# A study on assessment of groundwater quality and its suitability for drinking in Vuyyuru, Krishna(dist.), Andhra Pradesh

[1]B Vijaya Lalitha, [2]K Sai Tejaswini,
[1]Assitant Professor, [2]Student,
Civil Engineering Department,
Dhanekula Institute of Engineering & Technology,Ganguru,Vijayawada-521139

***Abstract* - Assessment of groundwater quality is necessary as it controls it's usability for drinking purpose. The study was carried out by the physico-chemical and biological analysis of groundwater to assess the suitability of groundwater for drinking. Seawater intrusion is the movement of seawater into freshwater aquifers due to natural processes or human activities. Seawater intrusion is a severe problem by decrease in the groundwater level compared to the seawater level. This draw-down also reduces the hydrostatic pressure. When this happens near an ocean coastal area, salt water from the ocean is pulled into the fresh . In Vuyyuru because of seawater intrusion most of the fertile lands are becoming wastelands and cultivation has been decreased. In the present study, groundwater samples were collected from ten sample stations in the Vuyyuru, Krishna delta region. Water samples are collected from bore wells of sample stations and are analyzed for concentrations. The concentrations of physical, chemical s parameters in groundwater samples were compared with the Bureau of Indian Standards (BIS) and World Health Organization (WHO), and observed that the water quality parameters were exceeding the permissible limits in some places of the study area. The water quality index is determined using weighted arithmetic index method. The conclusion of the analysis is that the groundwater in some places of study area is good for drinking and many areas have poor water quality. However the quality can be improved after undergoing the treatment processes**

*Index Terms*— Groundwater quality, Vuyyuru, Water quality index

## I. INTRODUCTION

It is essential to ensure proper quality of water used for drinking and irrigation purposes. Use of inferior quality of water for drinking will adversely affect human health. In developing countries like India, most of the population use untreated groundwater for various purposes, as they do not have access to good quality water. The chemical hazards are the Calcium, Magnesium, Nitrate *etc*. As the public health concern, the groundwater should be free from physical and chemical hazards. The environmental problems existing impact on groundwater quality have been the most prominent in the recent years. The Contamination of groundwater is the major environmental risk. Suitability of groundwater for drinking purposes depends upon its quality has been identified as one of the major threats to groundwater resources not only in India but throughout the world. The drinking quality of water depends on various suspended, dissolved and biological constituents. The Bureau of Indian Standards (BIS 2003) and the World Health Organization (WHO 2006) have prescribed maximum permissible limits for various dissolved ions in water used for human intake. Researchers around the world have studied the quality of water based on these standards.

## II. OBJECTIVES

The main objectives of the present study are

- To identify the status of water quality in Vuyyuru with respect to physico–chemical parameters.
- To evaluate the Water Quality Index of the study area using the Weighted Arithmetic Index method.
- To assess the suitability of groundwater for drink.

## III. EXPERIMENTAL PROGRAM

Groundwater is to be analyzed for various physico-chemical parameters such as pH, Electrical conductivity (EC), Total dissolved solids (TDS), Alkalinity (TA), Total hardness (TH), Sulphate ($SO_4^{-2}$), Chloride (Cl), Nitrate ($NO_3^{-2}$), Iron (Fe), calcium (Ca) and magnesium (Mg). B. Kotaiah and N. Kumara Swamy (water & waste water quality laboratory manual) standard methods and WQI can be computed using weighted arithmetic index method. Water quality index is the overall representation factor of quality of water. Application of Water Quality Index is a useful method in assessing the water quality of groundwater.

$$\mathbf{WQI} = \frac{\sum_{i=1}^{n} \mathbf{w_i q_i}}{\sum_{i=1}^{n} \mathbf{w_i}}$$

$$w_i = k / S_i$$

$$q_i = [(v_a - v_i)/(s_i - v_i)]*100$$

Where,
$w_i$ is a Weight age factor computed using Eq.(3.2).
$V_a$= Actual value of the $i^{th}$ water quality parameter obtained from laboratory Analysis,
$V_i$ = Ideal value of the $i^{th}$ parameter obtained from ideal values table,
$V_i$ for $p^H$ is 7, for DO is 4 and for other parameters it is equivalent to zero.

## IV.RESULT

The experimental results are presented in the following table, Table 4.1, 4.2, 4.3 ,4.4, 4.5. Computing the values of WQI and comparing them with standard values of WQI, quality of groundwater shall be categorized for all the bore wells at different locations in the study area.

