केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

BUNDI DISTRICT
RAJASTHAN

पश्चिमी क्षेत्र, जयपुर
Western Region, Jaipur

Report on

AQUIFER MAPPING AND GROUND WATER MANAGEMENT
DISTRICT BUNDI, RAJASTHAN

CENTRAL GROUND WATER BOARD
WESTERN REGION, JAIPUR

MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVANATION

GOVERNMENT OF INDIA

Submitted by:
Vipin Kumar, Sc.-B
Ms. Sayeli Tembhurne, Sc-B

Under Super Supervision of
Dr. R. K Kushwaha
Scientist E & HOO

March, 2022

AQUIFER MAPPING AND GROUND WATER MANAGEMENT
DISTRICT BUNDI, RAJASTHAN

CONTENTS

Report On National Aquifer Mapping and Management, Bundi District, Rajasthan

EXECUTIVE SUMMARY: NAQUIM STUDY OF BUNDI

Aquifer mapping study can be understood as a scientific process wherein a combination of geological, geophysical, hydrological & chemical fields and laboratory analyses are applied to characterize the quantity, quality, and sustainability of ground water in aquifers. Aquifer mapping is expected to improve our understanding of the geological framework of aquifer, their hydrologic characteristics, and water level in aquifer and how they change over time & space and the occurrence of natural and anthropogenic contaminants that affect the potability of groundwater. One such study was taken up during FY 2021-22 by CGWB, WR Office for the Bundi District.

Bundi district is located in the southeastern part of Rajasthan and is having geographical area of 5500 sq. km. and district population is 1110907 (Census 2011). Geologically, the area is occupied by Buried Pediments, pediment, plateau, Alluvial Plain and Ravines. The stage of ground water development is 97%. Major groundwater related problems in the district are Declining water level, Over-exploitation and low yield potential aquifers and chemical quality deterioration.

Trend analysis of Pre-monsoon water during the past decade (2011 – 2020) indicates declining trend of ground water levels in most parts of the District. Average declining rate in pre monsoon and post-monsoon seasons is 0.35 and 0.11 respectively. Major groundwater related issues in the district are:

i. **Decline in ground water level:** Long term water level data (pre monsoon 2010-21) have indicated declining water level trend in all the blocks. Over draft of ground water resources for various uses compared to its natural replenishment, has resulted incessant declining trend in the most part of the district. Hindoli and Nainwa blocks fall under over exploited category. Bundi and Keshorai Patan blocks fall in Semi-Critical category.

ii. **Deep ground water level:** Water level of more than 40 mbgl (as per pre 2020 Water level data) has been found in north western part of district covering parts of Nainwa block and southern part of Talera block. Water level between 20-40 mbgl is observed in almost all blocks. Deep water level causes consumption of more energy.

iii. **Ground water salinity**: Ground water salinity more than 3000ms/cm at 25^{o}C has been observed mainly in Southeastern part of Keshorai Patan block.

iv. **Fluoride and Nitrate Contamination**: Fluoride content more than 1.5 mg/l and Nitrate content more than 45 mg/l has also been found in several sampling sites.

Managing ground water is a grand challenging problem in its severity, pervasiveness and importance. To increase the water use efficiency, source sustainability plans of rain water harvesting and artificial recharge have been envisaged in the district.

Rain water harvesting and artificial recharge measures are recommended in areas showing declining ground water levels and also in blocks showing rise in ground water levels but having water levels deeper than 3 mbgl.

The management plan has been proposed for all 5 blocks namely Bundi, Hindoli, Keshorai Patam, Nainwa & Talera Blocks. Total volume of sub surface storage space available for artificial recharge is 719 mcm and total non-commited surplus surface water available in the district is 359 mcm, which can be utilized to bring down the Stage of Ground Water Development.

The management plan comprises two components namely supply-side management and

demand side management.

a. As a part of **Supply side Management**, three types of Intervention are suggested**:**
    i. Catchment area treatment
    ii. Construction of Mini percolation tanks (on Ist order streams), Percolation tanks, Mini storage tanks, Pacca check dams (on 3rd order streams), anicut etc. Capacity of MPT, PT, PCD, Anicut and MST as per availability
    iii. Construction of farm ponds

In order to ensure effective demand side management, measures should be taken to reduce draft such as change from traditional water intensive irrigation system to micro-irrigation/pressure irrigation practices, change in cropping pattern from water intensive crops to less water consuming crops as well as adopt innovative technologies, etc. and should be implemented in befitting manner.

By implementing the interventions which requires efforts from Stakeholders with an important step of capacity building, in all the blocks Stage of Ground Water Extraction will come below 100%

Recommendations

Planning for the development and management of ground water in any area in the state must address the factors like low rainfall, limited ground water storage availability, ground water salinity in many areas, excessive fluoride, high nitrate concentration, deep water levels. These aspects should be taken as a core consideration for planning and implementing ground water development and management programs. A holistic approach taking all aspects into consideration shall therefore, need to be adopted

The interventions discussed above needs to be implemented to bring down the Stage of Ground Water Development and put a halt to further decline of ground water levels. In irrigation sector sprinkler and drip system of irrigation should be promoted and made mandatory in phased manner, wherever feasible. Water efficient crops need to be promoted at suitable and markets should be developed accordingly.

The interventions above need to be supported by regulation on extraction from deeper aquifer. So, the deeper ground water resources are protected for future generation and also serve as ground water sanctuary in times of distress/drought.

Agricultural and urban runoff tainted with chemical pesticides and fertilizers are the sources of waste water from domestic and agriculture sites. Effluents from industries, mining sites etc. are also responsible for huge amount of waste water generation.

In domestic waste water for gardening, recharge and promotion economic use of water in bathing, cleaning, cooking, leakage from domestic taps, pipelines for water supply to urban areas be checked Considering wastewater as a resource, it can be cleaned to such standards that it can be reused in a number of ways – e.g. for flushing toilets, laundry machines or irrigation for crops. The waste water from these industrial areas can also be reused after defined treatment.

Effective solid waste disposal mechanism needs to be properly developed. This can utilized for manufacturing biogas.

Paving of surface for providing civic amenities in the towns & cities has led to reduced infiltration and increased run-off during the rainy season. Rainwater harvesting structures should therefore be constructed to intercept and recharge the roof-top run-off from individual house-holds in feasible areas. Local municipal bodies should encourage such a provision.

Concurrent with the above measures the work of impounding and recharging the storm water run-off from other sources may be adopted. Suitable locations in nalas & gullies should be utilised for the construction of check-dams, sub-surface dams, ponds etc. for ensuring stagnation of water & thus its infiltration underground for augmenting ground water storage. Such structures must be located and designed keeping in full view Geology, Geomorphology and Hydrogeological set-up prevailing in the area.

Since ground water abstraction structures are individually owned, operated and managed, it is difficult to have an account of ground water abstraction by volume. Voluntary registration of structures needs to be encouraged so as to obviate the requirement for enactment and enforcement of any legal measures.

Whereas restrictions must be laid on the construction and energization of individually owned structures for drinking and domestic use with a view to avoid wastage of water, but also, adequate supply from municipal water supply system shall have to be ensured in such areas. Also, Ground water markets will have to be regulated.

In terms of the critical issues for the drinking water such as source sustainability, water quality management and better operation and maintenance, it is important that strong grassroots awareness is generated. Thus, IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory ground water management.

District Bundi at a Glance

SALIENT INFORMATION		Bundi District
Longitude		75°15′00″ E to 76°15′00″ E
Latitude		24°59′00″ N to 25°53′00″ N
Geographical Area Sq.km		**5500**
Potential area in sq.km		**4237**
Population (2011)		**1110907**
Geomorphology		
Geomorphic Unit		**Buried Pediments, pediment, plateau, Alluvial Plain and Ravines**
Geology		Alluvium
		Shale/Sst/Lst/Phyllite
Basin/Sub-Basin		Chambal/Banas
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN		
Geographical Area in ha.		**5498**
Forest Area in ha.		**142949**
Cultivable Area in ha.		**87999**
Net Sown Area in ha.		**482464**
Area sown more than once in ha.		**216061**
	Rainfed Crop in ha.	**200734**
	Irrigated Crop in ha.	**281954**
Area under Irrigation (Net) in ha		
	Surface Water	**123255**
	Ground Water	**104817**
	Other sources	**2350**
Net irrigated Area in ha		**230419**
Wheat		**146747**
Jau		**1887**
Pulses		**52701**
Rice		**47006**
Hydrogeology		

Monitoring Stations		**122**
	CGWB	**12**
	SGWD	**110**
GROUND WATER RESOURCE & EXTRACTION		
Ground Water Recharge Worthy Area (ha)		**424018**
Command (ha)		**150555**
Non-Command (ha)		**273479**
Hilly Area (ha)		**125982**
Total Geographical Area (ha)		**550000**
Rainfall fed (ha)		**18240.18**
Canals (ha)		**149.16**
Surface Water Irrigation (ha)		**6382.02**
Ground Water Irrigation (ha)		**6538.82**
Tanks and Ponds (C+NC)		**2329.03**
Annual GW Recharge (C+NC) (ham)		**14829.85**
Total Annual Ground Water Recharge (ham)		**33645.97**
Natural Discharge (C+NC) (ham)		**3294.4**
Natural Discharge (ham)		**3291.93**
Annual Extractable Ground Water Resource (ham)		**30350.19**
Domestic Draft (ham)		**3536.64**
Industrial Draft (ham)		**0**
Irrigation Draft (MCM)		**26163.69**
Existing Gross Ground Water Draft for All uses (MCM)		**29699.91**
Provision for domestic and industrial requirement supply to 2025(MCM)		**3537.12**
Net Annual Ground Water Availability for Future Use (ham)		**4853.45**
Stage of Ground Water Development %		**97.85**
Category		**CRITICAL**
AR & Conservation Possibilities		
Existing Structures constructed by State Govt.		
Anicut		**81**
Contour Continuous Trench (CCT)		**560**

Deep CCT	**99**
Earthen Check dam	**4319**
Farm Pond / Khet Talai	**556**
Micro Storage Tank	**0**
Mini Percolation tank	**885**
Minor Irrigation Tank	**0**
Pakka Check dam	**312**
Percolation tank	**226**
Piezometer	**15**
Recharging Shaft for Aquifers	**25**
Staggered Trench	**426**
Sub Surface barrier	**15**
Sunken Pond	**8**
Talai (Talab)	**15**
Tanka	**0**
Water Harvesting Structure	**380**
Total	**7919**
Area of Block (Sq. Km.)	**5498.13**
Hilly Area sq.km	**1258.02**
Potential Area (sq km)	**4240.18**
Normal Annual RF (mm)	**3400.7**
Water level (m) Nov 2020	**53.47**
Trend (m/yr)	**4.49**
Volume of Sub surface Storage Space available for Artificial Recharge (MCM)	**1545.8**
Surplus Surface water Availability (MCM)	**718.87**
SUPPLY SIDE MANAGEMENT	
Catchment Area Treatment (ha)	**5991**
Water utilized in catchment area treatment (mcm)	**2.07**
Water Conservation Structures	
No. of existing village ponds (2.5 to 7.5 ha)	**317**
Proposed No. of Structures	**0**
Mini Percolation Tanks	**6482**

Percolation Tank		**2962**
Pacca Check Dams		**1526**
Anicut		**897**
Mini Storage Tanks		**50**
Total Volume of water utilized in catchment area and WC Structured mcm		**24.34**
Volume of Water expected to be conserved / recharged @ 50% efficiency (MCM)		**12.17**
Farm Ponds		**0**
No. of Farm Ponds		**2306**
1 farm pond in 3 ha land: capacity 1200 cum	water utilized by farm ponds (mcm)	**2.77**
DEMAND SIDE MANAGEMENT		
Area Irrigated through Ground Water (ha)		**104817**
Micro irrigation techniques		**0**
Irrigation Area (ha) proposed for irrigation through Sprinkler		**52408.5**
Water Saving by use of Sprinklers		**41.9268**
Crop Change		**0**
Area under Wheat Crop(ha)		**146747**
Cropping Area (ha) proposed for change in crop		**73373.5**
Water Saving by Change in Cropping Pattern		**73.3735**
EXPECTED BENEFITS		**0**
Net Ground Water Availability (MCM) 2020		**303.5**
Additional GW resources available after Supply side interventions (MCM)		**14.24**
Net Ground Water Availability after Supply side intervention		**317.74**
Existing Ground Water Draft for All Purposes (MCM)		**296.99**
Additional GW resources available after Supply side interventions (MCM)		**2.77**
GW draft after Supply Side Interventions (MCM)		**294.22**
Present stage of Ground Water Development (%)		**97.85**
Projected Stage of Ground Water Development after Supply		**92.59**

Side interventions (%)	
GW draft after Demand Side Intervention (MI Techniques) mcm	**252.2932**
Projected Stage of GW Development after (MI) Demand Side interventions (%)	**79.48**
GW draft after Demand Side Interventions Crop Change (MCM)	**178.9197**

Report on National Aquifer Mapping and Management
Bundi District, Rajasthan

1. Introduction

1.1 Objectives

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of groundwater under different hydrogeological situation and to evolve effective management practices with involvement of community for better ground water governance. In view of sprouting challenges in the ground water sector in the state there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resource available in different hydrogeological setting through a process of systematic data collection, compilation, data generation, analysis and synthesis. Hence, aquifer mapping and management of the study area is the need of the hour. The objective of present study is to compile Aquifer management Plan and maps of Bundi District on basis of available data base.

1.2 Scope of the study

Aquifer mapping can be understood as a scientific process wherein a combination of geological, geophysical, hydrological & chemical fields and laboratory analyses are applied to characterize the quantity, quality, and sustainability of ground water in aquifers. Aquifer mapping is expected to improve our understanding of the geological framework of aquifer, their hydrologic characteristics, and water level in aquifer and how they change over time & space and the occurrence of natural and anthropogenic contaminants that affect the potability of groundwater. Results of these studies will contribute significantly to resource management tools such as long-term aquifer monitoring network and conceptual and quantitative regional groundwater flow models to be used by planners, policy makers and other stake holders. Aquifer mapping at appropriate scale can help to prepare, implement, and monitor the efficacy of various management interventions aimed at long term sustainability of our precious groundwater resources, which in turn will help to tackle drinking water scarcity, and achieve improved irrigation facilities and sustainability of water resource in the state.

1.3 Approach & Methodology

Aquifer mapping is an attempt to integrate the geological, geophysical, hydrological & chemical field and laboratory analyses and are applied to characterize the quality, quantity and sustainability of groundwater in aquifer. Under the National Aquifer Programme, it is proposed to generate Aquifer Maps on 1:50000 scale, which basically aims at characterizing the aquifer geometry, behavior of groundwater levels and status of groundwater development in various aquifer system to facilitate planning of their suitable management. The major activities involved in this process encompass compilation of existing data, identification of data gaps, generation of data for feeling data gaps and preparation of different aquifer layers.

1.4 Location and extent

Bundi district is located in the southeastern part of Rajasthan. It is bounded in the north by Tonk district; in the northeast by Sawai Madhopur district; east to southeast by Kota district; south by Chittaurgarh and in the west by Bhilwara district. It stretches between 24^0 59' 22.09" to 25^0 53' 03.41" north latitude and 75^0 15' 35.63'' to 76^0 21' 32.20'' east longitude covering area of 5776.5 sq km (forming 1.62% of total area of Rajasthan State) (Fig.1). It is spread in the survey of India degree sheet nos. 450 (0/6, 0/7, 0/8, 0/9, 0/10, 0/11, 0/12, 0/13, 0/14,0/15,0/16), 54c (c/1, c/2, c/3, c/4, c/6) and 45P (P/9). The district has a systematic drainage system, and most part of the district is drained by the southwest to northeast flowing Chambal River and its tributaries. Small part of the district in the north is drained by tributaries of Banas River.

1.5 Administrative set up

A map of the district showing block boundaries is presented as Figure-1. Administratively, the district is divided into five blocks viz. Bundi, Hindoli, Keshorai Patan, Nainwa and Talera. The details are given below in table 1.

District	Blocks/ Panchayat Samitis	Geographical Area of Block (sq km)	No. of Gram Panchayat	No. of Villages	Tehsils (No. of Villages)	Population Human (2011 Census)
Bundi	Bundi	934.93	30	163	Bundi (163)	148640
	Hindoli	1,339.29	41	184	Hindoli (184)	221601
	Keshorai Patan	1,308.18	46	232	Indragarh (119) Keshorai patan (113)	199311
	Nainwa	1,142.34	34	190	Nainwa (190)	176585
	Talera	942.02	31	104	Talera(104)	159607

Table 1 - Administrative Units of Bundi District, Rajasthan. **Source**: Census of India 2011 (DISTRICT CENSUS HANDBOOK; DIRECTORATE OF CENSUS OPERATIONS, RAJASTHAN)

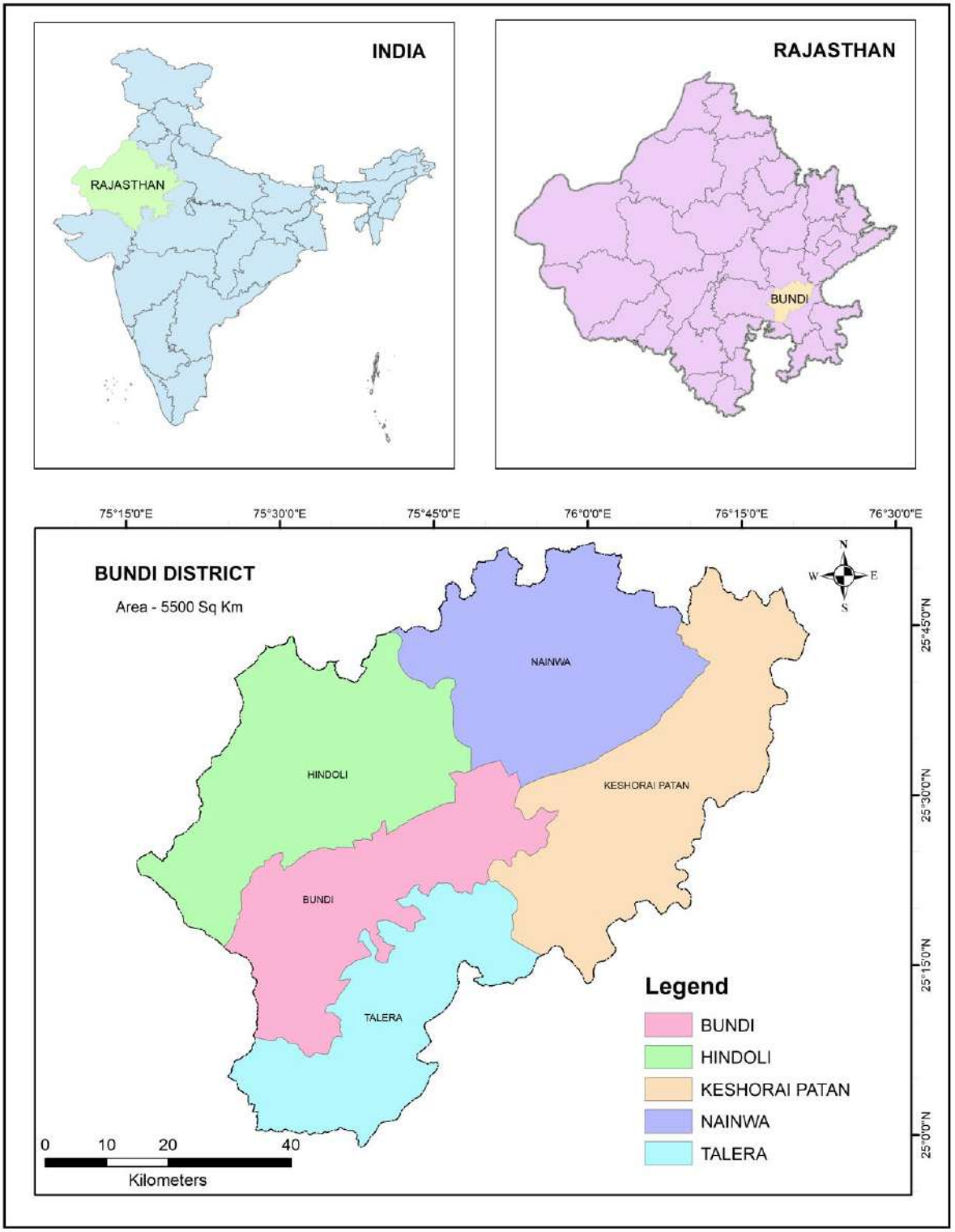


Fig. 1. Administrative map, Bundi district

1.6 Topography

Topography of the district is characterized by flat to undulating terrain with small isolated mounds. It is divided in almost two equal parts by NE-SW trending Vindhyan Range. The general topographic gradient is from southwest to northeast in the southern part of the Range whereas to the northern part of the ridge the gradient is generally from west to east. High

elevation hills are found southern part of the district around Budhpura and to the west of Bundi city. Chambal is the most prominent River in the district and there are some important tributaries like Dungari, Bhimlat, Mej, Bajian, Sugll and Kupal etc. The general topographic elevation in the district is between 250 m to 300 m above mean sea level. Elevation ranges from a minimum of 200 m above mean sea level in Keshorai Patan block in the southeastern part of the district and maximum of 547.1 m above mean sea level In Talera block in southern part of the district.

S. No.	Block Name	Minimum Elevation (m amsl)	Maximum Elevation (m amsl)
1	Bundi	215	539.8
2	Hindoli	242.3	538.6
3	Keshorai Patan	200	484.2
4	Nainwa	225.1	504.3
5	Talera	227.6	547.1

Table 2: Block wise minimum and maximum elevation Source: District Outline- Bundi, 2020

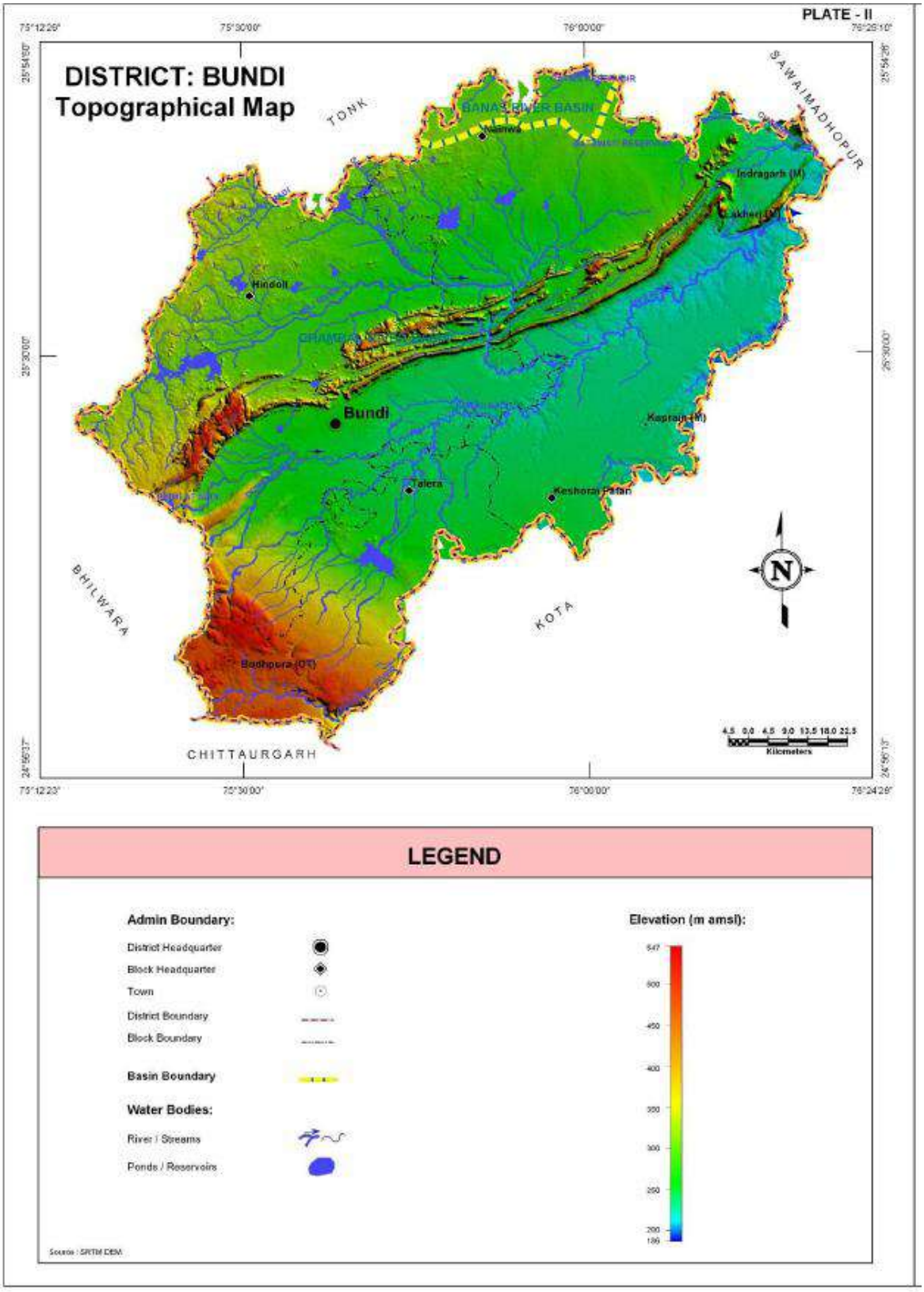


Fig. 2 : Topographical Map , Bundi District

1.7 Geomorphology

Origin	Landform Unit	Description
Denudational	Buried Pediment	Pediment covers essentially with relatively thicker alluvial, colluvial or weathered materials. Pediment
	Pediment	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss-crossed by fractures and faults.
Fluvial	Alluvial Fan	A fan shaped mass of sediment deposit at a point along a Nallah, river where there is a decrease in gradient. Alluvial Plain
	Alluvial Plain	Mainly undulating landscape formed due to fluvial activity, comprising of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium. Valley Fill
	Valley fill	Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles, gravels, sand, silt and clay. The unit has consolidated sediment deposits. Ravine
	Ravine	Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water.
Structural	Plateau	Formed over varying lithology with extensive, flat, landscapes, bordered by escarpment on all sides. Essentially formed horizontally layered rocky marked by extensive flat top and steep slopes. It may be criss crossed by lineament.
	Denudational, Structural Hill, Linear Ridge	Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments. Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc.Long narrow low-lying ridge usually barren, having high run off may form over varying lithology with controlled strike.

Table 3: Geomorphologic units, their description and distribution. Source: District Brochures-Bundi, 2019

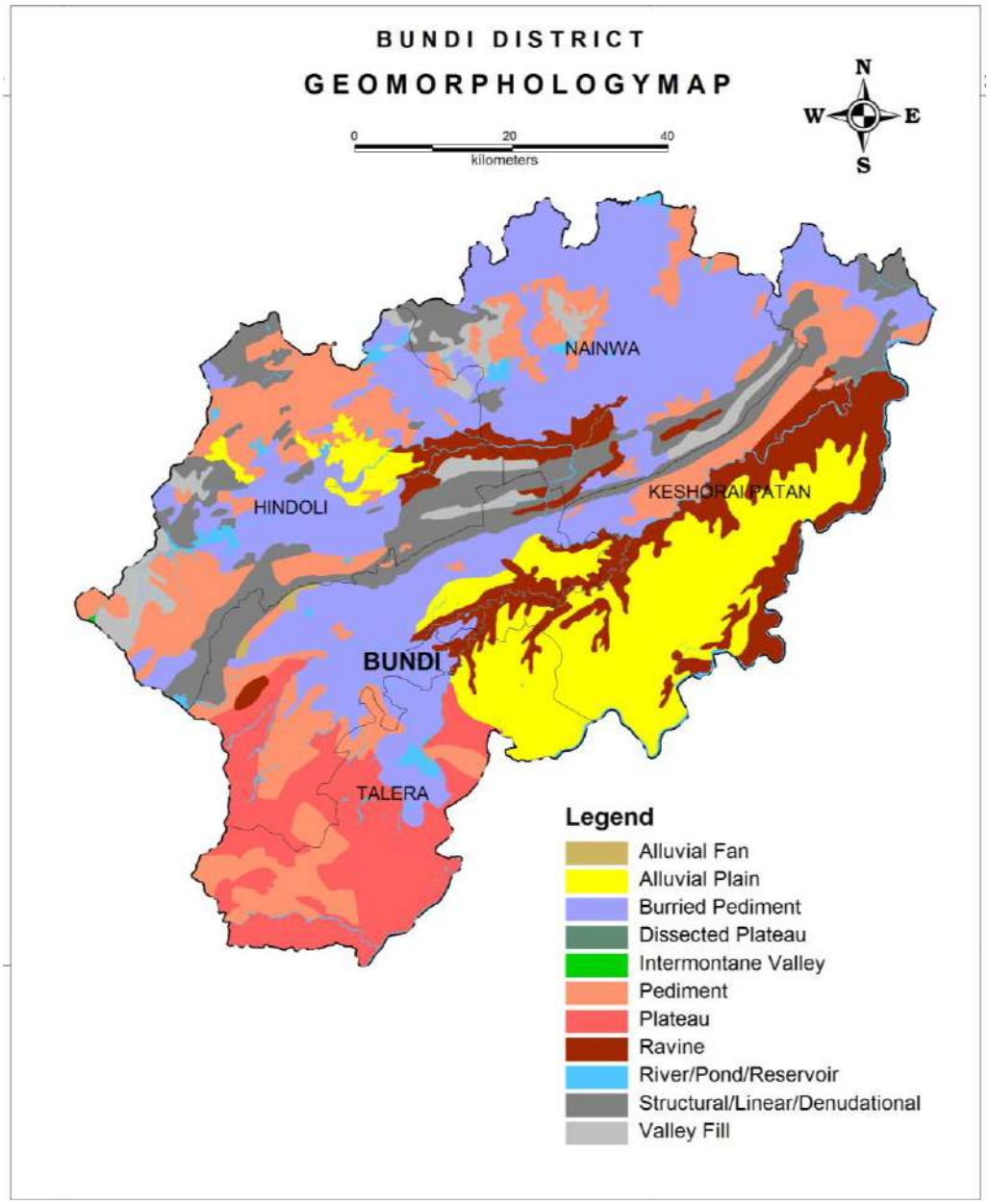


Fig. 3: Geomorphology Map, Bundi District

1.8 Climate and Rainfall

Summer season in Bundi district of Rajasthan extends from the month of March to the month of May. Summer season records very high temperatures often reaching 46^{0}C or above. The winter season starts from the month of November and lasts till February, and during this time the minimum temperature recorded is very low often around 3-4^{0}C. Monsoon season starts from July and end in early September. The monthly minimum, maximum and average temperatures are shown in Table 4 below:

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	16.9 °C	20.5 °C	26.2 °C	32.2 °C	35.6 °C	33.9 °C	29.1 °C	27.4 °C	28 °C	27.3 °C	23.1 °C	18.4 °C
Min. Temperature °C	9.9 °C	13 °C	18.1 °C	24 °C	28.7 °C	28.9 °C	26.1 °C	24.8 °C	24 °C	20.7 °C	16.3 °C	11.5 °C
Max. Temperature °C	24 °C	27.9 °C	33.8 °C	39.6 °C	42.2 °C	39.2 °C	32.8 °C	30.6 °C	32.5 °C	33.9 °C	30 °C	25.5 °C
Precipitation / Rainfall mm	7	6	4	4	6	72	260	233	82	11	6	3
Humidity (%)	48%	38%	25%	18%	21%	40%	69%	79%	65%	40%	40%	47%
Rainy days (d)	1	1	1	1	2	6	13	14	7	1	1	1

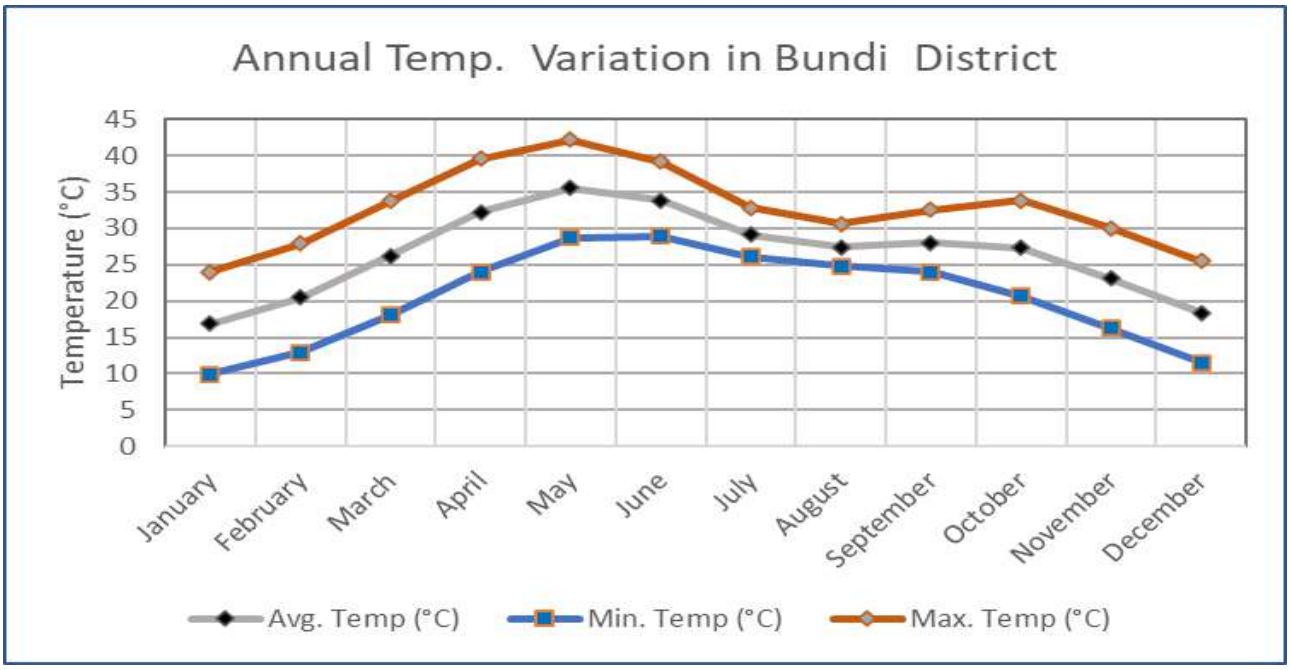


Fig. 4: Temperature Variations, Bundi District

Rainfall

Historical records of rainfall in the district are available for 5 stations The normal annual rainfall in the district is 681.3 mm. The long-term rainfall data (1970-2020) of the rain gauge stations located at all the block headquarters was subjected to various types of analysis to understand the characteristic of the rainfall. It was observed that the distribution of rainfall is quite uniform in the area except for Indergarh Block where the average annual rainfall of 50 years is higher than other blocks. The rains usually start in the July and last till the end of September. The rainfall received by the district is fairly good. District Average Normal Annual Rainfall is 681.3 mm based on 50 year data of all 5 blocks.

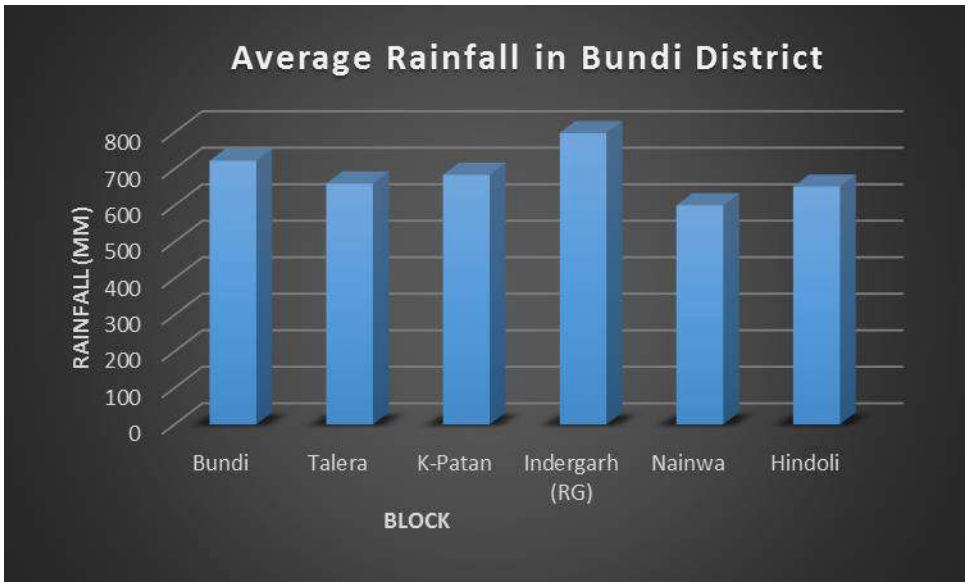


Figure 5: Normal Annual Rainfall of 5 blocks and critical Rain gauge of Bundi District.

Areal Distribution of Rainfall

Rainfall generally decreases from Eastern part of the district to North-Western part (figure 4.1). The perusal of spatial distribution of average annual rainfall in Bundi (figure. 2.3) shows that Indergarh hydro meteorological station receives maximum rainfall (average annual rainfall is 798.1 mm) and Nainwa station receives least rainfall (average annual rainfall is 600.5 mm). Figure

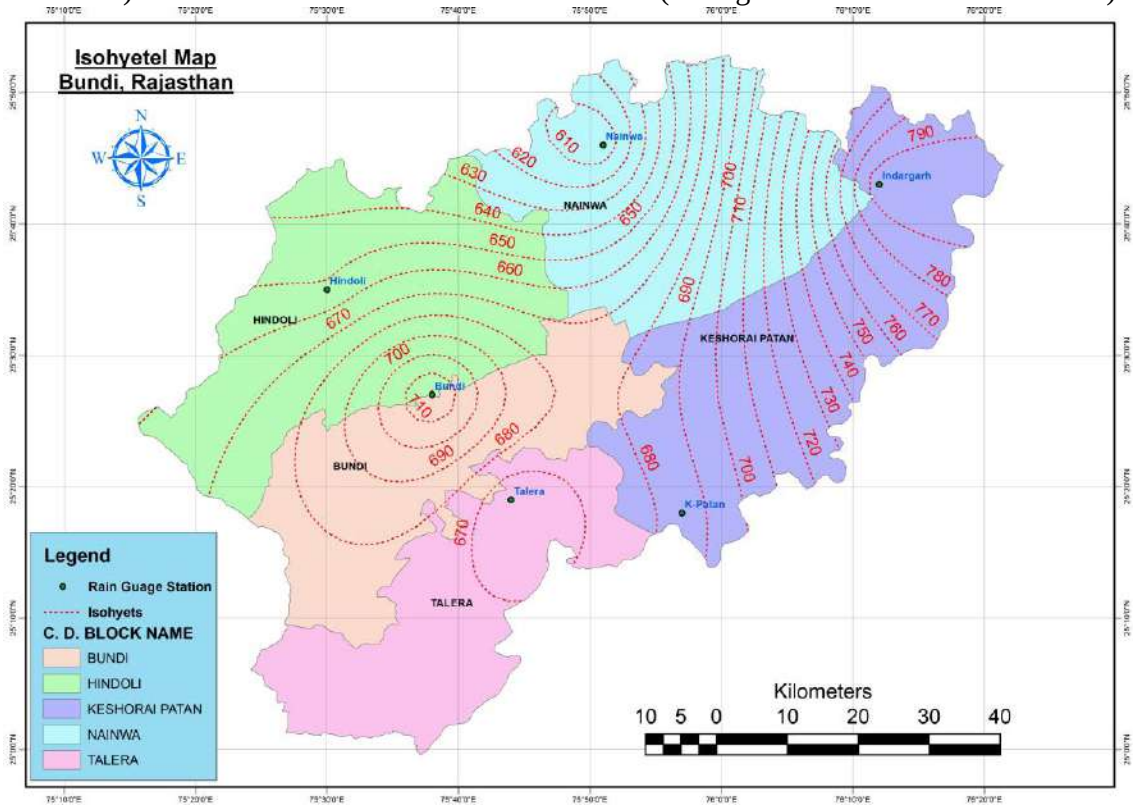


Fig 6: Isohyetal Map of Bundi District.

Statistical Analysis of rainfall data shows that rainfall in the district is quite erratic (figure 7). The coefficient of variation shows that it varies from 29.8% at Bundi to 4115% at Nainwa.

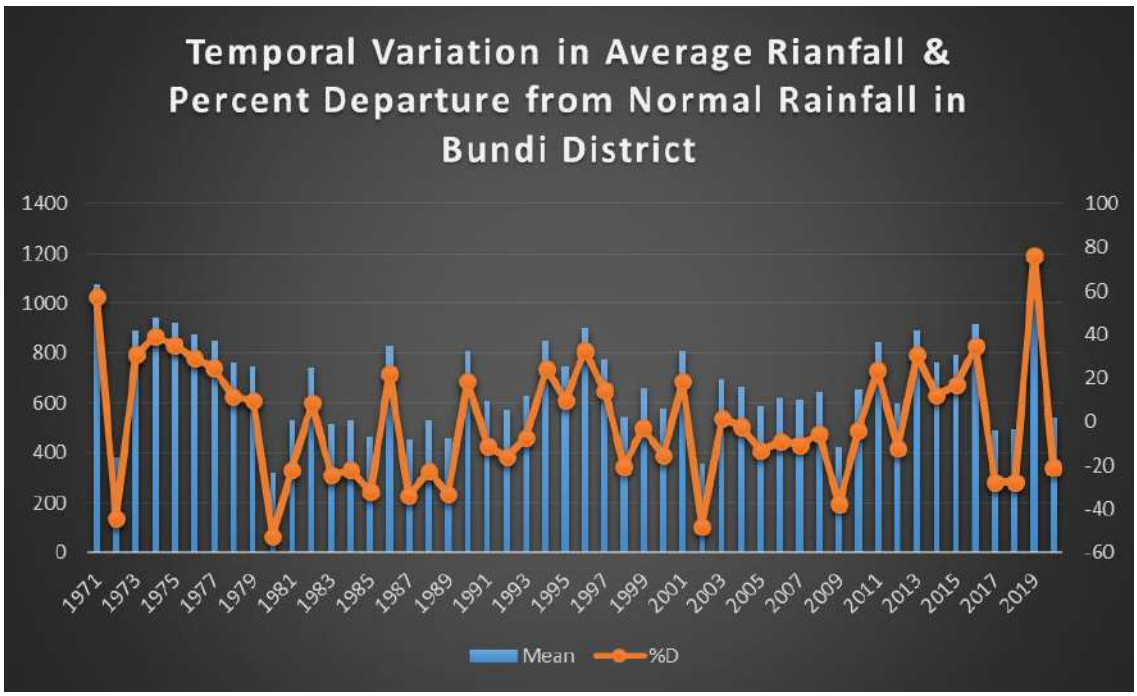


Table 5: Results of Statistical Analysis of Rainfall Data for the period 1970-2020

Parameter	Bundi	Talera	K-Patan	Indergarh	Nainwa	Hindoli
Mean Annual rainfall (mm)	722.604	660.108	683.704	798.10465	600.516	651.512
Highest Annual Rainfall (mm) with year	1330 (2019)	1329 (2019	1413 (1971)	1465 (1978)	1135 (2021)	1372 (2019)
Lowest Annual Rainfall (mm) with year	261 (1980	152 (1991)	118 (1972)	251 (1972)	186 (1989)	278 (1985)
Std. Deviation	215.54	230.51	222.95	314.92	247.15	237.15
Coefficient Of Variation	29.82	34.92	32.61	39.45	41.15	36.4

Drought Analysis

Drought frequencies and years of occurrence of droughts have been computed using agricultural Classification. It takes into account negative departure percentages of annual rainfall from mean annual rainfall. It is observed that almost whole of the area had experienced mild and normal droughts for 10 to 20% of years except for Khandar Block which has experienced more years of mild droughts. Sawai Madhopur Block has experienced only 20% of years of droughts that too of mild and normal types. Bonli Block has suffered most drought years viz. 60% at both of its stations of Bonli and Malarna Dungar.

