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# "GROUND WATER ANALYSIS IN AND AROUND PEENYA INDUSTRIAL AREA"

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**Abstract -** *Water is an essential natural resource for sustaining life and environment, but over the few decades the water quality is deteriorating due to it's over exploitation. Groundwater is the major source of drinking water in rural as well as in urban areas and over 94% of the drinking water demand is met by groundwater. Due to human and industrial activities the water bodies are contaminated and this is the serious problem nowadays. Thus, the analysis of the water quality is very important to preserve the natural ecosystem. The study was carried out to assess the water quality index (WQI) for the ground water of PEENYA. For this purpose, water samples were collected from different bore wells of PEENYA INDUSTRIAL AREA, BENGALURU. The ground water samples of all the selected bore wells were collected for a physiochemical and biological analysis. For calculating the present water quality status by statistical evaluation, following 22 parameters have been considered viz. pH, colour, turbidity, Total Dissolved Solids (TDS), conductivity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total hardness, calcium, chloride, zinc, sulphate, magnesium, alkalinity, fluoride, boron, copper, iron, chromium, odour, nitrate, manganese, residual free chlorine, E-coli. pH value in the study area found from 6.65 to 7.35. Total alkalinity between 246 mg/L to 435 mg/L. Total hardness ranged from 520 mg/L to 1100 mg/L and calcium varied from 130 mg/L to 265 mg/L. Magnesium varied from 46.8 mg/L to 88 mg/L and chloride from 217 mg/L to 468 mg/L. Values of nitrate concentration varied from 11 mg/L to 22 mg/L and fluoride from 0.79 mg/L to 0.92 mg/L while value of TDS ranges from 1070 mg/L to 2200 mg/L. The obtained results are compared with IS 10500:2012. The study of physicochemical and biological characteristics of water samples suggests that the evaluation of water quality parameters as well as water quality management practices should be carried out to protect the water resources.*

***Key words:*** Groundwater, Water quality, Physicochemical characteristics, Biological characteristics, etc.,

## 1. INTRODUCTION

Water has a profound influence on human health. At a very basic level, a minimum amount of water is required for consumption on a daily basis for survival and therefore access to some form of water is essential for life. However, water has much broader influences on health and wellbeing and issues such as the quantity and quality of the water supplied are important in determining the health of individuals and whole communities. The first priority must be to provide access for the whole population to some form of improved water supply. However, access may be restricted by low coverage, poor continuity, insufficient quantity, poor quality and excessive cost relative to the ability and willingness to pay. Thus, in terms of drinking-water, all these issues must be addressed if public health is to improve. Water quality aspects, whilst important, are not the sole determinant of health impacts.

It is most important that the water which people drink and use for other domestic purposes is clean water. This means that the water must be free of germs and chemicals and be clear (not cloudy). Water that is safe for drinking is called potable water. Disease causing germs and chemicals can find their way into water supplies. When this happens, the water becomes polluted or contaminated and when people drink it become very sick. Water that is not safe to drink is said to be non-potable. Throughout history there have been many occasions where hundreds and thousands of people have died because disease causing germs have been spread through a community by a polluted water supply.

One of the reasons this happens less frequently now is that people in many countries make sure drinking water supplies are potable. Water supplies are routinely checked for germs and chemicals which can pollute water. If the water, is not safe to drink it is treated. All the action taken to make sure that the drinking water is potable is called water treatment.

### 1.1 GROUNDWATER

Groundwater is the water present beneath Earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from and eventually flows to the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. Groundwater mainly comes from three sources. They are, first: 'Meteoric Water', which is the main source of groundwater and is received in the form of rain and snow. This water infiltrates from the surface through fissures, pores and joints of rocks till it is stored on non-permeable rocks in the form of groundwater; Second: 'Connate Water', which exists in pores and cavities of sedimentary rocks of seas and lakes. It is also called sedimentary water. Thirdly: 'Magmatic Water' which converts into water after condensation of vapor as a result of volcanic action at the time of entering hot rocks.

Groundwater is often cheaper, more convenient and less vulnerable to pollution than surface water. Therefore, it is commonly used for public water supplies. Groundwater is a prime natural resource in the Earth. It quenches thirst and fulfils all the house-hold demands. Groundwater is used for the irrigation purposes. The newly growing up industries catering to the various needs and luxuries of people consume volumes of water for their use. At present about two billion people in the world are dependent on groundwater. Fortunately, groundwater is a renewable source that is recharged every year through rainfall.

India is the largest user of groundwater in the world. It uses an estimated 230 cubic kilometres of groundwater per year - over a quarter of the global total. More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater. Urban residents increasingly rely on groundwater due to unreliable and inadequate municipal water supplies. Farms irrigated with groundwater have twice the crop water productivity of those that rely on surface-water alone. This is largely because the resource allows farmers greater control over when to irrigate their fields and how much water to use each time.

### 1.2 AQUIFER

An aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt). Groundwater can be extracted using a water well. The study of water flow in aquifers and the characterization of aquifers is called hydrogeology. Aquifers may occur at various depths. There are two types of aquifers; confined and unconfined.

