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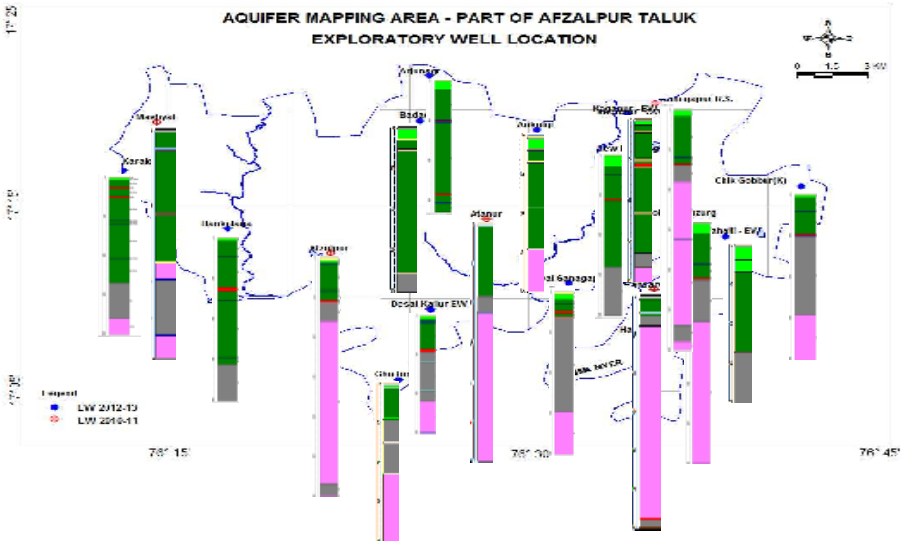
Government of India
Ministry of Water Resources,
River Development & Ganga Rejuvenation
Central Ground Water Board

AFZALPUR TALUK AQUIFER MAPS AND MANAGEMENT PLAN, GULBARGA DISTRICT, KARNATAKA STATE



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AFZALPUR TALUK AQUIFER MAPS AND MANAGEMENT PLAN, GULBARGA DISTRICT, KARNATAKA STATE

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1. SALIENT INFORMATION

Name of the taluk: **AFZALPUR**

District: Gulbarga;

State: Karnataka

Area: 1050 sq.km.

Population: 1,80,071

Annual Normal Rainfall: 667 mm

1.1 Aquifer Mapping study area

The Aquifer Mapping Study area is located in the northern part of Karnataka, which is generally known as Deccan plateau. The study area constitutes 1050 sq. km covering parts of Afzalpur Taluk of Gulbarga district and is falling in Survey of India Toposheets No. 56 C/3,C/4,C/7,C/8,C/11 & C/12 within the N Latitudes $17^0$03'30'' - $17^0$22'40''and E Longitudes $76^0$12'45'' - $76^0$42'35''. The area is bounded on the north by Aland taluk and Maharashtra State, on the west by the districts Maharashtra State, on the east by the Gulbarga taluk and on the south by the Jewargi taluk and Bijapur district. The Bhima River forms the entire southern boundary of the area (Figure-1.1). The taluk has a total geographical area of 1304.74 sq. kms. The taluk has 89 inhabited and 4 uninhabited villages. Afzalpur is the taluk headquarters.

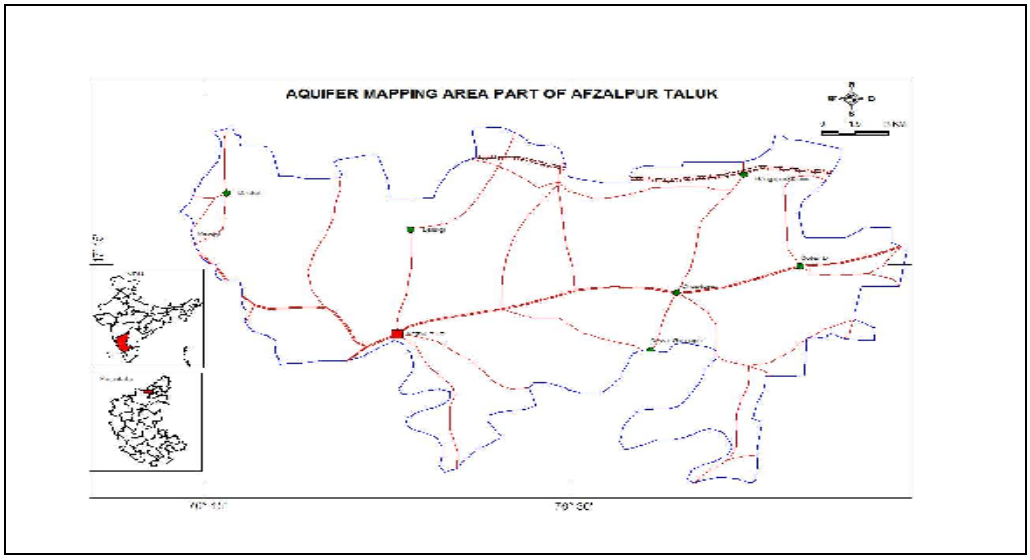

Fig 1.1: Location Map of Aquifer Mapping Study area, Afzalpur taluk,

1.2 Population: The population of the Afzalpur taluk according to the 2011 Census is 2,20,339, of which 1,93,251 (88%) constitutes the rural population. The population density of

the taluk is 169 /sq km. During the last decade (2001 to 2011), the taluk has witnessed a decennial growth rate of 22.36 %.

1.3 Rainfall

Rainfall is moderate to low, besides being quite capricious as a result drought and scarcity conditions occur in the area quite frequently. The average annual rainfall is 667 mm and there would be an average of 47 rainy days spread over 6 months period. The amount of rainfall increases slightly from southwest to northeast. SW monsoon, which accounts for 81% of annual precipitation usually sets in mid June and ends in September. Usually September month receives highest rainfall.

The area is categorized as drought prone due to low annual precipitation. The minimum and maximum actual annual rainfall recorded at Afzalpur rain gauge station in the last ten years are 472.5 mm and 951.4 mm respectively. The minimum actual annual rainfall recorded in the Aquifer Mapping Study area in the last decade is 424.9 mm in 2003 (Chaudapur) and maximum is 1171.8 mm in 2010 (Gobur Buzurg).

1.4 Land use pattern

As per the statistical figures of the taluk for the year 2010-11, nearly 1,20,230 hectares form the net area sown, which is about 92.1% of the area of the taluk. The gross cropped area of the taluk is 1,38,410 hectares and area sown more than once is 18,180 hectares.

1.5 Cropping Pattern

The main crops grown in the area are jowar, wheat, bajra, oilseeds, cotton, pulses and sugarcane. The pulses are grown in 77076 hectares and jowar in 30953 hectares. Area under pulses and sugarcane has increased significantly, when compared to 2005-06 and 2010-11.

