DISTRICT GROUND WATER BROCHORE
UNNAO DISTRICT, UTTAR PRADESH

(AAP: 2012-13)

-By-

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DISTRICT AT A GLANCE UNNAO DISTRICT, UTTAR PRADESH

1.	**GENERAL INFORMATION**			
	i.	Geographical Area (Sq km)	:	**4558 sq. km.**
	ii.	Administrative Divisions (2011-12) Number of Tehsil/Block Number of Panchayat /Villages City/Towns	:	Tehsils-05, Blocks-16, Nyaya Panchayat-173, Gram Sabha-954, Villages–1794, City/Towns- 19
	iii.	Population (As on 2001 Census)	:	2700324 (Male –1422509 and Female- 1277815), Male Female Ratio=898, Rural Population= 2288781, Urban Population= 411543
	iv.	Annual Normal Rainfall (mm)	:	852
	v	Average Temp. (in ^{0}C)		Max. , Min. 32.23 , 19.28
2.	**GEOMORPHOLOGY**			
	Major physiographic units		:	Indo Gangetic Plain- Low Land or Younger alluvial plain, and Up Land or Older alluvial plain.
	Major Drainages		:	Sub parallel Type – Mainly constituted of Ganga and Sai.
3.	**LAND USE (Hectares) (2010 –11)**			
	a)	Forest area	:	16981
	b)	Net area sown	:	305439
	c)	Gross area sown	:	478649
		Cropping Intensity		156.70 %
4.	MAJOR SOIL TYPES		:	Bhur or Sandy soils, Matiar or Clayey soils, and Dumat or Loam soils.

5.	GROSS AREA UNDER PRINCIPAL CROPS (Hectares) **(Year:2010-11)**	:	Rabi –269796 , Kharif – 183650 , Jayad-25192
6.	**IRRIGATION BY DIFFERENT SOURCES (Areas in Ha) - 2011-12**		
	Dugwells (Total No. 228)	:	769 Ha
	Tubewells/Borewells	:	Govt.TW (Total No.170)= 1440 ha, Private Tube Well/Bore Wells with Pumpsets (Total No. 96136)= 217626 Ha,
	Canals	:	(Total Length - 1757 Km) 68678 ha
	Other sources	:	Ponds = 231 ha, Others = 262 ha
	Net Irrigated area	:	289006 Ha
	Gross irrigated area	:	381570 Ha
	Irrigation Intensity		132 %
7.	**NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.3.2013)** **No of Dug Wells** **No of Piezometers**	: :	33 Nil
8.	**PREDOMINANT GEOLOGICAL FORMATIONS**		Central Ganga alluvial plain mainly constituted of clay, silt, sand, gravel, and kankar sediments of Quaternary age. .
9.	HYDROGEOLOGY & AQUIFER GROUP		The Aquifer System is by and large of Three Tier and mainly constituted of Sand and Gravel up to maximum explored depth of 455 mbgl .
	Major Water bearing formation	:	Sand, Gravel.
	Pre-monsoon Depth to water level during May' 2012		2.15 to 14.13 mbgl
	Post-monsoon Depth to water level during Nov'2012	:	0.60 to 13.33 mbgl

	Long term water level trend in 10 years (2003-12) in m/year	:	**Annual:** Fall 0.0003 to 0.5258 m/year, Rise 0.0086 to 0.2141 m / year **Pre-monsoon :** Fall 0.0053 to 1.595 m/year, Rise 0.028 to 0.1013 m/year **Post-monsoon:** Fall 0.0013 to 0.6014 m/year, Rise 0.0078 to 0.2535 m/year
10	**GROUND WATER EXPLORATION BY CGWB (As on 31-3-2013)**		
	No of wells drilled (EW, OW, PZ, SH, Total)	:	Exploratory Well- 14 , Piezometer-Nil
	Drilled- Depth Range (m)	:	EW- 354.93 to 550 mbgl
	Discharge	:	1670 to 3500 lpm
	Storativity (S)	:	**$1.31x10^{-4}$ to $8.11x10^{-3}$**
	Transmissivity (m^2/day)		**293 to 3225 m^2/day**
11.	**GROUND WATER QUALITY**		
	Presence of Chemical constituents more than permissible limit (e.g EC,F,As,Fe)	:	The Ground Water in the shallow or Phreatic Aquifers are in general of Permissible class, except in few pockets where the Flouride concentration (>1.5mg/lit.) is higher. The Ground Water in deeper aquifers also have higer concentration of Flouride beyond the permissible limit at places.
	Type of water		Generally fresh in shallow aquifers, Fresh and Moderately hard to very hard in deeper zones.
12.	**DYNAMIC GROUND WATER RESOURCES (2009) – in Hact. M**		
	Net Annual Ground Water Availability	:	151872.73
	Existing Gross Annual Ground Water Draft for all uses	:	114299.61
	Projected Demand for Domestic industrial Uses up to 2025	:	9990.98

	Stage of Ground Water Development	:	District = 75.26 % (Block wise range = 55.38 to 89.89 %)
	Net Annual Ground Water Availability for Future Irrigation Development		33738.22
13.	**AWARENESS AND TRAINING ACTIVITY**		
	Mass Awareness Programmes organized		One (01)
	Date		23-06-2005
	Place		Bangarmau, Unnao
	No. of participants		-
	Water Management Training Programme organized	:	NIL
	Date		-
	Place		-
	No of participants		-
14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**		
	Projects completed by CGWB (No & Amount spent)		NIL
	Projects under technical guidance of CGWB (Numbers)		NIL
15.	**GROUND WATER CONTROL AND REGULATION**		
	Number OF OE Blocks	:	Nil
	No of Critical Blocks	:	Nil
	No of blocks notified	:	NIL
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	:	**Ground Water quality problem** – occurrence of Flouride, Chromium, and Arsenic element beyond permissible limit in Ground Water at some places. **Declining Water level in space and time** at some places.

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I. INTRODUCTION

The Unnao district of U.P. lies between $26^0$05' and $27^0$02' north latitudes and $80^0$03' and $81^0$03' east longitudes, falling in the survey of India toposheet nos. 63A, B and F. Administratively the district is constituted of four tehsils namely Safipur, Hasanganj, Unnao, Purwa and Bighapur, and is further divided into 16 developmental blocks. The total population of the district is 2700324 as per 2001 census. It encompasses an area of 4558 Sq. Km. in the Indo-Gangetic plain and is occupied by the Quarternary alluvium. The granular zones consisting mainly of alluvial sands and gravels form the three tier subsurface aquifer system in the area. The depth to water level in the upper phreatic aquifer system varies from 2.15 to 14.13 m.b.g.l. during pre monsoon period, and the water level fluctuation between pre and post monsoon periods varies in general from - 0.50 to 3.50 metres during the year 2012.. The elevation of water table varies from 103 to 127 m.a.m.s.l. with a master slope from North-West to South-East. The major rivers Ganga and the Sai are of effluent nature. The ground water resources of the phreatic aquifer occurring in the area are generally fresh and suitable for irrigation & drinking purposes, except in few pockets, where the salinity and fluoride concentration is higher. The ground water resources of the deeper aquifer zones are also of brackish to saline in nature at some places having higher concentration of fluoride. Such water resources with higher degree of salinity and fluoride concentration, if used for the drinking purpose without proper treatment may be hazardous to human health. In the district the annual gross ground water draft for all uses is 114299.61 hact. metre and the net availability of the dynamic ground water resource component is 33738.22 hact. metre for the future irrigation development.

Considering the present level of ground water development, all blocks are falling under 'safe' category, thus leaving ample scope for the future ground water development.

II. GEOGRAPHICAL FEATURES

The geographical features of the district are mainly geomorphology, climate, rainfall, soils, agriculture and irrigation

GEOMORPHOLOGY:

The entire district is a alluvial plain of almost flat topography with the master slope in the direction NW to SE. It has two distinct topographical features viz. Low-land and Up-land. Low-land or the younger alluvial plain lies along the Ganga river in the west and along the Sai river in the extreme north and east. The upland or the older alluvial plains extends NW to SE between the two high banks of the above rivers. The lakes and ponds are also existing.