**4.1** Sampling from December 26nd –December 31st, 2016

| S.no | pH | EC | TDS | TH | Mg | $Cl^-$ | $No_3^{-2}$ | Alkalinity | DO | $So_4^{-2}$ | Fe | BOD | $Na^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 7 | 1.1 | 54 | 106 | 20 | 130.4 | 15.23 | 116 | 5.6 | 86 | 0.4 | 4.8 | 0.012 |
| **2** | 7.5 | 1.3 | 54 | 221 | 112 | 150.3 | 9.8 | 90 | 4.2 | 112 | 0.25 | 1.6 | 0.0125 |
| **3** | 7.5 | 1.41 | 55 | 184 | 63 | 170.4 | 1.3 | 124 | 5.6 | 99.6 | 0.32 | 3.5 | 0.0124 |
| **4** | 7.5 | 1.37 | 56 | 171 | 67 | 124.8 | 9.5 | 124 | 4.7 | 154 | 0.4 | 3.2 | 0.123 |
| **5** | 7.5 | 1.29 | 55 | 145 | 54 | 133.3 | 5.6 | 130 | 6 | 203 | 0.17 | 1.9 | 0.123 |
| **6** | 7 | 1.23 | 53 | 166 | 48 | 171.6 | 6.3 | 150 | 5.3 | 214 | 0.2 | 2.2 | 0.125 |
| **7** | 7.5 | 1.27 | 55 | 130 | 37 | 127.8 | 18.2 | 130 | 4.9 | 114 | 0.12 | 6.3 | 0.123 |
| **8** | 7.5 | 1.17 | 53 | 183 | 56 | 170.7 | 17.6 | 130 | 5.3 | 107 | 0.19 | 5.6 | 1.17 |
| **9** | 7.5 | 1.2 | 53 | 97 | 49 | 160.6 | 14.7 | 144 | 4.2 | 138 | 0.16 | 4.9 | 1.2 |
| **10** | 7.5 | 1.35 | 56 | 165 | 52 | 159.6 | 5.7 | 130 | 4.8 | 203 | 0.09 | 2.7 | 0.125 |

**4.2** Sampling from January 2nd – January 7th , 2017

| S.no | pH | EC | TDS | TH | Mg | $Cl^-$ | $No_3^{-2}$ | Alkalinity | DO | $So_4^{-2}$ | Fe | BOD | $Na^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 6.9 | 1.16 | 53 | 108 | 18 | 72 | 15.23 | 185 | 5.4 | 89 | 0.31 | 4.7 | 0.011 |
| **2** | 7.2 | 1.35 | 53.3 | 225 | 112 | 214.7 | 9.5 | 322 | 6.5 | 112 | 0.25 | 1.5 | 0.018 |
| **3** | 7.3 | 1.41 | 54 | 190 | 67 | 225.2 | 11 | 328 | 6.2 | 100 | 0.32 | 3.5 | 0.011 |
| **4** | 7.5 | 1.37 | 54.5 | 175 | 64 | 113.2 | 9.2 | 176 | 6.5 | 156.2 | 0.31 | 3.4 | 0.016 |
| **5** | 7.3 | 1.29 | 54 | 149 | 56 | 204 | 5.4 | 285 | 6.9 | 203.5 | 0.18 | 1.9 | 0.018 |
| **6** | 6.9 | 1.23 | 52.5 | 169 | 49 | 73.1 | 6.2 | 227 | 3.5 | 214 | 0.21 | 2.2 | 0.018 |
| **7** | 7 | 1.29 | 54.5 | 142 | 39 | 231.6 | 18.5 | 350 | 4.2 | 115 | 0.12 | 6.1 | 0.0185 |
| **8** | 6.8 | 1.18 | 52.5 | 187 | 59 | 178 | 17.3 | 307 | 4.6 | 109 | 0.19 | 5.4 | 0.0118 |
| **9** | 6.5 | 1.21 | 52.5 | 101 | 51 | 199 | 15.1 | 92 | 7 | 140 | 0.17 | 4.9 | 0.0187 |
| **10** | 7 | 1.12 | 55.5 | 722 | 48 | 58.74 | 8.2 | 261 | 6 | 204 | 0.09 | 2.7 | 0.0184 |

