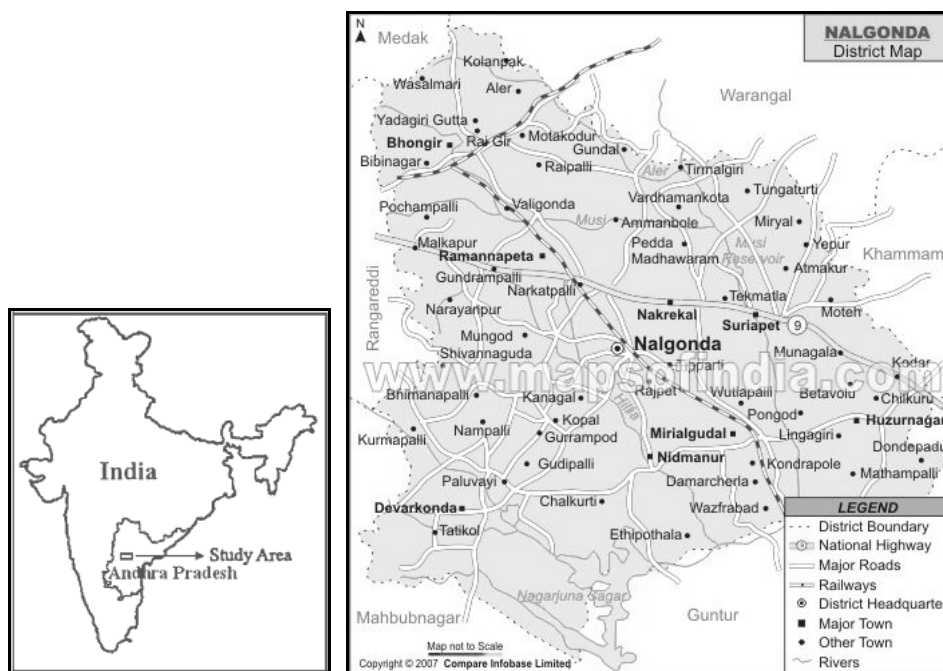
### **Geological survey of Nalgonda water resources**

Nalgonda is located at 15.05°N 78.27°E. It has an average elevation of 421 meters (1381 ft). Nalgonda experiences a semiarid climate. Summer temperatures, during the months of March to May, are quite high with the temperature often crossing 40 degrees Celsius. Rainfall is concentrated in the summer months of June to August, transforming the brown and bleak landscape into lush green<sup>6</sup>.

### **Factors, which define the quality of water**

Contaminants that may be present in untreated water include microorganisms such as viruses and bacteria; inorganic contaminants such as salts and metals; organic chemical

contaminants from industrial processes and petroleum use; pesticides and herbicides; and radioactive contaminants, use of water bodies as a heat sink, and overuse (which may lower the level of the water).



**Fig. 1: Location of the study area**

### Prevalence of fluorosis

In India, approximately 60-65 million people drink fluoride contaminated groundwater, and the number affected by fluorosis is estimated at 2.5-6 million, predominately children<sup>7,8</sup>. In India, the excessive presence of fluorides in groundwater is present in nearly 177 districts covering 19 states. It appears that high-well fluoride may exist in many more districts<sup>9-12</sup>.

Fluoride is well recognized as an element of public health concern. Fluoride is present universally in almost every water (higher concentrations are found in groundwater), earth crust, many minerals, rocks etc. It is also present in most of everyday needs, viz. toothpastes, drugs, cosmetics, chewing gums, mouthwashes and so on<sup>13,14</sup>. Though a small amount of it is beneficial for human health for preventing dental carries, it is very harmful when present in excess of 1.0 ppm. World Health Organization (WHO) and IS: 10500-1991 recommend that the fluoride content in drinking water should be in the range of 1.0 to 1.5

ppm. An intake of more than 6 ppm of fluoride results in multi-dimensional health manifestations, the most common being dental and skeletal fluorosis<sup>15,16</sup>. Higher concentration of fluoride also causes respiratory failure, fall of blood pressure and general paralysis. Loss of weight, anorexia, anaemia, wasting and cohexia are among the common findings in chronic fluoride poisoning. Continuous ingestion of nonfatal dose of fluorides causes permanent inhibition of growth. Fluoride ions inhibit a variety of enzymes often by forming complexes with magnesium ions and other metal ions<sup>17-19</sup>.

