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ASSESSMENT OF GROUNDWATER QUALITY FOR DRINKING PURPOSE IN BARWALA TOWN AND ITS SURROUNDINGS, PANCHKULA DISTRICT, HARYANA, INDIA

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Abstract
Water is important for drinking, agriculture and industrial purposes. Water quality plays vital role in its utilization for different purposes. Water quality for drinking purpose should be as per BIS drinking water standards (IS 10500:2012). Barwala town in Panchkula district, Haryana, India has been selected in the present study for groundwater quality assessment for drinking purpose. In the study area six groundwater samples were collected in the month of June 2019 in plastic 250 ml bottles. Geo-coordinates of the sample locations were noted with mobile GPS. Groundwater samples were analysed using Field Water Testing Kit prepared by Tamil Nadu Water Supply and Drainage Board (TWAD) Chennai for ten chemical parameters-pH, hardness, chloride, fluoride, iron, ammonia, nitrite, nitrate, phosphate and residual chlorine. In the study area pH ranges from7 to 8, hardness ranges from 150 mg/l to 400 mg/l, chloride ranges from 100 mg/l to 150 mg/l, fluoride ranges from 0.5 mg/l to 2 mg/l, iron ranges from 0 mg/l to 5.0 mg/l, ammonia ranges from 0.5 mg/l to 5.0 mg/l, nitrite ranges from 0.2 mg/l to 1 mg/l, nitrate ranges from 45 mg/l to 150 mg/l, phosphate ranges from 0.5 mg/l to 1.0 mg/l and residual chlorine ranges from 0 mg/l to 0.5 mg/l. In the study area groundwater quality is non-potable in five groundwater samples and potable in one groundwater sample. The study is highly useful for monitoring of groundwater quality for drinking purpose in the study area.

Keywords
Groundwater, quality, drinking, Barwala, Panchkula, Haryana.

Introduction

Water is important for drinking, agriculture and industrial purposes. Availability of good quality groundwater plays vital role in developmental activities. But the present developmental activities adversely affected the surface and groundwater quality as well as quantity. In urban areas sewerage and solid waste are mainly responsible for polluting the groundwater quality. Many workers have done work on groundwater quality assessment for drinking purpose in urban and rural areas. Some important studies are reported by Agrawal (2009), Ana *et al*. (2018), Balakrishnan, *et al* (2011), Das and Nag (2015),Durgadevagi, et al. (2016), Hussain and Prasad (2013). Jeihouni, *et al*. (2014), Mahadevaswamy, *et al*. (2011), Okoye, et al. (2016), Pandian and Jeyachandran (2014), Patel and Dhiman (2011), Rajesh, (2016),Sarkar, et al. (2012),Satyanarayana, *et al*. (2013),Saxena and Saxena (2015), Sengupta and Dalwani (2008), Shahida and Ummatul (2015), Sheikh and Kumari (2017), Sinha, *et al*. (2018), Subramani, *et al*. (2012), Thomas *et al*. (2015), Topper and Horn (2011), Vashisth (2017).

Study Area

The study area Barwala Town and its surroundings covers 7921850.61 m^2 area and lies between the latitude 30°34'33.72" N- 30°32'25.01" N and longitude 76°55'37.74"E-76°57'22.05" E (Figure1).Barwalais a sub-tehsil in the Panchkula District of Haryana State. Barwala is located 20 km towards south from Panchkula the district headquarters. The total geographical area of the town is 439 hectares and population 8,307 and about 1,569 houses. Barwala as a block consists of 35gram panchayats and 10 block sameeties.

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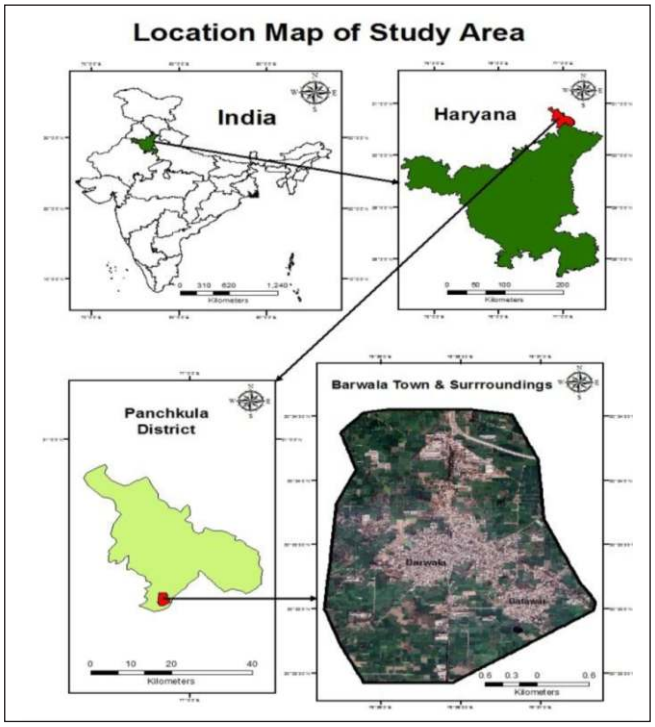

