CHAMOLI DISTRICT AT A GLANCE

Sl. No.	Items	Statistics
1	GENERAL INFORMATION	
	(i) Geographical area (sq.km.)	7820 sq.km.
	(ii) Population (as on 2001 census)	3,70,359
	(iv) Average Annual Rainfall (mm)	1230.80
2	GEOMORPHOLOGY	
	Major physiographic units	
	Major drainage	Alaknanda and its tributaries Dhauli Ganga, Nandakini, Pindar, Birhi ganga etc.
3	Land use (sq.km.)	1382.17
	(a) Forest	458.62
	(b) Net Sown area	315.53 }
	(c) Area Sown more than once	170.49 } 486.02
	(d) Cultivable area	923.55
4	MAJOR SOIL TYPES	Lithic/Typic Cryorthents, Lithic/Typic Udorthents and Dystric Eutrochrepts
5	AREA UNDER PRINCIPAL CROPS	Wheat-32.81%, Paddy-26.44%, Potato-6.60%, Manduwa-23.33%
6	IRRIGATION BY DIFFERENT SOURCES (area and numbers of structures)	
	Dug wells	Nil
	Tube wells/bore wells	Nil
	Tanks/Ponds	Nil
	Canals	1336
	Other sources	908
	Net Irrigated area	15.02 sq. km.
	Gross Irrigated area	27.05 sq. km.
7	NOS. OF GROUND WATER MONITORING WELLS OF CGWB	
	No. of Dug wells	Nil
	No. of piezometers	Nil
8	PREDOMINANT GEOLOGICAL FORMATIONS	Garhwal Group
9	HYDROGEOLOGY	
	Major water bearing formations	Rocks of Garhwal Group
	(pre-monsoon depth to water	-

	level Range	
	Long term water level trend in 10 yrs (1997-2006)	-
10	GROUND WATER E4XPLORATION BY CGWB	
	No. of wells drilled (EW,OW,PZ,SH, Total)	Nil
	Depth Range (m)	-
	Discharge (lpm)	-
	Storativity (S)	-
	Transmissivity (m^2/day)	-
11	GROUND WATER QUALITY	
	Presence of Chemical constituents more than permissible limit	Overall Ground water quality is good for domestic purpose except few locations
12	DYNAMIC GROUND WATER RESOURCES (2004) in mcm	Not calculated, as the ground water abstraction structures are negligible. Ground water abstraction is mainly done through handpumps.
	Annual replenishable Ground resources	-
	Net annual ground water draft	-
	Projected demand for domestic and industrial uses upto 2005	-
	Stage of ground water development	-
13	AWARENESS AND TRAINING ACTIVITY	
	Mass awareness programmes organized	Not yet organized
	Date	-
	Place	-
	No. of participants	-
14	EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING	
	Projects completed by cgwb (No. & ammount spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Nil
15	MAJOR GROUND WATER PROBLEMS AND ISSUES	

GROUNDWATER BROCHURE OF CHAMOLI DISTRICT, UTTARAKHAND

1.0 INTRODUCTION

Chamoli district lies in the northeastern part of Uttarakhand state. It is bounded by North Latitude 29º 55' 00" & 31º 03' 45" and East Longitude 79º 02' 39" & 80º 03' 29" and falls in Survey of India toposheet nos. 53O, M and N. The geographical area of the district is 7820 km^2. Chamoli district the second largest district of Uttarakhand, is also important from strategic point of view as it shares its northern boundary with Tibet (China).

District Chamoli shares its north-western boundary with Uttarkashi district, western boundary with Rudraprayag district, south-western boundary with Tehri Garhwal district, southern boundary with Almora district, south-eastern boundary with Bageshwar district and eastern & north-eastern boundary with Pithoragarh district.

Entire area is mountainous with agrarian economy. Forest cover (58.38%) is the main landuse. The total population, of the district, is 3,70,359 out of the male and female population are 1,83,745 and 1,86,614, respectively (Census, 2001). The population density is 42 persons/km^2 and the male, female sex ratio is 1000:1017. The overall literacy rate is 76.23%.