DRAINAGE:

The Ganga and the Sai are the main rivers constituting the drainage system of the district. The main tributaries of the Ganga are the Kalyani, Tinai, Loni and Morahi. These rivers are perennial and constituting an overall sub parallel type of the drainage pattern.

CLIMATE AND RAINFALL:

There are four distinct climatic seasons in the district viz. winter, summer, monsoon and receeding-monsoon.

The climatological data of the observatory at adjoining district Kanpur has been taken for the Unnao district, which is shown in the following Table-I.

Table-I

CLIMATOLOGICAL DATA

Temp. in degree Centigrade	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL /AVERAGE
MAX.	22.7	26.4	32.5	38.3	41.4	40.1	34.3	32.2	33	32.7	29	24.2	32.23
MIN.	8.5	11.3	16.6	22	26.5	26.7	26.7	25.9	24.9	20.2	13.2	8.9	19.28
AVERAGE	15.6	18.85	24.55	30.15	33.95	33.4	30.5	29.05	28.95	26.45	21.1	16.55	25.76
RELATIVE HUMIDITY (%) MORNING	79	66	52	37	37	54	80	87	81	69	65	76	65.25
RELATIVE HUMIDITY (%) EVENING	50	38	29	23	22	39	68	77	68	54	46	50	47.00
AVERAGE	64.5	52	40.5	30	29.5	46.5	74	82	74.5	61.5	55.5	63	56.13
MONTHLY RAINFALL (mm)	21.1	12.5	6.2	4.5	9.8	65.4	229.8	289.5	124.4	60.7	1	7.7	832.6
P.E. VALUE	1.21	0.598	0.228	0.136	0.294	2.454	10.67	14.326	5.62	2.714	0.033	0.38	38.659
POTENTIAL EVAPOTRANSPIRATION (mm)	60.7	88.8	157.3	205.3	253.8	229.8	146.6	125.4	132.8	125.5	78.3	56	1660.3
WIND SPEED IN KMPH	8	9.9	11.3	12.2	12.7	13.4	11.3	9.6	9.2	6.4	5.3	6	9.61
NO. OF RAINY DAYS	1.5	1	0.7	0.5	0.8	3.3	12	13.3	6.5	2.1	0.2	0.7	42.6

The monsoon enters the area in the mid of June or July and generally extends upto the end of September. The Normal rainfall data of the Unnao district is shown in the following table.

Table-II

NORMAL RAINFALL DATA OF UNNAO DISTRICT, U.P.

Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Non-Monsoon	Monsoon
Unnao	12.7	15.7	7.4	6.1	8.6	60.2	252.7	246.1	158.7	26.2	5.3	6.6	806.30	88.6	717.7
Purwa	14.2	16.5	8.6	5.8	8.4	78.1	264.9	254.3	167.1	29.5	4.8	6.6	858.80	94.4	764.4
Safipur	15.2	17.3	7.4	8.9	10.9	67.3	250.2	256.3	166.4	34.3	4.6	6.1	844.90	104.7	740.2
Hasanganj	13.2	17.5	7.6	6.1	10.9	70.6	280.7	232.7	168.4	21.2	4.6	5.3	838.5	86.4	752.1
Average total													**837.125**	**93.525**	**743.60**
Percentage (%)														**11.17**	**88.83**

The annual normal Rainfall of the district comes to 837.125 mm. The maximum rainfall occurs during the monsoon period i.e. June to Sept. having the normal value **743.60** mm of which is monsoon rainfall 88.83% of the total annual rainfall. The July and August are the wettest months having the normal rainfall of 262.125 and 247.35 mm respectively. The receding monsoon season extends from the end of September to October month.

SOILS:

The main soil types of the district are Bhur or Sandy soils, Matiar or clayey soils and Dumat or Loam. The Loam or Dumat soils are occurring in the plain, Bhur on the ridges and the Matiar in the topographic lows. The 'Reh' or Usar-soil patches are frequently occurring mainly in the Matiar or clay dominating soils.

AGRICULTURE AND IRRIGATION:

The district has 305439 hect. net cultivated area which is about 66% of the total area of the district. About 57% area of the net cultivated area is under cultivation more than once .The cropping intensity of the district is about 157 % .The Rabi, Kharif, other (Jayad), Sugarcane, Arhar and Groundnut crops are sown in the district.

The district has about 95% of its net cultivated area as irrigated, out of which only 24 % is irrigated by surface water resources and rest 76 % by the ground water resources. The gross irrigated area in the district is 381570 hect., which is about 125% of the net cultivated area.. The Sarda canal and its distributaries form the main canal system of the district. The Hardoi branch and its distributaries commands the northern half of the district, while the southern parts is irrigated by the Unnao and Purwa branches. The total length of canals in the district is 1757 Km. and the net area irrigated by the canal is 68678 hectares. The ground water irrigation is mainly by the State tubewells, shallow private tubewells, bores fitted with pumping set machines and rarely by dug wells.

III. GEOLOGY

The geology of the district may be described mainly under the general geology and sub-surface geological configuration, which are as follows:

GENERAL GEOLOGY:

The Unnao district is a part of the Central Ganga alluvial plain mainly constituted of clay, silt, sand, gravel and kankar sediments of Quaternary age. These alluvial deposits of the area may be broadly classified into newer and older litho-units on the basis of sedimentary constitution, depositional and developmental geological history. The generalised sub-surface geological sequence is as follows:

Age	Litho Unit	Sedimentary Constitution
Holocene	Newer Alluvium	Channel Alluvium Levee Alluvium
----------Disconformity----------		
Middle to Upper Pleistocene	Varanasi Older Alluvium	Clayey Facies Sandy Facies
----------Unconformity---------- (Basement Rock)		

The older alluvial litho-unit is mainly constituted of the cyclic sedimentary formations of oxidized clay, silt and grey to brown sand occasionally mixed with kankar and ferro-magnesium nodules. The major part of the study area is occupied by this litho-unit. This litho-unit had developed in the river-channel depositional environment between Middle to Upper Pleistocene Age. The Varanasi older alluvial plain is the main litho geomorphic unit developed in this older alluvium. This older alluvial unit may be further classified into clayey and sandy facies, as per their sedimentary constitution. The newer alluvium litho-unit constitutes mainly the present flood plain channel alluvium & sand bars etc. The newer alluvium had developed mainly during the Holocene period. This litho-unit is also constituted of the cyclic sedimentary formations of oxidized clay, silt and grey fine to medium grained sand.

SUB-SURFACE GEOLOGICAL CONFIGURATION:

The district has in general three prominent sub-surface granular zones. The upper most sub-surface granular zone extends upto the depth of 90 m.b.g.l., second from 100 to 250 m.b.g.l. and the third one extending from 250 to the drilled depth of 455 m.b.g.l. The vertical extension of the lower granular zone could not be ascertained in the district, but horizontally the same appears to be regionally extensive.

IV. GROUND WATER SCEINARIO

The aquifers in the district are constituted of mainly by the different grades of alluvial sands, gravel and kankar sediments. These porous and permeable sediments generally occurring in the form of granular-zones are fully saturated by the ground water. The granular-zones occurring in the zone of saturation generally have good permeability and transmissivity due to the interconnected wide intra-granular pore spaces. On the other hand, the sub-surface clay bed generally have insignificant permeability & transmissivity and act as the confining layers. The sub-surface cyclic occurrence of the granular-beds (zones) and the clay bed, results in a multi-layered aquifer system in the area. The district has in general three prominent aquifer systems viz.:

(i) The Upper or Phreatic Aquifer System
(ii) The Middle Aquifer System
(iii) The Lower Aquifer System

THE UPPER OR PHREATIC AQUIFER SYSTEM:

The upper aquifer system generally consists of fine to medium sand of micaceous nature. It is occurring below a capping of top-soil upto the depth of about 90 m.b.g.l. Where ground water is occurring under the water table condition.

This upper aquifer system forms the main source of water supply to the dugwells and the shallow tubewells/borewells of the area. The discharge of the private tubewells constructed in this system generally varies from 2.5 to 3.4 lps at moderate drawdowns of about 2 to 3 metres, and that of state tubewells between 8 to 13 lps at a drawdowns of about 6 to 10 metres. This system forms the main water bearing

formation and directly corresponds to the development of ground water through private sector.