Block	No. of Year & Freq. of Drought	Mild (0 to -25%)	Normal (-25% to -50%)	Sever (- 50% to -75%)	Most sever (-75% to -100%)
Bundi	No. of Year	14	7	2	0
	Freq. of Drought (%)	28	14	4	0
Talera	No. of Year	17	8	2	1
	Freq. of Drought (%)	34	16	4	2
K-Patan	No. of Year	18	6	2	1
	Freq. of Drought (%)	36	12	4	2
Nainwa	No. of Year	13	10	6	0
	Freq. of Drought (%)	26	20	12	0
Hindoli	No. of Year	14	10	3	0
	Freq. of Drought (%)	28	20	6	0
Bundi District	No. of Year	18	8	1	0
	Freq. of Drought (%)	36	16	2	0

Table6: Results of Statistical Analysis of Rainfall Data for the period 1970-2020 for drought analysis.

1.9 Soil Characteristics

The district is characterized by five types of soils given below.

a. **Lithosol and regosols of hills**
b. **Yellowish – brown soils of foot hills.**
c. **Recent alluvium**
d. **Brown soils-saline phase**
e. **Black soils**

Sl. No.	Type of soil	Area		Block
		Sq.km.	%	
A	Lithosol and regosols of hills	1206.64	21.74	In parts of Talera, Hindoli and Nainwa
B	Yellowish – brown soils of foot hills	895.55	16.14	In parts of Hindoli and Nainwa
C	Recent alluvium	1845.74	33.26	In parts of Talera, and Keshorai patan
D	Brown soils-saline phase	776.73	13.99	In parts of Hindoli and Nainwa
E	Black soils	825.34	14.87	In parts of Talera

Table 7: Distribution of soil types in the district **Source: District Groundwater Brochure (CGWB)**

1.10 Land use

The socio-cultural and economic factors have significantly influenced over land use both in rural and urban areas in the district. Land forms, slope, soils and natural resources are some of the important which controls the land use pattern of the district. District Land use statistics available on Web Based Land Use Statistics Information System is presented below in Table-8

Table 8: Total Area and Classification of Area in Bundi District of Rajasthan State for the Year Ending 2019-20 (Hectare)

District	Reporting Area for LUS	Classification of Reporting Area											Net Area Sown	Cropped Area	Area Sown More Than Once
		Forests	Not Available for Cultivation			Other Uncultivated Land Excluding Fallow Land				Fallow Land					
			Area Under Non Agricultural Uses	Barren and Unculturable Land	Total	Permanent Pasture and Other Grazing Land	Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	Culturable Waste Land	Total	Fallow Lands Other Than Current Fallows	Current Fallow	Total			
9.BUNDI	581938	141386	41254	48164	89418	23419	265	25670	49354	25581	9275	34856	266924	502098	235174

Source: Web Based Land Use Statistics Information System (https://aps.dac.gov.in/LUS/Public/Reports.aspx)

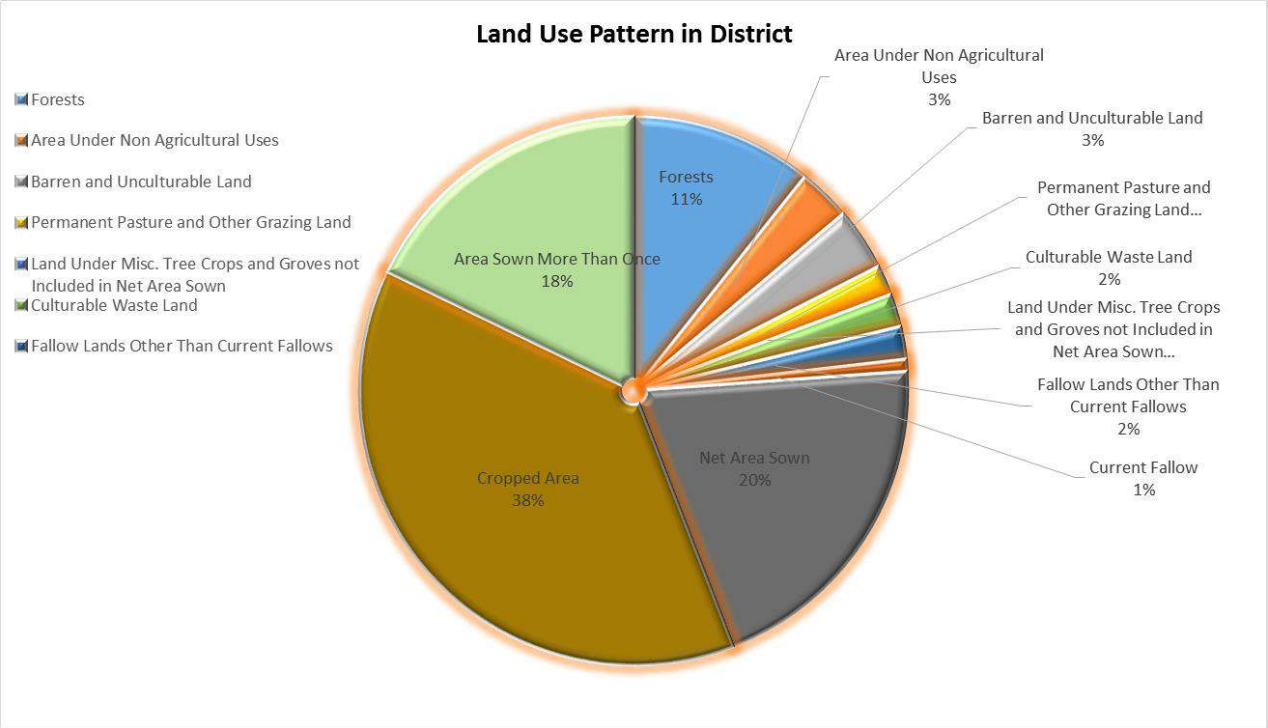


Fig. 8: Land Use in Bundi District

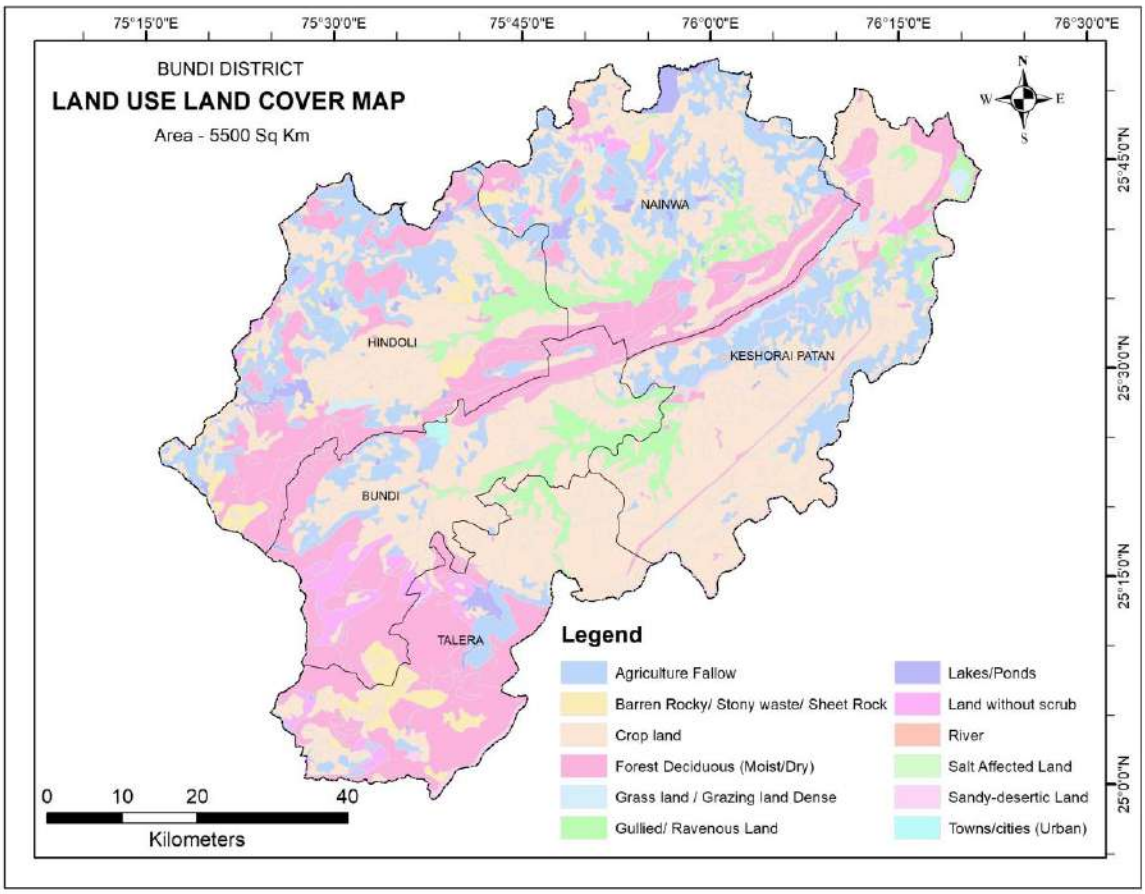


Fig. 9: Land Use pattern in Bundi District

Agriculture

Agriculture activity in the district is, by and large, confined to traditional kharif cultivation depending on monsoon rainfall and rabi cultivation is prevailing in areas where irrigation facilities are available. The major crops grown in the area are given in table 7 below:

Table 9: Major crops grown in Bundi District

Food Grain	Jowar, Bajra,Wheat, Barley, Maize, Rice
Cereals	Gram, other kharif cereals,Tur, other rabi cereals
Oil seeds	Rai & Mustard,Til, Ground Nut,Arandi/Taramira
Non food grains	Cotton,Onion,Red chilli,Tobacco,Potato,Jute

Irrigation

Canal irrigation by Chambal Left Main Canal (LMC) has brought green revolution in the Bundi district which constitutes the major source of irrigation. The principal means of irrigation in the district are through surface water which comes to around 54% and area irrigated through wells is 45% and only 1% area is irrigated by other sources. Source wise breakup of irrigation pattern is as below Table 10 below:

in Hect.	Dugwells		Tubewells		Ponds		Canals		others		Total	
Block	Net irrigated	Gross Irrigated	Net irrigated	Gross Irrigated	Net irrigated	Gross Irrigated	Net irrigated	Gross Irrigated	Net irrigated	Gross Irrigated	Net irrigated	Gross Irrigated
Bundi	4975	4153	3755	4861	0	0	37108	27369	6926	5020	56604	41403
Hindoli	19870	18467	10210	8703	261	261	11477	11153	14	14	41832	38598
K Patan	13323	13323	3641	3641	737	364	58472	53875	1243	1162	77416	71451
Nainwa	10860	17167	41776	40188	0	0	3218	3167	1558	158	64612	62080
Talera	2917	2149	1611	983	73	73	32096	24257	1129	894	37826	28356
Total	51945	55259	60993	58376	1071	698	142371	119821	10870	7248	278290	241888

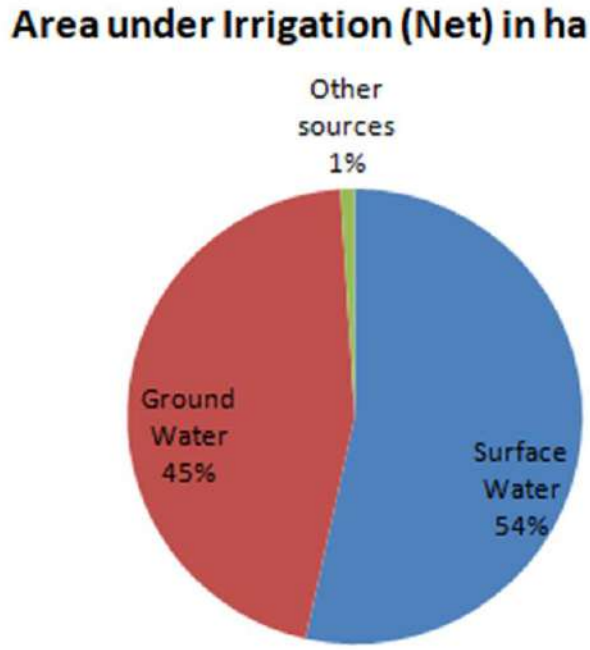
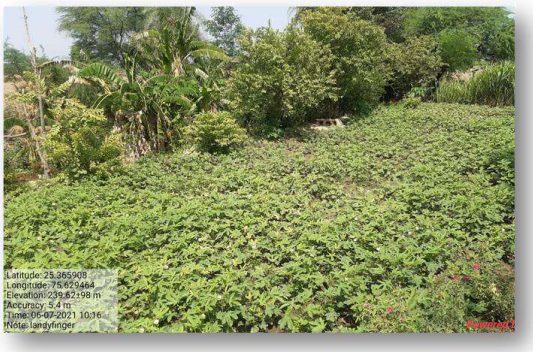


Fig. 10: Area under irrigation in Bundi Distrit

	**Poly house Farming in study area.**
	**Ravine Reclamation**
	**Agriculture activities in flood plains of the river**
Fig 11: Filed photographs of various type land use in district Bundi.	

1.11 Data Adequacy and Data Gap Analysis

The available data of the Exploratory wells drilled by Central Ground Water Board, Western Region, Jaipur, Geophysical Survey carried out in the area, Ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analyzed for adequacy of the same for the aquifer mapping studies. In addition to these the data on ground water monitoring stations and ground water quality stations of the State Govt. (GWD) was also utilized for data adequacy and data gap analysis. The data adequacy and data gap analysis were carried out for each of the quadrant of falling in the study area mainly in respect of following primary and essential data requirements:

- Exploratory Wells
- Geophysical Surveys
- Ground Water Monitoring and
- Ground Water Quality

After taking into consideration, the available data of Ground Water Exploration, Geophysical survey, Ground Water Monitoring and Ground Water Quality, the data adequacy is compiled and the summarized details of required, existing and data gap of Exploratory wells, Ground Water monitoring and Ground water quality stations is given below.

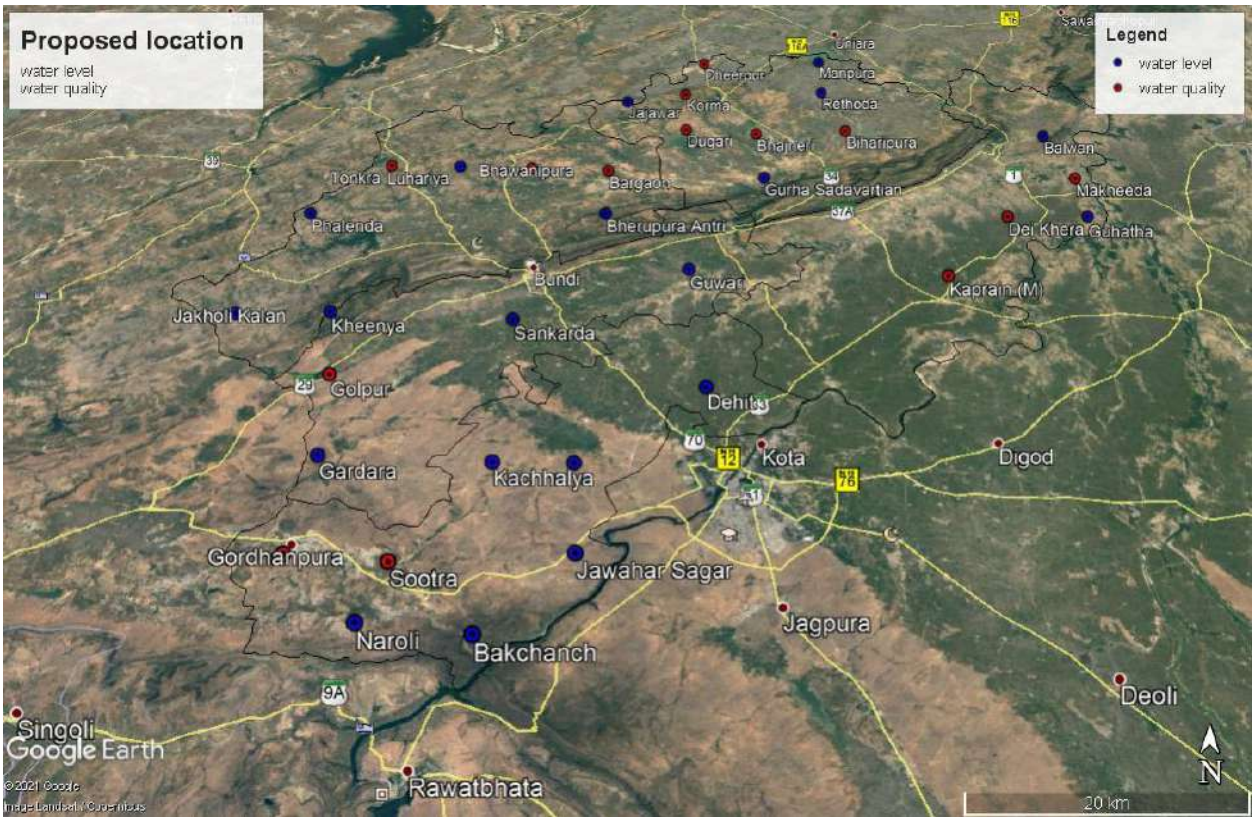


Fig 12: Data Gap Identified for Monitoring and Water Quality

Data Gap in Geophysical Surveys

Depending upon the percentage of the area falling in a particular quadrant, the quantity of VES data gap was proportionally calculated i.e. if area is > 25% of quadrant, 2 VES are taken for that very quadrant. After analysing, the quadrant wise 'total VES required' and 'VES / Logging number available', the 'VES data gap' in the aquifer mapping (valley) areas of Bundi District was calculated, as per the CGWB guidelines of 3 VES per quadrant in hard rock area. The toposheet wise summary of VES required to be conducted, available and Data Gap number is given in table 2. The VES Data Gap locations in Bundi district are shown in Figure 7.

Table 11. Toposheet wise summary of VES Required, Available and VES Data Gap Numbers in Bundi District.

S. No.	Toposheet No.	Total VES/TEM Required to be Conducted	VES & Logging Available	VES / TEM Data Gap	REMARKS
1.	45 O/6	10	0	10	Achieving these figures will solely depend upon the space availability and other field constraints.
2.	45 O/7	19	0	19	
3.	45 O/8	6	0	6	
4.	45 O/9	1	0	1	
5.	45 O/10	25	0	25	
6.	45 O/11	27	0	27	
7.	45 O/12	25	0	25	
8.	45 O/13	12	0	12	
9.	45 O/14	27	0	27	
10.	45 O/15	27	0	27	
11.	45 O/16	3	0	3	
12.	54 C/1	9	0	9	
13.	54 C/2	27	0	27	
14.	54 C/3	14	1	13	
15.	54 C/5	2	0	2	
16.	54 C/6	7	0	7	
	TOTAL	**241**	**1**	**240**	

- So, there is a VES Data Gap of 240 numbers (locations) in Bundi district, which are to be covered either by VES or TEM surveys.

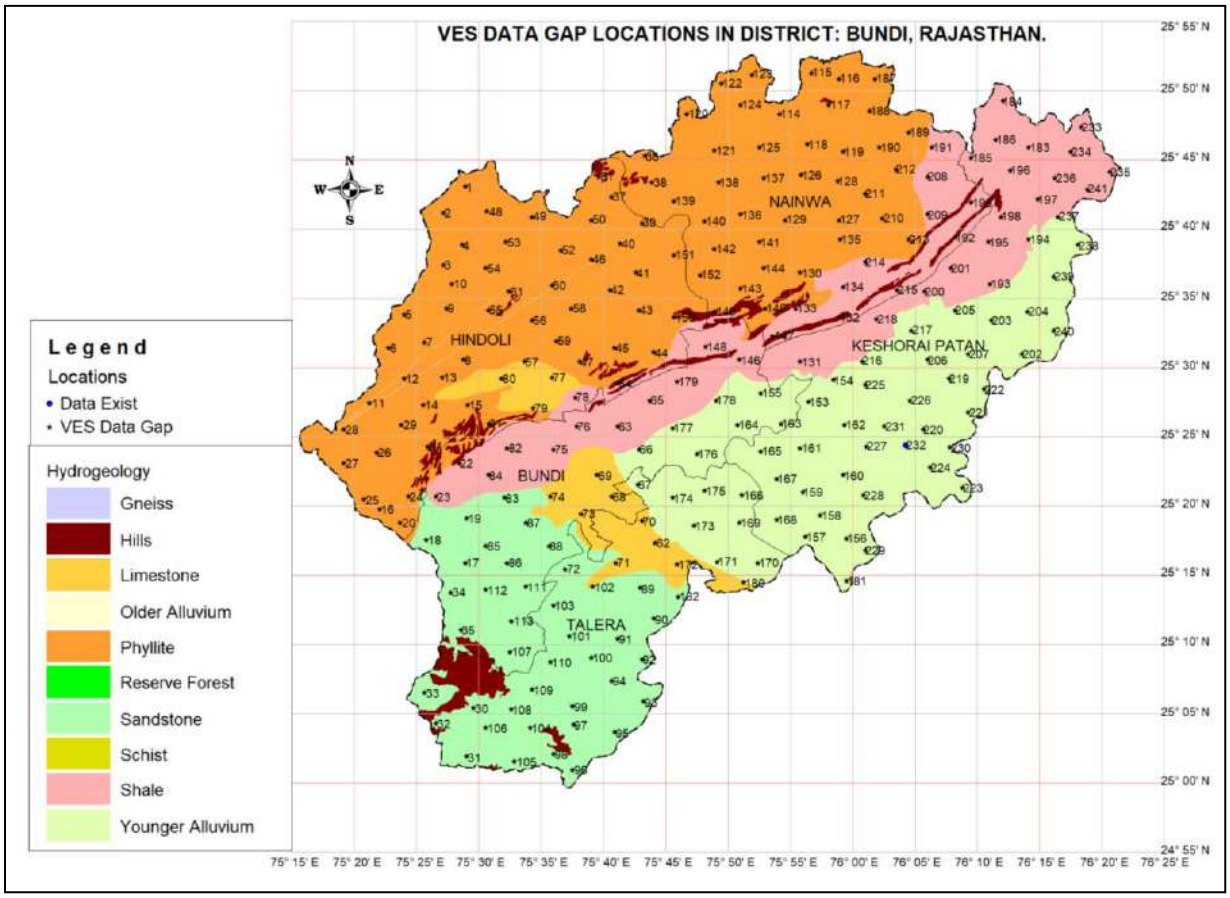


Fig 13: Map showing the VES Data Gap Locations in Bundi District, Rajasthan

2.0 GEOLOGY

2.1 General geology and structure

Geologically, the upper part of the district i.e. NE-SW exposed by rock formation belonging to oldest Archaean metamorphics of Bhilwara Super Group and lower part of the district belonging to the upper Proterozoic sedimentaries of Vindhyan Super Group. In Bhilwara Super Group rocks of Hindoli, Mangalwar & Jahajpur Groups are exposed. Vindhyan sedimentary sequences have occupied northeastern to southern part of the district. These are grouped as upper Vindhyan Super Group (100-600 m.y.) and separated from Bhilwara Super Group by a major reverse fault known as Great Boundary Fault. The Groups of Vindhyan Super Group i.e. Kaimur, Rewa & Bhander and their formations are well exposed in the district. Quaternary alluvium is observed along main river courses as shown in figure 8.

Table 12: General geology of Bundi District

Super Group	Group	Formation
Recent to sub-Recent		Soil Alluvium
Vindhyan	Upper Bhander	Upper Bhander shale, Balwan Limestone, Maihar Sandstone
	Lower Bhander	Sirbu shale, Lower Bhander sandstone, Samaria shale, Lower Bhander limestone, Ganugarh shale
	Rewa	Govindgarh sandstone, Jhiri shale, Indergarh sandstone, Panna shale
	Kaimur	Kaimur sandstone, Badanpur conglomerate
-------X--------X---Unconformity---X--------X--------		
		Acid & Basic intrusives
Bhilwara	Jhazpur	Dolomite, ferruginous, chert, carbonaceous, phyllite, ferruginous phyllites with thin band of conglomerate, gritty quartzite & quartzite
	Hindoli & Mangalwar complex	Shale, phyllite, mica schist, quartzite, dolomites, limestone, amphibolites, calc-silicates & quartzite

Source: District Atlas- Bundi, 2013

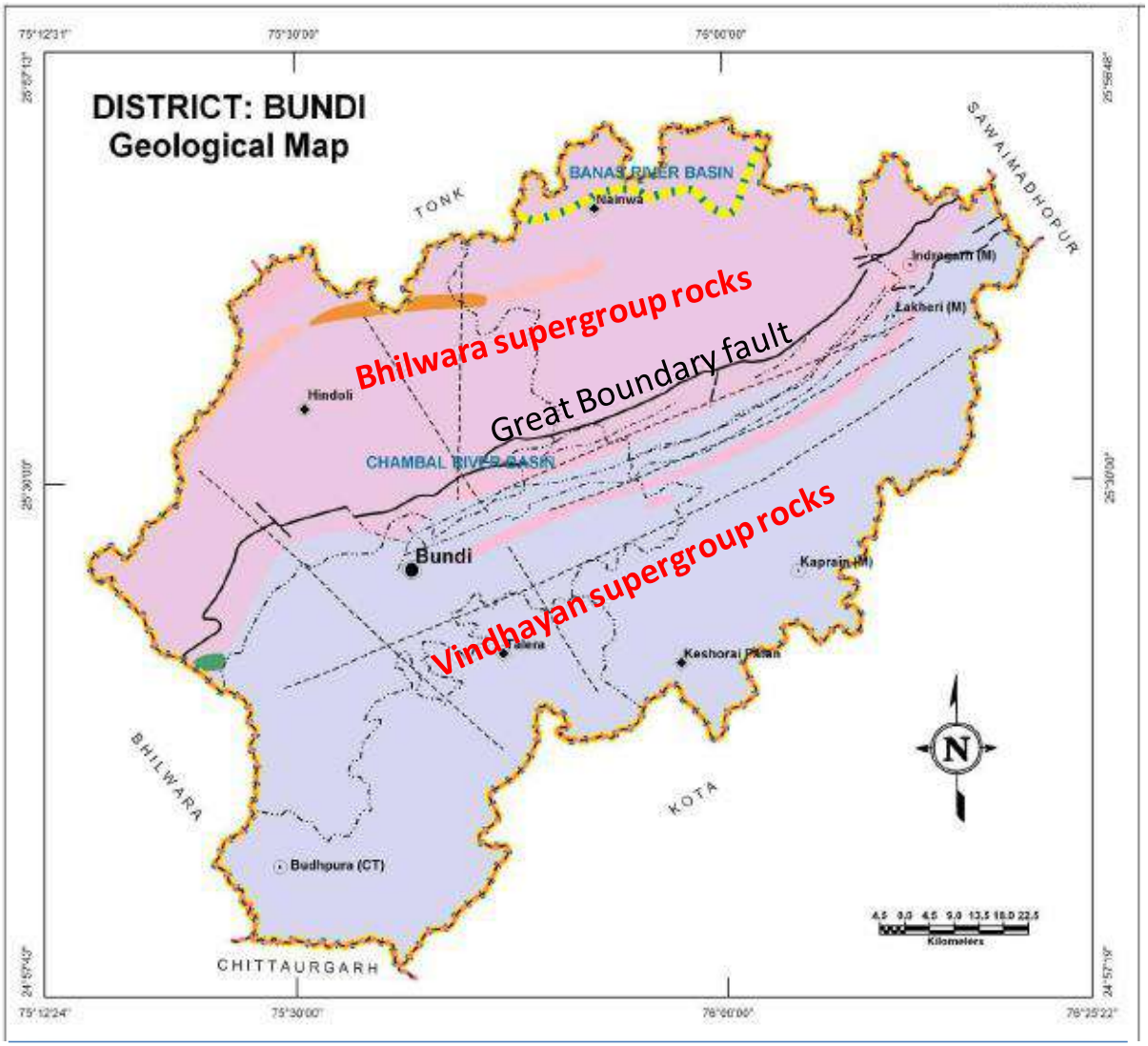


Fig 14: Geological Map of Bundi District

Archaeans

Archaeans are represented in the district by formations of Bhilwara supergroup comprising younger Jahazpur group and under Mangalwar complex. Rock belonging to Marwar supergroup is exposed in the northern half of the district adjoining Tonk and Bhilwara district.

The rocks belonging to Jahajpur group are located in the northern part of the district along a thin ENE-WSW trending belt and encompass mainly dolomite, dolomitic marble, banded ferruginous chert, phyllite, carbonaceous phyllite, quartzite and basic meta volcanics. These rocks are intruded by Pre-Aravalli intrusives like granite and dolerites which are exposed near village Basni, Deva ka Khera and Odhanda of Hindoli block of Bundi district. General trend of rocks is N 400 E with 600 NW dip.

Hindoli group of rocks covers the maximum area occupied by the Bhilwara Super Group. These comprise shale, slate, phyllite, metagraywacke, limestone, dolomitic marble, Meta basic volcanics, and quartzite and mica schists. This group is intruded by sills and dykes of dolerites. The boundary between Hindoli group and Vindhyan supergroup is marked by a

fundamental fracture (Bundi lineament) manifested in the Great Boundary Fault of Rajasthan.

Mangalwar Complex occupying the northern most tip of the district comprises migmatite, gneisses, felspathised mica-schist, garnetiferous mica-schist, quartzite, impure marble and amphibolite. The temporal relationship of Hindoli group with Mangalwar Complex is not clearly established. Hindoli group and Mangalwar Complex represent flysch type sedimentaries in geosynclinal trough (after GSI, Lithostratigraphic map of Aravalli Region, southern Rajasthan).

Vindhyans

Rocks belonging to Vindhyan supergroup are represented by younger Bhander group, Rewa group and the older Kaimur group. Bhander group mainly constitutes sandstone and limestone, Rewa group as sandstone and shale and Kaimur group constitutes sandstone, shale and conglomerates.

The formations belonging to Vindhyan supergroup occupy about 60% of the southern part of Bundi district. Most of this area is underlain by rocks of Bhander group, Rewa group is exposed S-W of Indergarh extending upto 5 km. and occur inbetween Taragarh fort of Bundi and Indergarh for about 72 km., whereas, the rocks belonging to Kaimur group occur along a thin ENE-WSW trending thin belt along the faulted contact of Vindhyans with Archaean.

Vindhyans sandstone belonging to Kaimur, Rewa and Bhander group are fine grained, grey to red in colour, very hard and compact. These are highly jointed and at places stand like high mounds and ridges giving rise to highly undulating topography. Sandstones are generally flat with low dip towards north-east.

Rocks of Kaimur group occur as outlier on the N-W of Great Boundary Fault in between Bundi – Indergarh area.

Rewa group comprises Panna shale, Indergarh sandstone (lower Rewa), Jhiri shale and Ganurgarh sandstone formation (upper Rewa). Panna shale and Indergarh sandstone are exposed S-W of Indergarh extending upto 5km. Jhiri shale and Ganurgarh sandstone are persistent and both occur together in between Taragarh fort of Bundi and Indergarh for about 72 km.

Limestone of Bhander group are fine to medium grained and are grey ,red, yellowish, pink and buff in colour. Red and brick colour varieties are non-siliceous and hence are prone to weathering where as grey bands are siliceous and are very hard. At places (Ballop) the ruggy limestones are encountered. In general Bhander limestone is cavernous and at places it exhibit evidence of algal life in the form of arch shaped structures called ‘stromatolite’ developed mostly west of Bundi and east of Lakheri. Limestone connotes rolling dips towards north-east.

Lakheri limestone on which Lakheri cement factory is based, belongs to lower Bhander sub-group and occurs in between greenish grey Samaria shale above and reddish brown

Ganurgarh shale below. It is marked by intraformational conglomerate and breccia at the base. It is exposed from east of Sarodara and runs to 5 km. north-east where appears in the form of anticline near village Satur and extends intermittently for 80 km. in 1 to 2 km. wide belt up to Indergarh.

Maihar sandstone occurs only in a hill on the east of Lakheri. Balwan limestone occurs conformably above the Maihar sandstone and is exposed near Kamleshwar Mahadev and in river Chaken. Its lower part is greyish, ferruginous, arenaceous and cherty in nature whereas upper horizon is pinkish and stromatolitic in nature. Dholpura shale conformably overlies the Balwan limestone and exposed near Dholpura, Daulatpura, Narayanpura and Sandenala. It is pinkish, purple, reddish and brown in colour, thinly bedded and horizontally disposed.

The Vindhyan shale is grey light green and purple in colour. These shales are mostly splintery in nature and give rise to nearly horizontal landscape with very gentle slope. These are generally exposed in nallah cuttings and in unlined well section thinly bedded. Shales are least developed at Detunda at the foot of Mir Sale Ka Dungar and in the Neighbourhood of Khatkar, Talwara and Lakheri.

Vindhyans are covered with a covering of alluvium in the southern and south-eastern part of the district.

Quaternary alluvium

Quaternary sediments represent alluvium, aolian, scree & talus and are encountered mainly along the central, southern and south-eastern parts of the district. Thickness of alluvium ranges from a few metres to 40 metres. Thick alluvium is restricted to the banks of Chambal, Kural and Mej rivers i.e. 30 to 40 m. Alluvium is composed of unconsolidated to semi-consolidated, fine grained sand, silt, clay and occasionally kankar.

3.0 HYDROGEOLOGY

The availability, occurrence and movement of groundwater is mainly controlled by the topographic features, physical characteristics and structural features present in the geological formations. The important water bearing formations besides alluvium are sandstone, limestone and shale of Vindhyan supergroup and phyllite & slate of Bhilwara supergroup. In hard rocks, the occurrence and movement of ground water is controlled through the bedding planes, fissures, joints, solution cavities and other structural weak planes. During the course of hydrogeological surveys, it has been observed that the weathered mantle of hard rocks form aquifer and yield good discharge. In alluvium, ground water occurs in the interstices of unconsolidated sand. Ground water occurs mainly under water table in all the formations. However at places, also occurs under semi- confined to confined conditions both in alluvium and hard rocks.

Aquifer system

Quaternary alluvium, rocks of Vindhyan supergroup and Bhilwara supergroup form the aquifer systems in the district. Bundi district is mostly underlain by the rocks of Vindhyan Super Group with minor outcrops belonging to Bhilwara Super Group and Post Delhi Intrusives at places overlain by Quaternary alluvium. The occurrence of groundwater in the area is mainly controlled by the topographic features, physical characteristics and structural features present in the geological formations. Ground water occurs under unconfined conditions in phreatic zones, semi-confined conditions in deeper zones and weathered & fractured portions of the hard rocks. Groundwater potential map of the area is depicted in Fig. 9.

Aquifers comprises Alluvium, Shale, Sandstone, Limestone and Phyllite. GBF plays important role in separating the aquifers formed in sedimentary rocks of Vindhyans with Bhilwara Super Groups. South of GBF, alluvium is the most prominent aquifer occupying about 22% of the spatial coverage of aquifers while shale, sandstone and limestone aquifers occupy 17.6%, 15.6% and 4.8% of the total aquifer area in the district. North of the GBF, phyllites are the only rocks that form aquifers. The primary openings in sandstones and secondary openings in other hard rock formation facilitate storage of underground water. Sand, silt gravels and pebbles within thick alluvial cover over the bedrocks
Constitute aquifers in alluvium.

Table 13: Aquifer potential zones their area and their description

Aquifer potential zones their area and their description			
Aquifer Potential Zone	Area (sq km)	% age of district	Description of the unit/Occurrence
Younger Alluvium	1,269.90	22	Aeolian and Fluvial sand, silt, clay, gravel and pebbles in varying proportions.
Limestone	276.8	4.8	fine to medium grained, grey, red yellowish, pink or buff in colour
Sandstone	898.4	15.6	Fine to medium grained, red colour and compact and at places.
Phyllite	2,129.10	36.9	meta sediments and represented by carbonaceous phyllite
Shale	1,016.70	17.6	Grey, light green and purple in colour and mostly splintery in nature.
Hills	185.6	3.1	

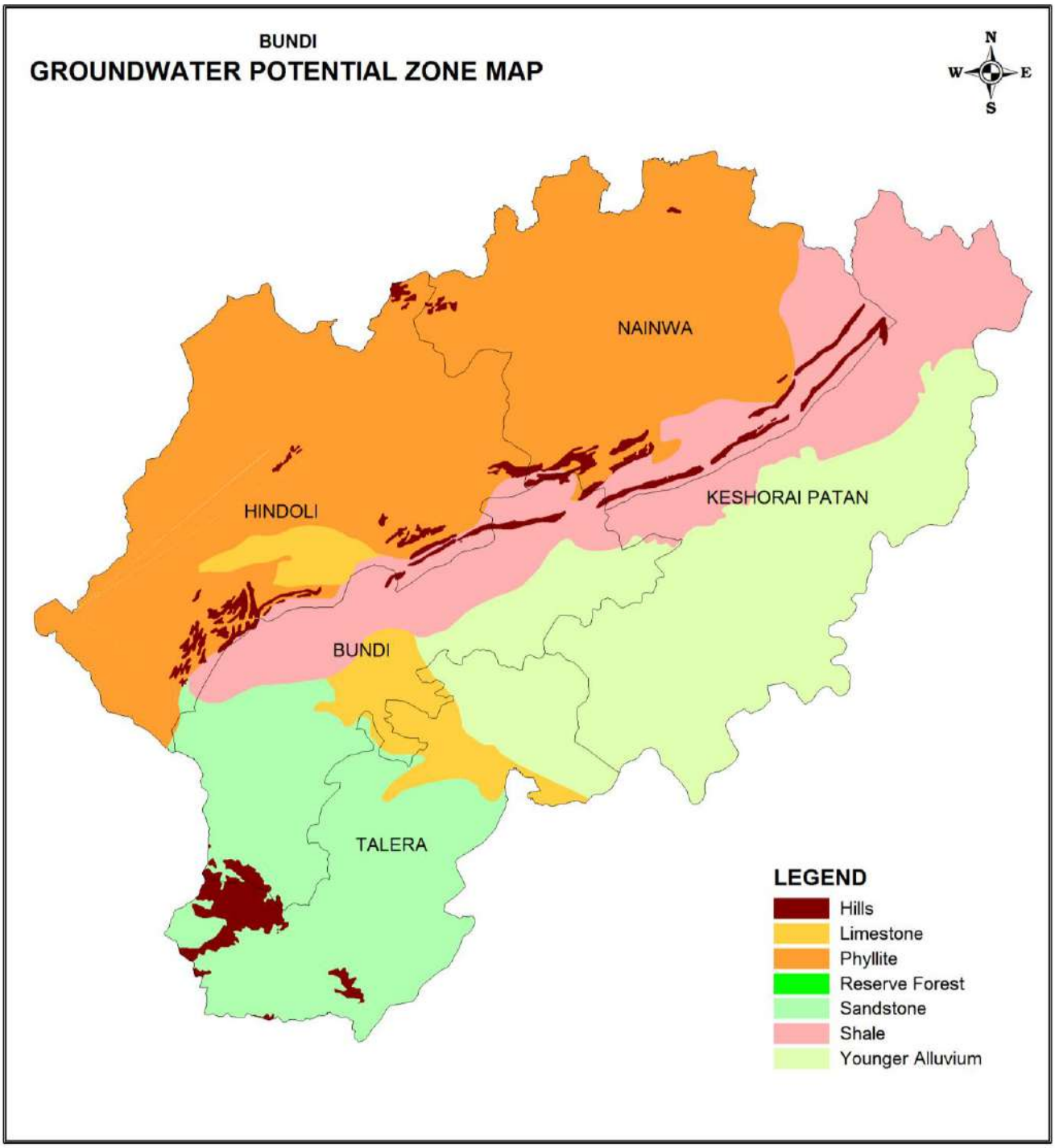


Fig.15: Groundwater Potential Map of Bundi district

3-D and 2-D Aquifer Disposition

The data generated during ground water exploration by constructing exploratory wells, observation wells, slim holes and piezometers was utilized to decipher the aquifer disposition in the area. Based on the existing data set 67 observation points were selected for the study of aquifer disposition in 3D and several hydrogeological sections along section lines using Rockworks software shown in Figures 15-18, to understand the subsurface disposition of aquifer system. Lithological 3D representation of the study area clearly depicts that it mainly comprises of the hard rock formations belonging to Vindhyan Supergroup, Bhilwara Super Group, and Delhi Super Group igneous crystalline and metamorphic rocks.

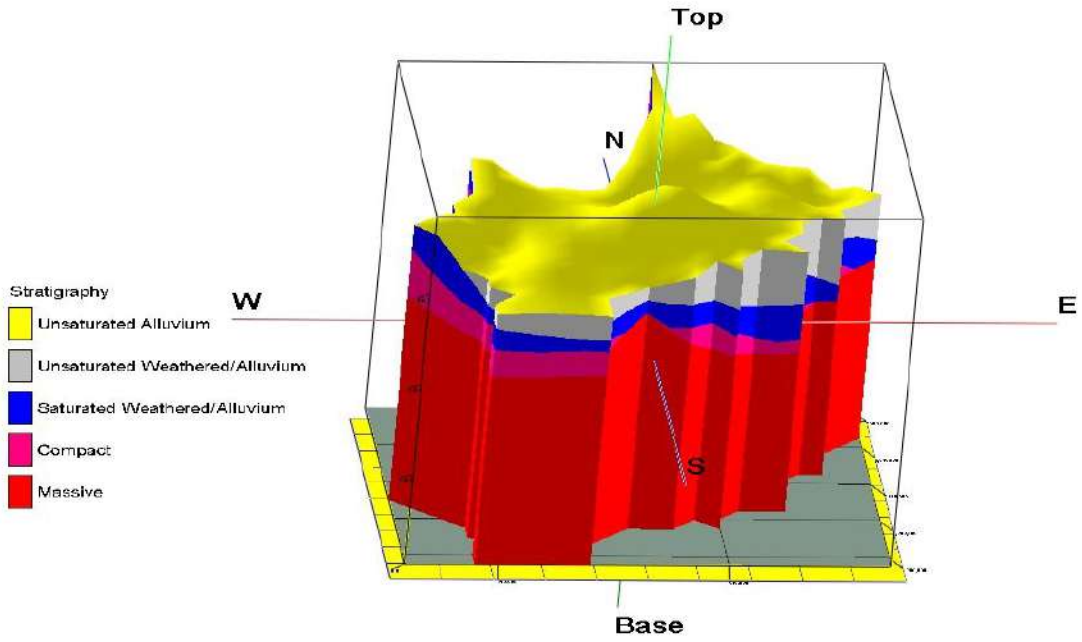


Fig 15: 3D aquifer disposition model of the Bundi District.