## EXPERIMENTAL

### Materials and methods

In view of the many issues and discussions raised against the quality of water in Nalgonda district, the study was designed to screen the quality of bore water of this region.

### Sites and sample collection

The samples were collected in clean and dry bottles, which were thoroughly rinsed with distilled water, 8% nitric acid and finally again with distilled water, and also with the water sample at the end just before collection. Collection of samples were done from different regions mentioned below and while collecting the samples, all the necessary precautions were taken, as reviewed from the literature<sup>20</sup>.

The samples were collected from the following places:

Place	Time	Date
Vinukonda	5:00 pm	12-2-2011
ZPHS, Koppole	3:10 pm	12-2-2011
Primary school, Bodapadu	2:30 pm	13-2-2011
VBHS, Nalgonda	4:30 pm	13-2-2011
Tangadapalli	2:30 pm	14-2-2011
Kalwapalli	4:30 pm	14-2-2011
Vignan College tap water, (VIPS) Deshmukhi	11:30 am	15-2-2011
Vignan College drinking water, (VIPS) Deshmukhi	12:00 pm	15-2-2011

### Total dissolved solids

**Source:** Total dissolved solids (TDS) consist mainly of carbonates, bicarbonates,

chlorides, sulfates, phosphates, nitrates, calcium, magnesium, sodium, potassium, iron, manganese, and a few others. They do not include gases, colloids, or sediment. The TDS can be estimated by measuring the specific conductance of the water. Dissolved solids in natural waters range from less than 10 mg/L for rain to more than 100,000 mg/L for brines. Since TDS is the sum of all materials dissolved in the water, it has many different mineral sources.

High levels of total dissolved solids can adversely industrial applications requiring the use of water such as cooling tower operations; boiler feed water, food and beverage industries, and electronics manufacturers. High levels of chloride and sulfate will accelerate corrosion of metals. The US EPA has a suggested level of 500 mg/L listed in the secondary drinking water standards.

**Treatment:** TDS reduction is accomplished by reducing the total amount in the water. This is done during the process of deionization or with reverse osmosis. Electro-dialysis will also reduce the TDS.

## Hardness

**Source:** Hard water is found over 80% of the United States. The hardness of a water supply is determined by the content of calcium and magnesium salts. Calcium and magnesium combine with bicarbonates, sulfates, chlorides, and nitrates to form these salts. The standard domestic measurement for hardness is grains per gallon (gpg) as  $\text{CaCO}_3$ . Water having a hardness content less than 0.6 gpg is considered commercially soft. The calcium and magnesium salts, which form hardness, are divided into two categories: (i) Temporary hardness (containing carbonates), and (ii) Permanent hardness (containing non-carbonates). Various combinations of permanent and temporary hardness along with their chemical formula are listed and some information on each is given.

### Temporary hardness salts

- (i) Calcium carbonate ( $\text{CaCO}_3$ ) : It is known as limestone and rare in water supplies. causes alkalinity in water.
- (ii) Calcium bicarbonate [ $\text{Ca}(\text{HCO}_3)_2$ ] : It is formed, when water containing  $\text{CO}_2$  comes in contact with limestone. It causes alkalinity in water. When heated,  $\text{CO}$  is released and the calcium bicarbonate reverts back to calcium carbonate, thus; forming scale.
- (iii) Magnesium carbonate ( $\text{MgCO}_3$ ) : It is known as magnesite and has properties similar to calcium carbonate.

- (iv) Magnesium bicarbonate [ $\text{Mg}(\text{HCO}_3)_2$ ] : It is similar to calcium bicarbonate in its properties.