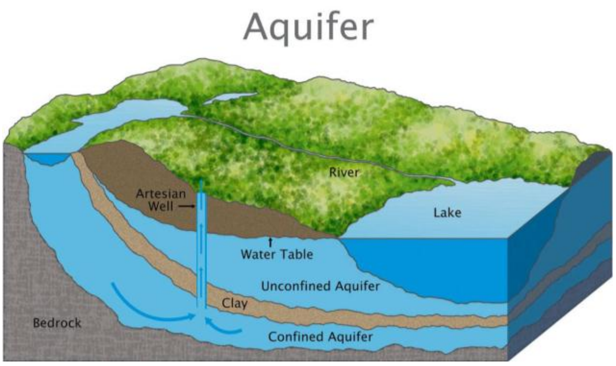


**Fig. 1.2 Aquifer**

### 1.3 GROUNDWATER RECHARGE

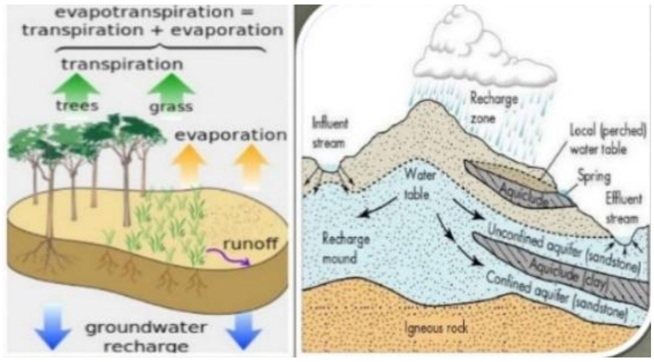


**Fig 1.3 Groundwater recharge**

Groundwater recharge or deep percolation is a hydrologic process, where water moves downward from surface water to groundwater. Recharge is the primary method through which water enters an aquifer. This process usually occurs below plant roots and, is often expressed as a flux to the water table surface. Groundwater recharge also encompasses water moving away from the water table farther into the saturated zone. Recharge occurs both naturally (through the water cycle) and through anthropogenic processes (i.e., "artificial groundwater recharge"), where rainwater and or reclaimed water is routed to the subsurface. Groundwater is recharged naturally by rain and snow melt and to a smaller extent by surface water (rivers and lakes). Recharge may be impeded somewhat by human activities including paving, development, or logging. These activities can result in loss of topsoil resulting in reduced water infiltration, enhanced surface runoff and reduction in recharge. Use of groundwaters, especially for irrigation, may also lower the water tables. Groundwater recharge is an important process for sustainable groundwater management, since the volume-rate abstracted from an aquifer in the long term should be less than or equal to the volume-rate that is recharged.

### 1.4 GROUNDWATER POLLUTANTS

Polluted groundwater is less visible, but more difficult to clean up, than pollution in rivers and lakes. Groundwater pollution most often results from improper disposal of wastes on land. Major sources include industrial and household chemicals and garbage landfills, industrial waste lagoons, tailings and process wastewater from mines, oil field brine pits, leaking underground oil storage tanks and pipelines, sewage sludge and septic systems, on-site sanitation systems, landfills, effluent from wastewater treatment plants, leaking sewers, petrol filling stations or from over application of fertilizers in agriculture.

Preventing groundwater pollution near potential sources such as landfills requires lining the bottom of a landfill with watertight materials, collecting any leachate with drains, and keeping rainwater off any potential contaminants, along with regular monitoring of nearby groundwater to verify that contaminants have not leaked into the groundwater.

The pollutant often creates a contaminant plume within an aquifer. Movement of water and dispersion within the aquifer spreads the pollutant over a wider area. Its advancing boundary, often called a plume edge, can intersect with groundwater wells or daylight into surface water such as seeps and springs, making the water supplies unsafe for humans and wildlife.

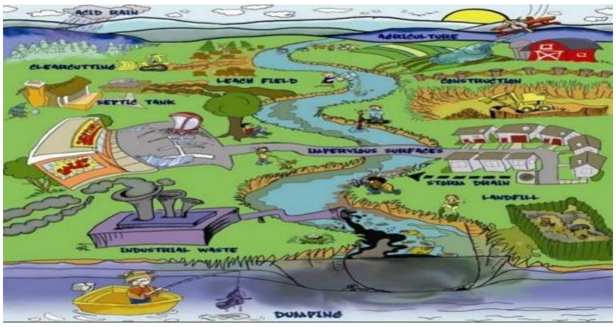


**Fig 1.4 Groundwater pollutants**

Contaminants found in groundwater cover a broad range of physical, inorganic chemical, organic chemical, bacteriological, and radioactive parameters. Principally, many of the same pollutants that play a role in surface water pollution may also be found in polluted groundwater, although their respective importance may differ. Some of the pollutants include; Arsenic and fluoride, Pathogens, Nitrate, Metals, Pharmaceuticals and others.

### 1.5 OBJECTIVE AND THE SCOPE OF THE STUDY

**Main Objective:**

The main objective is to assess the ground water quality in and around the PEENYA INDUSTRIAL area, Bangalore.

**Specific Objectives:**

- The specific objective is to carry out the analysis for various physicochemical and biological parameters.
- Comparative study of the results with IS standards.