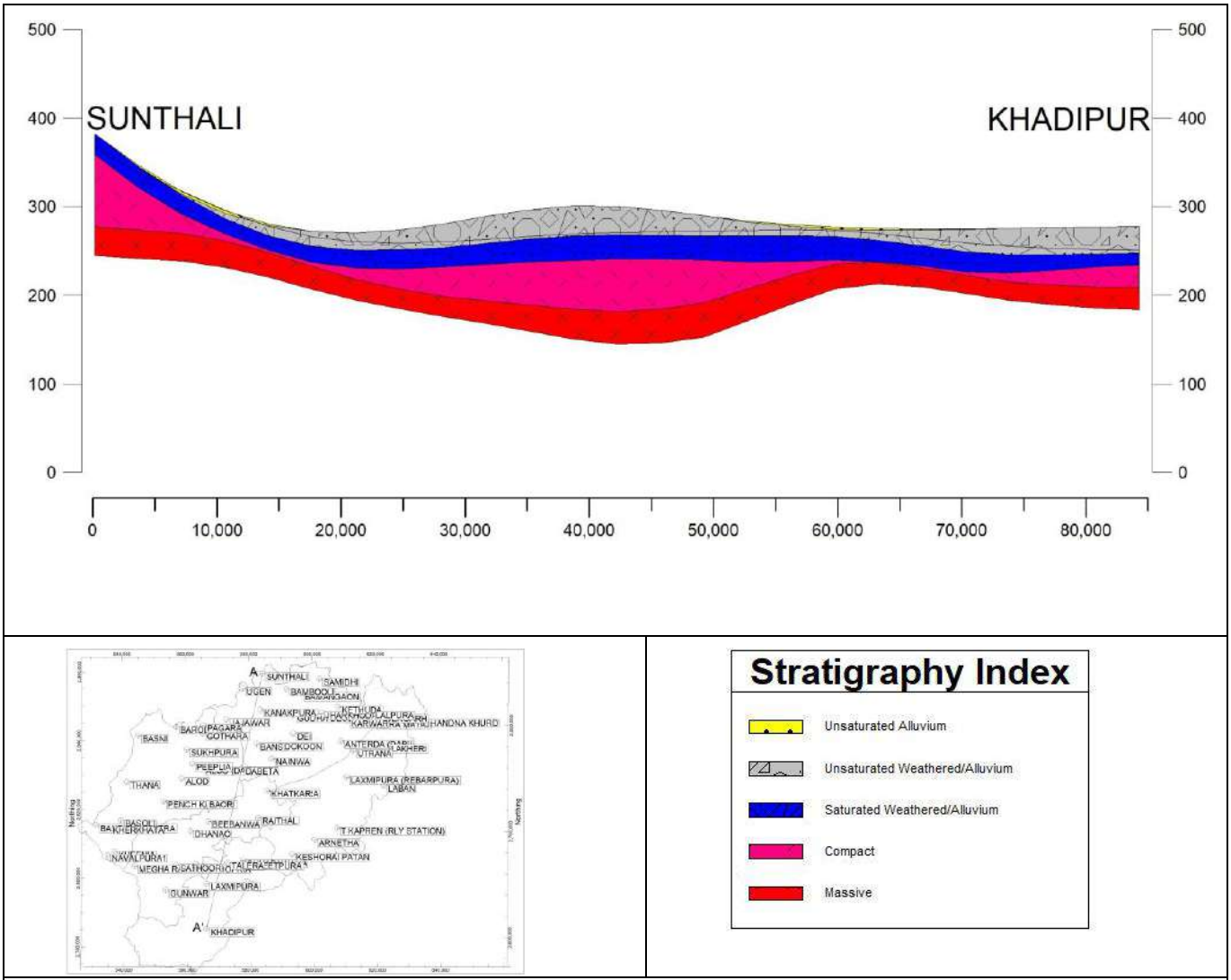


Fig 16: Cross Section along N-S direction in Bundi District

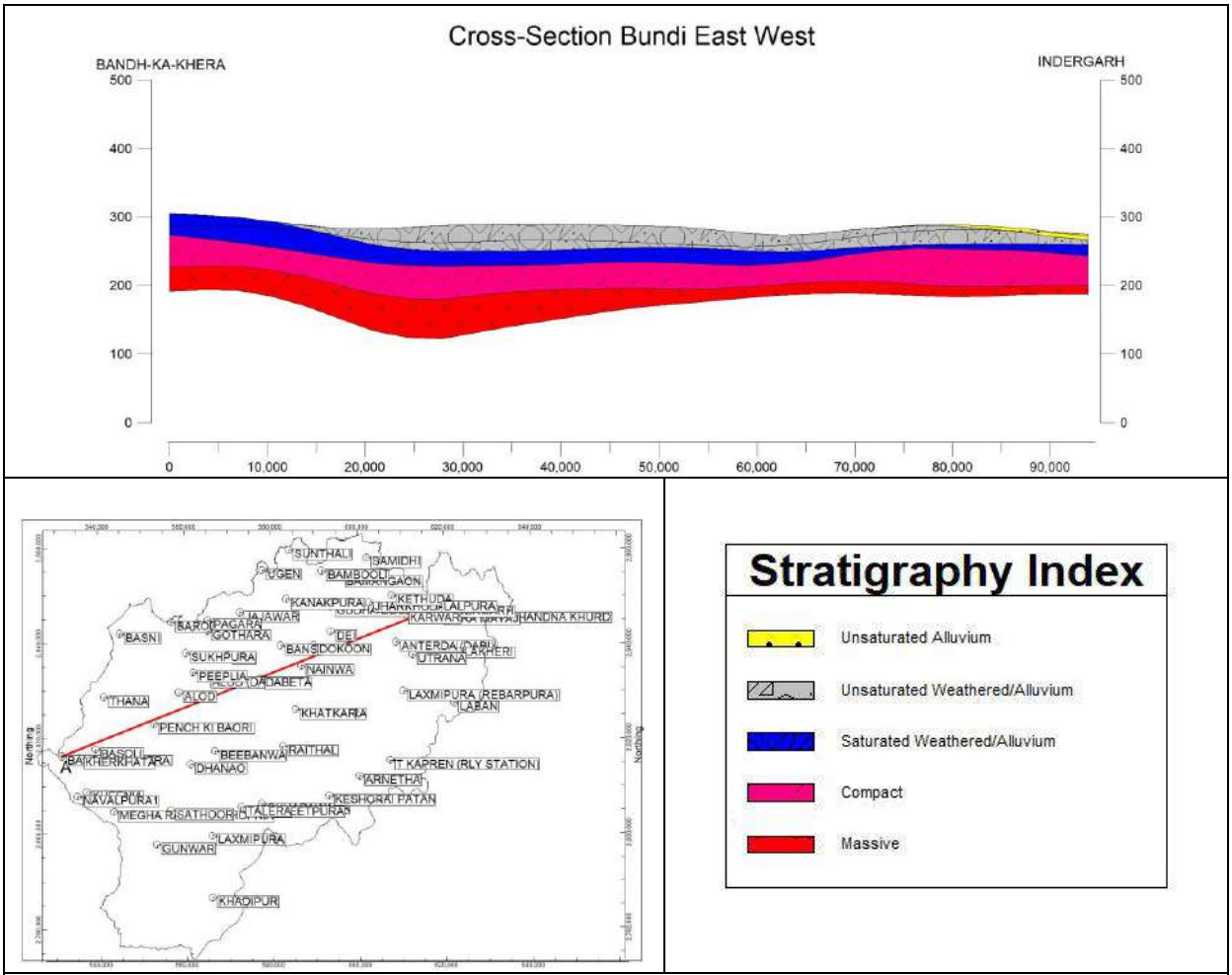
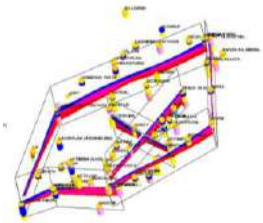


Fig 17: Cross Section along E-W direction in Bundi District



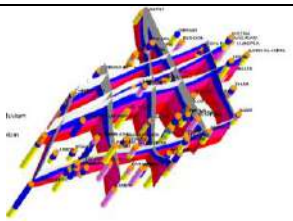


Fig 18 : 3D Fence Diagram in various direction in BUndi District.

BLOCKWISE LITHOLOGICAL SECTIONS

Block wise lithological sections showing aquifer disposition along with their alignment have been shown from Figure 26 to30.

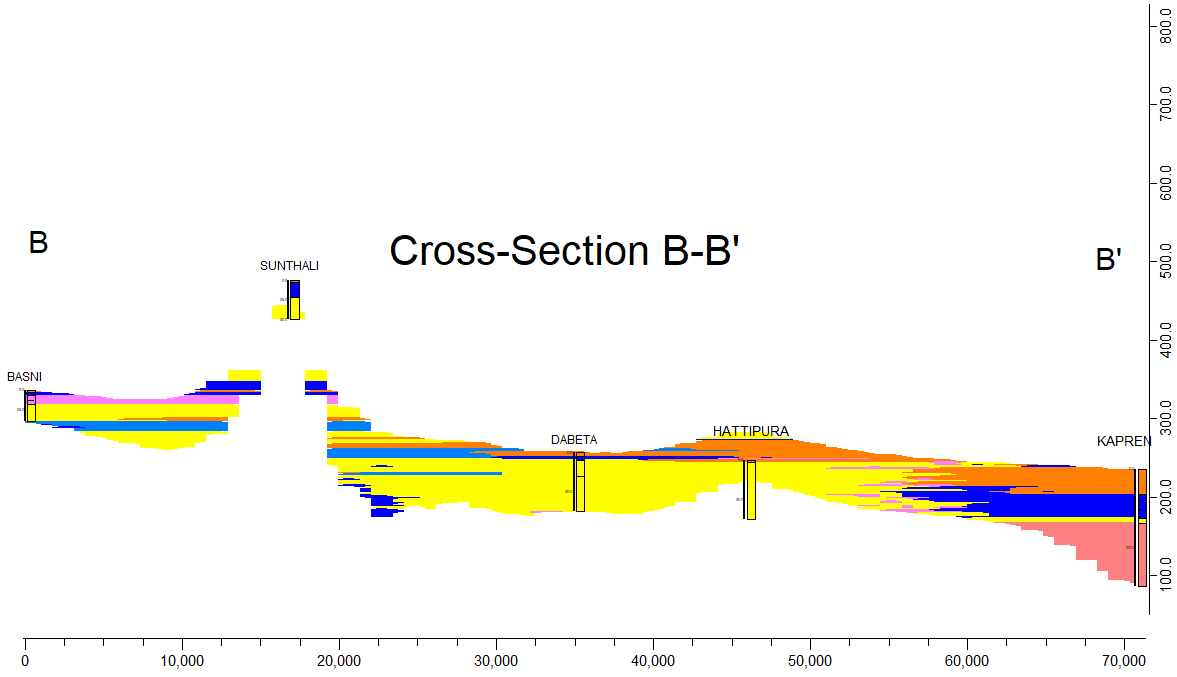


Fig. 19: lithological sections from Hindoli block

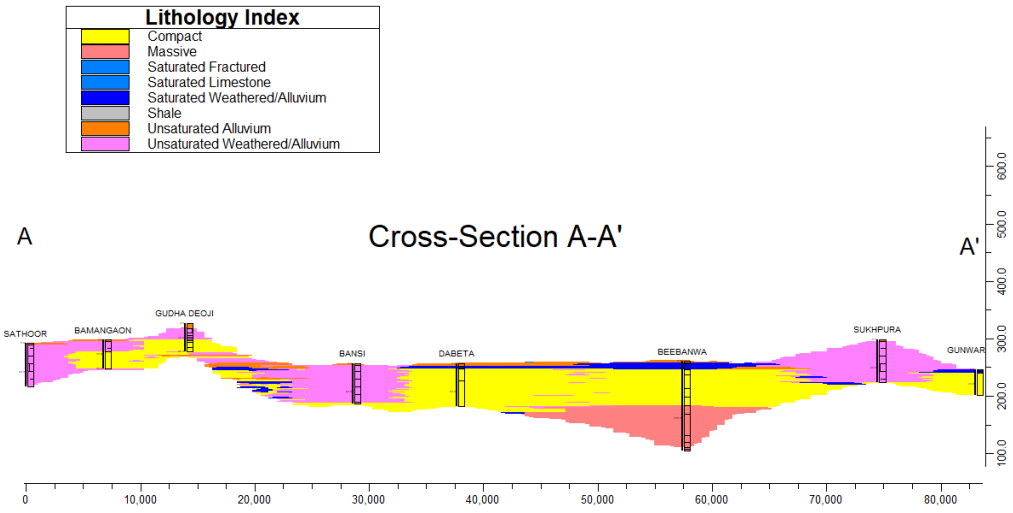


Fig. 20: Lithological section from Bundi block

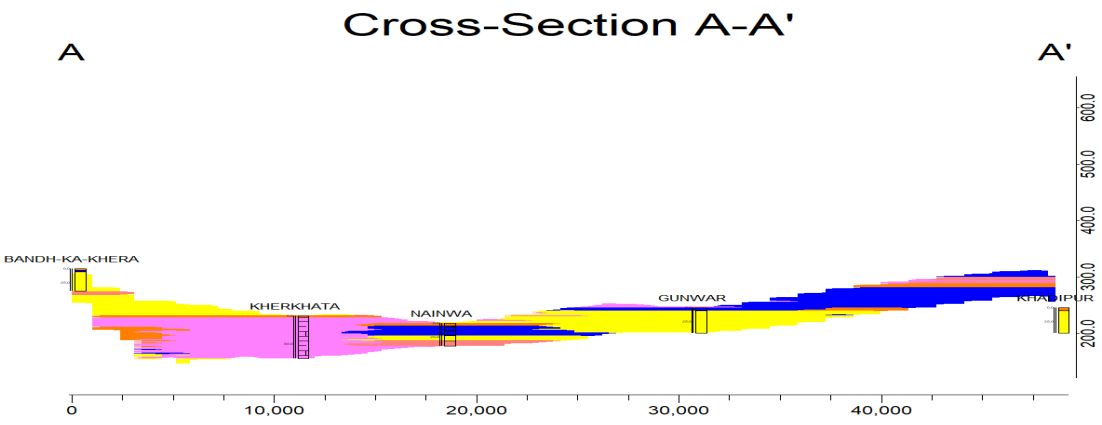


Fig. 21 : Lithological section from Nainwa block

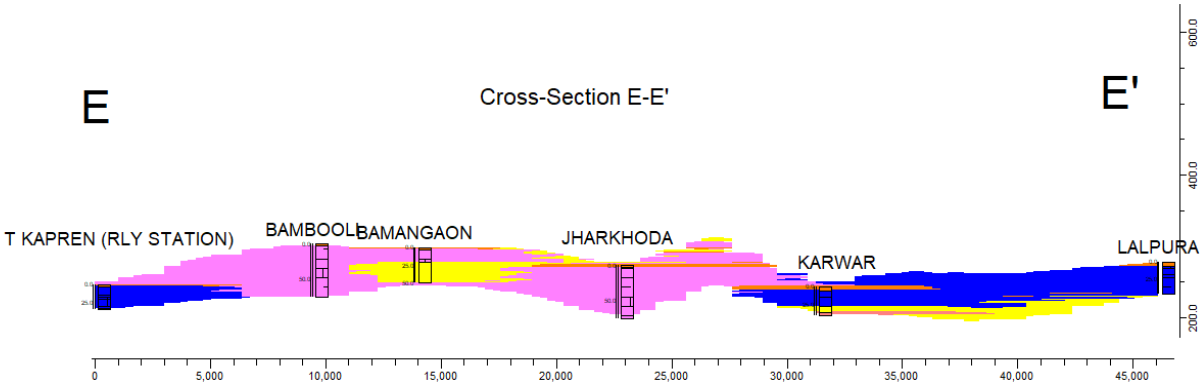


Fig. 22 : Lithological section from Keshorai Patan block

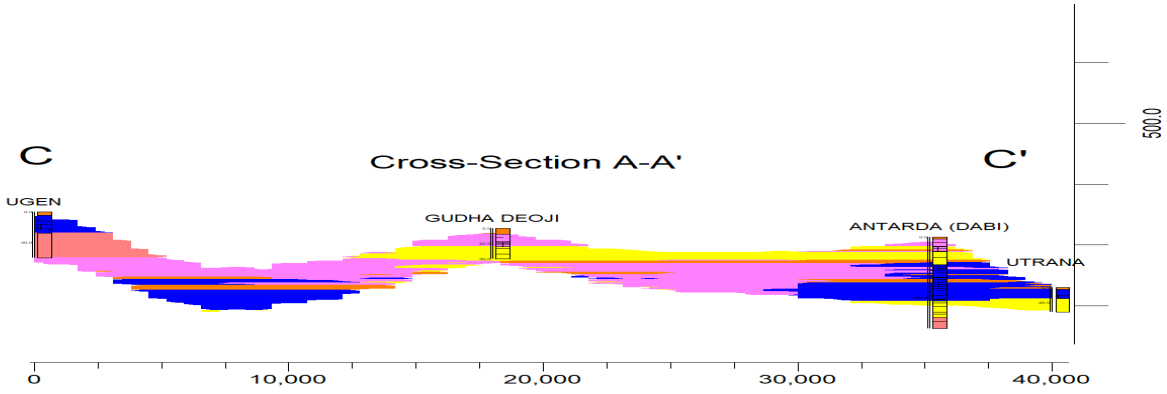


Fig.23: Hydrogeological section from Talera block

3.2 EXPLORATORY AND GROUND WATER MONITORING WELLS The sub-surface geology of the area is revealed by the boreholes drilled in the district by CGWB and GWD, Rajasthan state. The salient data of boreholes considered for NAQUIM study are given in Table 12. Their locations have been depicted in figure 9. The deepest borehole has been drilled by CGWB, at Hindoli down to a depth of 174 m at Guda Sadabartiyan.

Exploratory wells

Bundi district has well distributed network of large number of exploratory wells (89) in the district owned by RGWD (60) and CGWB (29) respectively. The exploratory wells have formed the basis for delineation of subsurface aquifer distribution scenario in three dimensions. Block wise count of wells is summarized in Table 11.

Table 14: Block wise Exploratory Wells, Bundi district

	Exploratory wells		
Block Name	CGWB	GWD	Total
Bundi	1	6	7
Hindoli	5	17	22
Keshorai Patan	9	14	23
Nainwa	6	18	24
Talera	8	5	13
Total	29	60	89

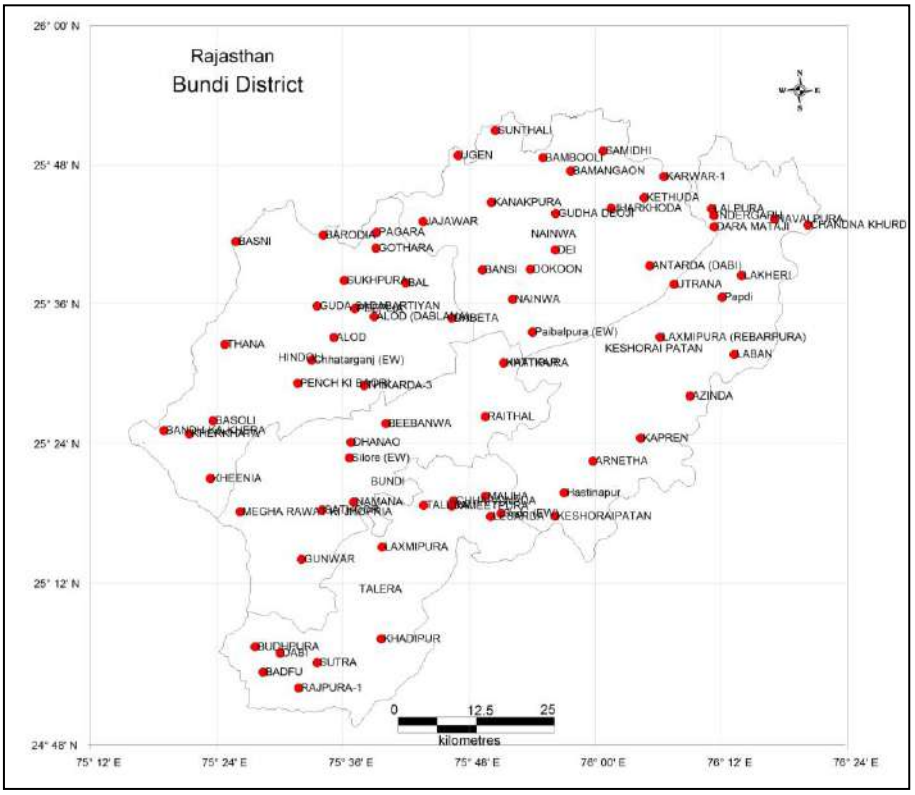


Fig. 24: Location map of Groundwater Exploration in Bundi District

Groundwater Monitoring

Central Ground Water Board periodically monitors the National Hydrograph Network Stations (NHNS) stations in the Bundi district, four times a year i.e. in January, May (Pre-monsoon), August and November (Postmonsoon).A location map of total of 146 hydrograph stations (comprising 123 Dugwells, 22 Peizometers, 1 DCB) is given in figure 11

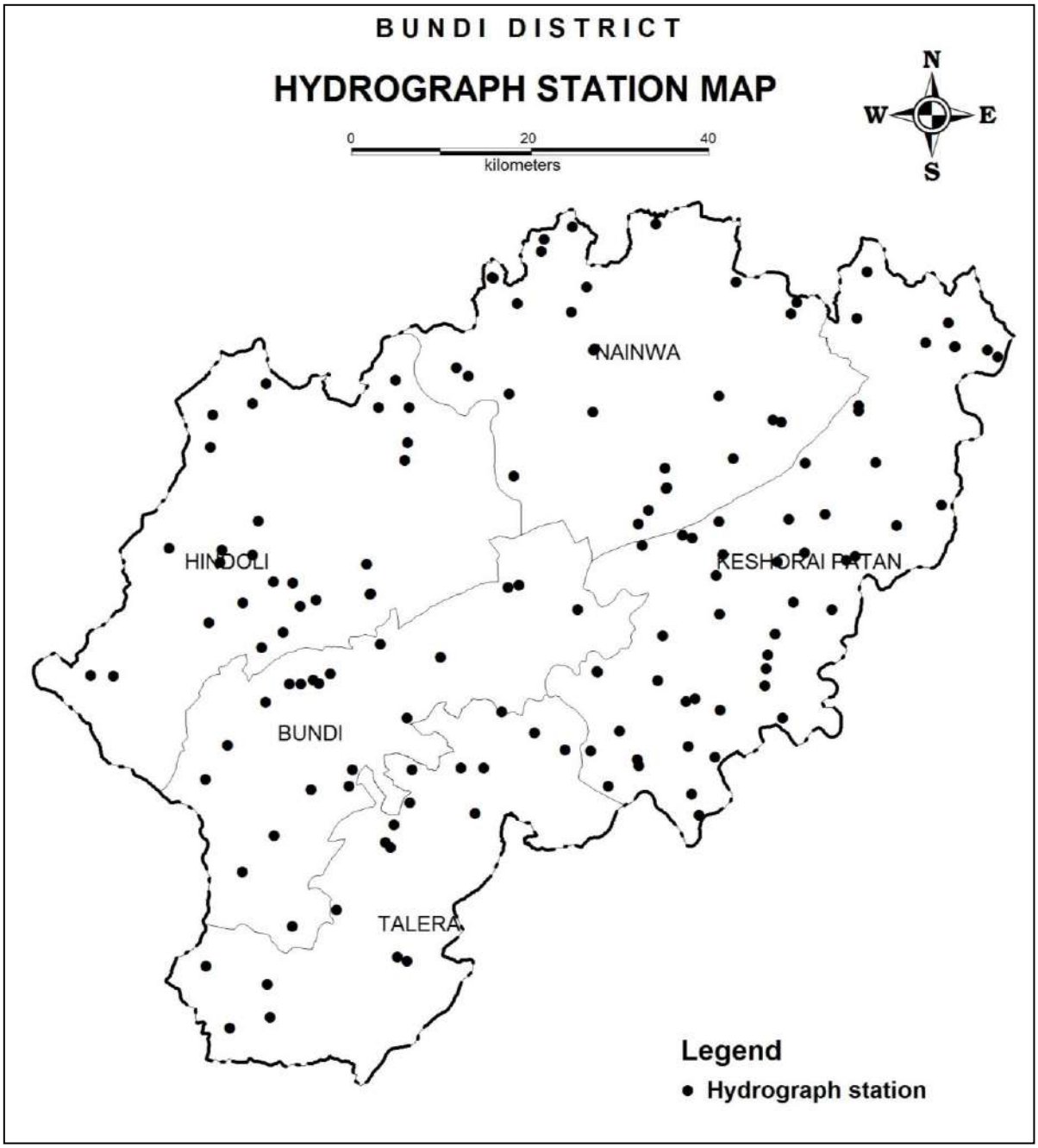


Fig.25: Location map of Groundwater Monitoring Wells in Bundi district.

3.3 Groundwater Dynamics

3.3.1. Depth to Water Level – Pre-monsoon (May-2020)

Depth to water level shows variation from less than 10m below ground level to about 40m below ground level. More than half area of the district has shown a generally moderate depth to ground water occurrence ranging between 10m and 20m of depth whereas the isolated patches have shown deeper water levels reaching upto 40m below ground level. The shallow occurrence of ground water (<10m bgl) is seen in south and south eastern parts of the district.

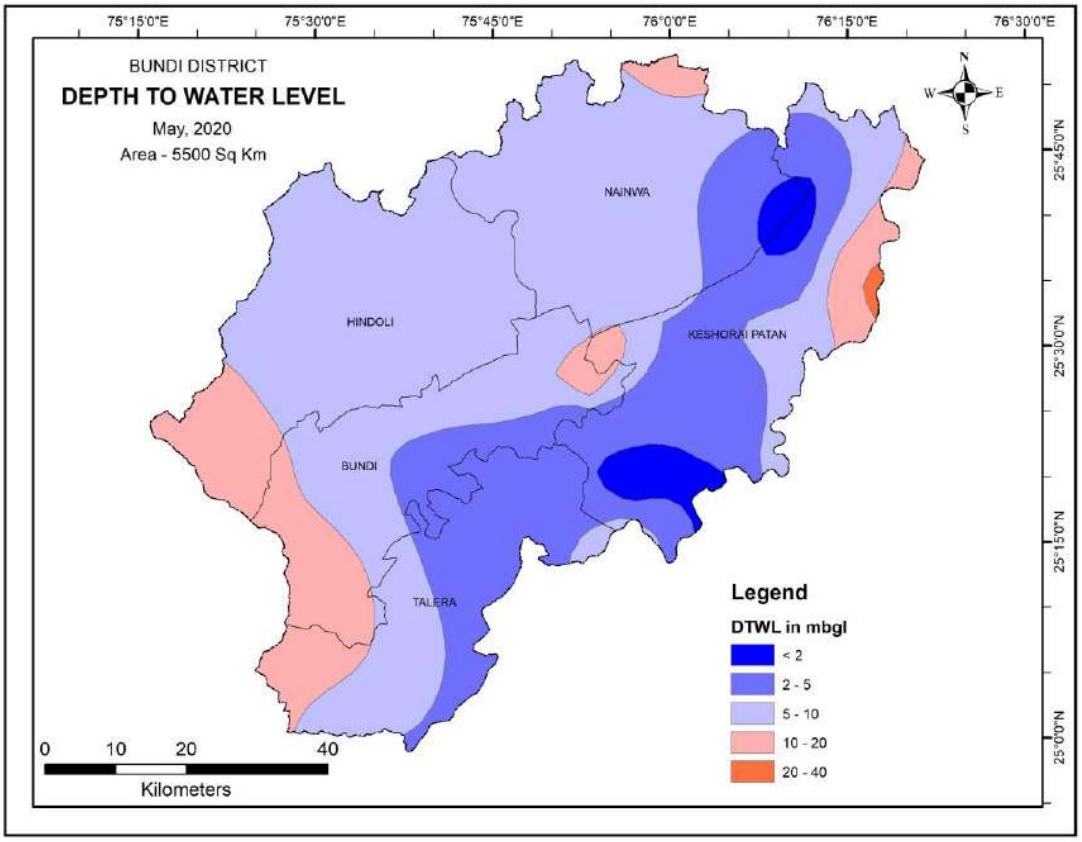


Fig. 26: Depth to Water Level during pre-monsoon, 2020, Bundi district

Table 15: Block-wise Range of Depth to ground Water Level, Bundi District, May, 2020

Sl.No.	Name of Block	Depth to Ground Water Level Range(mbgl) pre-monsoon 2020	
		From	To
1	Bundi	2.25	18
2	Hindoli	9.65	25.5
3	Keshorai Patan	1.5	24
4	Nainwa	8.8	29.4
5	Talera	1.7	12.15

3.3.2. Depth to Water Level – Post-monsoon (Nov-2020)

During Post monsoon, area under shallow ground water level (<10m bgl) increases while Area under moderate GWL (between 10m and 20m of depth) diminishes. Isolated patches of GWL ranging from depth of 20-40 mbgl still remains.

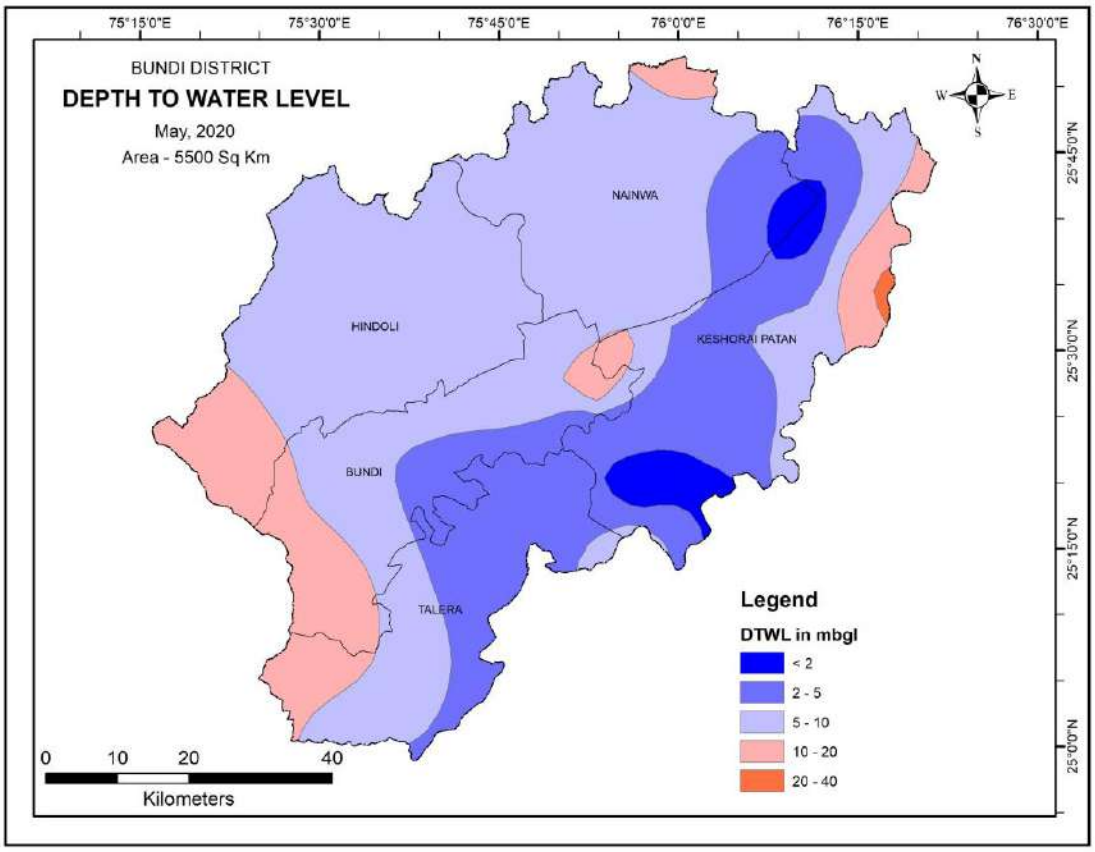


Fig. 27. Depth to Water Level during post-monsoon, 2020, Bundi district

3.3.4 Decadal Water level Fluctuation (2010-11 and May, 2021)

Decadal water level fluctuation map (2010-11 versus May, 2021) has been prepared (Figure 11). Perusal of map indicate decline in water level ranging from less than -20m to more than +20 m is being observed in major part of the district except some parts in eastern and southwest part of district where marginal rise in water level has been observed.

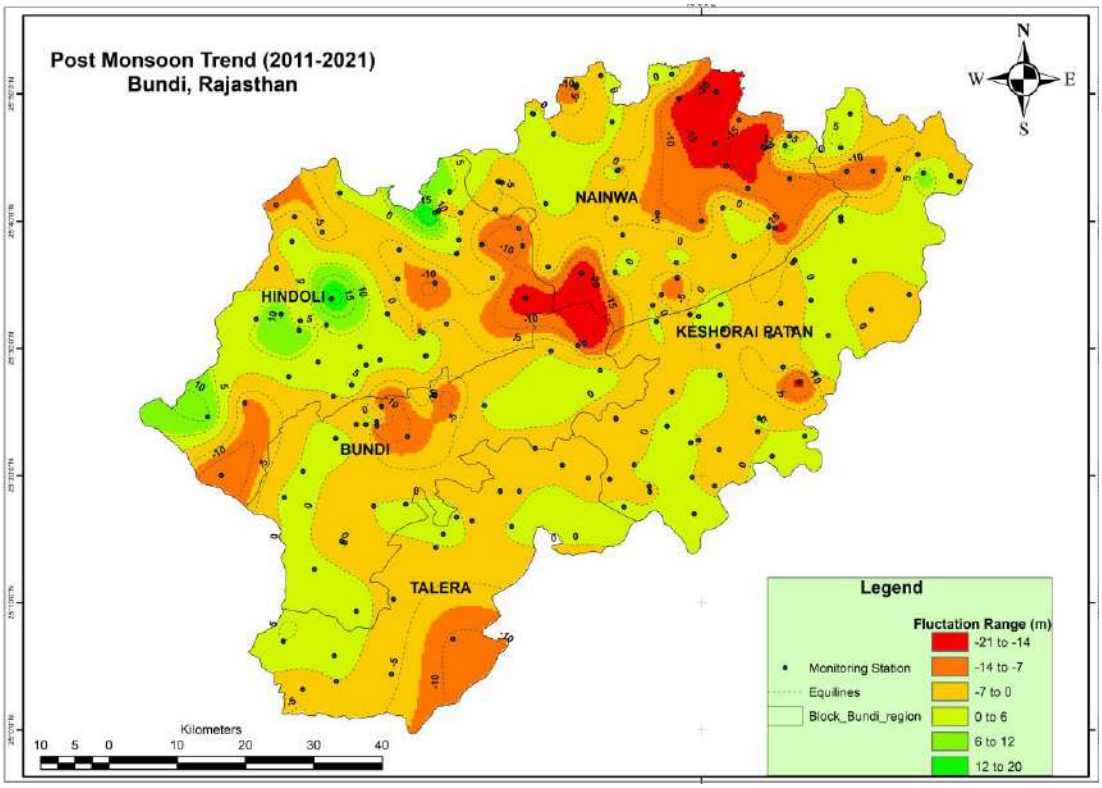


Fig.28- Decadal pre-monsoon ground water level trend map (2009-18 vs May, 2020), Bundi

3.3.5 Decadal Water level Fluctuation (2010-11 and Nov, 2021)

Decadal water level fluctuation map (2009-18 versus Nov, 2019) is shown in Figure 12. Perusal of map indicate rise in water level level ranging from less than 2m to more than 4m is being observed in almost all parts of the district.

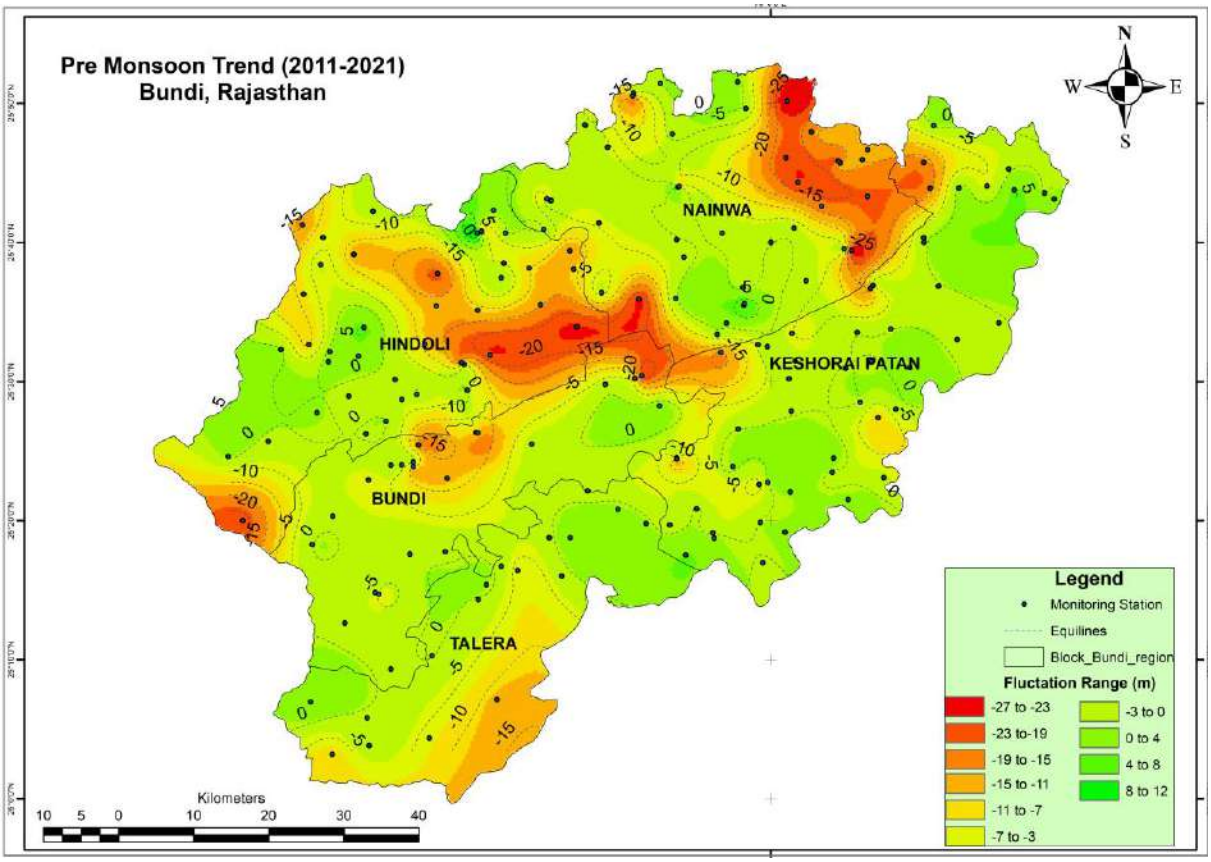
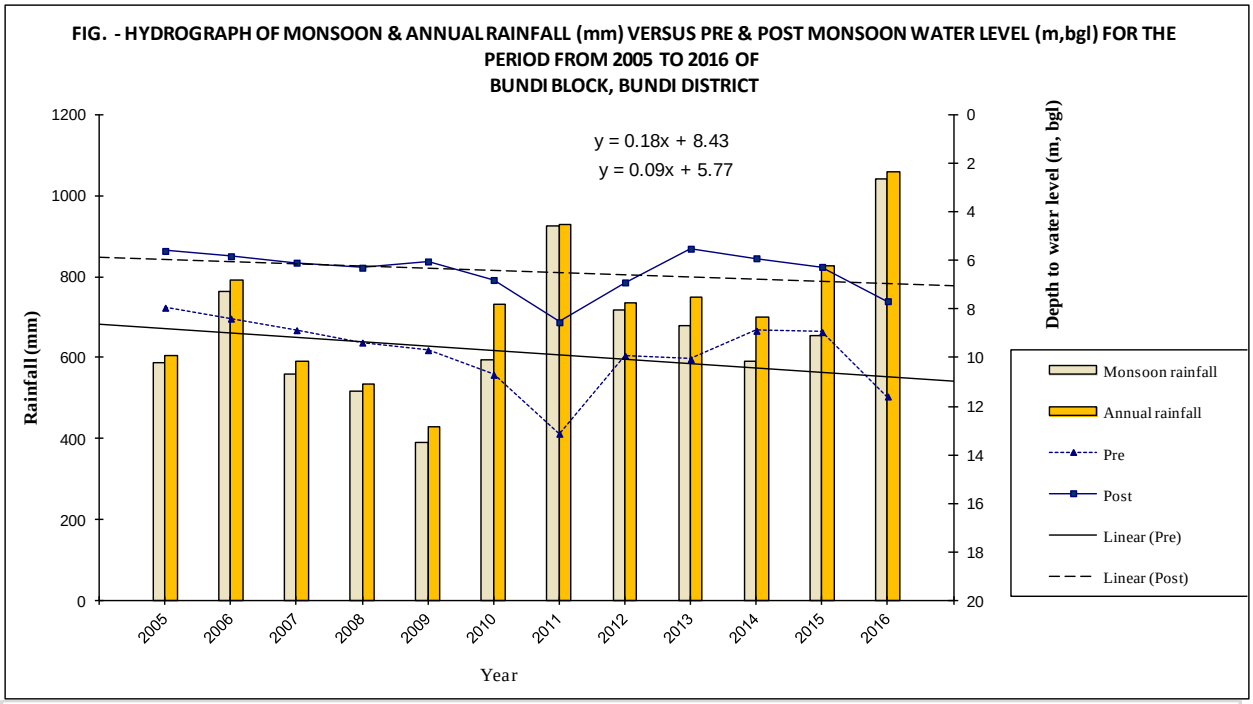


Fig. 29 : Decadal post-monsoon ground water level trend map (2010-11 vs Nov, 2021), Bundi district.

