केंद्रीय भूमि जल बोर्ड

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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

NARSINGHPUR DISTRICT, MADHYA PRADESH

उत्तर मध्य क्षेत्र, भोपाल

North Central Region, Bhopal

Government of India

Central Ground Water Board

Ministry of Water Resources, River Development &
Ganga Rejuvenation

GROUND WATER MANAGEMENT PLAN OF NARSINGHPUR DISTRICT MADHYA PRADESH

(2017-2018)

By

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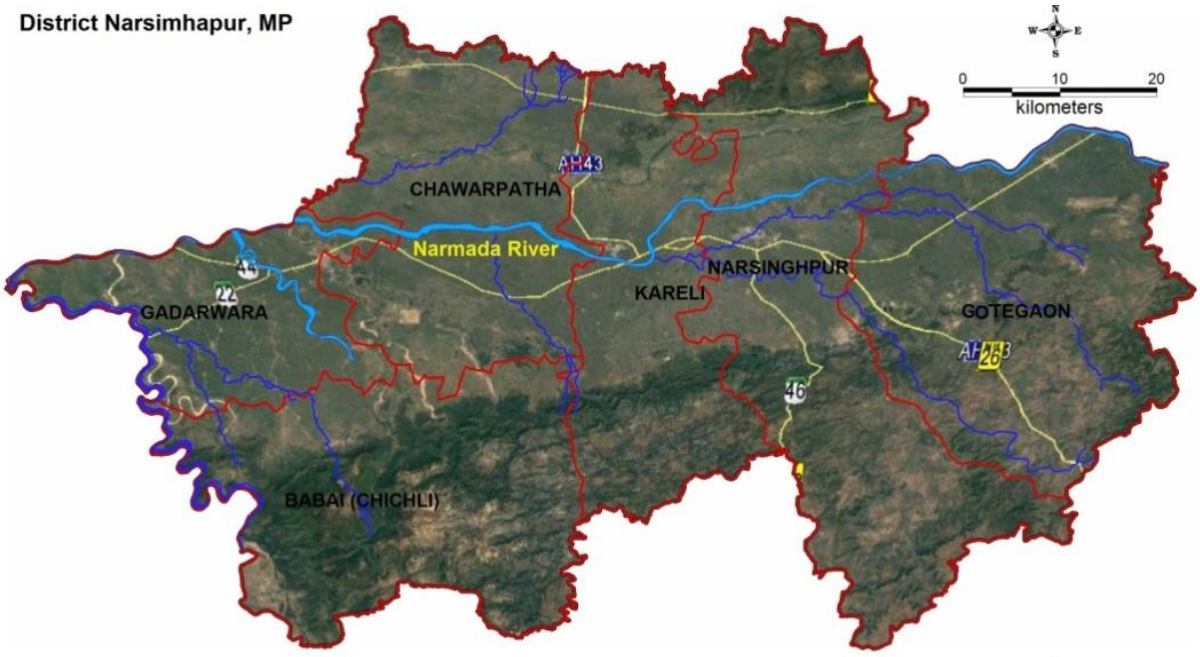

National Aquifer Mapping Programme
Management Plan of Narsinghpur District, Madhya Pradesh

North Central Region
March, 2018

NATIONAL AQUIFER MAPPING PROGRAMME
GROUND WATER MANAGEMENT PLAN OF NARSINGHPUR DISTRICT,MADHYA PRADESH

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PREFACE

Groundwater being a valuable asset and its relatively easy accessibility in comparison to surface water sources is primarily used for irrigation. The district of Narsinghpur with a total geographical area of about 5133 sq. km.Narsinghpur district is situated in the South central part of Madhya Pradesh State along both the Northern and southern banks of Narmada River and is bounded by Hoshangabad and Raisen districts in the west.

Under the National Aquifer Mapping (NAQUIM) project, multidisciplinary approach has been adopted for preparation of aquifer maps and ground water management plan for Narsinghpur district. The report consists of the existing hydrogeological, chemical and geophysical data that were compiled for the preparation of aquifer maps. The collected data was further processed to generate regional hydrogeological maps, thematic maps, water quality maps, cross-sections, 2-D and 3-D aquifer dispositions.

The aquifer management plan for Narsinghpur district has been prepared in which the ground water resources can be enhanced by 230.88 MCM through construction of artificial recharge structures viz. 231 percolation tanks, 1616 check dams/nala bunds, 462 recharge shafts and ensuring water use efficiency through maintenance/renovation of 1052 existing water bodies/water conservation structures. Adoption of micro-irrigation techniques such as sprinkler irrigation has also been proposed, that will reduce the draft and conserve ground water resources by saving 102.66 MCM of resource from overall irrigation draft. In Narsinghpur district, Sugarcane farming is the main source of livelihood on which the Sugar industries are dependent, therefore change in cropping pattern has not been proposed as an intervention. So we suggest changing our irrigation pattern from flood irrigation to micro irrigation technologies such as drip and sprinkler systems for rabi crops (such as wheat), are being increasingly promoted as technological solutions for achieving water conservation. The interventions suggested in the report will not only have a positive impact on the ground water regime but would also play a key role in augmenting the net cropping area and would ultimately enhance the agricultural productivity and economy of the district.

Parvinder Singh
(Regional Director)

CHAPTER-I Introduction

1.0 Location :

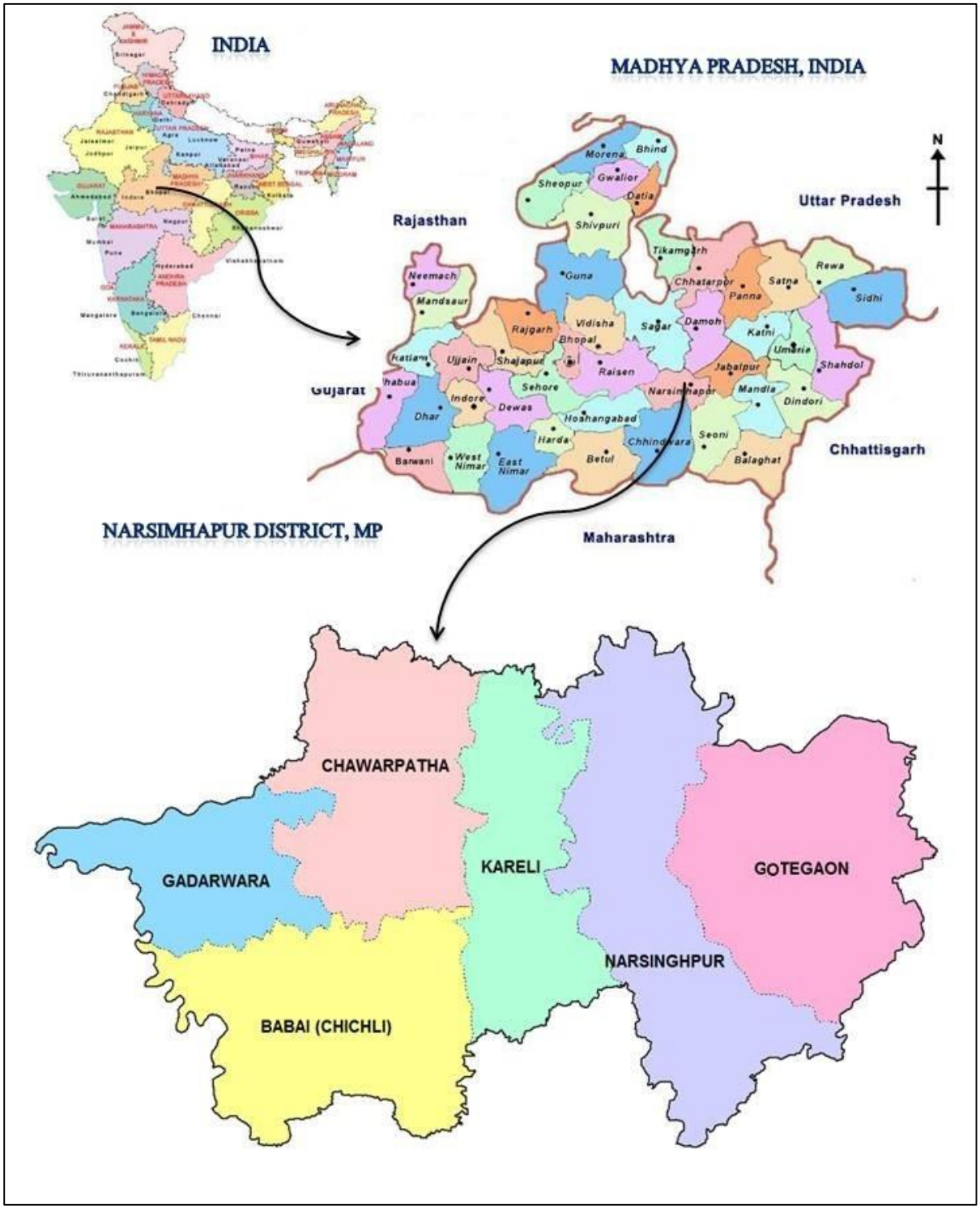
The Narsinghpur district lies in North latitudes 22° 36’ 00” and 23° 16’ 00” and East longitudes 78° 27’ 00” and 79° 40’ 00” in parts of Survey of India toposheet Nos 55I, 55J, 55M and 55N and encompasses an area of 5133 km². Narsinghpur district is situated in the South central part of Madhya Pradesh State along both the Northern and southern banks of Narmada River and is bounded by Hoshangabad and Raisen districts in the west.

The district is divided into five Tehsils and six Blocks. There are 1052 villages and 8 towns in the district.

Table 1: Administrative Divisions, District Narsinghpur, M.P.

S No	Block	Area (Sq Km)	No of towns
1.	ChawarPatha	933	1
2.	Chichli	960	1
3.	Gotegaon	728	1
4.	Kareli	933	2
5.	Narsinghpur	969	2
6.	Saikheda/Gadarwara	610	1
	TOTAL	**5133**	**8**

Fig:1 Administrative Map of Narsinghpur district, Madhya Pradesh



1.2 Objectives and approach:

The aquifer mapping study primarily depends on the existing data that are assembled, analyzed and interpreted from available sources. The data gaps analysis carried out helped to generate data from data-collection activites such as BDR of exploration drilling, water level measurements and groundwater quality analysis done by CGWB & State Department. By analyzing the existing data and the data generated, regional hydrogeological maps, thematic maps, water quality maps, cross-sections, 2-D and 3–D aquifer dispositions maps were generated. The objectives of the Management plan is to define the aquifer geometry, type of aquifers, ground water regime behaviors, hydraulic characteristics and geochemistry of Multi-layered aquifer systems on 1:50,000 scale .

Aquifer Mapping can be envisaged as follows:

1. **Data Compilation & Data Gap Analysis**:

One of the important aspect of the aquifer mapping programme is to synthesis the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were assembled, analyzed, examined, synthesized and interpreted from available sources. These sources were predominantly non computerized data, which was converted into computer based GIS data sets. On the basis of available data, Data Gaps were identified.

2. **Data Generation**:

There was also a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping.

3. **Previous studies prior to this study:**

The groundwater hydrogeology have been studied only in separate parts with many areas left untouched. As a result, there was no hydrogeological framework developed so as to understand the regional effects of groundwater development in the area.

4. **Preparation of Block wise ground water management plan**:

The Narsinghpur district that will guide the planers to manage the ground water resources in judicious manner and improve the ground water scenario of the district.

1.3 Rainfall & Climate:

The climate of Narsinghpur district is generally dry except during the southwest monsoon season. The year can be divided into four seasons. The winter commences from middle of November and lasts till the end of February. The period from March to about first week of June is the summer season. May is the hottest month of the year. The southwest monsoon starts from middle of June and lasts till end of September. October and middle of November constitute the post monsoon or retreating monsoon season. The normal annual rainfall of Narsinghpur district is 1217.6mm.District received maximum rainfall during south west monsoon period i.e. June to September. About 91.3 % of the annual rainfall received during monsoon season. Only 8.7 % of the annual rainfall takes place between Octobers to May period. The rainfall forms the sole source of the natural recharge to ground water regime and is mainly available during the south west monsoon period only.

The normal maximum temperature received during the month of May is 42.50 °C and minimum during the month of January is 8.20 °C. The normal daily mean monthly maximum temperature is 33.20 °C and daily mean minimum temperature is 18.10 °C.

The summer season is the driest period of the year. The relative humidity generally exceeds 90% in the month of August. The rest of year is drier. The driest part of the year is summer, when relative humidity comes down lowest in 39% in the month of April. It varies between 39% and 90% at different time in different seasons. The wind velocity is high during the monsoon period as compared to pre and post monsoon.

The wind velocity is highest in June around 8.0 km/hr and lowest is 2.0 km/hr in November. The average normal annual wind velocity of the district is 4.2 km/hr.

1.4 Geomorphology:

Physiographically, the district area can be broadly divided into three sectors- namely 1) Narmada Valley alluvial plain, 2) Satpura range in the south and 3) the Vindhyan range in the north. The vast alluvial plain of Narmada valley stretches from east to west throughout the district on both the sides of the Narmada River. The regional slope of the area is westward.

Geologically, the Narmada alluvial basin is created by sedimentation of the rift valley of the Narmada- Son lineament. The valley extends up to the marble rocks of Bheraghat, Jabalpur District in the East and up to Handia, Hoshangabad District in the West within the limits of

Narsinghpur District. The valley has a maximum extent of about 50km north to south and the entire length of the district East to West.

On the Southern side of Narmada, the plains stretch to about 25 to 35 km Southwards from the Narmada river with a general slope due North. The general elevation ranges from 230 to 265m above mean sea level. The topography of the area is monotonously even with depression only along the nala and river courses which take the shape of bad-land topography at places.

North of Narmada, the monotony of the plains is broken by scattered isolated hillocks. The width of the plain Southwards from the Narmada ranges from 5km. in the Eastern portion to about 15km in the Western portion with a general slope due South.

The Satpura ranges from the Southern boundary of the district. It trends in east-west direction and is almost continuous in nature. The highest elevation attained is 937.80 m, amsl (at top of hill in Salechauka Reserve Forest, 22°40'05" 78°46'30", 55J/14). The topography of the area is rugged and uneven with high hills and deep valleys. The hill slopes are steep and covered with forests. The area intermediate between the steep hill slopes and the Narmada plain is the piedmont zone, occupied by rock rubble, gravel and mixed sediments.

The Vindhyan ranges occur in the Northern boundary of the district. The hills are not very high in the district and are flat tapped. Their elevation rages from 457 to 533 m, amsl the topography is uneven and broken. The Southern scarp of the hills has an irregular contact with the alluvial plain and few isolated hillocks occurring within the alluvial plain are an extension of the range. The physiography of Narsinghpur district is given in plate.

1.5 Drainage:

The entire area of Narsinghpur district is drained by the river Narmada and its tributaries, barring a small area in the North-East which is drained by 1st and 2nd order streams of ken sub-basin of Yamuna basin. The river Narmada has its origin in the Amarkantak plateau at the North East apex of the Satpura ranges in Madhya Pradesh. After a course of about 150km. through the districts of Shahdol, Mandla and Jabalpur, it enters Narsinghpur districts from the North Eastern boundary and flows in a Westerly direction. The meandering of the river is open and gradual and of varying magnitude due to the varied geology and different formations through which it flows. The Sher, Shakkar and Dudhi rivers flowing due NW are the main tributaries joining the Narmada from the left bank, while Pandhjhir (Dobhi) river flowing due SW is the main tributaries are perennial except the Dudhi which has a very lean flow or is dry along major part of the stretch during the pre-monsoon period from February to June.

The Shakkar and Dudhi rivers have very long courses in the alluvial plains. Number of small nalas drain from the hill ranges and finally from the above two major tributaries.

Dudhi, one of the major tributaries of the Narmada forms the Western boundary of Narsinghpur district with Hoshangabad district. It originates from the Satpura in Chhindwara district and following a Northerly course emerges out in the plain meandering sharply and turns Westward near Sainkhera to confluence with river Narmada.

The Shakkar River rises about 19.5km. North of Amarwara in Chhindwara district and flows through Narsinghpur in a North Westerly direction joining the Narmada near Sokalpur after a total course of 115km. passing by Shahpur, Gadarwara and Paloha. It is joined by the Chhindwara river near Gadarwara, which rises in the hills of Chhindwara district and passes between Gangai village and Chichli township.

The Hiran River rises as the small river in a small tank near Kundam in Jabalpur district. It forms the Eastern boundary of Narsinghpur district with Jabalpur district and joins the Narmada at Sankal, Barurewa and Macharewa Rivers are the main tributaries of the river.

The drainage Pattern is dendritic with medium to coarse drainage density. The drainage density is 1.20 km/Sq. Km. in the alluvial / colluvial fan belt in the foot hills area, 0.81 Km/Sq. Km. in hill slope area and 0.25 to 0.51 Km/Sq.km in river alluvial plains.

Figure 2. Geomorphology map of Narsinghpur District, Madhya Pradesh

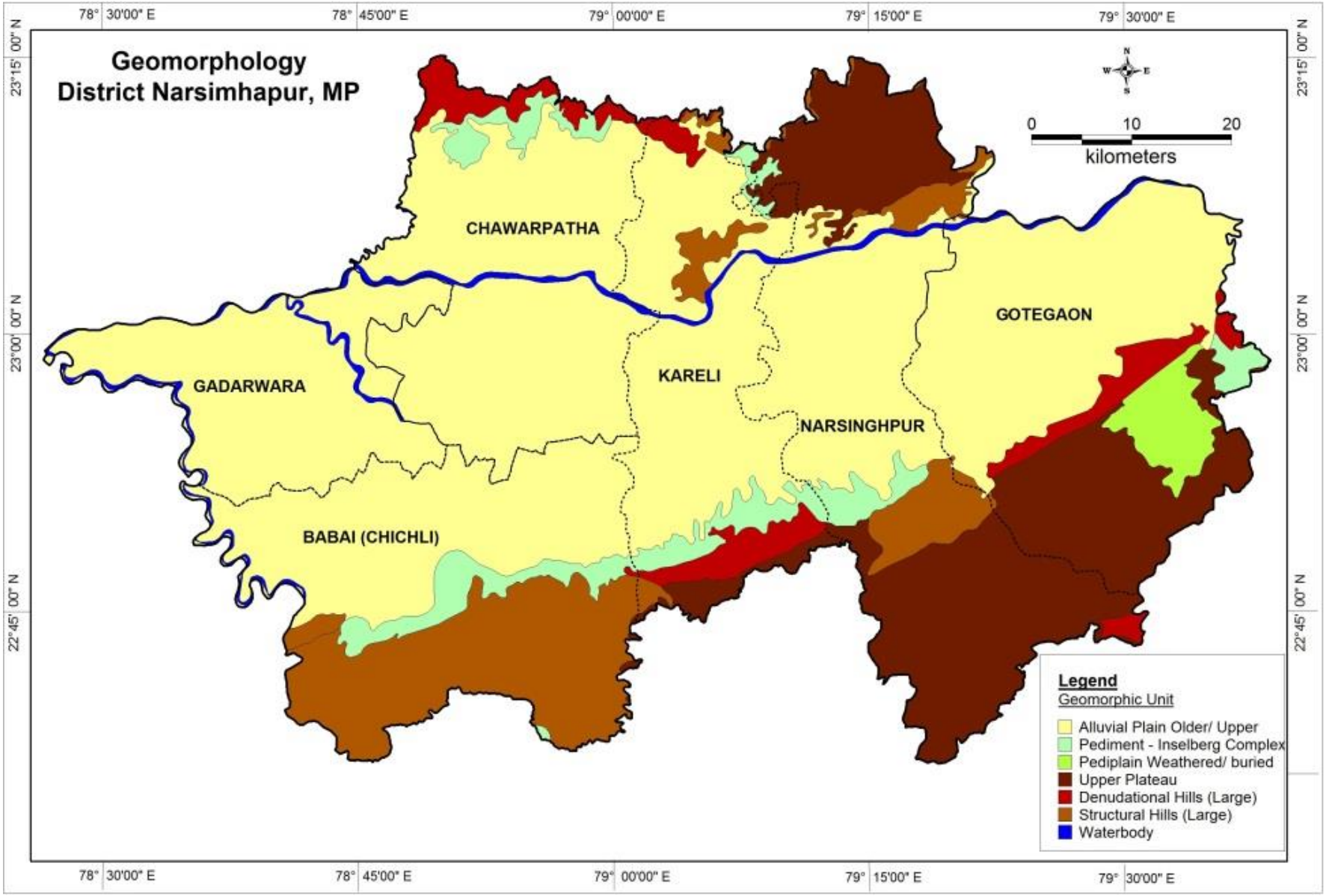
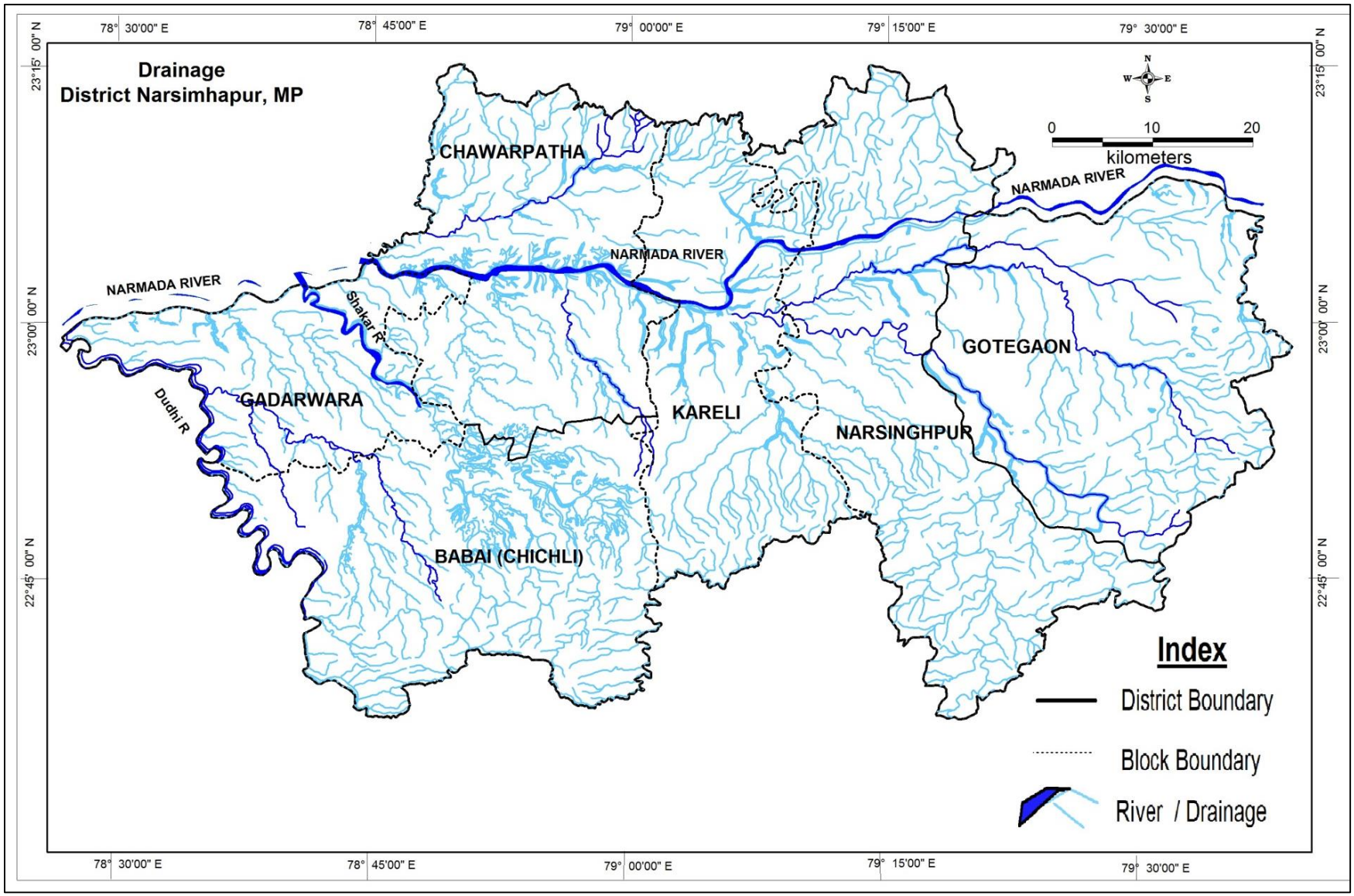


Fig 3: Drainage map of Narsinghpur District, Madhya Pradesh



1.6 Soil:

Soil Characteristics The areas in Northwest, East and Southeast of the district are generally covered with black soils derived from Basaltic rocks varying in the depth from 0.33m to over a meter. The soils are usually clayey to loamy in texture with calcareous concretions invariably present They are sticky and in summers, due to shrinkage, develop deep cracks. The soils predominantly consist of montmorillonite and beidellite type of clay minerals.