### Permanent hardness salts

- (i) Calcium sulfate ( $\text{CaSO}_4$ ) : It is known as gypsum and is used to make plaster of paris. It will precipitate and form scale in boilers, when concentrated.
- (ii) Calcium chloride ( $\text{CaCl}_2$ ) : It reacts in boiler water to produce a low pH as follows:  $\text{CaCl}_2 + 2 \text{HOH} \Rightarrow \text{Ca}(\text{OH})_2 + 2 \text{HCl}$
- (iii) Magnesium sulfate ( $\text{MgSO}_4$ ) : It is commonly known as epsom salts. It may have laxative effect if great enough quantity is present in the water.
- (iv) Magnesium chloride ( $\text{MgCl}_2$ ) : It is similar in properties to calcium chloride.

Sodium salts are also found in household water supplies, but they are considered harmless as long as they do not exist in large quantities.

**Treatment:** Softeners can remove compensated hardness up to a practical limit of 100 gpg. If the hardness is above 30 gpg or the sodium to hardness ratio is greater than 33%, then economy salt settings cannot be used. If the hardness is high, then the sodium will be high after softening. Then reverse osmosis be used for producing drinking water.

### Odour

**Source:** Taste and odour problems of different types can be encountered in drinking water. Trouble some compounds may result from biological growth or industrial activities. The tastes and odours may be produced in the water supply, in the water treatment plant from reactions with treatment chemicals, in the distribution system, and/or in the plumbing of consumers. Tastes and odours can be caused by mineral contaminants in the water, such as the “salty” taste of water, when chlorides are 500 mg/L or above, or the “rotten egg” odours caused by hydrogen sulfide. Odour in the drinking water is usually caused by blue-green algae. Moderate concentrations of algae in the water can cause it to have a “grassy”, “rusty” or “spicy” odour. Large quantities can cause the water to have a “rotten”, “septic”, “fishy” or “medicinal” odour. Decaying vegetation is probably the most common cause for taste and odour in surface water supplies. In treated water supplies, chlorine can react with organics and cause odour problems. The US EPA lists odour in the secondary drinking water standards. The contaminant effects are strictly aesthetic and a suggested threshold odour number (TON) of 3 is recommended.

**Treatment:** Odour can be removed by oxidation-reduction or by activated carbon adsorption. Aeration can be utilized if the contaminant is in the form of a gas, such as H<sub>2</sub>S (hydrogen sulfide). Chlorine is the most common oxidant used in water treatment, but it is only partially effective on taste and odour. Potassium permanganate and oxygen are also only partially effective. Chloramines are not at all effective for the treatment of taste and odour. The most effective oxidizers for treating taste and odour are chlorine dioxide and ozone. Activated carbon has an excellent history of success in treating taste and odour problems. The life of the carbon depends on the presence of organics competing for sites and the concentration of the odour-causing compounds.

### **Bicarbonates**

**Source:** The bicarbonate ion (HCO<sub>3</sub><sup>-</sup>) is the principal alkaline constituent in almost all water supplies. Alkalinity in drinking water supplies seldom exceeds 300 mg/l. Bicarbonate alkalinity is introduced into the water by CO<sub>2</sub> dissolving carbonate-containing minerals. Alkalinity control is important in boiler feed water, cooling tower water, and in the beverage industry. Alkalinity neutralizes the acidity in fruit flavors; and in the textile industry, it interferes with acid dyeing. Alkalinity is known as a ‘buffer’.

**Treatment:** In the pH range of 5.0 to 8.0, there is a balance between excess CO<sub>2</sub> and bicarbonate ions. Removing the free CO<sub>2</sub> through aeration can reduce the bicarbonate alkalinity. Feeding acid to lower the pH can also reduce the alkalinity. At pH 5.0, there is only CO<sub>2</sub> and zero alkalinity. A strong base anion exchanger will also remove alkalinity.

### **Taste**

**Source:** Generally, individuals have a more acute sense of smell than taste. Taste problems in water come from total dissolved solids (TDS) and the presence of such metals as iron, copper, manganese, or zinc. Magnesium chloride and magnesium bicarbonate are significant in terms of taste. Fluoride may also cause a distinct taste. Taste and odour problems of different types can be encountered in drinking water. Trouble some compounds may result from biological growth or industrial activities. The tastes and odours may be produced in the water supply, in the water treatment plant from reactions with treatment chemicals, in the distribution system, and/or in the plumbing of consumers. Tastes and odours can be caused by mineral contaminants in the water, such as the “salty” taste of water when chlorides are 500 mg/L or above. Decaying vegetation is probably the most common cause for taste and odour in surface water supplies. In treated water supplies; chlorine can react with organics and cause taste and odour problems.