Administratively the district is divided into six tehsils namely, Joshimath, Chamoli, Karnaprayag, Pokhari, Gairsain and Tharali. Further it is divided into nine development blocks viz: Joshimath, Dasoli, Pokhari, Ghat, Karnaprayag, Tharali, Narayanbagar, Dewal and Gairsain.

The details of the blocks are given in Table 1. and their spatial distribution is given in Fig 1.

Table 1. Details of the developmental blocks and tehsils, District Chamoli.

Sl. No.	**Name Block**	**Area (km^2)**	**Name of Tehsil**	**No. of Villages**	**No. of Towns**
1	Joshimath	2458.77	Joshimath		1
2	Dasoli	409.97	Chamoli		1
3	Pokhari	271.50	Pokhari		1

4	Ghat	133.66			1
5	Karnaprayag	285.04	Karnaprayag		1
6	Tharali	153.33			1
7	Narayanbagar	187.50	Tharali		1
8	Dewal	245.92			1
9	Gairsain	376.72	Gairsain		1
Forest		3285.27			
Total		**7820.00**			

Alaknanda river, Ramganga river and their tributaries drain the district. Prominent of the tributaries are Dhauli ganga, Birhi ganga, Nandakini, Pindar etc. The main drainage patterns are dendritic, sub-dendritic, trellis, sub-rectangular and rectangular. The major rivers are Alaknanda, Dhauli ganga, Pindar are of antecedent type, where the drainage in the structurally disturbed area of subsequent type. The administrative map including drainage of District Chamoli is given in Fig. 1.

Agriculture is the main occupation of the people. The agricultural activities are restricted to river terraces, gentle hill slopes and intermontane valleys. The major crops are rice, wheat, potato, pulses, millets and seasonal vegetables. The net sown area, in the district, is 517.14 sq. km. out of which 173.37 sq. km. is sown more than once in a year. The gross sown area is sq. km.

The sources of irrigation are springs, gad, gadheras and rivers. The spring water, which, flows through the gads and gadheras, is diverted to small canals and guls by the minor irrigation department. In areas where sources, for minor irrigation, aren't available lift irrigation is practiced. The total irrigated area, in the district, is sq. km.

2.0 CLIMATE AND RAINFALL

The climate varies from Sub-tropical monsoon type (mild winter, hot summer) to tropical upland type (mild winter, dry winter, short warm summer). The northern, northwestern, northeastern and western part of the district is perennially under snow cover, here the climate is sub-arctic type as the area is represented by lofty

Himalayan Range. Severe winter and comparatively higher rainfall are the characteristic features of the northern part. The year may be divided into four seasons viz. the cold winter season, (December to February), the hot weather season (March to May), southwest monsoon season (June to September) followed by post monsoon season (October to November). The normal maximum and minimum temperature varies between 31 and –2.9ºC respectively.

Larger part of the district is situated on the southern slopes of the outer Himalayas, monsoon currents can penetrate through trenched valleys, the rainfall reaches its maximal in the monsoon season that spans betweens June to September. Rainfall, spatially, is highly variable depending upon the altitude. In the Lesser Himalayan Zone (1000-3000m amsl) maximum rainfall occurs about 70 to 80% in southern half. August is the rainiest month. Rainfall rapidly decreases after September and it is the least in November. About 55 to 65% rainfall occurs in the northern half in Central Himalayan Zone. About 17% of the annual precipitation occurs in winter season. The winter precipitation is in association with the passage of the western disturbances and is mostly in the form of snowfall, particularly at higher elevations. The precipitation during the pre-monsoon month, which is about 7% of the annual total and the post-monsoon months, is frequently associated with thunderstorms. Its average normal annual rainfall is 1230.8 mm. The actual rainfall for the year 2003 is 986 mm.

