GURGAON DISTRICT AT A GLANCE

Sl. NO.	ITEMS	Statistics
1.	**GENERAL INFORMATION**	
	i. Geographical Area (sq. km.)	1254
	ii. Administrative Divisions (As on31-3-2009)	
	Number Of Blocks	04
	Number Of Villages	286
	iii. Population (As per 2011Census)	15,14,085
	iv. Average Annual Rainfall (mm)	596
2.	**GEOMORPHOLOGY**	
	Major Physiographic Units	Alluvial plain, residual hills and linear ridges
	Major Drainage (river)	Sahibi
3.	**LAND USE (sq.km)**	
	a. Forest Area	30
	b. Net area sown	980
	c. Cultivable area	1230
4.	**MAJOR SOIL TYPES**	Loamy sand
5.	**AREA UNDER PRINCIPAL CROPS (Sq.km)**	Wheat, Mustered, Jowar, Bajara
	Gross irrigated area(sq. km)	1040
6	**No. of M.I. units/ Ground water abstraction structures** Electric motor operated Diesel engine operated	 22207 736
7	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-3-2011)**	

	No. of dug wells	nil
	No of Piezometers	16
8.	**PREDOMINANT GEOLOGICAL FORMATIONS**	Alluvium
9.	**HYDROGEOLOGY**	
	Major Water bearing formation Pre-monsoon depth to water level Post-monsoon depth to water level Long term water level trend in 10 yrs in m /year	Sand, Gravel 3.3 - 79.70 mbgl 3.05 - 77.5 mbgl Decline in the range of 0.10 - 1.07m / year
10.	**GROUND WATER EXPLORATION BY CGWB (Ason31-3-2011)**	
	No. of wells drilled Exploratory Wells (EW) Piezometers (PZ)	 23 16
11.	**GROUND WATER QUALITY**	
	Presence of Chemical constituents more than the permissible limit EC (micro mhos at $25^{o}C$) F (mg/l)	 805 to 3410 0.57 to 4.35
	Type of water	Na- mixed anion
12	**DYNAMIC GROUND WATER RESOURCES(March-2009)**	
	Annual Replenishable Ground water Resources	23261 ham
	Net Annual Ground water Draft	53927 ham
	Stage of Ground Water Development	232%
13	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Ground water decline and salinity

1.0 INTRODUCTION

Gurgaon district is situated on South eastern part of Haryana state has an area of 1200 sq.km. In the North, it is bordered by the Union Territory of Delhi, in the east by Faridabad, in the North west by Jhajjar and Rewari districts of Haryana and in the west by the Alwar district of Rajasthan state and south by the Mewat district of Haryana state (plate 1). The study area is largely occupied by alluvial plains, traversed by elongated ridges of Delhi quartzites . The area is well connected by roads and railways. National Highway No. 8 connecting Dehi with Jaipur passes through the district. Major state highways are – No. 13, No 28, No 26 and No. 15A connecting Gurgaon – Alwar, Palwal – Sohna, Gurgaon – Rewari – Narnaul – Singhana road and Jhajjar – Farrukhnagar – Gurgaon respectively. Almost all the villages are connected by metalled roads. Northern Railway Broad gauge main line Delhi – Gurgaon – Rewari and branch line Garhi – Harsaru – Farrukhanagar meter gauge branch line was constructed as far back as in 1883 for the salt traffic of that area. Administratively, the district is divided in to four Blocks, namely, Gurgaon, Pataudi, Farrukhanagar, Sohna, and one sub – divisions, Gurgaon.. Gurgaon town is the headquarter of the district.

2.0 HYDROMETEOROLOGY

The climate of the district can be classified as tropical steppe,semi-arid and hot which is mainly characterized by the extreme dryness of the Air except during monsoon months, intensely hot summers and cold winters. During three months of south west monsoon from last week of June to September, the moist air of oceanic origin penetrate into the district and causes high humidity, cloudiness and monsoon rainfall. The period from October to December constitutes post monsoon season. The cold weather season prevails from January to the beginning of March and followed by the hot weather or summer season which prevails upto the last week of June.