THE MIDDLE AQUIFER SYSTEM:

The thick massive clay zone is extending from the 100 to 250 m.b.g.l. depths which have the middle aquifer system in the form of thin lenticular granular zones. The granular zones are generally constituted of medium sand with admixture of fine and coarse sands. This zone is encountered in a few state tubewells and C.G.W.B. exploratory boreholes. The lateral extension of this system is not very clear.

THE LOWER AQUIFER SYSTEM:

This lower aquifer system is generally extending below the depth of 250 metre upto the drilled depth of 455 m.b.g.l. Its lateral extension is very wide, covering almost the entire area of the district. The main sedimentary constituents of this aquifer system are the coarse to medium pink to grey coloured sand, which is generally associated with medium to fine gravel. This aquifer system has the ground water in a confined state of disposition. Intercalations of the clay beds are also found in this thick aquifer system. The piezometric head of the aquifers tapping this system varies from 8.80 to 12.35 m.b.g.l. An autoflow condition has also been recorded at Bharsar Naushera ($26^0$48'30", $80^0$14'00") in the Safipur tehsil with a piezometric head (free flow head) of 2.30 m.a.g.l. The autoflow is of the order 10.50 lps. Generally tubewells tapping this aquifer system are capable of yielding 50 to 67 lps discharge at the drawdown from 6 to 8 metres. The transmissivity of the aquifer material of this system ranges from 2367 to 2640 m^2/day and the hydraulic conductivity is of the order of 33 m/day. The average value of storativity was computed to be 8.1×10^{-3}.This aquifer system has hardly been exploited in the district. It has enormous potential for the large scale ground water development in the district adopting appropriate measure of sealing the saline/brackish zones. Table –III & Plate-II

Table-III

HYDROGEOLOGICAL DATA OF THE EXPLORATORY BOREHOLES DRILLED BY C.G.W.B., UNNAO DISTRICT, U.P.

Sr. No.	Location & Coordinates	Type of Well	Depth Drilled/ Bed rock (mbgl)	Lithology	Aquifer Zones tapped (mbgl)	Static Water Level (mbgl)	Discharge (lpm)	Drawdown	Specific Capacity (lpm/m) of DD	Transmissivity T (m^2/day)	Storativity S	Electrical Conductivity (micromhos/cm at 25^0C)	Chloride (mg/l)	Remarks
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1.	BHADARKA $26^0$27'40": $80^0$29'20" 63B/7	EW	437.50	Alluvium	287 – 293 296 – 303 310 – 319 328 – 342 347 – 355 358 – 362 375 – 382 388 – 396 398 – 404 419 – 430	12.32	3500	7.6	460.53	2644	$4.02x10^{-4}$	1582	240	
2.	BHARASHAR NAUSHERA $26^0$48' 30" : $80^0$14' 00"	EW	462.43	Alluvium	308 – 314 345 – 369 375 – 382 396 – 405 415 – 424	2.3 AGL	3245	26.66	121.72	2376	$3.31x10^{-5}$	765	50	Flowing
3.	BHATPURWA $26^0$54'50" : $80^0$29' 45" 63B/6	EW	447.00	Alluvium	207 – 219 230 – 242 286 – 298 324 – 330 334 – 340 349 – 359 362 – 365	4.6	2165	27.55	78.58	785	$2.26x10^{-4}$	1399	177	

Sr. No.	Location & Coordinates	Type of Well	Depth Drilled/ Bed rock (mbgl)	Lithology	Aquifer Zones tapped (mbgl)	Static Water Level (mbgl)	Discharge (lpm)	Drawdown	Specific Capacity (lpm/m) of DD	Transmissivity T (m^2/day)	Storativity S	Electrical Conductivity (micromhos/cm at 25^0C)	Chloride (mg/l)	Remarks
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
4.	CHAMRAULI $26^0$35'30": $80^0$36'00	EW	454.80	Alluvium	296 – 314 324 – 333 336 – 342 360 – 372 381 – 393 396 – 405 429 – 438	10.68	2030	17.71	114.62	945	$1.31x10^{-4}$	855	71	
5.	DATAULI $26^0$38'00": $80^0$47'30" 63 B/14	EW	452.50	Alluvium	214 – 230 274 – 280 293 – 300 324 – 340 350 – 360 380 – 395	4.27	1860	13.28	140.06	293	$4.25x10^{-4}$	1100	99	
6.	HAFIZABAD $26^0$33'30": $80^0$23'50"	EW	451.42	Alluvium	252 – 261 270 – 282 288 – 297 303 – 324 342 – 348 357 – 375 378 – 384	17.2	2200	15.6	141.03	3225	-	890	60	
7.	KIRATPUR $26^0$16'00'': $80^0$48'00" 63B/15	EW	448.94	Alluvium	270 – 294 300 – 324 330 – 354 360 – 375	8.37	2528	4.78	528.87	2908	$5.62x10^{-4}$	1641	-	

Sr. No.	Location & Coordinates	Type of Well	Depth Drilled/ Bed rock (mbgl)	Lithology	Aquifer Zones tapped (mbgl)	Static Water Level (mbgl)	Discharge (lpm)	Drawdown	Specific Capacity (lpm/m) of DD	Transmissivity T (m^2/day)	Storativity S	Electrical Conductivity (micromhos/cm at 25^0C)	Chloride (mg/l)	Remarks
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
8.	MARAONDA $26^0$39'04": $80^0$18'44 63B/6	-	452.00	Alluvium	295 – 307 310 – 319 326 – 332 335 – 341 351 -379 394 – 405	4.94	1670	7.98	209.27	2103	$5.13x10^{-5}$	777	28	
9.	RAJAPUR -1 $26^0$23'45": $80^0$42'30" 63B/11	EW	354.93	Alluvium	-	-	-	-	-	-	-	-	-	Abnd. cal
10.	RAJAPUR -2 $26^0$23'45": $80^0$42'30" 63B/11	EW	455.01	Alluvium	262 – 272 276 – 286 290 – 300 327 – 340 343 – 350 360 – 380	8.78	3500	8.88	394.14	2307	$8.11x10^{-3}$	1550	206	
11.	LAVANI	EW	450.90 414.00	Alluvium	282.00 -	0.65	1870	15.77	118.58					
12.	LILY PARK	EW	444.50 410.00	Alluvium	311.00 -	17.4	1820	6.75	269.63					
13.	DADLAHA AECP	EW	426.00 375.00	Alluvium	252 – 260	2.85	2000	8.95	223.46					
14.	BANGARMAU	EW	550.00 527.00	Alluvium	61 – 65 76 -	8.6	1900	8.6	220.93					

DEPTH TO WATER LEVEL:

A perusal of the depth to water level in the uppermost phreatic aquifer system during the year 2012for pre-monsoon period (Plate-III) reveals that the shallow water level (0 to 3.00 mbgl) areas are occurring mainly in the form of pockets along the canal network of Sarda canal near Ajgain, Bichia, Malauna section.. These shallower depth to water level conditions are prevailing mainly due to the sub-surface infiltration from the canal network. On the other hand, the deepest depth to water level (10.39 to 14.13 mbgl) lies mainly in the Ganjmoradabad, Sikanderpur, Sikandarpur Karon & Sumerpur section where these pockets are extending from NW to SE. The comparatively deeper condition of the depth to water level in this zone may be due to the high level ground water draft, land relief, and sedimentary constitution. A perusal of the post-monsoon depth to water level map (Plate- IV) shows that the areas of shallow depth to water level zones have been expanded considerably, while the area sof deeper depth to water level zones have been reduced accordingly. (Plate III & IV) Table- IV

Table-IV

DEPTH TO WATER LEVEL AND WATER LEVEL FLUCTUATION (Pre and Post) OF MONITORING WELLS (N.H.S.) IN UNNAO DISTRICT, U.P. (Year 2012)