### 1.6 STUDY AREA

#### 1.6.1 PEENYA INDUSTRIAL AREA, BANGALORE

Bangalore is located at a latitude of 12° 58′N and longitude of 77° 35′E at an altitude of 921 m above mean sea level. Bangalore is a cosmopolitan city which is expanding both in space and in technical development and is heavily dependent on groundwater for its water requirements.

#### 1.6.2 LOCATION

The Peenya industrial area is located on the north-western suburbs of Bangalore city between 13° 1′ 42″N and 77° 30′ 45″E. It is the region's largest enclave of industrial units, which houses around 3,100 industries dominated by chemical, leather, pharmaceutical, plating, metal and allied industries spread over an area of 40 $km^2$ of land. The total population within the zone is 350,000.

## 2. LITERATURE REVIEW

### 2.1 STUDIES ON GROUNDWATER ANALYSIS

In this section of literature review, the focus is on studies conducted on various groundwater samples for the assessment of groundwater quality.

#### 2.1.1 Assessment of Groundwater Quality for Drinking Purpose in Rural Areas Surrounding a Defunct Copper Mine (H. Annapoorna and M.R. Janardhana) (INTERNATIONAL CONFERENCE ON WATER RESOURCES, COASTAL AND OCEAN ENGINEERING ICWRCOE 2015).

The suitability of groundwater quality of 22 wells located in the rural areas surrounding Ingaldhal defunct copper mine in Chithradurga district of Karnataka state was assessed for drinking purpose. In Ingaldhal region of the Chirthradurga district, Karnataka State there is no public water supply system and the population in these villages depends on groundwater for their needs. The analytical results of physical and chemical parameters of groundwater were compared with the standard guideline values recommended by the World Health Organization (WHO, 2011) for drinking purpose. Hydro chemically the ground water contains higher concentrations of TDS, Mg2+ and HCO3-, moderate concentrations of Ca+, Na+ and Cl, and lower concentrations of K+ , SO4 2- , F and NO3 - . Further, hydro chemical data reveal that the groundwater of the study region consists of 3 hydro chemical facies, viz., CaMgHCO3, CaMgSO4 and NaCl. Assessment of quality of the groundwater from 22 bore wells indicate that majority of the bore wells of the study region is unfit for drinking purposes. The groundwater is laden with objectionable concentration of cations and anions which may possibly have been derived through combined sources viz., mineralization, chemical weathering of rock, mine tailings, sewage contamination and intense agricultural activities. This preliminary study calls for continuous monitoring of the quality of the groundwater in the region as further exploitation of groundwater may increase the values of the some of the parameters viz., EC, TDS, Mg2+, NO3 - and F and deteriorate the water quality in near future which ultimately will prove to be disastrous for the entire living beings in the region. Assessment of groundwater samples from various parameters indicates that groundwater in most part of the study area is chemically unsuitable for drinking purpose.

#### 2.1.2 Analysis of groundwater quality using water quality index of greater Noida (Region), Uttar Pradesh (U.P), India (Mohd Saleem, Gauhar Mahmood and Athar Hussain 2016).

The objectives of this study are to analyze the underground water quality of Greater Noida region by water quality index. Nine physico-chemical parameters such as Calcium, Magnesium, Chloride, Sulphate, Total Hardness, Fluoride, Nitrate, Total Dissolved Solids, Alkalinity collected from 10 different locations since a period of 2015. In the present study 90% water samples were found good quality and only 10% water samples fall under moderately poor category. The water quality index ranges from 16.49 to 64.65. Therefore, there is a need of some treatment before usage and also required to protect that area from contamination. The rain water harvesting structures should be installed to restore the ground water aquifers for improvement of ground water resources in order to maintain the quality and quantity of ground water reservoir and thus diluting the higher concentration of chemical constituents and dissolved salts. Public awareness program should be begun to enhance the knowledge and awareness to save water pollution on human being around their dweller.

**2.1.3 Correlation Study on Physicochemical Parameters and Quality Assessment of Ground Water of Bassi Tehsil of District Jaipur, Rajasthan, India (Umesh Saxena and Swati Saxena 2015).**

The study was carried out to assess the ground water quality and its suitability for drinking purpose in most rural habitations of Bassi tehsil of district Jaipur, Rajasthan, India. For this purpose, 50 water samples collected from hand pumps, open wells and bore wells of villages of study area were analyzed for different physicochemical parameters such as pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids. pH value in the study area found from 7.0 to 8.1. EC ranges from 392-5152 µmhos/cm and total alkalinity between 190 to 980 mg/L. Total hardness ranged from 60 to 2400 mg/L and calcium hardness from 20 to 1150 mg/L. Magnesium hardness varied from 40 to 1250 mg/L and chloride from 20 to 2000 mg/L. Values of nitrate concentration varied from 2 to 380 mg/L and fluoride from 0.3 to 9.6 mg/L while value of TDS ranges from 560 to 7360 mg/L. The study reveals that almost all parameters were exceeding the permissible limits. As per the desirable and maximum permissible limit for fluoride, nitrate, total dissolved solids and chloride in drinking water, determined by WHO BIS and ICMR standards, 44%, 14%, 24% and 42% of groundwater sources are unfit for drinking purposes respectively. Due to the higher fluoride level in drinking water several cases of dental and skeletal fluorosis have appeared in this region. After evaluating the data of this study, it is concluded that drinking water of Bassi tehsil is not potable and there is an instant need to take ameliorative steps in this region to prevent the population from adverse health effects.