RAINFALL:

The normal annual rainfall in Gurgaon district is about 596 mm spread over 28 days. The south west monsoon sets in the last week of June and withdraws towards the end of September and contributes about 85% of the annual rainfall. July and August are the wettest months. 15% of the annual rainfall occurs during the non-monsoon months in the wake of thunder storms and western disturbances.

Normal Annual Rainfall	596 mm
Normal monsoon Rainfall	508 mm
Temperature	
Mean Maximum (May&June)	40°C
Mean Minimum (January)	5.1°C
Normal Raindays	28

3.0 GEOMORPHOLOGY AND SOIL TYPES

The area is conspicuously flat topography, however, in the north-eastern part small isolated hillocks of Precambrian rocks are exposed. The alluvial plain is formed by the sahibi river which is tributary of River Yamuna. Soils of the Gurgaon district are classified as tropical and brown soils, existing in the north western extreme, northern and north eastern parts of the district and water logged and salt affected soils in the southern parts of the district. The soils are medium textured loamy sand is the average texture in Gurgaon and Sohna blocks. In Pataudi and Sohna blocks the organic content of soils is lowest, just up to 0.20 per cent (very low category). In the rest of the district, organic contents is 0.2 to 0.40 percent and falls in low category.

4.0 HYDROGEOLOGY

4.1 GENERAL GEOLOGY

The Gurgaon district is occupied by Quaternary alluvium and Pre-Cambrian meta- sediments of Delhi Super Group. The alluvium comprises of thick beds of fine to coarse-grained sand with alternating layers of thin clays. The generalised geological formation met within the area and their water bearing characteristics are given below in table1:

TABLE-1: **GENERALISED GEOLOGICAL SUCCESSION, GURGAON DISTRICT**

Geological Age	**Stratigraphic Units**	**Lithological characters**
Recent	Wind-blown sand	Medium to fine grained sand buff coloured over the alluvium
Pleistocene	Newer alluvium	Stream laid sand , silt, clay and gravel
	Older alluvium	Semi-consolidated, poorly sorted fine to medium grained sand, silt and caly occasionally mixed with kankar
----------UNCONFORMITY----------		
Delhi	Ajabgarh	Slates,Phyllites, Quartzites. Mica-schists, with intrusive pagmatites
	Alwar	Quartzites,mica-schists with intrusive pagmatites
----------U n c o n f o r m i t y----------		
Archeans	Aravalli	Mica-schists, crystalline limestone, Quartzites and schistose conglomerates

4.2 AQUIFER SYSTEM

The major part of Gurgaon district is underlain by Quaternary alluvium consisting of sand, clay and silt. The quartzite ridge trending NNE-SSW is located about 7 km east of town in which ground water occurs in fractures,joints and crevaces. Sandy layers at various depth form major water bearing horizons above the crystalline basement.Ground water in the Gurgaon block occurs in unconfined and semiconfined condition.The upper zone of saturation consists of fine sand with silt varying from place to place .In Udyog vihar and city area the depth of first aquifer varies from 34 to 43 mbgl.However in industrial area of Manesar top most aquifer can be encountered at 20m . The thickness of sandy layer is very limited.The drawdown are generally high indicating absence of highly potential ground water bearing aquifers. Tubewells in the depth range of 45 to 90 m bgl have been installed by different agencies in the block. The yield of these tubewells varies in different areas ranging within 129 to 606 lpm. The hydrogeological details of some of the tubewells drilled by Central Ground Water Board and state Govt. agencies are given in Table-2.

4.3 FENCE DIAGRAM OF GURGAON BLOCK

With the help hydrogeological data obtained from drilling operations, a fence diagram was prepared on the basis of lithological log /Geophysical logging result showing fresh/ saline water interface and thickness of unsaturated zone (fig3) .It is evident from the fence diagram that northwest part of the area has saline ground water and less thickness of unsaturated zone where as central part and easteren part are having fresh ground water.In westeren part of the block saline water occurs at a depth of about 70m below ground level..In sector 29 bore hole, fresh ground water has been found upto about around 85m only below which quality of ground water deteriorates sharply.