**Treatment:** Taste and odour can be removed by oxidation-reduction or by activated

carbon adsorption. Aeration can be utilized if the contaminant is in the form of a gas, such as H<sub>2</sub>S (hydrogen sulfide). Chlorine is the most common oxidant used in water treatment, but it is only partially effective on taste and odour. Potassium permanganate and oxygen are also only partially effective. Chloramines are not at all effective for the treatment of taste and odour. The most effective oxidizers for treating taste and odour are chlorine dioxide and ozone. Activated carbon has an excellent history of success in treating taste and odour problems. The life of the carbon depends on the presence of organics competing for sites and the concentration of the taste and odour-causing compound.

### Nitrites

**Source:** Nitrites are not usually found in drinking water supplies at concentrations above 1 or 2 mg/L (ppm). Nitrates are reduced to nitrites in the saliva of the mouth and upper GI tract. This occurs to a much greater degree in infants than in adults, because of the higher alkaline conditions in their GI tract. The nitrite then oxidizes haemoglobin in the blood stream to methaemoglobin; thus, limiting the ability of the blood to carry oxygen throughout the body. Anoxia (an insufficiency of oxygen) and death can occur. The US EPA has established the MCL (maximum contaminant level) for nitrite at 1 mg/L.

**Treatment:** Nitrites are removed in the same manner as nitrates; reverse osmosis, anion exchange, or distillation.

### Chlorides

**Source:** Chloride (Cl<sup>-</sup>) is one of the major anions found in water and is generally combined with calcium, magnesium, or sodium. Since almost all chloride salts are highly soluble in water, the chloride content ranges from 10 to 100 mg/L. Sea water contains over 30,000 mg/L as NaCl. Chloride is associated with the corrosion of piping because of the compounds formed with it; for example, magnesium chloride can generate hydrochloric acid, when heated. Corrosion rates and the iron dissolved into the water from piping increases as the sodium chloride content of the water is increased. The chloride ion is instrumental in breaking down passivating films that protect ferrous metals and alloys from corrosion, and is one of the main causes for the pitting corrosion of stainless steel. The suggested maximum contaminant level for chloride is 250 mg/L, which is due strictly to the objectionable salty taste produced in drinking water.

**Treatment:** Reverse osmosis will remove 90-95% of the chlorides because of its salt rejection capabilities. Deionization and distillation are two more processes that can be used to reduce the chloride content of water. Strong base anion exchanger, which is the later



portion of a two-column deionizer does an excellent job at removing chlorides for industrial applications

### **Fluorides**

**Source:** Fluoride ( $F^-$ ) is a common constituent of many minerals. Municipal water treatment plants commonly add fluoride to the water for prevention of tooth decay, and maintain a level of 1.5-2.5 mg/L. Concentrations above 5 mg/L are detrimental to tooth structure. Higher concentrations are present in waste water from the manufacture of glass and steel, as well as from foundry operations. Organic fluorine is present in vegetables, fruits, and nuts. Inorganic fluorine, under the name of sodium fluoride, is a waste product of aluminum and is used in some rat poisons. The MCL established for drinking water by the US EPA is 4 mg/L.

**Treatment:** Fluoride can be reduced by anion exchange. Adsorption by calcium phosphate, magnesium hydroxide or activated carbon will also reduce the fluoride content of drinking water. Reverse osmosis will remove 93-95 % of the fluoride.

### **Magnesium**

**Source:** Magnesium ( $Mg^{2+}$ ) hardness is usually 33% (approximately) of the total hardness of a particular water supply. Magnesium is found in many minerals, including dolomite, magnesite, and many types of clay. It is in abundance in sea water where its concentration is five (5) times the amount of calcium. Magnesium carbonate is seldom a major component of scale. However, it must be removed along with calcium where soft water is required for boiler make-up, or for process applications.