1.6 Irrigation facilities

Groundwater accounts for about 88% of the net area under irrigation and thus, groundwater forms the main source of irrigation in the Afzalpur taluk.

The net area under irrigation is 21487 Ha. The net area under irrigation has increased by 85% in the area due to 632% increase in the area under bore wells and 33% area increase under dugwells since 2005-06. Similarly, the area irrigated under Lift Irrigation Scheme has increased by 198% in the taluk since last five years.

1.7 Physiography, Geomorphological features and landforms

The area presents a gently rolling topography and vast stretches topped by block cotton soil. Broad valleys with intervening flat-topped country are by far the most predominant geomorphic feature in the terrain. In general, the area exhibits an undulating topography with

table lands characteristics of Deccan traps in the north of the study area. The average land elevation is in the range of 400 and 520 m amsl. The general slope of the area is towards south direction.

1.8 Drainage and Morphometric parameters

The **Bhima River** is a major tributary of the Krishna River. Bhima river forming the southern boundary, meanders from west to east. The area has an intricate drainage network comprising Bhima River and its tributaries. Bhima, which is the only perennial river, traverses the entire area in SW-SE direction. The area falls in Bhima sub-basin of Krishna River basin. A number of minor streams and nallas join the river and Amarja river, Bori river and Garaganji Nalla are the important tributaries of Bhima River in the Aquifer Mapping Study area of Afzalpur taluk (Fig 1.2).

Drainage pattern is dendritic and trellis type, which are typical of black cotton soils and Deccan trap country. The drainage density measured quadrant wise in 1:50,000 scale ranges from 0.80 to 1.81 km/km^2.

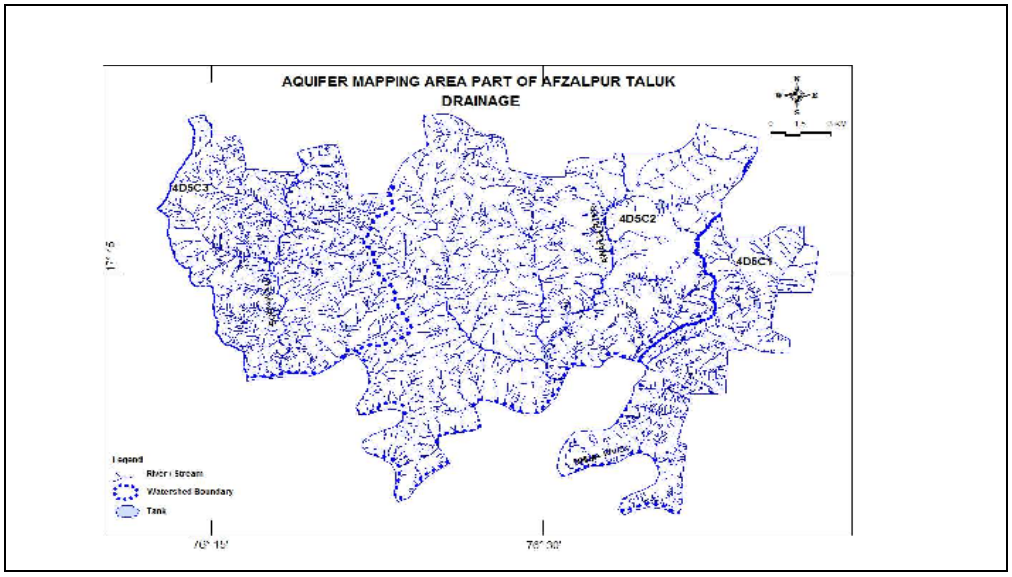

Fig 1.2: Drainage Map, parts of Afzalpur taluk, Gulbarga district

1.9 Soils and their characteristics

Most of the area on the bank of river Bhima, consists of black cotton soils with patches of murrem and sandy soils on the elevated parts. The soils have developed on weathered, vesicular and amygdaloidal traps. Red soils have high rate of infiltration, followed by mixed soils and black cotton soils.

1.10 Water Use and Demand

There are 759 bore wells in Afzalpur taluk drilled by Public Health Engineering Department for rural water supply. In addition to bore wells, a number of dug wells are also catering to the

needs of water supply. During summer, the role of groundwater in water supply has become very significant. There are 113 water supply schemes and 124 mini water supply schemes in Afzalpur taluk to meet drinking water supply.

1.11 Irrigation projects – Major, Medium and Minor

The major irrigation project is Bhima Lift Irrigation Scheme across Bhima river which is located at Sonna site of Afzalpur taluk. The total length of canal is 99.55 km with command area of 24292 hectares. The number of villages benefitted from the project is 44.

The medium irrigation Amarja Project across Amarja river is located at about 1.5 km south of Sangolgi village, Aland Taluk. The total length of canal is 97.26 km with gross command area of 14959 hectares.

1.12 Ground Water Resources Availability, Extraction, and future water demands

As per ground water estimation 2011, in Afzalpur taluk the net annual ground water availability is 5667 Ham. The existing gross ground water draft for irrigation is 3139 Ham and draft for domestic and industrial water supply is 223 Ham. Thus, the total ground water draft for all uses amounts to 3362 Ham (Table-1.1).

Allocation for domestic and industrial water supply for next 25 years is 268 Ham. The net ground water availability for future irrigation development is 2260 Ham. The existing stage of ground water development is 59% is categorized under 'Safe' category.

As on March 2011, the total ground water resource availability is 7580 ham, of which annual replenishable ground water resource is 5667 ham and fresh in-storage ground water resources in fractured aquifers up to the depth of 200m is 1913 ham (Table-1.2).

Table 1.1: Ground Water Resources in Afzalpur Taluk (2011) (in Ha.m.)

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF KARNATAKA STATE - AMINISTRATIVE UNIT WISE RESOURCE (2011) (in Ham)

District	Taluk	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Allocation for Domestic And Industrial Use for Next 25 Years	Net Ground Water Availability for future Irrigation Development	Existing Stage of Ground Water Development
Gulbarga	Afzalpur	5667	3139	223	3362	268	2260	59

Tble-1.2: Availability of Total Fresh Ground Water Resources in Afzalpur Taluk, Gulbarga District (Ham)

Name of the Assessment Unit		Annual Replenishable Ground Water Resources	Fresh In-Storage Ground Water Resources		Total Availability of Fresh Ground Water Resources
District	Taluk		Phreatic	Fractured	Dynamic + Phreatic + Fractured
Gulbarga	Afzalpur	5667	1146	767	7580

1.13 Depth to Water Levels

To study the behaviour of groundwater level in the study area, 65 observation wells were established along with the Exploratory Wells drilled by CGWB and were monitored monthly. The depth to water levels during the pre-monsoon period varies from 1.15 to 12.52 mbgl in dug wells (Table-1.3). The depth to water level of less than 2.00 mbgl is recorded throughout the year near Bhima River at south of Afzalpur and more than 10 mbgl in the northern belt of study area. The water table is deeper in the northern parts because of higher ground elevation and non-command area. About 59% of wells are within the water level range of 5 – 10 mbgl.