In rest of alluvial areas , mixed clays , black , brown to reddish brown , derived from sandstones and basalt rocks are observed and are predominantly sandy - clayey in nature with calcareous concretions.Near the banks of the rivers and at river confluences,light yellow to yellowish brown soils are noticed which were deposited during the recent past. These soils are clayey to silty in nature. The soils near the foots hills are gravelly with good porosity.

1.7 Landuse, Agriculture/Irrigation/Cropping pattern

The statistical data of land use, crop sown, area irrigated by tubewell, dugwell, Ponds of Narsinghpur district has been extracted from the statistical hand Booklet-Narsinghpur district 2016. Canal command area is taken from district groundwater survey unit-39 Narsinghpur.

Table No.2: Area Irrigated by Different Source in Narsinghpur District as on 30th June 2016.

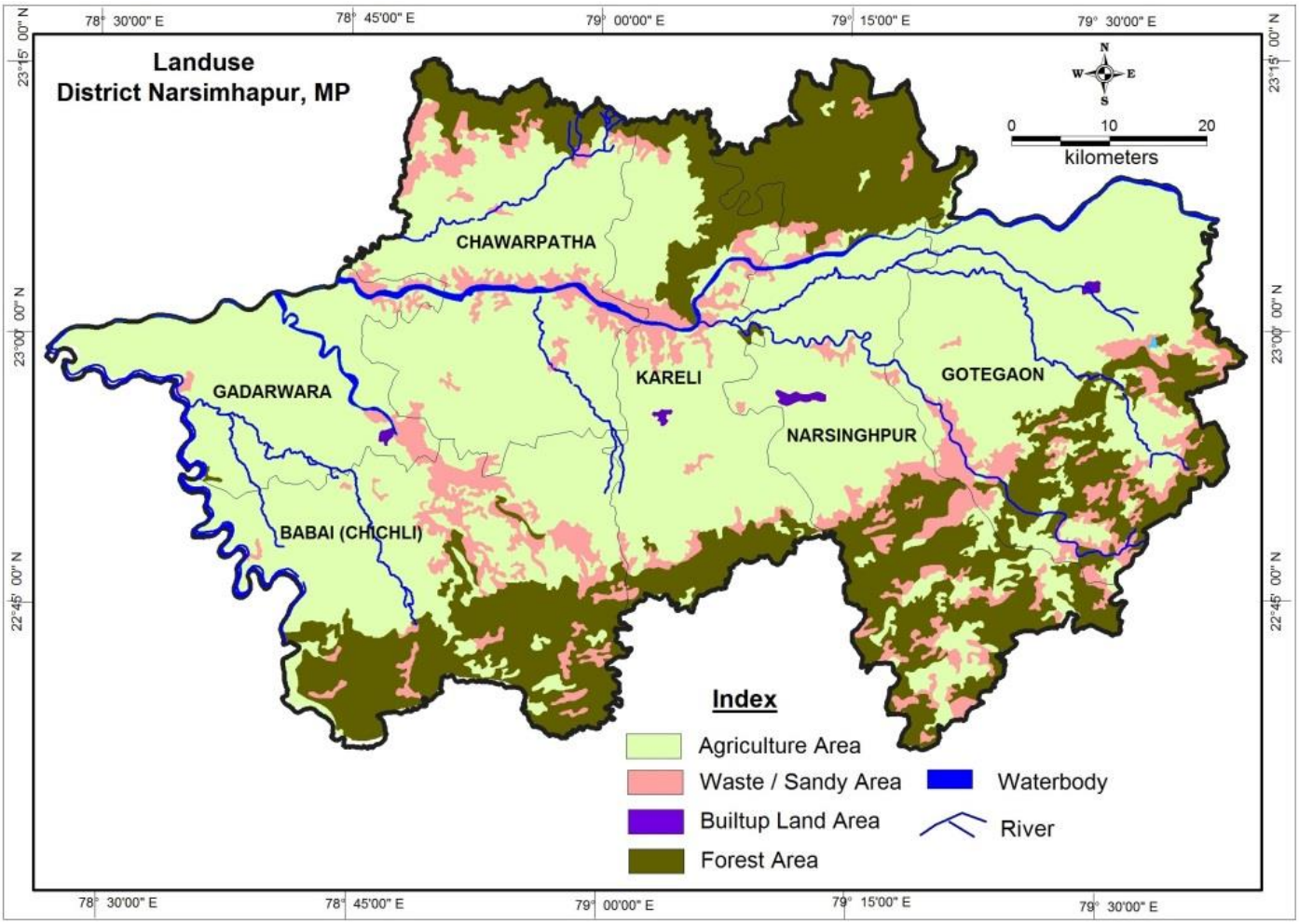
Block	Area Irrigated by Tube Well	Area Irrigated by Dug Well	Total Area Irrigated by Ground Water	Area Irrigated by Canals	Area Irrigated by Ponds	Total Area Irrigated by Surface Water Area	Kharif	Rabi
	(Ha)	(Ha)	(Ha)	(Ha)	(Ha)	(Ha)	(Ha)	(Ha)
ChawarPatha	33000	8860	41860	0	6	6	29971	49692
Chichli	47200	5000	52200	0	0	0	32608	31541
Gotegaon	54400	10400	64800	20900	0	20900	32401	61960
Kareli	35600	1600	37200	18631	0	18631	23174	34232
Narsinghpur	34200	2300	36500	13238	0	13238	30190	41338
Saikheda	43400	8900	52300	0	0	0	28909	37893
TOTAL	247800	37060	284860	52769	6	52775	177253	256656

As shown in table No 3 Gross sown area of Narsinghpur district in 2015-16 is337635 ha.

Table No.3: Gross Sown Area of Narsinghpur District

Area	Type of soil	Gross Area sown (ha) (2015-16)	Area irrigated by surface water (ha) (2015-16)	Area Irrigated by GW (ha) (2015-16)
Narsinghpur District	Black Cotton soil, mixed soil, gravelly sandy soil and Red Loamy soil	3,37,635	52,775	2,84,860

Fig 4 : Landuse Map



Chapter II Data Collection and Generation

2.1 General Geology and Stratigraphy

The geology of the district in this part of the Narmada upland valley has been studied by numerous field geologists in the past belonging to Geological Survey of India, Central Ground Water Board and State department of Geology and Mining.

These studies unfold the occurrence of various rock formations as old granites of Archean to the alluvium of Recent age. The other important formations outcropping in the district are Deccan Traps of Cretaceo-Eocene, Lametas of Upper Cretaceous, Gondwanas of Paleozoic to Mesozoic, Sandstones belonging to Semri Series of Vindhyans and Bijawar dolomitic limestone Phyllites, Schists, Quartzites of Archaeans. The Geology of the district is shown in the Hydrogeological Map Fig-7.

A brief description of the different litho units is as follows:

Archaeans

The Archaeans are represented by granites and phyllite schists, quartzite, limestone and breccias belonging to the Bijawar series.

The granites are pink and buff in colour, medium grained, hard massive and compact when fresh. They show gneissose and augen structures due to metamorphosis. The granites are extensively weathered and jointed up to a depth of 20mbgl.

The Bijawars are represented mainly by limestone quartzite and dolomites and occur as small isolated patches. The limestone is grey to grayish white, hard and compact and dolomite in nature. They are weathered down to depth of 8-10m.

The Bijawars occur mostly along the Northern bank of river Narmada in isolated out crops near Barman hat, near villages Chanwarpatha, Betli and Gumda.

The younger metamorphic of the Upper Pre-Cambrian occur as few scattered outcrops and are confined are seen Southwest of Gadarwara and Narsinghpur and South of Gotegaon. The rock types are mostly phyllites, schists, quartzites, dolomite, limestone and calcareous slates.

Vindhyans

The Vindhyans are represented by hard reddish to purple coloured massive sandstone and quartzite with thin alternating bands of buff shale. They occur in the North Eastern part of the district and can be seen as continuous hillocks along the Bhopal Jabalpur road (NH-12). The sandstones are not much weathered but show jointing up to a depth of 20m.

An isolated small outcrop of the Semri series consisting of fine –grained sandstone and micaceous shales occurs due East of Tendukhera (23˚10′/78˚57′ , 55I/14) Such an occurrence is probably due to unevenness of the floor of the older rocks.

Gondwanas

The rocks belonging to Gondwana System occur over an area of about 700sq. km In the Southern part of the district. These rocks outcrop as high hills and narrow steep valleys forming the Satpura range which is mostly covered by forests. The total thickness of the formation in Satpura Hills ranges from 2,000 to 3,000 m. The beds generally dip at low angles to the North and are frequently faulted. Various stages and series of the Gondwana System occurring in the district are the Talchir stage comprising clay and boulder beds.

The Barakar stage comprising felspathic sandstone, shale and coal seams, the Denwa stage comprising alternating sandstone and shale of green, red and buff colours and having considerable thickness , the Bagras comprising conglomerate and clay & the Jabalpur stage comprising about 150 m thick beds of sandstone with some white clay. Sandstone beds of various stages in the Gondwanas are moderately porous and permeable. The rocks are generally weathered up to 3 to 10 mbgl. The rocks are folded into series of synclines and anticlines.

Lametas

The Lametas lie conformably over the Jabalpur in the type area and North of Barman on Kareli-Sagar road and comprise light coloured limestone, Sandstone and clays or shales of fluviatile origin.

Deccan Traps

In general, the Traps occur in the form of volcanic flows, dykes and sills. The Traps are remarkable in their persistent flatness with gentle dip towards North.

The weathered material derived from the Traps forms the most fertile black cotton soil and under favorable conditions gives rise to later ties.

Basaltic lava flows belonging to the Deccan Trap formation occupy about 800sq. km. of area in the Southeastern part of the district. This area is rugged and hilly forming part of the Satpura ranges. The basaltic rock is dark grey in colour fine to medium- grained, massive and compact. Each lava flow comprises about 70% basal massive unit and about 30% upper vesicular unit. Generally a marker horizon in the form of red bole bed or inter trappean bed separates one flow from the other.

Alluvium:

Almost 70% of the study area is occupied by the alluvium. The alluvial valley is bordered by the Vindhyan in the North and Satpura in the South and occurs all along the Narmada River in the district. They are of variable thickness depending upon the bedrock configurations. The alluvium comprises 35 to 176 m thick deposits fillings the trough of the rift valley. The thickness of alluvial deposit is maximum along the midrib region but gradually decreases on either side with a few exceptions. South of the Narmada, alluvium is underlain by compact and variegated clay beds belonging to Denwa Series of Upper Gondwana. However, north of the Narmada the Gondwanas are completely absent and the alluvial deposits directly overlie the Vindhyans or the Archaeans and Bijawars.

The alluvium comprises mostly stiff, yellow, yellowish brown and grey clay with numerous intercalated bands of sand and gravel, which from the aquifer material, while kankers in the form of ferruginous concretionary and calcareous nodules and conglomerates are also occasionally associated. The formation is generally very coarse grained is the foothill region but gradually becomes finer towards the central part.

The general geological successions in the district are given in table-4.

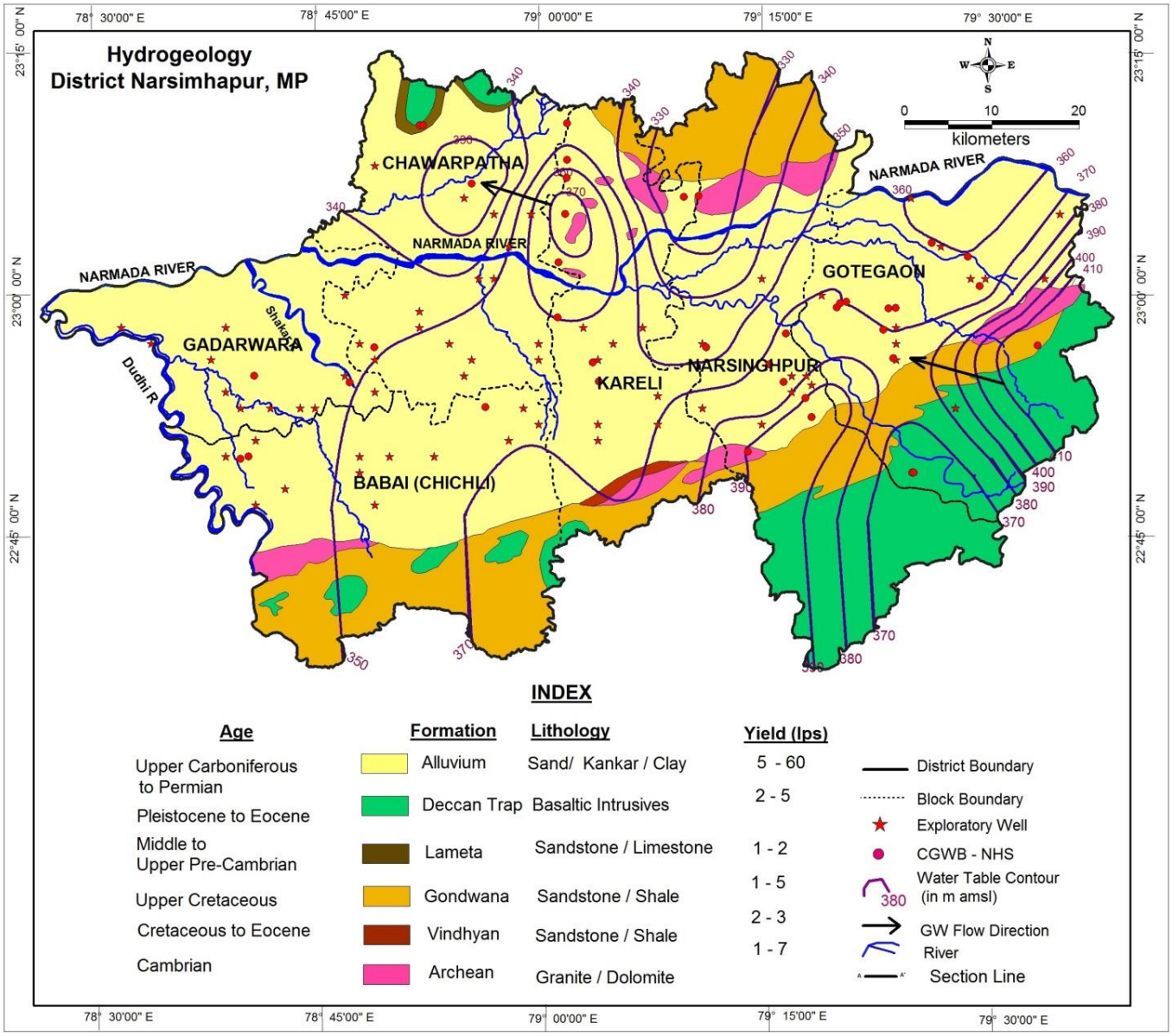
Table-4: General Geological successions of Narsinghpur district.

Age		Stratigraphic Unit	Lithology
Recent Pleistocene			alluvium & soil cap comprising clays, sand, gravels etc.
---------- Unconformity ----------			
Cretaceous to Eocene		Deccan trap and intertrappeans	Basaltic lava flows and intertrappean bed comprising red bole.
---------- Unconformity ----------			
upper cretaceous		Lametas	sandstones, silt stones , limestones & Marls
Permian to upper cretaceous	Upper Gondwana	Jabalpur series, (Jabalpur stage, chaugan stage)	soft porous sandstones and light coloured shales & clays
		Mahadeva series (Bagra stage & Denwa stage)	pebble beds & conglomerates white & yellow sandstones and shales
---------- Unconformity ----------			
upper carboniferous to Permian	lower Gondwanas	Danuda series, Barakar stage	white to lava coloured sandstones & grits with occasional conglomerates and shales
		Talchir series, Talchir stage	green boulder with clays & shales
---------- Unconformity ----------			
Cambrian	Vindhyan	Upper Bhander series	Reddish purple to buff coloured sandstones and quartzites.
---------- Unconformity ----------			
upper to middle Precambrian	metamorphic	calcareous crystalline quartzite phyllites & schist bijawars granitic gneiss	Dolomite, limestone & calcareous shales quartzitic &cal-granulites phyllites & various schist marbles and banded ferrigenous quartzites granites & granitic gneiss

2.2 Hydrogeological Data Collection

Groundwater is the principal source of irrigation in the district and all the alluvial deposits of Narmada valley in the district forms very potential aquifers. Hydrogeological set up of the district is shown in **Fig 5.**

Fig 5: Hydrogeological Setup of Narsinghpur District, Madhya Pradesh



2.2.1 Water Levels

Ground water levels form a very important parameter of the ground water system, as these are its physical reflection. The groundwater balance expresses itself in the change in water levels; hence a continuous record is important and useful. CGWB has 17 National Hydrograph Stations (NHS) and 5 Peizometers in Narsinghpur district. Due to large-scale ground water development and the dug wells are drying up.

Pre-monsoon (May 2017)

Depth to water level during pre-monsoon, 2017 ranged between 2.43m bgl at Bachai and 22.7m bgl atRamkhiria. Water levels, in general fall between 5-15m bgl. Shallow water levels of less than3 m bgl occur in small southern part of Narsinghpur block. Deeper water levels, more than 15 m occur in northern part of Narsinghpur, Kareliand Chanwarpatha blocks and in small patch of gotegaon block.During May 2017, pre-monsoon the depth to water level in Narsinghpur districts as shown in Fig 6.

Post-monsoon (November 2017)

During post-monsoon period of the same year, November 2017, the water levels varied from 2.02m bgl at Koudiya to 17.7m bgl at Dobhi. The water level, in general lies between 3 to 15m bgl during this period. Shallow water levels, less than 3 m bgl occur in parts of the Chichli and Saikheda blocks and patches of Narsinghpur block. Deep water levels above 10 m bgl occur in the Narsinghpur, Chanwarpatha and Gotegaon blocks as shown in Fig 7.

Water level Trend (2008-2017):

The decadal water level falling trend of pre-monsoon and post-monsoon is in the range between 0.04 to 0.29m/year and0.1 to 0.41m/yr respectively.The decadal water level rising trend in the pre-monsoon and post monsoon is in the range of 0.01to 0.51m/yr and 0.01 to 0.75m/yr respectively. Out of 21 hydrograph stations 7 stations and 5 stations were showing declining trend in last 10 years in premonsoon and post monsoon respectively. The water level trend of Narsinghpur district is shown in figure8 and figure 9.