**Treatment:** Magnesium may be reduced to less than 1 mg/L with the use of a softener or purification exchanger in hydrogen form.

### ***Escherichia coli***

**Source:** Bacteria are tiny organisms occurring naturally in water. Biological contamination may be separated into two groups: (i) Pathogenic, which are disease causing and (ii) Non-pathogenic, which do not cause disease. Pathogenic bacteria cause illnesses such as typhoid fever, dysentery, gastroenteritis, infectious hepatitis, and cholera. If *E. coli* is found in a water supply along with high nitrate and chloride levels, it usually indicates that waste has contaminated the supply from a septic system or sewage dumping, and has entered by way of runoff, a fractured well casing, or broken lines. If *coli* form bacteria are present, it is an indication that disease-causing bacteria may also be present. Four or fewer colonies / 100 mL of *coli* forms, in the absence of high nitrates and chlorides, imply that surface water

is entering the water system. The most common non-pathogenic bacteria species found in water is iron bacteria. Iron bacteria can be readily identified by the red, feathery flock that forms overnight at the bottom of a sample bottle containing iron and iron bacteria.

**Treatment:** Bacteria can be treated by microfiltration, reverse osmosis, ultra filtration, ultraviolet sterilization, or chemical oxidation and disinfection. Ultraviolet treatment does not provide residual bactericidal action; therefore, periodic flushing and disinfection must be done. Ultraviolet sterilization is usually followed by 0.2-micron filtration when dealing with high purity water systems to remove the inert bacteria. The most common and undisputed method of bacteria destruction is chemical oxidation and disinfection. Ozone injection into a water supply is one form of chemical oxidation and disinfection. A residual of 0.4 mg/L must be established and a retention time of four minutes is required. Chlorine injection is the most widely recognized method of chemical oxidation and disinfection. Chlorine must be fed at 3 to 5 ppm to treat for bacteria and a residual of 0.4 ppm of free chlorine must be maintained for 30 minutes in order to meet US EPA standards. Reverse osmosis will remove 99+ % of the bacteria in a drinking water system.

## **Colour**

**Source:** Colour in water is almost always due to organic material, which is usually extracted from decaying vegetation. Colour is common in surface water supplies, while it is virtually non-existent in spring water and deep wells. Colour in water may also be the result of natural metallic ions (iron and manganese). A yellow tint to the water indicates that humic acids are present, referred to as “tannins”. A reddish colour would indicate the presence of precipitated iron. Stains on bathroom fixtures and on laundry are often associated with colour also. Reddish-brown ferric hydroxide (iron) will precipitate, when the water is exposed to air. Dark brown to black stains are created by manganese. Excess copper can create blue stains.

**Treatment:** Colour is removed by chemical feed, retention and filtration. Activated carbon filtration will work effectively to remove colour in general. Anion scavenger resin will remove tannins, but must be preceded by a softener.

## **Calcium**

**Source:** Calcium is the major component of hardness in water and is usually found in the range of 5-500 mg/L, as calcium carbonate ( $\text{CaCO}_3$ ). Calcium is derived from nearly all rocks, but the greatest concentrations come from limestone and gypsum. Calcium ions are the principal cations in most natural waters. Calcium reduction is required in treating cooling

tower makeup. Complete removal is required in industries such as metal finishing, textile operations, and boiler feed applications.

**Treatment:** Calcium, as with all hardness, can be removed with a simple sodium form cation exchanger (softener). Calcium can also be removed with the hydrogen form cation exchanger portion of a deionizer system. Reverse osmosis will remove 95% - 98% of the calcium in the water. Deionization and ultrafiltration also will remove calcium.

### Aluminium

**Source:** Aluminium ( $Al^{3+}$ ) is an abundant metal in the Earth's surface, but its solubility in water is so low that it is seldom a concern in municipal or industrial water systems. The majority of natural water contains from 0.1 ppm up to 9.0 ppm of aluminium; however, the primary source of aluminium in drinking water comes from the use of aluminium sulfate (alum) as a coagulant in water treatment plants. Aluminium is on the US EPA's secondary drinking water standards list with suggested levels of 0.05-0.2 mg/L; dependent on case-by-case circumstances.