The depth to water levels during post- monsoon period varies from 0.40 to 14.79 mbgl in the open wells (Table-1.3). Depth to water level of 2 - 5 mbgl is observed in 35% of wells. The Pre- and Post-monsoon depth to water level maps are shown in Figures 1.3 & 1.4 respectively for Aquifer-I.

In the bore wells, the minimum depth water level ranges from 0.13 to 5.24 mbgl and maximum ranges from 13.15 to 30.0 mbgl (Table-1.4)**.** The Pre- and Post-monsoon depths to water level maps are shown in Figures 1.5 & 1.6 respectively for Aquifer-II.

Table-1.3: Depth to water level range in Dug Wells (Aquifer-I) 2012-13

Month	**No. of wells analysed**	**Depth to Water Level (mbgl)**	
		Minimum	**Maximum**
Pre-monsoon (June-July)	53	1.15 (Bonnahatti)	12.52 (Ganagapur Station)
August	50	0.80 (Igdangi)	13.99 (Mashyal)
September	54	0.55 (Bonnahatti)	11.32 (Ganagapur Station)
Post-monsoon (November)	52	0.40 (Guddewadi)	14.79 (Mashyal)
December		0.83 (Bonnahatti)	11.98 (Basnalwadi)
March	51	0.50 (Igdangi)	14.78 (Gobur Buzurg)

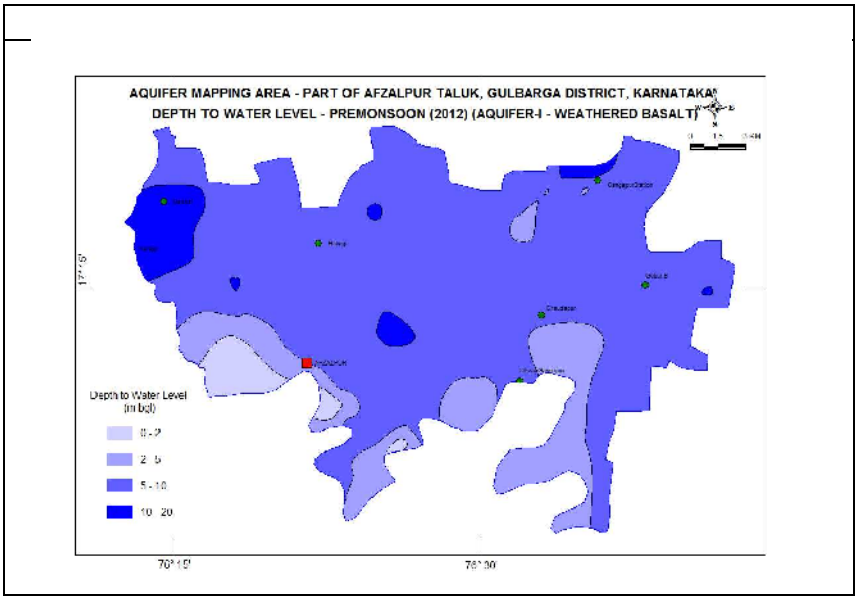

Fig1.3: Pre-monsoon Depth to Water Level (Aquifer-I)

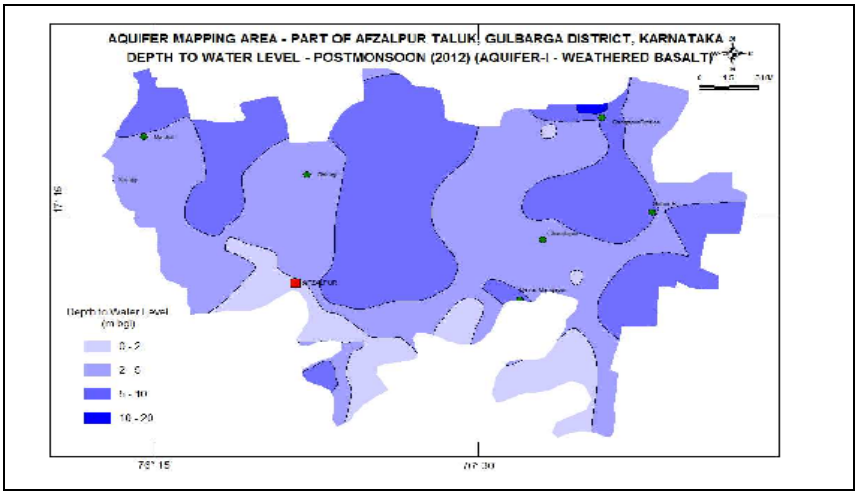

Fig 1.4: Depth to Water Level – Post-monsoon, Aquifer-I

Table 1.4: Depth to water level range in Bore Wells (Aquifer-II) 2012-13

Month	No. of wells analysed	Depth to Water Level (mbgl)	
		Minimum	Maximum
Pre-monsoon (June-July)	3	5.24 (Sonna)	13.15 (Nandarga)
August	5	4.50 (Sonna)	22.97 (Ganagapur Station)
September	14	2.02 (Deval Ganagapur)	29.03 (Bhosga)
Post-monsoon (November)	18	0.13 (Arjunagi)	28.80 (Bhosga)
December		2.13 (Deval Ganagapur)	28.52 (Bhosga)
March	22	2.52 (Deval Ganagapur)	30.0 (Bhosga)

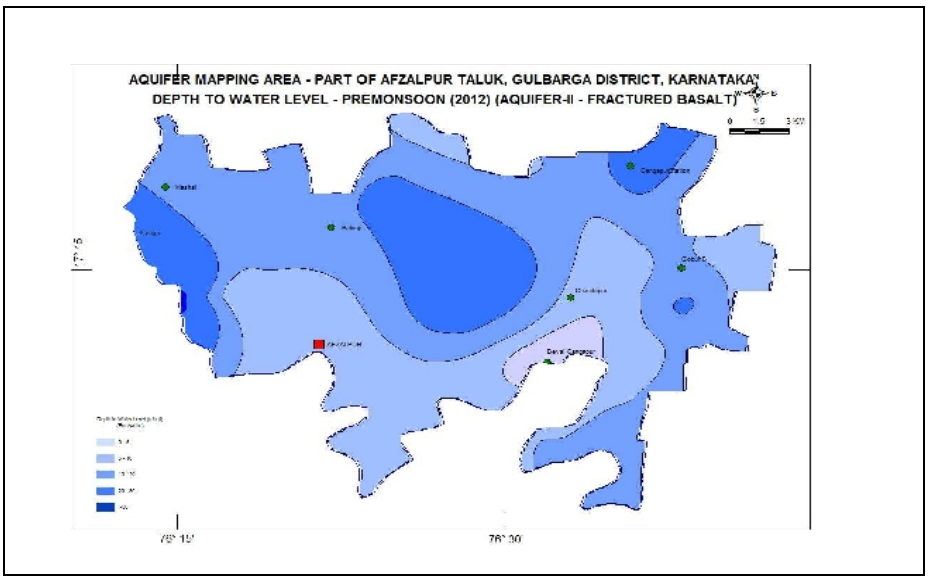

Fig 1.5: Pre-monsoon Depth to Water Level (Aquifer-II)