Sl.No.	Name of Block	Ground Water Level Trend (metre/year)	Remarks
1	Bundi	0.18 (pre), 0.09 (post)	Declining
2	Hindoli	0.11 (pre and post)	Declining
3	Keshorai Patan	0.12 (pre) , 0.10 (post)	Declining
4	Nainwa	0.35 (pre), 0.12 (post)	Declining
5	Talera	00 (pre), 0.03 (post)	Declining

Table 16: Block wise Ground water level trend

3.3.6 Block wise Ground water level trend



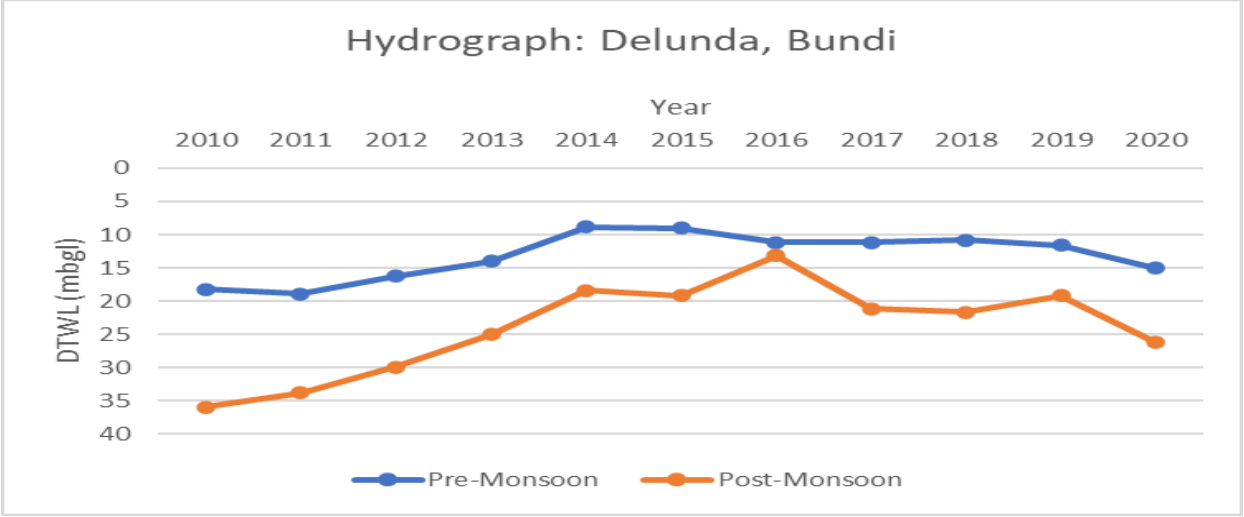
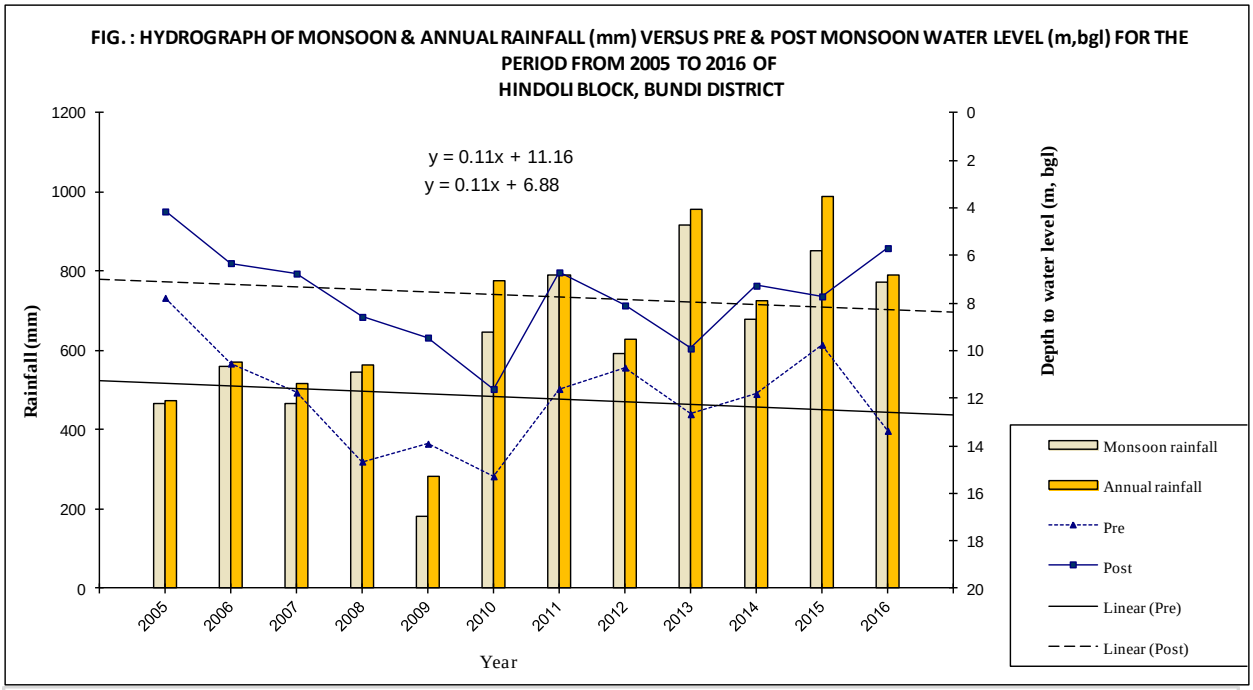


Fig. 30: Hydrograph for Bundi Block



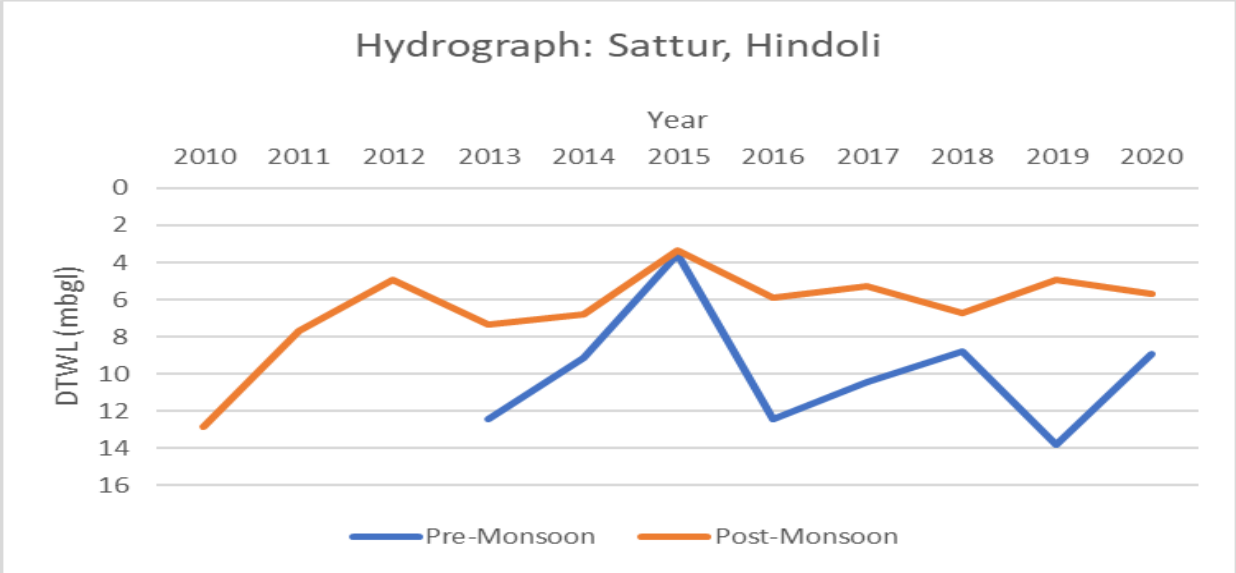
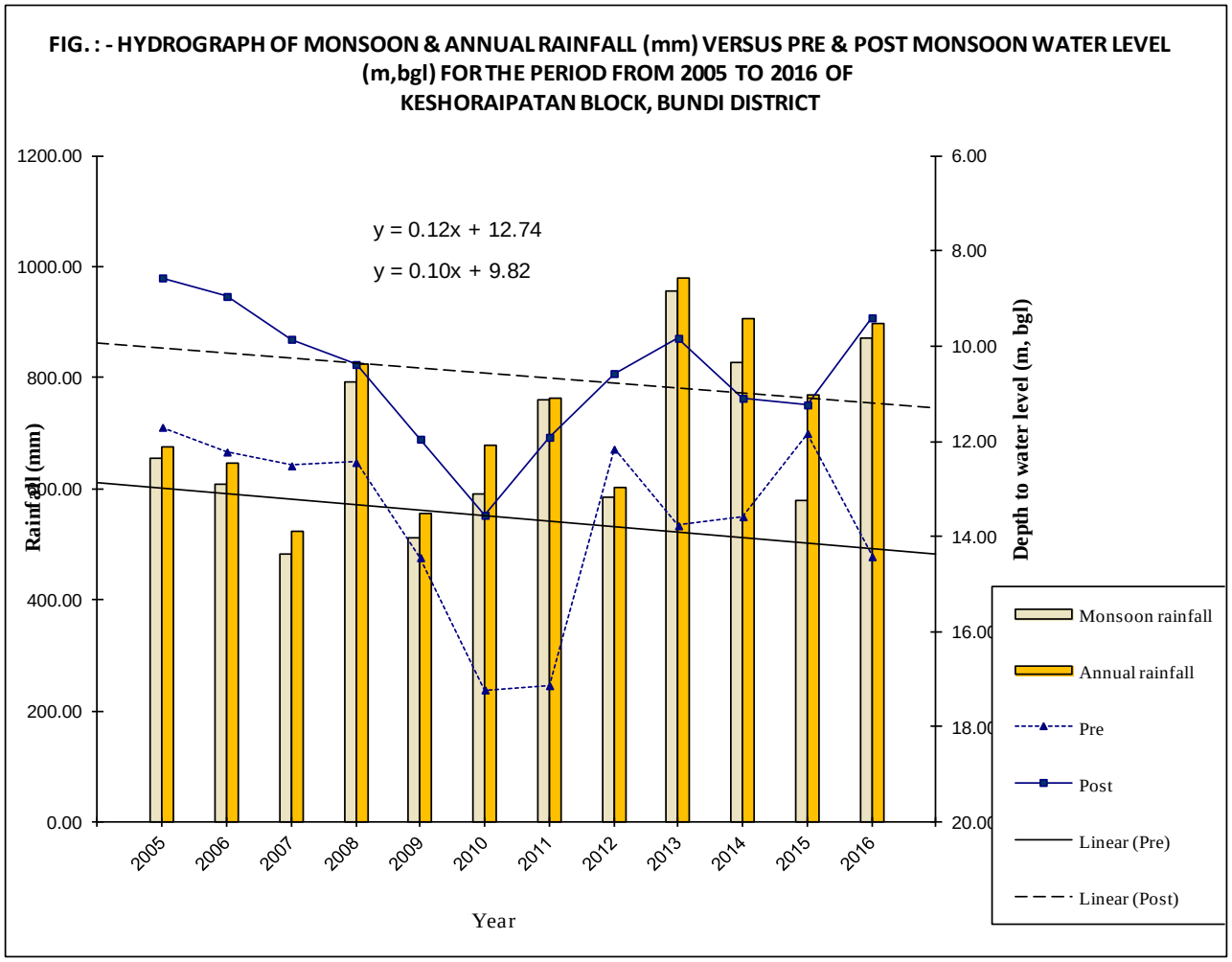


Fig 31: Hydrograph for Hindoli Block



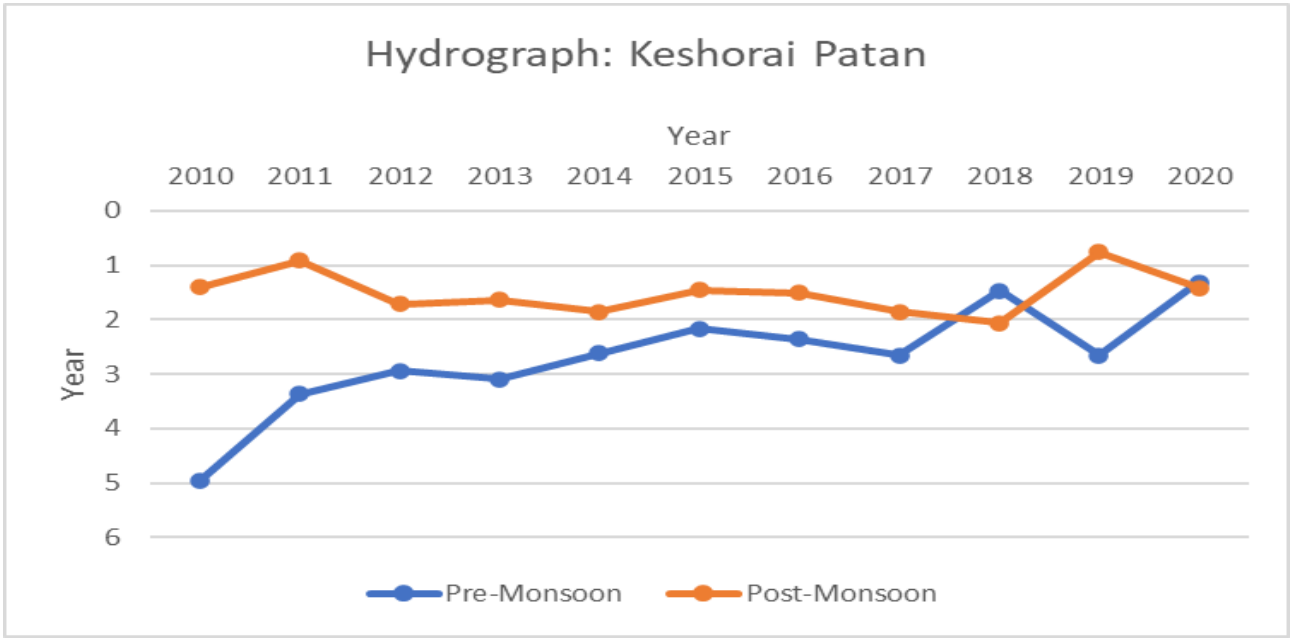
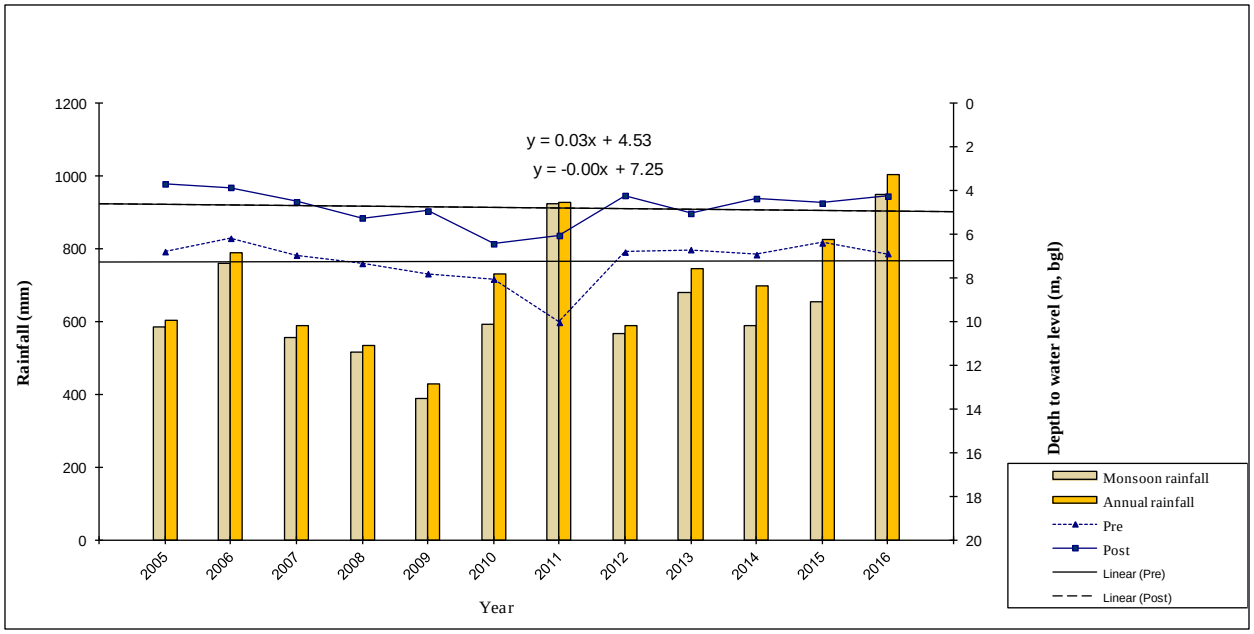


Fig 32: Hydrograph for Keshoraipatan Block



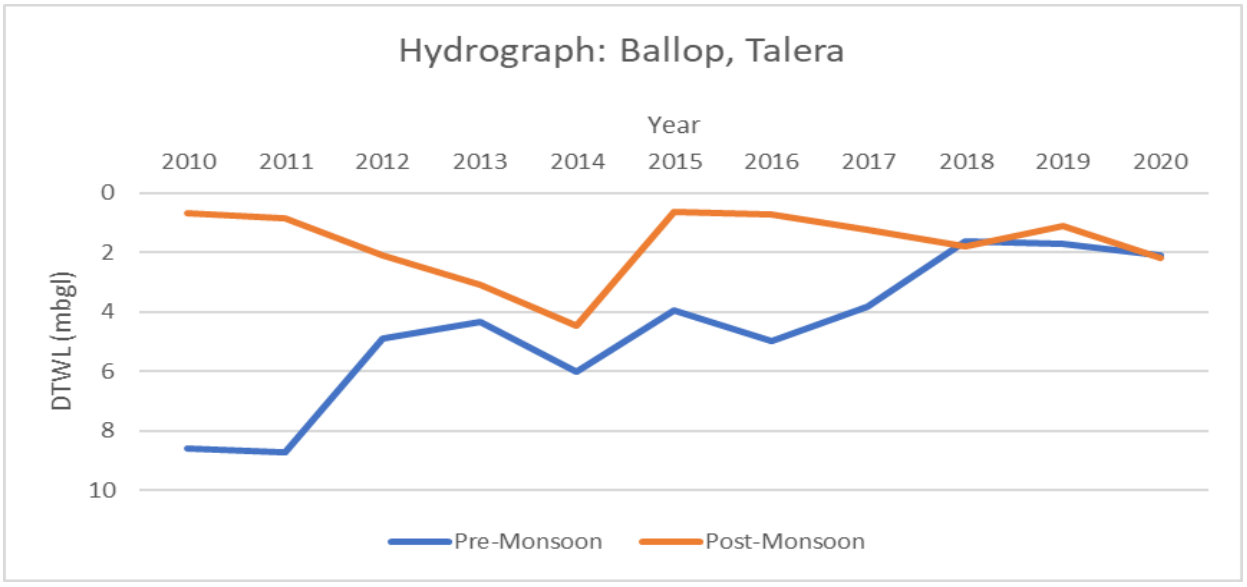
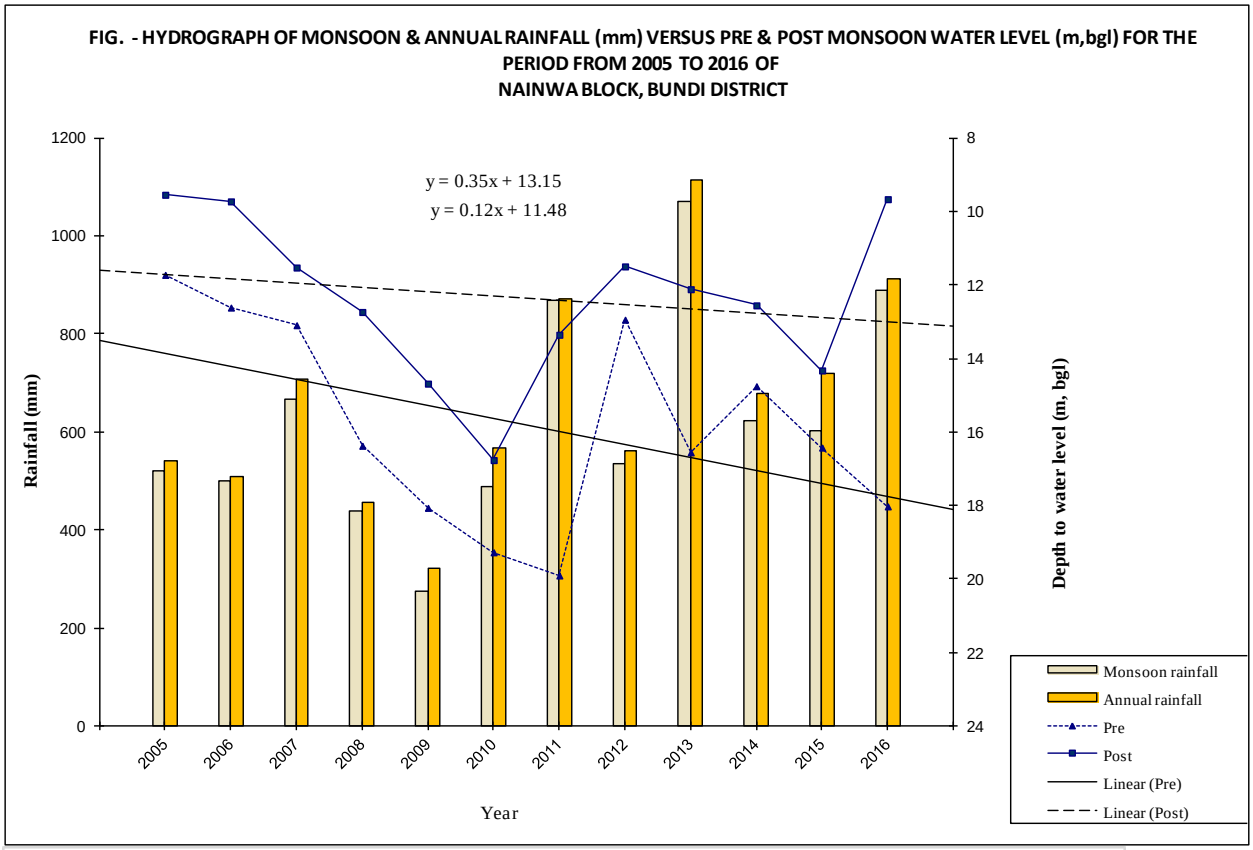


Fig 33: Hydrograph for Talera Block



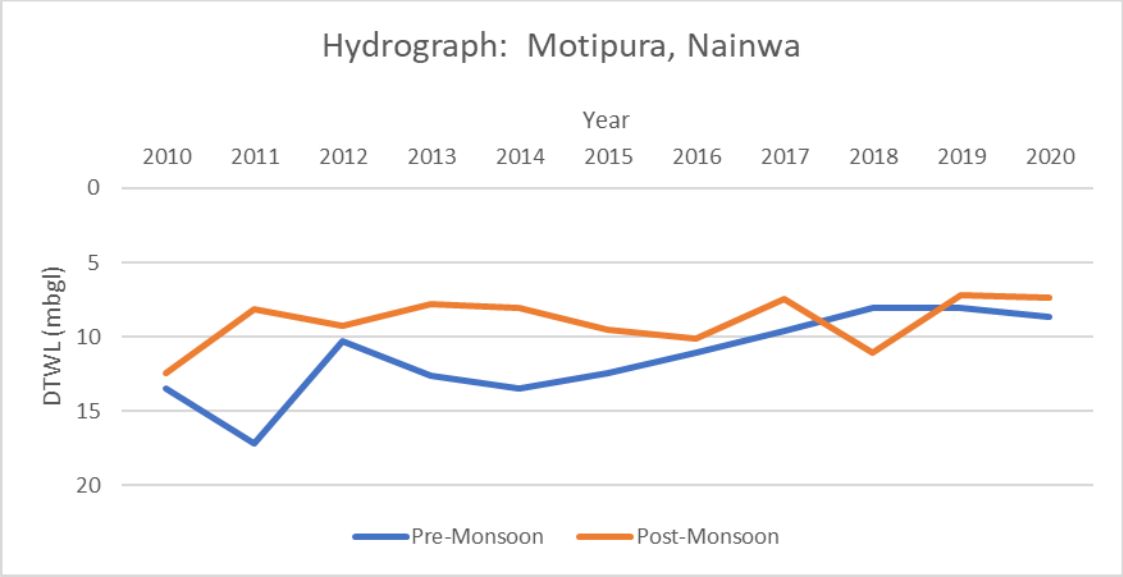


Fig 34: Hydrograph for Nainwa Block

The trend data indicates that declining trend has been observed in all the blocks.

Water Table Contour

The water table contour map reveals the direction of groundwater flow in the district which is from north-west to south-east and in the southern direction it flows from south-west to north east.

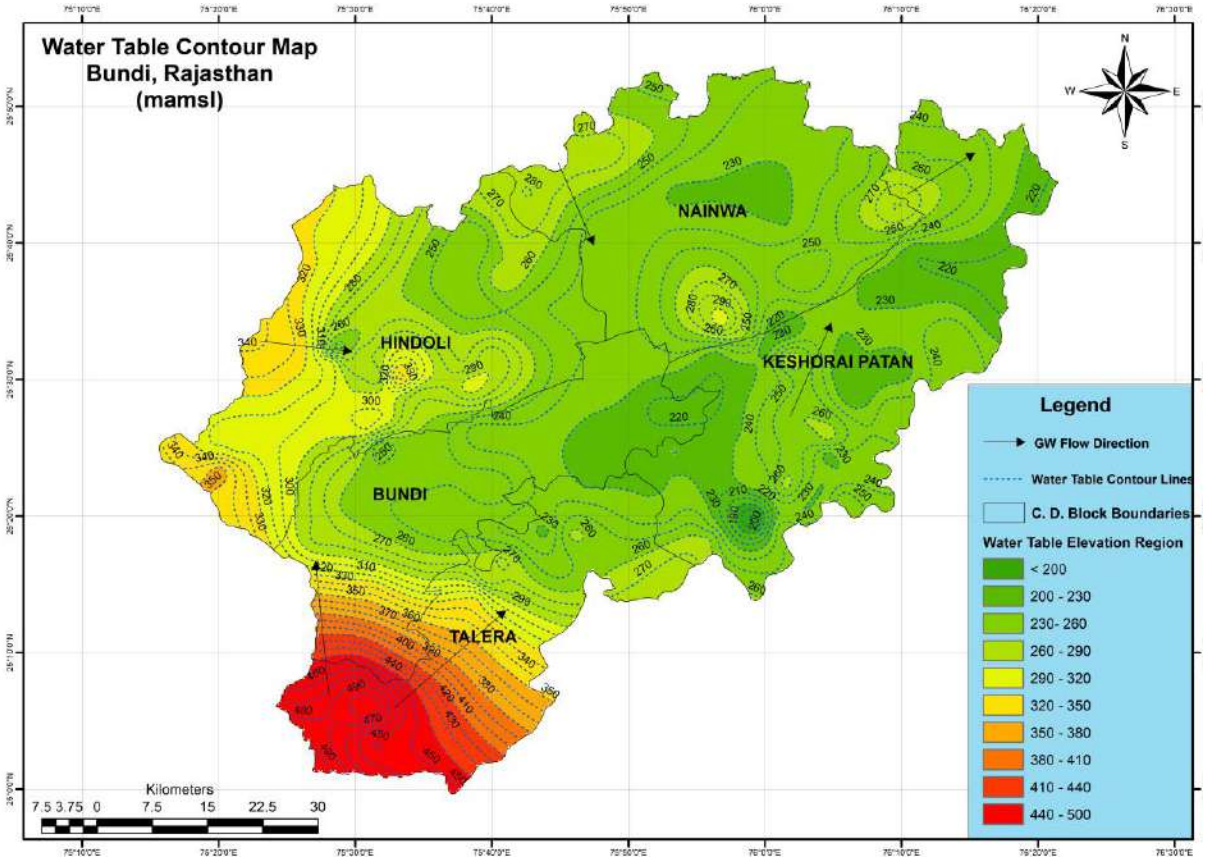


Fig. 35. Water Table Elevation Contour Map, Bundi District (P-Monsoon, 2021)

3.5 GEOPHYSICAL STUDIES

In Bundi district, only 2 VES and 5 borehole geophysical loggings have been conducted, upto 31-03-2021.

As per available data, a total of 5 Borehole Geophysical Loggings have been conducted in Hastanipur, Kapren, Ajeda, Kapren (2019) and Sedri sites for deciphering the depth to ground water potential zones / fractures, saline ground water zones, depth to hard rock etc. Out of these five loggings, only at one site namely Kapren (2019), the logging is conducted upto the depth of 200 m bgl. So, only one logging data is available and this logging is considered as equivalent to VES data available, for arriving at VES data gap number. The details of boreholes location, depth logged, zones encountered etc. are given in table 1 and are shown on Bundi district map in Figure 36.

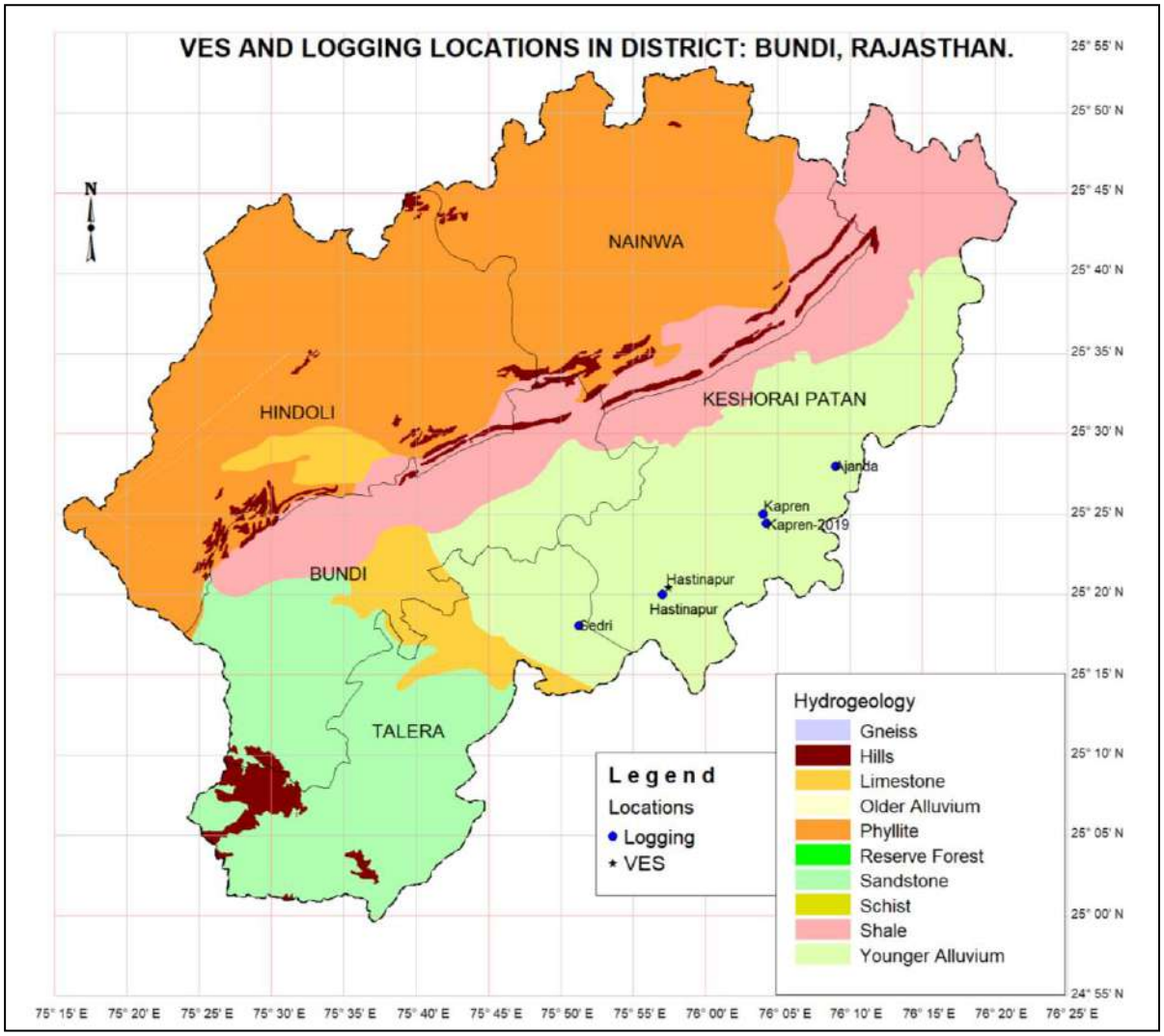


Figure 36: Map showing the Location of VES & Logging Conducted in Bundi District

Inference from the Resistivity Surveys and Borehole

- From the interpretation of VES data, it is clearly seen that the high resistivity values start from the depth range of 30 to 36 m bgl, which indicates the starting of hard shale formation.

- The VES interpretation indicates 4 to 6 sub-stratum geo-electrical layers in the depth range of 70 m bgl to 100 m bgl.

- The resistivity sounding curves obtained in the area are multi-layered in nature and represent H or HA type curves.

- The low resistivity value corresponds to water saturated formation whereas the high resistivity value represents hard rock formation.

- The resistivity values in the range of 50 $\pm$ 10 Ohm-m, indicates the gravel or sand mixed formation, saturated / partially saturated with water.

- The weathered / fractured formations saturated / partially saturated with water gives resistivity values in the range of 70 $\pm$ 10 Ohm-m.

- From the logging data it is inferred that there are fractures / thin ground water potential zones in the area, with low to moderate potential.

- The alluvium cover thickness varies from depth range of 30 to 36 m bgl.

- The ground water, in general is saline at deeper depth, i.e. beyond 40 m bgl.

4.0 GROUND WATER QUALITY

In general, quality of ground water is suitable for irrigation and domestic uses. Shallow ground water in the district is alkaline in nature with pH varying from 7.2 to8.4.

4.1 Electrical conductivity

The Electrical conductivity (at 25^0 C) distribution map is presented in Fig. 19. The areas with low EC values in ground water (<3000 µS/cm) are shown in Blue, yellow and light orange color which occupy almost 90% of the district area indicating that, by and large the ground water in this district is suitable for domestic purpose. The areas with moderately high EC values (3000 -5000 µS/cm) largely eastern part of the district.

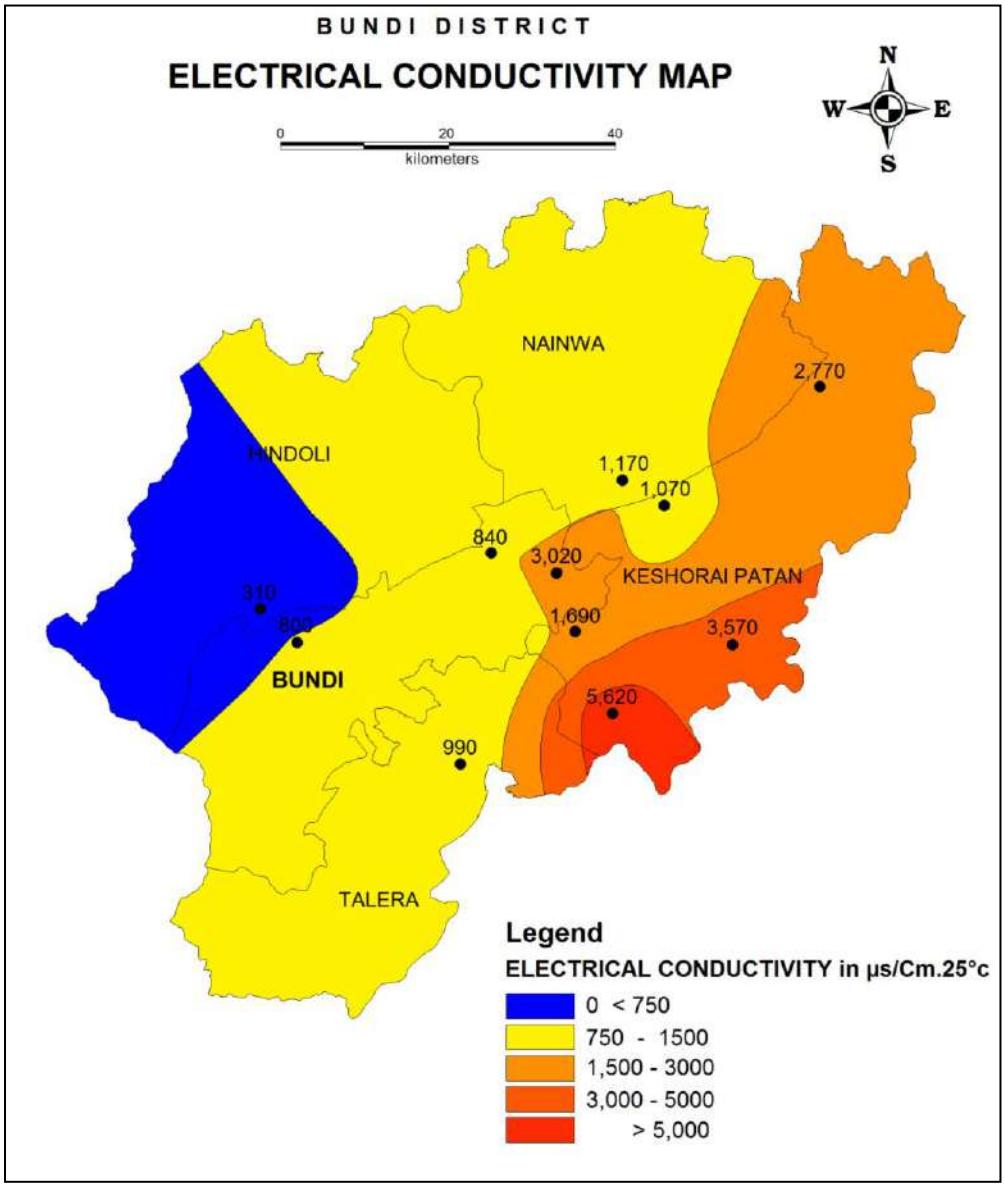


Fig. 37. Distribution of electrical conductivity in groundwater, Bundi District (May, 2020)

4.2 Chloride

The blue coloured regions in fig.20 are such areas where chloride concentration is low (<250 mg/l) which occupy more than 85% of the district. The ground water in this region is suitable

for domestic purpose. The areas with moderately high chloride concentration (250-1000mg/l) are shown in orange color and occupy largely eastern part of the district.

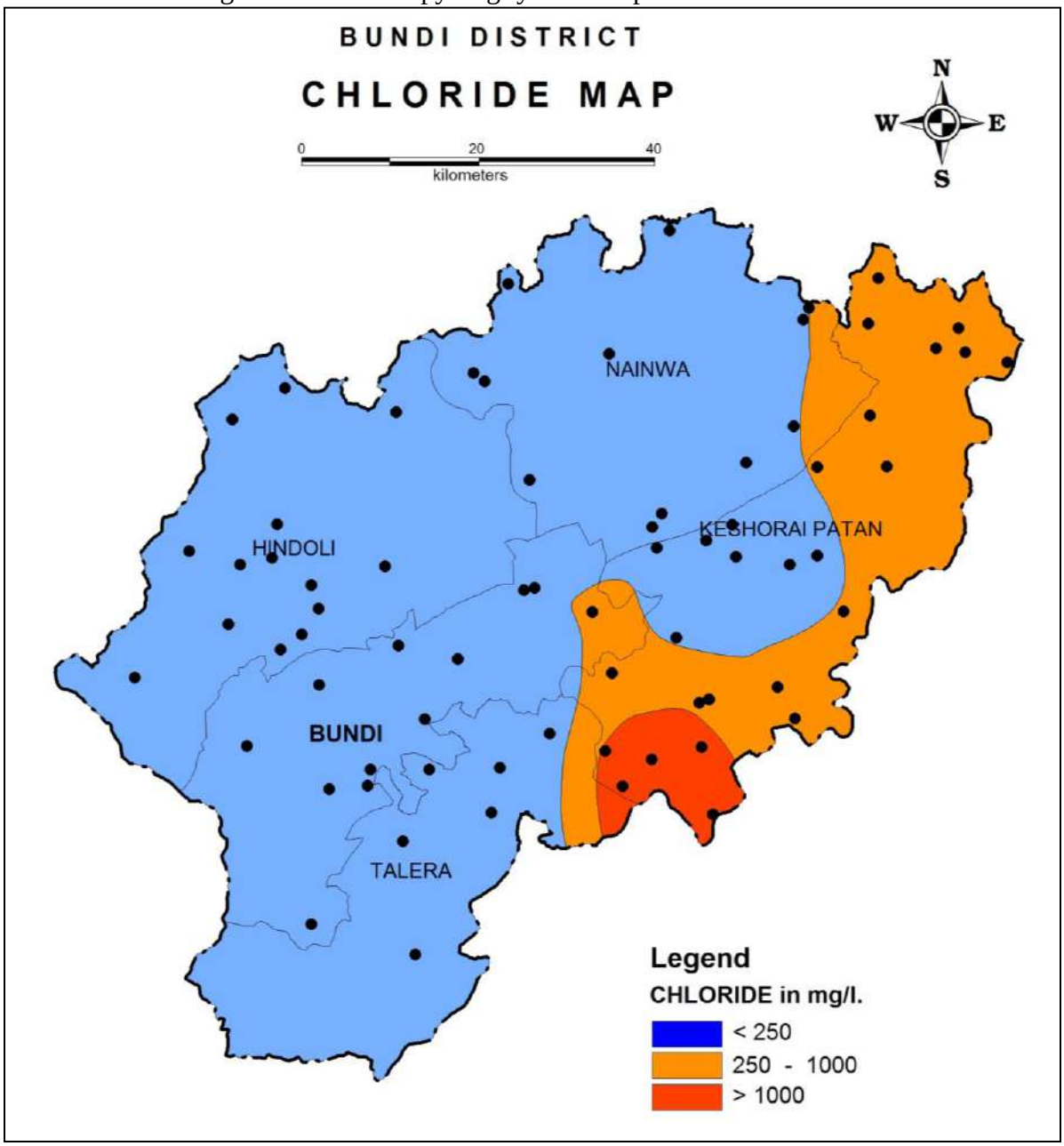


Fig. 38. Distribution of Chloride in groundwater, Bundi District (May, 2021)

4.3 Fluoride

The Fluoride concentration map is presented in Fig 21. High fluoride concentration areas are not present within the district which makes the ground water by and large suitable for domestic purposes however; some scattered areas have shown moderately high concentration of fluoride in ground water. The areas with low concentration (i.e. <1.5mg/l) are shown in green points which occupy majority of the district area indicating that it is suitable for domestic purpose. The areas with moderately high concentration (1.5 – 3.0 mg/l) are shown in red points which are seen to have scattered in Bundi, Talera and Keshorai Patan.

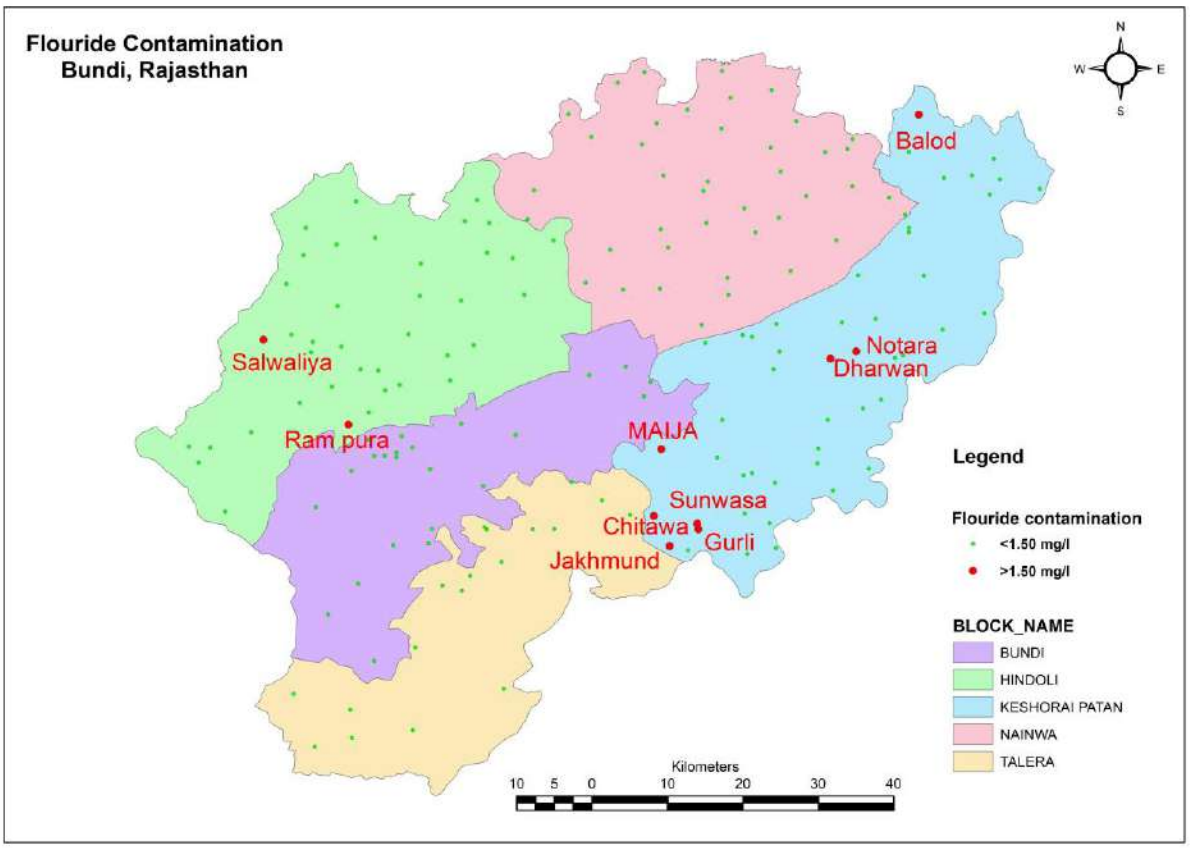


Fig. 39: Distribution of fluoride in groundwater, Bundi District (May, 2021)

4.4 Nitrate

High nitrate concentration in ground water renders it unsuitable for drinking purpose. Fig. 22 shows distribution of Nitrate in ground water. Low nitrate concentration area (<45 mg/l) is seen in green color and are suitable for drinking purpose. High nitrate concentration (>45 mg/l) areas which are shown in red colored points, are not suitable for drinking purposes.