**Treatment:** Aluminium can be removed from water by a cation exchanger in the hydrogen form. Reverse osmosis will reduce the aluminium content of drinking water by 98%<sup>21</sup>.

#### Diseases caused due to excess and deficiency of elements

Elements	Deficiency	Toxicity (Excess)
Fluoride	Cavities and weakened tooth enamel	Arthritis
	Brittle bones	Asthma
		Cold
		Dental fluorosis
		Diabetes insipidus
	Scotoma	
Magnesium	Osteoporosis	Low systolic blood pressure
	Fatigue	Low diastolic blood pressure
	Migraine	Arrhythmia
	Allergies	Weak appetite
	Anxiety	Drowsiness
	Asthma	Attention defect hyper-activity disorder (ADHD)

Cont...

Elements	Deficiency	Toxicity (Excess)
Copper	Hematological and Neurological disorders	Anxious / agitated Poor concentration
	Menkes diseases	Hyper-activity
	Myelodysplasia	Tinnitus (ringing in ears)
	Anemia	Temper / tantrums
	Leukemia Leukopenia	
Calcium	Osteoporosis	Fatigue
	Rickets	Depression
	Tetany	Confusion
	Carpopedal spasm	Constipation
	Laryngospasm	Pancreatitis
	Cardiac arrhythmias	Increased urination Kidney stones
Bicarbonates	Malaise	Carpopedal spasms
	Headache	Chvostek's sign
	Abdominal pain	Muscle twitches
	Respiratory depression	Siezuers
	Acid urine	

## RESULTS AND DISCUSSION

After performing various tests for the water samples collected as per the BIS guidelines<sup>22</sup>, the results were found as follows:

### Essential tests for drinking water

#### Total hardness as CaCO<sub>3</sub> (mg/L)

Following formula is used to calculate total hardness;

Total hardness (EDTA), [MgCaCO<sub>3</sub>] mg/L =  $A \times B \times 1000/\text{mL sample}$

Where, A = mL EDTA titrated for sample

B = mg CaCO<sub>3</sub> equivalent to 100 mL EDTA titrant

#### Chloride as Cl (mg/L)

Following formula is used to calculate the chloride content in water :

$$\text{Mg Cl/L} = (A - B) \times N \times 35.450/\text{mL sample}$$

Where, A = mL titration for sample;

B = mL titration for blank

N = Normality of AgNO<sub>3</sub>.

### **Fluoride as F (mg/L)**

Following formula is used to calculate fluoride content in water sample:

$$\text{mg F}^-/\text{L} = A/(B \times R)$$

A: mg F<sup>-</sup> reading from standard curve;

B: Volume of diluted or undiluted sample taken for colour development, mL

R: When sample is diluted, volume of sample taken for dilution or final volume after dilution.

### **Desirable tests for drinking water**

#### **Calcium as Ca (mg/L)**

Following formula is used to calculate calcium content in water:

$$\text{Mg Ca/L} = A \times B \times 400.8/\text{mL sample}$$

A: mL titrant for sample

B: mL of standard calcium solution taken for titration per mL EDTA titrant

#### **Magnesium as Mg (mg/L)**

From the following formula, the magnesium content in the water is calculated.

$$\text{mg Mg/L} = (\text{TH as mg CaCO}_3/\text{L} - \text{Calcium hardness as mg CaCO}_3/\text{L}) \times 0.243$$

TH = Total hardness mg CaCO<sub>3</sub>/L

#### **Total alkalinity mg CaCO<sub>3</sub>/L**

From the following formula alkalinity content in the water is calculated.

$$\text{Phenolphthalin alkalinity, mg CaCO}_3/\text{L} = A \times N \times 50000/\text{mL sample}$$