The relative humidity is high during monsoon season, generally exceeding 70% on the average. The driest part of the year is the pre-monsoon period when the humidity may drop to 35% during the afternoon. The normal annual average humidity is 64% during morning and 56% during evening.

Skies are heavily clouded during the monsoon period and for short spells when the region is affected by the passage of western disturbances. During the rest of the year the skies are generally clear to lightly clouded. The normal annual average wind speed is 5.2 kmph.

3.0 GEOMORPHOLOGY AND SOIL TYPE

Chamoli district comprises of high hills and mountains with very narrow valleys, deep gorges having very high gradient. The northern, northwestern, eastern and northeastern part of the district comprises Tethyan Himalaya with snow covered throughout the year.

Physiographically the catchment of Alaknanda River comes under Gangotri-Badrinath-Kedarnath Complex (i.e. Himadri, Greater Himalaya zone) shows Radial Drainage pattern. Alaknanda River flows towards East, Bhilangana River towards Southwest, Mandakini River towards Southeast and Bhagirathi River flows towards Northwest. This zone is about 50 km. wide and ranges in elevation from 4800-7820mamsl. The topography is highly precipitous, consisting of series of peaks like Nandadevi, Kamet, Mana, Trishul, Chaukhamba, Dunagiri, Nandakot, Hathiparvat, Neelkanth, Nar & Narayan parvat. The slopes of these peaks are covered with glaciers. These peaks are separated by the traverse, deep, narrow gorges of Alaknanda, Saraswati, Dhauli Ganga, Birhi Ganga, Rishi Ganga, Kail, Pindar, Nandakini etc. river. Glaciers, horned peaks, cirques, hanging valley etc, sculpture this zone. The morainic materials occupy the valleys areas. The prevalent landforms are lateral moraines, end moraines, U-shaped glacier valleys, V-shaped fluvial valleys, river terraces and Denudational Structural Mountain. The geomorphological aspects of District Chamoli are summarized in Table 2. and shown in Fig. 2.

Alaknanda river originates from the Satopath Glacier. The River initially has a West-East course before meeting Saraswati River at Keshav prayag near Mana village at the north of Badrinath Shrine and further it flows almost North- South. The whole catchment area of Alaknanda River has very scanty vegetation in Garhwal Himalaya embodies a host of geomorphic features of glacial and fluvial origin. Distinct ‘U’ shaped glacial troughs, hanging valleys, moraines and other landforms indicated a major phase of glacial activity in the area during Pleistocene. The interglacial phase was dominated by fluvial activity washing out considerable amount of glacial waste and depositing it in a number of valley floor basins formed by the blockade of the valley side deposits of the Alaknanda river. The ravaging fluvial activity assisted by rock structure was also responsible for the formation of several gorges in the main valley. The valley side slopes

are steep and are covered with morainic deposit. The Alaknanda River possesses depositional terraces with Quaternary sediments.

Alaknanda River occupies an antecedent gorge, which is deep, narrow and sinuous. Towards upstream the narrow gorge becomes highly sinuous and the channel shows meandering. The valley becomes wide around Langasu, Nandaprayag and around Karnaprayag before confluence with Pindar River. The tributaries of Alaknanda River forms a Trellis drainage pattern, with almost all of them meeting at High angle. The tributaries generally follow along strike directions. Alaknanda River also appears to follow the general Himalayan trend. The Rivers of Chamoli district generally flow with great force in steep and narrow channels often resulting in excessive erosion and collapse of the banks.

The soils are natural, dynamic, heterogeneous, non-renewable resource, which support plant and animal life. The tract of Chamoli district consists of outward succession of ridges viz; Greater Himalaya and Lesser Himalaya of decreasing height. These hills posses very little level land. The soils have developed from rocks like granite, schist, gneiss, phyllites, shales, slate etc. under cool and moist climate.