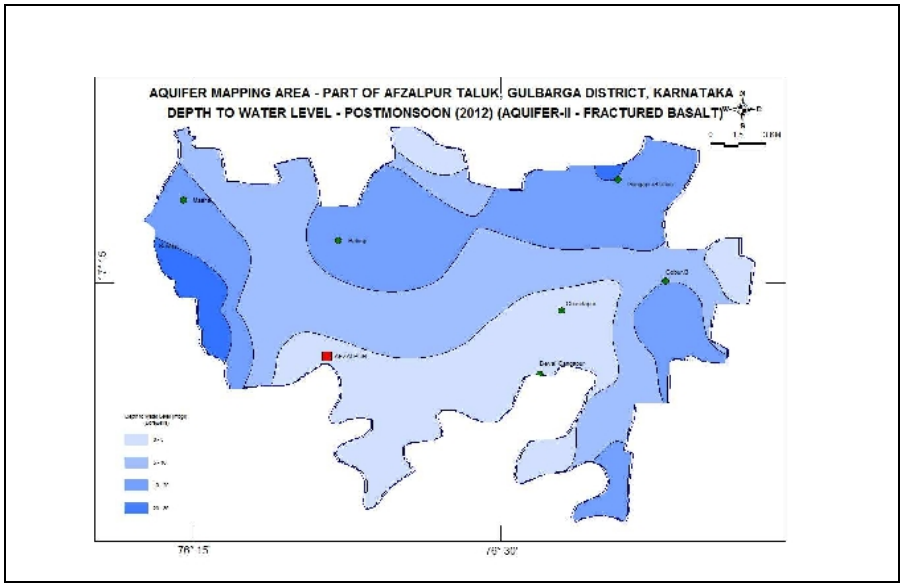

Fig 1.6: Post-monsoon Depth to Water Level (Aquifer-II)

In phreatic aquifer (Aquifer-I), general ground water flow is from North to South (Figure-1.7).

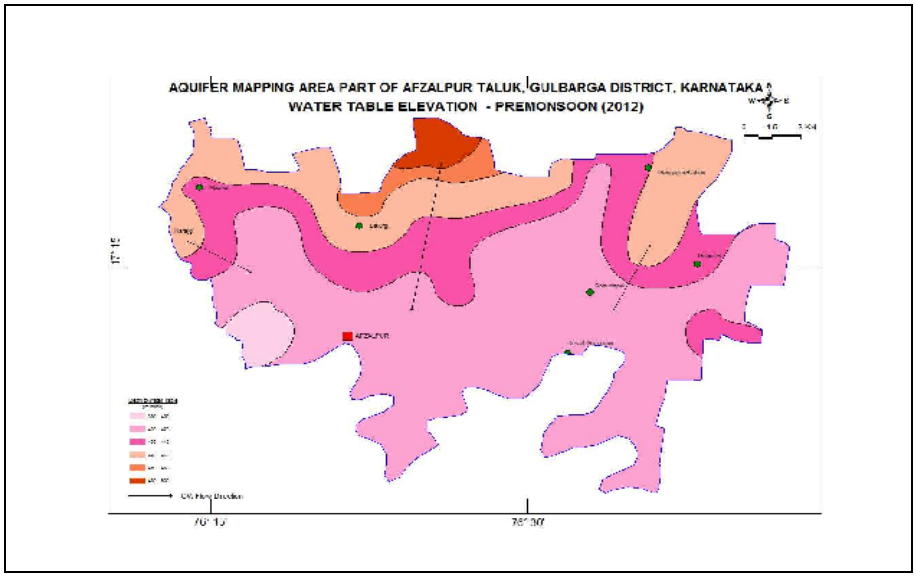

Fig 1.7: Water Table Elevation map (Pre-monsoon)

2. AQUIFER DISPOSITION

2.1 Geology

The Aquifer Mapping Study area is underlain by granitic gneisses of Archaean which are overlain by Shales and Limestones of Bhimas of Proterozoic age and basalts of Deccan traps (Eocene to Upper Cretaceous).

Peninsular gneisses are not exposed in the area and not encountered till the depth of 300 mbgl. **The Bhima formations** are represented by Sandstones, Shales and Limestones and they are also not exposed in the study area of Afzalpur taluk. Sandstones are not encountered in the study area. Limestones and shales are flaggy, bedded, fine grained and variegated colors. They occur at depths ranging from 25 mbgl near Bhima river to about 176 mbgl away from river in the northern end.

Between the Bhima Group of rocks and the overlying Deccan traps occurs a red bole horizon, varying in thickness from less than 1.0 m to 3.0 m. The basalts of first flow overlie the Bhima group with a parallel unconformity and are separated by red bole horizon.

Deccan Traps: Basaltic rocks of different flows overlie the Bhima formations and they occupy the entire area of the Aquifer Mapping Study in Afzalpur taluk. These are distinct flows identified with varying thickness ranging from 10.0 to 65 m. Six flows were differentiated in the elevation range 540 to 730 m above msl.

The red bole bed is a red colored clayey material and occurs as horizontal bands, varying in thickness from a few centimeters to about 3.0 meters. The Deccan traps comprise numerous

flows, each of which erupted separately. During the interval until the next eruption took place, the weathering of the exposed flows continued and sediments were deposited. The sedimentary beds were overlain by the subsequent flows. These inter-trappeans are generally porous and help in the recharge of groundwater. The Deccan trap flows show considerable lateral variation.

River alluvial deposits of recent origin are observed along the courses of Bhima and some of its tributaries and their thickness is less than 5.00 m. These are mostly composed of gravel, sand, silt and clayey loam with pebbles.

2.2 Aquifer geometry – shallow & deeper

Based on the drilling data the occurrence of three types of aquifers viz., shallow weathered zone, fractured and deep aquifers have been inferred. The study of the fence diagram (Figure-2.1) and 3-D block diagram (Figure-2.2) indicates a broad classification of three types of aquifers viz.

1. The top weathered zone, weathered basalt, which extends down to the depth of 30 m and forms the shallow or phreatic aquifer, tapped mostly by dug wells, dug-cum-bore wells and shallow bore wells.
2. Fractured aquifer, fractured basalt, limestones and shales which lies below the shallow zone, extends to a depth of 80 m. The maximum depth drilled in the area by the farmers is 110 m.
3. Deeper aquifer, the Bhima formations of shale and limestone, which is partially fractured and massive in nature and occurs below 80 to 110 m depth.