Figure 1: Location map of the study area.

Objective

The main objective of the study was to assess groundwater quality for drinking purpose in the study area.

Materials and Methods

Six groundwater samples were collected during field visit in the month of June 2019 in plastic 250 ml bottles (Table 1). Geo-coordinates of groundwater sample locations were noted using mobile GPS. Chemical analysis of groundwater samples was done using Tamil Nadu Water Supply and Drainage Board (TWAD), Chennai - prepared Field Water Testing Kit for ten chemical parameters-pH, hardness, chloride, fluoride, iron, ammonia, nitrite, nitrate, phosphate and residual chlorine(Table2). The groundwater samples analysis results have been categorized as desirable, permissible and non-potable on the basis of BIS Drinking Water Standards (IS 10500:2012) (Table3).

Results and Discussion

pH

In the study area pH varies from 7 to 8. pH is desirable in all the six groundwatersamples-Shiv Colony-S1, Barwala (8.0), Near Bhareli Road, Barwala (7.0), Shiv Colony-S2, Barwala (7.5), Power House Colony-S1, Batawar, Near Bhagwanpur Road, Batawar (7.5) and Power House Colony-S2, Batawar (7.0) (Figure 2).

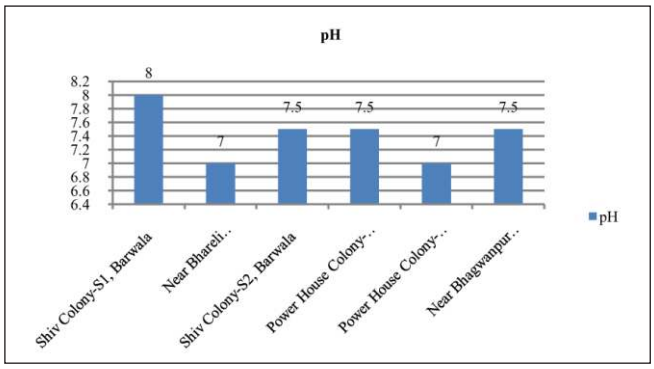

Figure 2: pH in groundwater samples.

Table 1: Groundwater sample locations in the study area.

S. No.	Sample Location	Source	Latitude	Longitude
1.	Shiv Colony-S1, Barwala	Hand Pump	30.556763°	76.943313°
2.	Near Bhareli Road, Barwala	Hand Pump	30.554332°	76.938308°
3.	Shiv Colony-S2, Barwala	Tube Well	30.557629°	76.942901°
4.	Power House Colony-S1, Batawar	Tube Well	30.557288°	76.947365°
5.	Near Bhagwanpur Road, Batawar	Tube Well	30.552843°	76.946186°
6.	Power House Colony-S2, Batawar	Hand Pump	30.557135°	76.947375°

Table 2: Results of chemical analysis of groundwater samples.

S. No.	Sample Location	pH	Hardness (mg/l)	Chloride (mg/l)	Fluoride (mg/l)	Iron (mg/l)	Ammonia (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	Residual Chlorine (mg/l)
1.	Shiv Colony-S1, Barwala	8.0	250	150	0.5	1.0	2.0	0.5	100	1.0	0.2
2.	Near Bhareli Road, Barwala	7.0	400	100	1.0	2.0	5.0	0.2	150	0.5	0.5
3.	Shiv Colony-S2, Barwala	7.5	400	150	1.0	5.0	0.5	0.2	45	0.5	0.2
4.	Power House Colony-S1, Batawar	7.5	150	150	1.0	0.3	5.0	1.0	100	0.5	0.2
5.	Near Bhagwanpur Road, Batawar	7.5	310	150	1.0	0	0.5	0.2	45	1.0	0
6.	Power House Colony-S2, Batawar	7.0	300	100	0.5	0.3	5.0	0.5	100	1.0	0.2