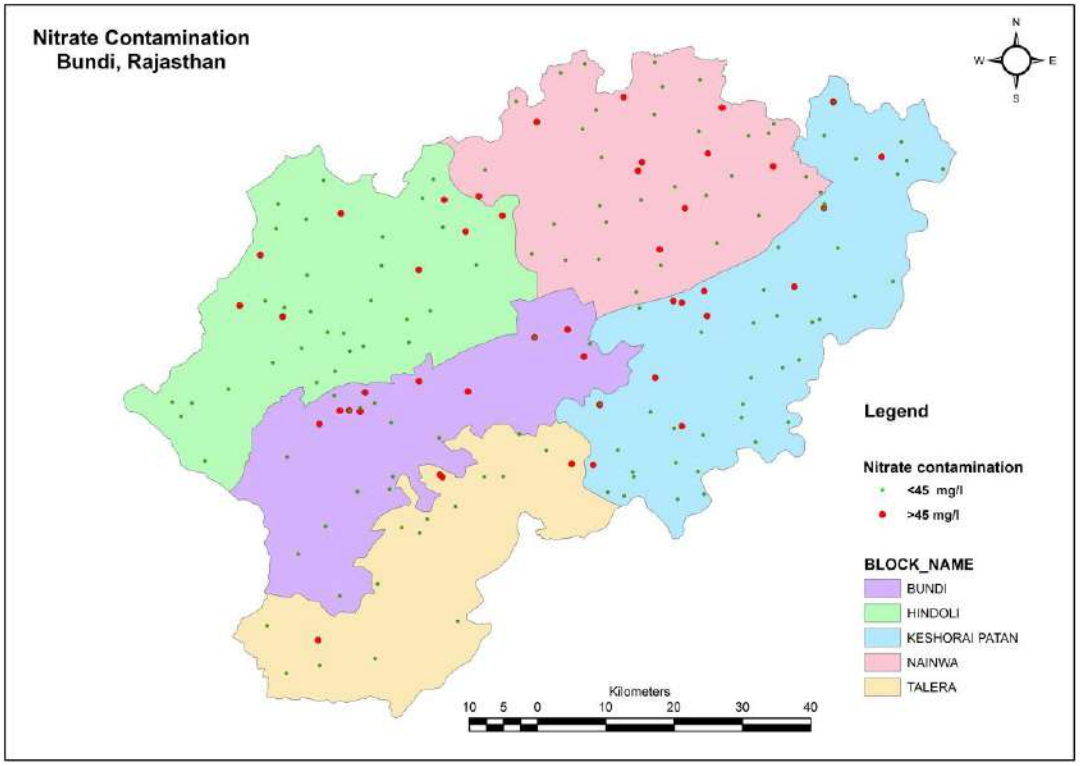


Fig. 40. Distribution of nitrate in groundwater, Bundi district (May, 2021)

Sodium Absorption Ratio (SAR)

The assessment of sodium hazard is necessary while considering the suitability of groundwater for irrigation and sodium adsorption ratio (SAR) is one of the most important criteria in determining sodium hazard. It is an easily measured property that gives information on the comparative concentrations of Na2+, Ca2+, and Mg2+ in soil. Irrigation water having high SAR levels can lead to the build-up of high soil sodium levels over time, which in turn can adversely affect soil infiltration and percolation rates due to soil dispersion. The SAR analysis reveals that the groundwater is excellent to good for irrigation.

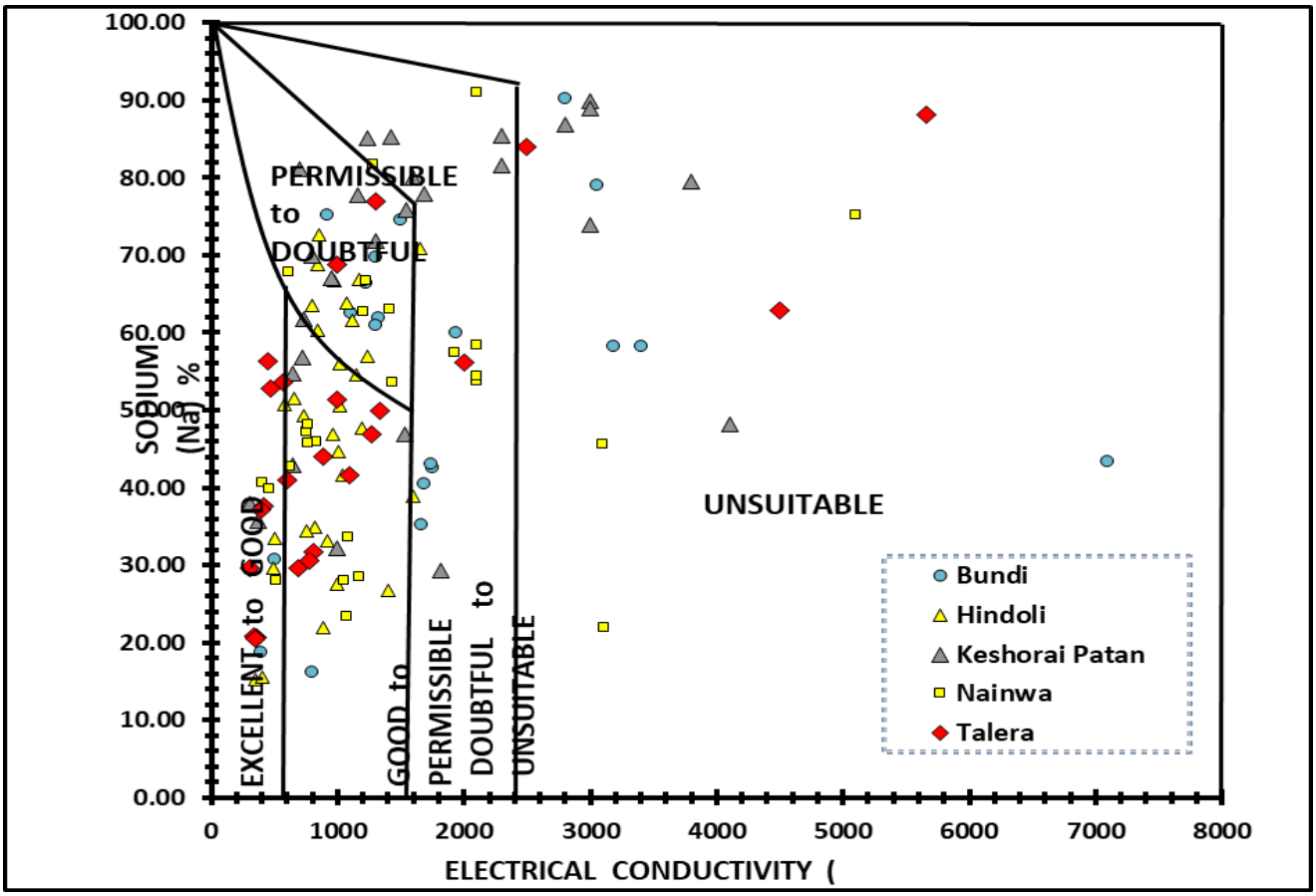
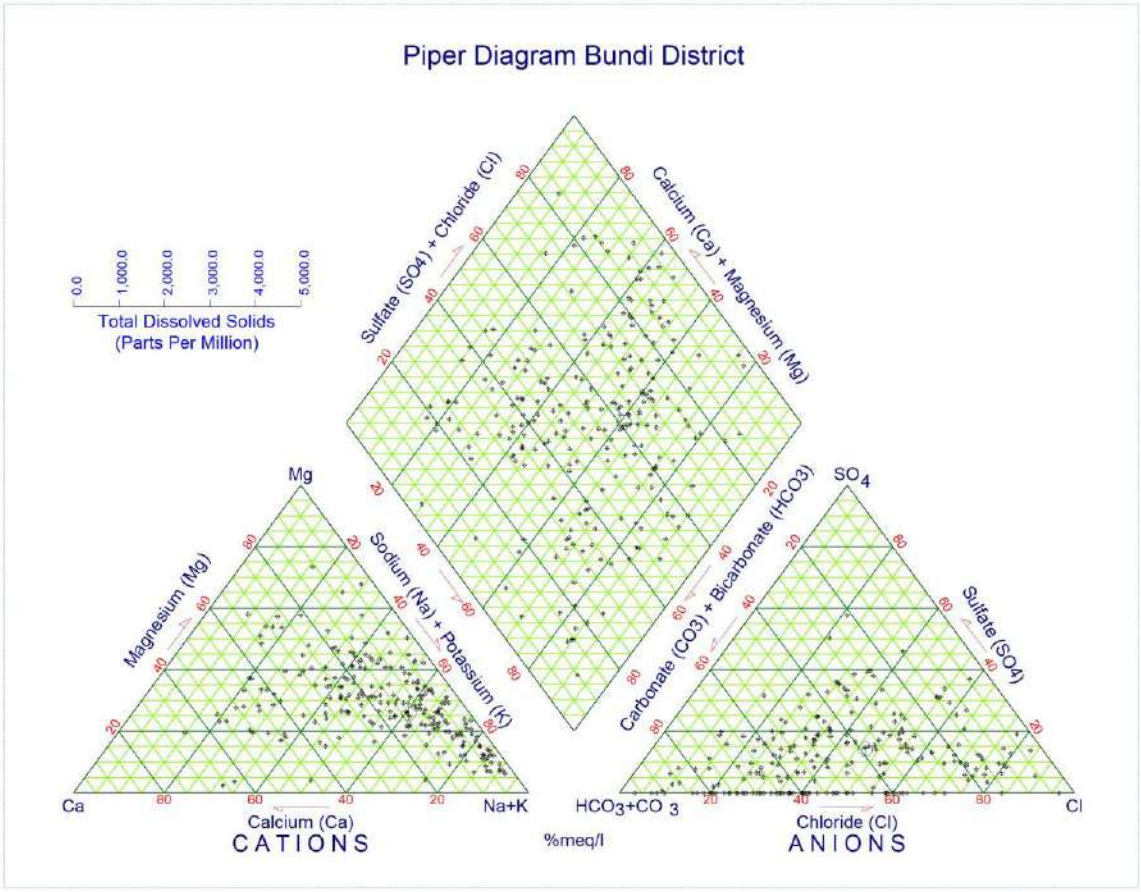


Fig 41. WILCOX Diagram for suitability for Irrigation (May, 2021)



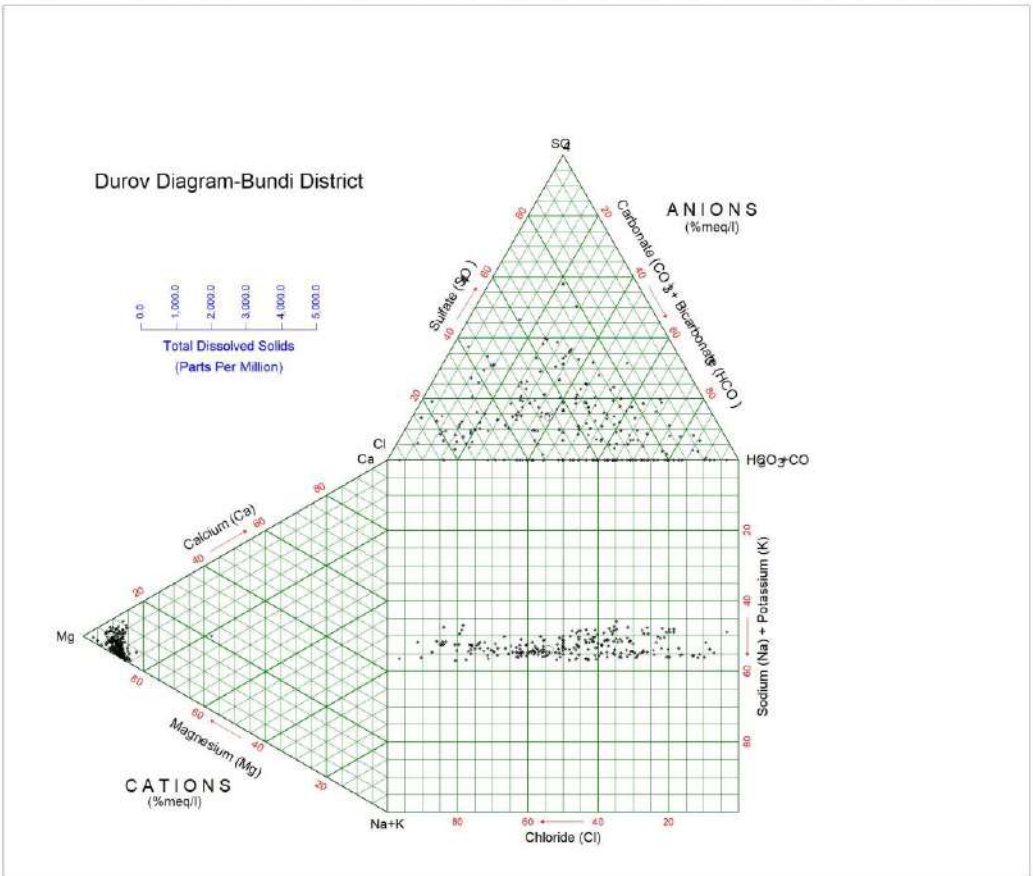


Fig 42. Piper Diagram and Durov Diagram for suitability for water sample from Bundi District (May, 2021)

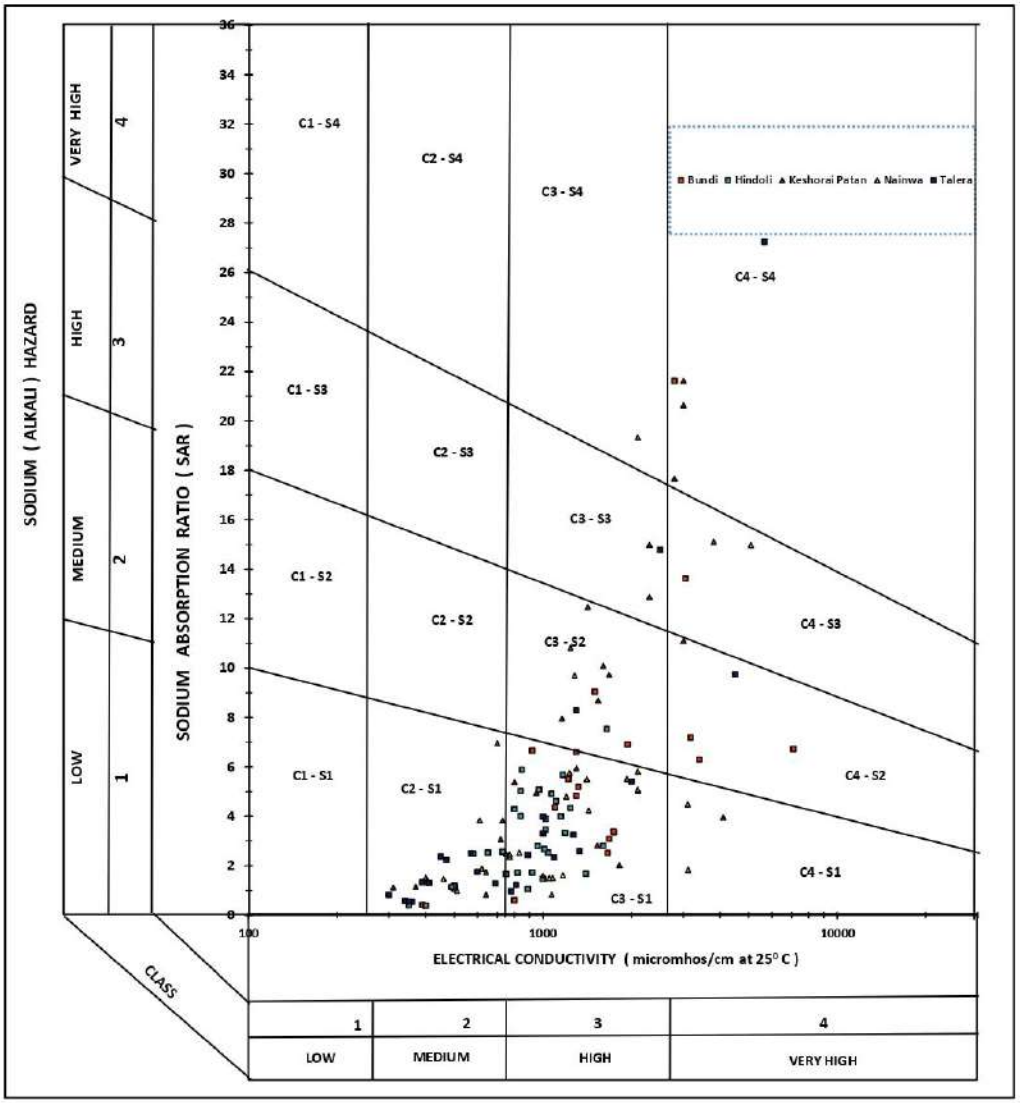


Fig 43. Distribution of water samples as per US Salinity diagram for sample from Bundi District (May, 2021)

Fig 44: Field Photographs Showing Water Samples and collection During field work

5.0. GROUND WATER RESOURCES

Resources 2020 are presented in Table 15. Net annual ground water availability in the district has been estimated as 303.52 mcm. Annual ground water draft for all uses in the district has been assessed to be 297.01 mcm with overall stage of ground water development at 97.85%.

Table 17: Block wise summary of Dynamic Ground water Resources as on March 2020

Block	Annual Extractable Ground Water Resource (ham)	Domestic draft (ham)	Irrigation draft (ham)	Ground Water Extraction for all uses (ham)	Stage of Ground Water Extraction (%)
BUNDI	5535.19	429.13	5022.79	5451.91	98.5
HINDOLI	6954.95	949.90	8219.50	9169.39	131.8
KESHORAI PATAN	7747.85	651.63	5022.79	5674.43	73.2
NAINWA	6244.32	1356.47	6288.63	7645.1	122.4
TALERA	3870.51	150.10	1610.69	1760.79	45.5
District Total	30352.82	3537.23	26164.4	29701.62	97.85

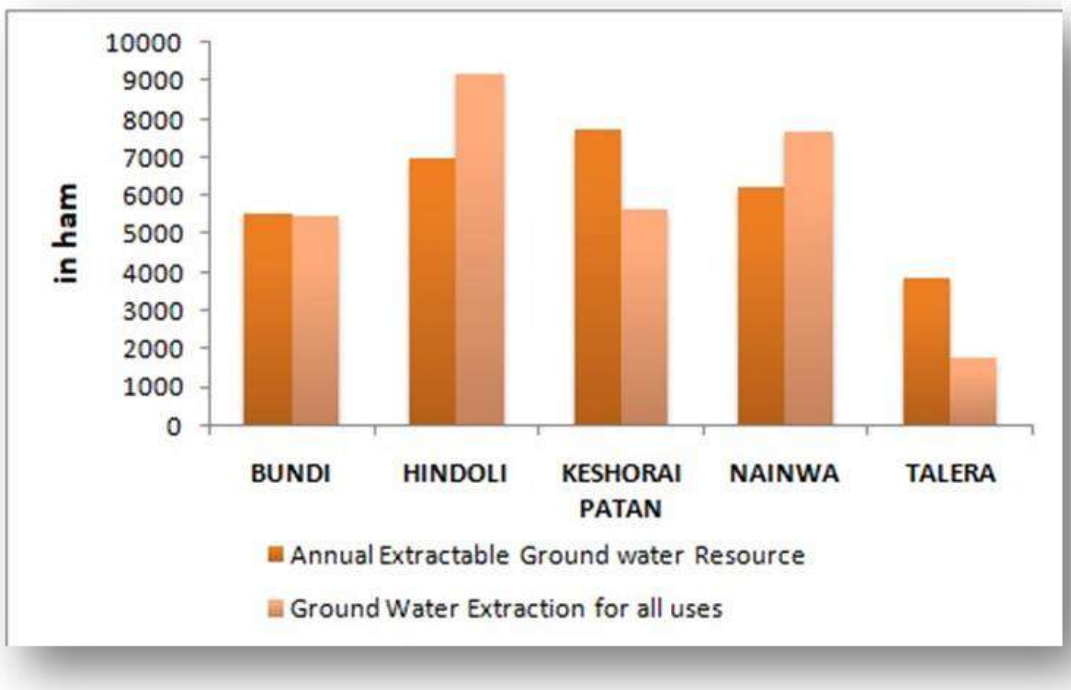


Fig 45: Graph showing Ground Water Availability and Draft (As on March 2020)

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

6.1 Decline in ground water level

Long term water level data (pre monsoon 2010-21) have indicated declining water level trend in all the blocks. Over draft of ground water resources for various uses than its natural replenishment, has resulted incessant declining trend in the most part of the district. Hindoli and Nainwa blocks fall under over exploited category. Bundi and Keshoraipatan blocks fall in Semi-Critical category.

6.2 Deep ground water level

Water level of more than 40 mbgl (as per pre 2020 Water level data) has been found in north western part of district covering parts of Nainwa block and southern part of talera block. Water level between 20-40 mbgl is observed in almost all blocks. Deep water level causes consumption of more energy.

6.3 Ground water salinity

Ground water salinity more than 3000ms/cm at 25^{o}C has been observed mainly in Southeastern part of Keshorai Patan block.

6.4 Fluoride and Nitrate Contamination

Fluoride content more than 1.5 mg/l and Nitrate content more than 45 mg/l has also been found in several sampling sites.

7.1 In-Storage water resources computation

Study of 3D hydrogeological model representing the area, made using pre-monsoon 2019 water level data, helped in finding out the in storage (static)water resources. This further helped in finding out the sustainability of available total Groundwater resources given the existing draft conditions.

Static resources calculation from the 3D model is given in Table 16 and sustainability (in no. of years) is given in table 17 respectively.

Table 18: Showing sustainability (in no. of years) of Total available water resources given the existing draft

Blocks	Total Static Resources (A) mcm	Total Dynamic Resources (B) mcm	Total Available Resources (A+B) mcm	Existing Draft mcm	Sustainability (in no. of years) (given the existing draft)
BUNDI	323.7	86.29	410.0	70.65	Sustainable for years
HINDOLI	163.3	82.28	245.5	92.59	15.8
K. PATAN	312.5	147.93	460.4	105.80	Sustainable for years
NAINWA	158.6	63.20	221.8	75.42	13
TALERA	402.4	94.87	497.3	59.30	Sustainable for years

The above study reveals that if we continue to withdraw groundwater at present rate given the existing rainfall, our available ground water resources cannot sustain us for more than 15.8 years in Hindoli block and 13 years in Nainwa block. Evidently, it is high time that water should be conserved as much as possible by constructing various conservation structures such as recharge shafts, percolation tanks, storage tanks etc. This will be regarded as supply side management. Along with supply side management, demand side management must also be given more emphasis in order to tackle depleting ground water resources in Overexploited blocks. Section 8 discusses the ground water management strategy in detail.

8.0 GROUND WATER MANAGEMENT STRATEGY

Hindoli and Nainwa blocks are over exploited, while Bundi and Keshoraipatan falls in semi critical category, thereby, leaving no/limited scope of further ground water development for various consumptions. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. The management plan comprises two components- supply side management and demand side management. Since there is ample surplus surface water available in this district, intervention in the form of supply side management is proposed.

8.1 **Supply Side Management**

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also, it is necessary to understand the unsaturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Bundi district is computed based on following; the area feasible for recharge, unsaturated depth below 3 m bgl and the specific yield of the aquifer.

8.1.1 Artificial recharge to ground water through interventions of various structures

The following parameters are inevitable for planning of artificial recharge to ground water.

- Availability of sufficient storage space to accommodate recharged water
- Availability of surplus water to recharge
- Feasibility of sub-surface geological formations

In case of Bundi district, sufficient sub-surface storage space is available to accommodate the recharged water. Details of the subsurface storage, surplus surface water per block is given in Table 18.

Table 19: gives general information about subsurface storage availability, Surface water surplus, Category of blocks

Block	Geographical Area of Block (sq km)	Potential Area (sq km)	Water level (m) Nov 2020	Trend (m/yr)
Bundi	1175.13	773.11	7.29	0.25
Hindoli	1275.3	884.81	15.76	2.33
Keshorai Patan	1243.51	1152.88	6.93	0.41
Nainwa	1095.19	966.85	15.68	1.04
Talera	710.87	462.53	7.81	0.46

To enhance ground water availability from supply side, Artificial recharge through 4 Interventions are considered. These are:

Intervention 1: Catchment area treatment (which includes plantation, constructing staggered trenches, continuous contour trench) wherein catchment area is taken as 10% of Pasture and Barren land Surplus Water utilized in Catchment area treatment is given in Table 19.

Table 20: Surplus water utilization in Catchment area treatment (after Intervention 1)

Block	Volume of sub surface storage space available (50% of unsaturated thickness) for artificial recharge (MCM)	Surface water Surplus (mcm)	Pasture land (ha) (PL)	Barren land (ha) (BL)	Area recommended for Catchment area treatment (ha) (10% of PL+BL)	Surplus water utilized in Catchment area treatment (mcm)	Surplus water available (mcm)
Bundi	80.40	124.63	4728	5631	1036	0.35	124.28
Hindoli	286.90	169.18	5311	10956	1627	0.57	168.60
Keshorai Patan	80.62	174.55	4647	8020	1267	0.48	174.08
Nainwa	1051.23	134.15	5650	2807	846	0.26	133.89
Talera	46.65	116.54	3285	8865	1215	0.41	116.14

Intervention 2: By constructing Mini percolation tanks (on I order streams), Percolation tanks, Mini storage tanks, Pacca check dams (on 3rd order streams), anicut etc. Capacity of MPT, PT, PCD, Anicut and MST is 1000cum, 2000 cum, 4000cum, 6000cum and 9000cum respectively. Surplus water utilized by these structures is calculated by summing up the water stored by these structures.

Table 21: Surplus water utilization after Intervention 3 of conservation plan

Block	Surplus water available for (MPT/PT/PCD/Anicut/MST) (mcm)	Mini Percolation Tank (A)	Percolation Tank (B)	Pacca Check dam (C)	Anicut (D)	MST (E)	Surplus water utilized by (MPT/PT/PCD/Anicut/MST) (mcm)	Surplus water available for Farm Pond (mcm)
Bundi	124.28	1070	483	259	170	8	4.16	120.12
Hindoli	168.60	1481	714	320	237	12	5.72	162.89
Keshorai P	174.08	1557	685	352	207	12	5.69	168.39
Nainwa	133.89	1368	626	367	172	10	5.21	128.68
Talera	116.14	1006	454	228	111	8	3.56	112.58

Intervention 3: By constructing farm ponds (one pond in 3 hectares of land; proposed in 25% of arable land)

Table 22: Surplus water utilization by farm ponds

Block	Arable/ Cultivable land (ha)	Surplus water available for Farm Pond (mcm)	No of Recharge/ Farm Pond (One farm pond in 3 ha land proposed in 25% of arable land)	Surplus water utilized by Farm Pond of 1200 cum capacity (mcm)
Bundi	2683	120.12	224	0.27
Hindoli	6564	162.89	547	0.66
Keshorai Patan	8110	168.39	676	0.81
Nainwa	5571	128.68	464	0.56
Talera	4744	112.58	395	0.47

Table 23 summarizes the impact of interventions proposed.

	Before Interventions				Interventions				After Interventions				
Block	Annual Extractable Ground Water (mcm) (A)	Current annual gross ground water extraction for 'All Uses' (mcm) (F)	Resource Available before Intervention	Stage of GW extraction(%)	Surplus water utilized in Catchment area treatment (mcm) (B)	Surplus water utilized in Recharge Shaft/ Injection well (mcm) (C)	Surplus water utilized by (MPT/PT/ PCD/Anicut/MST) (mcm) (D)	Surplus water utilized by Farm Pond (mcm) (E)	Annual Extractable Ground Water (mcm) after intervantions X = (A +B+ C*0.7 +D*0.5)	Gross ground water extraction for 'All Uses' after intervanations (mcm) Y= (F- E)	Resource avilability after intervantions proposed (mcm) (X - Y)	Stage of GW extraction (%)	Surface Surplus water available after all interventions
Bundi	86.2927	70.6501	15.64	81.9	0.35	0.00	4.16	0.27	88.7207	70.3818	18.34	79.33	119.85
Hindoli	82.2778	92.5862	-10.31	112.5	0.57	0.00	5.72	0.66	85.7084	91.9298	-6.22	107.26	162.23
Keshorai I	147.0875	102.0374	45.05	71.5	0.48	0.00	5.69	0.81	150.4079	101.2264	49.18	67.30	167.58
Nainwa	63.2048	75.4208	-12.22	119.3	0.26	0.00	5.21	0.56	66.0673	74.8637	-8.80	113.31	128.13
Talera	94.8710	59.2987	35.57	62.5	0.41	0.00	3.56	0.47	97.0582	58.8243	38.23	60.61	112.10

We can still observe ample availability of Surplus Surface water. This surplus surface water can be managed by Surplus management plan that can be comprised of Channelizing the surplus water to other water deficient canals for stabilizing the existing command areas, provision of Safe drinking water, Creation of irrigation facility / command area etc. It is suggested that surplus water available should be used in OE block for artificial recharge to Groundwater. In safe and semi-critical blocks, surplus water can be utilized in aquaculture or horticulture activities to increase farmer income.

Supply side interventions in Keshoraipatan and Talera blocks, bring down the stage of Groundwater development from 71.5 to 67.30 % and 62.5 % to 60.61 % respectively. For Hindoli and Nainwa, even after interventions proposed, extraction will be more than available dynamic resources, therefore, **more emphasis should be given on demand side management in these blocks**. For Bundi, as stage of GW development is still above 70%, Demand side interventions are recommended. Demand side management is proposed in the next section.

To balance the water economy (including agriculture, industries etc.), and to avoid water logging problems, efforts should be made to develop Ground water optimally (70%). Thus, at this point of time, demand side interventions in K. Patan, Talera blocks can be opted later when Stage of GW development in these blocks starts increasing in future to counter the declining water trends and in order to keep the stage of GW development to the optimal. However, in section 8.2, for study purpose, a case has been presented where if demand side interventions are implemented to Semi-critical and safe blocks (over and above the supply side interventions where optimal Stage of GW development has already been achieved), what would be the projected stage of Ground water development in these blocks.

	Hill to Valley Approach- Supply Side Management
	Anicut
	Step Well

Fig : 46: Field photographs of various supply side intervention in Bundi district

8.2 Demand Side Management

In order to ensure effective demand side management, measures should be taken to reduce draft such as change from traditional water intensive irrigation system to micro-irrigation/pressure irrigation practices, change in cropping pattern from water intensive crops to less water consuming crops as well as adopt innovative technologies, etc. should be implemented in befitting manner.

Fig 47: Sprinkler Irrigation in Bundi, photo captured during Field Work

8.2.1 Change in irrigation pattern

Change from traditional irrigation system like flooding/spreading to micro-irrigation system such as sprinkler/drip irrigation can save large amount of water. Considering 50% of total irrigated area for sprinkler irrigation can save 41.92 mcm of water (Table 24). Based on feasibility, result and adaptation, entire area can be covered by sprinkler/pressure irrigation.

8.2.2 Crop diversity/Diversification of cropping pattern

There is need of the hour to change in cropping pattern from existing water intensive crops to water efficient crops. Considering change in 50 % irrigated area under wheat to gram can save 115.3 mcm of water (Table 24)

Table 24: Demand Side Management Options/recommendations.

Blocks	Bundi	Hindoli	Keshorai Patan	Nainwa	Talera
Area Irrigated through Ground Water (ha)	9663	26735	12176	52358	3885
Micro irrigation techniques					
Irrigation Area (ha) proposed for irrigation through Sprinkler	4831.5	13367.5	6088	26179	1942.5
Water Saving by use of Sprinklers (mcm)	3.87	10.69	4.87	20.94	1.55
Crop Change					
Area under Wheat Crop(ha)	35361	27938	52340	5633	25475
Cropping Area (ha) proposed for change in crop	17680.5	13969	26170	2816.5	12737.5
Water Saving by Change in Cropping Pattern (mcm)	17.6805	13.969	26.17	2.8165	12.7375
Total water saving (mcm)	**21.55**	**24.66**	**31.04**	**23.76**	**14.29**

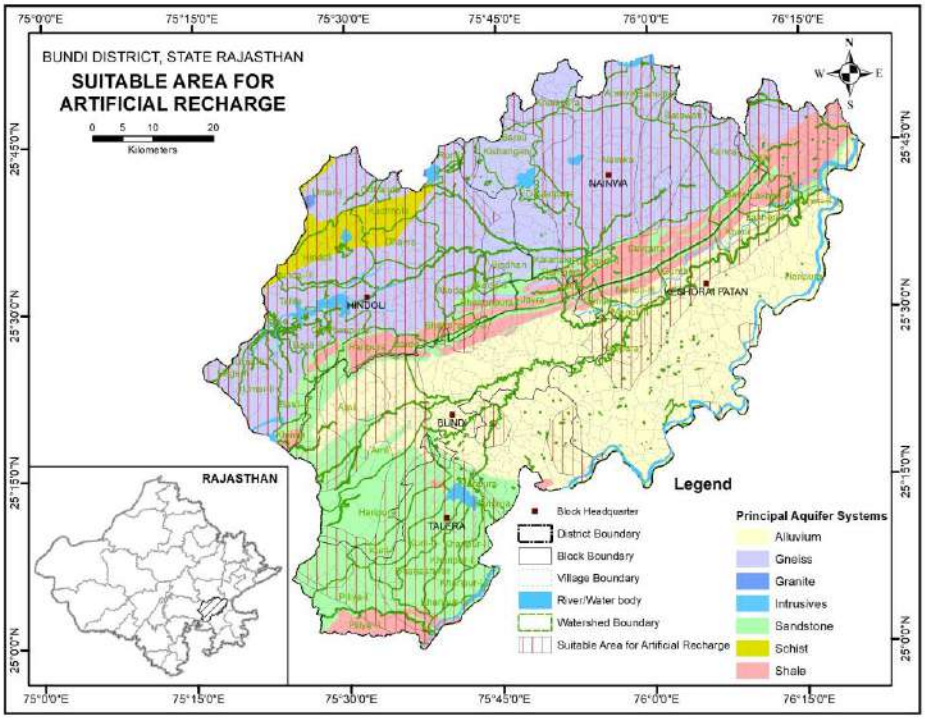


Fig 48: Area suitable for artificial recharge-Bundi.

Fig 49: Agricultural Activities in Bundi District: Dual cropping

Fig .50: Pictures of Ravine Reclamation activities for agricultural uses in Bundi Block

8.3 Innovative Technologies

Green house, solar pumps can be used for fruit plantation as implemented in other parts of the State that has resulted in socio-economic development of local people in different parts of Rajasthan.

84 Impact Assessment and Monitoring

Assessment of impact of the artificial recharge/ water conservation schemes implemented would be an essential step in assessment of the efficacy of structures constructed. It helps in identification of cost-effective recharge mechanisms for optimal recharge into the ground water system. It also helps to make necessary modifications in site selection, design and construction of structures in future. It is proposed to construct appropriate number of piezometers at suitable locations for monitoring of water levels, in the vicinity of proposed recharge structure.

8.5 Revival, Repair of Water Bodies

The existing ponds and tanks with time lose their storage capacity as well as the natural ground water recharge through these water bodies has also become negligible due to siltation and encroachment by farmers for agriculture purposes. There are several such villages where ponds/ tanks are in dilapidated condition. These existing village tanks, which are normally silted and damaged, can be modified to serve as recharge structure in case these are suitably located to serve as percolation tanks. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure.

8.6 Expected Outcome

Supply side measures can save only small amount of water by existing/proposed interventions. Agriculture/irrigation consumes major part of ground water. Demand side management can have major impact on water resources in the block. Net groundwater availability after implementation of supply side and demand side measures coupled with people's participation will result in availability of additional quantity of water. This implies more area can be brought under irrigation, besides increased sustainability of tube wells/ dug wells or feasibility of additional cropping between major crops in the block. The expected outcome is presented in Table 26.

Table 25: Projected stage of G.W development after supply and demand side options.

Block	Present stage of Ground Water Development (%)	Water Saving by use of Sprinklers	Water Saving by Change in Cropping Pattern	Projected Stage of Ground Water Development after Supply Side interventions (%)	Projected Stage of GW Development after (MI) Demand Side interventions (%)
BUNDI	98.5	3.87	17.68	93.87	87.18
HINDOLI	131.84	10.69	13.97	124.75	110.09
KESHORAI PATAN	73.24	4.87	26.17	69.22	63.20
NAINWA	122.43	20.94	2.82	116.21	84.14
TALERA	45.49	1.55	12.74	41.89	38.09

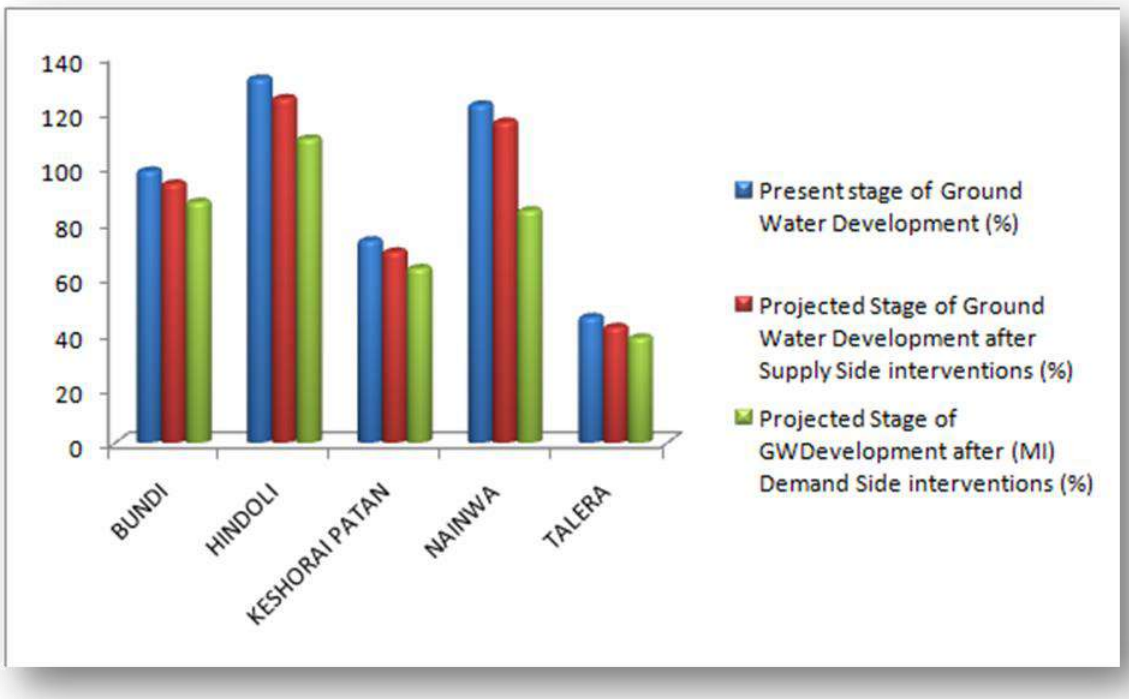


Fig .51: Bar diagram depicting effect of various intervention on stage of groundwater development in Bundi.

The perusal of data indicates that saving of ground water through supply side and demand side interventions may lead to increase in Ground water availability and decrease in the net ground water draft and may reduce the stage of ground water development of the district.

10.0 Conclusions

Accelerated groundwater development over the past few decades has resulted in great social and economic benefits, by providing low-cost, drought-reliable and (mainly) high-quality water supplies for urban areas, for the rural population, and for irrigation of (potentially high-value) crops. However, investment in resource management has been seriously neglected.

The sustainability of groundwater is closely linked with a range of micro- and macro-policy issues influencing land-use and surface water, and represents one of the major challenges in natural-resource management.

Practical advances are urgently needed but there is no simple blueprint for action, due to the inherent variability of groundwater systems and of related socio-economic situations. As a part of water management plan, we tried to chalk out and asses the possibilities of groundwater management options. Thus, after assessment of groundwater resources of 2020 of Bundi District, the need of proposing the water conservation and artificial recharge in the block has emerged as a vital due to availability of surplus water and subsurface storage.

Thus, the management plan for the block includes the catchment area treatment and construction of water conservation structures viz. Percolation tanks, Anicuts, Pacca Check dams and also construction of farm ponds under supply side management options and also need of demand side management interventions viz. adopting micro-irrigation techniques and change in cropping pattern which will ultimately reduce the stage of groundwater extraction and will cope up with future use.

10.1 Recommendation –

We can adopt some measures in coordination with our line departments such as PHED, water resource department, forest department, agriculture department and some groundwater level implementation can be done with the help of KVK (Krishi Vigyan Kendra), Block development officers and Panchayat such as –

- Recycling and reusing waste water: If at least 50% of groundwater being extracted as domestic and industrial draft can be recycled and reused after treatment to such standards that it can be reused for non-drinking purposes e.g., for flushing toilets, laundry machines or irrigation for crops.
- Community Participation: Strong grassroots awareness is required to be generated. Thus, IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory ground water management.
- Roof Top Rain Water Harvesting: Awareness for harvesting rainwater by individual households or at community level will also reduces the stress on the water supply system
- Move toward Integrated farming: Diversification in agriculture (horticulture, vegetables, green houses, agro-forestry, fodder crops and Diversification of Livelihoods are required with limiting extensive groundwater withdrawals by limiting agricultural electricity subsidies.
- Ravines and bad land topography is covers major region in Keshorai patan which are good sources of groundwater, thus ravine reclamation should be adopted to give away more land for agriculture.
- There is urgent need for coordinated efforts from various State Government agencies, non-Governmental and social service organizations, academic institutions and the stakeholders for evolving and implementing suitable ground water management strategies.