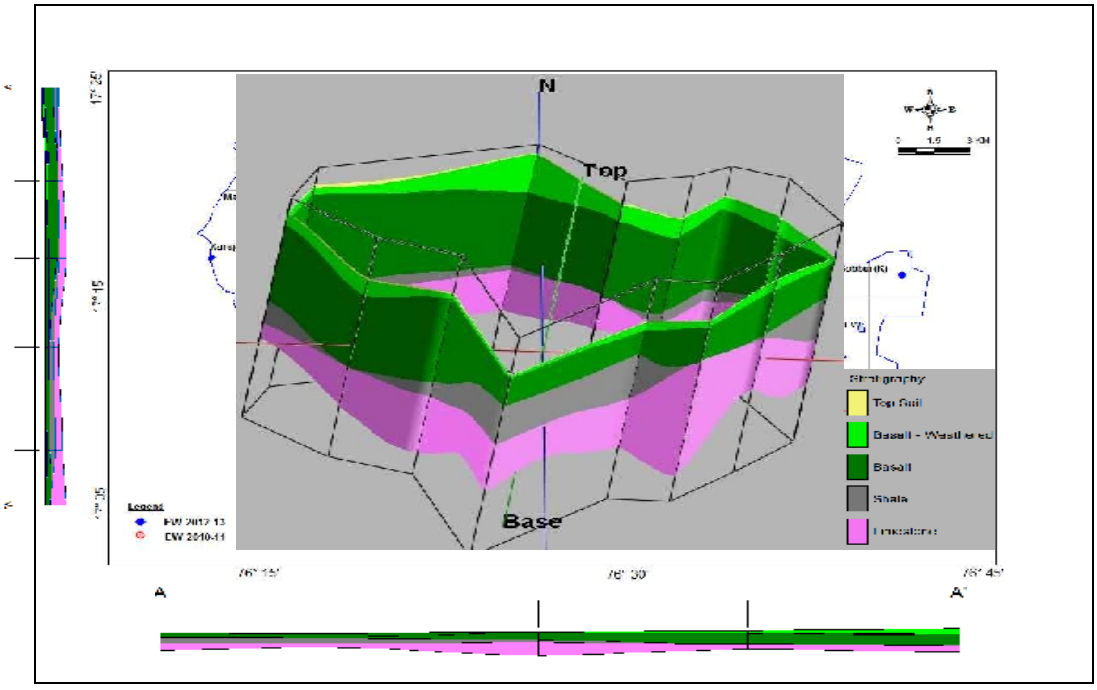

Fig 2.1: Fence Diagram & Cross Sections

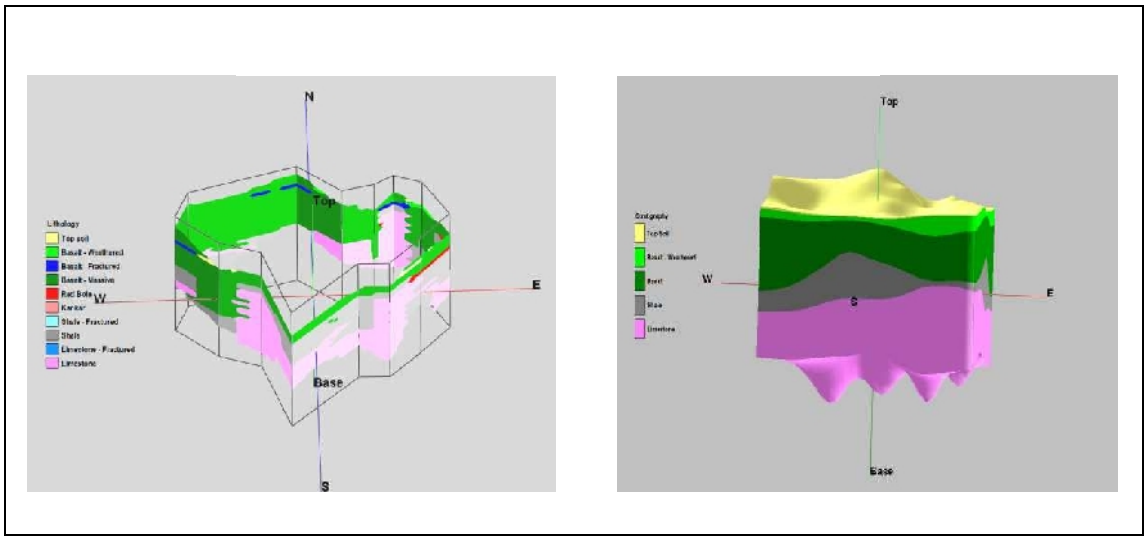

Fig 2.2: 3-D Block diagram of aquifers

2.3 Aquifer characteristics

The depth of the exploratory wells drilled varied from 58.55 to 302.30 m bgl and that of observation wells varied from 56.50 to 121.50 m bgl. The depth of the casing lowered ranges from 5.00 to 34.00 m bgl. The depth to water levels at the time of drilling varied from 0.63 to 200 m bgl. It has been observed that most of the fractures were encountered in the depth range 5 to 60 m bgl and only a few at deeper zones up to the depth of 187 m bgl. The results of the test data of these wells indicate that the transmissivity of the fractured aquifer varied from 0.80 m^2/day to 35 m^2/day. Location of exploratory wells along with 2-D strip diagram of litholog is given in Figure-2.3.