Fig 6:Premonsoon Water Level (May-2017) of Narsinghpur District, Madhya Pradesh

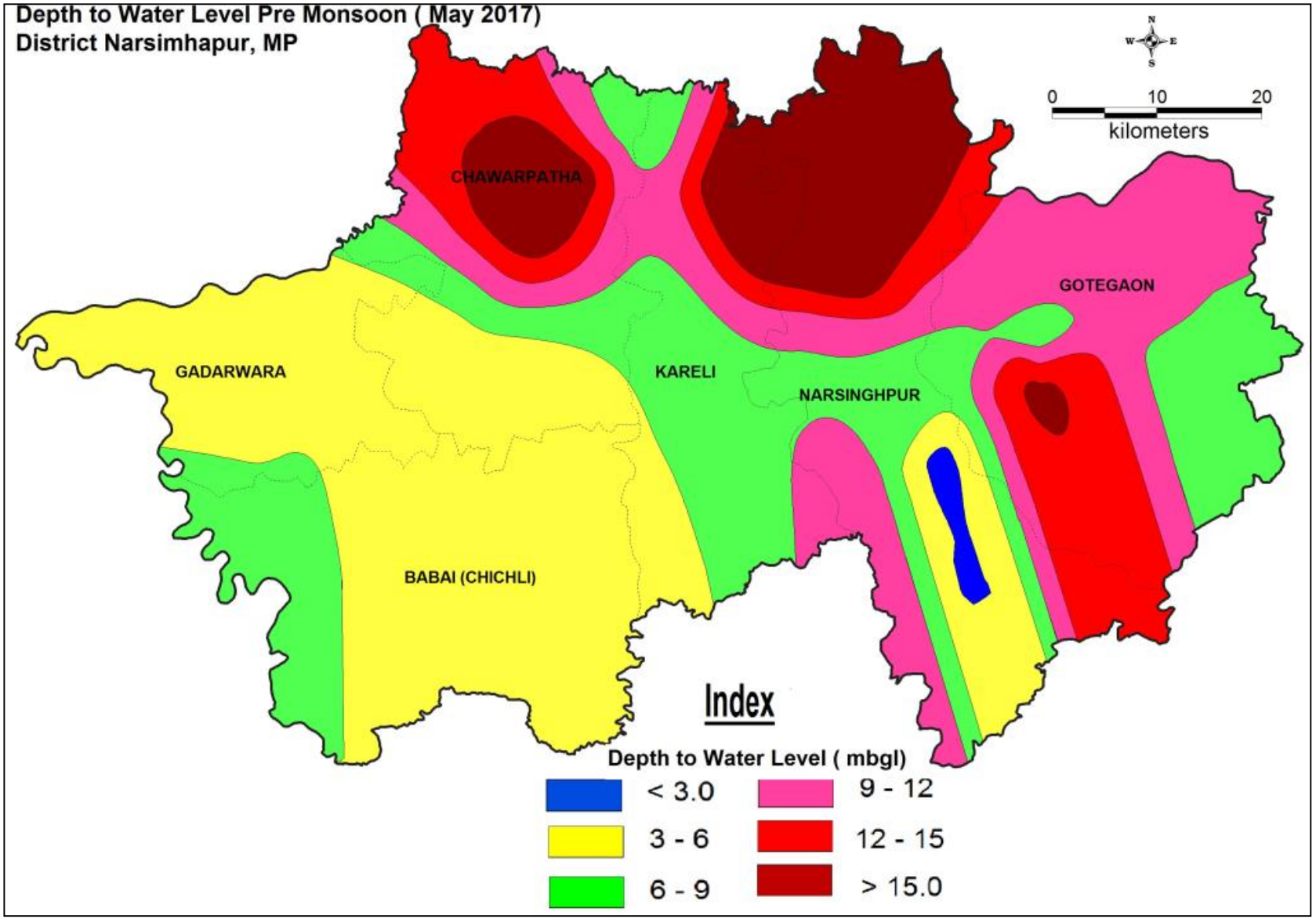


Fig 7: Postmonsoon Water Level (November-2017)of Narsinghpur District, Madhya Pradesh

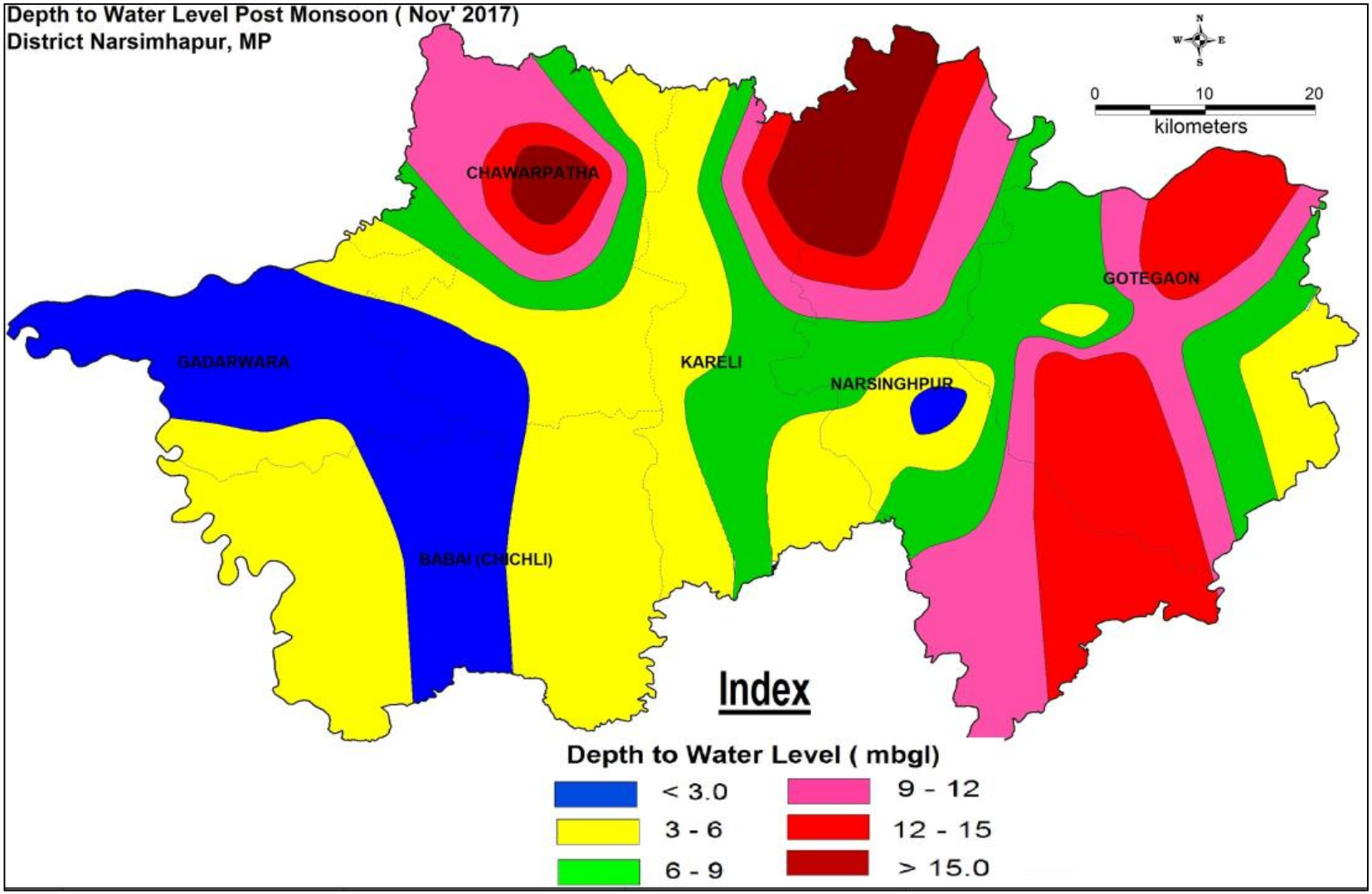


Fig 8: Decadal Water Level Trend (May2008 – May2017) of Narsinghpur District Madhya Pradesh

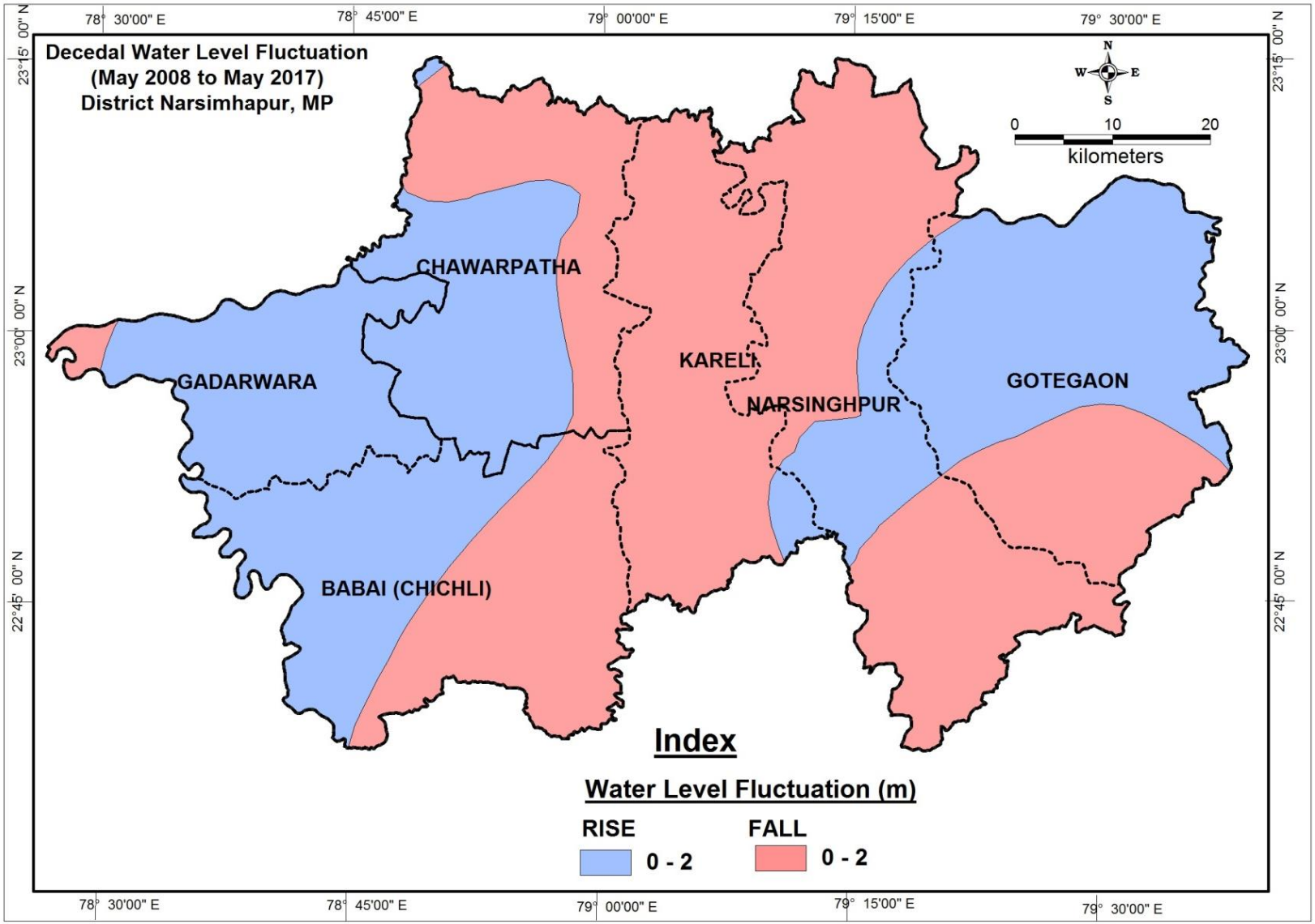
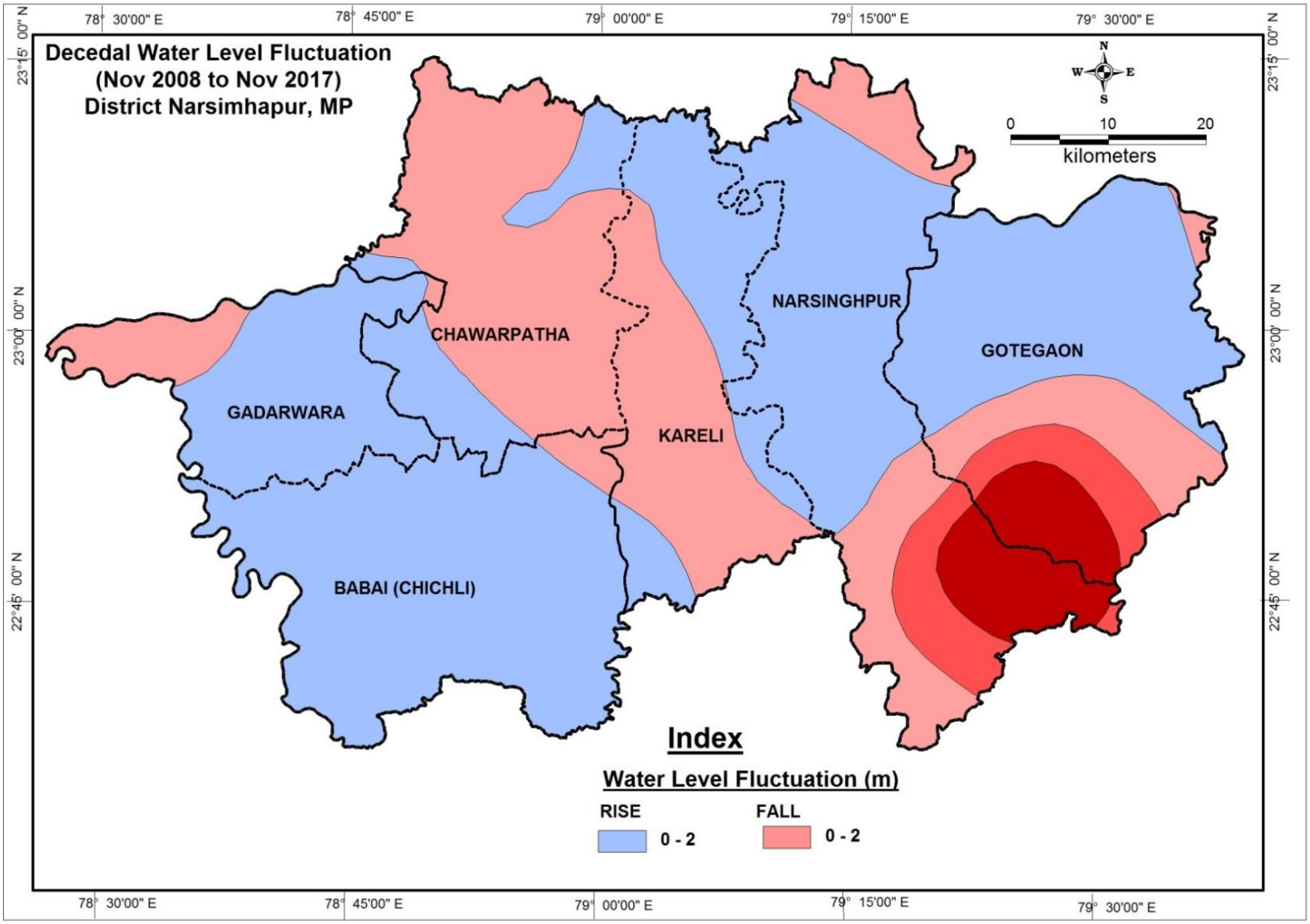


Fig 9: Decadal Water Level Trend (Nov2008 – Nov2017) of Narsinghpur District Madhya Pradesh



2.3 Hydrogeological Data Generation (Exploratory Drilling):

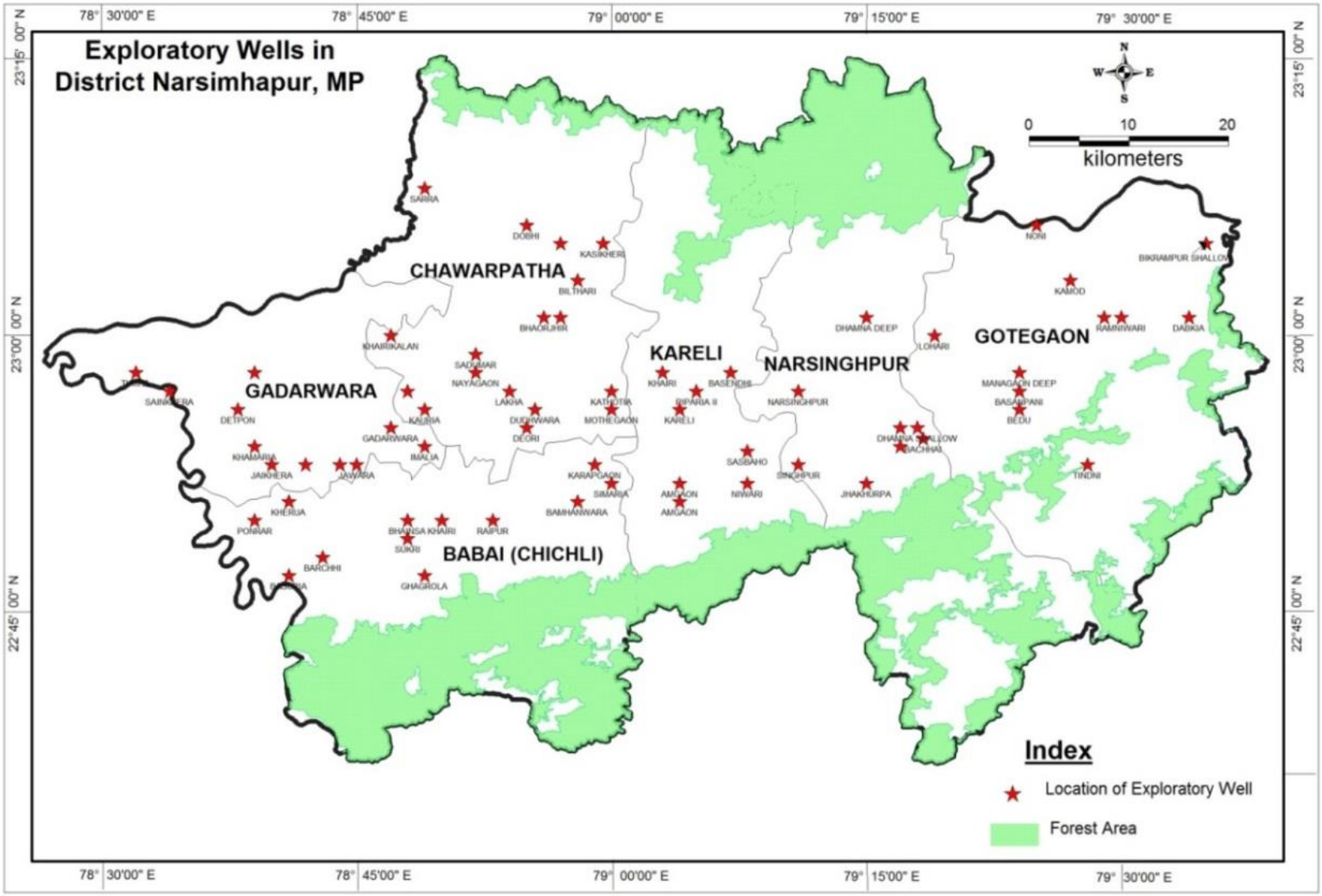
About 72 exploratory tube wells were drilled in Narsinghpur district by the Central Ground Water Board during the Narmada Project Period (1972-1978) (annexure). Extrapolation & correlation of the litho logs of these exploratory wells gave some insight of the surface geology of the area. Based on the borehole data, well distributed over the entire district, a fence diagram **(plate VIII)** was prepared which reveals the following:

The Precambrian to Cambrian basement is quite uneven The metamorphic basement occurs at a shallow depth at Sarra (44.6m), Dobhi (68.0m) in the NW, Simaria (49.0m) in the mid SW, Tindni (62 m) South of Narmada in the NE and Jharkhurpa (34.5m) in the mid SE near the Southern fringe of Alluvial contact. Near this location, it appears that the basement is encountered in the boreholes located very closely in both the Eastern and Western direction. Deep basement is encountered in the midrib region of the district at basendhi (295 m). Amgaon (365.0m) Singhpur (400.0m), Samnapur (262.0m), the last two being on both the sides of Jharkhurpa borehole having a very shallow basement depth indicating a fault. The basement rocks encountered are pre Cambrian Granites, quartzites and phyllites, Bijawar slates and rocks belonging to calcareous crystallines and Vindhyan shales.

Overlying the Archaean basement the Gondwanas of considerable thickness are encountered at Amgaon (250 m.) Singhpur (287.m), Samnapur (160 m thick) Bedu (140 m) Basendhi (124.0 m), Manegaon (90 m.) and Bikrampur (70 m) Gondwanas are completely missing in the North of Narmada river The thicknes of these formations increases in the midrib region from Basendhi to Amgaon attaining maximum at Singhpur and decreasing towards East and North East. At Jharkhurpua the Gondwanas are completely absent strongly suggesting presence of a fault. Compact and variegated clay beds belonging to Denwa series of upper Gondwanas are delineated by borehole logs.

Lametas and traps have not been seen occurring at depth within the area covered by the fence.

Fig 10. Location Map showing exploratory drilled wells



2.4 Hydrochemical Data

Ground Water Quality of Narsinghpur District

The water samples were collected from National Hydrograph Stations in clean double stopped poly ethylene bottles from 16 different locations of Narsinghpur district during May 2015.

The pH of ground water of Narsinghpur district ranged in between 7.56 to 8.31. As per BIS recommendation, all water samples recorded within the permissible limit of 6.5 to 8.5. In the Narsinghpur district, pH has been observed more than 8.20 in the dug well of Gotegaon (8.23), Karakbale New (8.27) and Salichauka (8.31).The ground water of the study area can be assessed as slightly neutral to alkaline in nature.The electrical conductivity of ground water in Narsinghpur district ranges between 460 to 1495 µS/cm at 25°C.The maximum value of electrical conductivity observed in the dug well of Deoribadwani village. The electrical conductivity shows that the ground water in Narsinghpur district is slightly saline in nature.