Fig 3

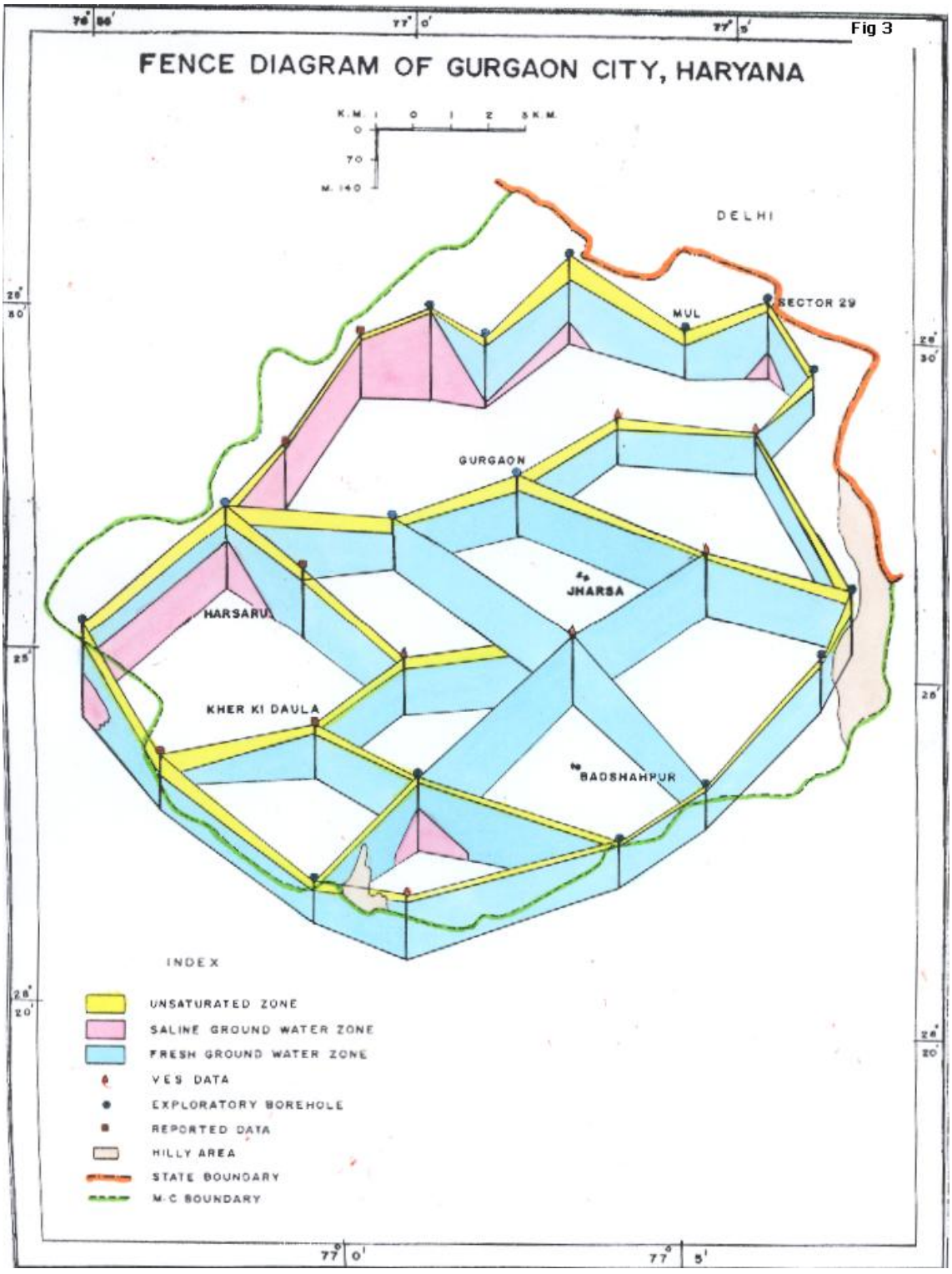

FENCE DIAGRAM OF GURGAON CITY, HARYANA
K.M. 1 0 1 2 3 K.M.
0
70
M. 140
DELHI
MUL
SECTOR 29
GURGAON
JHARSA
HARSARU
KHER KI DAULA
BADSHAHPUR
INDEX
UNSATURATED ZONE
SALINE GROUND WATER ZONE
FRESH GROUND WATER ZONE
VES DATA
EXPLORATORY BOREHOLE
REPORTED DATA
HILLY AREA
STATE BOUNDARY
M.C BOUNDARY