Very steep to steep hills and Glacio-fluvial valleys are dominantly occupied with very shallow to moderately shallow excessively drained, sandy-skeletal to loamy-skeletal, neutral to slightly acidic with low available water capacity soils. They have been classified as Lithic/Typic Cryorthents. These soils are in general under sparse vegetation.

The Lesser Himalayan range is mainly composed of highly compressed and altered rocks like granite, phyllites, quartzite etc. and a major part of it is under forest. Intermittent sparse patchy terraced cultivation is also practiced on fairly steep hill slopes whereas dry and wet cultivation are prevalent on the uplands and low-lying valleys respectively. The broader valley slopes dominantly have deep, well drained, fine-loamy, moderately acidic and slightly stony.

4.0 GROUNDWATER SCENARIO

4.1 Geology

Geologically the area belong to the Lesser Himalayas and lies in a tectonic fore deep. The Lesser Himalayas are comprised of fanglomerates followed by bedded

quartzites, slates, phyllites and low-grade schists. The rock types are ranging from green schist to lower amphibolite facies. The main rock types are schists, phyllites and quartzites.

Central Crystallines: Archaen

The central crystalline rocks are well exposed in the Higher Himalaya of Alaknanda valley of district Chamoli. The rocks of Central Crystalline Group form the oldest crystalline basement of the Himalaya. The gneisses, migmatites, crystalline schist, thick quartzite with conspicuous horizons of calc-silicates with psammite gneisses in the upper part form bulk of the metasediments.

The major geological formations of the Central Crystallines along with the lithology are given in Table 3.

Table 3. Major geological formations of the Central Crystallines along with the lithology

Geological Formation	**Lithology**
Badrinath	Garnet, Sillimanite, Muscovite and kyanite, migmatites, calc-silicates. Leucogranite, pegmatite and garnet amphibolite.
Pandukeshwar	Banded quartzite gneiss and interbedded quartz mica-schist, para-amphibolite
Joshimath	Garnet mica-gneiss, staurolite and kyanite-gneisses, garnet amphibolite.
Bhimgora Quartzite	White quartzite with gneiss and schist
Ragsi	Mica-schist.

Garhwal Group (Supersequence): Palaeoproterozoic

The Garhwal Group forms the most extensive Group of rocks in district Chamoli. The rocks of palaeoproterozoic time-span are grouped in Garhwal Group. It forms the major part of the Lesser Himalaya and is represented by thick sequence of low-grade metasediments consisting of quartzite with penecontemporaneous mafic metavolcanics and carbonate rocks. Garhwal Group is limited in the north by the Main central Thrust and in the south by the Main Boundary Fault.

The Garhwal Group consists of quartzite, phyllite, slate and limestone. Acid and basic igneous rocks intrude the Garhwal Group. **Vaikrita Group: Mesoproterozoic to Neoproterozoic**

Vaikrita group (Supersequence) of rocks represents the higher-grade metamorphics of the Higher Himalaya pervasively penetrated by young Tertiary granite. The rocks comprising, this group, are micaceous schists, talcose rocks, phyllites and gneisses overlying mainly the granite gneisses. Spatial extension wise the Vaikrita Group includes the metasedimentaries exposed between the granite-gneisses constituting the Central Crystalline and the overlying Martoli Group and its equivalents.

The granite intrudes both the Vaikrita and Martoli Groups and includes biotite granite, tourmaline granodiorite, tourmaline aplite and pegmatite.

Lesser Himalaya (Supersequence): Mesoproterozoic to Neoproterozoic

This supersequence, in Lesser Himalaya, is represented by two groups, viz. the older Jaunsar Group and the younger Dudatoli Group. These two groups are briefly described below.