Appendix

Micro-level Aquifer Management Plan : Village Bishanpura BLOCK : Hindoli DISTRICT : Bundi		
Gram/village		Thana Gram Panchayat
Introduction		Bishanpura is a small Village/hamlet in Hindoli Tehsil in Bundi District of Rajasthan State, India. It comes under Bishanpura Panchayath. It belongs to Kota Division. It is located 20 KM towards North from District head quarters Bundi. 181 KM from State capital Jaipur
longitude		75.383273
lattitude		25.541828
Block		Hindoli
DISTRICT		Bundi
State		Rajasthan
Nearest Town (with distance)		Bundi
Nearest Railway Station		Bundi
Name of Gram Pradhan / Sarpanch		Shivji Ram Meena
Postal Addess of Gram Panchayat with PIN code		Bishanpura, Hindoli, Bundi, Rajasthan. PIN- 323025 , Post - Umar
Area		417 hectares
Population	(2011) Reported now	674
Physiographical Description		Elevation 256 m amsl
River & Drainage System No. of ponds/Anicuts/Bandha		Balandi river Basin
Climate		Warm and Temperate
Temperature		22 to 42 °C
Rainfall (mm)		Mean average RF of block: 653 mm
Soil		Yellow soil and black soil
Irrigation Facilities		Through dugwell and Tubewell
Flora & Fauna		Desi Babool, Neem
Agriculture		Soya, Mustard,& Wheat rice
Animal Husbandry		Cow, Buffalo, sheeps and Goats
Mines & Minerals		NA
Industrialization		NA
Transport & Communication		Bundi Rail Way Station is very nearby railway stations to Bishanpura.
Any other relevant Information(Census statistics)	Total No. of Houses	144
	Population	674

	Child (0-6)	121
	Schedule Caste	89 (13.2%)
	Schedule Tribe	585 (86.8%)
	Literacy	48.1%
	Total Workers	362
	Main Worker	241
	Marginal Worker	121
Hydrogeology:	EW Drilled	
	SWL	
	Discharge	
	Transmissivity	
	Lithology	
Sources of water (in terms of quantity and quality), irrigation, domestic, industry		Domestic- 5 Tubewell of Gram Panchayat, Handpumps Irrigation – Tubewell
Demand of water (irrigation sector, Domestic consumption, Drinking water, animal husbandry, other consumption)		As per norms (70 lpcd) :47180 lit/day/capita
Present status of development (Irrigation sector, Domestic consumption)		• No PHED supply. • 3 village ponds exist used for Cattle, needs renovation.
Gap Assessment /Water problem		• Non availability of water for irrigation is huge problem. • Groundwater availability in pre monsoon is also a major issue.
Ground water quality		Fresh water
Solutions	Management Plan	
	Supply Side Management:	• Groundwater conservation structures should be constructed under MJSA. • Watershed management activity should be taken up. • Farm ponds should be taken up to fulfill the irrigation needs. • Restoration and renovation of village Ponds required with a governing body. • Roof top Rain water harvesting can be adopted to meet the domestic requirements other than drinking.

	Demand Side Management:	• Irrigation through drip and sprinklers on a large scale can be adopted. • Less water intensive crops should be given priority.
	Exploration of deep aquifer:	
	Depth of EW Drilled	
Works to be taken		• Catchment area treatment, • Roof top rain water harvesting, • Restoration and renovation of ponds. • Constituting a Pani Samiti or any governing body
Implementation mechanism		• Groundwater rules and regulation with governing body should be present for irrigation sector. • IEC (Information Education and Communication) activities should be taken up to educate the villagers about the sustainable development of groundwater.
Operation and maintenance		A governing body should be made which will maintain all the water bodies and their catchments from being encroached, polluted and over-exploited.
Conclusions & Recommendations		• The village is facing groundwater availability problem due to scanty and erratic rainfall. • PHED should supply drinking water. • Lift irrigation can be done through Balandi river dam. • As the villagers are mostly tribal, their development is farfetched. They don't have any knowledge about micro-irrigation techniques, farm ponds, rainwater harvesting measures, etc. • It is important to educate the villagers through IEC activities about sustainable development of groundwater and irrigation techniques and also the subsidies provided by government. • Water conservation structures can be constructed.

		• Restoration and renovation of Ponds is required • Roof top Rain water harvesting can be adopted to meet the domestic requirements other than drinking • Farm ponds are recommended in farms.

Micro-level Aquifer Management Plan : Village Kota Khurd BLOCK : Keshorai patan DISTRICT : Bundi		
Gram/village		Kota khurd Gram Panchayat: Kota Khurd
Introduction		Kota Khurd is a small Village/hamlet in Keshoraipatan Tehsil in Bundi District of Rajasthan State, India. It comes under Kota Khurd Panchayath. It belongs to Kota Division. It is located 42 KM towards East from District head quarters Bundi. 197 KM from State capital Jaipur.
longitude		76.2217
lattitude		25.509025
Block/Tehsil/Panchayat samiti		Guhata
DISTRICT		Bundi
State		Rajasthan
Nearest Town (with distance)		Lakheri (25 km)
Nearest Railway Station		Kapren
Name of Gram Pradhan / Sarpanch		Sunil meena
Postal Addess of Gram Panchayat with PIN code		kota khurd , keshorai patan , bundi , Rajasthan . PIN- 323603 , Post - Lakher
Area(SqKm)		16.52
Population	(2011) Reported now	1632
Physiographical Description		Elevation 220 m amsl
River & Drainage System No. of ponds/Anicuts/Bandha		Area fall in the catchment of chambal River
Climate		Warm and Temperate
Temperature		22 to 42 °C
Rainfall (mm)		Mean average RF of block: 653 mm
Soil		Yellow soil and black soil
Irrigation Facilities		Through Tubewell and surface river water
Flora & Fauna		Desi Babool, Neem
Agriculture		Soya, Mustard,& Wheat rice
Animal Husbandry		Cow, Buffalo, sheeps and Goats
Mines & Minerals		NA
Industrialization		NA
Transport & Communication		Arnetha Rail Way Station, Kapren Rail Way Station are the very nearby railway stations to Kota Khurd.

Any other relevant Information(Census statistics)	Total No. of Houses	352
	Population	1632
	Child (0-6)	230
	Schedule Caste	376 (23%)
	Schedule Tribe	815 (49.9%)
	Literacy	54.5%
	Total Workers	873
	Main Worker	319
	Marginal Worker	300
Hydrogeology:	EW Drilled	
	SWL	
	Discharge	
	Transmissivity	
	Lithology	Younger Alluvium
Sources of water (in terms of quantity and quality), irrigation, domestic, industry		Domestic- 50 Tubewell of Gram Panchayat, Handpumps Irrigation – Tubewell and bimukhi canal water
Demand of water (irrigation sector, Domestic consumption, Drinking water, animal husbandry, other consumption)		As per norms (70 lpcd) :114240 lit/day/capita
Present status of development (Irrigation sector, Domestic consumption)		• No PHED supply. • 2 village ponds exist used for Cattle, needs renovation. • Bimukh canal water is used for irrigation.
Gap Assessment /Water problem		• Ground water quality is deteriorating day by day which is causing many health problems in people like stomach ache, Knee problem, etc
Ground water quality		Flouride is increasing
Solutions	Management Plan	
	Supply Side Management:	• Groundwater conservation structures should be constructed under MJSA. • Farm ponds should be taken up to fulfill the irrigation needs where there is absence of groundwater till 200 m. • Restoration and renovation of village Ponds required with a governing body.

		• Roof top Rain water harvesting can be adopted to meet the domestic requirements other than drinking.
	Demand Side Management:	• Irrigation through drip and sprinklers on a large scale can be adopted. • Less water intensive crops should be given priority.
Works to be taken		• Catchment area treatment, • Roof top rain water harvesting, • Restoration and renovation of ponds. • Constituting a Pani Samiti or any governing body
Implementation mechanism		• Groundwater rules and regulation with governing body should be present for irrigation sector. • RO plant for purifying the groundwater for domestic use. • Ravine reclamation for expansion agriculture land
Operation and maintenance		A governing body should be made which will maintain all the water bodies and their catchments from being encroached, polluted and over-exploited.
Conclusions & Recommendations		• The village is facing groundwater quality problem due to deteriorated ground water quality hence RO is recommended. • Water conservation structures can be constructed. • Restoration and renovation of Ponds is required • Roof top Rain water harvesting can be adopted to meet the domestic requirements other than drinking • Farm ponds are recommended in farms with no canal supply and absence of groundwater. • Ravine reclamation activities should be taken up on a large scale for agricultural and grazing activities.

Public interaction program conducted during Field visit in Bundi District

- Bundi Block
- Hindoli Block
- Keshoraipatan Block
- Nainwa Block
- Talera Block

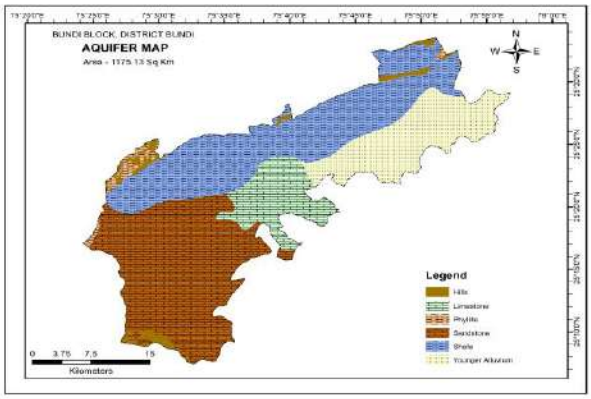
BUNDI BLOCK

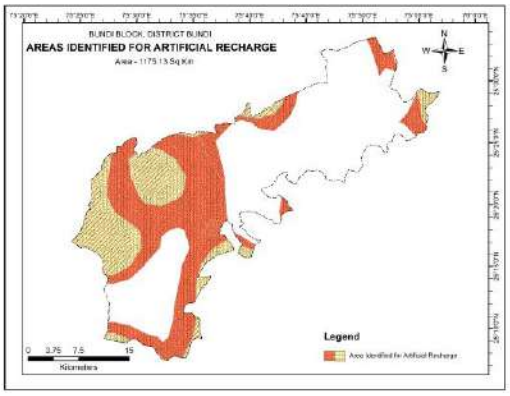
SALIENT INFORMATION		**Bundi Block**
Block Name		**Bundi**
Longitude		75°25'00" to 75°57'00"
Latitude		25°07'00" to 25°33'30"
Geographical Area Sq.km		**1175.13**
Potential area		773
Population (2011)		2,51,926
Geomorphology		
Geomorphic Unit		Buried Pediments, Alluvial Plain,Valley Fills,platue, alluvial fans, Ravines
Geology		Alluvium
		Shale/Sst/Lst/Phyllite
Basin/Sub-Basin	**Drainage**	Chambal/Banas
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN		
	Geographical Area in ha.	1175
	Forest Area in ha.	27837
	Cultivable Area in ha.	16421
	Net Sown Area in ha.	82112
	Area sown more than once in ha.	38752
	Rainfed Crop in ha.	20027
	Irrigated Crop in ha.	62085
Area under Irrigation (Net) in ha		
	Surface Water	30379
	Ground Water	9663
	Other sources	1421
Net irrigated Area in ha		41463
Principal Crops		
	Crop Type	
	Cereals	Rice, **Wheat,** , Jau
	Pulses	Gram, Masoor
Crop wise area irrigated		
Wheat		35361
Jau		521
Pulses		1420
Rice		21675
Hydrogeology		
Monitoring Stations		20
	CGWB	3
	SGWD	17

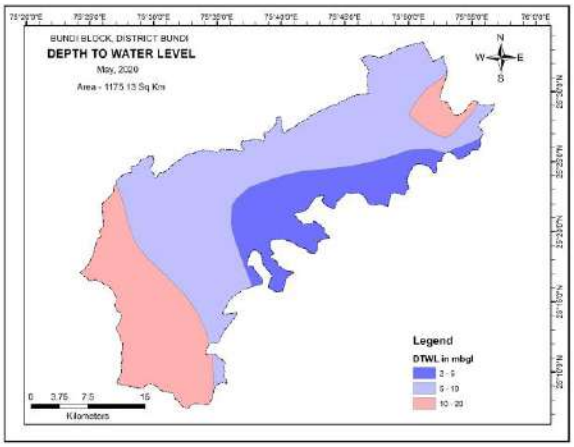
GROUND WATER RESOURCE & EXTRACTION		
Ground Water Recharge Worthy Area (Sq. Km.)		77311
Command		38587
Non Command		38740
Hilly Area		40202
Total Geographical Area (ha)		117513
Recharge from		
Rainfall		2484.18
Canals		7.32
Surface Water Irrigation		1860
Ground Water Irrigation		1255
Tanks and Ponds (C+NC)		464.03
Annual GW Recharge (Command)		4666.41
Annual GW Recharge (Non-Command)		1405.71
Total Annual Ground Water Recharge (ham)		6072.12
Natural Discharge (Command)		466.65
Natural Discharge (NC)		70.28
Natural Discharge (ham)		536.93
Annual Extractable Ground water Resource (ham)		5535.19
Domestic Draft (ham)		429.13
Industrial Draft (ham)		0
Irrigation Draft (MCM)		5022.79
Existing Gross Ground Water Draft for All uses(MCM)		5451.91
Provision for domestic and industrial requirement supply to 2025(MCM)		429.13
Net Annual Ground Water Availability for Future Use (ham)		389.38
Stage of Ground Water Development %		98.490
Category		**Critical**
AR & Conservation Possibilities		
Existing Structures constructed by State Govt.		
	Anicut	13
	Contour Continuous Trench (CCT)	20
	Deep CCT	7
	Earthen Checkdam	7
	Mini Percolation tank	53
	Pakka Checkdam	4
	Percolation tank	14
	Piezometer	3
	Recharging Shaft for Aquifers	5
	Staggered Trench	6
	Sub Surface barrier	3
	Talai (Talab)	3
	Water Harvesting Structure	52

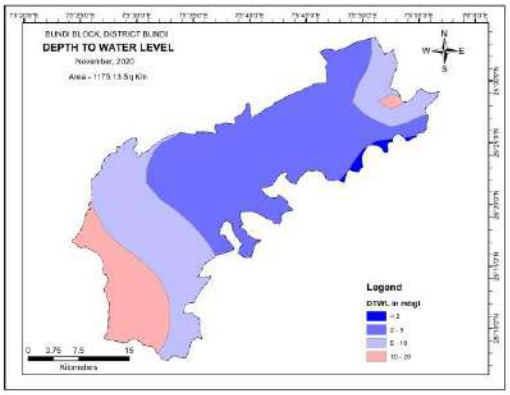
	Total	187
Area of Block (Sq. Km.)		1175.13
Hilly Area sq.km		402.02
Potential Area (sq km)		773.11
Normal Annual RF (mm)		668.1
Water level (m) Nov 2018		7.29
Trend (m/yr)		0.25
Average Specific Yield		
Volume of Sub surface Storage Space available for Artificial Recharge (MCM)		80.40
Surplus Surface water Availability (MCM)		124.63
SUPPLY SIDE MANAGEMENT		
Catchment Area Treatment	Area proposed for catchment area treatment in ha	1036
Water utilized in catchment area treatment (mcm)		0.35
Water Conservation Structures		
No. of existing village ponds (2.5 to 7.5 ha)		47
Proposed No. of Structures		
Mini Percolation Tanks		1070
Percolation Tank		483
Pacca Check Dams		259
Anicut		170
Mini Storage Tanks		8
Total Volume of water utilized in catchment area and WC Structured mcm		4.16
Volume of Water expected to be conserved / recharged @ 50% efficiency (MCM)		2.08
Farm Ponds		
No. of Farm Ponds		224
1 farm pond in 3 ha land :capacity 1200 cum	water utilized by farm ponds (mcm)	0.27
DEMAND SIDE MANAGEMENT		
Area Irrigated through Ground Water (ha)		9663
Micro irrigation techniques		
Irrigation Area (ha) proposed for irrigation through Sprinkler		4831.5
Water Saving by use of Sprinklers		3.87
Crop Change		
Area under Wheat Crop(ha)		35361
Cropping Area (ha) proposed for change in crop		17680.5
Water Saving by Change in Cropping Pattern		17.6805
EXPECTED BENEFITS		
Net Ground Water Availability (MCM) 2020		55.35
Additional GW resources available after Supply side interventions (MCM)		2.43
Net Ground Water Availability after Supply side intervention		57.78

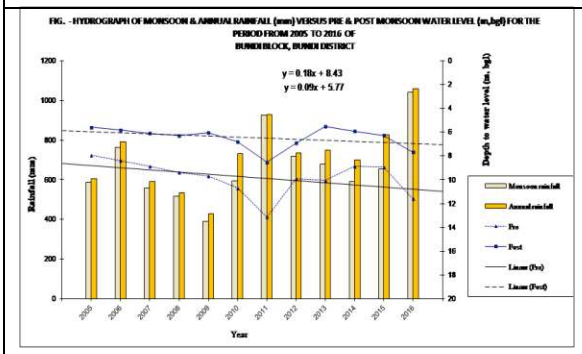
Existing Ground Water Draft for All Purposes (MCM)	54.51
Additional GW resources available after Supply side interventions (MCM)	0.27
GW draft after Supply Side Interventions (MCM)	54.24
Present stage of Ground Water Development (%)	98.50
Projected Stage of Ground Water Development after Supply Side interventions (%)	93.87
GW draft after Demand Side Intervention (MI Techniques) mcm	50.37
Projected Stage of Development after (MI) Demand Side interventions (%)	87.18
GW draft after Demand Side Interventions Crop Change (MCM)	32.69
	56.58

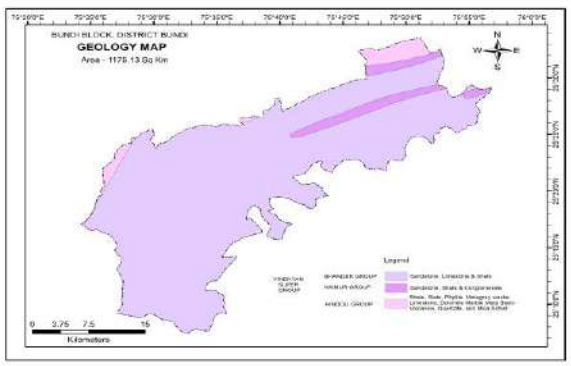


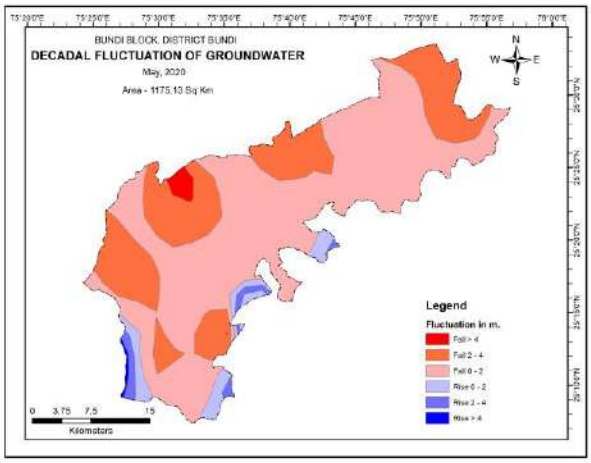


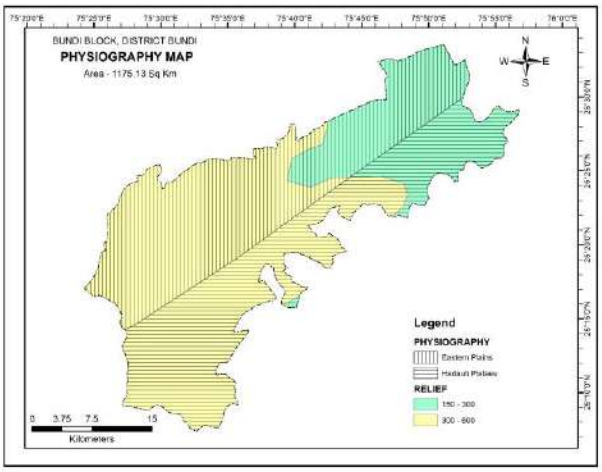


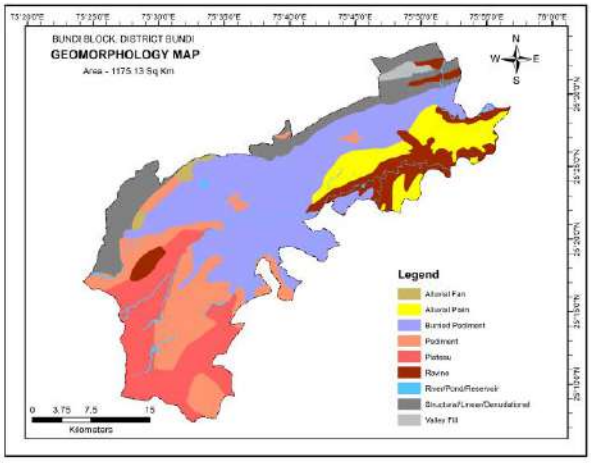


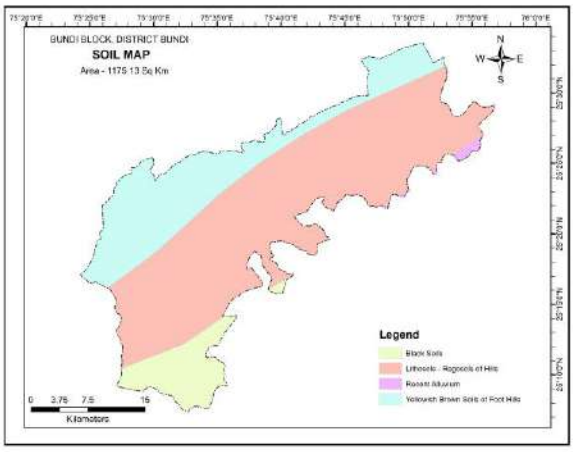


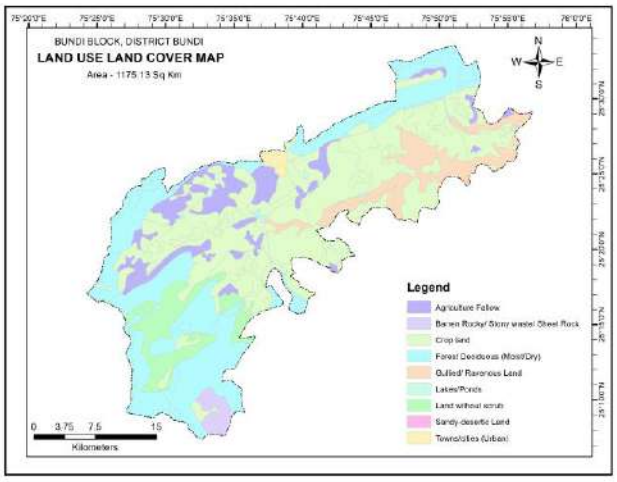


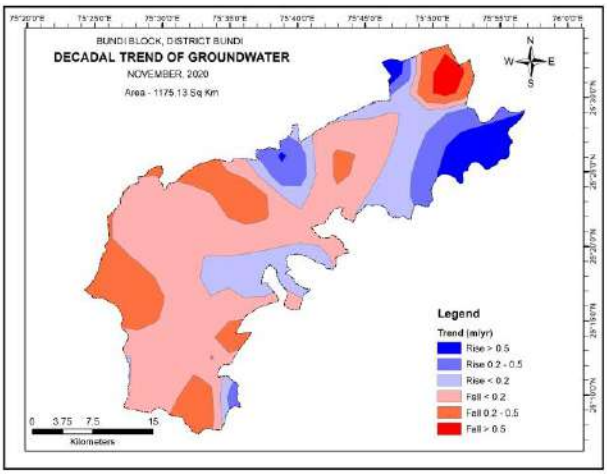

BUNDI BLOCK, DISTRICT BUNDI
DECADAL FLUCTUATION OF GROUNDWATER
May, 2020
Area - 1175.13 Sq Km
Legend
Fluctuation in m.
Fall > 4
Fall 2 - 4
Fall 0 - 2
Rise 0 - 2
Rise 2 - 4
Rise > 4
0 3.75 7.5 15
Kilometers

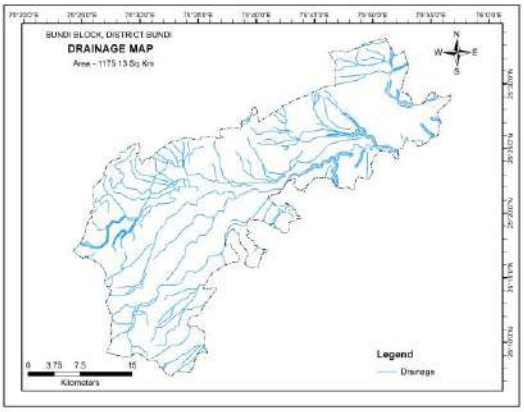

BUNDI BLOCK, DISTRICT BUNDI
PHYSIOGRAPHY MAP
Area - 1175.13 Sq Km
Legend
PHYSIOGRAPHY
Eastern Plains
Hadauti Plateau
RELIEF
150 - 300
300 - 600
0 3.75 7.5 15
Kilometers

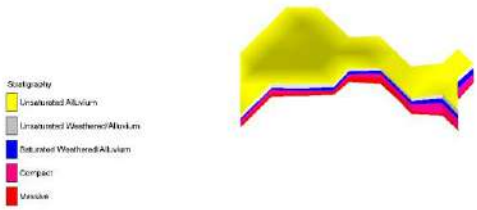

BUNDI BLOCK, DISTRICT BUNDI
GEOMORPHOLOGY MAP
Area - 1175.13 Sq Km
Legend
Alluvial Fan
Alluvial Plain
Buried Pediment
Pediment
Plateau
Ravine
River/Pond/Reservoir
Structural/Linear/Denudational
Valley Fill
0 3.75 7.5 15
Kilometers

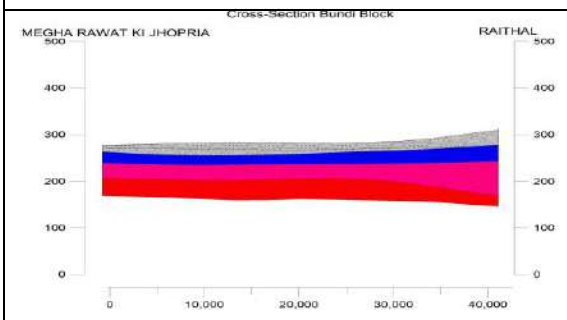

BUNDI BLOCK, DISTRICT BUNDI
SOIL MAP
Area - 1175.13 Sq Km
Legend
Black Soils
Lithosols - Regosols of Hills
Recent Alluvium
Yellowish Brown Soils of Foot Hills
0 3.75 7.5 15
Kilometers


BUNDI BLOCK, DISTRICT BUNDI
LAND USE LAND COVER MAP
Area - 1175.13 Sq Km
Legend
Agriculture Fallow
Barren Rocky/ Stony waste/ Sheet Rock
Crop land
Forest Deciduous (Moist/Dry)
Gullied/ Ravenous Land
Lakes/Ponds
Land without scrub
Sandy desertic Land
Towns/cities (Urban)
0 3.75 7.5 15
Kilometers


BUNDI BLOCK, DISTRICT BUNDI
DECADAL TREND OF GROUNDWATER
NOVEMBER, 2020
Area - 1175.13 Sq Km
Legend
Trend (m/yr)
Rise > 0.5
Rise 0.2 - 0.5
Rise < 0.2
Fall < 0.2
Fall 0.2 - 0.5
Fall > 0.5
0 3.75 7.5 15
Kilometers


BUNDI BLOCK, DISTRICT BUNDI
DRAINAGE MAP
Area - 1175.13 Sq Km
N
W
E
S
0 3.75 7.5 15
Kilometers
Legend
Drainage


Stratigraphy
Unsaturated Alluvium
Unsaturated Weathered Alluvium
Saturated Weathered Alluvium
Compact
Massive


Cross-Section Bundi Block
MEGHA RAWAT KI JHOPRIA
RAITHAL
500
400
300
200
100
0
0
10,000
20,000
30,000
40,000

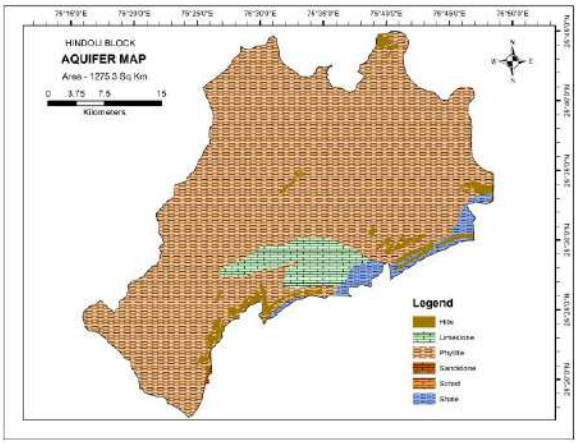
HINDOLI BLOCK

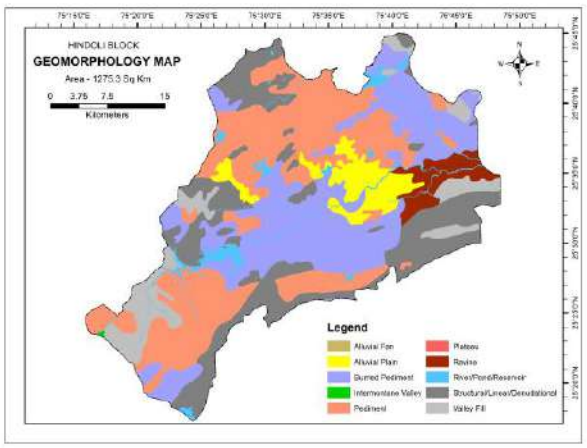
SALIENT INFORMATION		Hindoli Block
Block Name		**Hindoli**
Longitude		75°25'00" to 75°57'00"
Latitude		25°07'00" to 25°33'30"
Geographical Area Sq.km		**1275.3**
Potential area		884
Population (2011)		2,21,602
Geomorphology		
Geomorphic Unit		Buried Pediments, Alluvial Plain,Valley Fills, pediment, Structural and denudational form
Geology		Quartzite/dolomite
		Shale/Sst/Lst/Phyllite
Basin/Sub-Basin		Chambal/Banas
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN		
Geographical Area in ha.		1275
Forest Area in ha.		44489
Cultivable Area in ha.		22215
Net Sown Area in ha.		82035
Area sown more than once in ha.		35253
Rainfed Crop in ha.		64687
Irrigated Crop in ha.		53712
Area under Irrigation (Net) in ha		
	Surface Water	10955
	Ground Water	26735
	Other sources	520
Net irrigated Area in ha		38210
Principal Crops		
	Crop Type	
	Cereals	Rice, **Wheat,** , Jau
	Pulses	Gram, Masoor
Crop wise area irrigated		
Wheat		27938
Jau		563
Pulses		5803
Rice		2310
Hydrogeology		
Monitoring Stations		21
	CGWB	1
	SGWD	20
GROUND WATER RESOURCE & EXTRACTION		
Ground Water Recharge Worthy Area (Sq. Km.)		88481
Command		8800

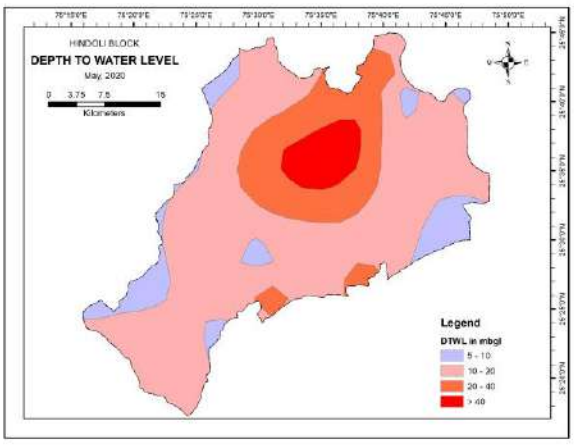
Non Command	79681
Hilly Area	39049
Total Geographical Area (ha)	127530
Recharge from	
Rainfall	4733
Canals	69.28
Surface Water Irrigation	679.8
Ground Water Irrigation	2054
Tanks and Ponds (C+NC)	189
Annual GW Recharge (Command)	1278
Annual GW Recharge (Non-Command)	6449.72
Total Annual Ground Water Recharge (ham)	7727
Natural Discharge (Command)	127
Natural Discharge (NC)	644
Natural Discharge (ham)	772
Annual Extractable Ground water Resource (ham)	6954
Domestic Draft (ham)	949.89
Industrial Draft (ham)	0
Irrigation Draft (MCM)	8219.49
Existing Gross Ground Water Draft for All uses(MCM)	9169.00
Provision for domestic and industrial requirement supply to 2025(MCM)	949.9
Net Annual Ground Water Availability for Future Use (ham)	234.62
Stage of Ground Water Development %	131.830
Category	**over exploited**
AR & Conservation Possibilities	
Existing Structures constructed by State Govt	
Anicut	17
Contour Continuous Trench (CCT)	135
Deep CCT	23
Earthen Check dam	1078
Farm Pond / Khet Talai	139
Micro Storage Tank	0
Mini Percolation tank	208
Minor Irrigation Tank	0
Pakka Check dam	77
Percolation tank	53
Piezometer	3
Recharging Shaft for Aquifers	5
Staggered Trench	105
Sub Surface barrier	3
Sunken Pond	2
Talai (Talab)	3
Tanka	0

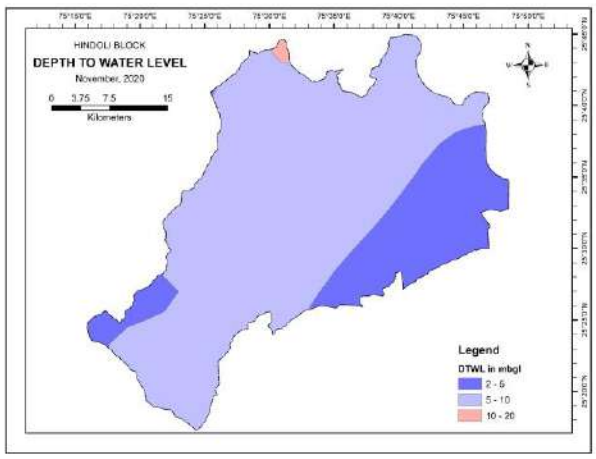
Water Harvesting Structure		82
Total		1933
Area of Block (Sq. Km.)		1275
Hilly Area sq.km		390
Potential Area (sq km)		884.81
Normal Annual RF (mm)		702.2
Water level (m) Nov 2018		15.76
Trend (m/yr)		2.33
Average Specific Yield		
Volume of Sub surface Storage Space available for Artificial Recharge (MCM)		286.90
Surplus Surface water Availability (MCM)		169.00
SUPPLY SIDE MANAGEMENT		
Area proposed for catchment area treatment in ha		1627
Water utilized in catchment area treatment (mcm)		0.57
Water Conservation Structures		
No. of existing village ponds (2.5 to 7.5 ha)		73
Proposed No. of Structures		
Mini Percolation Tanks		1481
Percolation Tank		714
Pacca Check Dams		320
Anicut		237
Mini Storage Tanks		12
Total Volume of water utilized in catchment area and WC Structured mcm		5.72
Volume of Water expected to be conserved / recharged @ 50% efficiency (MCM)		2.86
Farm Ponds		
No. of Farm Ponds		547
1 farm pond in 3 ha land :capacity 1200 cum	water utilized by farm ponds (mcm)	0.66
DEMAND SIDE MANAGEMENT		
Area Irrigated through Ground Water (ha)		26735
Micro irrigation techniques		
Irrigation Area (ha) proposed for irrigation through Sprinkler		13367.5
Water Saving by use of Sprinklers		10.69
Crop Change		
Area under Wheat Crop(ha)		27938
Cropping Area (ha) proposed for change in crop		13969
Water Saving by Change in Cropping Pattern		13.969
EXPECTED BENEFITS		
Net Ground Water Availability (MCM) 2020		69.54
Additional GW resources available after Supply side interventions (MCM)		3.43

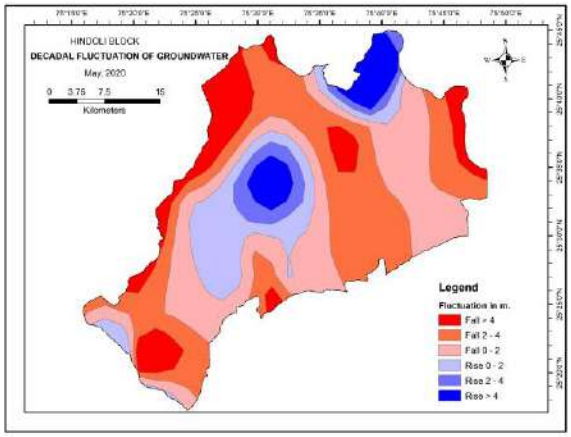
Net Ground Water Availability after Supply side intervention	72.97
Existing Ground Water Draft for All Purposes (MCM)	91.69
Additional GW resources available after Supply side interventions (MCM)	0.66
GW draft after Supply Side Interventions (MCM)	91.03
Present stage of Ground Water Development (%)	131.84
Projected Stage of Ground Water Development after Supply Side interventions (%)	124.75
GW draft after Demand Side Intervention (MI Techniques)mcm	80.34
Projected Stage of GWDevelopment after (MI) Demand Side interventions (%)	110.09
GW draft after Demand Side Interventions Crop Change(MCM)	66.37
	90.95

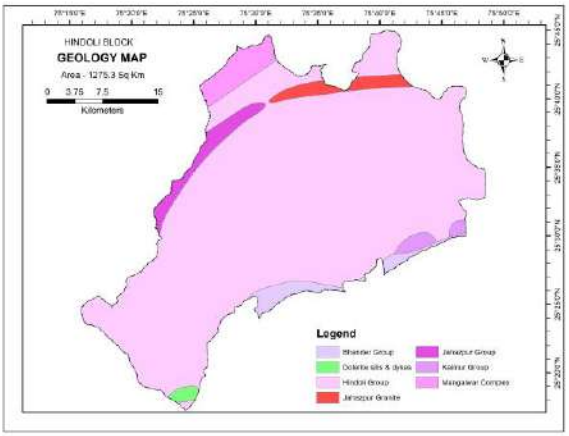


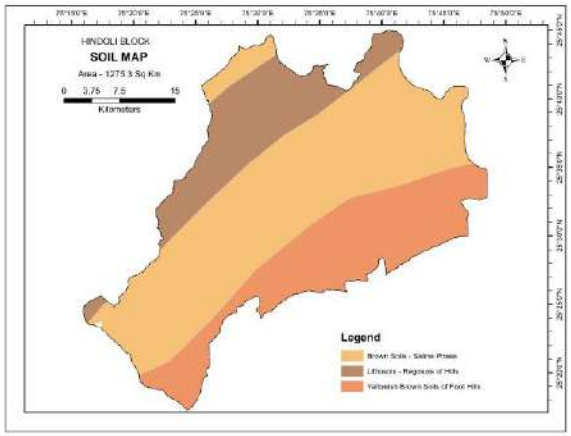


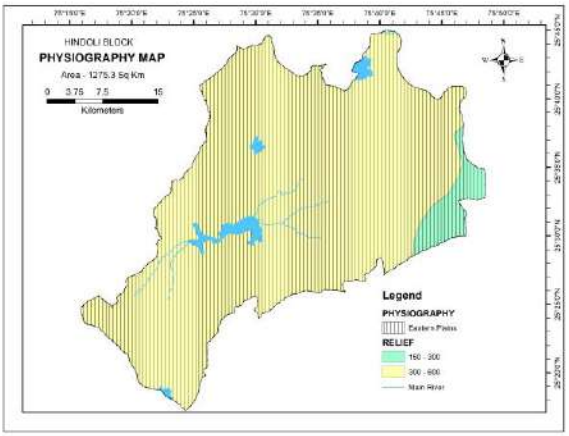


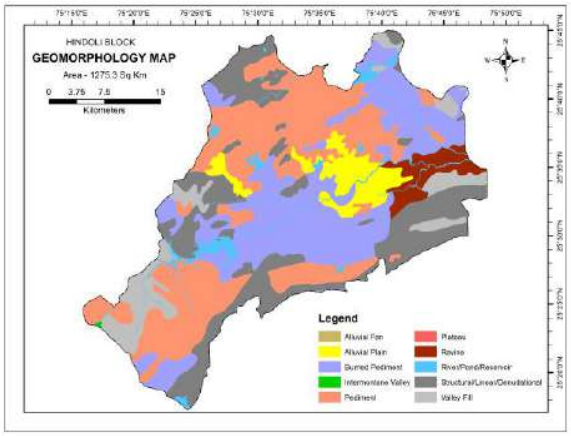


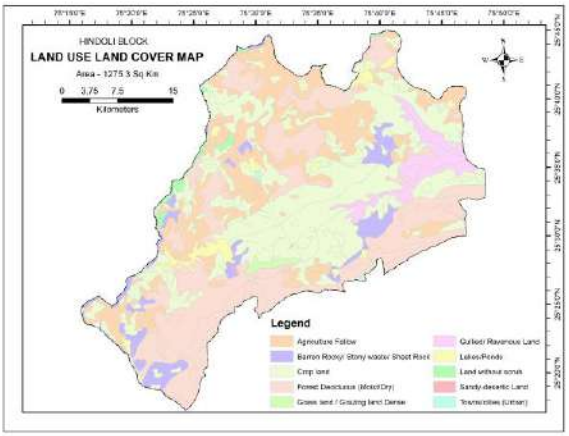

HINDOLI BLOCK
DECADAL FLUCTUATION OF GROUNDWATER
May, 2020
0 3.75 7.5 15
Kilometers
Legend
Fluctuation in m.
Fall > 4
Fall 2 - 4
Fall 0 - 2
Rise 0 - 2
Rise 2 - 4
Rise > 4


HINDOLI BLOCK
GEOLOGY MAP
Area - 1275.3 Sq Km
0 3.75 7.5 15
Kilometers
Legend


HINDOLI BLOCK
SOIL MAP
Area - 1275.3 Sq Km
0 3.75 7.5 15
Kilometers
Legend


HINDOLI BLOCK
PHYSIOGRAPHY MAP
Area - 1275.3 Sq Km
0 3.75 7.5 15
Kilometers
Legend
PHYSIOGRAPHY
RELIEF


HINDOLI BLOCK
GEOMORPHOLOGY MAP
Area - 1275.3 Sq Km
0 3.75 7.5 15
Kilometers
Legend


HINDOLI BLOCK
LAND USE LAND COVER MAP
Area - 1275.3 Sq Km
0 3.75 7.5 15
Kilometers
Legend

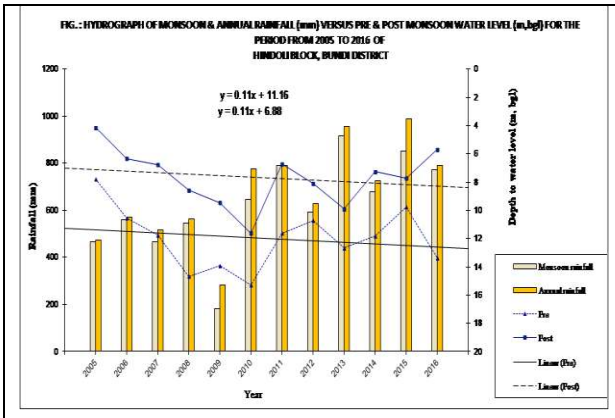
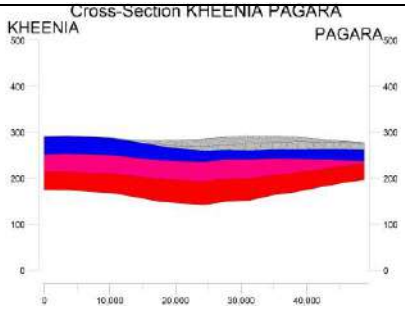