TABLE 2: HYDROGEOLOGICAL PARAMETERS OF TUBEWELLS DRILLED IN GURGAON CITY

S. No.	Location	Year	Depth of T/W (m)	Aquifer Deciphered (m)	SWL at time of construction (m)	Drawdown (m)	Discharge (lpm)
1.	Sector-40	1995	73.5	34.8037.8,43.9-47.0,53-70.1.	21.60	11.17	473
2.	Sector-29	1996	79.6	34.8-37.8,56.1-59.1,65.2-67.4, 71.3-77.4.	22.2	13.90	473
3.	Sector-23	1996	89.00	28.7-31.7, 53.4-60.4, 68.3-71.3,74.4-80.5,83.5-86.6.	22.00	6.80	265
4.	Sector-15 Part-1	1995	84.1	50.3-86.9	27.7	7.2	606
5.	Sector-39	1995	79.9	36.6-67.1,73.2-91.5	21.80	10.6	606
6.	Sector-40	1995	57.6	34.80-57.90	20.90	12.1	455
7.	Sector-55, 56	1995	67.1	27.4-37.8,48.8-56.1,59.8-64.0	19.1	7.0	436
8.	Jharsa	1994	68.9	31.1-68.3	23.9	10.3	227
9.	Govt.school nearHospital	1994	66.5	25.6-64.0	27.9	6.8	360
10.	Civil Lines	1994	68.9	22.6-45.1,54.6-65.9	27.7	8.8	340
11.	Sector-34	1994	72.6	42.1-79.3	15.6	5.4	379
12.	Sector-5	1994	43.0	24.4-30.5,36.6-48.80	21.0	7.2	152
13.	Sector-32	1993	65.9	28.7-65.2	25.0	10.3	227
14.	GWC Office	1998	60.0	44-47,49-56	31.06	-	129
15.	Samaspur	1957	224.0	20.7-31.1 178.78-181.05 190.19-194.46	N.A.	N.A.	732

4.4 Water level behavior

Depth to Water Table

The pre-monsoon depth to water level in the district ranges from 3.30 mbgl to 79.70 m bgl . The water level is deep in the northeastern, central and southeastern parst of the district .

Pre-monsoon -

During the pre-monsoon the water levels of 40 key observation wells are monitored and the water level ranges between 3.30 to 79.70 m.bgl. The deeper water level is observed at Dundahera, Gurgaon. . Water level is less than 10 m in small patches in northwestern and southeastern parts adjacent to Jhajjar and Faridabad district and between 10 and 20 m in northwestern and southeastern parts of the district. The water level ranges between 20 and 30 m in major parts viz. central southern and eastern parts of the district.. Deepar water level has been observed in Gurgaon and northern parts of Sohana blocks which is due to Infrastructural development and industrialization in these areas. The Depth to water level map is prepared by considering the Ground water observation wells of CGWB and state govt. wells which has been presented in Plate no. 3

Post monsoon -

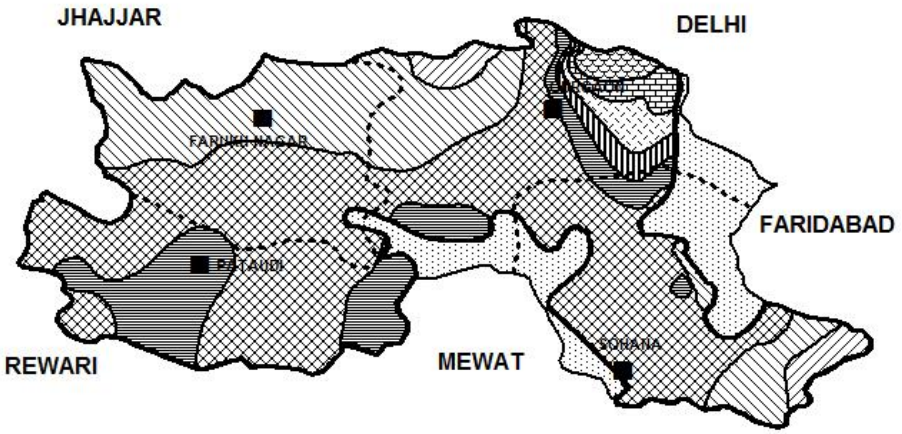
During the post-monsoon, the water levels range between 3.05 to 77.55 m.bgl. The deeper water level is recorded at Dundahera, Gurgaon. The Depth to water level map is prepared by considering the Ground water observation well of CGWB and state govt. wells and is given in Plate no. 4