**2.1.4 Assessment of Water Quality Index for the Groundwater in Tumkur Taluk, Karnataka State, India (C. R. RAMAKRISHNAIAH, C. SADASHIVAIAH and G. RANGANNA 2008).**

The present work is aimed at assessing the water quality index (WQI) for the groundwater of Tumkur taluk. This has been determined by collecting groundwater samples and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, the following 12 parameters have been considered: pH, total hardness, calcium, magnesium, bicarbonate, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides. The WQI for these samples ranges from 89.21 to 660.56. The high value of WQI has been found to be mainly from the higher values of iron, nitrate, total dissolved solids, hardness, fluorides, bicarbonate and manganese in the groundwater. Almost ninety nine percent of the samples exceeded 100, the upper limit for drinking water. About 63.5% of water samples are poor in quality. In this part, the groundwater quality may improve due to inflow of freshwater of good quality during rainy season. Magnesium and chloride are significantly interrelated and indicates that the hardness of the water is permanent in nature. The results of analysis have been used to suggest models for predicting water quality. The analysis reveals that the groundwater of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination.

**2.1.5 Urban Groundwater Quality Assessment: A Case Study of Greater Visakhapatnam Municipal Corporation Area, Andhra Pradesh, India (P. Satyanarayana, N. Appala Raju, K. Harikrishna and K. Viswanath. International Journal of Engineering Science Invention ISSN 2013).**

Groundwater pollution is one of the environmental problems in urban areas. The paper presents urban groundwater quality assessment of Greater Visakhapatnam Municipal Corporation, Andhra Pradesh, India and analysed for their physicochemical characteristics. The results of this analysis were compared with the water quality standards of WHO, BIS and CPHEEO. The water samples have been collected from 21 bore wells in GVMC area in Visakhapatnam city. In this analysis the various physicochemical parameters such as PH, EC, Total Dissolved Solids, Total Hardness, Ca, Mg, Na, NO3, K, Fe, Cl, SO4, Cr, Cu, HCO3 and Manganese were determined using standard procedures. In this study, the most of the major ions of the water samples from industrial area have been found in excess of BIS, WHO and CPHEEO recommended guide line values due to impact of industrial effluents. The water quality of the various areas in GVMC clearly indicates that the water samples are highly polluted. It is observed that the water taken from Old Gajuwaka, Pedagantyada, Akkayyapalem set polluted followed by Port area. These areas situated nearer to the Steel Plant, BHPL, Fertilizers industries. So, the proper environment management plan may be adopted to control the release of effluent. But most of the chemical parameters of water samples were found bore well within the limit and groundwater is suitable drinking purpose. It is suggested that regular monitoring of groundwater quality is required to assess pollution activity from time to time for taking for necessary measures to mitigate the intensity of pollution activity. There is an urgent need to educate people and bring awareness about the causes, affects and prevention of groundwater pollution and also the consequences of impacts of pollution on human health.

## 3 MATERIALS AND METHODOLOGY

### 3.1 Odour IS 3025

**Method:** By Inhalation Method

**Procedure:** Clean the container and wash with plenty of water, Rinse with dilute hydrochloric acid solution, Once again rinse with distilled water.
Fill the container half volume with sample insert the stopper.
Shake vigorously for 2 to 3 seconds open the lid and inhale the air.

### 3.2 Taste IS 3025

**Method:** By Swirling in Mouth.

**Procedure:** Taste cannot be observed when the sample is at cold condition or hot condition.

Wash the mouth and goggle with sodium chloride solution and rinse with distilled water.
Take 50ml of sample in mouth swirl with Tongue for 15 seconds and taste the water.

### 3.3 Turbidity IS 3025

**Method:** Nephelometric Method

**Reagents:** Hexamethylene Tetramine 10gms, Distilled water 100ml.

**Procedure:**

Standard solution - 40NTU.

Mix solution A- 10ML

Mix solution B-10ML

Set aside for 24 hours.
dilute with water to100ml. Standard Turbidity is 40 NTU.

### 3.4 Ph [Potential of Hydrogen Ion Concentration]

**Method:** Electrometric Method

Sample temperature- 20°C to 25°C

Neutral Ph= 7.0, Acidic Ph**=** <7.0, Alkaline Ph**=** >7.0

Take a sample in 100 ml plastic beaker.
**Procedure:** Check the temperature of the sample and adjust the temperature to 20 to 25 degree centigrade.
Instrument Setting: Dip the electrode in distilled water. Check for zero, using calibrate knob adjust the heading to 7. Dip the electrode in pH 4.0 Buffer solutions. Press the knob to read. pH

shall be 4.0. If not using side screw of buffer calibrate knob set to pH 4.0

Reading: Wash line electrode with water and immerse the electrode in sample solutions. Press the knob to read. Note the reading, it shall be within 6.5 to 8.5.

Preparation of Buffer Solution: Dissolve pH 4.0 Buffer tablet in 100ml of distilled water and set aside for 3 minutes, then use for calculation.

### 3.5 Total Hardness

**Procedure:** The water samples were first buffered to a pH of 10.0 with ammonia buffer and 2 or 3 drops EBT indicator was added.