The fluoride concentration in Narsinghpur district ranged in between 0.12 to 1.19 mg/l. The maximum concentration of fluoride has been recorded in Bachai village i.e. 1.19 mg/l. As per BIS recommendation, all water samples recorded fluoride concentration within the permissible limit of 1.50. In the district, nitrate concentration in ground water ranged in between 3 to 109 mg/l. The 68.75 % ground water samples recorded nitrate concentration within the BIS acceptable limit of 45 mg/l and 31.25% water samples recorded more than 45 mg/l of BIS recommendation. The concentration of nitrate more than 100 mg/l has been detected in ground water of Kareli Basti (109 mg/l) dug wells. High nitrate in ground water appears may be due to anthropogenic activities or excessive use of fertilizers etc.

Total hardness of ground water in the study area ranged in between 183 to 490 mg/l. The maximum concentration of total hardness has been recorded in Sundernagar village i.e. 490 mg/l.

In the district water are calcium bicarbonate and calcium chloride types, it shows temporary and permanent hardness type of water respectively.The US Salinity Diagram of Narsinghpur district shows the ground water is low to high salinity classes i.e. C_2S_1 and C_3S_1 classes.

Fig 12: Electrical Conductivity Map of (Pheratic Aquifer) Groundwaterfrom dugwells, Narsinghpur District, Madhya Pradesh (2015)

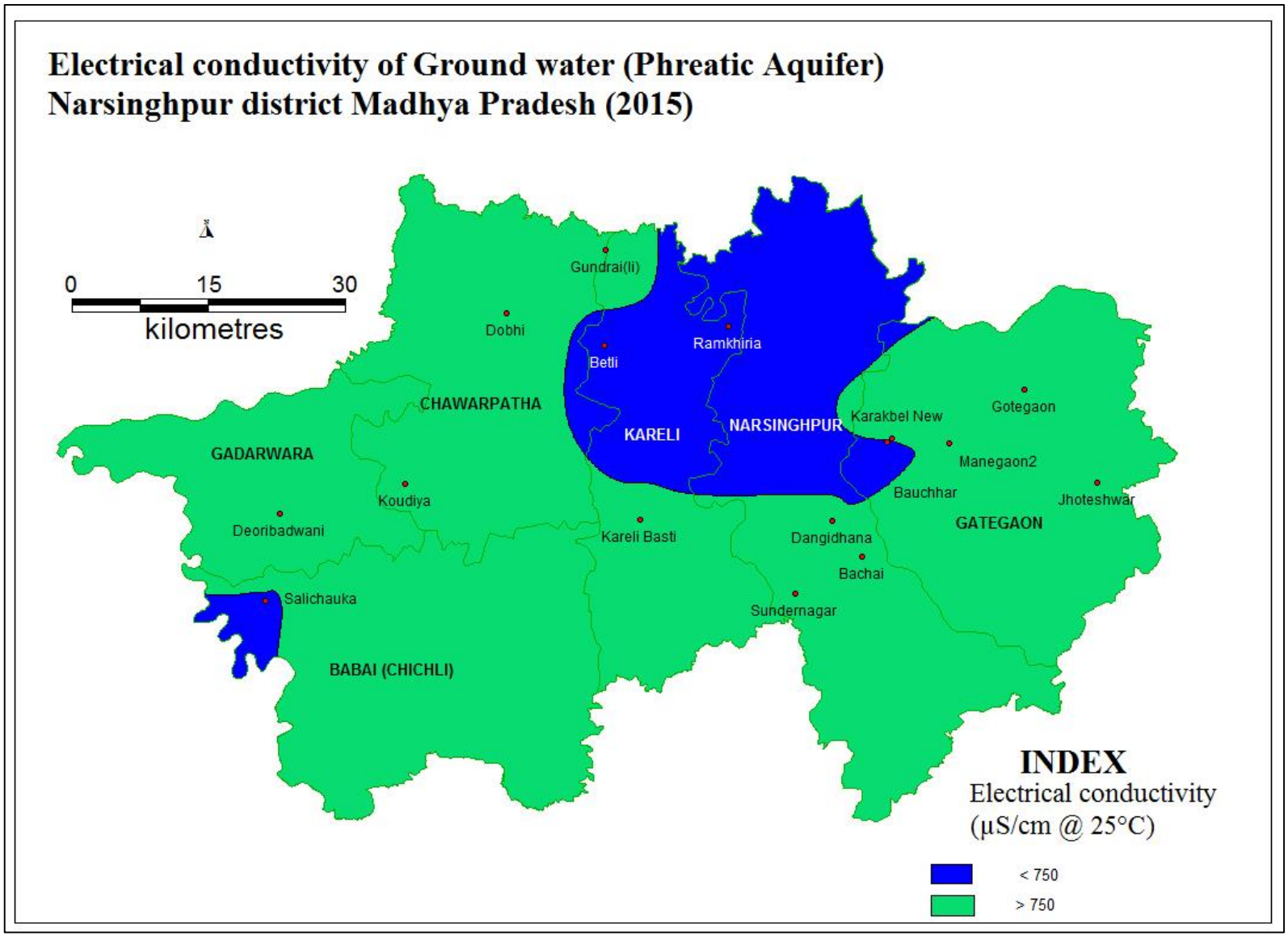
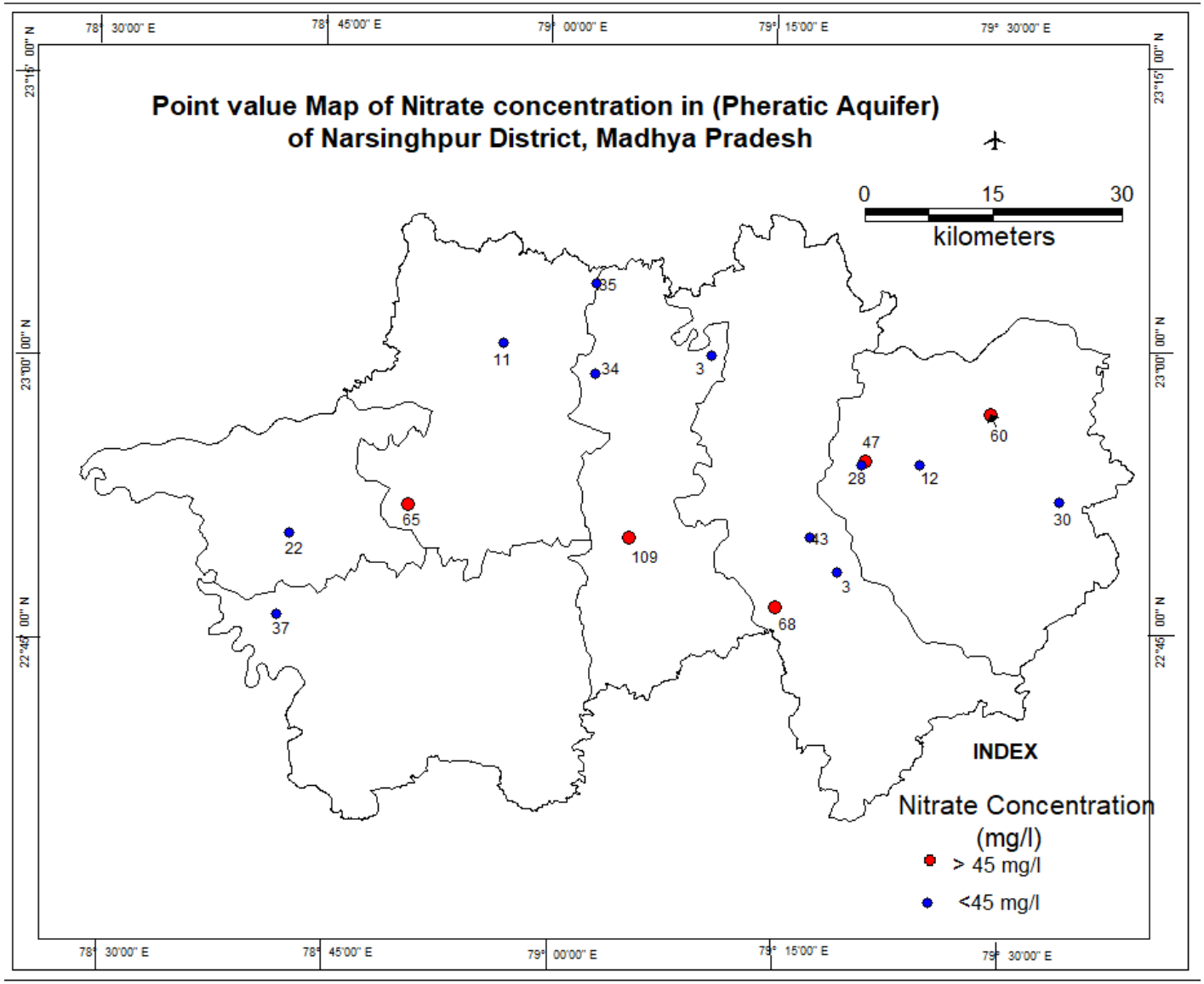


Fig 13: Map showing Area affected by Nitrate Concentration in groundwater of Narsinghpur District.



Nitrate Concentration

The overall fluctuation over optimum recommended limit of nitrate concentrations in waters sampled from Narsinghpur District can be understood from this figure.

Fig 14: Variation with BIS optimum limit of Nitrate concentrationalong with stations

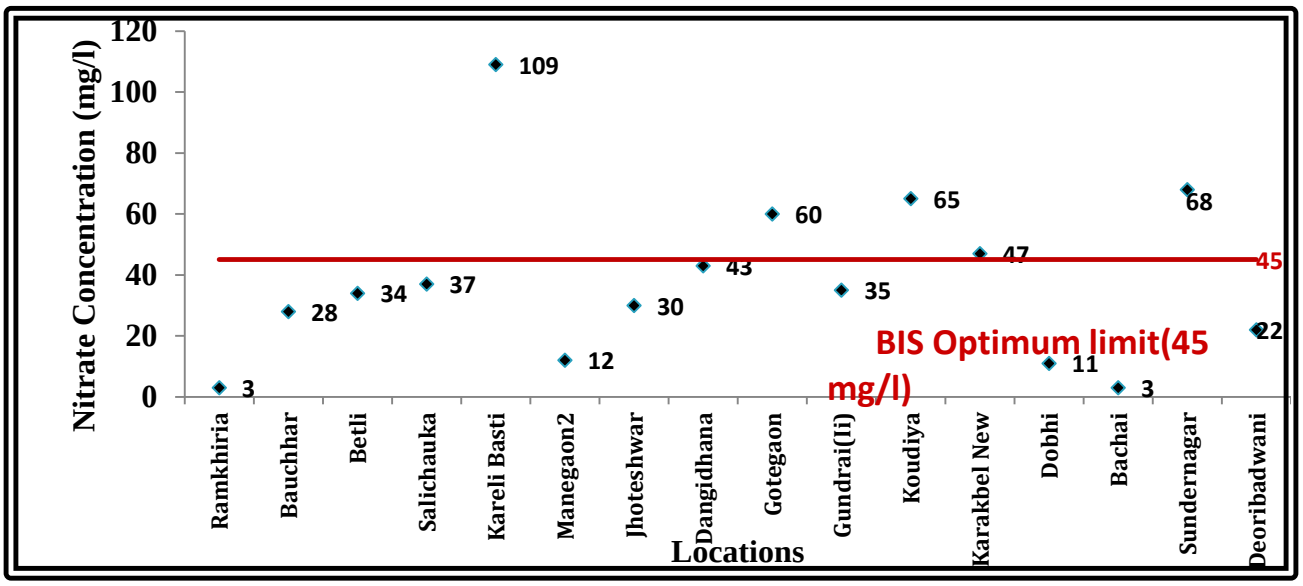
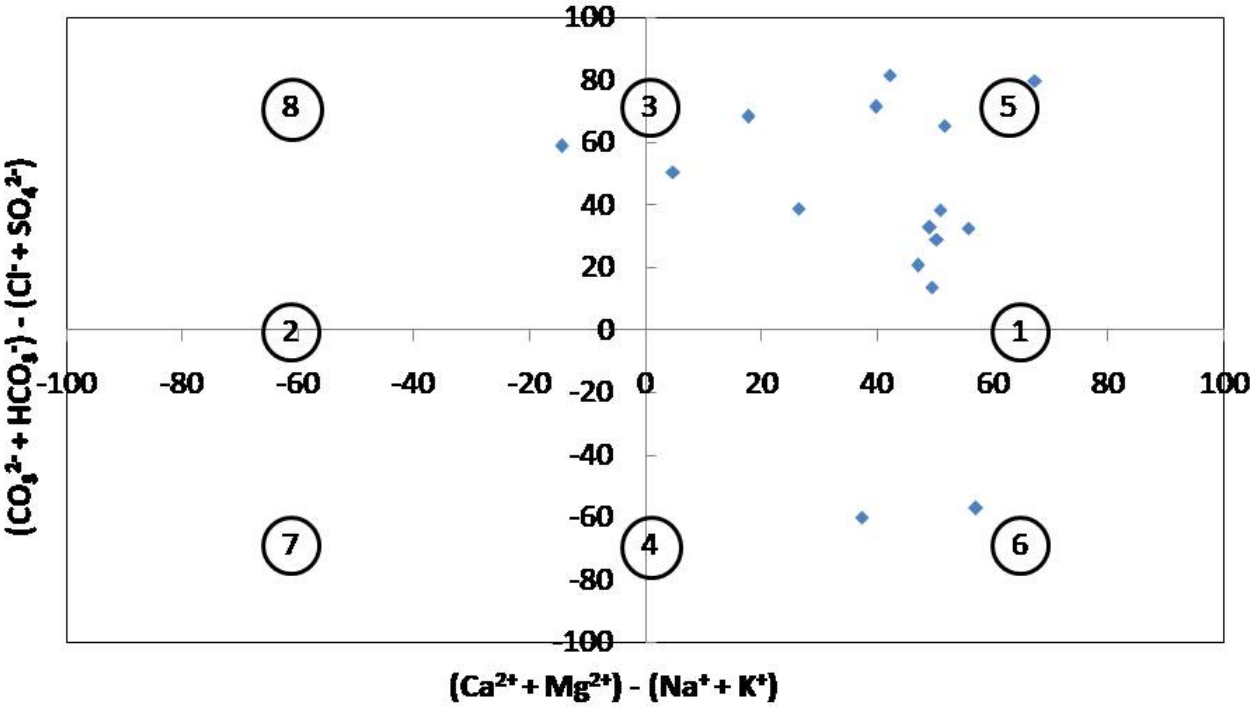
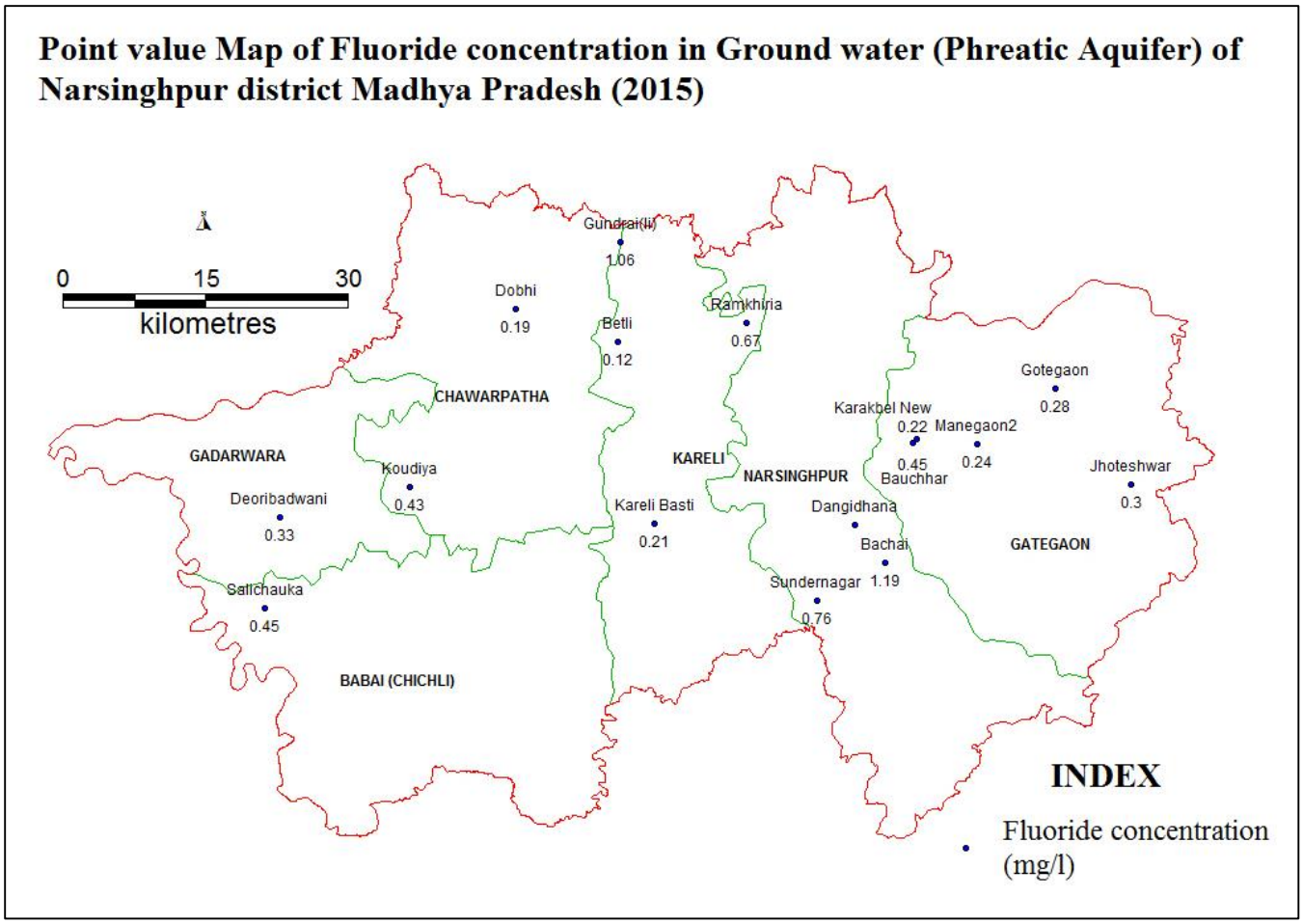


Fig 15:Chadha's Diagram



- **Type 5**- 82.3% of samples fall in this type. The alkaline earth and weak acidic anions exceed both alkali metals and strong acidic anions respectively. Such water has temporary hardness.
- **Type 6**- 11.8% of samples fall in this type in which alkaline earth exceed alkali metals and strong acidic anions exceed weak acidic anions. Such water has permanent hardness and does not deposit residual sodium carbonate in irrigation use.
- **Type 8**- 5.9% of samples fall in this type. The alkali metals exceed the alkaline earth and weak acidic anions exceed strong acidic anions respectively. Such water deposit residual sodium carbonate in irrigation use and cause foaming problems.

Fig 16: Point valueMap of Fluoride Concentration in groundwater of Narsinghpur District (2015).



2.5 SubSurface Geophysics

The geophysical borehole logging plays a vital role by providing information on the character of the rocks and fluid penetrated by boreholes. This information is useful for lithostructural interpretation of the aquifer systems as well as for evaluation of hydrogeological characteristics and the water quality distributions in the aquifer system.

Borehole logging wasconducted on Babai Chichli, Saikhera, Narsinghpur, Kareli, Gotegaon blocksof Narsinghpur district for deciphering the aquifer geometry identification. On the basis of that electrical logging such as Resistivity, gamma, and Spontaneous Potential logging, potential zones were deciphered and matched with the borehole data and corrected lithologies were prepared for the assembly design.