Sl. No.	Well Name (Well No.)	Premonsoon (mbgl)	Postmonsoon (mbgl)	Fluctuation (m)
1	Auras (11B)	5.90	4.60	1.30
2	Azmatnagar (30)	7.80	8.30	-0.50
3	Baksar (46)	6.92	5.62	1.30
4	Bangarmau (06A)	7.25	6.05	1.20
5	Behta Majawar (29)	7.60	7.00	0.60
6	Bhagwant Nagar (45A)	5.10	2.90	2.20
7	Bichhia (20)	2.15	0.95	1.20
8	Bighapur (08)	5.00	1.50	3.50
9	Chakalvanshi (26)	2.55	1.35	1.20
10	Ganj Moradabad (21)	11.50	10.50	1.00
11	Hasanganj I (02A)	-	7.46	-
12	Hasewan (48)	3.85	1.95	1.90
13	Kali Mitti (22)	3.70	3.80	-0.10

Sl. No.	Well Name (Well No.)	Premonsoon (mbgl)	Postmonsoon (mbgl)	Fluctuation (m)
14	Kantha (40)	3.90	1.70	2.20
15	Makur (47)	3.30	1.80	1.50
16	Malauna (43)	2.40	0.60	1.80
17	Maurawan (16)	8.31	7.36	0.95
18	Methi Tikur (34)	4.52	2.72	1.80
19	Miyanganj (07)	5.10	3.60	1.50
20	Newalganj (27)	4.55	1.25	3.30
21	Pariyar (10)	8.10	7.70	0.40
22	Pinjra (42A)	6.35	5.70	0.65
23	Purwa (05)	5.95	2.75	3.20
24	Safipur I (01A)	10.15	8.45	1.70
25	Santakhera (36)	2.94	3.28	-0.30
26	Sikanderpur I (35)	14.13	13.33	0.80
27	Sumerpur (15)	10.33	9.03	1.30
28	Thaura (18)	3.14	0.84	2.30
29	Tonda (33)	3.60	0.70	2.90
30	Unchagaon kila (38)	2.89	0.69	2.20
31	Unchagaon I (13)	5.36	2.86	2.50
32	Unnao (03)	8.75	7.75	1.00
33	Raniganj New (23A) (B – Sindarpur Karon)	12.84	11.44	1.40

WATER LEVEL FLUCTUATION:

A perusal of the water level fluctuation data of the monitoring wells (NHS) for the year 2012 reveals that the major parts of the district show a general rise in water table after monsoon period which varies from 0.40 to 3.50 meters. The seasonal rise in the water table is more prominent in the canal command areas extending in the parts of Auras, Safipur, Sikandarpur ,Bichhia, Purwa, Bighapur, Newalganj, Unchgaon, Tonda etc. areas. In these areas the seasonal water level fluctuation ranges from 1.00 to 3 metres and more. However, the maximum part of the district area shows a general rise ranging from 0.50 to 1.00 metres. A few pockets of area also show a decline in water level ranging between 0.10 to 0.50 metres during post-

monsoon period, which may be due to ground water overdraft or localised poor monsoon rainfall recharge. The average water level fluctuation for the entire district has been worked out as 1.50 metres.

LONG TERM WATER LEVEL TREND:

A study of the behavior of ground water regime in space and time on the basis of available water level data of National Hydrograph Stations for the period 2003 to 2012 reveals that out of total 33 nos. of N.H.S. only 06 are showing rising trend @ 0.0086 to 0.2141 m/year and the remaining 27 nos. are showing declining trend @ 0.0003 to 0.5258 m/year. Whereas only pre monsoon data analysis shows Rise of 0.028 to 0.1013 m/year and Fall 0.0053 to 1.595 m/year. likewise, the postmonsoon data shows the fall of 0.0013 to 0.6014 m/year, and rise of 0.0078 to 0.2535 m/year.

Table-V

LONG TERM TREND OF WATER LEVEL, UNNAO DISTT. U.P.

(From Year 2003 – Year 2012)

Sl. No.	Location	Per Monsoon			Post Monsoon			Annual		
		Data Points	*Rise (m/year)*	*Fall (m/year)*	*Data Points*	*Rise (m/year)*	*Fall (m/year)*	*Data Points*	*Rise (m/year)*	*Fall (m/year)*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1	Hasanganj 1	8		0.1013	9		0.1644	36		0.1215
2	Miyaganj	10		0.0628	9		0.0458	38		0.0331
3	Auras	8		0.2688	7		0.1503	38		0.2432
4	Maurawan	10		0.0516	10		0.1385	39		0.1306
5	Behta Majawar	10		0.0053	9		0.1194	34		0.0343
6	Tonda	8		0.1531	8		0.0242	32		0.1376
7	Kantha	10		0.1123	10		0.0394	38		0.0389
8	Makur	9		0.1007	9		0.0209	35		0.0094
9	Hasewan	10		0.0759	9		0.0148	37		0.0003
10	Newalganj	10	0.0306		9	0.2535		37	0.2141	
11	Safipur 1	7		0.1686	9		0.2549	34		0.2609
12	Unnao	10		0.1048	10		0.3823	39		0.2660
13	Purwa	10		0.1545	10		0.1138	39		0.1357
14	Bangarmau (new)	9		0.0445	10		0.0765	38		0.0600
15	Bighapur	10		0.1239	10		0.0029	37		0.0644

Sl. No.	Location	Per Monsoon			Post Monsoon			Annual		
		Data Points	*Rise (m/year)*	*Fall (m/year)*	*Data Points*	*Rise (m/year)*	*Fall (m/year)*	*Data Points*	*Rise (m/year)*	*Fall (m/year)*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
16	Pariyar	10	0.0028		10		0.0366	39	0.0086	
17	Unchagaon 1	10		0.1845	10		0.1238	37		0.1341
18	Sumerpur	10		0.1044	10		0.1177	52		0.0706
19	Thaura	10		0.0112	10	0.0078		35	0.0277	
20	Bichhia	10	0.216		10		0.0547	39		0.0015
21	Ganj Moradabad	10		0.1155	10	0.1881		38		0.0016
22	Kali Mitti	9		0.0315	10		0.1611	37		0.0523
23	Sikanderpur	7		1.1595	4			20		
24	Chakalvanshi	10		0.0938	10		0.0665	38		0.0655
25	Azmatnagar	10		0.5380	9		0.6014	38		0.5258
26	Methi Tikur	10		0.0780	10		0.0589	38		0.0676
27	Sikanderpur 1	10		0.0969	9		0.1846	36		0.0639
28	Unchagaon Kila	10		0.0482	9		0.0250	36		0.0114
29	Pinjra	10		0.01054	8		0.1465	34		0.1609
30	Malauna	9	0.0108		9	0.0407		35	0.0178	
31	Bhagwant Nagar	10		0.0292	10		0.0811	39		0.0889
32	Baksar	10	0.1013		9	0.0013	38	0.0767		
33	Santakhera	10	0.0423		8		0.0153	35	0.0705	

WATER TABLE ELEVATION AND GROUND WATER FLOW:

The water table elevation in the district during pre-monsoon period, by and large, varies from 103 to 127 m.a.m.s.l., and the pattern of water table contours is the subdued replica of the general surface topography. The water table is sloping from NW to SE direction in accordance with the master slope of the alluvial plain. The water table gradient in general varies from 0.10 m to 1.50 m/Km. As the ground water movement is generally titled towards the major perennial rivers, so the major rivers are of effluent type gaining the ground water from the phreatic aquifer in the form of base flow.

GROUND WATER QUALITY:

The quality of ground water resources has been assessed on the basis of chemical analysis results of water samples collected from the Ground Water Monitoring Wells during year 2012-13 and presented in Table VI.