Table 3: BIS drinking water standards (IS 10500:2012)

S. No.	Constituent	Potable		Non-Potable
		Desirable	Permissible	
1.	pH	6.5 to 8.5	-	<6.5 to >8.5
2.	Total Hardness (mg/l)	<200	200-600	>600
3.	Chloride (mg/l)	<250	250-1000	>1000
4.	Fluoride (mg/l)	<1.0	1.0-1.5	>1.5
5.	Iron (mg/l)	<0.3	-	>0.3
6.	Ammonia (mg/l)	<0.5	-	>0.5
7.	Nitrite (mg/l)	<1.0	-	>1.0
8.	Nitrate (mg/l)	<45	-	>45
9.	Phosphate (mg/l)	<1.0	-	>1.0
10.	Residual Chlorine (mg/l)	<0.2	0.2-1	>1.0

Hardness

In the study area, hardness ranges from 150 mg/l to 400 mg/l. Hardness is desirable in groundwater sample at Power House Colony-S1, Batawar (150 mg/L) and permissible in groundwater samples at Shiv Colony-S1, Barwala (250 mg/l), Near Bharel Road, Barwala (400 mg/l), Shiv Colony-S2, Barwala (400 mg/l), Near Primary Health Centre, Barwala (360 mg/l),NearBhagwanpur Road, Batawar (310 mg/l), Power House Colony-S2, Batawar (300 mg/l) (Figure 3).

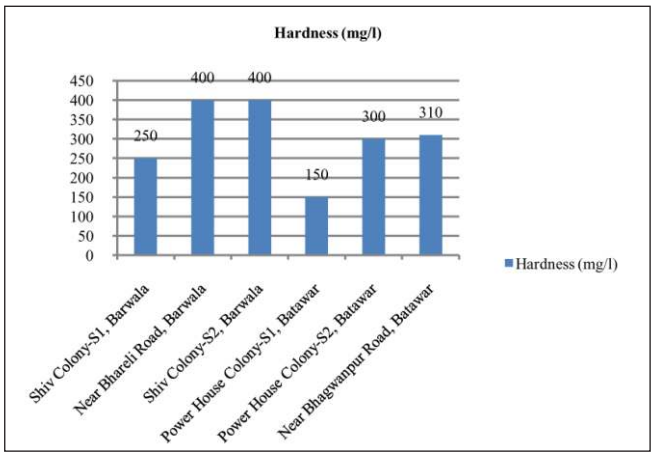

Figure 3: Hardness in groundwater samples.

Chloride

In the study area, chloride ranges from 100 mg/l to 250 mg/l. Chloride is desirable in all the sixgroundwater samples - Shiv Colony-S1, Barwala (150 mg/l), Near Bhareli Road, Barwala (100 mg/l), Shiv Colony-2, Barwala (150 mg/l), NearBhagwanpur Road, Batawar (150 mg/l), Power House Colony-S2, Batawar (100 mg/l), Power House Colony-S1, Batawar (150 mg/) (Figure 4).

Fluoride

In the studyarea, fluoride ranges from 0.5 mg/l to 1 mg/l.Fluoride is desirable in all the six groundwater samples at Shiv Colony-S1, Barwala (0.5 mg/l), Near Bhareli Road, Barwala (1.0 mg/l), ShivColony-S2, Barwala (1.0 mg/l), Power House Colony-S1, Batawar (1.0 mg/l), Near Bhagwanpur Road, Batawar (1.0 mg/l), Power House Colony-S2, Batawar (0.5 mg/l) (Figure 5).

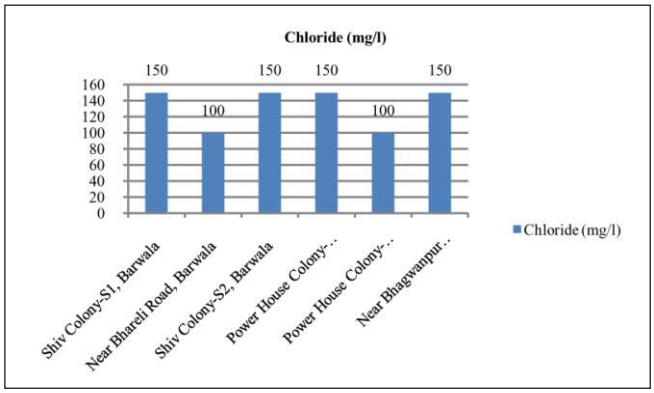

Figure 4: Chloride in groundwater samples.