The indicator reacts with calcium and magnesium ions to yield a wine-red coloured complex. As EDTA is added, it combines with free calcium and magnesium ions in the sample to produce 9 EDTA – calcium and EDTA – magnesium complexes.
When all free ions are used up, EDTA begins to break the red metal–indicator complex and combines with the free calcium and magnesium ions.
Then the colour of the solution changes from wine red to pale blue.

### 3.6 Calcium IS 3025

**Method:** Edta Volumetric Method

**Procedure:** Take volume of sample 100 ml, L.R. grade Nitric acid 5 ml, if precipitate forms add more 5 ml portions of nitric acid till clear. Take volume of sample 50 ml, sodium hydroxide solution 2 ml, Patton reader indicator 100 mg, 0.01m EDTA consumed 10 ml. It should not be more than 15 ppm.

### 3.7 Magnesium IS 3025

**Method:** Volumetric Method

**Procedure:** Water sample contains calcium and magnesium, when titrated with EDTA at pH 10 using erichrome black T solution, it estimates total volume of calcium and magnesium.

Volume of sample taken 50 ml, hydroxyl amine HCl solution 10 ml.
potassium cyanide solution 2 ml, trietharlomine solution 25 ml, distilled water 100 ml,E.B.T solution 0.2 ml, volume of 0.01m EDTA consumed, and do the calculation.

### 3.8 Chloride IS 3025

**Method:** Volumetric Titration, Argentometric Method

**Procedure:** Take volume of sample 100 ml, potassium chromate solution 1ml, 0.0141N $AgNO_3$. If solution turns to black, colour changes yellow to copious red. It should not be more than 200 ppm.

**3.9 Total Dissolved Solids**

**Method:** Gravimetric Method

**Procedure:** Evaporate the sample in previously weighed silica or porcelain crucible.

Dry the silica/porcelain crucible in hot air oven at 105 degree centigrade for 30 minutes,
Weigh the dried crucible and calculate the values.

**3.10 Manganese IS 3025**

**Method:** Dryness Method

**Procedure:** Take volume of sample 250 ml, sulphuric acid solution 4 ml, evaporated to dryness and cool + Hydrogen peroxide and nitric acid mixture 5 ml + Distilled water 10 ml + Evaporated to dryness.

Distilled water of 50 ml, phosphoric acid of 2 ml, potassium per iodate 0.2 gm.
Boil for 10 minutes and cool.
Transfer to 50 ml Nessler cylinder. If necessary, make up to 50 ml of distilled water.
Compare the colour of test sample solution with known concentration of standard solution.

**3.11 Sulphate IS 3025**

**Method:** Gravimetric Method

**Procedure:** Weight of empty silica crucible hast to be taken.

Keep the filter paper in silica crucible ignite the filter paper in electric Bunsen to 800 degree centigrade. Set the sulphate reside.

**3.12 Nitrate**

**Method:** Undistilled Method

**Procedure:** Take volume of filtrate of 50 ml, EDTA reagent 1 drop, Nessler reagent 2ml.

Mix slowly and uniformly. Set aside for 10 minutes, compare the colour of the test solution with standard solution.
Colour of the test solution should match with 30 ppm solution.
Nessler: First beaker; 60gm NaOH in 100ml $H_2O$, dissolve and cool + 1gm KI.

Second beaker; 100ml $H_2O$+1gm $MgI_2$ dissolve to saturation limit. Add first beaker to second beaker, stir well and filter the clear solution.

**3.13 Fluoride IS 3025**

**Method:** Spadns Method

**Procedure:** Pipette 0.0, 0.5, 2.0, 3.0, 4.0, 5.0, 6.0 and 7.0 ml Fluoride standard solution into 100 ml, Nessler tube sand make up to 50 ml mark with distilled water.

Add exactly 10.0 ml acid zirconyl SPADNS reagent to each tube and mix well.

Set the spectrophotometer or filter photometer to zero absorbance using reference solution at 570 mu and measure the standards immediately. Plot a calibration curve.

Place 50ml of sample or an aliquot diluted to 50ml in a 100ml Nessler tube. If the sample contains any residual chlorine, add 1 drop of sodium arsenite solution for each 0.1 mg $Cl_2$ and mix well.

Add exactly 10ml of the acid zirconyl SPADNS reagent and mix well.

After setting the spectrophotometer to zero absorbance with reference solution, measure the absorbance of sample. Find out the Mg fluoride of the sample equivalent to observed optical density from calibration graph. Express result as mg Fluoride (as F) per litre of the sample.

**3.14 Total Alkalinity IS 3025**

**Method:** Trimetry.

**Procedure:** Take phenolphthalein alkalinity if sample pH is above 8.3, volume of sample taken 20ml, phenolphthalein solution of 0.2 ml, 0.02 ml $H2SO_4$ consumed x ml.

Till pink colour appears retains for 30 seconds.

**3.15 Residual Free Chlorine IS 3025**

**Method:** Iodometric Method

**Procedure:** Take volume of sample up-to 1000 ml or 500 ml, acetic acid solution to reach pH of 3ml, potassium iodide of 1gm.

If yellow colour persists- residual free chloride is present.
If present titrate with 0.01N $Na_2S_2O_3$ solution.