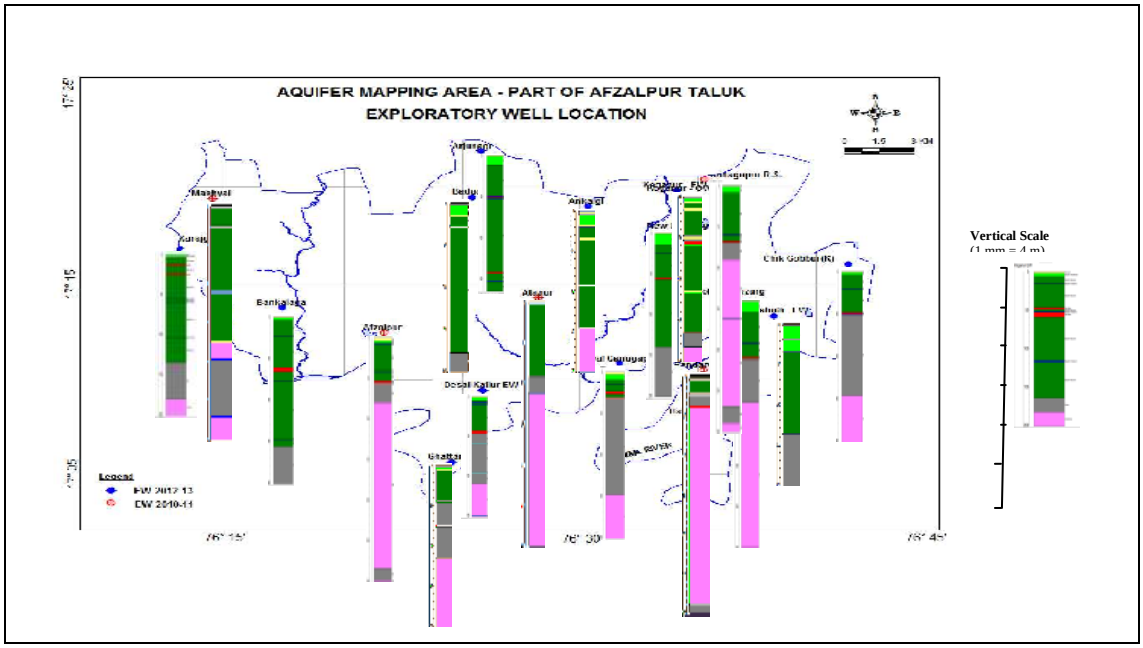

Fig 2.3: Location of Exploratory Wells with 2-D strip diagram of aquifers

2.4 Yields of groundwater abstraction structures

The yields of dug wells and dug-cum-bore wells vary from 20 to 200 m^3 /day for 2 to 8 hours of pumping. The yield goes down during summer months due to decline in water levels and poor storage.

In major part of the area (about 75%) the yields are <1lps. In about 20 % of the area, yields are within the range of 1-5 lps and in the rest it is >5 lps. In basalts, the productivity of wells is high in the depth range of 40-80 m. The productivity of wells drilled to the depth range of 40-60 m in limestone terrain is the highest. The productivity of wells drilled to the depth greater than 100 m is the lowest.

Bore wells drilled with depth range of 60 – 100 m recorded moderate discharge (3 lps) indicating good prospects for groundwater development through. The hydrogeological map is given in Figure-2.4.

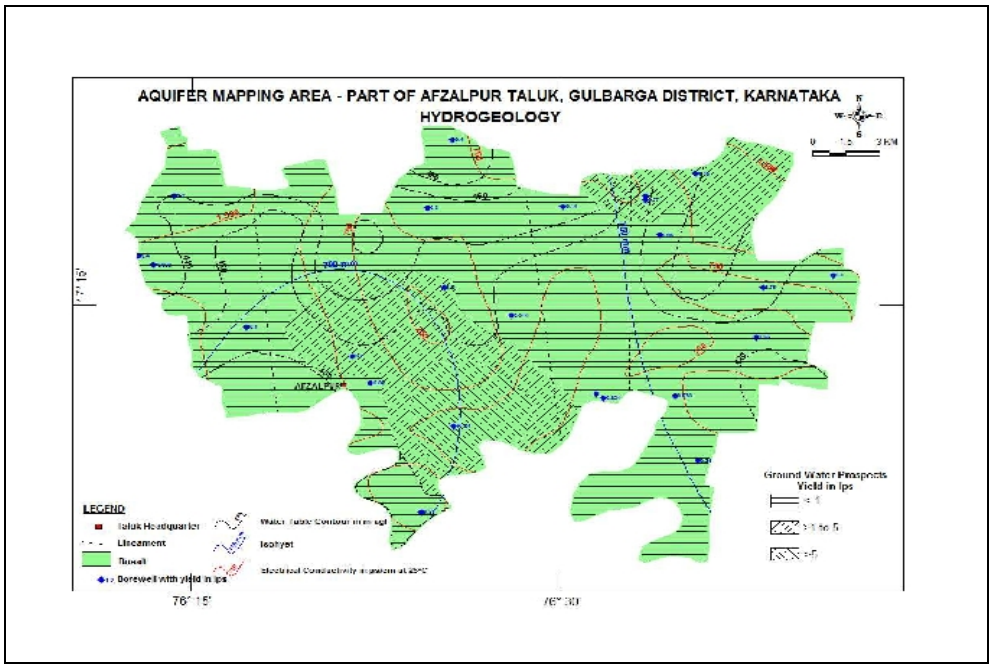

Fig 2.4: Hydrogeology map of parts of Afzalpur taluk, Gulbarga district

3. HYDROCHEMISTRY

For evaluation of chemical quality of ground water, 61 samples have been collected from key wells and subjected to chemical analysis in the Regional Chemical Laboratory, CGWB, SWR, Bangalore.

Hydrogen Ion Concentration (pH)

The pH of the groundwater varies from 7.4 to 9.8 and is within the permissible limit for drinking water standards (WHO 1971). pH value of more than 8.5 is observed in 25% of wells.

Specific Conductance (EC)

In the present study area the conductivity of groundwater samples varies from 230 to 2440 micro-mhos/cm at 25^0 C. However, the concentration of EC of 97% of the samples is within the permissible limit. Only 3% of samples falls under brackish in quality. EC map for Aquifer-I & Aquifer-II is given in Figure-3.1 & 3.2 respectively.

Figure-3.1: EC map

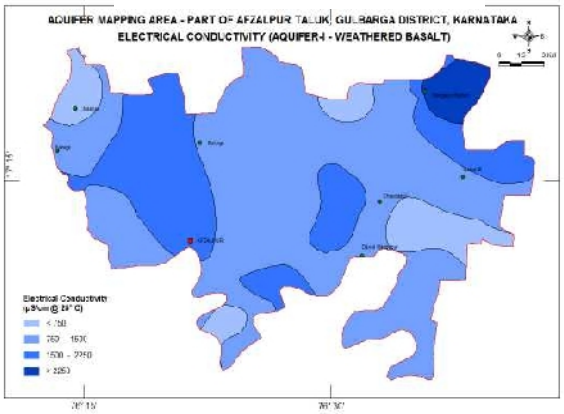

Fig 3.1: EC map (Aq-I)

Figure-3.2: EC map

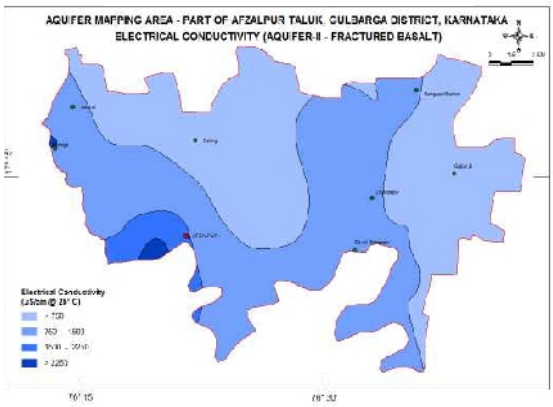

Fig 3.2: EC map (Aq-II)

Nitrate

In the present area under investigation, the nitrate concentration in groundwater ranges from 14 to 277 mg/l. Higher concentration (>45ppm) of nitrate is observed in 67% of 61 samples analysed. Higher concentration of nitrate may be due to use of excessive fertilizers in these areas for Sugarcane etc. The concentration of nitrate in weathered basalt (shallow aquifer-I) and fractured basalt (deeper aquifer-II) is presented in Figures-3.3 & 3.4 respectively.