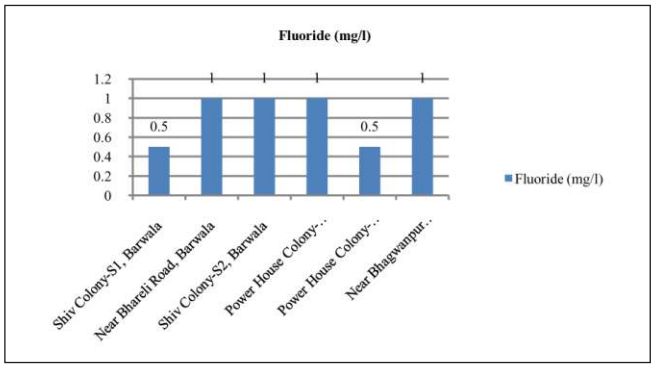

Figure 5: Fluoride in groundwater samples.

Iron

In the study area, iron ranges from 0 mg/l to 5.0 mg/l.Iron is desirable in groundwater samples at Power House Colony-S1, Batawar (0.3 mg/l), Near Bhagwanpur Road, Batawar (0 mg/l),Power House Colony-S2, Batawar (0.3 mg/l) and non-potable in groundwater samples at Shiv Colony-S1, Barwala

(1.0 mg/l), Near Bhareli Road, Barwala (2.0 mg/l), Shiv Colony-S2, Barwala (5.0 mg/l) (Figure 6).

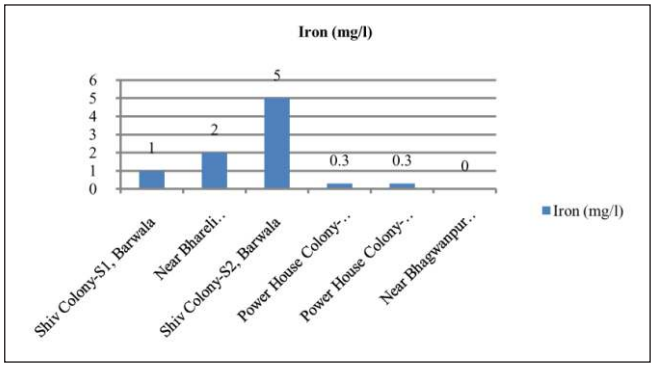

Figure 6: Iron in groundwater samples.

Ammonia

In the study area, ammonia ranges from 0.5 mg/l to 5.0 mg/l. Ammonia is desirable in groundwater samples atShiv Colony-S2, Barwala (0.5 mg/l),Near Bhagwanpur Road, Batawar (0.5 mg/l) and non-portable in groundwater samples at Shiv Colony-S1, Barwala (2.0 mg/l), Near Bhareli Road, Barwala (5.0 mg/l), Power House Colony-S1, Batawar (5.0 mg/l),Power House Colony-S2, Batawar (5.0 mg/l) (Figure 7).

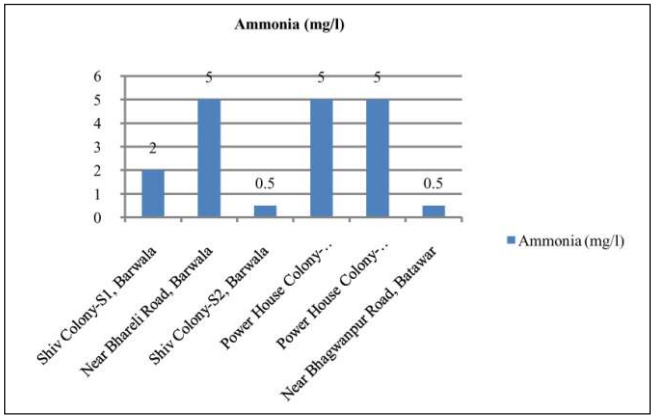

Figure 7: Ammonia in groundwater samples.

Nitrite

In the study area, nitrite ranges from 0.2 mg/l to 1 mg/l. Nitrite is desirable in allthe six groundwater samples - Shiv Colony-S1, Barwala (0.5 mg/l), Near Bhareli Road, Barwala (0.2 mg/l), ShivColony-S2, Barwala (0.2 mg/l), Power House Colony-S1, Batawar (1.0 mg/l), Near Bhagwanpur Road, Batawar(0.2 mg/l) and Power House Colony-S2, Batawar (0.5 mg/l) (Fig.8).