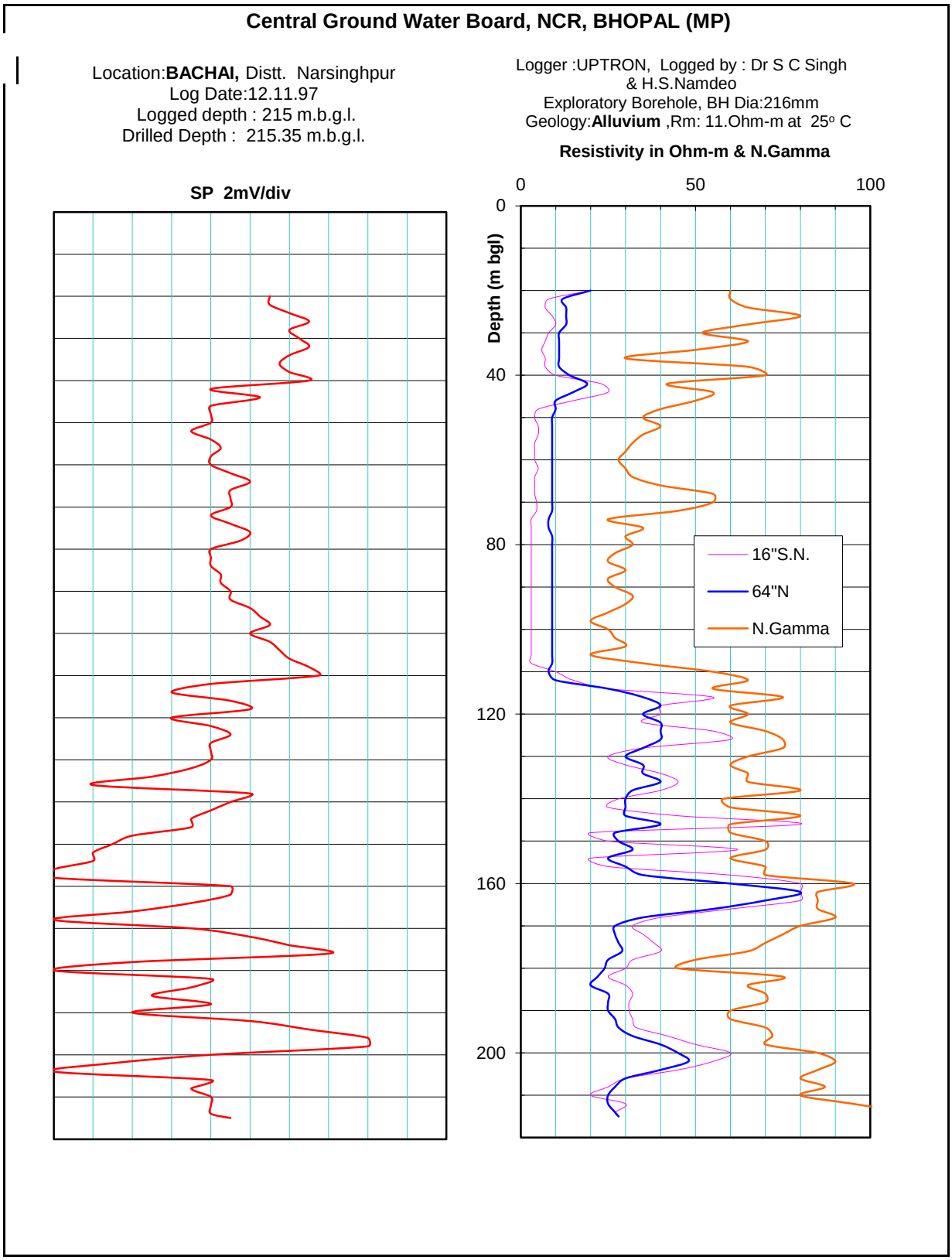


Fig:17 Resistivity, Natural gamma and SP logging in exploratory borewell of Bachai village.

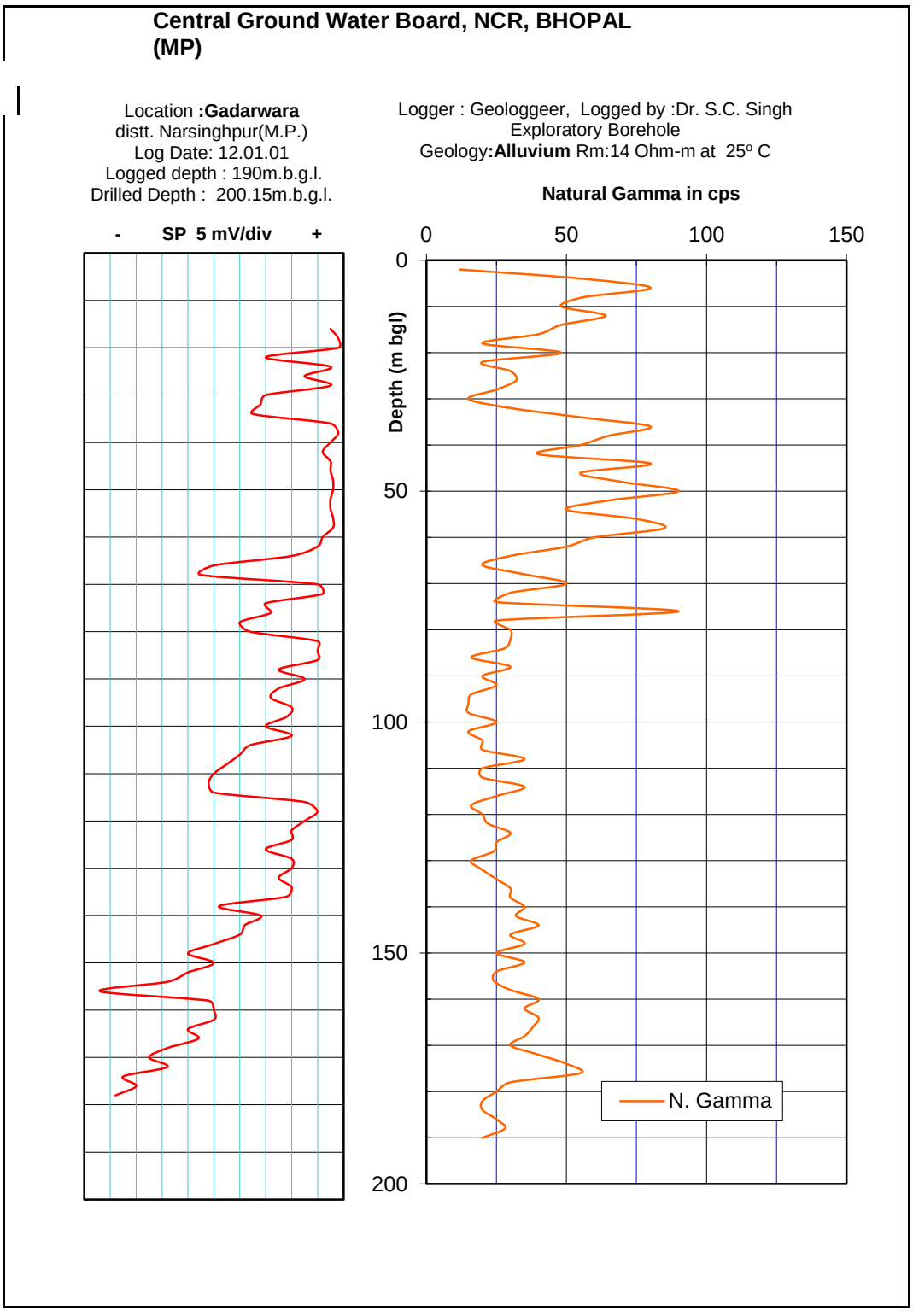


Fig 18: Natural gamma and SP logging in exploratory borewell of Gadarwara village

CHAPTER-III Data Interpretation/Integration of Aquifer Map

3.1 3Dimentional Lithological Model

A 3-Dimensional model was prepared for the Narsinghpur district, Madhya Pradesh after detailed analysis of the pre-existing and available bore-log data collected from the Basic Data Reports of CGWB. A comprehensive analysis was made as per lithology and stratigraphy of the area. The location details with RL values and their corresponding stratigraphic details as per the Rockworks format is provided in the Annexures- II and III.

In Narsinghpur District, the alluvial aquifer is the most extensive, although other type of formation also found, but for the large area it is difficult to include each and every rock type in a single model. Since we mainly concerned with the groundwater, thereforeto simplify,the model is classifiedinto Unsaturated Zone/Black Cotton Soil, Aquiclude, Aquifer and Granite/Gneiss/ Slate.Therefore thelayers have potential groundwater or have very less to no groundwater potential.

3.2 2D Lithological diagram/Cross sections

Fence diagram of Narsinghpur and three 2-D cross section was prepared using rockworks and by autocad. The cross section AA' along southwest- northeast direction using borewells Khairi, Mothegaon, basendhi, Tindni, Bikrampur and Noni were prepared. Cross-section BB' in the N-S direction was prepared using 5 borewells Tindni, Dhamna, Pansi, Bhaorjhir and Samnapur and 3rd cross section CC' along E-W direction and it was prepared by using 6 borewells Jhiria, Nayagaon, Dungaria, Basendhi, Pansi and Manegaon.

Fig19: 3 Dimensional model of Narsinghpur District, Madhya Pradesh

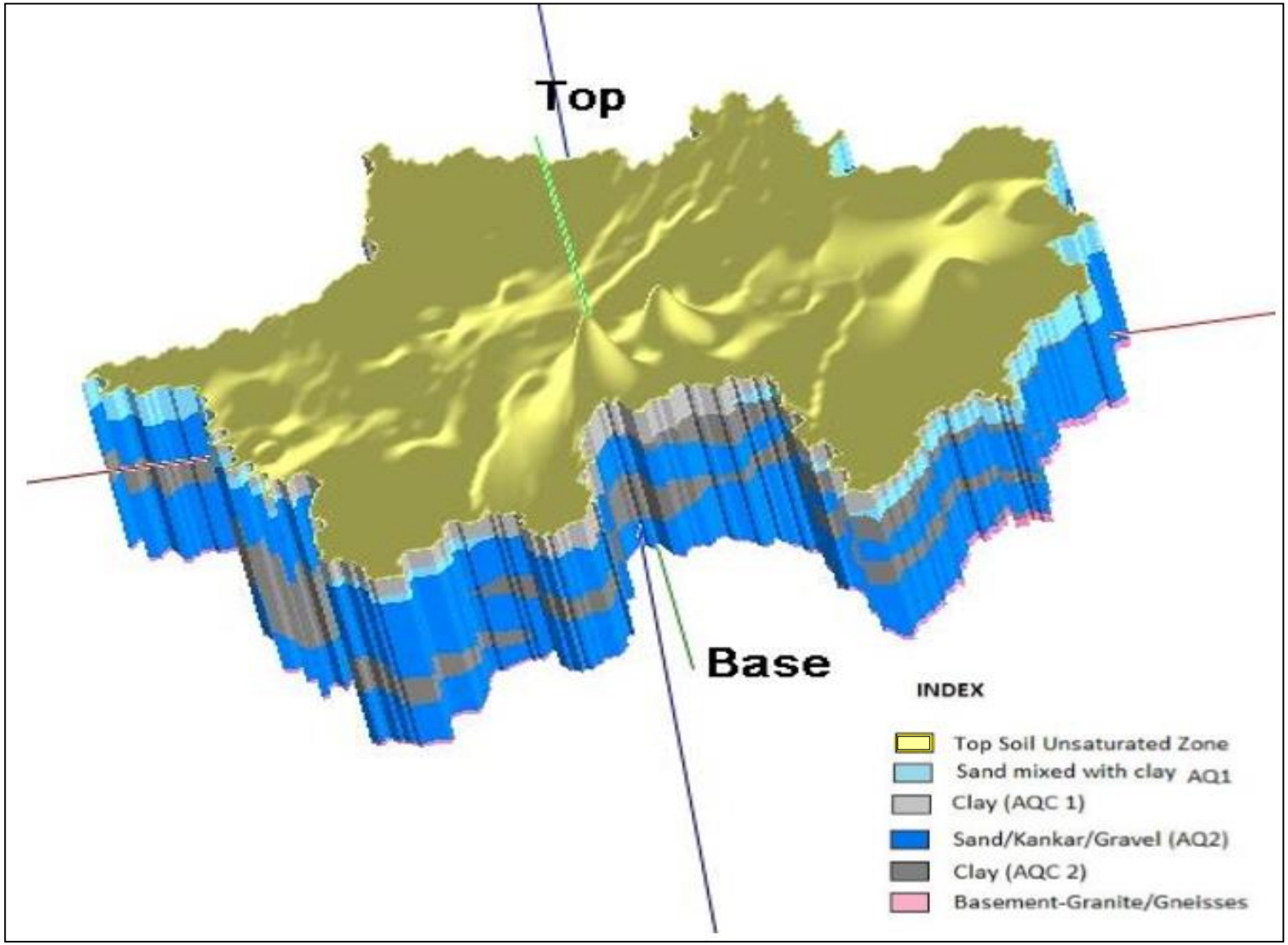


Fig 20: 2-Dimensional Cross-Section

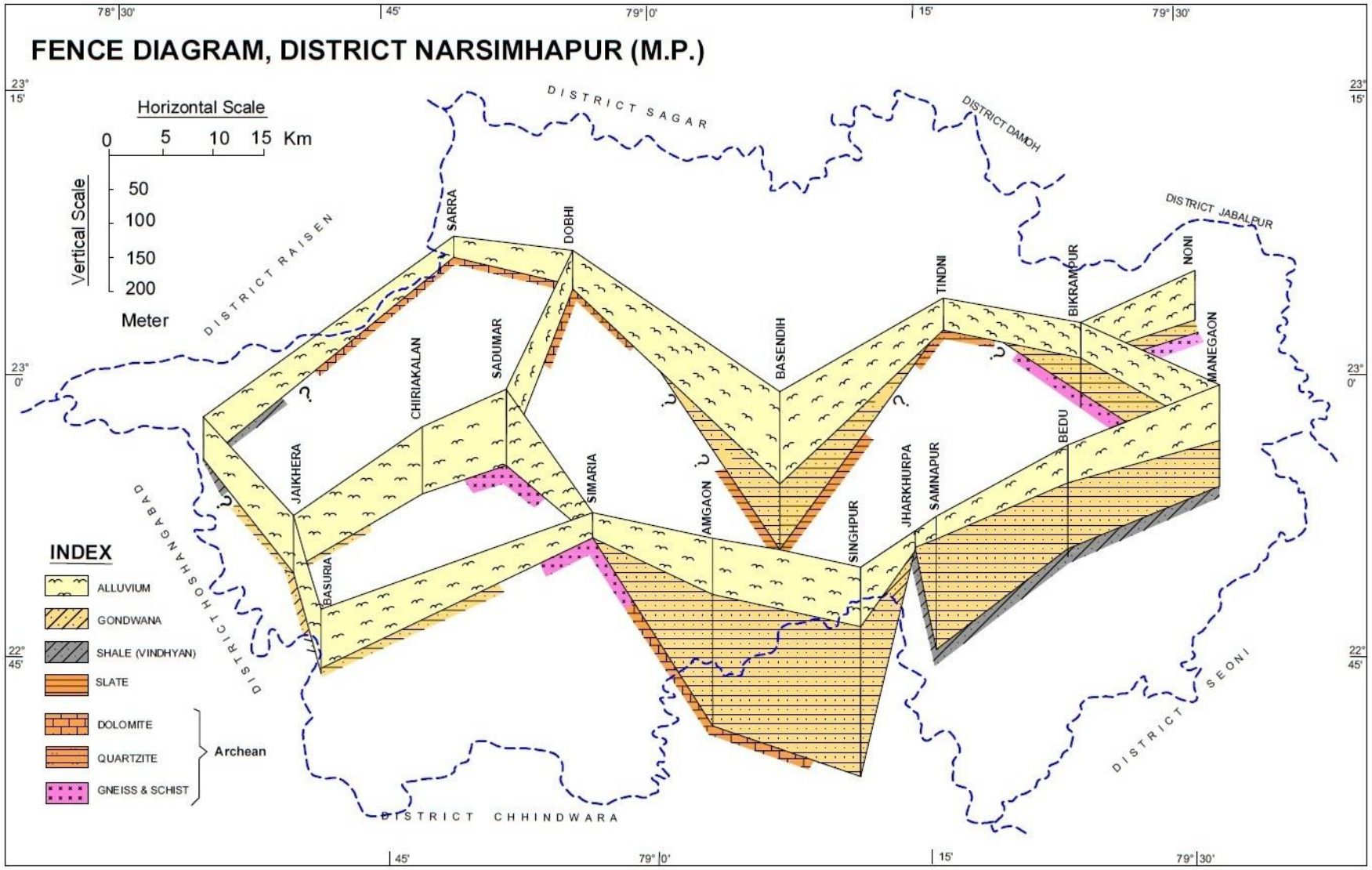


Fig 21: 2 D Cross-section along (E-W) direction, along KhairiNarsinghpur dist. M.P