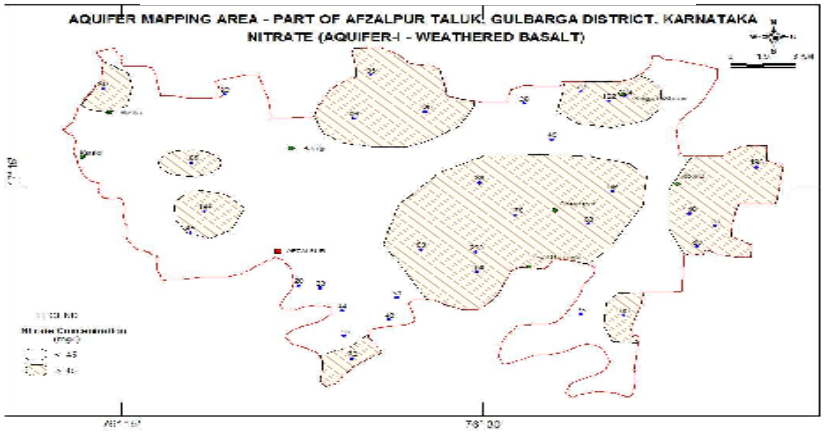

Fig 3.3: Concentration of Nitrate (Aquifer-I)

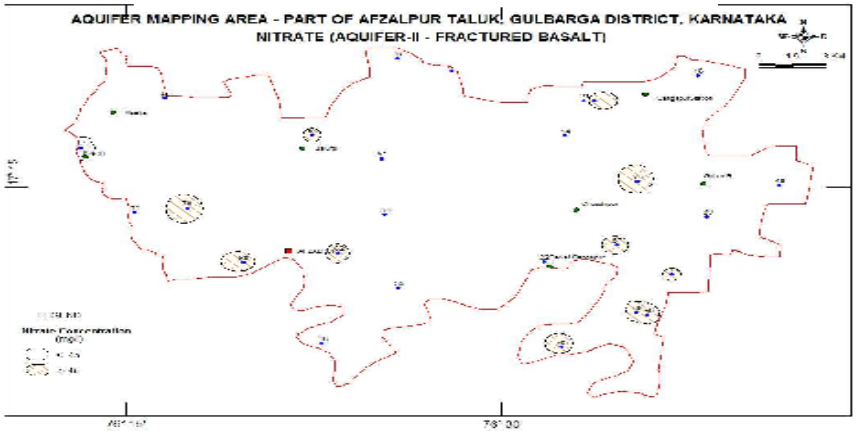

Fig 3.4: Concentration of Nitrate (Aquifer-II)

Fluoride

The fluoride concentration in groundwater of the area under investigation ranges from 0.20 to 3.35 mg/l. Majority of samples show the fluoride concentration less than 1.5 mg/l, which constitute 95% and only 5% of samples are in the range of more than 1.5 mg/l. The other constituents like K, Na, Ca, Mg, Co3, HCo3, So4, Cl etc are within the permissible limits.

In general, the ground water quality in the aquifer mapping study area of parts of Afzalpur taluk is potable for drinking and irrigation purposes.

3.1 Ground Water Vulnerability

The vulnerability map for parts of Afzalpur taluk is shown in Figure-3.5. It is seen from the map that parts of Afzalpur taluk falling in command areas as marked in the map is prone for pollution from fertilisers / insecticides and water logging in reaches close to Bhima River

drainage courses. Vulnerability to nitrate contamination in the taluk is seen in major parts of Afzalpur taluk.

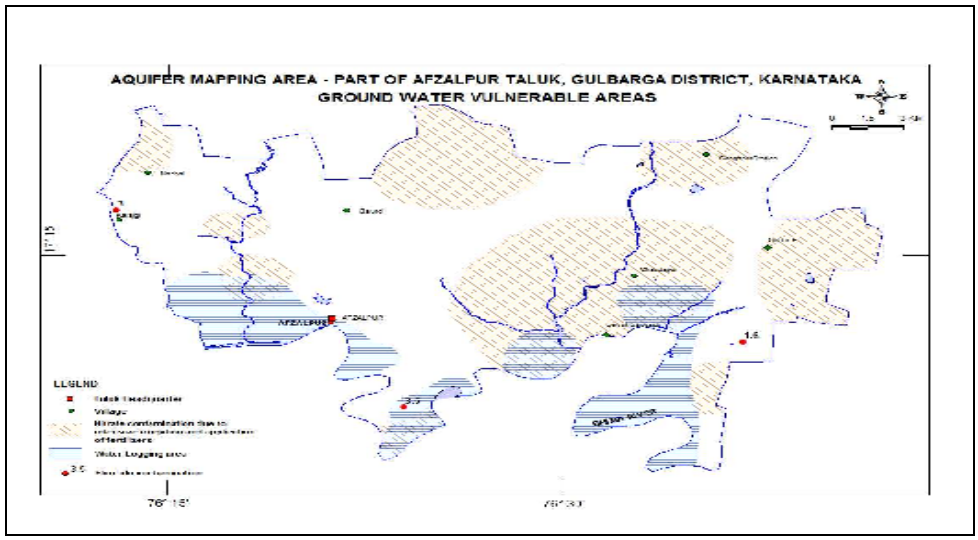

Fig 3.5: Vulnerability Map

4. AQUIFER MANAGEMENT PLAN

Based on the field study and analysis of hydrogeological data following recommendations are made for management plan of aquifers and optimum yield of the available water resources in the Aquifer Mapping Study area of parts of Afzalpur taluk, Gulbarga district.

4.1 Ground water resource enhancement from Artificial Recharge

The surplus non-committed monsoon runoff available for recharge is calculated as 15 MCM and rechargeable quantum is 8.313 MCM (Table 4.1).93 check dams and 6 percolation tanks are proposed as artificial recharge structures. The area feasible for water conservation has been arrived from the Depth to Water Level data and Slope data (Fig 4.1).