Jaunsar Group:

The rocks of this group are continuously exposed in the outer Lesser Himalaya. In Chamoli district it is exposed in the southwestern part. It is divided into three formations, viz. Mandhali, Cahndpur & Nagthat, and consists mainly of phyllite, quartzite and slate

Tethys Himalaya:

Martoli Group is represented by a thick sequence of unmetamorphosed to feebly metamorphosed rocks in district Chamoli. The rocks of this group are exposed Alaknanda River basin. The main rock types are silver grey phyllite with interbedded thin quartzite, garnetiferous grey phyllite, foliated quartzite with biotite bearing phyllite, thin laminated greenish grey, brown purple quartzite slate with thin calcareous lenses.

Ordovician to Carboniferous (Supersequence)

The development of this supersequence is restricted to the Tethys Himalayan zone only. There is no record from Lesser Himalaya where the rocks of Martoli Group are unconformably

overlain by the rocks of early Permian period. In the Tethys Himalaya this supersequence comprises the Sumna and Kanawar Groups. The rocks of the Sumna Group range in age from Early Ordovician to Devonian and it is divided into Ralam and Garbyans formations. The rock types are purple conglomerate, purple to greenish grey quartzite, quartzite with bands of calcilutite, calc-siltstone and brown dolomictic limestone with chlorite layers in the lower part. The sequence of limestone and black shale unconformably overlying the Sumna Group constitute the Kanawar Group. The rock types are sandy dolomite, carbonaceous shale, limestone and quartzite, which conformably lie over the Sumana Group.

Late Permian to Late Triassic (Supersequence)

In district Chamoli the rocks of Lilang Group are exposed in its northeastern part. Chocolate limestone is the main geological formation of this group, which consists of limestone alternating with thin greenish black shale

4.2 Hydrogeology

A large part of the district is perennially under snow covered (Fig. 1). Groundwater investigation is not feasible in the snow-covered areas due to the accessibility problem. Groundwater is mainly developed through handpumps. The Lesser Himalayas are comprised of fanglomerates followed by bedded quartzites, slates, phyllites and low-grade schists. The areas with dissected hills have very high gradient and very low permeability, which does not support groundwater transmission and storage. Such areas do not have aquifers with promising groundwater potential. The moderately sloping terrains are covered with a thin layer of weathered rocks. Water through precipitation infiltrate to the jointed rocks and weak planes through this weathered cover giving rise to local pockets of ground water with limited volume. Such pockets also occur along the courses of small nalas. These localized water pockets support hand humps with low discharge. Ground water occurrence in hilly terrain is generally channelized along structural discontinuities of rocks, which are highly weathered, fractured/jointed areas hence it does not define uniform flow patterns.

Hydrogeologically, Chamoli district may be divided into two, viz. (1) Alluvium) and (2) Hard rocks. These are briefly described hereunder:

(1) Alluvium: Alluvium occurs along the river courses and in their flood plains. The alluvial deposits are paper thin to as thick as 55m. These are unconsolidated to semi-

Fig. 4 Hydrogeological map of Chamoli district, Uttarakhnad

consolidated deposits. At places, big boulders are buried within the alluvium. The alluvial thickness is more where the valleys are broad and ground slope is gentle such as Langasu, Nandprayag and Kaleshwar, Gauchar, Malukot and Simli valleys. The alluvium is both porous and permeable and hence suitable for groundwater development. The ground water is mainly developed through handpumps. The depth of the handpumps tapping alluvium ranges from 36.57 to 53.34m.

(2) Hard rocks: Barring the alluvial deposits along the river courses and flood plains, entire area of District Chamoli is covered by hard rocks. The main rock types are quartzites, phyllites, slates, gneisses of varying degree of metamorphism along with granite intrusives and metabasics. The topography is highly undulating and geological formations are moderately to steeply dipping. Due to frequent undulations of high magnitude a continuous water table doesn't exist. However, permeable formation overlays an impermeable one, the water table exists, its extension depends upon the distribution of the aquifer forming rocks and topography.