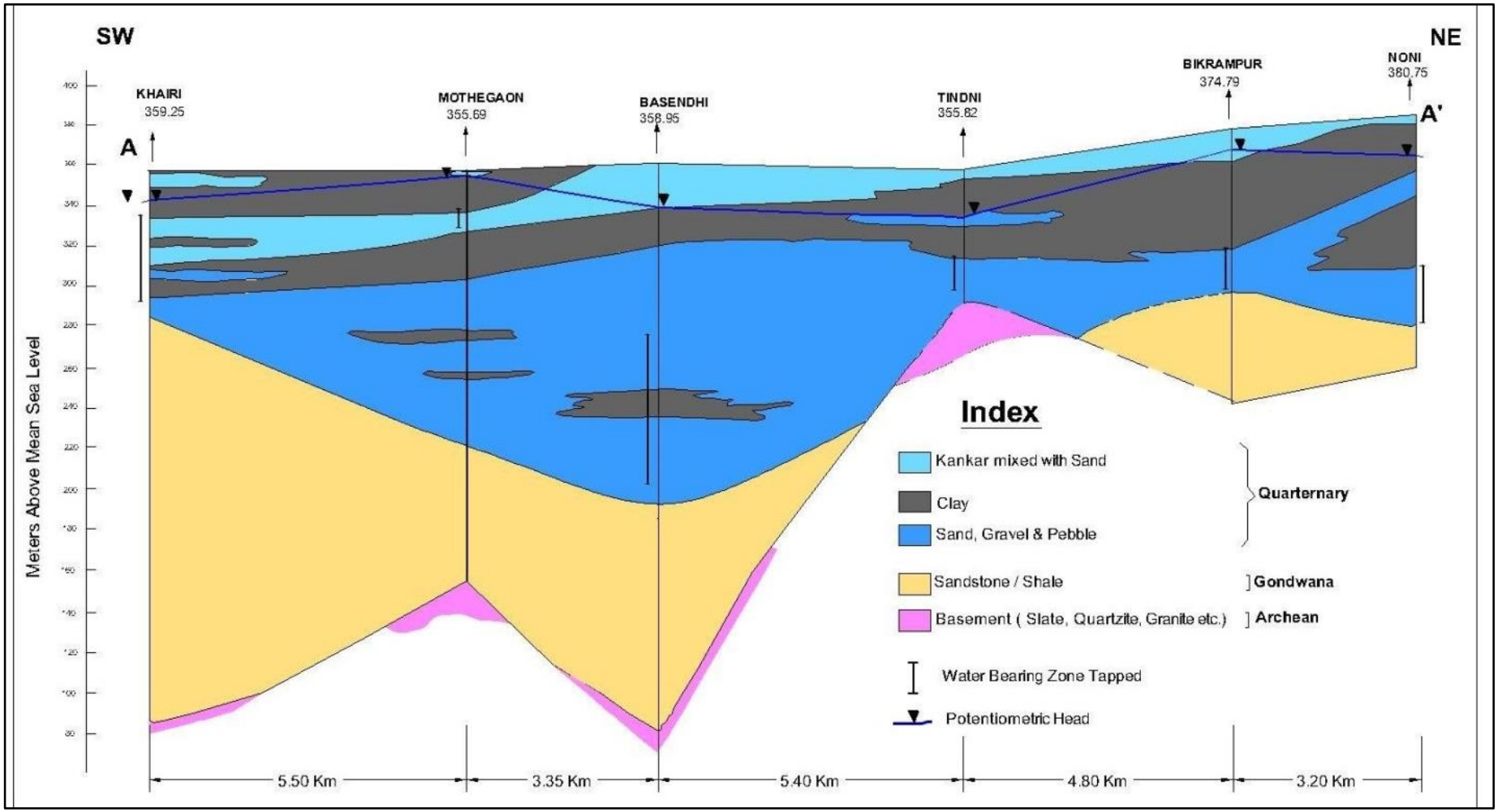


Fig 22: 2 D Cross-section along BB' (TIDNI-PANSI-SAMNAPUR)Narsinghpur dist. M.P

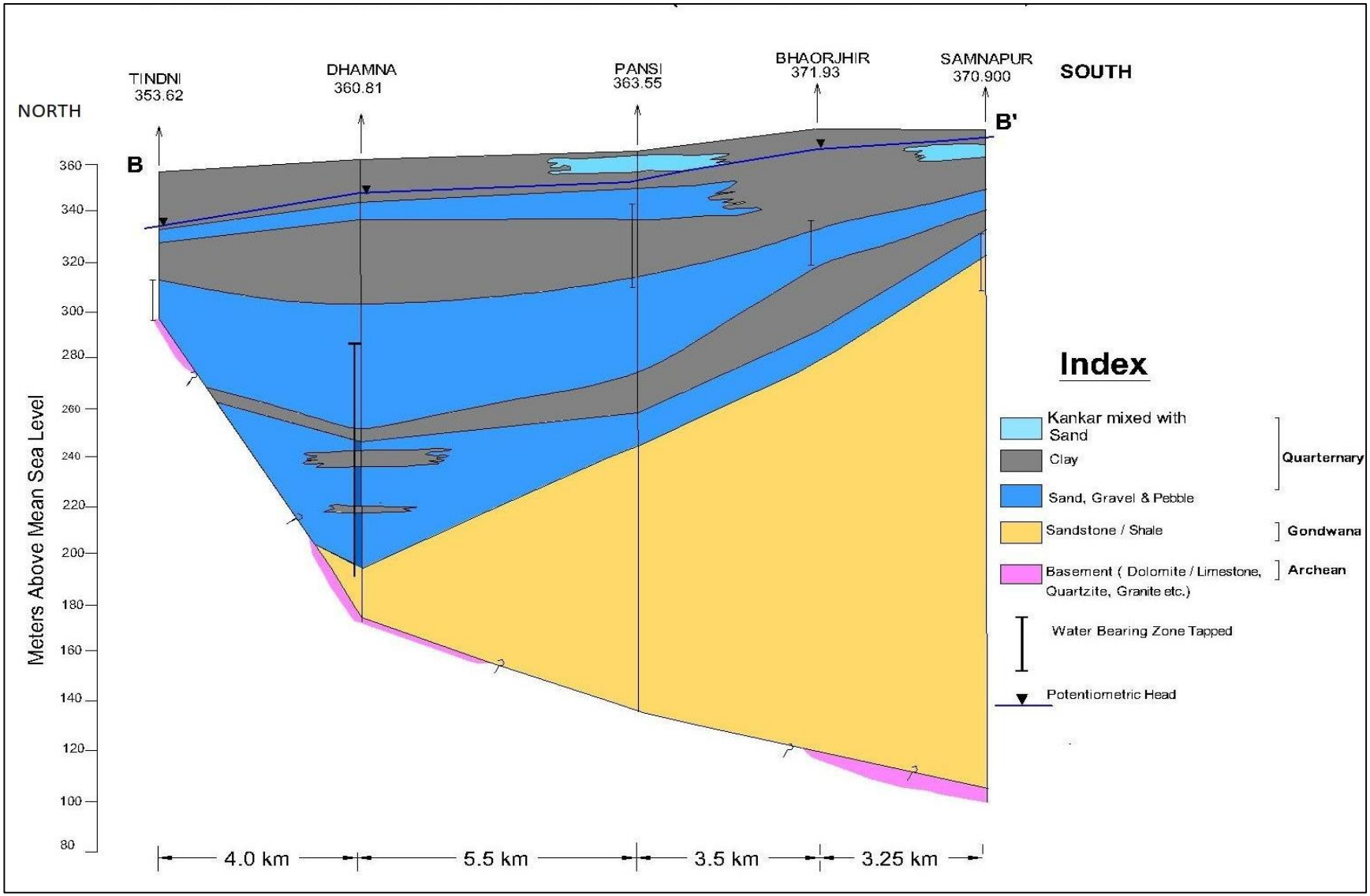
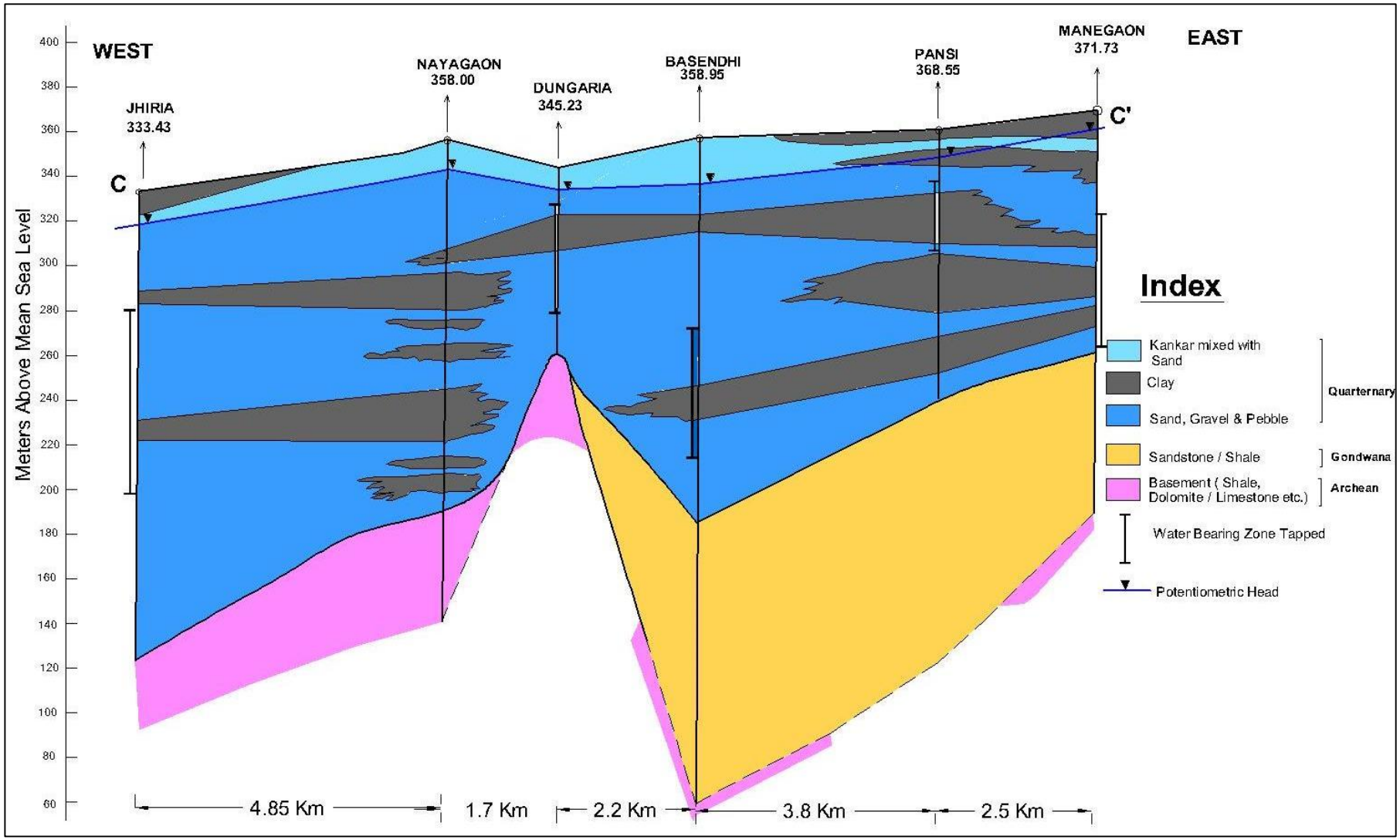


Fig23: TwoDimensional Cross-section along CC' (JHIRIA-BASENDHI-MANEGAON) Narsinghpur dist. M.P



3.3 Result and Data Interpretation:

Lithological data collected from CGWB bore wells, Piezometers, State ground water Piezometers etc. were studied and aquifer geometry and properties interpreted detail Lithologs of boreholes were studied and compressed data in form of Rockworks data sheet.

Aquifer System

The Alluvial aquifer system is most extensive one in the district . Two to three and places more number of granular zones are encountered in the alluvium, comprising fine to medium to coarse grained sand,gravel and kankar separated by clay lenses .The upper phreatic aquifers in general ranges in thickness from 2 to 10 m. and its top is encountered at a depth range of 5 to 20 m bgl . The yield of dugwells tapping the phreatic aquifer ranges from 7.5 to 12 lps.

The Archaean schists and phyllites form phreatic aquifers wherever weathered /jointed . In general the aquifer systems in these rocks have poor potential and very few dug wells are found in the areas occupied by Schist\Phyllites . The yield of these dugwells range from 1 to 2 lps.

The dolomitic limestones of the Bijawars have a high potential and the aquifer system formed by solution cavities and fractures /joints sustain a good yield of the order of 7 lps, wherever solution cavities are encountered directly e.g. around Chanwarpatha village , [55 I/16 ,55M/4] and a moderate potential if the structure is located in jointed fractured rock . The yield of these structures range from 3 to 5 lps.

The fractured Vindhyan sandstones and shales occurring in the northern part of the district form poor phreatic aquifers and dug wells taping these formations sustain only 2 to 3 hours of pumping daily . The Vindhyans encountered in some bore holes at depth ranging between 50 to 80 mbgl do not form aquifers as such but their upper contact with overlying rocks yield 2 to 3 lps water .

The phreatic aquifers occurring in the southern part of the district are formed by weathered zone of shales of Gondwana formations and fine to medium grained Vindhyan sanstones. These aquifers have moderate potential. The yield of the dug wells constructed in these aquifer systems range from 2 to 3 lps.

Gondwana formations occurring at depth below alluvium form confined to semi-confined aquifers which are not very productive and yield less than 5 lps water . In the exploratory bore holes drilled by CGWB during Narmada Project , granular zones in the Gondwana were encountered at Dabkia , Bikrampur , Dhamna , Singhpur etc.

The Lametas , occurring only in North Western part of the district are weathered on surface and dug wells in the weathered portion yield a poor discharge ranging from 1to 2 lps .

Deccan traps in the Northern part of the district overlie the Lametas and occur at the hill tops where no ground water structure exists . However in the South Eastern part of the district , Deccan traps form moderate to good phreatic aquifers and dug wells sustain a good discharge ranging from 2 to 5 lps .

Aquifers Parameters

The results of the pumping tests show that the Transmissivity of the alluvial aquifers tapped by dug wells ranges from 57 to 400 m^2/day while the hard rock aquifers have very low Transmissivity of the order of 19 m^2/ day.

Exploratory wells tapping multi-aquifer system. The Transmissivity of these confined to semiconfined aquifers ranges from 23 to 2400 m^2/day. Storativity values ranges from 2.01 x 10^{-6} to 1.15 x10^{-3} indicating confined to semi confined nature of deep aquifers.

CHAPTER-IV Ground Water Resources

4.1 Dynamic Ground Water Resource& Draft:

The dynamic ground water resources of the Madhya Pradesh State assessed jointly by the CGWB and State Ground Water Departments under the supervision of the State level Committees. The base year of computation of the resources is 2012-13.

The dynamic ground water resources are also known as Annual Replenishable Ground Water Resources since it gets replenished/ recharged every year. The Annual Replenishable Ground Water Resource for the Narsinghpur District has been assessed as **125309.14**ham. The major source of ground water recharge is the monsoon rainfall. Block-wise Ground Water Resources of Narsinghpur District as on March, 2013 is given in Table No 8 and the presents the over-all scenario of ground water resource utilization and availability of the District.

The assessment of ground water draft is carried out based on the Minor Irrigation Census data and sample surveys carried out by the State Ground Water Departments. The Annual Ground Water Draft of the entire district for 2012-13 has been estimated as**83649.30** ham. Agriculture sector remained the predominant consumer of ground water resources. About 97% of total annual ground water draft i.e. 814 mcm is for irrigation use. Only 22 mcm is for Domestic & Industrial use which is about 3% of the total draft. An analysis of ground water draft figures indicates that in the district 66.75% is stage of ground water development.

The status of ground water development is very high in non- command areas of the two blocks i.e., Narsinghpur and Gotegaon where the Stage of Ground Water Development is more than 80% which comes under Semi-Critical category. The stage of ground water development is less than 70% in rest of the blocks. The ground water development activities have increased generally in the areas where future scope for ground water development existed. This has resulted in increase in stage of ground water development. List of categorization of Blocks / Districts is given in Table No 5.

Table No 5. Dynamic Ground Water Resource (Zone of Fluctuation)

S.N.	Assessment Unit / District	Command / Non Command	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham (5+6)	Allocation For Domestic & Industrial Water Supply in Ham	Net Ground Water Availability for Future Irrigation Development in Ham (4-5-8)	Stage of Ground Water Development in % {(4/7)* 100}	Category
1	2	3	4	5	6	7	8	9	10	11
1	ChawarPatha	Non-Command	22599.86	15532.56	444.26	15976.82	500.00	6567.30	70.69	Semi-critical
		Block Total	**22599.86**	**15532.56**	**444.26**	**15976.82**	**500.00**	**6567.30**	**70.69**	**Semi-critical**
2	Chichlii	Non-Command	16211.97	10600.20	393.42	10993.62	553.00	5058.77	67.81	Safe
		Block Total	**16211.97**	**10600.20**	**393.42**	**10993.62**	**553.00**	**5058.77**	**67.81**	**Safe**
3	Gotegaon	Command	3640.77	429.41	40.19	469.60	55.00	3156.36	12.90	Safe
		Non-Command	16236.84	13104.00	377.89	13481.89	600.00	2532.84	83.03	Semi-Critical
		Block Total	**19877.61**	**13533.41**	**418.08**	**13951.49**	**655.00**	**5689.20**	**70.19**	**Semi-critical**
4	Kareli	Command	3763.36	145.15	26.10	171.25	36.30	3581.91	4.55	Safe
		Non-Command	20931.59	13759.20	269.96	14029.16	408.70	6763.69	67.02	Safe
		Block Total	**24694.95**	**13904.35**	**296.06**	**14200.41**	**445.00**	**10345.60**	**57.50**	**Safe**
5	Narsinghpur	Command	5886.18	390.10	41.76	431.86	58.08	5438.00	7.34	Safe
		Non-Command	17651.86	15374.88	300.70	15675.58	412.00	1864.98	88.80	Semi-Critical
		Block Total	**23538.04**	**15764.98**	**342.46**	**16107.44**	**470.08**	**7302.98**	**68.43**	**Semi-critical**
6	Saikheda	Non-Command	18386.71	12091.68	327.84	12419.52	443.00	5852.03	67.55	Safe
		Block Total	**18386.71**	**12091.68**	**327.84**	**12419.52**	**443.00**	**5852.03**	**67.55**	Safe
		District Total	**125309.14**	**81427.18**	**2222.12**	**83649.30**	**3066.08**	**40815.88**	**66.75**	**Safe**

4.2 Static Ground Water Resource & Draft- (Outcome of NAQUIM)

The Ground Water Resource of Narsinghpur district has been calculated block-wise considering the variable lithology and their associated aquifer parameters like specific yield. The In-storage resource for the shallow aquifer below zone of fluctuation (upto 30 mbgl) is computed to be around 882.48mcm. The static resource for the deeper aquifer (30-300 mbgl) is computed as 16359.51mcm. The draft of dug well and tube well has been calculated separately to assess the ground water draft for irrigation from shallow and deeper aquifers that accounts to 224.548mcm and 611.94mcm respectively. The block-wise details of ground water resources and draft as an outcome of NAQUIM are presented in the Table no 6.

Table 6: Static Ground Water Resources (Outcome of NAQUIM), Narsinghpur District, Madhya Pradesh

Block	**ChanwarPatha**	**Chichli**	**Gotegaon**	**Kareli**	**Narsinghpur**	**Saikheda**	**total**
Shallow Aquifer							
Dynamic Resources (MCM)	226.00	162.12	198.78	246.95	235.38	183.87	**1253.09**
In- Storage Resources (MCM)	64.49	403.96	224.62	67.19	35.74	86.47	**882.48**
Total Resources (MCM)	290.485	566.082	423.394	314.143	271.125	270.341	**2135.570**
Irrigation (MCM)	55.08	27.378	40.446	25.7256	25.056	28.6416	**202.3272**
Domestic+Industries (MCM)	4.4426	3.9342	4.1808	2.9606	3.4246	3.2784	**22.2212**
GW Draft (MCM)	59.523	31.312	44.627	28.686	28.481	31.920	**224.548**
Deeper Aquifer							
Static Resources (MCM)	2454.08	3153.75	2129.40	4097.72	1562.81	2220.40	**16359.51**
GW Draft (MCM)	100.24	78.62	94.89	113.32	132.59	92.28	**611.94**
Total Static Resources (Shallow+ Deeper Aquifer)							
Total GW Resources (MCM)	**2744.57**	**3719.83**	**2552.79**	**4411.86**	**1833.93**	**2490.74**	**18495.08**
Gross Ground Water Draft (MCM)	**159.76**	**109.94**	**139.51**	**142.00**	**161.07**	**124.20**	**836.49**

CHAPTER-V Ground Water Related Issues

5.1 Grund Water Depletion

The long-term water level trend analysis of shallow aquifers indicates declining trend varies from 0.034m/yr to 0.26m/yr for pre -monsoon and 0.03m/yr to 0.65m/yr for post – monsoon in the last 10 years i.e from (2007 to 2016). During pre-monsoon season, out of 21 Hydrograph Stations, 8 stations are showing declining trend (Fig. 17).Similarly, during post-monsoon season, out of 21 stations 9 stations are showing falling trend in the district.

Ground Water Resource Estimation also reveals that out of 6 Blocks of the district3 Blocks have crossed 70% stage of ground water development. Over all stage of ground water development of the district is computed as 66.75%, which cautions for further uncontrolled withdrawal of ground water.

5.2 Groundwater Quality

The groundwater of Narsinghpur district is comparatively of good quality except in some parts of Kareli village of Kareli Block where high nitrate concentration of 109 mg/L is reported. This may be due to excessive use of fertilizer in the agricultural field.

Fig 24: Map showing Area affected by Nitrate Concentration in groundwater of Narsinghpur District.

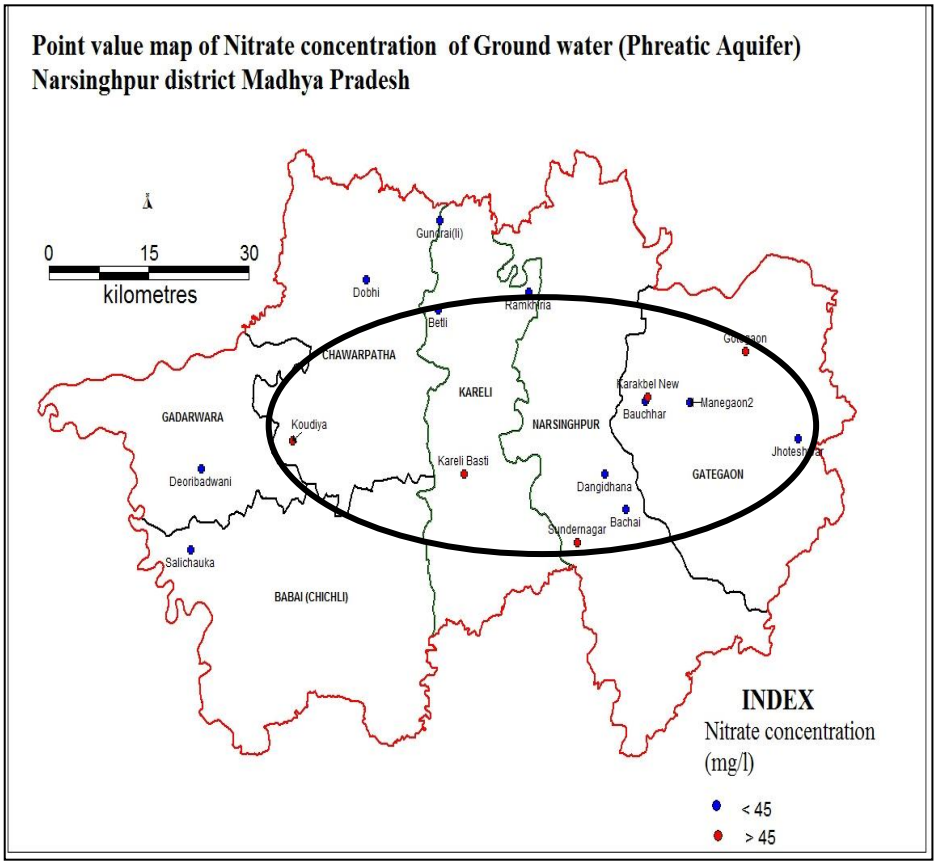


Fig 25: Hydrographs showing declining water level trend during Pre-monsoon and Post-Monsoon at sites (a) Sundergarh and (b) Betli,Narsinghpur District, Madhya Pradesh.

Fig 25 (a)Sundernagar village, Narsinghpur Block

Declining trend(2007-2016) : Pre-Monsoon: 0.23 m/yr; Post-Monsoon: 0.65 m/yr

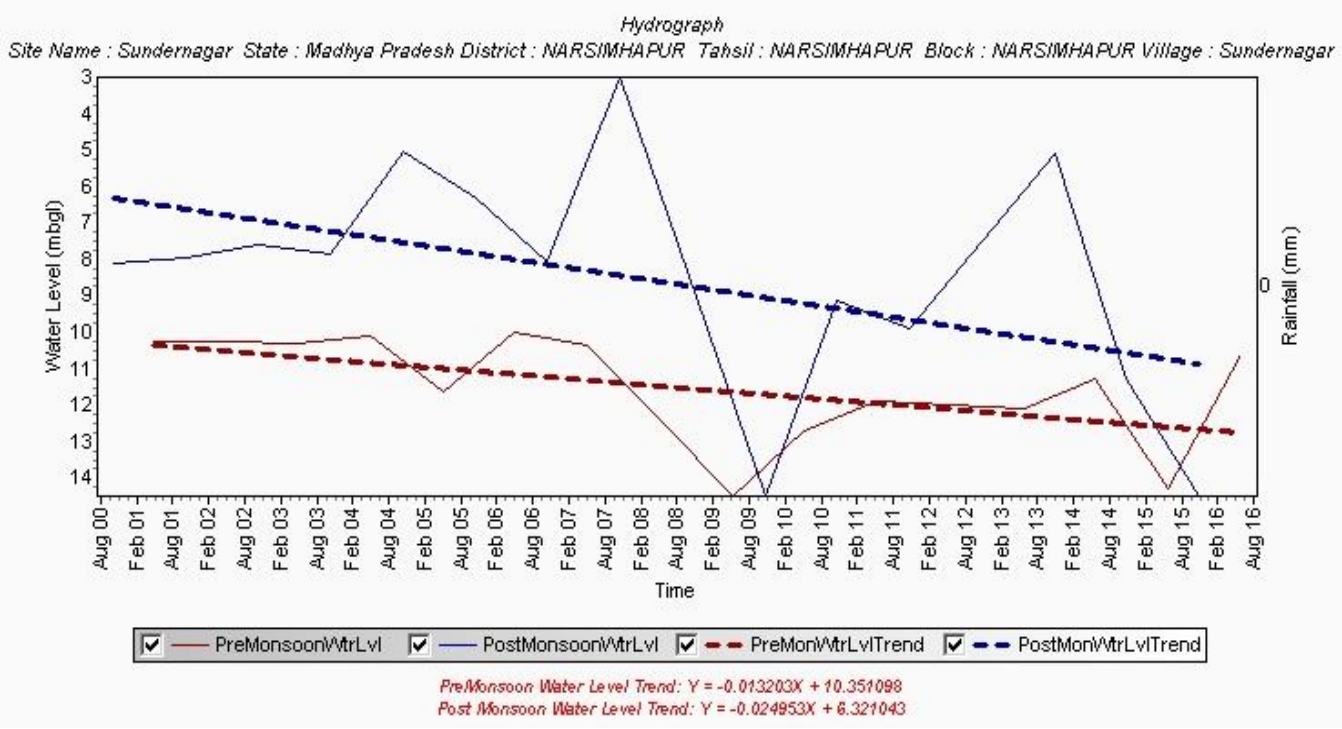
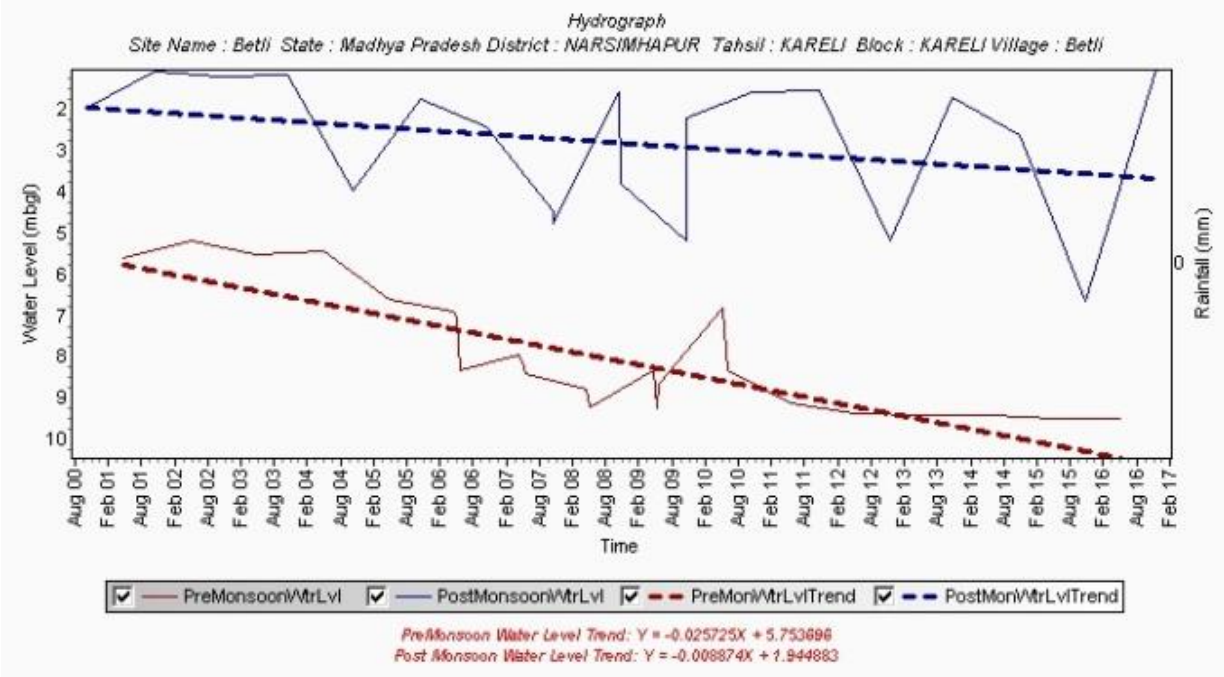