Add starch solution 1ml colour may be changed to blue. 0.01N Thiosulphate solution consumed 3 ml.

**3.16 Copper**

**Method:** Neo cuproine Method, Spectrophotometry.
**Procedure:** Take stock copper solution of 1ml=200mcg cu, Copper powder /toil of 0.2 gms, nitric acid of 10 ml,

sulphuric acid of 1 ml. Take intermediate copper solution 1 ml=20mcg/lit. Stock copper solution of 10 ml, distilled water of 90 ml. Standard copper solution 0.4mcg/ml. Intermediate copper solution of 1ml, distilled water 49ml.

### 3.17 Zinc

**Method:** Spectrophotometry
**Procedure:** Take volume of sample of 50 ml, hydrochloric acid 1 ml, boil for 5 minutes. Adjust the pH of test solution taken 10ml, sodium ascorbate 0.5gm, potassium cyanide solution 1ml, buffer solution 5ml, zincon solution 1ml. The test solution should absorb 620 nm.

### 3.18 Iron IS 3025

**Method:** Spectrophotometry

**Procedure:** Take standard iron solution of 10ml, potassium bisulphate 0.3 gm. Dryness +dried residue +ammonia solution of 5ml, dilute hydrochloric acid of 10ml.

Distilled water of 20ml, thio glycolic acid solution of 2ml, ammonia solution of 2.5ml make up-to 50 ml with distilled water.

**3.19 Biochemical Oxygen Demand (Bod):** BOD was also determined titrimetrically by adopting in to the procedure adopted for the measurement of DO but only after incubation for five days at 200C. BOD was then calculated on the basis of oxygen depleted when compared to DO before incubation.

## 4. RESULTS

Ground water is collected from PEENYA INDUSTRIAL AREA in BANGLORE. Its exact position on the map is on latitude 13° 1' 42''N and longitude 77° 30' 45''E. The sampling was considered at 6 spots to evaluate physio-chemical and biological characteristics of ground water.

### 4.1 POINTS OF COLLECTION

| SAMPLE NO | SOURCE | LATITUDE | LONGITUDE | DEPTH |
|---|---|---|---|---|
| 1 | Borewell | N 13°1'2" | E77°31'25" | 540 |
| 2 | Borewell | N 13°0'52" | E77°30'18" | 700 |
| 3 | Borewell | N 13°0'57" | E77°30'31" | 620 |
| 4 | Borewell | N 13°0'45" | E77°30'33" | 420 |
| 5 | Borewell | N 13°0'40" | E77°30'39" | 430 |
| 6 | Borewell | N 13°0'45" | E77°30'40" | 300 |

The sample was collected on 29-03-2019. During the period after sampling the analysis was carried out for 22 parameters as per Bureau of Indian Standards and the list of method are presented in appendix.

### 4.2 Test Sample Results

#### 4.2.1 Limits

**Table 4.2.1**

| TESTS | MAX ACCEPTABLE LIMITS (mg/l) | MAX PERMISSIBLE LIMITS (mg/l) |
|---|---|---|
| Color, Hazen Units | 5 | 25 |
| Odor | Agreeable | --- |
| Turbidity, NTU | 1 | 5 |
| PH Value | 6.5 - 8.5 | No Relaxation |
| Total Hardness as CaCO3, mg/l | 200 | 600 |
| Calcium as Ca , mg/l | 75 | 200 |
| Magnesium as Mg , mg/l | 30 | 100 |
| Chloride as Cl , mg/l | 250 | 1000 |
| Total Dissolved solids, mg/l | 500 | 2000 |
| Sulphate as SO4 , mg/l | 200 | 400 |
| Nitrate as NO3, mg/l | 45 | No Relaxation |
| Fluoride as F , mg/l | 1.0 | 1.5 |
| Iron as Fe , mg/l | 0.3 | 1 |
| Chromium as Cr, mg/l | 0.05 | No Relaxation |
| Zinc as Zn, mg/l | 5.0 | 15 |
| Copper as Cu, mg/l | 0.05 | 1.5 |
| Boron as B , mg/l | 0.5 | 1 |
| Manganese as Mn , mg/l | 0.1 | 0.3 |
| Residual Free Chlorine , mg/l | 0.2 | --- |
| Total Alkalinity as Caco3 ,mg/l | 200 | 600 |
| Free Ammonia as NH3 , mg/l | NIL | ----- |

### 4.2.2 Sample-1

**Table 4.2.2**

| TESTS | RESULTS |
|---|---|
| Color, Hazen Units | <0.01 |
| Odor | Agreeable |
| Turbidity, NTU | 1.5 |
| PH Value | 6.9 |
| Total Hardness as CaCO3,mg/I | 700 |
| Calcium as Ca , mg/l | 180 |
| Magnesium as Mg , mg/l | 60 |
| Chloride as Cl , mg/l | 384 |
| Total Dissolved solids, mg/l | 1460 |
| Sulphate as SO4 , mg/l | 120 |
| Nitrate as NO3, mg/l | 15 |
| Fluoride as F , mg/l | 0.88 |
| Iron as Fe , mg/l | 0.16 |
| Chromium as Cr, mg/l | <0.04 |
| Zinc as Zn, mg/l | <0.1 |
| Copper as Cu, mg/l | <0.05 |
| Boron as B , mg/l | <0.5 |
| Manganese as Mn , mg/l | <0.1 |
| Residual Free Chlorine , mg/l | 0.42 |
| Total Alkalinity as Caco3 ,mg/l | 246 |
| Free Ammonia as NH3 , mg/l | NIL |
| Total coliform in 100 ml | NIL |