Table-VI

CHEMICAL ANALYSIS DATA OF SAMPLES COLLECTED FROM GROUND WATER MONITORING WELLS IN UNNAO DISTT (2012-13)

S. No.	Block	pH	EC µS/cm at 25°C	HCO_3	Cl	F	NO_3	SO_4	TH	Ca	Mg	Na	K	TDS	RSC meq/l	SAR	SI	SSP %
				mg/l														
1	Miyaganj	8.23	520	256	21	0.74	0	22	210	40	27	22	5	348	-0.02	0.66	-22.3	18
2	Auras	7.98	740	342	28	0.79	0	36	210	48	22	74	3	496	1.40	2.22	-17.1	43
3	Purwa	7.83	940	427	39	0.98	45	32	290	20	58	84	3	630	1.23	2.15	-16.1	39
4	Hasanganj	8.12	480	244	21	1.29	1	16	210	44	24	17	3	322	-0.17	0.51	-22.8	15
5	Bangarmau	7.70	530	275	14	0.59	14	18	170	44	15	47	4	355	1.08	1.56	-19.8	37
6	Safipur	8.14	750	244	64	0.98	71	30	310	40	51	30	5	503	-2.19	0.74	-21.5	17
7	Ganj Muradabad	8.18	460	232	21	0.55	13	7	200	48	19	16	3	308	-0.16	0.49	-22.9	15
8	Sikanderpur sirosi	7.98	510	256	11	0.7	3	30	170	28	24	39	4	342	0.83	1.31	-20.6	33
9	Nawabganj	8.30	890	427	46	1.38	14	46	240	20	46	106	4	596	2.22	2.98	-13.9	49
10	Bighapur	8.30	510	268	14	1.14	1	18	190	28	29	31	4	342	0.61	0.98	-21.4	26
11	Sumerpur	8.28	990	549	14	1.53	5	26	130	12	24	170	4	663	6.43	6.52	-7.5	74
12	Asoha	8.00	650	305	35	0.49	9	20	230	48	27	44	4	436	0.38	1.26	-20.1	29
13	Fatehpur Chaurasi	7.83	1630	207	213	0.58	0	343	450	108	44	172	5	1092	-5.61	3.52	-7.3	45
14	Sikanderpur Sirosi	7.99	630	336	11	1.08	3	25	230	32	36	40	4	422	0.95	1.15	-20.5	28
15	Bichhia	7.89	580	317	25	0.77	0	10	250	28	44	23	6	389	0.18	0.63	-22.2	17
16	Hilauli	7.80	850	427	50	0.86	0	22	280	44	41	72	6	570	1.43	1.88	-17.3	36

The chemical properties and the general range of concentration of different inorganic elements present in the ground water of the phreatic or shallow aquifer system of the district are as follows:

pH	--------	7.7 to 8.30
E.C.	--------	460 to 1630 micro siemens/cm. at 25^0C
Chloride	--------	11 to 213 mg/lit.
Carbonate	--------	Not analysed
Bicarbonate	--------	207to 549 mg/lit.
Nitrate	--------	0 to71 mg/lit.
Flouride	--------	0.49 to 1.53 mg/lit.
Calcium	--------	12 to 108 mg/lit.
Magnesium	--------	15 to 58 mg/lit.
Sodium	--------	16 to 172 mg/lit.
Potassium	--------	3 to 6 mg/lit.
Total Hardness	--------	130 to 450 mg/lit.
SAR		0.49 to 6.52

pH VALUE:

It is a measure of alkalinity in the water as the alkalinity is usually associated with the high pH value. The ICMR (1925) has prescribed the permissible limit range of pH from 7.00 to 8.5, but allows a range of 6.5 to 9.2 for the domestic use. In general the pH value of the ground water of the area varies from 7.8 to 8.20, indicating that the ground water in the shallow aquifers is mildly alkaline in reaction and well within the permissible limit for drinking purposes.

SPECIFIC CONDUCTANCE (E.C.):

The specific conductance or the Electric Conductivity (E.C.) is a measure of the total dissolved solids (T.D.S.) in the water. The Ground Water is falling in the permissible class for the uses.

Chloride:

The ICMR has proposed the desirable limit for chloride concentration in drinking water as 200 mg/lit., however it allows concentration upto 1000 mg/lit in the absence of any other alternative source of water, hence the water is well within the permissible limit.

Carbonates:

The concentration of bicarbonates below 600 mg/lit. is considered to be fairly safe and good for irrigation and domestic usage. In the major part of the area concentration of bicarbonates is well within the limit

Nitrates:

The W.H.O. Standards (1963) indicates the limit of general acceptability of the nitrate concentration upto 45 mg/lit., whereas the 100 mg/lit. is the upper limit of nitrate concentration allowed by the European Drinking Water Standards (1970). In the major part of the area concentration of Nitrate is well within the limit

Flouride:

The desirable and the maximum permissible limits of the flouride concentrations in the drinking water are 0.6 mg/lit. and 1.5 mg/lit. respectively (ICMR-1975). Although the ground water resources of the Unnao district, U.P. are considered to be of higher Flouride concentrations, but the present chemical analysis indicates that it is well within the permissible limit as the phreatic aquifers are concerned, exept in Sumerpur block where it is a little higherer side. In the entire study area the Flouride concentration ranges from 0.05 to 1.5 mg/lit. However, the high concentration of Flouride beyond the maximum permissible limit, may cause Fluorosis disease if used for drinking purposes without treatment. It has been observed that in the Ashoha block the Flouride concentration in the ground water is below the minimum desirable limit viz. 0.6 mg/lit. (Plate-IX), which may cause dental-caries, if used for drinking purposes without taking proper remedial measures.

Total Hardness:

The total hardness as $CaCO_3$ in the ground water generally ranges from 130 to 310 mg/lit., but it rises upto 450 mg/lit. at Fatehpur Chaurasi block. The hardness above 120 mg/lit. may have an economic importance due to high soap consumption in cloth washing. The following table shows the limits prescribed to classify the water according to hardness. The ICMR (1975) permits 300 mg/lit. of Hardness but allows 600 mg/lit. In general the ground water is well within the maximum allowed limit of 600 mg/lit. and belongs to 'Moderately Hard' to 'Very Hard' class of the degree of hardness.

V. GROUND WATER MANAGEMENT STRATEGY

The rainfall is the main source of ground water recharge in the district. The quantum of recharge mainly depends on the intensity of rainfall, surface water runoff, nature of surface soil cover, vegetation cover, land use and cropping pattern etc. The other sources of ground water recharge are canal seepage, return seepages from irrigation, surface water bodies viz. ponds, lakes & reservoirs etc. The blockwise recharge of ground water has been estimated by the methodology of GEC-1997.

Ground Water Draft:

The existing ground water draft for all uses has been estimated 114299.61 hact. metre in the district, whereas, the gross GW draft only for irrigation is 108143.53 hct.m., and gross draft for domestic & industrial water supply works out 6158.08 hat.m.

Ground Water Development:

The ground water development in the district varies from 55.38% to 89.89% in the different developmental blocks All the developmental blocks have been categorized as Safe leaving ample scope for the scientific development of the existing ground water resources.

Net Annual Ground Water Availability for Irrigational Future Uses:

The net annual ground water availability for future irrigational use has been estimated 33738.22 hact. metre. (Table-VII & Plate-V)

Table-VII

GROUND WATER RESOURCE POTENTIAL OF UNNAO DISTRICT, U.P.

(as on March 2009)

(in Ha. meter)

Sl. No.	Blocks	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply	Existing Gross Ground Water Draft for All Uses (11+12)	Provision for Domestic and Industrial Requirement Supply for 2025	Net Ground Water Availability for Future Irrigation Development (10-11-14)	Stage of Ground Water Development (13/10)×100 (%)	Category of the Block
1	*2*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
1	ASOHA	7505.62	5956.75	358.19	6314.94	556.80	992.07	84.14	Safe
2	AURAS	9138.72	5689.00	354.18	6043.18	584.21	2865.51	66.13	Safe
3	BANGAR MAU	8304.06	6358.92	373.99	6732.91	619.52	1325.62	81.08	Safe
4	BIGHA PUR	11454.74	9343.44	317.94	9661.38	448.92	1662.38	84.34	Safe
5	BICHHIA	14088.8515	8320.16	439.03	8759.19	742.19	5026.50	62.17	Safe
6	FATEHPUR CHAURASI	10309.95	7460.42	343.49	7803.91	529.83	2319.70	75.69	Safe
7	GANG MURADABAD	8009.991	6121.00	337.73	6458.73	521.03	1367.96	80.63	Safe
8	HASANGANG	10805.922	8547.75	408.16	8955.91	665.09	1593.08	82.88	Safe
9	HILAULI	6894.5775	4558	407.08	4965.08	670.57	1666.0075	72.01	Safe
10	MIYAGANJ	12396.492	7902.11	386.78	8288.89	613.53	3880.852	66.86	Safe
11	NAWABGANJ	6812.991	5686.50	437.4	6123.9	757.79	368.70	89.89	Safe