**4.3** Sampling from January 9th –January 16th, 2017

| S.NO | pH | EC | TDS | TH | Mg | $Cl^-$ | $No_3^{-2}$ | Alkalinity | DO | $So_4^{-2}$ | Fe | BOD | $Na^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 6.5 | 1.15 | 52 | 97 | 22 | 70 | 14.72 | 188 | 5.4 | 88.12 | 0.27 | 4.8 | 0.0118 |
| **2** | 6.2 | 1.33 | 52.1 | 230 | 105 | 214 | 9 | 324 | 6.5 | 112 | 0.25 | 1.5 | 0.0118 |
| **3** | 6.3 | 1.4 | 53 | 185 | 56 | 220 | 11 | 330 | 6.1 | 98 | 0.28 | 3.3 | 0.0186 |
| **4** | 6.6 | 1.31 | 54 | 173 | 53 | 115 | 9.4 | 182 | 6.4 | 152 | 0.29 | 3.5 | 0.0184 |
| **5** | 6.3 | 1.34 | 54 | 144 | 48 | 198 | 5.6 | 297 | 6.7 | 200 | 0.15 | 2.12 | 0.0184 |
| **6** | 6.3 | 1.27 | 53 | 116 | 41 | 71 | 6.4 | 225 | 6.9 | 211 | 0.21 | 2.5 | 0.0185 |
| **7** | 7.6 | 1.21 | 51 | 151 | 39 | 215 | 16 | 354 | 3.6 | 115 | 0.23 | 5.1 | 0.0185 |
| **8** | 6.2 | 1.15 | 51.5 | 133 | 54 | 172 | 15 | 310 | 3.9 | 106 | 0.11 | 5.6 | 0.0118 |
| **9** | 6.3 | 1.26 | 50 | 182 | 49 | 200 | 9 | 92 | 4.5 | 137 | 0.2 | 4.7 | 0.0185 |
| **10** | 6.9 | 1.18 | 51 | 80 | 35 | 60 | 7 | 262 | 7.1 | 206 | 0.21 | 2.8 | 0.0184 |

**4.4** Sampling from January 17th –January 23rd ,2017

| S.NO | pH | EC | TDS | TH | Mg | $Cl^-$ | $No_3^{-2}$ | Alkalinity | DO | $So_4^{-2}$ | Fe | BOD | $Na^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 6.3 | 1.12 | 51.5 | 95 | 20 | 72 | 15.01 | 189 | 5.2 | 82.12 | 0.22 | 4.6 | 0.0184 |
| **2** | 6.2 | 1.31 | 52 | 225 | 101 | 217 | 9.9 | 327 | 6.3 | 110 | 0.21 | 1.3 | 0.0118 |
| **3** | 6.2 | 1.39 | 51 | 181 | 54 | 225 | 11.9 | 334 | 5.9 | 92 | 0.23 | 3.1 | 0.0184 |
| **4** | 6.5 | 1.3 | 52 | 167 | 51 | 118 | 9.7 | 187 | 6.1 | 147 | 0.25 | 3.2 | 0.0118 |
| **5** | 6.3 | 1.31 | 52 | 140 | 42 | 201 | 5.8 | 230 | 6.2 | 198 | 0.12 | 2.1 | 0.0118 |
| **6** | 7 | 1.24 | 51 | 112 | 37 | 75 | 6.7 | 227 | 6.4 | 210 | 0.2 | 2.5 | 0.0185 |
| **7** | 6.5 | 1.2 | 48 | 149 | 34 | 219 | 16.6 | 359 | 3.2 | 112 | 0.21 | 5.2 | 0.018 |
| **8** | 6.5 | 1.12 | 51 | 131 | 51 | 175 | 15.7 | 312 | 3.1 | 101 | 0.1 | 5.5 | 0.0184 |
| **9** | 6.2 | 1.24 | 46 | 180 | 42 | 210 | 9.8 | 99 | 4.4 | 129 | 0.21 | 4.4 | 0.0118 |
| **10** | 6.3 | 1.16 | 49 | 79 | 32 | 6 1 | 7.5 | 268 | 6.6 | 201 | 0.24 | 2.4 | 0.0184 |