Fig 25 (b)Betli village, Kareli Block

Declining trend(2007-2016): Pre-Monsoon: 0.13 m/yr; Post-Monsoon: 0.10 m/yr



CHAPTER-VI Ground Water Management Strategies

6.1 Need of Ground Water Management

The demand of fresh water for agriculture, drinking and industrial uses etc. has significantly increased due to population growth and socio-economic development. Although only three blocks are showing semi-critical category, the groundwater level of **Narsinghpurdistrict** is rapidly declining due to rapid construction of tube wells for irrigation.Thus there is urgent need for taking up suitable water management interventions based on integrated approach, which on one hand includes augmentation of ground water resources through appropriate techniques, and on the other hand requires the adoption of suitable water conservation measures, such as ensuring water use efficiency through creation of additional water storage facility, maintenance/ renovation of existing water bodies etc. Water awareness and capacity building of the stakeholders are also the important attributes of water management interventions as envisaged in the National Water Policy.

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost effective technology to mitigate the problems of over exploitation of ground water resources. The technology serves as a means for restoring the depleted ground water storage, ameliorate the ground water quality problems and also enhance the sustainability of wells in the affected areas. A detailed knowledge of geology, hydrogeology, land use pattern, geomorphology and hydro-meteorological features are however, essential for selection of appropriate artificial recharge techniques as well as design and sites of ground water recharge structures.

District Groundwater Level Management Plan (Outcome of NAQUIM)

As per directions of Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India,preparation of Aquifer Management Plan for Narsinghpurdistrict in the State has been prepared block wise as shown in Table no11and financial outlay plan is also shown in Table No12 Each Plan discusses the broad framework of ground water situation in the block, status of water availability (both surface and ground water), identification of feasible areas for interventions, feasibility of artificial recharge and other water conservation structures, their design considerations, numbers and cost estimates. The expected outcomes of the proposed interventions have also been elucidated and given in table no13.

As Narsinghpur district having **Stage of Development 66.75%** after proposed intervention **Stage of Development will be 58.79%**

6.2 Supply Side Management

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost effective technology to mitigate the problems of over exploitation of ground water resources. The artificial recharge technique simultaneously rejuvenates the depleted ground water storage, reduces the ground water quality problems and also improves the sustainability of wells in the affected areas.

The supply side management plan for Narsinghpur district has been formulated using the basic concepts of hydrogeology. Sub-surface storage is calculated by multiplying the total area with the respective specific yield (considering the variable lithology) and the unsaturated zone thickness obtained by subtracting 3 meters from the post-monsoon water level. The volume of ground water recharge generated through pre-existing rain water harvesting/water conservation structures is subtracted from the sub-surface storage to assess the available storage potential. Thus, the surface water requirement to completely saturate the sub-surface storage is obtained by multiplying a factor of 1.33 to available storage potential. A runoff coefficient factor of 0.18 has been considered for Narsinghpur district to calculate the total surface water runoff, 30% of which accounts to the non-committed runoff which is available to sustain the proposed artificial recharge structures.

Although the Sub-Surface Storage is more than non-committed runoff, so we use 100% of non- committed runoff for the artificially recharge of groundwater using available resources.Further, the number of structures has been calculated by allotting 35%, 20% 35% and 10% of non-committed runoff to Percolation tanks, Recharge shafts/Tube wells and Nala bunds/Check dams/Cement Plugs and village ponds respectively. A detailed calculation of the proposed artificial recharge structures is presented in the Table no. 8.

A financial outlay plan has also been chalked out, assuming the cost for the artificial recharge structures to be Rs. 20 lakhs each for percolation tanks, Rs. 10 lakhs each for Nala bunds/Check Dams/Cement Plugs, Rs. 5 lakhs each for Recharge shafts/Tube wells and Rs. 2 lakhs each for renovation of Village tanks/ponds/WCS. This accounts to a total of Rs. 252.24 Crores to

successfully implement the supply side management strategy. Table no. 9represents the complete financial outlay plan for the district.

6.3 Demand Side Management

InNarsinghpur district,Sugarcane farming is the main source of livelihood on which the Sugar industries are dependent, therefore change in cropping pattern has not been proposed as an intervention. So we suggestchanging our irrigation pattern from flood irrigation to micro irrigation technologies such as drip and sprinkler systems for rabi crops (such as wheat), are being increasingly promoted as technological solutions for achieving water conservation.

Adoption of Sprinkler irrigation techniques would save 20% of gross ground water draft for irrigation. Also, the 60% of additional recharge created by construction of artificial recharge structures can be utilized to increase the total cropping area, thereby enhancing the productivity and economy of the district.

Fig26: Picture showing sugarcane factories.

Fig27: Sprinkler irrigation

Table No 7: Assessment unit wise Categorization of Dynamic Ground Water Resource

District	Blocks	Sub units	Stage of groundwater development (%)	Water Level Trend (cm/year)	Is there any significant decline? (yes/No)	Water Level Trend (cm/year)	Is there any significant decline? (Yes/No)	Category
				Pre-Monsoon		**Post Monsoon**		
Narsinghpur	Chawar Patha	Non command	70.69	Falling 4.96 cm/year	No	Falling 33.03 cm/year	Yes	Semi-Critical
		Block total	**70.69**					
	Chichli	Non Command	67.81	Rise 0.16 cm/year	No	Falling 13.87 cm/year	No	Safe
		Block total	**67.81**					
	Gotegaon	command	12.90	Falling 6.5 cm/year	No	Rise 0.16 cm/year	No	Safe
		Non Command	83.03	Falling 23.34 cm/year	Yes	Falling 40.5 cm/year	Yes	Semi-Critical
		Block total	**70.19**					
	Kareli	Command	4.55	Falling 18.9 cm/year	No	Falling 55.5cm/year	Yes	Safe
		Non Command	67.02	Falling 12.8 cm/year	No	Falling 11.8 cm/year	No	Safe
		Block total	**57.50**					
	Narsinghpur	Command	7.34	Rise 2.5 cm/year	No	Falling 14 cm/year	No	Safe
		Non Command	88.80	Falling 5.09 cm/year	No	Falling 31.7 cm/year	Yes	Semi-Critical
		Block total	**68.43**					
	Saikheda	Non command	67.55	Falling 13.07 cm/year	No	Falling 12.66 cm/year	No	Safe
		Block total	**67.55**					
	District Total		**66.75**					

Table No 8:Narsinghpur District, Block Wise Management Plan
(Source Water for Artificial Recharge and number of Recharge Structure)

Station	Rain-fall (m)	Area (Sq Km)	Area suitable for recharge (Sq Km)	Average post-monsoon water level (m)	Unsaturated zone (m)	Specific Yield %	Sub-surface storage (mcm)	Surface water required (mcm)	Surface water (Run-off) available (mcm)	Non-committed Run-off (mcm)	Percola-tion tank	Recharge shaft/ Tube well	NB/ CD/ CP	No of Village tank, pond and WCS
ChawarPatha	1.05	933	919	7.31	4.31	0.01/0.16	562.93	748.70	175.60	52.68	53	106	369	212
Chichli	0.79	960	856	8.21	5.21	0.01/0.16	426.28	566.95	135.77	40.73	41	82	285	150
Gotegaon	0.79	728	728	4.92	1.92	0.01/0.16	182.45	242.66	102.96	30.89	31	62	216	244
Kareli	0.79	933	834	8.05	5.05	0.01/0.16	491.55	653.76	131.95	39.59	40	80	277	143
Narsingh-pur	0.79	969	844	6.81	3.81	0.01/0.16	400.76	533.01	137.04	41.11	41	82	288	200
Saikheda	0.79	610	610	9.61	6.61	0.16	645.15	858.05	86.27	25.88	26	52	181	103
TOTAL	**0.83**	**5133**	**4791**				**2709.12**	**3603.13**	**769.59**	**230.88**	**231**	**462**	**1616**	**1052**

Table No 9:Narsinghpur District, Block Wise Financial Outlay Plan

Block	**Area Suitable for AR**	**Volume of Surface Water available for AR (MCM)**	**Volume of Water required for recharge (MCM)**	**Proportionate Surface water for planning AR (MCM)**	**Percolation Tanks**		**Recharge shaft/ Tube well**		**NB/ CD/ CP**		**Village tank, pond and WCS**		**Total Cost of (Rs. in crores)**
					structure	***cost***	***Structure***	***cost***	***structure***	***cost***	***structure***	***cost***	
					Nos	***(crores)***	***Nos***	***(crores)***	***Nos***	***(crores)***	***Nos***	***(crores)***	
ChawarPatha	919	175.60	748.70	52.68	53	10.6	106	5.3	369	36.9	212	4.24	57.04
Chichli	856	135.77	566.95	40.73	41	8.2	82	4.1	285	28.5	150	3	43.8
Gotegaon	728	102.96	242.66	30.89	31	6.2	62	3.1	216	21.6	244	4.88	35.78
Kareli	834	131.95	653.76	39.59	40	8	80	4	277	27.7	143	2.86	42.56
Narsinghpur	844	137.04	533.01	41.11	41	8.2	82	4.1	288	28.8	200	4	45.1
Saikheda	610	86.27	858.05	25.88	26	5.2	52	2.6	181	18.1	103	2.06	27.96
TOTAL	**4791**	**769.59**	**3603.13**	**230.88**	**231**	**46.2**	**462**	**23.2**	**1616**	**161.6**	**1052**	**21.04**	**252.24**

Table No 10:Narsinghpur District, Management Plan after Intervention

Assessment Unit / District	Net Ground Water Availability in mcm (Shallow aquifer)	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprink-lar irriga-tion	Additio-nal recharge created by AR (in mcm)	Net Groundwater availability after intervention of AR Structures (in mcm)	Additional GW draft created after utilisation of 60% of net GW available from intervene-tion of AR Structures (in mcm)	Total draft after adopting sprinkler irrigation & Existing Gross Ground Water Draft for All Uses in mcm	Additional area irrigated by GW after interventio n in sq.km.	Stage of Development after interventions
ChawarPatha	226.00	159.77	**70.69**	19.88	52.68	278.68	31.61	171.50	79.02	**61.54**
Chichli	162.12	109.94	**67.81**	12.62	40.73	202.85	24.44	121.76	61.10	**60.02**
Gotegaon	198.78	139.51	**70.19**	24.78	30.89	229.66	18.53	133.26	46.33	**58.03**
Kareli	246.95	142.00	**57.50**	13.69	39.59	286.53	23.75	152.06	59.38	**53.07**
Narsinghpur	235.38	161.07	**68.43**	16.54	41.11	276.49	24.67	169.21	61.67	**61.20**
Saikheda	183.87	124.20	**67.55**	15.16	25.88	209.75	15.53	124.57	38.82	**59.39**
TOTAL	1253.09	836.49	**66.75**	102.66	230.88	1483.97	138.53	872.36	346.31	**58.79**

Management Plan of Chawarpatha Block

Chanwarpatha Block	Statistics
Area in Sq Km	933
Rainfall in m	1.05
Area Suitable for Recharge in Sq Km	919
Average Post Monsoon DTW in mbgl	7.31
Unsaturated Zone in m	4.31
Average Specific Yield in %	0.01- 0.16
Sub Surface Storage Potential (MCM)	562.93
Surface Water Required (MCM)	748.7
Runoff Available (MCM)	175.6
Non committed Runoff available (MCM)	52.68
No. of Percolation tanks	53
No. of Recharge Shaft/ Tube Wells	106
No. of NB/CD/CP	369
No. of Village Pond/Tank	212

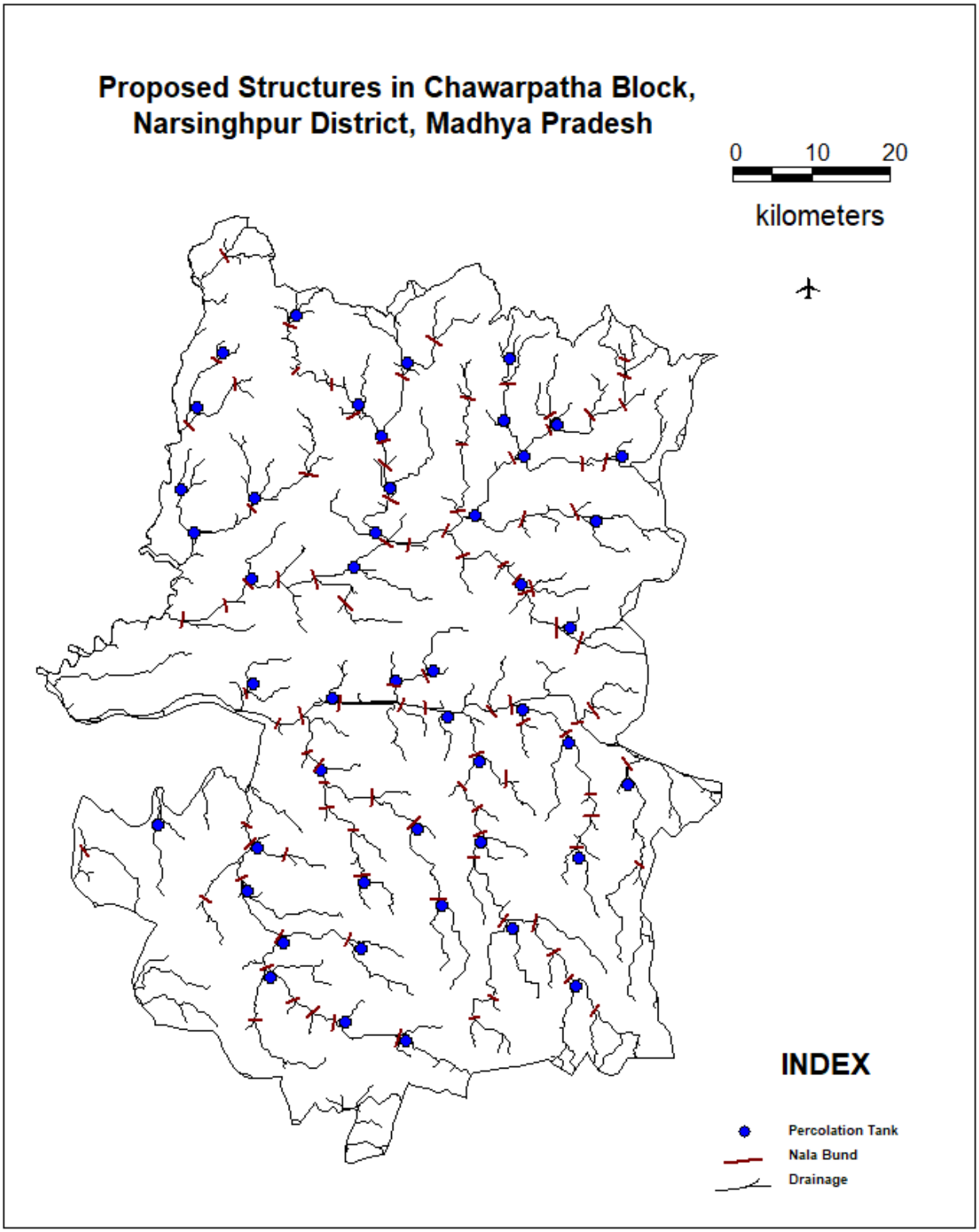
Ground Water Resources of Chanwarpatha	
First Aquifer	**MCM**
Dynamic Resources (MCM)	226
Instorage-Resources (MCM)	64.49
Total Resources (MCM)	**290.485**
GW Draft (MCM)	59.523
Second Aquifer	
Static Resources (MCM)	2454.08
GW Draft (MCM)	100.24
Total GW Resources (MCM)	**2744.57**
Total Ground Water Draft (MCM)	**159.76**

Financial Outlay Plan of CHANWARPATHA Block		
Type of Structures	Number	Cost (in Crores)
Percolation Tanks	53	10.6
Recharge shaft/ Tube well	106	5.3
NB/ CD/ CP	369	36.9
Village Pond/Tank	212	4.24
Total Cost		57.04

IMPACT

Block	Net Ground Water Availability in mcm	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprinklar irrigation	Additional recharge created by AR in mcm	Net Groundwater availability after intervention of AR Structures in mcm	Additional GW draft created after utilisation of 60% of net gw available from intervention of AR Structures in mcm	Total draft after adopting sprinkler irrigation & Existing Gross Ground Water Draft for All Uses in mcm	Additional area irrigated by GW after intervention in sq.km.	Stage of Development after interventions
Chawar Patha	226	159.77	70.69	22.3824	72.07	298.07	43.24	180.63	108.1	60.6

Fig 28: Proposed Structures (Percolation tank and Nala bund/Check dams) in Chawarpatha Block, Narsinghpur District, Madhya Pradesh



Management Plan of Chichli Block

Chichli Block	Statistics
Area in Sq Km	960
Rainfall in m	0.79
Area Suitable for Recharge in Sq Km	856
Average Post Monsoon DTW in mbgl	8.21
Unsaturated Zone in m	5.21
Average Specific Yield in %	0.16/0.03
Sub Surface Storage Potential (MCM)	426.28
Surface Water Required (MCM)	566.95
Runoff Available (MCM)	135.77
Non committed Runoff available (MCM)	40.73
No. of Percolation tanks	41
No. of Recharge Shaft/ Tube Wells	82
No. of NB/CD/CP	285
No. of Village Pond/Tank	150