Nitrate

In the study area, nitrate ranges from 20 mg/l to 150 mg/l. Nitrate is desirable in groundater samples atShiv Colony-S2, Barwala Town (45 mg/l), Near Bhagwanpur Road, Batawar (45 mg/l) andnon-portable in groundwater samples atShiv Colony-S1, Barwala (100 mg/l), Near Bhareli Road, Barwala (150 mg/l), Power House Colony-S1, Batawar (100 mg/l) andPower House Colony-S2,Batawar (100 mg/l) (Figure 9).

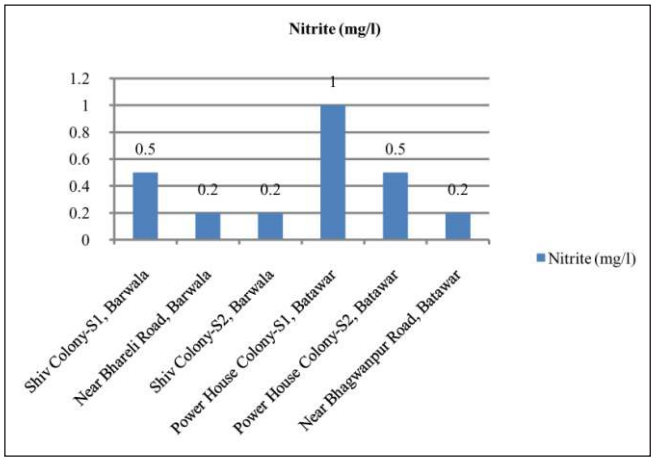

Figure 8: Nitrite in groundwater samples.

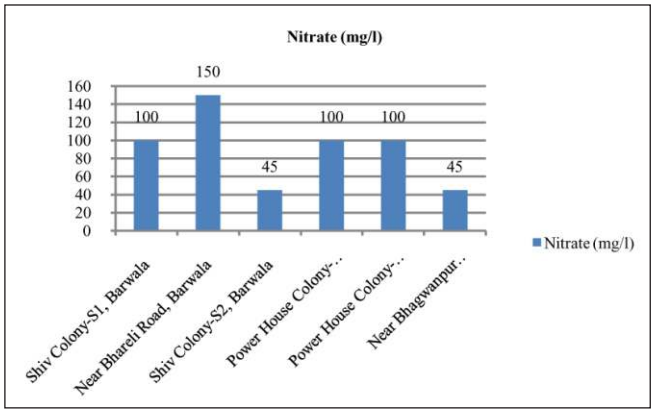

Figure 9: Nitrate in groundwater samples.

Phosphate

In the study area, phosphate ranges from 0.5 mg/l to 1.0 mg/l. Phosphate is desirable in all the six groundwater samples- Shiv Colony-S1, Barwala (1.0 mg/l), Near Bhareli Road, Barwala (0.5mg/l), Shiv Colony-S2, Barwala (0.5 mg/l), Power House Colony-S1, Batawar(0.5 mg/l), Near Bhagwanpur Road, Batawar (1.0 mg/l), Power House Colony-S2, Batawar (1.0 mg/l) (Figure 10).

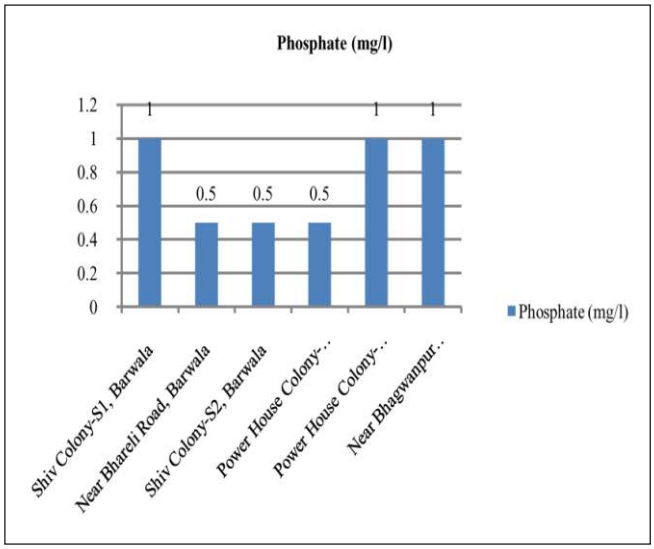

Figure 10: Phosphate in ground water samples.