Sl. No.	Blocks	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply	Existing Gross Ground Water Draft for All Uses (11+12)	Provision for Domestic and Industrial Requirement Supply for 2025	Net Ground Water Availability for Future Irrigation Development (10-11-14)	Stage of Ground Water Development (13/10)×100 (%)	Category of the Block
1	*2*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
12	PURWA	9047.943	7589.00	277.96	7866.96	376.15	1082.793	86.95	Safe
13	SAFIPUR	8835.768	6431.86	355.50	6787.36	553.06	1850.848	76.82	Safe
14	SIKANDARPUR KARAN	9386.244	5947.6	516.32	6463.92	900.99	2537.654	68.87	Safe
15	SIKANDAR SIRAUSI	9222.40	7247.28	477.06	7724.34	900.20	1074.919	83.76	Safe
16	SUMERPUR	9658.467	4983.74	365.27	5349.01	551.10	4123.627	55.38	Safe
	Total District	**151872.73**	**108143.53**	**6156.08**	**114299.61**	**9990.98**	**33738.22**	**75.26**	

VI. Ground Water Related Issues And Problems

Ground Water quality problem:

Occurrence of Flouride element beyond permissible limit in shallow, and also in deeper aquifer zones at so many places is a serious geogenic problem in the district. The development of industrial clusters in the district is continuously posing a threat to ground water quality. The Chromium (VI) is toxic and carcinogenic if present in drinking water beyond the permissible limit. The short term investigations by CGWB reveals that there is contamination of Chromium (>50 microgram/lit.) in the ground water resource, as well as in the industrial effluents at many locations. The presence of Chromium in the district is a matter of concern though it has not yet polluted Aquifer system significantly. But in due course of time Chromium may reach in the considerable part of Ground Water system, and may cause major health hazard, if the suitable remedial actions have not been initiated timely. The significant contamination of Arsenic "Sankhia" (>50 microgram/ lit.) in the ground water resources has been found at some places viz. Shuklaganj, Dakari, Katari, Budha, Antwa, Maswari, and Rishinagar areas of the district. The remedial measures should be under taken, and alternative sources of potable water should be made available to the inhabitants of these areas for the drinking purpose. The high salinity in ground water has also been reported in few industrial pockets.

Declining Water level:

The declining trend of water level in space and time at so many places is another problem which may be due to less recharge and more surface run off of Monsoon rain fall, it may be arrested by adopting artificial ground water recharge techniques, especially in urban areas. Artificial Ground Water Recharge may also improve Ground Water quality.

VII. MASS AWARENESS AND TRAINING ACTIVITY

The C.G.W.B. has organized one mass awareness Programme at Bangarmau on the date 23 June 2005. The subject of programme was Bangarmau Ki Bhujal Samasya Evam Samadhan.

VIII. GROUND WATER CONTROL AND REGULATION

There is no any OE, Critical or Notified block in the district.

IX. RECOMMENDATION

The following recommendations are made for the future ground water development, utilization and management.

1- For tapping the fresh ground water aquifer zones, the borehole must be electrically logged before lowering the well assembly for the proper demarcation of sub-surface saline zones and thereafter to seal up these saline zones with the cement to avoid the mixing of saline ground water with fresh water in the tubewell.

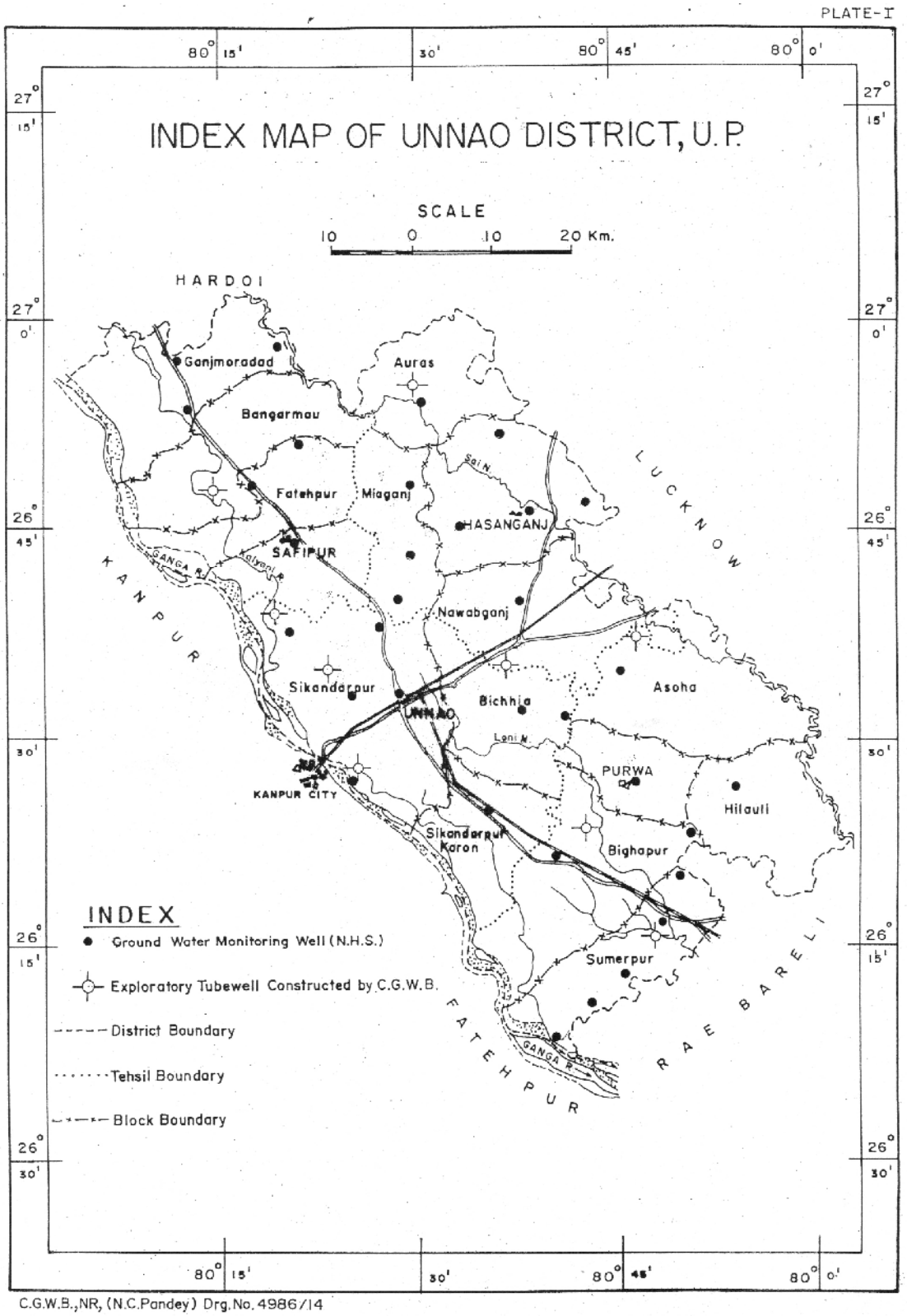
2- Specific attention should be paid to the areas where higher concentrations of Flouride, Chromium and Arsenic in ground water has been detected. Suitable remedial measures must be adopted while using the ground water having higher concentration of such elements.

3- The rain water harvesting methods eg. Rooftop Rain water Harvesting etc. may be suggested in the areas experiencing declining water table. By adopting such water conservation practices, the decline in water table may be checked and side by side the intensity of salinity in ground water, may also be reduced to some extent.

4- The cultivated land is still falling under the unirrigated status, may be reduced by the scientific development of ground water & surface water resources conjunctively.

5- The average cropping intensity in the district is only 157% which may be increased up to the ultimate target of 200% by increasing the irrigation potential on scientific manner and by assured irrigation facilities.