FIG. : HYDROGRAPH OF MONSOON & ANNUAL RAINFALL (mm) VERSUS PRE & POST MONSOON WATER LEVEL (m,bgl) FOR THE PERIOD FROM 2005 TO 2016 OF HINDOLI BLOCK, BUNDI DISTRICT
y = 0.11x + 11.16
y = 0.11x + 6.88
Rainfall (mm)
Depth to water level (m, bgl)
Year
Monsoon rainfall
Annual rainfall
Pre
Post
Linear (Pre)
Linear (Post)


Cross-Section KHEENIA PAGARA
KHEENIA
PAGARA


Stratigraphy
Unsaturated Alluvium
Unsaturated Weathered Alluvium
Saturated Weathered Alluvium
Compact
Massive

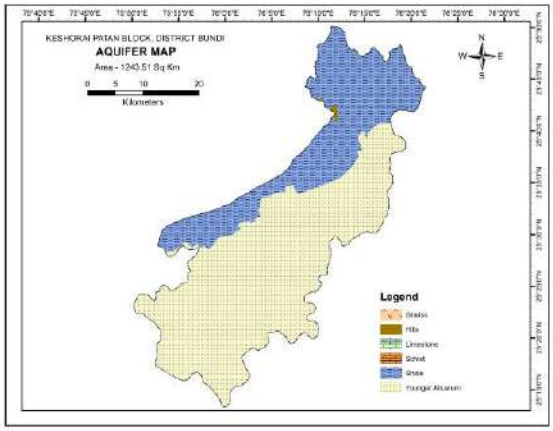
KESHORAI PATAN BLOCK

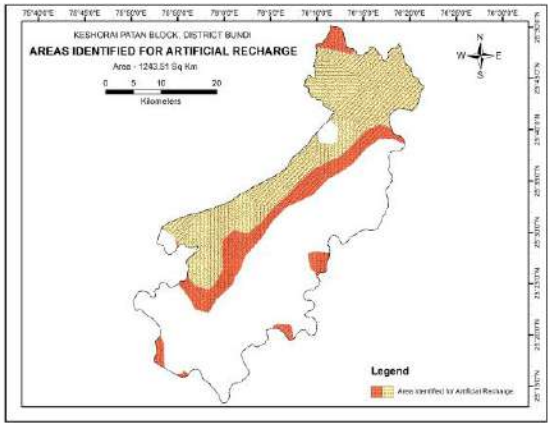
SALIENT INFORMATION		Keshorai Patan Block
Block Name		**Bundi**
Longitude		75°25'00" to 75°57'00"
Latitude		25°07'00" to 25°33'30"
Geographical Area Sq.km		**1243.51**
Potential area		1152
Population (2011)		2,81,702
Geomorphology		
	Geomorphic Unit	Alluvial Plain and Ravines
Geology		Alluvium
		Shale/Sst/Lst/Phyllite
Basin/Sub-Basin	**Drainage**	Chambal/Banas
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN		
	Geographical Area in ha.	1243
	Forest Area in ha.	15157
	Cultivable Area in ha.	22465
	Net Sown Area in ha.	144243
	Area sown more than once in ha.	65823
	Rainfed Crop in ha.	49662
	Irrigated Crop in ha.	94169
Area under Irrigation (Net) in ha		
	Surface Water	57585
	Ground Water	12176
	Other sources	42
Net irrigated Area in ha		69803
Principal Crops		
	Crop Type	
	Cereals	Rice, **Wheat,** , Jau
	Pulses	Gram, Masoor
Crop wise area irrigated		
Wheat		52340
Jau		443
Pulses		5796
Rice		9129
Hydrogeology		
Monitoring Stations		43
	CGWB	6
	SGWD	37
GROUND WATER RESOURCE & EXTRACTION		
Ground Water Recharge Worthy Area (Sq. Km.)		115288
Command		81941

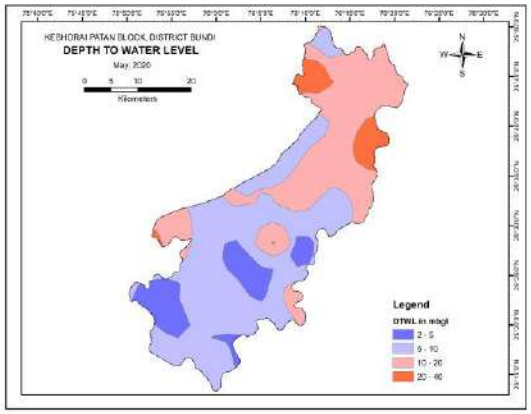
Non Command		33347
Hilly Area		9063
Total Geographical Area (ha)		124351
Recharge from		
Rainfall		4072
Canals		12.98
Surface Water Irrigation		2457.72
Ground Water Irrigation		1255
Tanks and Ponds (C+NC)		809
Annual GW Recharge (Command)		6257.99
Annual GW Recharge (Non-Command)		2350
Total Annual Ground Water Recharge (ham)		8608.71
Natural Discharge (Command)		625
Natural Discharge (NC)		235
Natural Discharge (ham)		860
Annual Extractable Ground water Resource (ham)		7747
Domestic Draft (ham)		651.62
Industrial Draft (ham)		0
Irrigation Draft (MCM)		5022.79
Existing Gross Ground Water Draft for All uses(MCM)		5674.00
Provision for domestic and industrial requirement supply to 2025(MCM)		651.62
Net Annual Ground Water Availability for Future Use (ham)		2073.43
Stage of Ground Water Development %		73.230
Category		**semi critical**
AR & Conservation Possibilities		
Existing Structures constructed by State Govt		
	Anicut	17
	Contour Continuous Trench (CCT)	135
	Deep CCT	23
	Earthen Checkdam	1078
	Farm Pond / Khet Talai	139
	Micro Storage Tank	0
	Mini Percolation tank	208
	Minor Irrigation Tank	0
	Pakka Checkdam	77
	Percolation tank	53
	Piezometer	3
	Recharging Shaft for Aquifers	5
	Stagered Trench	105
	Sub Surface barrier	3
	Sunken Pond	2
	Talai (Talab)	3

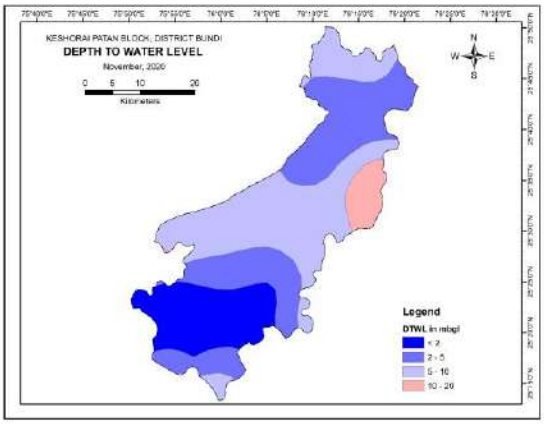
	Water Harvesting Structure	82
	Total	1933
Area of Block (Sq. Km.)		1243
Hilly Area sq.km		90
Potential Area (sq km)		1152.88
Type of Aquifer		
Soft Rock		0
Hard Rock		Hard Rock
Normal Annual RF (mm)		754.5
Water level (m) Nov 2018		6.93
Trend (m/yr)		0.41
Average Specific Yield		
Volume of Sub surface Storage Space available for Artificial Recharge (MCM)		80.62
Surplus Surface water Availability (MCM)		174.55
SUPPLY SIDE MANAGEMENT		
Catchment Area Treatment	Area proposed for catchment area treatment in ha	1267
Water utilized in catchment area treatment (mcm)		0.48
Water Conservation Structures		
No. of existing village ponds (2.5 to 7.5 ha)		48
Proposed No. of Structures		
Mini Percolation Tanks		1557
Percolation Tank		685
Pacca Check Dams		352
Anicut		207
Mini Storage Tanks		12
Total Volume of water utilized in catchment area and WC Structured mcm		5.69
Volume of Water expected to be conserved / recharged @ 50% efficiency (MCM)		2.845
Farm Ponds		
No. of Farm Ponds		676
1 farm pond in 3 ha land :capacity 1200 cum	water utilized by farm ponds (mcm)	0.81
DEMAND SIDE MANAGEMENT		
Area Irrigated through Ground Water (ha)		12176
Micro irrigation techniques		
Irrigation Area (ha) proposed for irrigation through Sprinkler		6088
Water Saving by use of Sprinklers		4.87
Crop Change		
Area under Wheat Crop(ha)		52340
Cropping Area (ha) proposed for change in crop		26170

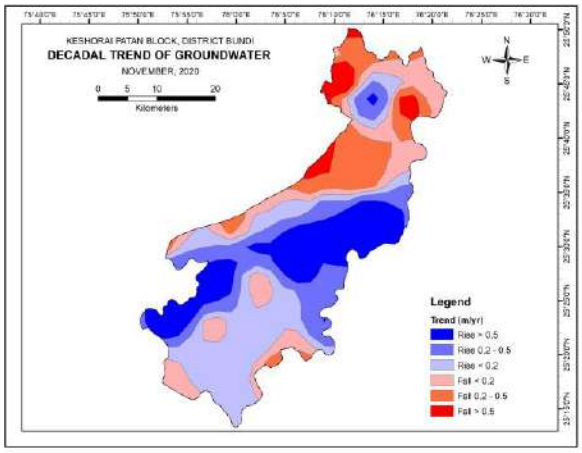
Water Saving by Change in Cropping Pattern	26.17
EXPECTED BENEFITS	
Net Ground Water Availability (MCM) 2020	77.47
Additional GW resources available after Supply side interventions (MCM)	3.33
Net Ground Water Availability after Supply side intervention	80.80
Existing Ground Water Draft for All Purposes (MCM)	56.74
Additional GW resources available after Supply side interventions (MCM)	0.81
GW draft after Supply Side Interventions (MCM)	55.93
Present stage of Ground Water Development (%)	73.24
Projected Stage of Ground Water Development after Supply Side interventions (%)	69.22
GW draft after Demand Side Intervention (MI Techniques) mcm	51.06
Projected Stage of GW Development after (MI) Demand Side interventions (%)	63.20
GW draft after Demand Side Interventions Crop Change (MCM)	24.89
	30.81

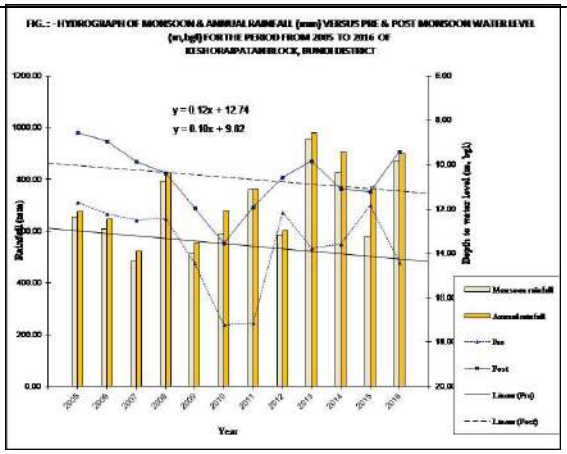


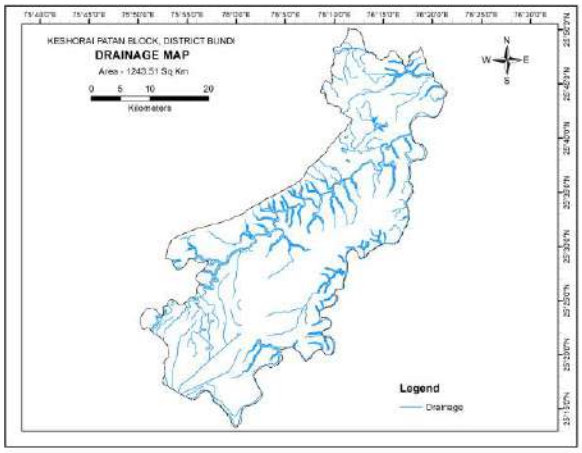


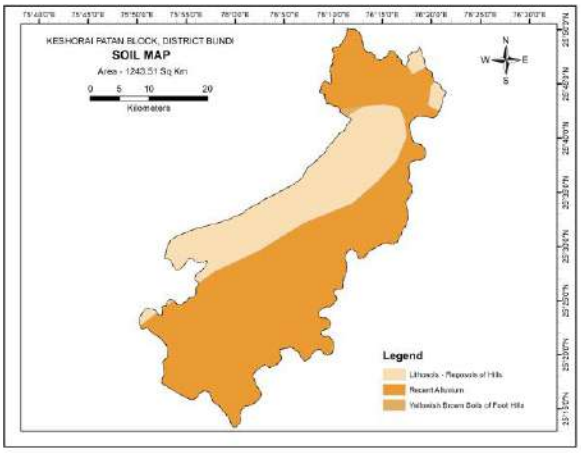


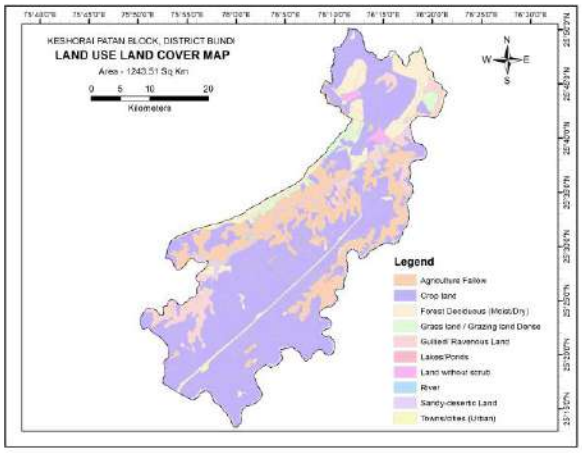


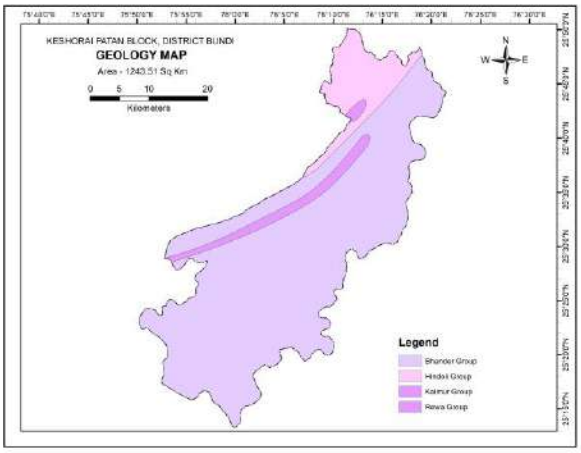

KESHORAI PATAN BLOCK, DISTRICT BUNDI
DECADAL TREND OF GROUNDWATER
NOVEMBER, 2020
0 5 10 20
Kilometers
N
W E
S
Legend
Trend (m/yr)
Rise > 0.5
Rise 0.2 - 0.5
Rise < 0.2
Fall < 0.2
Fall 0.2 - 0.5
Fall > 0.5

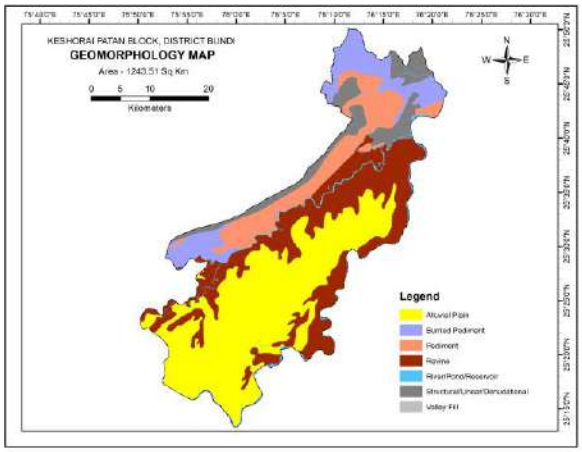

y = 0.12x + 12.74
y = 0.10x + 9.82
Rainfall (mm)
Depth to water Level (m. bgl)
Year
Monsoon rainfall
Annual rainfall
Pre
Post
Linear (Pre)
Linear (Post)

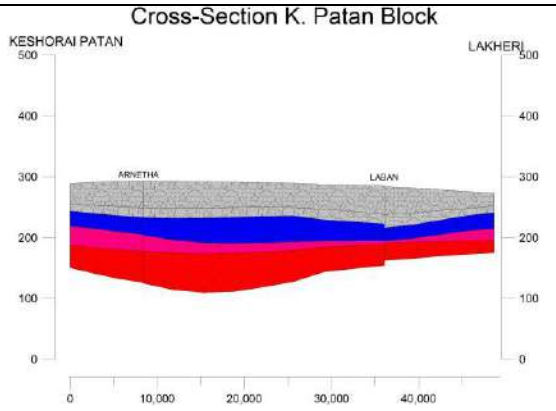

KESHORAI PATAN BLOCK, DISTRICT BUNDI
DRAINAGE MAP
Area - 1243.51 Sq Km
0 5 10 20
Kilometers
N
W E
S
Legend
Drainage

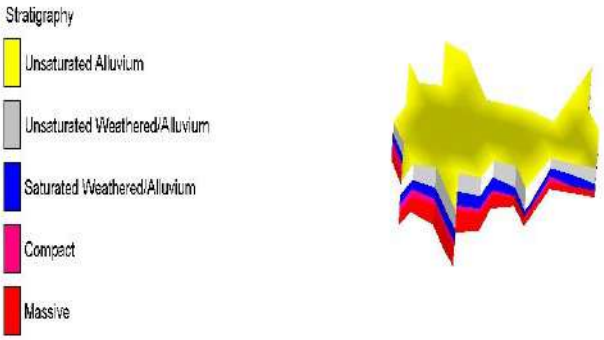

KESHORAI PATAN BLOCK, DISTRICT BUNDI
SOIL MAP
Area - 1243.51 Sq Km
0 5 10 20
Kilometers
N
W E
S
Legend
Lithosols - Regosols of Hills
Recent Alluvium
Yellowish Brown Soils of Foot Hills


KESHORAI PATAN BLOCK, DISTRICT BUNDI
LAND USE LAND COVER MAP
Area - 1243.51 Sq Km
0 5 10 20
Kilometers
N
W E
S
Legend
Agriculture Fallow
Crop land
Forest Deciduous (Moist/Dry)
Grass land / Grazing land Dense
Gullied/ Ravenous Land
Lakes/Ponds
Land without scrub
River
Sandy-desertic Land
Towns/cities (Urban)


KESHORAI PATAN BLOCK, DISTRICT BUNDI
GEOLOGY MAP
Area - 1243.51 Sq Km
0 5 10 20
Kilometers
N
W E
S
Legend
Bhander Group
Hindoli Group
Kaimur Group
Rewa Group


KESHORAI PATAN BLOCK, DISTRICT BUNDI
GEOMORPHOLOGY MAP
Area - 1243.51 Sq Km
0 5 10 20
Kilometers
N
W
E
S
Legend
Alluvial Plain
Buried Pediment
Pediment
Ravine
River/Pond/Reservoir
Structural/Linear/Denudational
Valley Fill


Cross-Section K. Patan Block
KESHORAI PATAN
LAKHERI
ARNETHA
LAGAN
500
400
300
200
100
0
0
10,000
20,000
30,000
40,000


Stratigraphy
Unsaturated Alluvium
Unsaturated Weathered/Alluvium
Saturated Weathered/Alluvium
Compact
Massive

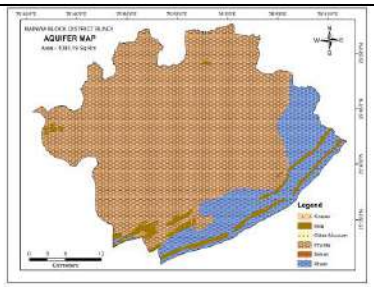
NAINWA BLOCK

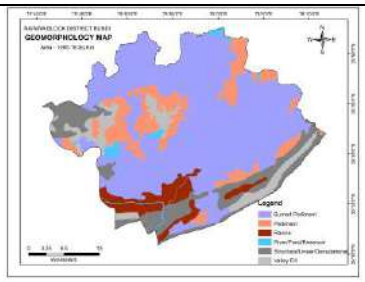
SALIENT INFORMATION		Nainwa Block
Block Name		**Nainwa**
Longitude		75°25'00" to 75°57'00"
Latitude		25°07'00"to 25°33'30"
Geographical Area Sq.km		**1095.19**
Potential area		966
Population (2011)		1,96,070
Geomorphology		
Geomorphic Unit		Buried Pediments, pediment and Ravines
Geology		quartzite/dolomite
		Shale/Sst/Lst/Phyllite
Basin/Sub-Basin	**Drainage**	Chambal/Banas
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN		
	Geographical Area in ha.	1095
	Forest Area in ha.	21171
	Cultivable Area in ha.	11095
	Net Sown Area in ha.	118140
	Area sown more than once in ha.	49623
	Rainfed Crop in ha.	29275
	Irrigated Crop in ha.	27039
Area under Irrigation (Net) in ha		
	Surface Water	0
	Ground Water	52358
	Other sources	0
Net irrigated Area in ha		52358
Principal Crops		
	Crop Type	
	Cereals	Rice, **Wheat,** , Jau
	Pulses	Gram, Masoor
Crop wise area irrigated		
Wheat		5633
Jau		310
Pulses		39309
Rice		124
Hydrogeology		
Monitoring Stations		21
	CGWB	1
	SGWD	20
GROUND WATER RESOURCE & EXTRACTION		
Ground Water Recharge Worthy Area (Sq. Km.)		96685

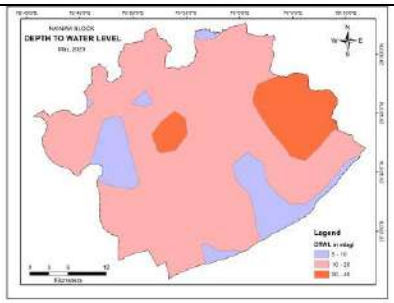
Command		0
Non Command		96685
Hilly Area		12834
Total Geographical Area (ha)		109519
Recharge from		
Rainfall		4678
Canals		51.45
Surface Water Irrigation		532.44
Ground Water Irrigation		1572.15
Tanks and Ponds (C+NC)		103
Annual GW Recharge (Command)		51.45
Annual GW Recharge (Non-Command)		6886.69
Total Annual Ground Water Recharge (ham)		6938.14
Natural Discharge (Command)		5.15
Natural Discharge (NC)		688
Natural Discharge (ham)		693
Annual Extractable Ground water Resource (ham)		6244
	Domestic Draft (ham)	1356.00
	Industrial Draft (ham)	0
	Irrigation Draft (MCM)	6288.62
Existing Gross Ground Water Draft for All uses(MCM)		7645.00
Provision for domestic and industrial requirement supply to 2025(MCM)		1356.47
Net Annual Ground Water Availability for Future Use (ham)		46.3
Stage of Ground Water Development %		122.430
Category		**over exploited**
AR & Conservation Possibilities		
	Anicut	17
	Contour Continuous Trench (CCT)	135
	Deep CCT	23
	Earthen Checkdam	1078
	Farm Pond / Khet Talai	139
	Micro Storage Tank	0
	Mini Percolation tank	208
	Minor Irrigation Tank	0
	Pakka Check dam	77
	Percolation tank	53
	Piezometer	3
	Recharging Shaft for Aquifers	5
	Staggered Trench	105
	Sub Surface barrier	3
	Sunken Pond	2
	Talai (Talab)	3
	Tanka	0
	Water Harvesting Structure	82

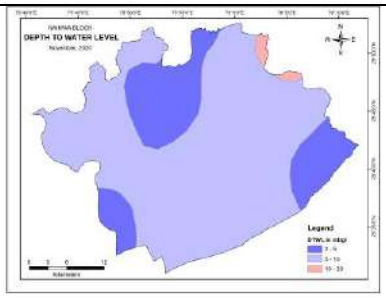
	Total	1933
Area of Block (Sq. Km.)		1095
Hilly Area sq.km		128
Potential Area (sq km)		966.85
Type of Aquifer		
Soft Rock		0
Hard Rock		Hard Rock
Normal Annual RF (mm)		608.9
Water level (m) Nov 2018		15.68
Trend (m/yr)		1.04
Average Specific Yield		
Volume of Sub surface Storage Space available for Artificial Recharge (MCM)		1051.23
Surplus Surface water Availability (MCM)		134.15
SUPPLY SIDE MANAGEMENT		
Catchment Area Treatment (ha0		846
Water utilized in catchment area treatment (mcm)		0.26
Water Conservation Structure		
No. of existing village ponds (2.5 to 7.5 ha)		83
Proposed No. of Structures		
Mini Percolation Tanks		1368
Percolation Tank		626
Pacca Check Dams		367
Anicut		172
Mini Storage Tanks		10
Total Volume of water utilized in catchment area and WC Structured mcm		5.21
Volume of Water expected to be conserved / recharged @ 50% efficiency (MCM)		2.605
Farm Ponds		
No. of Farm Ponds		464
1 farm pond in 3 ha land :capacity 1200 cum	water utilized by farm ponds (mcm)	0.56
DEMAND SIDE MANAGEMENT		
Area Irrigated through Ground Water (ha)		52358
Micro irrigation techniques		
Use of Sprinklers for Irrigation	Irrigation Area (ha) proposed for irrigation through Sprinkler	26179
Water Saving by use of Sprinklers		20.94
Crop Change		
Area under Wheat Crop(ha)		5633
Cropping Area (ha) proposed for change in crop		2816.5
Water Saving by Change in Cropping Pattern		2.8165
EXPECTED BENEFITS		

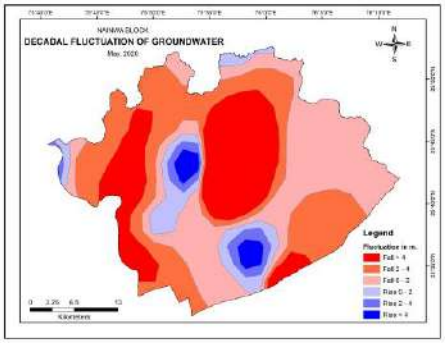
Net Ground Water Availability (MCM) 2020	62.44
Additional GW resources available after Supply side interventions (MCM)	2.87
Net Ground Water Availability after Supply side intervention	65.31
Existing Ground Water Draft for All Purposes (MCM)	76.45
Additional GW resources available after Supply side interventions (MCM)	0.56
GW draft after Supply Side Interventions (MCM)	75.89
Present stage of Ground Water Development (%)	122.43
Projected Stage of Ground Water Development after Supply Side interventions (%)	116.21
GW draft after Demand Side Intervention (MI Techniques) mcm	54.95
Projected Stage of GW Development after (MI) Demand Side interventions (%)	84.14
GW draft after Demand Side Interventions Crop Change (MCM)	52.13
	79.83

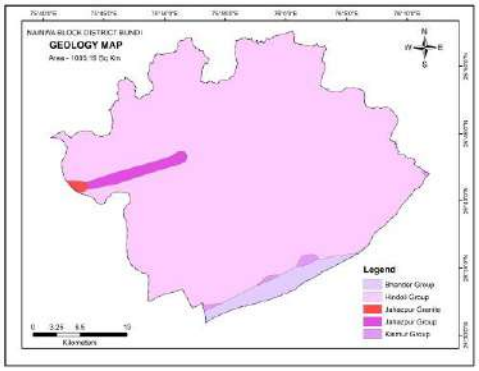


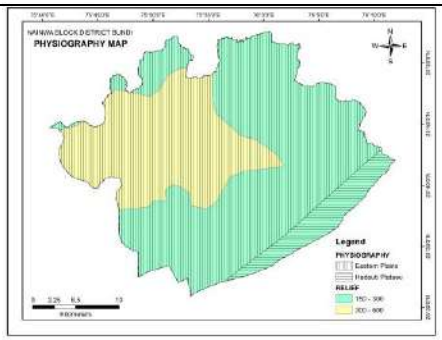


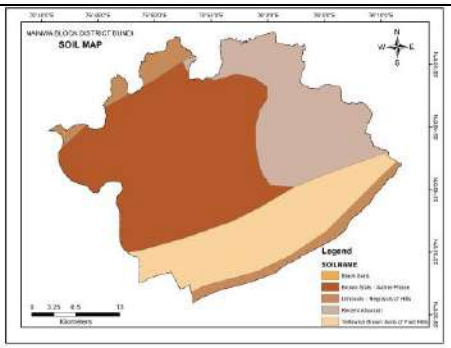


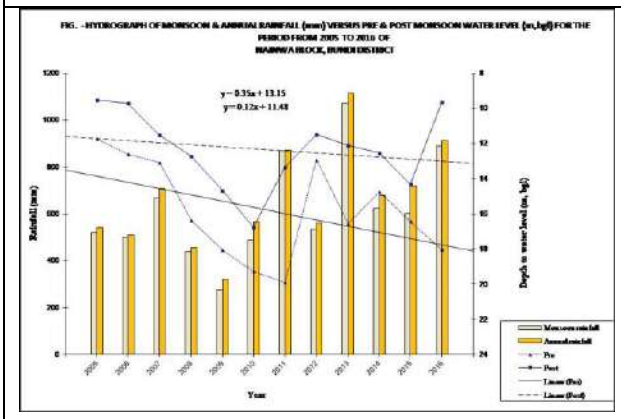


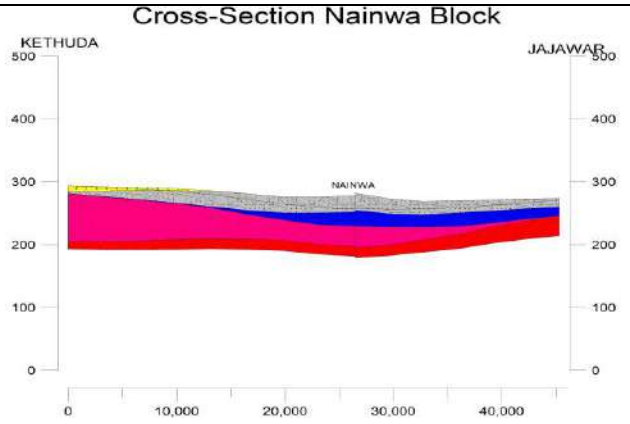





PHYSIOGRAPHY MAP
Legend
PHYSIOGRAPHY
Eastern Plains
Pratisth Plateau
RELIEF
150 - 300
300 - 600


SOIL MAP
Legend
SOILNAME


y = 0.35x + 13.15
y = 0.12x + 11.48
Rainfall (mm)
Depth to water level (m, bgl)
Year


Cross-Section Nainwa Block
KETHUDA
JAJAWAR
NAINWA
500
400
300
200
100
0
0
10,000
20,000
30,000
40,000


Stratigraphy
Unsaturated Alluvium
Unsaturated Weathered/Alluvium
Saturated Weathered/Alluvium
Compact
Massive

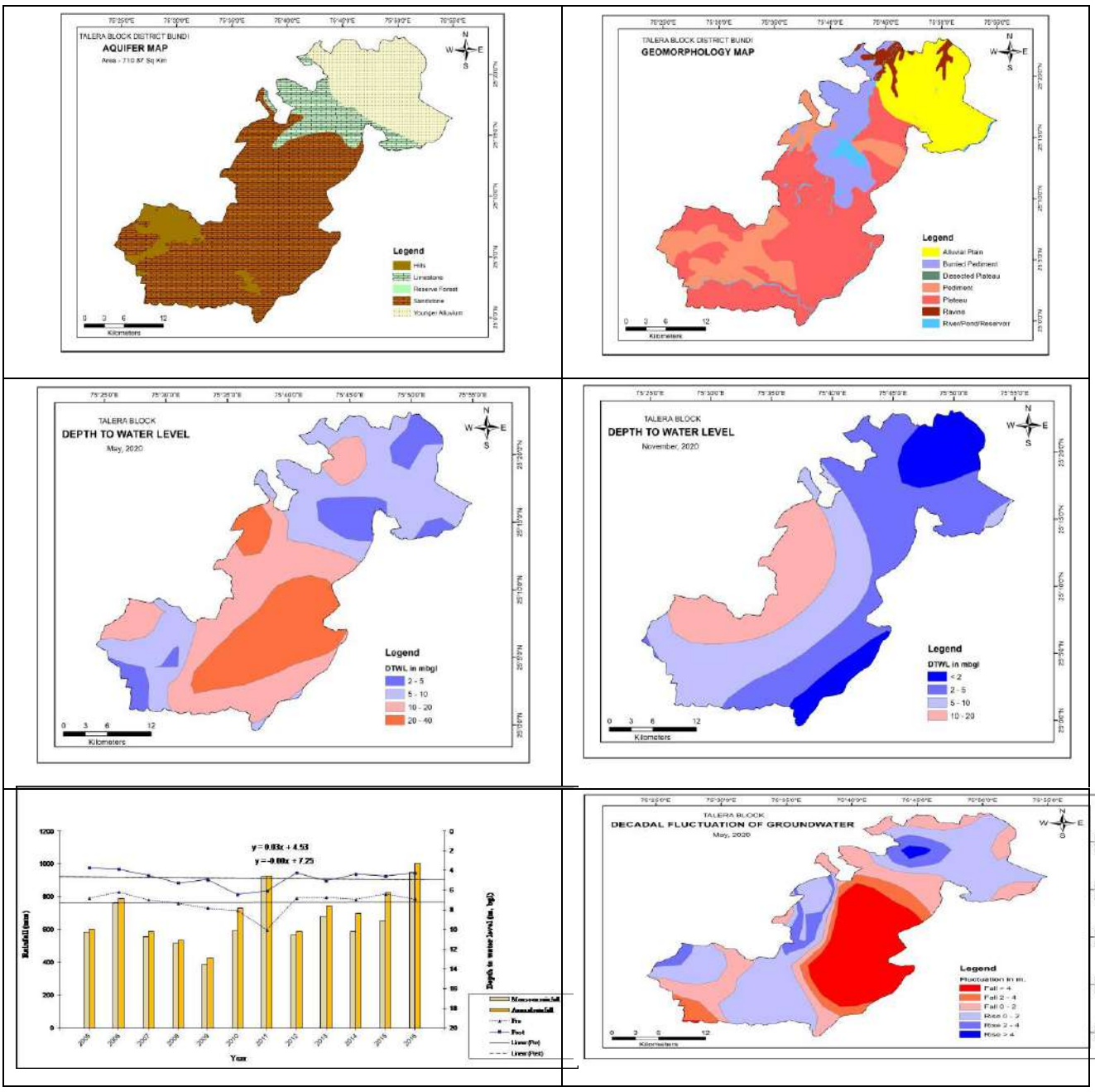
TALERA BLOCK

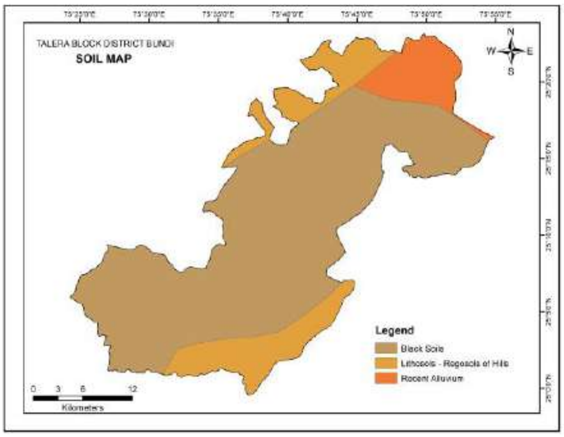
SALIENT INFORMATION		**Talera Block**
Longitude		75°25'00" to75°57'00"
Latitude		25°07'00" to 25°33'30"
Geographical Area Sq.km		**710.87**
Potential area		462
Population (2011)		1,59,607
Geomorphology		
Geomorphic Unit		Buried Pediments, pediment, plateau, Alluvial Plain and Ravines
Geology		Alluvium
		Shale/Sst/Lst/Phyllite
Basin/Sub-Basin		Chambal/Banas
LAND USE, AGRICULTURE, IRRIGATION & CROPPING PATTERN		
Geographical Area in ha.		710
Forest Area in ha.		34295
Cultivable Area in ha.		15803
Net Sown Area in ha.		55934
Area sown more than once in ha.		26610
Rainfed Crop in ha.		37083
Irrigated Crop in ha.		44949
Area under Irrigation (Net) in ha		
Surface Water		24336
Ground Water		3885
Other sources		367
Net irrigated Area in ha		28585
Principal Crops		
Crop Type		
Cereals		Rice, Jowar, **Wheat,** , Jau
Pulses		Gram, Masoor
Crop wise area irrigated		
	Wheat	25475
	Jau	50
	Pulses	373
	Rice	13768
Hydrogeology		
Monitoring Stations		17
	CGWB	1
	SGWD	16
GROUND WATER RESOURCE & EXTRACTION		
Ground Water Recharge Worthy Area (Sq. Km.)		46253

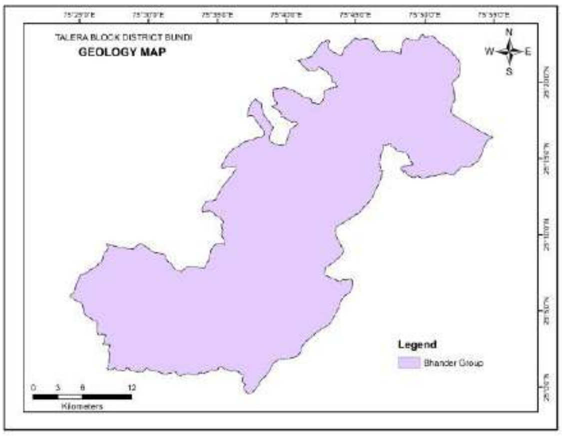
Command	21227
Non Command	25026
Hilly Area	24834
Total Geographical Area (ha)	71087
Recharge from	
Rainfall	2273
Canals	8.13
Surface Water Irrigation	852.06
Ground Water Irrigation	402.67
Tanks and Ponds (C+NC)	764
Annual GW Recharge (Command)	2576
Annual GW Recharge (Non-Command)	1724
Total Annual Ground Water Recharge (ham)	4300
Natural Discharge (Command)	257
Natural Discharge (NC)	172
Natural Discharge (ham)	430
Annual Extractable Ground water Resource (ham)	3870
Domestic Draft (ham)	150.00
Industrial Draft (ham)	0
Irrigation Draft (MCM)	1610.00
Existing Gross Ground Water Draft for All uses(MCM)	1760.00
Provision for domestic and industrial requirement supply to 2025(MCM)	150
Net Annual Ground Water Availability for Future Use (ham)	2109.72
Stage of Ground Water Development %	45.490
Category	**safe**
AR & Conservation Possibilities	
Existing Structures constructed by State Govt.	
Anicut	17
Contour Continuous Trench (CCT)	135
Deep CCT	23
Earthen Checkdam	1078
Farm Pond / Khet Talai	139
Micro Storage Tank	0
Mini Percolation tank	208
Minor Irrigation Tank	0
Pakka Check dam	77
Percolation tank	53
Piezometer	3
Recharging Shaft for Aquifers	5
Staggered Trench	105
Sub Surface barrier	3
Sunken Pond	2
Talai (Talab)	3
Water Harvesting Structure	82
Total	1933

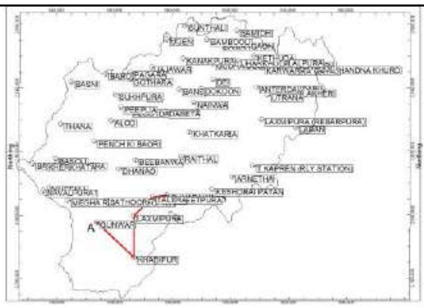
Area of Block (Sq. Km.)		710
Hilly Area sq.km		248
Potential Area (sq km)		462.53
Normal Annual RF (mm)		667
Water level (m) Nov 2018		7.81
Trend (m/yr)		0.46
Average Specific Yield		
Volume of Sub surface Storage Space available for Artificial Recharge (MCM)		46.65
Surplus Surface water Availability (MCM)		116.54
SUPPLY SIDE MANAGEMENT		
Catchment Area Treatment (ha)		1215
Water utilized in catchment area treatment (mcm)		0.41
Water Conservation Structures		
No. of existing village ponds (2.5 to 7.5 ha)		66
Proposed No. of Structures		
Mini Percolation Tanks		1006
Percolation Tank		454
Pacca Check Dams		228
Anicut		111
Mini Storage Tanks		8
Total Volume of water utilized in catchment area and WC Structured mcm		3.56
Volume of Water expected to be conserved / recharged @ 50% efficiency (MCM)		1.78
Farm Ponds		
No. of Farm Ponds		395
1 farm pond in 3 ha land :capacity 1200 cum	water utilized by farm ponds (mcm)	0.47
DEMAND SIDE MANAGEMENT		
Area Irrigated through Ground Water (ha)		3885
Micro irrigation techniques		
Irrigation Area (ha) proposed for irrigation through Sprinkler		1942.5
Water Saving by use of Sprinklers		1.55
Crop Change		
Area under Wheat Crop(ha)		25475
Cropping Area (ha) proposed for change in crop		12737.5
Water Saving by Change in Cropping Pattern		12.7375
EXPECTED BENEFITS		
Net Ground Water Availability (MCM) 2020		38.70
Additional GW resources available after Supply side interventions (MCM)		2.19
Net Ground Water Availability after Supply side intervention		40.89
Existing Ground Water Draft for All Purposes (MCM)		17.60
Additional GW resources available after Supply side interventions (MCM)		0.47

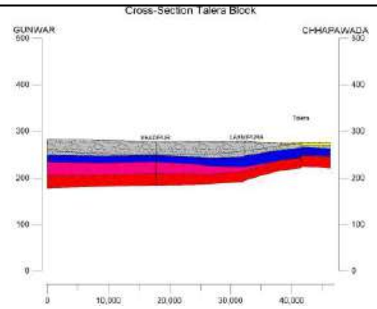
GW draft after Supply Side Interventions (MCM)	17.13
Present stage of Ground Water Development (%)	45.49
Projected Stage of Ground Water Development after Supply Side interventions (%)	41.89
GW draft after Demand Side Intervention (MI Techniques) mcm	15.58
Projected Stage of GW Development after (MI) Demand Side interventions (%)	38.09
GW draft after Demand Side Interventions Crop Chang e(MCM)	2.84



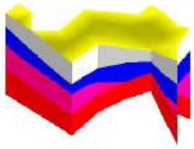

TALERA BLOCK DISTRICT BUNDI
SOIL MAP
Legend
Black Soils
Lithosols - Regosols of Hills
Recent Alluvium
Kilometers


TALERA BLOCK DISTRICT BUNDI
GEOLOGY MAP
Legend
Bhander Group
Kilometers




Cross-Section Talera Block
GUNWAR
CHHAPAWADA


Stratigraphy
Unsaturated Alluvium
Unsaturated Weathered/Alluvium
Saturated Weathered/Alluvium
Compact
Massive