Residual Chlorine

In the study area, residual chlorine ranges from 0 mg/l to 0.5 mg/l. Residual Chlorine is desiarable in five groundwater samples- Shiv Colony-S1, Barwala (0.2 mg/l), Shiv Colony-S2, Barwala (0.2 mg/l), Power House Colony-S1, Batawar (0.2 mg/l), Near Bhagwanpur Road, Batawar (0 mg/l), Power House Colony-S2, Batawar (0.2 mg/l) and permissible in Near Bhareli Road, Barwala (0.5 mg/l) groundwater sample (Figure 11).

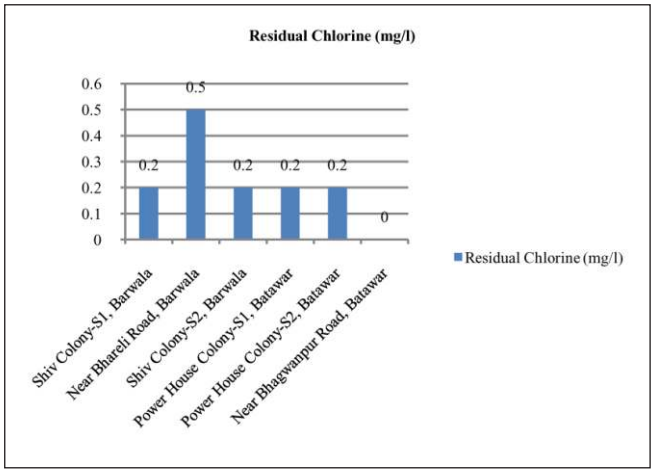

Figure 11: Residual Chlorine in groundwater samples.

Groundwater Quality At Sample Sites

Shiv Colony-S1, Barwala

In groundwater sample at Shiv Colony-S1, Barwala pH (desirable), hardness (permissible), chloride (desirable), fluoride (desirable), iron (non-potable), ammonia (non-potable), nitrite (desirable), nitrate (non- potable), phosphate (desirable) and residual chlorine (desirable) (Figure 12). Overall the groundwater is non-potable due to high iron, ammonia and nitrate.

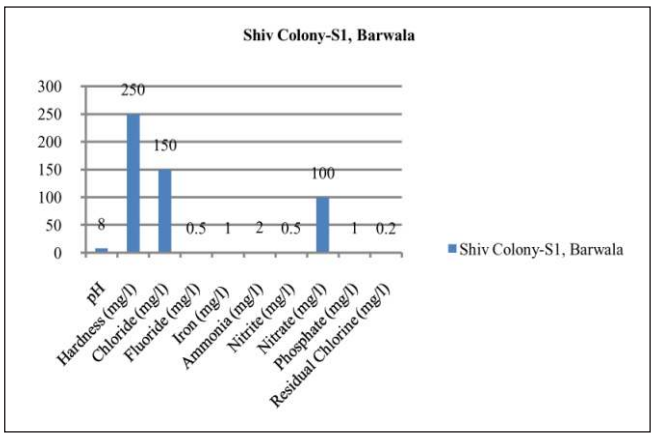

Figure 12: Groundwater quality at Shiv Colony-S1, Barwala.

Shiv Colony-S2, Barwala

In groundwater sample at Shiv Colony-S2, Barwala pH (desirable), hardness (permissible), chloride (desirable), fluoride (desirable), iron (non-potable), ammonia (desirable), nitrite (desirable), nitrate(desirable), phosphate (desirable) and residual chlorine (desirable) (Figure 13). Overall the groundwater is non-potable due to high iron in the groundwater.

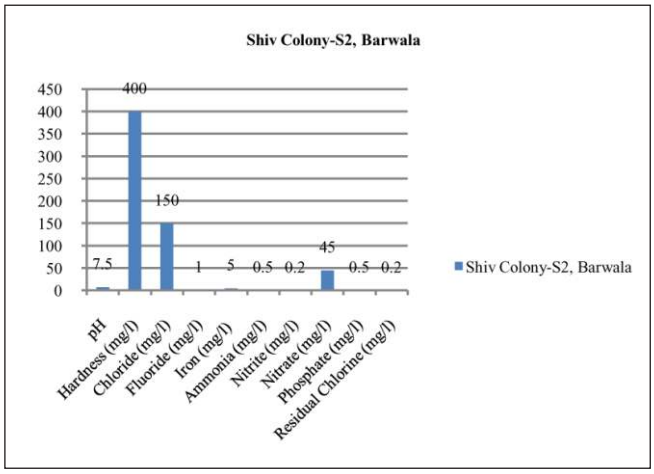

Figure 13: Groundwater quality at Shiv Colony-S2, Barwala.