The rocks have undergone intensive metamorphism and recrystallization. The pre-existing rocks got mineralogically and physically rearranged at temperatures higher than the ones at which the rocks were originally formed. This resulted in sealing the primary porosity of the rocks. The area of Uttarkashi district was reshaped by repeated tectonic activities, which gave rise to the development of folds, faults and joints. These structures helped developing the secondary porosity and permeability. The so developed porosity and permeability pave the path for groundwater movement and occurrence where they exist in combination with the favourable topography, the water table is formed and at such locations the hand pumps are installed to develop groundwater. Many of these handpumps yield water perennially, which is a testimony to the sustaining water table. The location of hand pumps are given in Fig. 3 and total depth and discharges of few handpumps in different geological formations are given in Table 4. The water level data

of the handpumps are summarized with respect to geological formations and given in Table 5. Maximum number of handpumps is constructed in Garhwal Group of rocks. The depth of the handpumps ranges from 36.57 to 99.80 mbgl. The Pre-monsoon Depth to Water (DTW) ranges from 1.02 to 55.90 mbgl whereas the Post-monsoon DTW ranges from 9.06 to 60.75 mbgl. (Period, 2006). The seasonal Water level fluctuations, for the year 2006, range from –10.44 to 11.02

The occurrence of springs is a common phenomenon in District Chamoli. The moving groundwater surfaces out as springs at the contact of different rock types and through joints/fractures etc. The topographic breaks also are the favourable location for spring formations. The springs are located, geological formationwise, in Fig. 4. Various aspects of springs, geological formation, are summarized in Table 6. The pre-monsoon and post-monsoon discharges of springs range from 2 to 150 lpm and from 1 to 87.71 lpm respectively (Period, 2006). The seasonal fluctuation, in the springs discharges range from -8 to 33.65 lpm. The springs have been developed for drinking and irrigation water supplies. The hot water springs are more common in Central Crystallines than the Lesser Himalayan rocks.

Based on geology and geomorphology, the hydrogeological map has been prepared and shown in fig. 4.

4.3 Ground Water Resources

Ground water assessment has not been carried out as the ground water abstraction is done mainly through handpumps with almost negligible discharges.

4.4 Ground Water Quality

53 numbers of water samples collected from handpumps got analyzed for EC, pH, Calcium, Magnesium, Sodium, Potassium, Bicarbonate, Chloride and Nitrate. The geological formationwise details of different chemical parameters in respect of, handpumps are given in Table 7. The Water quality of spring water is studied with the help data on 31 numbers of samples. The geological formationwise details, in respect of,

spring water quality are given in Table 8. The variations of different chemical parameter, in District Chamoli, are as given Table 9.

Table 9. Variations of different chemical parameter, District Chamoli

Parameter	Hand pumps	Springs
Electrical Conductivity	83-1080 µmohos	62-680 µmohos
pH	7.80 - 8.20	7.80 – 8.20
Calcium	8-44 mg/l	4-40 mg/l
Magnesium	2.4-66 mg/l	2.4-72 mg/l
Sodium	1.5-106 mg/l	0.5-19 mg/l
Potassium	1-39 mg/l	0.4-9.5 mg/l
Bicarbonate	37-293 mg/l	18-360 mg/l
Chloride	3.5-135 mg/l	3.5-35 mg/l
Nitrate	Nil-130 mg/l	Nil-24 mg/l
Fluoride	Nd-1.20 mg/l	Nd-0.89 mg/l
Total hardness as $CaCO_3$	35-305 mg/l	35-350 mg/l

Barring few local contaminations the water in the area is suitable for domestic and irrigation requirements. The nitrate concentration at Karnaprayag is anomalously high, this is due to local contamination.

4.5 Status of Ground Water Development (Block wise)

Ground water abstraction is mainly done through handpumps with very negligible discharges. The other source of ground water in the district is in the form of springs. Large-scale ground water development is not possible in the Chamoli district since it is a hard rock area with steep slopes and low ground water potential.