Annexure I

CGWB Monitoring Wells Used for Data Gap Analysis in NAQUIM Study

SITE_ID	BLOCK	VILLAGE	TYPE	AGENCY	LONG	LAT	FORMATION	MAY_2020	NOV_2020
W251600075450001	Talera	BALLOP	Dug	CGWB	75.75	25.2667	Limestone	2.1	2.18
W253100076100001	Keshorai Patan	Dahi Khera	Dug	CGWB	76.1667	25.5167	Younger Alluvium	5.73	6.8
W252815075520001	Bundi	DELUNDA	Dug	CGWB	75.8667	25.4708	Younger Alluvium	15.04	11.15
W253230075594501	Keshorai Patan	GAINDOLI	Dug	CGWB	75.9958	25.5417	Shale	4.6	7.19
W252328076042501	Keshorai Patan	KAPREN	Dug	CGWB	76.0736	25.3911	Younger Alluvium	2.16	1.45
W251908075555001	Keshorai Patan	KESHORAIPATAN	Dug	CGWB	75.9306	25.3189	Younger Alluvium	1.31	1.42
W254000076110001	Keshorai Patan	LAKHERI	Dug	CGWB	76.1833	25.6667	Shale	1.3	2.53
W252430075531501	Keshorai Patan	MAIJA	Dug	CGWB	75.8875	25.4083	Younger Alluvium	2.4	0.67
W253412075565001	Nainwa	MOTIPURA	Dug	CGWB	75.9472	25.57	Phyllite	8.64	0
W252940075472401	Bundi	RAJWAS	Dug	CGWB	75.79	25.4944	Shale	6.39	3.84
W252400075333001	Bundi	RAMNAGAR (JATAN)	Dug	CGWB	75.5583	25.4	Shale	5.34	3.44
W252614075305501	Hindoli	SATUR	Dug	CGWB	75.5153	25.4372	Phyllite	8.9	5.7

Annexure II

GWD Monitoring Wells Used for Data Gap Analysis in NAQUIM Study

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Keshoraipatan	Ajanda	**Ajanda**	Public well	East of village, Behind Mahaveer Temple	25.4671	76.1499	247.44	Alluvium	A (C)	17.20	1.80	3.1
Bundi	Ajeta	**Ajeta**	Public well	Near Bhanwar Singh Flour Mill	25.5246	76.0292	270.68	Alluvium	A (C)	15.25	2.15	2.9
Hindoli	Akoda	**Akoda**	Sh. Giriraj Bohra	LHS of road from Bundi to Rameshwar Mahadev, after crossing	25.5318	75.6642	294.96	Phyllite	Ph(Nc)	26.00		
Keshoraipatan	Sarsala	**Anatpura**	Public well	RHS of Road Rangpura to village, near Pipal Tree	25.3676	76.0234	264.52	Alluvium	A (C)	8.50	6.80	3.2
Nainwa	Antarda	**Antarda**	Public well	LHS of road to Karwar to Talwas, near Panchayat Bhawan	25.6571	76.0968	284.96	Phyllite	Ph(Nc)	33.30		18.7
Nainwa	Antarda	**Antarda**	GWD	In the school Premises	25.6591	76.0879	267.93	Phyllite	Ph(Nc)	75.00	18.25	
Keshoraipatan	Arnetha	**Arnetha**	Public well	Near Radha Kishanji ka Mandir	25.3793	75.9962	239.09	Alluvium	A (C)	12.40	7.40	5.1
Kesoraipatan	Babai	**Babai**	Sh.Ram Narayan	RHS of Road Indergarh to Som Sunaram ka kua	25.8070	76.1951	244.63	SH/LS	SH/Ls(Nc)	12.90	6.30	4.8
Talera	Badoonda	**Badoonda**	Public well	R.H.S. of road Bajaj to Anthra Near Canal	25.3470	75.8169	237.63	Alluvium	A (C)	5.50	4.12	1.4
Hindoli	Bargaon	**Bal**	Sh. Madhu Gurjar	LHS of road from Bundi to Raniphur, first enter to village	25.6360	75.7110	263.58	Phyllite	Ph(Nc)	13.90		
Keshoraipatan	Balod	**Balod**	Public well	South-west of village, Panghat ka Kua	25.8070	76.1951	245.63	Alluvium	A (C)	22.90	6.10	4.7
Hindoli	Kherkhata	**Bandha Ka Khera**	Sh.Sugan Singh	Near of village	25.4112	75.3245	330.78	Phyllite	Ph(Nc)	22.40	5.20	15.3

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Kesoraipatan	Chardana	**Banjharli**	Public well	North-West of village, Panghat Ka Kua	25.3584	76.0926	256.25	Alluvium	A (C)	19.20	6.20	3.6
Hindoli	Bara Naya Gaon	**Bara Naya Gaon**	School well	Centre of village	25.5034	75.5295	287.08	Phyllite	Ph(Nc)	20.95	13.50	12.7
Hindoli	Barodiya	**Barodiya**	Public well	Centre of village, near Bada mandir.	25.4846	75.5762	289.31	Limestone	Ls(Nc)	18.50	10.90	11.05
Talera	Baroondhan	**Baroondhan**	Mool Chand Meena	R.H.S. of road from Bundi to village ½ Km before village	25.3119	75.6805	244.98	Limestone	Ls(C)	15.00	10.2	5.05
Hindoli	Chatarganj	**Barwas**	Narsing Lal	LHS of Road to Mangli Barwas	25.5304	75.5066	290.31	Phyllite	Ph(c)	18.35	12.85	10.4
Hindoli	Basoli	**Basoli**	Raguveer Paliwal	RhS of road Bundi to Besoli, Just entrance to village, Near Electric Transformation.	25.4282	75.3986	323.64	Phyllite	Ph(Nc)	25.00	10.40	
Nainwa	Kethooda	**Batawati**	Public well	In The temple Premises	25.7994	76.0489	288.81	Phyllite	Ph(Nc)	18.50		17.3
Nainwa	Kethooda	**Batawati**	GWD	In school premises	25.6701	75.8875	262.65	Phyllite	Ph(Nc)	75.00	19.70	
Bundi	Dhanatari	**Bharta Baori**	Public well	L.H.S. of road to Alpha nagar, Near M. Canal	25.2785	75.6773	274.79	Sandstone	Ss(Nc)	8.60	2.15	2.15
Talera	Dhaneshwar	**Bhawani Pura**	Sh. Chaturbhuj	Near Hanuman Temple	25.3196	76.0170	245.19	Alluvium	A (C)	12.05	5.4	2.05
Kesoraipatan	Bheeya	**Bheeya**	Public well	Just entrance to village from K.Patan	25.3311	75.9876	179.87	Alluvium	A (C)	13.55	4.20	2.1
Talera	Budhpura (Ct)	**Budhpura (CT)**	Sh. Shankar	R.H.S. of road Budhpura to Dohrala after cross	25.1161	75.4494	477.49	Sandstone	Ss(Nc)	9.40	12.3	10.8

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Bundi	Bundi (M)	**Bundi**	GWD	In the Premises of forest Office	25.4390	75.6475	264.85	SH/LS	SH/Ls(Nc)	50.00	32.15	29.25
Nainwa	Khanpura	**Chainpuriya**	Sh. Govind Dhakar	Panghat ka Kua, East of village	25.7807	75.8048	287.82	Phyllite	Ph(Nc)	19.30	11.20	11.05
Kesoraipatan	Chanda Khurd	**Chanda Khurd**	Public well	LHS of road Indergarh to village, Just entrance	25.7186	76.3394	233.87	Shale	SHALE(Nc)	21.50	21.60	16.3
Kesoraipatan	Chanda Khurd	**Chanda Khurd**	GWD	RHS of Road towards village	25.7259	76.3281	233.86	Shale	SHALE(Nc)	75.00	10.50	10.4
Kesoraipatan	Chitawa	**Chitawa**	Sh. Madho Mali	RHS of road to Talera from K. Patan	25.3282	75.8790	241.64	Alluvium	A (C)	22.80	5.30	3.1
Talera	Dabi	**Dabi**	Public well	Centre of village, Near Temple	25.0968	75.5169	505.21	Sandstone	Ss(Nc)	15.90	5.45	5.1
Hindoli	Datoonda	**Datoonda**	Public Well	LHS of road Sathoor to Basoli Mahadev ji ki Padi	25.4629	75.4568	308.91	Limestone	Ls(Nc)	14.50	10.80	10.2
Bundi	Hatipura	**Daulat Pura**	Public well	L.H.S. of road Bundi to Dijolia	25.4035	75.5721	259.27	SH/LS	SH/Ls(Nc)	14.53	7.10	7.05
Kesoraipatan	Daulatpura	**Daulatpura**	School well	West of village, near school	25.7346	76.2589	259.16	Shale	SHALE(Nc)	25.00	10.10	11.3
Kesoraipatan	Dei Khera	**Dei Khera**	Public well	West of village, Near Ganesh ji ka Than	25.5201	76.1764	235.99	Alluvium	A (C)	22.20	10.30	7.2
Hindoli	Mangli Kalan	**Deroli**	Sh. Kajod Moti Mali	East of village, Malionka Imliwala Kua	25.5237	75.4704	324.29	Phyllite	Ph(Nc)	21.20	13.90	13.7
Kesoraipatan	Dhagariya	**Dhagariya**	Public well	Centre of village, Near Chatri	25.5631	76.1438	248.82	Alluvium	A (C)	31.20	15.50	13.9
Hindoli	Ramchandraji Ka Khera	**Dhanao**	Sh. Suja Gurjar	RHS of road Bundi to Alod, after crossing the village	25.5201	75.634	286.79	Phyllite	Ph(Nc)	19.70	11.05	16.7

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Nainwa	Suwanya	**Dhanoogaon**	Sh. Radhey Shyam	Talab wala kua, Near peepal Tree	26.6500	75.8958	298.20	Phyllite	Ph(Nc)	26.00	15.20	17.4
Nainwa	Suwanya	**Dhanoogaon**	GWD	Inside the Panchayat Bhawan	25.8575	75.8676	264.45	Phyllite	Ph(Nc)	100.00	17.10	
Kesoraipatan	Notara	**Dharwan**	Sh. Mahavir Prasad	East of village, Near jain Temple	25.5157	76.0898	231.76	Alluvium	A (C)	19.80	10.90	8.7
Hindoli	Dhowara	**Dhowara**	Sh.Gokul Mali	Sheko wala Kua	25.5908	75.5998	278.06	Phyllite	Ph(Nc)	17.00	dry	
Talera	Dora	**Dora**	Sh. Fateh Lal	In front of Panchayat Bhawan	25.2388	75.6500	318.75	Sandstone	Ss(Nc)	10.00	4.3	2.05
Nainwa	Gambheera	**Gambheera**	Sh. Gopal Mali	Khelwala kua, LHS of road Kharpuria to village	25.8592	75.9605	251.94	Phyllite	Ph(Nc)	18.20	9.95	10.1
Bundi	Jaoti Kalan	**Ganpatpura**	Public well	Near Mahadev Temple, In the village	25.5443	75.9848	259.09	SH/LS	SH/Ls(Nc)	15.50	7.15	7.1
Bundi	Garadara	**Garadara**	Public well	On way to Bijolya near Peopal Tree Panghat ka Kua	25.2105	75.4905	388.08	Sandstone	Ss(Nc)	21.00	5.90	6.55
Kesoraipatan	Gendoli	**Goontha**	Sh. Gyarsi Lal	LHS of road to lakheri before entrance	25.5576	76.0254	230.26	SH/LS	SH/Ls(Nc)	20.40	10.65	12.3
Hindoli	Gothra	**Gothra**	GWD	On L.H.S of Road Towards Village	25.6778	75.6487	276.98	Phyllite	Ph(Nc)	75.00	34.95	34.3
Hindoli	Gurha	**Guda-Gokulpura**	Kesa Meena	LHS of road Thana to petch Ki Baori, Centre of village	25.5359	75.4723	250.61	Phyllite	Ph(c)	17.70	11.85	9.7
Bundi	Gurha Nathawatan	**Gudha Nathawatan**	Sh. Ganesh Lal	L.H.S. of road to Bundi, Near Ganesh Temple	25.3820	75.5186	263.56	SH/LS	SH/Ls(Nc)	20.25	7.55	9.3
Kesoraipatan	Gurli	**Gurli**	Sh. Bardha Mali	South-East of village, near Railway line	25.2922	75.8981	270.36	Alluvium	A (C)	15.80	13.35	2.1

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Bundi	Loicha	**Guwar**	Sh. Gopal Dhakad	R.H.S. of road near to Gudha 200 mt from village	25.2472	75.5264	330.75	Sandstone	Ss(Nc)	8.50	3.00	3.1
Bundi	Loicha	**Hari Pura**	Sh. Gopal	L.H.S. of road Namana to village, near Tapriya Farm	25.2961	75.6106	256.32	Sandstone	Ss(Nc)	11.25	6.45	3.3
Hindoli	Sathoor	**Haripura**	Sh. Madhu Gurjar	In Farm of Madho Gujar	25.4521	75.5394	309.03	Limestone	Ls(Nc)	21.00	15.30	12.6
Kesoraipatan	Higoniya	**Haripura**	Sh. Nand Kishore	South-East of village, Khelwala Kua	25.4644	76.0247	257.00	Alluvium	A (C)	10.25	4.05	3.2
Bundi	Hatipura	**Hattipura**	Sh. Sumaji Ka Kua	L.H.S. of road, Hatipura to Guda nathawat	25.4099	75.5911	261.27	SH/LS	SH/Ls(Nc)	24.40	9.10	7.3
Hindoli	Hindoli	**Hindoli**	GWD	Near Primary School Khanti Antary	25.5647	75.5131	295.37	Phyllite	Ph(Nc)	50.00	32.95	31.9
Kesoraipatan	Jaithal	**Jaithal**	Sh. Kalu Ddakad	S.S.e. of village (Kua ki Modi)	25.4431	75.9609	231.53	Alluvium	A (C)	20.90	7.95	6.2
Nainwa	Jajawar	**Jajawar**	Public well	Balaji Ki Baori, East of village	25.7170	75.7363	288.98	Phyllite	Ph(Nc)	23.00	10.30	17.2
Nainwa	Jajawar	**Jajawar**	GWD	In side the Govt Sr.Sec.School	25.7189	75.7322	293.85	Phyllite	Ph(Nc)	100.00	16.50	
Kesoraipatan	Jaloda	**Jaloda**	Public well	North-West of village	25.3979	75.9546	235.14	Alluvium	A (C)	10.40	7.50	7.7
Talera	Jameetpura	**Jameetpura**	Public well	R.H.S. of road to K. Patan from Bundi, Opp. Of flour mill	25.3127	75.7602	266.14	Alluvium	A (C)	15.85	11.1	5.3
Nainwa	Jetpur	**Jetpura**	Sh. Chhoga	LHS of road to Dei from Bundi after crossing village	25.6125	75.9667	271.87	Phyllite	Ph(Nc)	26.75	11.20	12.6
Kesoraipatan	Jhalaji Ka Baran	**Jhalaji Ka Baran**	School Well	Center of village, near Hanuman Temple	25.5033	76.0218	253.04	Alluvium	A (C)	19.00	10.20	10.7
Talera	Dora	**Kachhaliya**	Sh. Ratra Megha	Patelji ka Kua, Antriwala Kua	25.1714	75.5946	376.50	Sandstone	Ss(Nc)	13.50	6.35	1.3

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Nainwa	Mani	**Kanakpura**	Sh. Jagnath	West of village	25.7081	76.7053	288.65	SH/LS	SH/Ls(Nc)	20.50	15.95	14.3
Nainwa	Mani	**Kanakpura**	GWD	In the school Premises	25.7169	75.7375	289.78	SH/LS	SH/Ls(Nc)	75.00	19.70	18.8
Talera	Dhaneshwar	**Kanwarpura**	Public well	Talab Ki Palwala Kua, near electric Pole	26.1228	75.6617	371.08	Sandstone	Ss(Nc)	8.50	2	1.95
Kesoraipatan	Kaprain (M)	**Kaprain (M)**	Guiron Ki Kui	LHS road to Kapren Rly Station	25.4082	76.0756	227.17	Alluvium	A (C)	9.35	6.40	2.4
Kesoraipatan	Kaprain (M)	**Kaprain (M)**	GWD	In the Premises of CAD	25.4222	76.0773	260.69	Alluvium	A (C)	35.00	2.40	1.6
Kesoraipatan	Kaprain (M)	**Kapren Rly.St.**	Public well	LHS of road to Lakheri near small temple	25.4433	76.0862	259.79	Alluvium	A (C)	14.15	4.75	1.9
Nainwa	Mani	**Kashipura**	Sh. Moti Meena	South of village, Peepali wala Kua	25.7778	76.1161	254.92	SH/LS	SH/Ls(Nc)	16.00	Dry	
Kesoraipatan	Keshoraipatan (M)	**Keshoraipatan (M)**	Sh. Ganpat Patel	Infront of Irrigation Dak Banglow	25.3123	75.9322	266.36	Alluvium	A (C)	17.60	9.30	8.3
Talera	Jawahar Sagar	**Khadipur**	GWD	In the school premises	25.1187	75.6722	395.46	Sandstone	Ss(Nc)	57.00	28.35	24.7
Kesoraipatan	Makheeda	**Khakata**	Public well	West of village.	25.5701	76.2734	239.46	Alluvium	A (C)	22.10	18.35	14.7
Hindoli	Kherkhata	**Kherkhata**	Sh. Ram Laxman	RHS of road Bundi to Negarh	25.4100	75.3503	332.89	Phyllite	Ph(Nc)	24.70	21.30	21.2
Kesoraipatan	Nawalpura	**Kolaspura**	Sh. Kalyan Meena	RHS of road, Indergarh to village, panghat ka Kua	25.7544	76.2847	251.41	Shale	SHALE(Nc)	18.40	15.10	14.5
Bundi	Gadegal	**Kotkhera**	Public well	R.H.S. of road Bundi to Kota, near Hotel Out of village	25.3639	75.6759	259.65	Limestone	Ls(C)	11.35	7.05	4.5
Kesoraipatan	Labaan	**Labaan**	Public well	West of village	25.5505	76.2233	253.77	Alluvium	A (C)	29.40	6.70	3.9

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Kesoraipatan	Lakheri (M)	**Lakheri (M)**	Sh. Salam Singh	R.H.S. of Road to Indergarh from lakhari near temple	25.6721	76.1831	255.33	Shale	SHALE(Nc)	23.18	11.30	10.2
Kesoraipatan	Babai	**Lalpura**	GWD	In the school premises	25.7607	76.1832	282.09	SH/LS	SH/Ls(Nc)	45.00	31.50	30.2
Talera	Lambakhoh	**Lambakhoh**	Public well	Near House of Sobhag Singh Hari Singh Laxminath	25.0532	75.4749	467.51	Sandstone	Ss(Nc)	14.50		
Talera	Laxmi Pura	**Laxmipura**	Public well	Near Post Office & Temple Centre of the village	25.2566	75.6599	271.04	Sandstone	Ss(Nc)	16.80	11.5	10.5
Kesoraipatan	Lesarda	**Lesarda**	Sh. Devi Shankar	LHS of road K. Patan to Ajeta before entering the village, near Gram Panchayat	25.3476	75.9113	238.60	Alluvium	A (C)	6.45	3.15	1.3
Bundi	Loicha	**Loicha**	Public well	R.H.S. of road namana to Guwar School campus	25.2931	75.5682	264.33	Sandstone	Ss(Nc)	16.20	6.30	4
Hindoli	Mendi	**Luhariya**	Public Well	East of village, Panghat Ka Kua, Near Pipal Tree	25.6778	75.6829	271.48	Phyllite	Ph(Nc)	13.60	7.00	3.9
Kesoraipatan	Madhorajpura	**Madhorajpura**	Public Well	North of village, near Mahadev Temple, naya kua	25.2617	76.0855	310.68	Alluvium	A (C)	13.45	3.10	2.4
Nainwa	Mani	**Mani**	Sh. Gopal Meena	West of village, just entrance from Kashipura	25.7660	76.1097	266.68	SH/LS	SH/Ls(Nc)	20.00	Dry	30.1
Bundi	Matoonda	**Matoonda**	Ram Ratan Meena	In house of Ram Ratan, L.H.S of road Matunda to Tokutri	25.4249	75.7141	240.84	SH/LS	SH/Ls(C)	6.90	4.55	3.95
Kesoraipatan	Mayaja	**Mayaja**	Public Well	RHS of road, Khalkar to K. Patan	25.4074	75.8876	230.19	Alluvium	A (C)	20.05	Dry	
Bundi	Neem Ka Khera	**Megharawat Ki Jhonpariyan**	Sh. Shiv Gurjar	L.H.S. of road to Bundi from Bijolya	25.3045	75.4511	284.72	Sandstone	Ss(Nc)	16.40	8.90	7.3
Talera	Seenta	**Meharana**	Sh. Chotu Genaji	R.H.S. of road to Girth near to high Potential Line	25.2830	75.9903	242.78	Alluvium	A (C)	8.05	6.25	3.8

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Nainwa	Nainwa (M)	**Nainwa (M)**	Sh. Nurdeen	East of village on way to Bari Pratap Fakir wala Kua	25.7714	75.8650	262.15	Phyllite	Ph(Nc)	19.50	7.90	7.7
Bundi	Namana	**Namana**	Public well	Near Panchayat Ghar	25.3127	75.6145	252.71	Limestone	Ls(C)	21.15	6.25	5.2
Hindoli	Datoonda	**Narayanpur**	Sh.Nathu S/o Onkar	LHS of road to Basoli from Sathoor, NE of village	25.4823	75.4950	299.32	Limestone	Ls(Nc)	20.80	7.80	7.75
Kesoraipatan	Nawalpura	**Nawalpura**	Sh. Kaisra Jagan Nath	RHS of road Daulatpura to Chandna Kallan	25.7300	76.2918	248.80	Shale	SHALE(Nc)	17.20	10.20	10.1
Kesoraipatan	Nawalpura	**Nawalpura**	GWD	Opposite Grampanchayat	25.7299	76.2916	249.16	Shale	SHALE(Nc)	40.00	20.70	20.3
Bundi	Neem Ka Khera	**Neem Ka Khera**	Sh. Narayan Bhil	R.H.S. of the road from Bundi	25.3386	75.4757	269.22	SH/LS	SH/Ls(Nc)	10.20	6.10	6.05
Kesoraipatan	Notara	**Notara**	Sh. Babu Lal	Bohraji ka Kua, near Mataji Ka Esthan, south of village	25.5245	76.1207	231.33	Alluvium	A (C)	19.50	4.05	2.8
Hindoli	Pagara	**Pagara**	Sh. Laxmi N. Luhar	RHS of Road to Pagara, before Entrance	25.7037	75.5240	312.90	Phyllite	Ph(Nc)	21.50	11.45	11.3
Bundi	Gardha	**Palka**	Public well	West of village	25.1554	75.5457	427.57	Sandstone	Ss(Nc)	23.55	10.40	6.15
Kesoraipatan	Papri	**Papri**	Public well	RHS of the road K. Patan to lakheri	25.6144	76.2010	242.87	Shale	SHALE(Nc)	22.90	18.80	19.2
Hindoli	Pech Ki Baori	**Pech Ki Baori**	Sh. Jamna Lal Tali	RHS of Road Hindoli to Deoli after crossing the village, near Hotel	25.6400	75.4612	328.61	Phyllite	Ph(Nc)	19.95	9.90	12.1
Kesoraipatan	Pholai	**Pholai**	Public well	LHS of road to lakheri from Khalkar near School	25.5349	75.9402	242.24	SH/LS	SH/Ls(Nc)	18.30	Dry	
Nainwa	Phuleta	**Phuleta**	GWD	In Panchayat Bhawan	25.7327	75.8889	246.39	Phyllite	Ph(Nc)	100.00	26.05	17.6

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Talera	Raithal	**Piliya**	Sh. Har Lal	East of village, near Nala	25.0636	75.5193	453.91	Sandstone	Ss(Nc)	7.30	2.05	2.1
Nainwa	Dugari	**Raghunathpura**	Sh. Bhagu	Gyori Maharaj ka Kua	25.6898	75.7946	243.18	Phyllite	Ph(Nc)	23.20	7.10	10.35
Nainwa	Rajlawata	**Rajlawata**	Public well	Centre of village, near school, Panchayat Bhawan	25.7965	75.8824	271.85	Phyllite	Ph(Nc)	25.00	14.65	15.3
Bundi	Bhairoopura Ojha	**Rajwas**	Public well	R.H.S. of the road Bundi to Khalkor	25.4965	75.8020	240.50	SH/LS	SH/Ls(C)	14.60	3.10	2.95
Talera	Seelor	**Rampuriya Barad**	Sh. Kishan Singh	Panghat ka Kuma Bada Kua	25.3998	75.5455	257.35	Sandstone	Ss(Nc)	10.72	3.95	4.1
Kesoraipatan	Rebarpura	**Rebarpura**	Public well	Centre of village near P.O. & Jain Temple	25.5590	76.1036	240.31	Alluvium	A (C)	22.30	10.40	10.1
Hindoli	Bhawanipura	**Ren**	Sh. Govind Dass	N.E. of Tejaji Temple	25.6419	75.6806	273.62	Phyllite	Ph(Nc)	20.00	dry	
Hindoli	Roneeja	**Roneeja**	Ladu Nenuji Gurjar	LHS of road Nainwa to Gothra, just entrace, near Pipal tree	25.7051	75.6682	283.52	Phyllite	Ph(Nc)	21.50	15.10	14.7
Hindoli		**Rooppura**	Sh. Kana Bhil	RHS of road Kheeniya to Basoli	25.6419	75.6806	273.62	Phyllite	Ph(Nc)	15.80	13.05	12.2
Hindoli		**Rooppura**	GWD	On LHS of Road Towards Kheenia	25.6244	75.6773	277.65	Phyllite	Ph(Nc)	100.00	9.05	8.2
Kesoraipatan	Roteda	**Roteda**	Public well	Centre of village, Near Malion ka Mandir	25.3848	76.1355	252.90	Alluvium	A (C)	28.40	19.60	19.5
Nainwa	Motipura	**Sabalpura**	Sh. Kalyan Meena	RHS of road Bundi to Nainwa Behind Hotel	25.5564	75.9356	279.87	SH/LS	SH/Ls(Nc)	18.10	10.60	9.3
Nainwa	Sadera	**Sadera**	Sh. Kishan Mali	East of village, Badiya ka Kua	25.6066	75.7980	251.28	Phyllite	Ph(Nc)	25.00	15.15	14.7

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Hindoli	Sahaspuriya	**Salawlya**	Heera Gurjar	Bank of River	25.5446	75.4470	333.36	Phyllite	Ph(c)	21.80	dry	
Talera	Leelera Byasan	**Satheli**	Public well	Kharia Kua, Centre of village	25.3688	75.7811	236.37	Alluvium	A (C)	18.00	9.3	6.1
Hindoli	Sathoor	**Sathoor**	Sh.Sohan Lal Meena	LHS of road Sathoor to hindoli (Pithapura)	25.4783	75.5586	294.64	Limestone	Ls(Nc)	18.80	8.60	10.7
Nainwa	Shahan	**Shahan**	Public well	Panchayat ka Kua, Near Bad tree, just entrance	25.6841	76.0278	239.51	Phyllite	Ph(Nc)	15.00	8.20	8.1
Kesoraipatan	Soonagar	**Soonagar**	Public well	Opp. School, Near Sahkari Bhandar	25.3764	75.9858	246.80	Alluvium	A (C)	8.20	Dry	
Nainwa	Suwanya	**Sunthli**	Sh. Gopal Meena	RHS of Road, Nainwa to Nagar	25.8455	75.8358	267.48	Phyllite	Ph(Nc)	21.80	14.80	15.1
Talera	Suwasan	**Suwasan**	Public well	R.H.S. of road Talna to K. Patan, Near Bus Stand	25.3297	75.8508	241.09	Alluvium	A (C)	9.00	6.3	4.45
Talera	Talera	**Talera (CT)**	Public well	L.H.S. of road Bundi to Kota	25.3124	75.7350	267.47	Limestone	Ls(C)	14.40		6.11
Talera	Talera	**Talera (CT)**	GWD	In the Panchayat samiti Bhawan	25.3130	75.7350	235.72	Limestone	Ls(C)	40.00	14.8	
Nainwa	Talwas	**Talwas**	Public well	Near Girl School	25.6207	76.0423	265.56	SH/LS	SH/Ls(Nc)	16.70	7.05	7.2
Hindoli	Thana	**Thana**	Sh. Ram Karan Gurjar	LHS of road from Salawalya to village Gujron ki Baori	25.5383	75.4136	348.36	Phyllite	Ph(Nc)	20.15	13.25	13.4
Hindoli	Theekarda	**Theekarda**	Bhanwar Lal Meena	Centre of village	25.4897	75.6363	307.90	Limestone	Ls(Nc)	24.00	17.65	17.1
Hindoli	Theekarda	**Theekarda**	GWD	On LHS of Road	25.4899	75.6373	311.70	Limestone	Ls(Nc)	50.00	17.00	14.7
Hindoli	Tonkra	**Tonkra**	Banwar Lal Babaji	LHS of road from Gurhi Gudha Gokulpura to village	25.6049	75.4409	322.46	Phyllite	Ph(Nc)	15.80	dry	

Block	Grampanchayat	Village	Owner_Name	Address/Location	Latitude	Longitude	RL (m)	Hyd_Formation	Zone	Total_Depth_bgl	DTWL May 2020	DTWL Nov 2020
Nainwa	Bachhola	**Ugen**	Sh. Prahlad Bairwa	Near Temple, Panghat Ka Kua	25.8076	75.7775	279.41	Phyllite	Ph(Nc)	17.30	11.30	10.3
Nainwa	Bachhola	**Ugen**	GWD	In front of school	25.8071	75.7784	278.93	Phyllite	Ph(Nc)	75.00	13.60	13.9
Hindoli	Umar	**Umar**	Sh. Sita Ram Luhar	RHS of road for Pech ki Baori to village, before entrance	25.6724	75.4641	328.09	Phyllite	Ph(Nc)	27.00	13.20	13.1
Kesoraipatan	Utrana	**Utrana**	Sh. Kashi Ram	RHS of road to lakheri near KM stone No. 16	25.6152	76.1225	234.30	SH/LS	SH/Ls(Nc)	13.40	6.70	7.3

Annexure III

List of Exploratory Wells Used NAQUIM Study in Bundi District

SR_HR	Location	Latitude	Longitude	Type of Well	Year_of_cons_	Depth_drilled m_	Depth constr_m_	Zones tapped mbgl From	Zones tapped_mbgl_t	Formation_tapped	SWL__m_	Disc lpm_	DD m_	Trans_m2_day	EC_mmhos_cm_at_25_C	Cl_mg_l	F_mg_l	Remarks	Agency	Block_Map
SR	Ajenda	25.4667	76.15	SH	93-94	47.6		-	-	Allu	-	-	-	-				Shale basement at 46 m depth	OLD	KESHORAI PATAN
HR	Badfu	25.0725	75.4731	EW	03-04	170.47	170.47	Naked		Vindhyans, Sst & SSh	-	Neg.	-	-					OLD	TALERA
HR	Budhpura	25.1089	75.4606	EW	03-04	170.47	170.47	Naked		Vindhyans, Sst & SSh	8.89	380	3.51	-	1260	192	0.29		OLD	TALERA
HR	Chhatarganj (EW)	25.5222	75.5	EW	03-04	81	81	Naked		Phyllite	7.14	1440		-	820	50	3		OLD	HINDOLI
HR	Dabi	25.1	75.5	EW	03-04	166.92	166.92	Naked		Vindhyans, Sst & SSh	23.23	400	46.87	-	1020	135	0.67		OLD	TALERA
HR	Dei	25.6917	75.9611	EW	03-04	175	175	Naked		Vindhyans, Sst & SSh	38.57	240	43.16	-	600	21	1.77		OLD	NAINWA
HR	Gudasada bartyan	25.5975	75.8922	EW	03-04	174.67	174.67	Naked		Vindhyans, Sst & SSh	15.75	165	22.37	-	710	50	0.69		OLD	NAINWA
SR	Hastinapur	25.3333	75.95	SH	93-94	40.25		-	-	Allu	-	-	-	-				Shale basement at 37.5 m depth	OLD	KESHORAI PATAN
SR	Kapren	25.4167	76.0667	EW	94-95	41.3	39	16 28	22 33	Allu	2.72	330	12.04	59.89	3220	795	0.18		OLD	KESHORAI PATAN
SR	Kapren	25.4167	76.0667	SH	93-94	40.5		-	-	Allu	-	-	-	-	-	-	-	Shale basement at 38.5 m depth	OLD	KESHORAI PATAN
SRHR	Kapren	25.4071	76.0705	EW	18-19	200						Not measurable			4400	510	0.38		OS	KESHORAI PATAN
HR	Karwar I (EW)	25.7833	76.1083	EW	03-04	150.7	150.7	Naked		Phylliie	30.2	70		-	1200	163	2		OLD	NAINWA
HR	Karwar II (EW)	25.7833	76.1083	EW	03-04	123.2	123.2	Naked		Phyllite	28.74	75		-					OLD	NAINWA
SR	Keshoraipatan	25.3	75.95	EW	93-94	35.5	35	12 29	15 34	Allu	4.45	132	15.37	13.72	710	28	2.4		OLD	KESHORAI PATAN
HR	Kharipur	25.1203	75.6583	EW	03-04	164.8	164.8	Naked		Vindhyans,	7.7	570	13.45	-	480	36	0.57		OLD	TALERA

										Sst & SSh									
SR_HR	**Location**	**Latitude**	**Longitude**	**Type of Well**	**Year_of_cons_**	**Depth_drilled m_**	**Depth constr_m_**	**Zones tapped mbgl From**	**Zones tapped_mbgl__t**	**Formation_tapped**	**SWL__m_**	**Disc lpm_**	**DD m_**	**Trans_m2_day**	**EC_mmhos__cm_at_25_C**	**Cl_mg_l**	**F_mg_l**	**Remarks**	**Agency**	**Block_Map**
SR	Laban	25.55	76.2167	SH	93-94	47		-	-	Allu	-	-	-	-	-	-	-	Lst. Basement at 41.5 m depth.	OLD	KESHORAI PATAN
SR	Lesard	25.3	75.8333	EW	93-94	34	34	23 28	26 33	Allu	2.92	155 (PYT)	0.74		1170	28	6	Shale basement at 29 m depth	OLD	TALERA
SR	Maiza	25.3167	75.8167	SH	93-94	29.8		-	-	Allu	-	-	-	-	6675	866	-	Shale basement at 23.7 m depth	OLD	TALERA
SR	Namana (EW)	25.3167	75.6167	EW	03-04	70	70	Naked		S.St.	13.87	40		-	1205	135	1		OLD	BUNDI
HR	Paibalpura (EW)	25.5061	75.8972	EW	03-04	142	142	Naked		Phyllite	I5.19	I50		-	360	7	0.3		OLD	KESHORAI PATAN
SRHR	Papdi	25.6142	76.1993	EW	18-19	200						Not measurable			17000	4644	0.68		OS	KESHORAI PATAN
HR	Rajpura I	25.05	75.5294	EW	03-04	170.47	170.47	Naked		Vindhyans, Sst & SSh	55.97	520	1.18	-	800	78	0.34		OLD	TALERA
HR	Rajpura I I	25.05	75.5294	EW	03-04	170.47	170.47	Naked		Vindhyans, Sst & SSh	55.91	470	7.52	-	820	78	0.37		OLD	TALERA
SRHR	Sedri	25.3011	75.8539	EW	18-19	121						21.72			3410	530	0.7		OS	TALERA
HR	Silore (EW)	25.3783	75.6089	EW	02-03	120.7	120.7	Naked		Shale/S.St.	14.5	1500	-	-	1475	199	1.55		OLD	BUNDI
HR	Sutda	25.0861	75.5589	EW	03-04	139.37	139.37	Naked		Vindhyans, Sst & SSh	58.25	500	2.12	-	640	43	0.54		OLD	TALERA
HR	Talera (EW)	25.3	75.7333	EW	04-05	88.5	88.5	Naked		Shale	12.9	720	-	-	650	35	0.7	*Backlog of 2003-04	OLD	TALERA
SR	Thikarda I (EW)	25.4833	75.6333	EW	03-04	67.7	67.7	Naked		S.St & Sh	I9.1	110		-	470	21	2		OLD	HINDOLI
HR	Thikarda II (EW)	25.4833	75.6333	EW	03-04			Naked		S.St & Sh				-					OLD	HINDOLI
SR	Thikarda III (EW)	25.4833	75.6333	EW	03-04	153.5	153.5	Naked		S.St & Sh	37.04	meager		-					OLD	HINDOLI

Annexure III

Locations of Water Quality Data used for NAQUIM Studies

SITE_ID	SITE_NAME	LAT	LONG	CO3	HCO3	CCl	SO4	NO3	F	PO4	NITRATE _NI	TOT ANION	TOT CATION	DATE
W2531000 76100001	Dahi Khera	25.5170	76.1670	-	1,183.0	2,609.0	254.00	11.00	0.74	0.025	2.48	98.49	98.63	31-05-2019
W2528150 75520001	DELUNDA	25.4710	75.8670	-	524.0	1,517.0	218.00	73.00	0.74	0.105	16.48	57.14	57.23	31-05-2019
W2523280 76042501	KAPREN	25.3910	76.0740	84.0	476.0	71.00	77.00	-	0.65	0.032	0	14.24	14.29	31-05-2019
W2519080 75555001	KESHORAIPATAN	25.3190	75.9310	-	451.0	1,205.0	126.00	3.20	0.80	0.11	0.72	44.11	44.13	31-05-2019
W2540000 76110001	LAKHERI	25.6670	76.1830	-	329.0	638.00	158.00	302.00	0.21	0.105	68.19	31.57	31.63	31-05-2019
W2524300 75531501	MAIJA	25.4080	75.8880	-	671.0	425.00	220.00	52.00	1.15	0.11	11.74	28.47	28.50	30-05-2019
W2524000 75333001	RAMNAGAR (JATAN)	25.4000	75.5580	-	244.0	2,127.0	182.00	213.00	0.45	0.017	48.1	71.25	71.27	31-05-2019
W2526140 75305501	SATUR	25.4370	75.5150	-	439.0	822.00	168.00	28.00	0.91	0.108	6.32	34.38	34.42	31-05-2019

SITE_ID	SITE_NAME	LAT	LONG	RSC	CA	NA	K	MG	PH	EC	TDS	TH	TOT ALKALI	PHENOL_ ALK	SAR	PERCENT_NA
W2531000 76100001	Dahi Khera	25.5170	76.1670	5.79	100.00	1,950.0	7.89	104.67	8.00	9,840.0	6,396.0	680.0	969.67	0	32.53	86.01
W2528150 75520001	DELUNDA	25.4710	75.8670	1.79	56.00	1,155.0	7.30	48.69	8.10	5,660.0	3,679.0	340.0	429.51	0	27.25	87.79
W2523280 76042501	KAPREN	25.3910	76.0740	8.80	16.00	285.0	3.47	12.18	8.44	1,400.0	910.0	90.0	530.16	140	13.07	86.78
W2519080 75555001	KESHORAIPATAN	25.3190	75.9310	(10.21)	120.00	607.0	4.96	141.16	7.91	4,380.0	2,847.0	880.0	369.67	0	8.90	59.83
W2540000 76110001	LAKHERI	25.6670	76.1830	(11.81)	176.00	303.0	49.00	102.33	7.88	3,100.0	2,015.0	860.0	269.67	0	4.49	41.67
W2524300 75531501	MAIJA	25.4080	75.8880	8.20	16.00	588.0	4.80	24.33	8.61	2,800.0	1,820.0	140.0	550.00	0	21.62	89.75
W2524000 75333001	RAMNAGAR (JATAN)	25.4000	75.5580	(36.40)	368.00	695.0	25.00	267.89	7.58	7,100.0	4,615.0	2,020.0	200.00	0	6.73	42.42
W2526140 75305501	SATUR	25.4370	75.5150	(7.20)	116.00	389.0	121.0	104.69	7.90	3,400.0	2,210.00	720.0	359.84	0	6.31	49.17

Annexure IV

Locations of Water Sample Collection Sites during Pre-Monsoon NAQUIM Field Work

S. No.	Bottle No.*	Location*	Block*	District*	Source*	Depth (m)*	Sample Temperature	Field EC	Latitude*	Longitude*	location
1	1	Amartya	Hindoli	Bundi	handpump	20	33.4	832	25.597037	75.515431	turn left side of hindoli to uniyara road, the well is located opposite to lokedaswer hittor temple on roaad going to amartya village
2	2	Bishanpura	Hindoli	Bundi	tubewell	28	31.8	938	25.541828	75.383273	in Bishanpura , opposite to mata temple
3	3	jhakoli khurd	Hindoli	Bundi	handpump	25	32	792	25.385525	75.320905	in village on right hand side near hanuman mandir(bajrangsingh ji well)
4	4	Jajawar	Nainwa	Bundi	tubewell	21.5	35.8	958	25.716566	75.740509	in village opposite to water tank in ashok ji farm land
5	5	Rethoda	Nainwa	Bundi	tubewell	40	36.6	770	25.740707	75.98661	in village near tyemple from baori(step well)
6	6	Kota kurd	keshorai patan	Bundi	handpump	40	36.8	1190	25.509025	76.2217	in end of village a dug well is present
7	7	baswara	keshorai patan	Bundi	Tubewell	40	34	1062	25.650227	76.289421	in entry of village on left side a dug cum bore is present (chotulal ji well)
8	8	Dhaneshwar	talera	Bundi	Tubewell	20	29	472	25.026495	75.58562	rang lal well in end ofvillage on right of kota chittorgarh highway
9	9	Gardara	Bundi	Bundi	dugwell	8	32.8	710	25.212685	75.485955	near bridge a well is located in end of village

S. No.	Bottle No.*	Location*	Block*	District*	Source*	Depth (m)*	Sample Temperature	Field EC	Latitude*	Longitude*	location
10	10	Dehit	Talera	Bundi	handpump	14	36.8	1382	25.276875	75.830657	a step well in village(teja ji temple)
11	11	Sankarda	Bundi	Bundi	Dug cum bore	6			25.366045	75.629602	in start of village on right side the well is of Dhanraj Suman
12	12	Samarba	bundi	Bundi	Dug well	20	38	1720	25.482643	75.800638	on way to village it is before 1 km on right side(near 1/200 samarba stone)
13	13	Dabeta	Hindoli	Bundi	Borewell	20	34.6	1262	25.566886	75.761846	kanhaji well in dabeta village(sample taken from bore of ranjeet singh)

ANNEXURE V

Details of Zones Encountered in Logging Conducted in Exploratory Wells of Bundi District.

S. No.	Village	Block	District	Well Type	Date of Logging	Longitude	Latitude	Logged Depth (m bgl)	Drilled Depth (m bgl)	Parameter Measured	Zones Encountered	Remarks
1.	Hastinapur	Keshorai Patan	Bundi	EW	17-07-1993	75°57’	25°20’	36.5	40	SP, SPR	-	Shale basement at 37.5 m depth
2.	Ajanda	Keshorai Patan	Bundi	EW	14-08-1993	76°09’	25°28’	43	47	SP, N16", N64”, SPR, 6' Lateral.	23-33,36-43.	EC=3600-5000 micromho/cm. Shale basement at 46 m bgl.
3.	Kapren	Keshorai Patan	Bundi	EW	23-03-1994	76°04’	25°25’	36	40.5	SP, N16", N64", SPR, 6' Lateral.	16-22, 28-33.	Shale basement at 32.5 m depth, SWL - 2.5 m bgl. EC=3220 micromho/cm. Disc.-330 lpm.
4.	Kapren-2019	Keshorai Patan	Bundi	EW	04-05-2019	76°04'13.80"	25°24'25.40"	199.00	**200.00**	SP, N16", N64", NG.	123-124, 136-137.	Not measurable, TDS=2860 ppm, T=0.97 m2/day. Shale basement at 36 m bgl.
5.	Sedri	Talera	Bundi	EW	04-05-2019	75°51'14.10"	25°18'03.80"	120.70	121.00	SP, N16", N64", NG.	85-86, 107-108, 113-114, 117-118.	21.72 lps, TDS=1130 ppm, T=26.81m2/day. Shale basement at 63 m bgl.