Near Bhareli Road, Barwala

In groundwater sample at Near Bhareli Road, Barwala pH (desirable), hardness (permissible), chloride (desirable), fluoride (desirable), iron (non-potable), ammonia (non-potable), nitrite (desirable), nitrate (non-potable), phosphate (desirable) and residual chlorine (desirable) (Figure 14). Overall the groundwater is non-potable due to high iron, ammonia and nitrate.

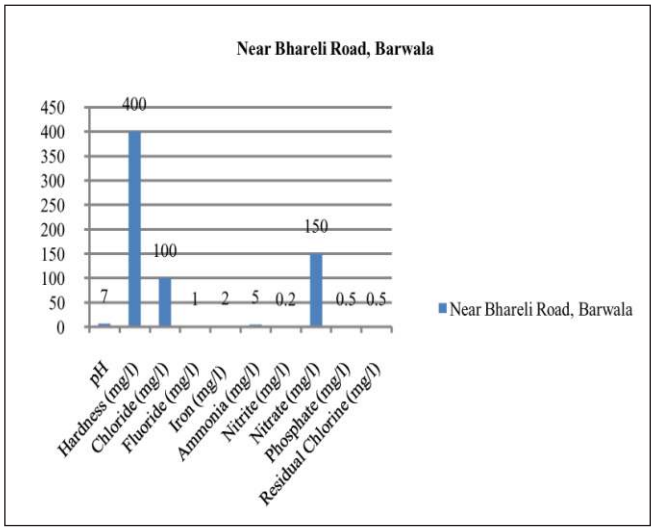

Figure 14: Groundwater quality at Near Bhareli Road, Barwala.

Power House Colony-S1, Batawar

In groundwater sample at Power House Colony-S1, Batawar pH (desirable), hardness (desirable), chloride (desirable), fluoride (desirable), iron (desirable), ammonia (non-potable), nitrite (desirable), nitrate (non-potable), phosphate (desirable) and residual chlorine (desirable) (Figure 15). Overall the groundwater is non-potable due to high ammonia and nitrate.

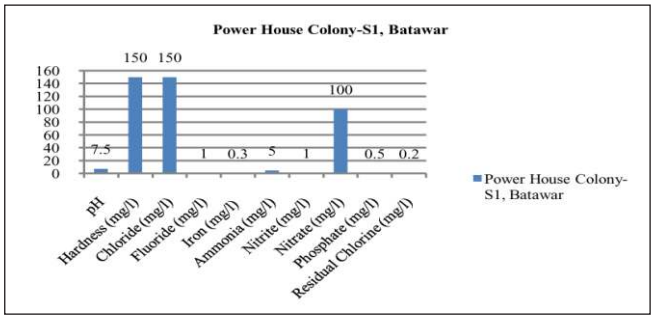

Figure 15: Groundwater quality at Power House Colony-S1, Batawar.

Power House Colony-S2, Batawar

In groundwater sample at Power House Colony-S2, Batawar pH (desirable), hardness (permissible), chloride (desirable), fluoride (desirable), iron (desirable), ammonia (non-potable), nitrite (desirable), nitrate (non-potable), phosphate (desirable) and residual chlorine (desirable) (Figure 16).Overall the groundwater is non-potable due to high ammonia and nitrate.

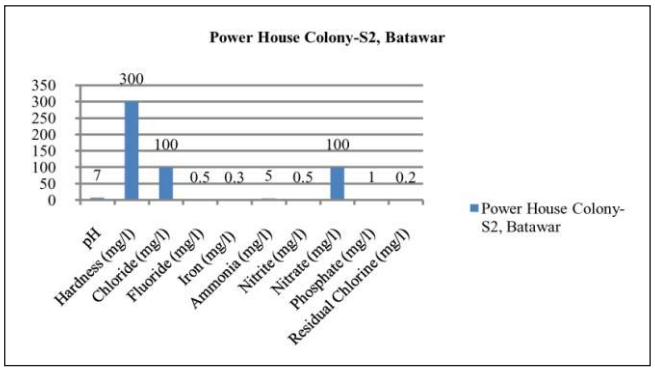

Figure 16:Groundwater quality at Power House Colony-S2, Batawar.