A = mL titrant used to phenolphthaline end point

N = Normality of the titrant

Table 1: Essential tests for drinking water

Village name	Colour	Odour	Taste	pH	Total hardness (mg/L)	Chlorine (mg/L)	Fluoride - standard curve values		Fluoride - levels in sample	
							Con	Abs (nm)	Abs (nm)	Fluoride (mg/L)
Vinukonda	Pale yellow	Odourfree	Agreeable	6.7	679.7	395.87	0	0	0.238	14.5
Koppole	Colourless	Odourfree	Agreeable	7.5	678.7	390.8	1	0.013	0.202	8.5
Bodapadu	Colourless	Odourfree	Agreeable	8.0	680	490.8	2	0.053	0.160	7.5
Nalgonda	Colourless	Odourfree	Agreeable	6.9	680.4	465.85	5	0.117	0.230	13.5
Tangadapalli	Colourless	Odourfree	Agreeable	8.3	679.4	495.8	10	0.202	0.151	7.0
Kalwapalli	Colourless	Odourfree	Agreeable	7.4	997.6	470.8	30	0.341	0.187	8.5
College tap water (VIPS)	Colourless	Odourfree	Agreeable	6.6	560	340.8	50	0.441	0.145	6.5
College drinking water (VIPS)	Colourless	Odourfree	Agreeable	7.0	0	320.9	70	0.534	0.012	1.0

Table 2: Desirable tests for drinking water

Village name	Calcium (mg/L)	Magnesium (mg/L)	Total alkalinity (mg CaCO <sub>3</sub> /L)	Aluminium- levels in samples (535 nm)		Coli form Bacteria		Total dissolved salts (TDS)
				Absorbance (nm)	Aluminium (mg/L)	LFB single strength	LFB double strength	
Vinukonda	230.86	109.06	283.3	0.002	0.007	+	+	Within limits
Koppole	128	133.33	350	0.019	0.0064	-	+	Within limits
Bodapadu	153	122.06	483.3	0.018	0.0057	-	+	Within limits
Nalgonda	179.2	121.79	316.6	0.0193	0.0064	-	+	Within limits
Tangadapalli	153	127.91	450	0.018	0.0057	+	-	Within limits
Kalwapalli	204.8	192.65	420	0.016	0.004	+	+	Within limits
College tap water (VIPS)	102.6	111.14	250	0.014	0.002	-	-	Within limits
College drinking water (VIPS)	51.3	12.4	0	0.013	0.001	-	-	Within limits

Note: + Indicates presence of *E.coli*, -Indicates absence of *E.coli*

Table 3: Essential and desirable characteristics

Essential characteristics			Desirable characteristics				
Characteristic	Desirable	Permissible	Inference	Characteristic	Desirable (mg/L)	Permissible (mg/L)	Illation
Colour	5	25	Agreeable	Calcium	75	200	Vinukonda, kalwapalli samples were out of limits. Remaining with in limits.
Odour	Agreeable	-	Odourless	Magnesium	30	100	Out of limits
pH	6.5-8.5	No relaxation	Within limits	Alkalinity	200	600	Within limits
Total hardness	300	600	Out of limits	Aluminium	0.03	0.2	Within limits
Chlorides	250	1000	Within limits	TDS	--	--	No dissolved solids formed.
Fluorides	1.0	1.5	Out of limits	<i>E.coli</i>	--	--	Within limits



### **Total dissolved salts (TDS)**

From the following formula total dissolved solids can be calculated;

$$\text{Total solids (mg/L)} = (A - B) \times 1000/\text{mL sample}$$

Where, A: Weight of dish + Residue (mg)

B: Weight of dish (mg)

### **CONCLUSION**

Out of the water samples collected from different localities of Nalgonda district, the analysis of their essential and desirable characteristics revealed that total hardness, fluoride, calcium and magnesium were out of limits and few samples were also found to contain *E. coli*. In spite of many measures undertaken by the Government to provide safe water for the people and in spite of many efforts put forth by many NGO's, the dream of making safer water available to all the people is yet not achieved. From the results, we infer that the efforts made so far is not sufficient and collective approach in collaboration of the Govt. with all the NGO's, educational institutions and the local people have to be achieved in order to improve our basic standards of living, which is the ultimate requirement for any Nation.

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