### 4.2.3 Sample-2

**Table 4.2.3**

| TESTS | RESULTS |
|---|---|
| Color, Hazen Units | <0.01 |
| Odor | Agreeable |
| Turbidity, NTU | 1.1 |
| PH Value | 7.2 |
| Total Hardness as CaCO3, mg/I | 520 |
| Calcium as Ca , mg/l | 130 |
| Magnesium as Mg , mg/I | 46.8 |
| Chloride as Cl , mg/I | 217 |
| Total Dissolved solids, mg/I | 1070 |
| Sulphate as SO4 , mg/I | 60 |
| Nitrate as NO3, mg/I | 11 |
| Fluoride as F , mg/I | 0.79 |
| Iron as Fe , mg/I | 0.13 |
| Chromium as Cr, mg/I | <0.04 |
| Zinc as Zn, mg/I | <0.1 |
| Copper as Cu, mg/I | <0.05 |
| Boron as B , mg/l | <0.5 |
| Manganese as Mn, mg/I | <0.1 |
| Residual Free Chlorine , mg/I | 0.31 |
| Total Alkalinity as Caco3 ,mg/l | 295 |
| Free Ammonia as NH3 , mg/l | NIL |
| Total coliform in 100 ml | NIL |

### 4.2.4 Sample-3

**Table 4.2.4**

| TESTS | RESULTS |
|---|---|
| Color, Hazen Units | <0.01 |
| Odor | Agreeable |
| Turbidity, NTU | 3.6 |
| PH Value | 6.65 |
| Total Hardness as CaCO3, mg/I | 850 |
| Calcium as Ca , mg/l | 220 |
| Magnesium as Mg , mg/I | 76 |
| Chloride as Cl , mg/I | 363 |
| Total Dissolved solids, mg/I | 1490 |
| Sulphate as SO4 , mg/I | 140 |
| Nitrate as NO3, mg/I | 18 |
| Fluoride as F , mg/I | 0.89 |
| Iron as Fe , mg/I | 0.22 |
| Chromium as Cr, mg/I | <0.04 |
| Zinc as Zn, mg/I | <0.1 |
| Copper as Cu, mg/I | <0.05 |
| Boron as B , mg/l | <0.5 |
| Manganese as Mn, mg/I | <0.1 |
| Residual Free Chlorine , mg/I | 0.38 |
| Total Alkalinity as Caco3 ,mg/l | 312 |
| Free Ammonia as NH3 , mg/l | NIL |
| Total coliform in 100 ml | NIL |

### 4.2.5 Sample-4

**Table 4.2.5**

| TESTS | RESULTS |
|---|---|
| Color, Hazen Units | <0.01 |
| Odor | Agreeable |
| Turbidity, NTU | 1.9 |
| PH Value | 7.35 |
| Total Hardness as CaCO3, mg/I | 770 |
| Calcium as Ca , mg/l | 195 |
| Magnesium as Mg , mg/I | 69 |
| Chloride as Cl , mg/I | 415 |
| Total Dissolved solids, mg/I | 1530 |
| Sulphate as SO4, mg/I | 210 |
| Nitrate as NO3, mg/I | 19.5 |
| Fluoride as F , mg/I | 0.83 |
| Iron as Fe , mg/I | 0.16 |
| Chromium as Cr, mg/I | <0.04 |
| Zinc as Zn, mg/I | <0.1 |
| Copper as Cu, mg/I | <0.05 |
| Boron as B , mg/l | <0.5 |
| Manganese as Mn , mg/I | <0.1 |
| Residual Free Chlorine , mg/I | 0.45 |
| Total Alkalinity as Caco3 ,mg/l | 347 |
| Free Ammonia as NH3 , mg/l | NIL |
| Total coliform in 100 ml | NIL |

#### 4.2.6 Sample-5

**Table 4.2.6**

| TESTS | RESULTS |
|---|---|
| Color, Hazen Units | <0.01 |
| Odor | Agreeable |
| Turbidity, NTU | 1.3 |
| PH Value | 6.8 |
| Total Hardness as CaCO3, mg/I | 1100 |
| Calcium as Ca , mg/l | 265 |
| Magnesium as Mg , mg/I | 88 |
| Chloride as Cl , mg/I | 468 |
| Total Dissolved solids, mg/I | 2200 |
| Sulphate as SO4 , mg/I | 270 |
| Nitrate as NO3, mg/I | 22 |
| Fluoride as F , mg/I | 0.92 |
| Iron as Fe , mg/I | 0.21 |
| Chromium as Cr, mg/I | <0.04 |
| Zinc as Zn, mg/I | <0.1 |
| Copper as Cu, mg/I | <0.05 |
| Boron as B , mg/l | <0.5 |
| Manganese as Mn , mg/I | <0.1 |
| Residual Free Chlorine , mg/I | 0.49 |
| Total Alkalinity as Caco3 ,mg/l | 435 |
| Free Ammonia as NH3 , mg/l | NIL |
| Total coliform in 100 ml | NIL |