Table-4.1: Artificial Recharge Structures Proposed

Area (Sq.Km.)	1050
Hilly Area (Sq.km)	100
Non committed monsoon runoff available (MCM)	15
Number of Check Dams	93
Number of Percolation Tanks	6
Total Cost of CD (lakhs)	277
Total Cost of PT (lakhs)	46.9

Recharge from all CDs (MCM)	5.5
Recharge from all PTs (MCM)	2.813
Cost Benefit (Rs. / Cu M of Water Harvested)	4.25
Net Availability Before AR Project (HAM)	5667
Net Availability After AR Project (HAM)	7167
GW Draft (HAM)	3362
Improvement in Stage of GW Development (%)	59 to 52

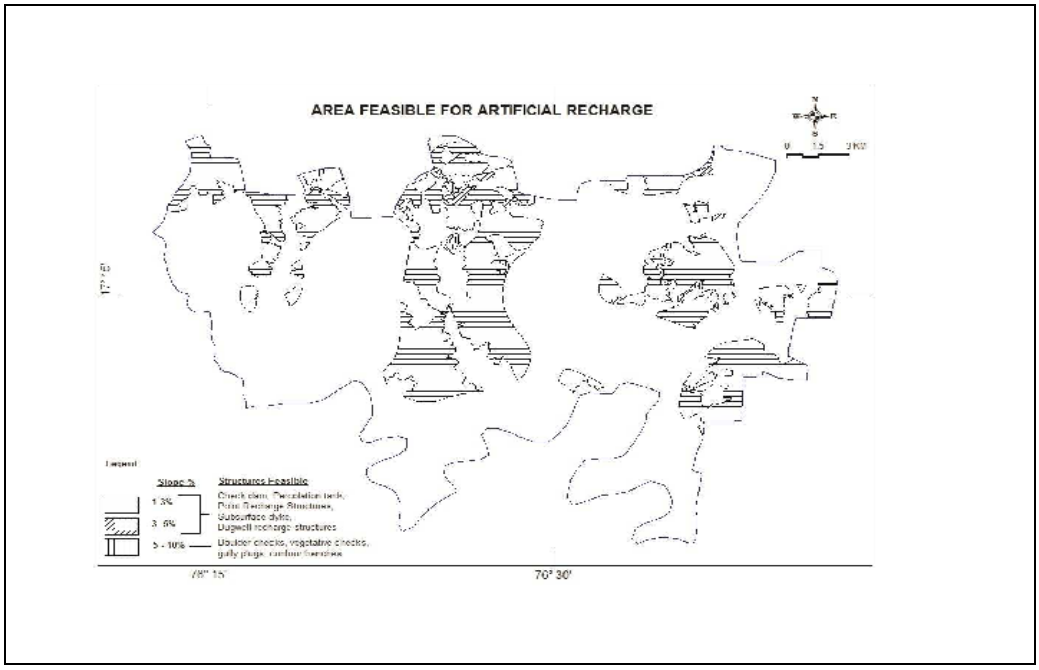

Fig 4.1: Areas feasible for Artificial Recharge structures in parts of Afzalpur taluk

4.2 Other Interventions

1. **Irrigation Projects:** Early commencing of Bhima Lift Irrigation Scheme and Amarja River Irrigation Projects (Figure-4.2), which were under construction, will help in recharging the weathered shallow aquifer in the command areas and increase in yield of both dugwells and borewells. Also, the agricultural scenario would undergo a welcome change and witness an era of prosperity after commissioning of the project. Locations of irrigation Projects are shown in Figure 4.2.
2. **Conjunctive Use in Water Logged areas:** There is a possibility of water logging and salinity problems in the areas of Lift Irrigation all along the Bhima river due to intensive irrigation. It is noticed that water level along the Bhima river is generally ranges from 0 to 2 and 2 to 5 m (Figure 4.3). It is suggested that conjunctive use of surface and ground water in these areas may be practiced.

It is not advised to lower the water level in water logged areas along the Bhima river, which may cause drying up of wells in other areas due to deep slope towards south.

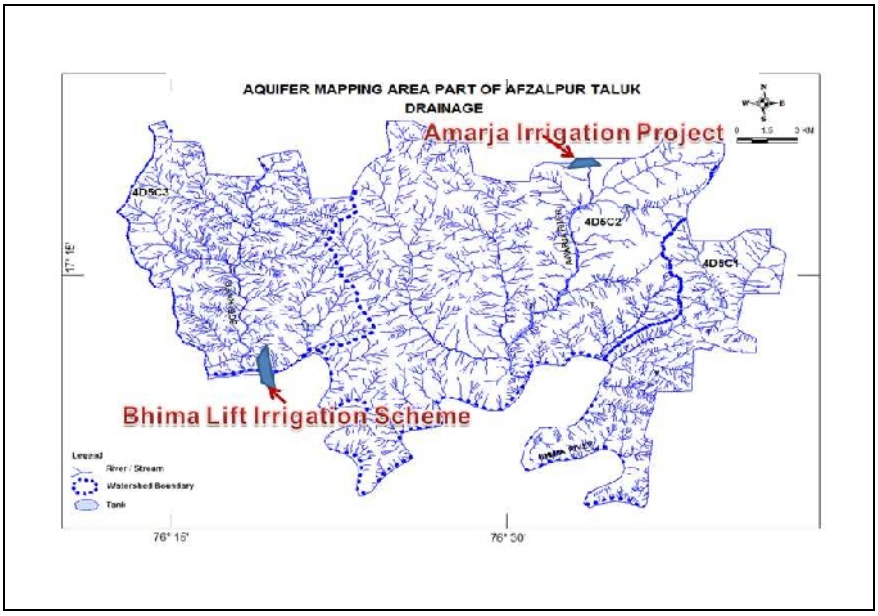

Fig 4.2: Location of Irrigation Projects

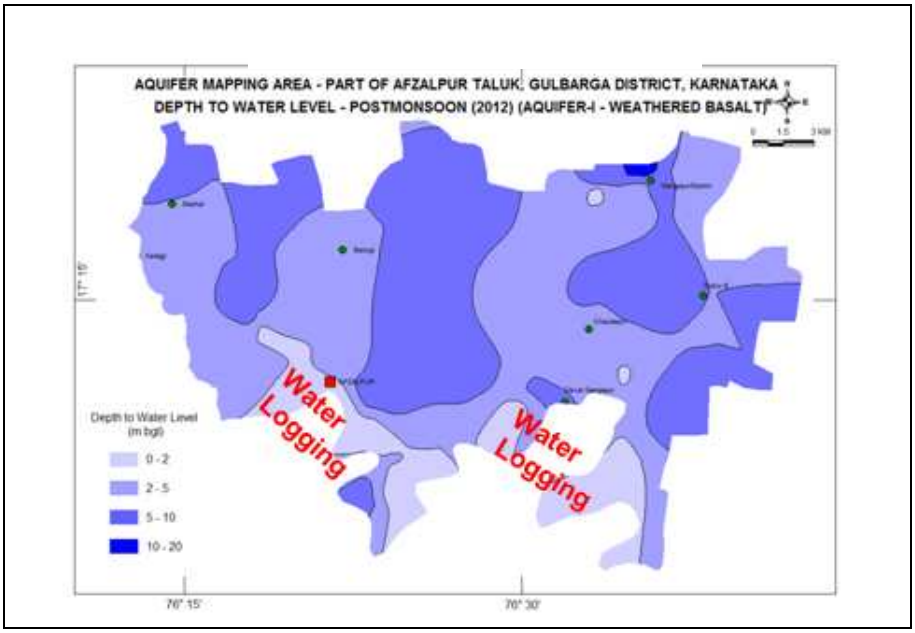

Fig 4.3: Water Logging areas