**4.5** Sampling Date from January 24th –January 31st ,2017

| S.NO | pH | EC | TDS | TH | Mg | $Cl^-$ | $No_3^{-2}$ | Alkalinity | DO | $So_4^{-2}$ | Fe | BOD | $Na^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 6.1 | 1.1 | 51 | 91 | 21 | 75 | 15.5 | 191 | 5 | 80 | 0.21 | 4.1 | 0.0184 |
| **2** | 6 | 1.3 | 51.5 | 221 | 99 | 218 | 10.1 | 329 | 6.1 | 109 | 0.2 | 1.2 | 0.0118 |
| **3** | 6.2 | 1.37 | 49.5 | 179 | 51 | 229 | 12.1 | 338 | 5.2 | 91 | 0.21 | 3 | 0.016 |
| **4** | 6.3 | 1.29 | 51 | 165 | 47 | 121 | 10 | 189 | 6 | 143 | 0.19 | 2.9 | 0.0185 |
| **5** | 6.2 | 1.3 | 51.5 | 138 | 41 | 207 | 6.1 | 235 | 6.1 | 195 | 0.1 | 2 | 0.0118 |
| **6** | 7.1 | 1.21 | 48 | 111 | 32 | 78 | 6.2 | 231 | 6.1 | 208 | 0.21 | 2.2 | 0.0184 |
| **7** | 6.5 | 1.19 | 47.5 | 147 | 31 | 220 | 15.9 | 364 | 3 | 110 | 0.2 | 5.1 | 0.1184 |
| **8** | 6.1 | 1.1 | 50 | 129 | 50 | 179 | 15.1 | 316 | 2.9 | 100 | 0.13 | 5.2 | 0.018 |
| **9** | 6 | 1.21 | 44.7 | 179 | 41 | 213 | 9.1 | 101 | 4.1 | 127 | 0.2 | 4.1 | 0.0184 |
| **10** | 6.1 | 1.17 | 48 | 74 | 31 | 69 | 7.2 | 271 | 6.2 | 200 | 0.21 | 2.1 | 0.011 |

**Water Quality Parameters, WHO Standard Values, Ideal Values and Weightage Factors of Water Quality Parameters**

| S.no | Parameter | Max value | Min value | Standard value ($S_i$) | Ideal value ($V_i$) | Weightage factor ($W_i$) |
|---|---|---|---|---|---|---|
| 1 | pH | 8.5 | 6.5 | 8.5 | 7 | 0.1176 |
| 2 | Electrical conductivity(µmhos/cm) | - | - | - | - | - |
| 3 | Total dissolved solids (mg/l) | 2000 | 500 | 500 | 0 | 0.0020 |
| 4 | Alkalinity (mg/l) | 600 | 200 | 200 | 0 | 0.005 |
| 5 | Total hardness (mg/l) | 600 | 300 | 200 | 0 | 0.005 |
| 6 | Sulphate (mg/l) | 400 | 200 | 200 | 0 | 0.0014 |
| 7 | Chloride (mg/l) | 1000 | 250 | 250 | 0 | 0.0040 |
| 8 | Nitrate (mg/l) | 100 | 45 | 45 | 0 | 0.0222 |
| 9 | Iron (mg/l) | 1.0 | 0.3 | 0.3 | 0 | 3.3333 |
| 10 | Calcium (mg/l) | 200 | 600 | 75 | 0 | 0.0133 |
| 11 | Magnesium **(**mg/l) | 100 | 50 | 30 | 0 | 0.0333 |
| 12 | DO (mg/l) | 4 | 7 | - | 4 | - |
| 13 | Sodium | - | - | - | 0 | - |
| 14 | BOD | 100 | 30 | - | - | - |