#### 4.2.7 Sample-6

**Table 4.2.7**

| TESTS | RESULTS |
|---|---|
| Color, Hazen Units | <0.01 |
| Odor | Agreeable |
| Turbidity, NTU | 1.7 |
| PH Value | 7.05 |
| Total Hardness as CaCO3, mg/I | 730 |
| Calcium as Ca, mg/l | 168 |
| Magnesium as Mg, mg/I | 70 |
| Chloride as Cl, mg/I | 355 |
| Total Dissolved solids, mg/I | 1580 |
| Sulphate as SO4 , mg/I | 160 |
| Nitrate as NO3, mg/I | 17 |
| Fluoride as F , mg/I | 0.85 |
| Iron as Fe , mg/I | 0.19 |
| Chromium as Cr, mg/I | <0.04 |
| Zinc as Zn, mg/I | <0.1 |
| Copper as Cu, mg/I | <0.05 |
| Boron as B , mg/l | <0.5 |
| Manganese as Mn, mg/I | <0.1 |
| Residual Free Chlorine, mg/I | 0.33 |
| Total Alkalinity as Caco3, mg/l | 360 |
| Free Ammonia as NH3, mg/l | NIL |
| Total coliform in 100 ml | NIL |

#### 4.2.8 SUMMARY

The present study is initiated on one particular ground body that is the ground water in Bangalore. This ground water is subjected to qualitative analysis for its physical, chemical and biological characteristics. The 6 samples were collected from different bore-wells. The results of analysis for all the 22 parameters are as per IS 10500-2012.

From the test parameters tested in laboratory, we found that;

1)pH- Ranges between 6.65 and 7.35. All the samples are within the permissible limit of 6.5-8.5.
2) Dissolved solids- Ranges between 1070mg/l and 2200mg/l. Sample 5 exceeds the permissible limit of 2000mg/l.
3) Sulphates- Ranges between 60mg/l and 270mg/l. All samples are within the permissible limit of 400mg/l.
4) Chlorides- Ranges between 217mg/l and 468mg/l. All the samples are well within the permissible limit of 1000mg/l.
5) Copper- Ranges < 0.05. All the samples are well within the permissible limit of 1.5mg/l.
6) Hexavalent chromium- Ranges <0.04mg/l. All the samples are less than the acceptable limit of 0.05mg/l.
7) Zinc- Ranges < 0.1mg/l. All the samples are well within the permissible limit of 15mg/l.
8) Manganese- It ranged <0.1mg/l. All the samples are within the permissible limit of 0.3mg/l.
9) Iron- Ranges between 0.13mg/l and 0.22mg/l. All the samples are well within the permissible limit of 1mg/l.
10) Cadmium- Concentration of cadmium was observed to be below the detection limits.
11) Nitrate as $NO_3$- Ranges between 11mg/l and 22mg/l. All the samples are well within the acceptable limit of 45mg/l.
12) Phenolic compounds- Not detected in any of the samples.
13) Hardness- Ranges between 520mg/l and 1100mg/l. Sample1, Sample3, Sample4, Sample5 and Sample6 are exceeding the permissible limit of 600mg/l. Only Sample2 is well within the permissible limit of 600 mg/l.
14) Calcium as Ca- Ranges between 130mg/l and 265mg/l. Sample3 and Sample5 are exceeding the permissible limit of 200mg/l.
15) Magnesium as Mg- Ranges from 46.8mg/l and 88mg/l. All the samples are within the permissible limit f 100mg/l.
16) Fluoride- Ranges between 0.79mg/l and 0.92mg/l. All the samples are well within the permissible limit of 1.5mg/l.
17) Turbidity- Ranges between 1.1mg/l and 3.6mg/l. All the samples are well within the permissible limit of 5mg/l.
18) Alkalinity- Ranges between 246mg/l and 435mg/l. All the samples are within the permissible limits of 600mg/l.
19) Copper as Cu- Ranges <0.05mg/l. All the samples are well within the permissible limit of 1.5mg/l.
20) Boron- Ranges <0.5mg/l. All the samples are well within the permissible limit of 1mg/l.

21) Residual free chlorine- Ranges between 0.31mg/l and 0.49mg/l. All the samples are well within the permissible limit of 2mg/l.
22) Total Coliform Bacteria in 100ml- Not detectable in any of the samples.

**5. CONCLUSIONS**

1) The pH value in the study area is in normal range.
2) The samples having Total hardness and TDS more than the permissible limit are not good for industrial purpose as it is hard. Similarly, it cannot be used for domestic purpose since it cannot produce lather with soap. From the test parameters we tested in laboratory, we found that the Sample 1, Sample 3, Sample 4, Sample 5 and Sample 6 have Total Hardness exceeding the permissible limit. Those water are not suitable for industrial purposes.
3) For Sample 5, total hardness content is exceeding the permissible limit and it has high rate of TDS and calcium content. Hence it is not suitable for both domestic as well as industrial purposes.
4) Among all samples, the test parameters of Sample 2 are well within the permissible limit. And hence it is suitable for domestic purposes.

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