5.0 GROUNDWATER MANAGEMENT STRATEGY

5.1 Ground Water Development

The district Chamoli is mainly occupied by Himalayan Mountain ranges. Around 50% of the area is perennially covered under snow. Hence there is no scope of ground water development in the area. However, at lower reaches, there is scope of ground water development through hand pumps. For this, hydrogeological investigation is required at micro level so as to decipher the water bearing rock formations, which has sufficient secondary porosity like joints, fractures, lineaments etc. These discontinuous aquifers along with favourable physiographical set-up can help to develop ground water by hand pumps.

Besides, there are number of natural springs which can be utilized to cater the need for drinking and irrigation. There are numerous springs with sufficient discharge, the water of these springs can be channelized for irrigation. During non-monsoon period, the discharge of springs gets reduced. To augment the discharge and sustainability of these springs, small surface water reservoir can be developed at suitable locations on higher level. The reservoir can be developed by constructing gully plugs, check dams, gabion structures etc. at suitable places. These reservoirs will not only provide surface water availability but will also help in recharging the aquifers.

Few tube wells have been drilled in ITBP, Gauchar having shallow depth and moderate discharge. Keeping in mind on successful drilling of tube wells, few valleys have been identified with sufficient thickness of valley fill deposits, for future ground water development. These valleys are situated at Kaleshwer, Simli, Gauchar (Karnaprayag block) and Malukot (Gairsain block) of Chamoli district.

Ground water in these valleys can be developed by constructing large diameter dug wells and shallow tube wells. The large diameter dug wells and shallow tube wells will able to sustain the discharges between 250 to 1000lpm.

5.2 Water Conservation and Artificial Recharge

Groundwater, in the area, is mainly developed through handpumps. The area replenishing the handpumps should be identified precisely. Suitable groundwater recharge structures like gully plugs, check dams, gabion structures etc. can be constructed so that the yield of the handpump is sustained round the year.

Further, ground water is also developed naturally through springs. It oozes out in the under gravity and favorable geological structures intercepting the topography. Basically *spring* is a localized natural discharge of ground water issuing on the land surface through outlets. The discharge of spring may vary from a trickle to as big as a stream. Rain water harvesting structures like gully plugs, check dams, gabion structures, contour bunding, ditches/furrows etc. for terraced agriculture land, may be constructed in the catchment area in the vicinity of springs and nalas to agument the discharge.

6.0 GROUNDWATER RELATED ISSUES AND PROBLEMS

In this hilly district water sources are not easily accessible hence water for drinking and irrigation is a problem for the local populace. Agriculture is mostly rainfed. Hence new sources need to be identified and existing sources need to be conserved and augmented.

7.0 AWARENESS AND TRAINING ACTIVITY

7.1 Mass Awareness Programme (MAP) & Water Management Training Programme (WMTP) by CGWB

Till date Mass Awareness Programme (MAP) & Water Management Training Programmes has not yet organized by CGWB in Chamoli district.

8.0 AREAS NOTIFIED BY CGWA/SGWA

No area has been notified in Chamoli district by CGWA. Uttarakhand State does not have State Ground Water Authority.

9.0 RECOMMENDATIONS

On the basis of hydrogeological, geomorphological and geophysical studies, following recommendations are made:

(1) The Chamoli district is occupied by Himalayan ranges, therefore large-scale development of ground water is not possible.

(2) Ground water can be developed through Hand pumps and Springs in the area occupied by Lesser Himalaya.

(3) Small-scale ground water development can be made in the identified valleys viz. Kaleshwer, Simli, Gauchar and Malukot by constructing shallow tube wells and large diameter dug wells.

(4) Small surface water reservoir may be developed at suitable locations so as to increase the recharge of the aquifer and surface water availability

(5) The water of the high discharge springs may be channelized for irrigation at lower altitude.

(6) Due to sufficient rainfall and more number of rainy days, roof top rainwater harvesting in urban as well as rural areas may be promoted to cater the domestic requirement.

Organizing Mass Awareness Programme is required to aware the public regarding harvesting of Rainwater.