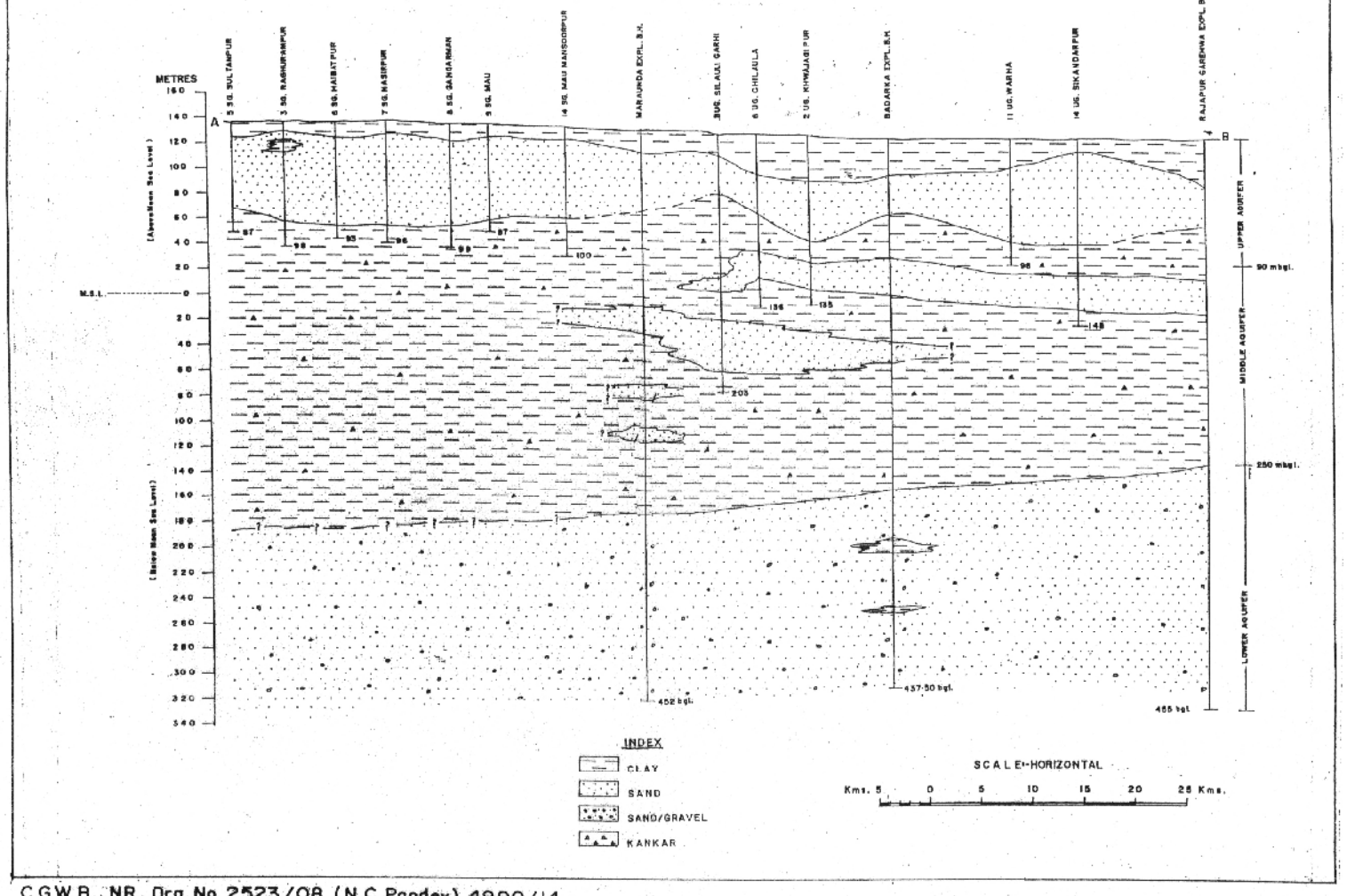
PLATE-I



C.G.W.B.,NR, (N.C.Pandey) Drg.No. 4986/14

PLATE-II

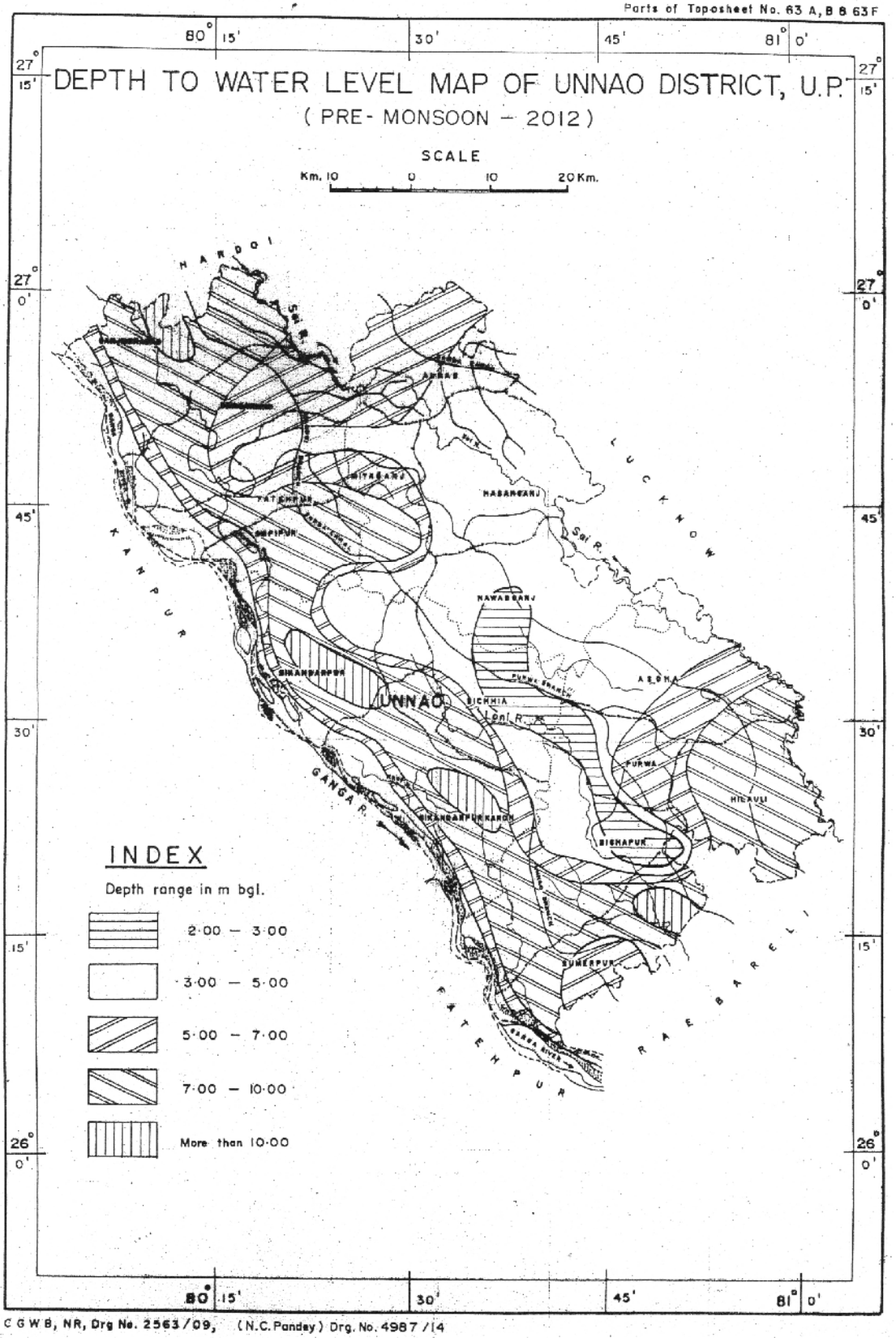
GEOLOGICAL CROSS SECTION SHOWING THE DISPOSITION OF AQUIFERS, UNNAO DISTRICT, U.P.