**Spatial variation of Water Quality Index values in Vuyyuru**

Sampling from December 26nd –December 31st, 2016

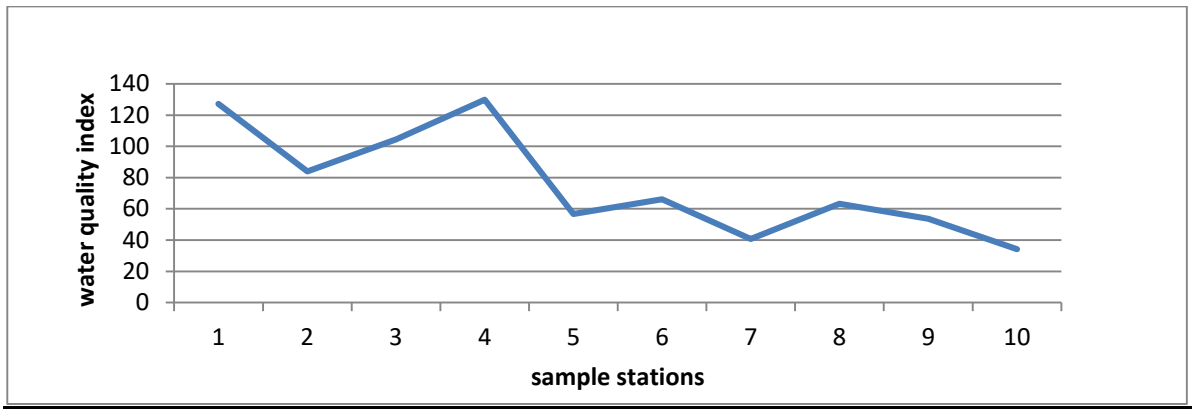


**Figure 4.1** WQI Values : Sampling 1

Sampling from January 2nd – January 7th , 2017

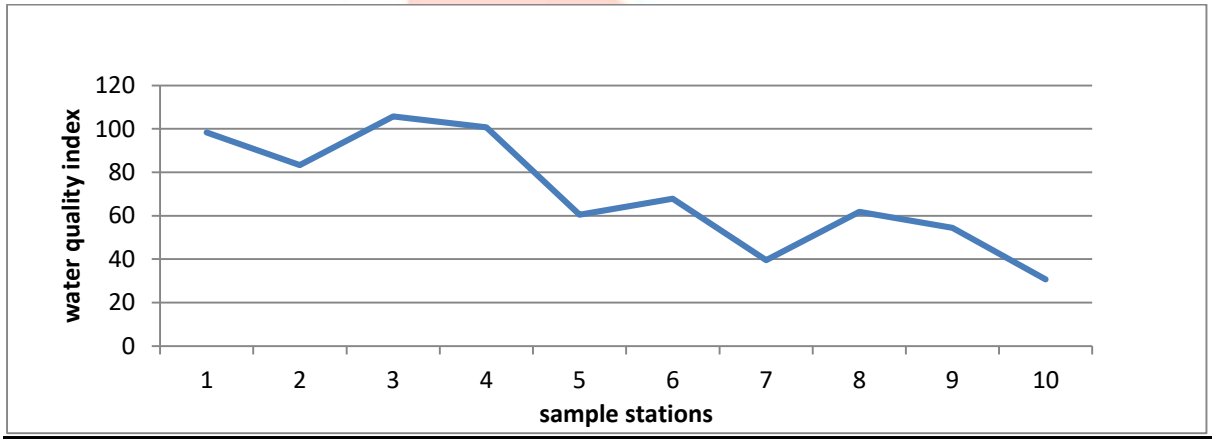


**Figure 4.2** WQI Values : Sampling 2

Sampling Date from January 9th –January 16th, 2017

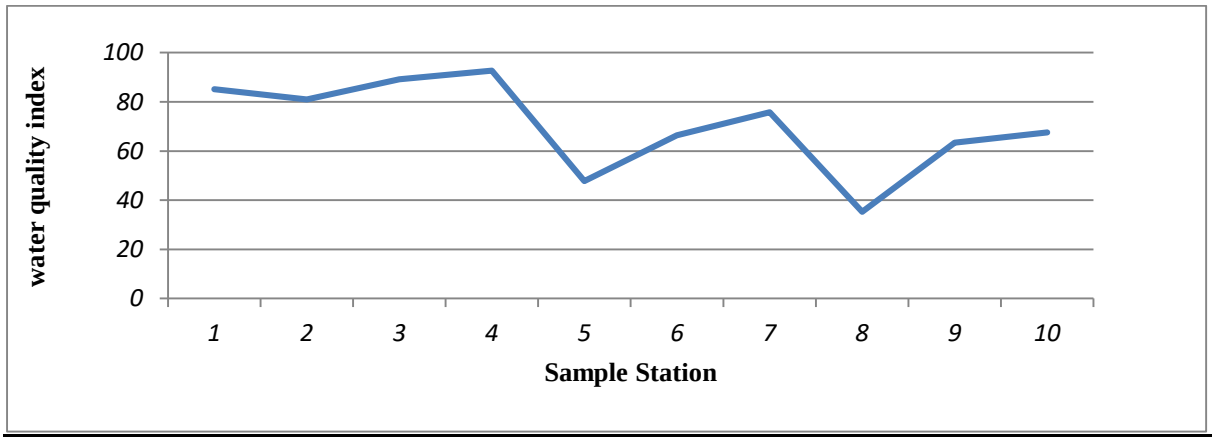


**Figure 4.3** WQI Values : Sampling 3

Sampling from January 17th –January 23rd ,2017

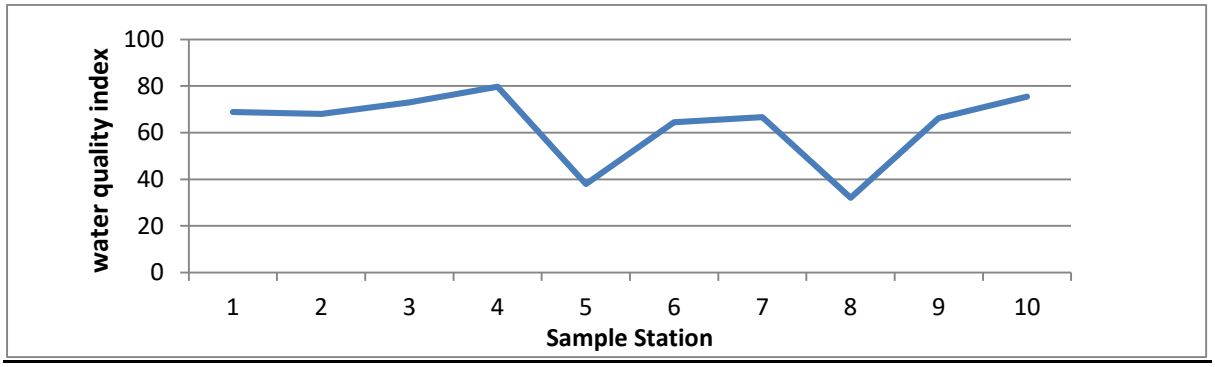


**Figure 4.4** WQI Values : Sampling 4

Sampling Date from January 24th –January 31st ,2017