4.5 Seasonal Fluctuation

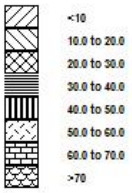
The seasonal fluctuation is between –3.0 m to +4.10 m. Maximum decline is seen at villages Bhorakalan and Gudana of Pataudi block. The areas which comes under purview of groundwater regulation (Gurgaon and northern parts of Sohana blocks) show general rise in water level while rest of the areas of the district show fall in water level which is possibly due to reckless construction of groundwater abstraction structures.

PLATE-3

DEPTH TO WATER LEVEL
(PRE-MONSOON)
DISTRICT GURGAON, HARYANA



INDEX
DEPTH TO WATER LEVEL (M. BGL)

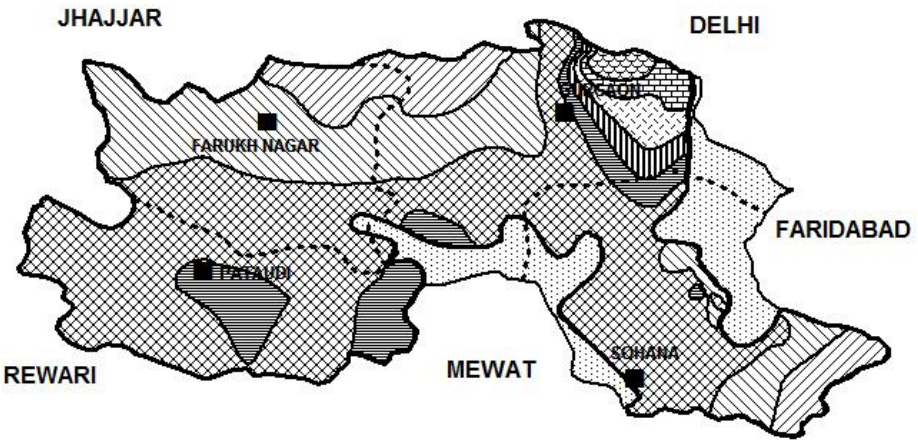


HILLY AREA

---------- BLOCK BOUNDARY

PLATE-4

DEPTH TO WATER LEVEL
(POST MONSOON)
DISTRICT GURGAON , HARYANA



INDEX

DEPTH TO WATER LEVEL (M. BGL)

- <10
- 10.00 to 20.00
- 20.00 to 30.00
- 30.00 to 40.00
- 40.00 to 50.00
- 50.00 to 60.00
- 60.00 to 70.00
- >70

HILLY AREA

BLOCK BOUNDARY

4.6 Ground water flow

In general, the water table contours follow the surface topography. The altitude of water table ranges between 176.78 to 274.85 m amsl. In north and western parts of the district, the water table slopes north and north-west of the area whereas in southern part water table slopes toward southeastern direction with an average hydraulic gradient of 1.5 m/km.

4.7 GROUND WATER RESOURCES

Ground Water Resources estimation of the district was done in 2009 for Gurgaon district. Perusal of the Estimates reveals overall stage of ground water development in the block is of the order of 232% which has exceeded the replenishable recharge and thus the district has been categorized as over exploited. Net annual ground water availability of the district is 23261 ham and existing gross ground water draft for all users is 53927 ham Table 3.