C.G.W.B., NR, Drg. No. 2523/08 (N.C. Pandey) 4990/14

PLATE-III

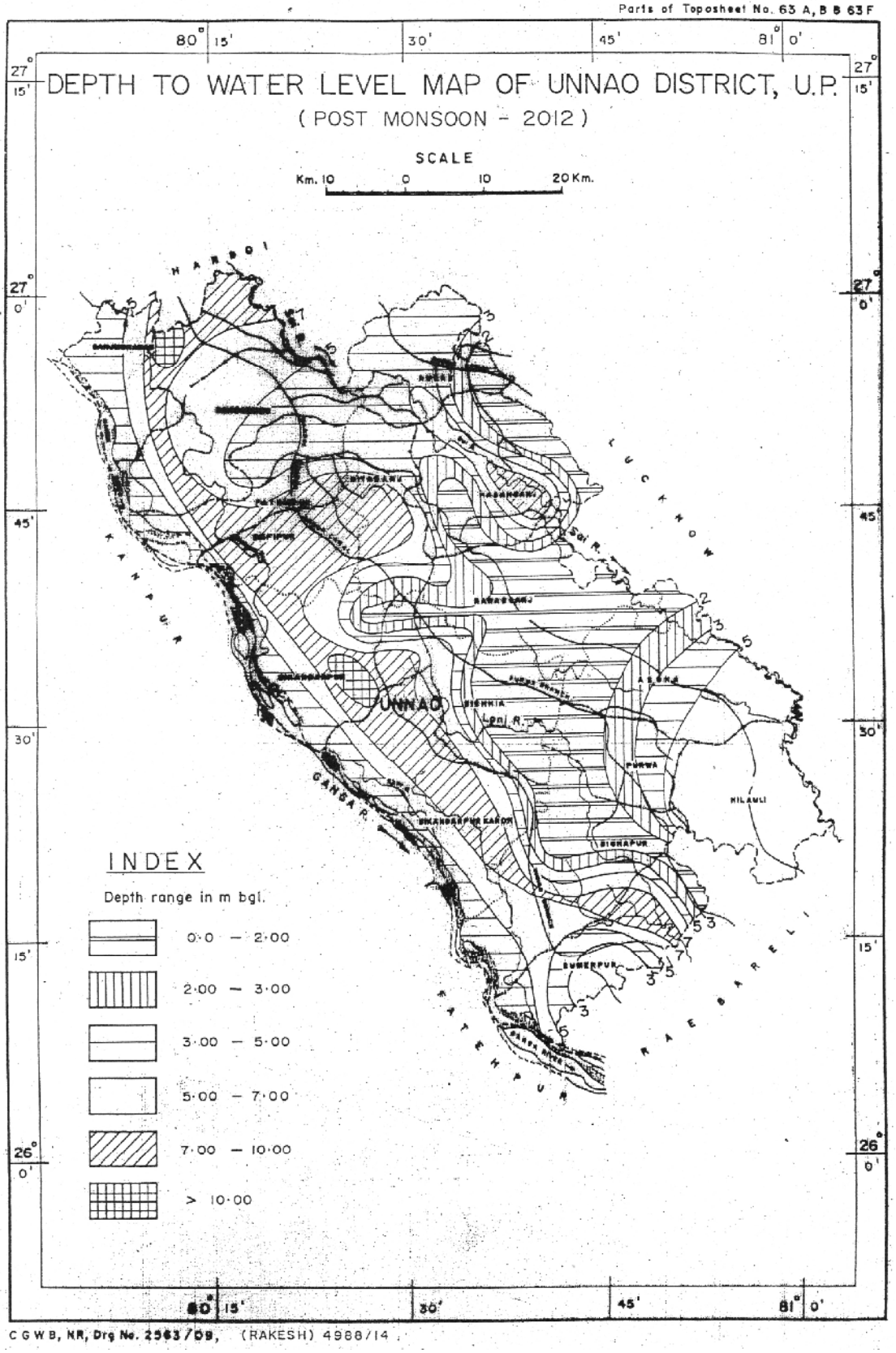
Parts of Toposheet No. 63 A, B & 63F



C G W B, NR, Drg No. 2563/09, (N.C. Pandey) Drg. No. 4987 /14

PLATE – IV

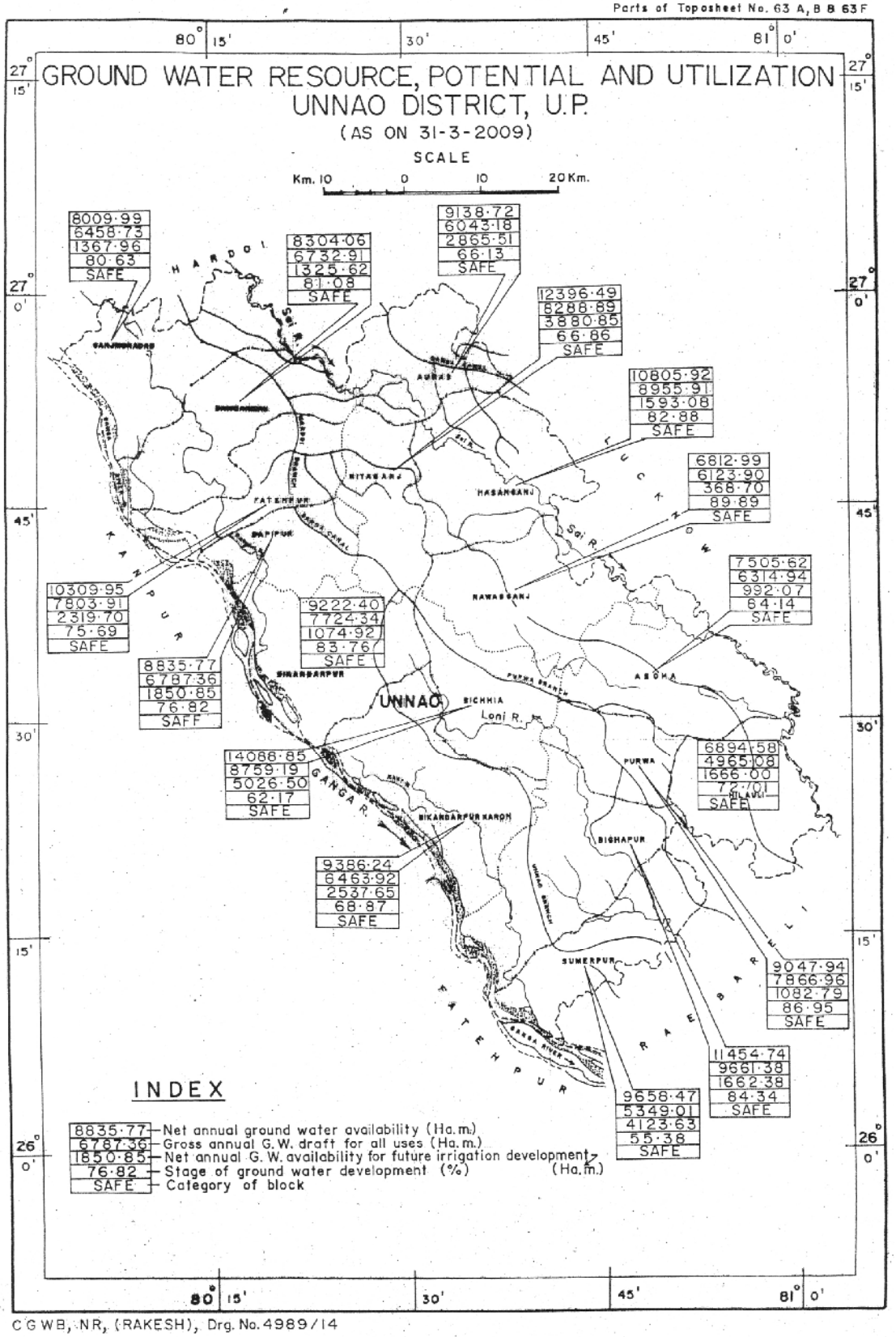
Parts of Toposheet No. 63 A, B & 63 F



CGWB, NR, Drg No. 2563/DB, (RAKESH) 4988/14

PLATE - V

Parts of Toposheet No. 63 A, B & 63 F



C G W B, N R, (RAKESH), Drg. No. 4989/14