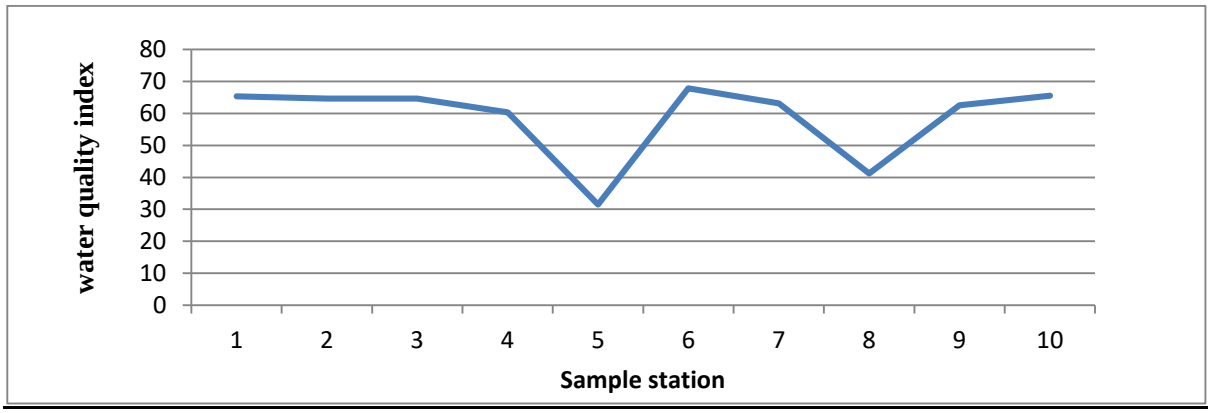


**Figure 4.5** WQI Value : Sampling station 5

**Water Quality Index Values for Collected Groundwater Samples**

| S.NO | WQI | STATUS | SAMPLE LOCATION |
|---|---|---|---|
| 1 | 0-25 | Excellent | - |
| 2 | 26-50 | Good | SI.No.1 Gandigunta |
| | | | SI.No.7 Rajesh Nagar |
| | | | SI.No.8 Jagannadhapuram |
| | | | SI.No.10 Mantada |
| 3 | 51-75 | Poor | SI.No.2 Rotary Eye Hospital |
| | | | SI.No.4 Vuyyuru Main Center |
| | | | SI.No.5 KCP Colony |
| | | | SI.No.6 Sowbhagya Nagar |
| 4 | 76-100 | Very Poor | SI.No.3 Eginipadu |
| | | | SI.No.9 KCP Sugar Industry |
| 5 | Above 100 | Unsuitable for Drinking | - |