TABLE 3: GROUND WATER RESOURCE AND DEVELOPMENT POTENTIAL OF GURGAON DISTRICT AS ON 31ST MARCH, 2009 in ha m

District Name	Assessment Unit/Block	Net Ground Water Availability (ham)	Existing Gross Ground Water Draft for irrigation (ham)	Existing gross Ground Water Draft for domestic and industrial water supply (ham)	Existing Gross Ground Water Draft for all uses (ham)	Allocation for domestic and industrial requirement supply upto next 25 years (ham)	Net Ground Water Availability for future irrigation development (ham)	Stage of ground water development %
Gurgaon	Farukhnagar	3649	8053	177	8230	177	-4581	276
	Gurgaon	7585	6254	17128	23382	17128	-15797	308
	Pataudi	7495	11455	438	11893	438	-4398	159
	Sohna	4532	10015	407	10422	407	-5890	230
	Total	23261	35777	18150	53927	18150	-30666	232

4.8 STATUS OF GROUND WATER DEVELOPMENT

The water supply to the Gurgaon district is mainly based on groundwater through tubewells. 100 % of the urban population is covered under drinking water supply scheme. The water supply to the villages is meet out with the installation of hand pumps by the villager as spot and convenient source of water .

The shallow tubewells for irrigation purpose in the district range from 45 to 70m. deep, tapping the aquifer from 31m to 50 m. with a discharge of 400 to 1000 lpm. Most of the shallow tube wells are either run by diesel engines or electric motors. As on February 2009 there are 22207 electric motors and 736 diesel operated tubewells are working. The major part of the district is being irrigated through ground water. The unit draft calculated for irrigation is 1.65 ham .

5.0 Ground Water Quality for drinking and irrigation purpose:

The shallow ground water of the district is alkaline in nature (pH 7.25 to 8.13) and is moderately to highly saline (EC 805 to 3410µS/cm). Among cations, sodium is the dominant cation in 63% samples and in the remaining mixed cationic character is observed whereas among anions, mostly mixed anionic character dominates. However, bicarbonate is found to be the dominant anion in 25% samples.

On comparing the concentration values of major ions with the recommended desirable and permissible concentration limits for drinking water (Bureau of Indian Standards) it is found that ground waters is mostly unsuitable for drinking purposes in 88% of wells mainly due to high nitrate and fluoride contents that exceed the maximum permissible limits of these parameters which are 45 mg/l and 1.5mg/l respectively.

Salinity (EC), Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) are generally the parameters for ascertaining the suitability of ground water for irrigational uses. These parameters range from 805 to 3410 µS/cm at

25^0C, 1.57 to 15.27 and –17.15 to 5.30 milli-equivalents respectively. Plot of USSL diagram used for the classification of irrigation waters indicated that ground water samples mostly fall under class C_3S_1 & C_3S_2 (56%). Such waters are likely to cause medium to high salinity hazards but they may not cause sodium hazards because of low SAR. The remaining 44% of water samples fall under C_3S_3, C_3S_4, C_4S_1, C_4S_2 C_4S_3 and C_4S_4 classes of irrigation water. Waters having C_4, C_3 and S_3 and S_4 may lead to both salinity and sodium hazards when used for irrigation under normal practices. Such waters, nevertheless, can be used for semi-salt tolerant to salt tolerant crops along with appropriate amount of gypsum on well drained soils.

District at a Glance

Presence of chemical constituents more than the permissible limits

Chemical Constituent	**Total Wells**	**BIS Limit 1991 (revised in 2007)**	**Above limits**	**Location with value**
EC	16	3000µS/cm.	1	Ghangola (3410)
F	16	1.5 mg/l	6	Chandu (4.35), Hailymandi (3.65), Ghangola (2.18), Bilaspur (3.80), Bhondsi (4.86), Harchandpur(3.80)
Fe	6	1.0 mg/l	0	-
As	7	0.01 mg/l	0	-

Type of water: Mainly Na –Mixed Anion type

6.0 GROUND WATER MANAGEMENT STRATEGY

6.1 Ground Water Development

The stage of ground water development for the district is 232% and all the four blocks fall in over-exploited categories. That means that the ground water is under stress and the ground water level is declining. There is no

scope for further ground water development. Only measures should be taken to reduce on the dependence on ground water, and to augment the ground water resources and provision of water supply through canal water.

6.2 Water Conservation & Artificial Recharge

The stage of ground water development for the district is 232% that means the net annual withdrawal is more than the net annual recharge. During the last 20 years the ground water level has declined in whole of the area of the district and the decline is in the range of 0.77 to 1.07 m/yr. So there is an urgent need to take measures to arrest the decline of ground water level and artificial recharge to ground water is one of such measures. Whole of the district is suitable for artificial recharge to ground water. Excess rain water in agricultural field, surplus canal water and rooftop rain water can be recharged to ground water system. Recharging shafts and injection wells are the most viable recharging structures suitable for the district.