Near Bhagwanpur Road, Batawar

In groundwater sample at Near Bhagwanpur Road, Batawar pH (desirable), hardness (permissible), chloride (desirable), fluoride (desirable), iron (desirable), ammonia (desirable), nitrite (desirable), nitrate (desirable), phosphate (desirable) and residual chlorine (desirable) (Figure 17). Overall the groundwater is drinkable because all the analysed chemical parameters are under potable category of BIS drinking water standards (IS 10500:2012).

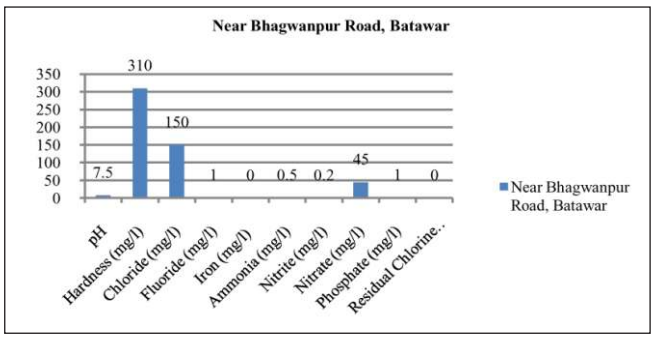

Figure 17:Groundwater quality at Near Bhagwanpur Road, Batawar.

CONCLUSIONS

In the study area pH ranges from 7 to 8 and desirable for drinking purpose in all the six groundwater samples. Hardness ranges from 150 mg/l to 400 mg/l and desirable in one groundwater sample and permissible in groundwater samples at Shiv Colony-S1, Barwala (250 mg/l), Near Bharel Road, Barwala (400 mg/l), Shiv Colony-S2, Barwala (400 mg/l), Near Primary Health Centre, Barwala (360 mg/l), Near Bhagwanpur Road, Batawar (310 mg/l), Power House Colony-S2, Batawar (300 mg/l). Chloride ranges from 100 mg/l to 150 mg/l and desirable in all the six groundwater samples. Fluoride ranges from 0.5 mg/l to 2 mg/l and desirable in all the six groundwater samples. Iron ranges from 0 mg/l to 5.0 mg/l and desirable in three groundwater samples and non-potable in groundwater samples at Shiv Colony-S1, Barwala (1.0 mg/l), Near Bhareli Road, Barwala (2.0 mg/l),Shiv Colony-S2, Barwala (5.0 mg/l), Near Primary Health Centre, Barwala (3.0 mg/l). Ammonia ranges from 0.5 mg/l to 5.0 mg/l and desirable in two groundwater samples and non-potable in groundwater samples at Shiv Colony-S1, Barwala (2.0 mg/), Near Bhareli Road, Barwala (5.0 mg/l), Power House Colony-S1, Batawar (5.0 mg/l),Power House Colony-S2, Batawar (5.0 mg/l). Nitrite ranges from 0.2 mg/l to 1 mg/l and desirable in all the six groundwater samples. Nitrate ranges from 45 mg/l to 150 mg/l and desirable in two groundwater samples and non-portable in groundwater samples at Shiv Colony-S1, Barwala (100 mg/l), Near Bhareli Road, Barwala (150 mg/l),Power House Colony-S1, Batawar (100 mg/l) andPower House Colony-S2,Batawar (100 mg/l). Phosphate ranges from 0.5 mg/l to 1.0 mg/l and desirable in all the six groundwater samples. Residual chlorine ranges from 0 mg/l to 0.5 mg/l and desirable in five groundwater samples and permissible in Near Bhareli Road, Barwala (0.5 mg/l) groundwater sample. Shiv Colony-S1, Barwala groundwater is non-potable due to high iron, ammonia and nitrate, Shiv Colony-S2, Barwala groundwater is non-potable due to high iron in the groundwater, Near Bhareli Road, Barwala groundwater is non-potabledue to high iron, ammonia and nitrate, Power House Colony-S1, Batawar groundwater is non-potable due to high ammonia and nitrate, Power House Colony-S2, Batawar groundwater is non-potable due to highammonia and nitrate, Near Bhagwanpur Road, Batawar groundwater is drinkable because all the analysed chemical parameters are under potable category.

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