## V. Conclusions and Recommendations

1. Monitoring of the water quality of groundwater is done by collecting representative water samples and analysis of physicochemical characteristics of water samples at different locations of Vuyyuru.
2. The status of ground water quality is identified in all the sample stations of the study area with respect to physical and chemical parameters.
3. Water quality index is evaluated using the Weighted Arithmetic Index method for the study area.
4. Based on water quality index the suitability of groundwater in 10 sample stations of the study area is determined.
5. The quality of ground water in KCP colony (SI.NO.5), Rotary eye hospital, Vuyyuru main center, Sowbhagya nagar (SI.NO.2,4,6)is Poor.
6. The quality of water in KCP sugar industry (SI.NO.3), Eginipadu (SI.NO.9) is very poor.
7. The quality of groundwater in Gandigunta, Rajesh nagar, Jagannadhapuram, Mantada (SI.NO.1,7,8,10), is found as good.
8. From the above results conclusions are, some areas in the study area are having good water quality standards. Some areas are having poor and very poor quality. By treating the water in that areas, the groundwater can be used for drinking purposes. And though the study area previously used for agriculture.

## VI. SCOPE FOR THE FURTHER STUDY

The investigations into groundwater contamination can be done in unexposed areas in Krishna district like in present study area. Water suitability can also be found out. By calculating Water Quality Indices further treatment can be done to the poor and very poor water quality areas by adopting the suitable treatment methodologies

## VII. REFERENCES


[1] S. Parimala renganayaki & L. Elango, Department of Geology, Anna University, Chennai, Tamil Nadu, India, "Groundwater quality assessment of suitability for drinking and irrigation purposes" Arab J Geosci, Saudi Society for Geosciences 05,jul,2013,Spinger journal

[2] Ashifa Soomro, Altaf Ali Siyal, Muhammad Saffar Mirjat, Allah Wadhayo Gandahi, Abdul Latif Qureshi, "Seasonal Variation Of Groundwater Quality Assessment For Irrigation And Drinking Purpose In Phuleli Canal Command Area (Sindh), Pakistan", International Water Technology Journal, IWTJ Vol. 4 - No. 4, December 2014

[3] Environmental engineering laboratory manual, Environmental and water resources engineering division, Department of civil engineering, Indian institute of technology madras, Chennai -600 036

[4] Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring - Second Edition, Edited by Deborah Chapman© 1992, 1996 UNESCO/WHO/UNEP, ISBN 0 419 21590 5 (HB) 0 419 21600 6 (PB)

[5] Dr. Reeta kori, expert resource person, Mrs. Suniti Parashar, SSA, under the guidance of Dr. D.D. Basu, Scientist 'e' &Sh. J.S.Kamyotra, member secretary, CPCB. Ms. Sarita Kumari, S.P.Gautam, "Guide Manual-Water and Waste water analysis

[6] Bereau of Indian Standards (BIS) for drinking Water Specification IS: 10500, BIS, New Delhi, India, 2012

[7] Usharani K., Umarani K., Ayyasamy P.M., Shanthi K., Lakshmana perumalsamy P,, "Physico-Chemical and Bacteriological Characteristics of Noyyal River and Ground Water Quality of Perur, India" Journal of Applied Sciences and Environmental Management, Vol. 14, No. 2, June, 2010, pp.29-35

[8] "Shivaji Park turns into a garbage dump". *The Hindu*. 14 March 2012. Retrieved 8 June 2014.

[9] Standard Methods for the Examination of Water and Waste Water, 1995. 20$^{th}$Edition, APHA.

[10] Standard Methods for the Examination of Water and Waste Water, 1995. 20$^{th}$Edition, APHA.

[11] Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, 1985. McGraw Hill International Editions, New York.

[12] Sawyer, C.L., McCarthy, P.L. and Parkin, G. F.,1994. Chemistry for Environmental Engineering. McGraw Hill International Editions, New York.

[13] MetCalf and Eddy.,1991. Wastewater Engineering, Treatment, Disposal and Reuse. 3rd Edition, Tata McGraw Hill, New Delhi

[14] N.Rajkumar, T.Subramani, L.Elango,International Journal of Environmental Sciences volume 1, no1,2010.

[15] G. SrinivasRao, G. Nageswararao "Assessment of Groundwater quality using Water Quality Index" ARCH. ENVIRON. SCI. (2013), 7, 1-5.