7.0 GROUND WATER RELATED ISSUES & PROBLEMS

Ground water decline and salinity

Ground water decline and salinity is the major problem in the district. Ground water is declining at a rate with the range of0.77m/yr to (Bilaspur) to 1.07 m/yr (Haily Mandi) .All the blocks are Over exploited, the stage of ground water development is 232 %.

8.0 AREAS NOTIFIED BY CGWA

Gurgaon block and adjoining industrial area was notified by the Central Ground Water Authority on 26th December, 2002 for ground water regulation and for registration purpose Farukhnagar and Pataudi blocks were notified in 13th march and 20th November 2006 respectively. CGWA notified whole of Gurgaon block vide public notice no. 1/2006 dated 13.3.2006. Now CGWA has notified whole of Gurgaon district vide public notice no. 2/2011 dated 13.8.2011.

9.0 RECOMMENDATIONS

The ground water availability in Gurgaon is limited and presently being over exploited results in decline of ground water levels. The Gurgaon town is situated in semi-arid area and rain is the main source of recharge to ground water. Due to heavy urbanization and industrialization, most of the storm runoff goes to the sewer or storm drains and reduce the recharge contribution from rainfall. The over exploitation of this vital resource along with the ground water pollution may lead to adverse environmental impact. Thus there is an urgent need for protection of this vital resource by adopting the following measures.

1. In order to arrest the declining trend of water levels in the district, the rooftop rainwater harvesting technology should be adopted and recharge structures may also be constructed in depression areas where water gets accumulated during rainy season. This will help in enhancing the recharge to ground water reservoir.
2. The crops consuming less quantity of water may be grown in place of crops requiring more water in the over exploited block
3. The abandoned dug wells may be cleaned and should be used for recharging the ground water by utilising the surface monsoon runoff.
4. The water level monitoring network needs to be increased in the block.
5. The contribution of surface water to irrigation in the district is very less. Measures should be made to increase the canal water supply for irrigation and also for drinking purposes.
6. Local populaces to be educate regarding consequences of mining of ground water and need for its effective and economic use.
7. Roof top rain water harvesting for factories institutional buildings, housing complexes and other big buildings has been made mandatory to augment the ground water recharge and may be included in building laws. The law should be strictly implemented.
8. Water harvesting and artificial recharge structures should be constructed in Delhi ridge area, which is one of the major recharge zones for Gurgaon. The run off should be diverted to abandoned mining pits. Small

check dams can be constructed in hilly areas to recharge/ utilize surplus run off.

9. The industrial effluents causing ground water pollution should be treated before discharge so as to curb ground water pollution.
10. Strict regulatory measures are required for ground water pumpage, particularly for industrial use. Water meter should be fitted on every tubewell and be allowed to withdraw fixed quantity of ground water.
11. Industries should be persuaded to recycle the effluents to minimize consumption of water.
12. Construction of new tubewells by individuals for domestic purpose should be regulated.
13. The municipal sewage should be treated properly to avoid ground water contamination. The same may be utilized for horticulture and other industrial uses, thus reducing the pressure on ground water.
14. Periodic monitoring of chemical quality should be carried out, particularly with reference to heavy metals, fertilizers, nitrates etc,
15. Some areas of north- western portions of Gurgaon block is underlain by shallow ground water level where quality is also poor ie saline. Such areas should be de- notified.
16. Strict regulatory measures are required for ground water pumpage, particularly for construction and infrastructural development purposes.
17. As per state govt. record, In and around Gurgaon city, there are 47 no. of ponds whose area ranges from 2 acre to 8 acre. These ponds which are either dried up or filled with municipal waste and garbage needs repair, renovation and restoration which will help to augument ground water resources by natural recharge.
18. There are 7 no. of natural drain along the foothill of Aravalli range in Gurgaon town which can be utilized for rain water harvesting and artificial recharge to ground water.
19. More artificial recharge structures should be constructed in Udyog Vihar area and peripheral areas by factories, NGO and state government department where water level is declining at fast rate.