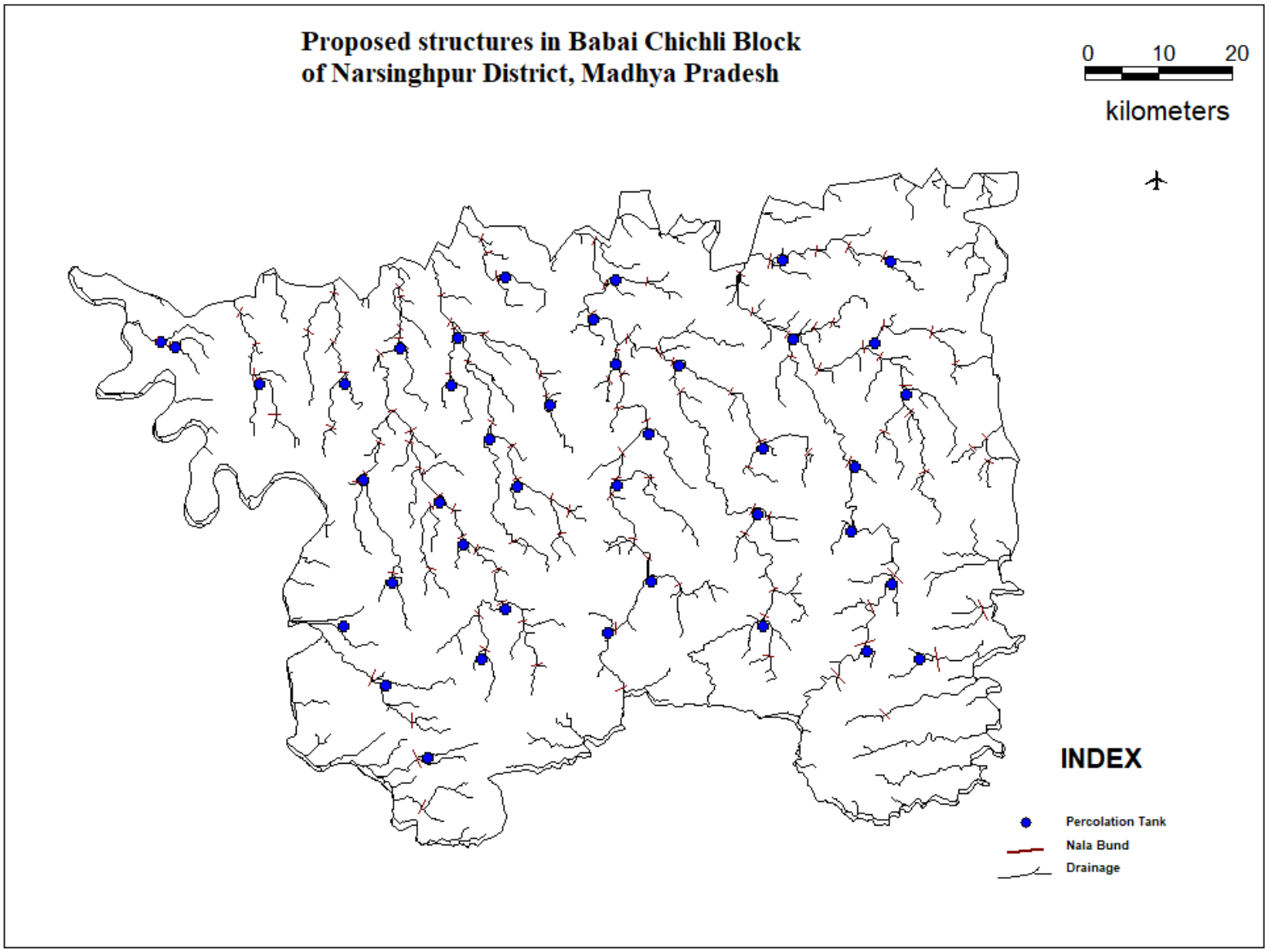
Ground Water Resources of Chichli	(MCM)
First Aquifer	
Dynamic Resources (MCM)	162.12
Instorage-Resources (MCM)	403.96
Total Resources (MCM)	566.08
GW Draft (MCM)	31.31
Second Aquifer	
Static Resources (MCM)	3153.75
GW Draft (MCM)	78.62
Total GW Resources (MCM)	3719.83
Total Ground Water Draft (MCM)	109.94

Financial Outlay Plan of CHICHLI Block		
Type of Structures	Number	Cost (in Crores)
No. of Percolation tanks	41	**8.2**
No. of Recharge Shaft/ Tube Wells	82	**4.1**
No. of NB/CD/CP	285	**28.5**
No. of Village Pond/Tank	150	**3**
Total Cost of Structures (Rs. In Crores)		**43.8**

IMPACT

Block	Net Ground Water Availability in mcm	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprinklar irrigation	Additional recharge created by AR in mcm	Net Groundwater availability after intervention of AR Structures in mcm	Additional GW draft created after utilisation of 60% of net gw available from intervention of AR Structures in mcm	Total draft after adopting sprinkler irrigation & Existing Gross Ground Water Draft for All Uses in mcm	Additional area irrigated by GW after intervention in sq.km.	Stage of Development after interventions
Chichli	162.12	109.94	67.81	23.24	50.44	212.56	30.27	116.96	75.66	55.02

Fig 29: Proposed Structures (Percolation tank and Nala bund/Check dams) in Chichli Block, Narsinghpur District, Madhya Pradesh



Management Plan of Gotegaon Block

Gotegaon Block	Statistics
Area in Sq Km	728
Rainfall in m	0.79
Area Suitable for Recharge in Sq Km	728
Average Post Monsoon DTW in mbgl	4.92
Unsaturated Zone in m	1.92
Average Specific Yield in %	0.01- 0.16
Sub Surface Storage Potential (MCM)	182.45
Surface Water Required (MCM)	242.66
Runoff Available (MCM)	102.96
Non committed Runoff available (MCM)	30.89
No. of Percolation tanks	31
No. of Recharge Shaft/ Tube Wells	62
No. of NB/CD/CP	216
No. of Village Pond/Tank	250
Total Cost of Structures (Rs. In Crores)	

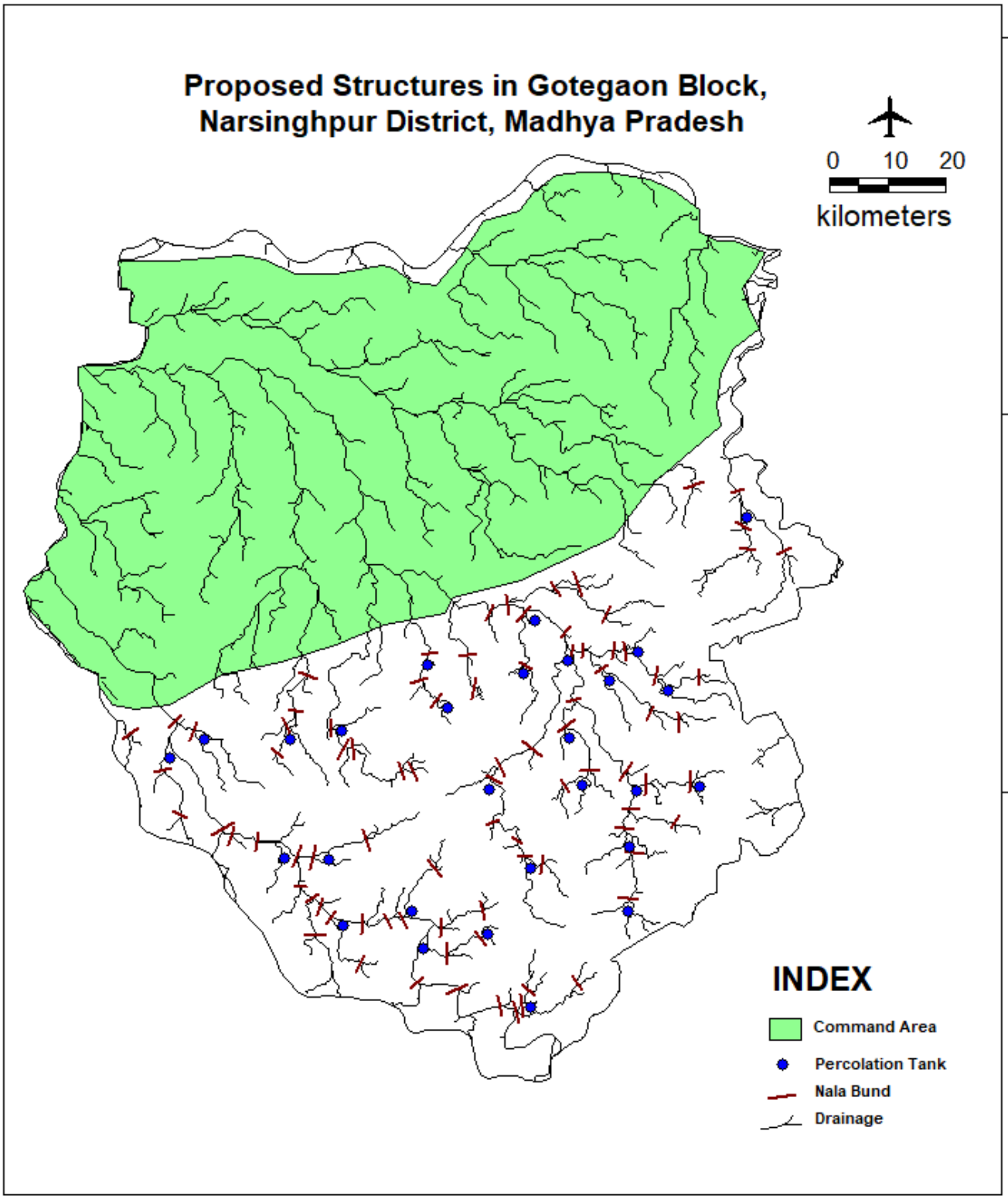
Ground Water Resources	
First Aquifer	
Dynamic Resources (MCM)	198.78
Instorage-Resources (MCM)	224.62
Total Resources (MCM)	**423.39**
GW Draft (MCM)	44.63
Second Aquifer	
Static Resources (MCM)	2129.4
GW Draft (MCM)	94.89
Total GW Resources (MCM)	**2552.79**
Total Ground Water Draft (MCM)	**139.51**

Financial Outlay Plan of Gotegaon Block		
Type of Structures	Number	Cost in Crores
Percolation Tanks	31	**6.2**
Recharge shaft/ Tube well	62	**3.1**
NB/ CD/ CP	216	**21.6**
Village Pond/Tank	250	**5**
Total Cost		**35.9**

IMPACT

Block	Net Ground Water Availability in mcm	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprinklar irrigation	Additional recharge created by AR in mcm	Net Groundwater availability after intervention of AR Structures in mcm	Additional GW draft created after utilisation of 60% of net gw available from intervention of AR Structures in mcm	Total draft after adopting sprinkler irrigation & Existing Gross Ground Water Draft for All Uses in mcm	Additional area irrigated by GW after intervention in sq.km.	Stage of Development after interventions
Gote gaon	198.78	139.51	70.19	20.328	42.90	241.68	25.74	144.93	64.35	59.97

Fig 30: Proposed Structures (Percolation tank and Nala bund/Check dams) in Gotegaon Block, Narsinghpur District, Madhya Pradesh



Management Plan of KARELI Block

Kareli Block	Statistics
Area in Sq Km	933
Rainfall in m	0.79
Area Suitable for Recharge in Sq Km	834
Average Post Monsoon DTW in mbgl	8.05
Unsaturated Zone in m	5.05
Average Specific Yield in %	0.01- 0.16
Sub Surface Storage Potential (MCM)	491.55
Surface Water Required (MCM)	653.76
Runoff Available (MCM)	131.95
Non committed Runoff available (MCM)	39.59
No. of Percolation tanks	40
No. of Recharge Shaft/ Tube Wells	80
No. of NB/CD/CP	277
No. of Village Pond/Tank	143

Ground Water Resources of Kareli Block	
First Aquifer	
Dynamic Resources (MCM)	246.95
Instorage-Resources (MCM)	67.19
Total Resources (MCM)	**314.14**
GW Draft (MCM)	28.69
Second Aquifer	
Static Resources (MCM)	2832.24
GW Draft (MCM)	113.32
Total GW Resources (MCM)	**3146.38**
Total Ground Water Draft (MCM)	**142**

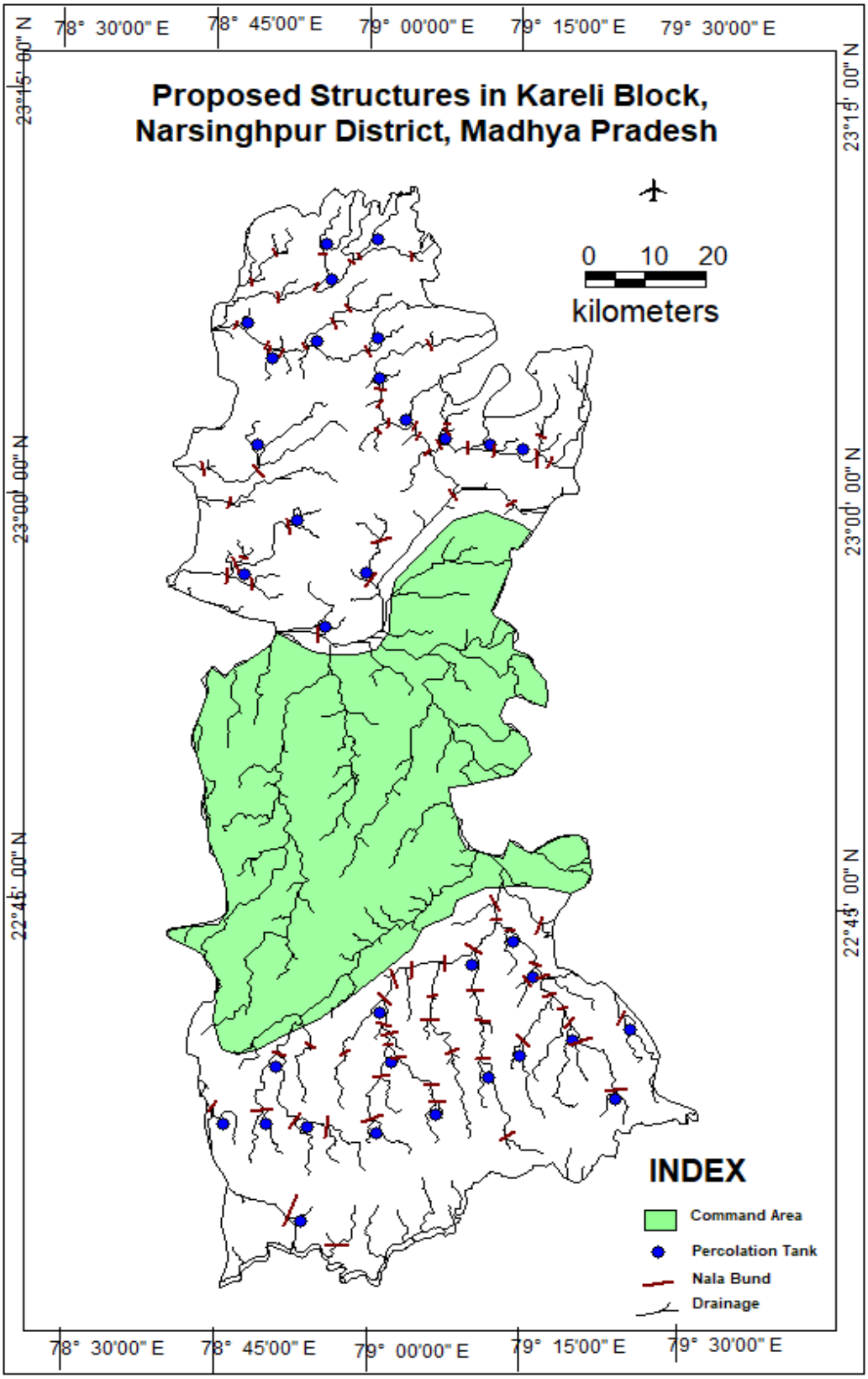
Financial Outlay Plan of Kareli Block

Type of Structures	Number	Cost in Crores
Percolation Tanks	40	**8**
Recharge shaft/ Tube well	80	**4**
NB/ CD/ CP	277	**27.7**
Village Pond/Tank	143	**2.86**
Total		**42.56**

IMPACT

Block	Net Ground Water Availability in mcm	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprinklar irrigation	Additional recharge created by AR in mcm	Net Groundwater availability after intervention of AR Structures in mcm	Additional GW draft created after utilisation of 60% of net gw available from intervention of AR Structures in mcm	Total draft after adopting sprinkler irrigation & Existing Gross Ground Water Draft for All Uses in mcm	Additional area irrigated by GW after intervention in sq.km	Stage of Development after interventions
Kareli	**246.95**	**142.00**	**57.50**	**13.69**	**39.59**	**286.53**	**23.75**	**152.06**	**59.38**	**53.07**

Fig 31: Proposed Structures (Percolation tank and Nala bund/Check dams) in Kareli Block, Narsinghpur District, Madhya Pradesh



Management Plan of Narsinghpur Block

Narsinghpur Block	Statistics
Area in Sq Km	969
Rainfall in m	0.79
Area Suitable for Recharge in Sq Km	844
Average Post Monsoon DTW in mbgl	6.81
Unsaturated Zone in m	3.81
Average Specific Yield in %	0.02- 0.16
Sub Surface Storage Potential (MCM)	400.76
Surface Water Required (MCM)	533.01
Runoff Available (MCM)	137.04
Non committed Runoff available (MCM)	41.11
No. of Percolation tanks	41
No. of Recharge Shaft/ Tube Wells	82
No. of NB/CD/CP	288
No. of Village Pond/Tank	200

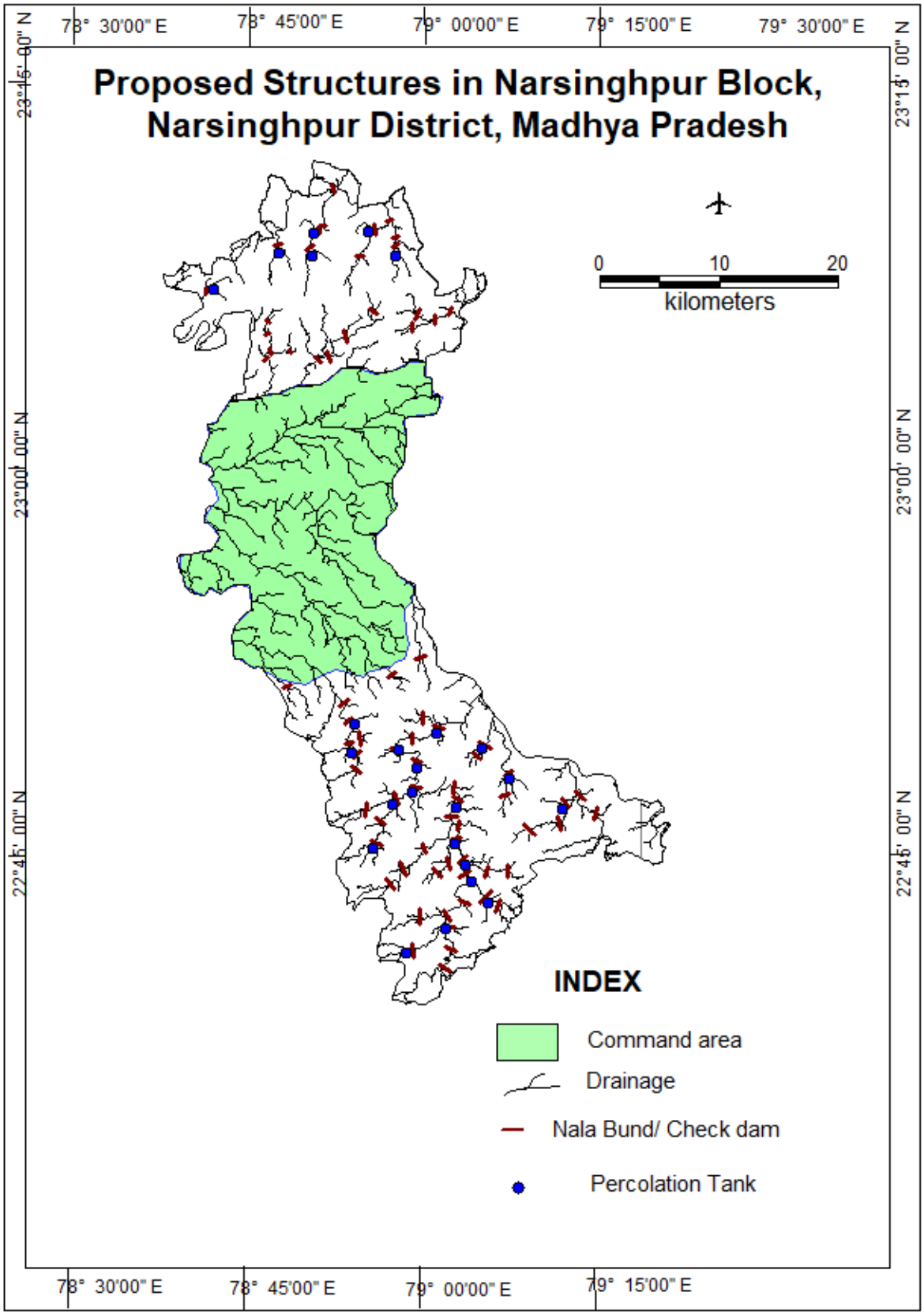
Ground Water Resources of Narsinghpur	
Shallow Aquifer	
Dynamic Resources (MCM)	235.38
Instorage-Resources (MCM)	35.74
Total Resources (MCM)	**271.13**
GW Draft (MCM)	28.48
Deeper Aquifer	
Static Resources (MCM)	999.1
GW Draft (MCM)	132.59
Total GW Resources (MCM)	**1270.23**
Total Ground Water Draft (MCM)	**161.07**

Financial Outlay Plan of Narsinghpur Block		
Type of Structures	Number	Cost in Crores
Percolation Tanks	41	**8.2**
Recharge shaft/ Tube well	82	**4.1**
NB/ CD/ CP	288	**28.8**
Village Pond/Tank	200	**4**
Total		**45.1**

IMPACT

Block	Net Ground Water Availability in mcm	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprinklar irrigation	Additional recharge created by AR in mcm	Net Groundwater availability after intervention of AR Structures in mcm	Additional GW draft created after utilisation of 60% of net gw available from intervention of AR Structures in mcm	Total draft after adopting sprinkler irrigation & Existing Gross Ground Water Draft for All Uses in mcm	Additional area irrigated by GW after intervention in sq.km.	Stage of Development after interventions
Narsingh pur	**235.38**	**161.07**	**68.43**	**16.54**	**41.11**	**276.49**	**24.67**	**169.21**	**61.67**	**61.20**

Fig 32: Proposed Structures (Percolation tank and Nala bund/Check dams) in Narsinghpur Block, Narsinghpur District, Madhya Pradesh



Management Plan Of Saikheda Block

Saikheda Block	Statistics
Area in Sq Km	610
Rainfall in m	0.79
Area Suitable for Recharge in Sq Km	610
Average Post Monsoon DTW in mbgl	9.61
Unsaturated Zone in m	6.61
Average Specific Yield in %	0.16
Sub Surface Storage Potential (MCM)	645.15
Surface Water Required (MCM)	858.05
Runoff Available (MCM)	86.27
Non committed Runoff available (MCM)	25.88
No. of Percolation tanks	26
No. of Recharge Shaft/ Tube Wells	52
No. of NB/CD/CP	181
No. of Village Pond/Tank	103

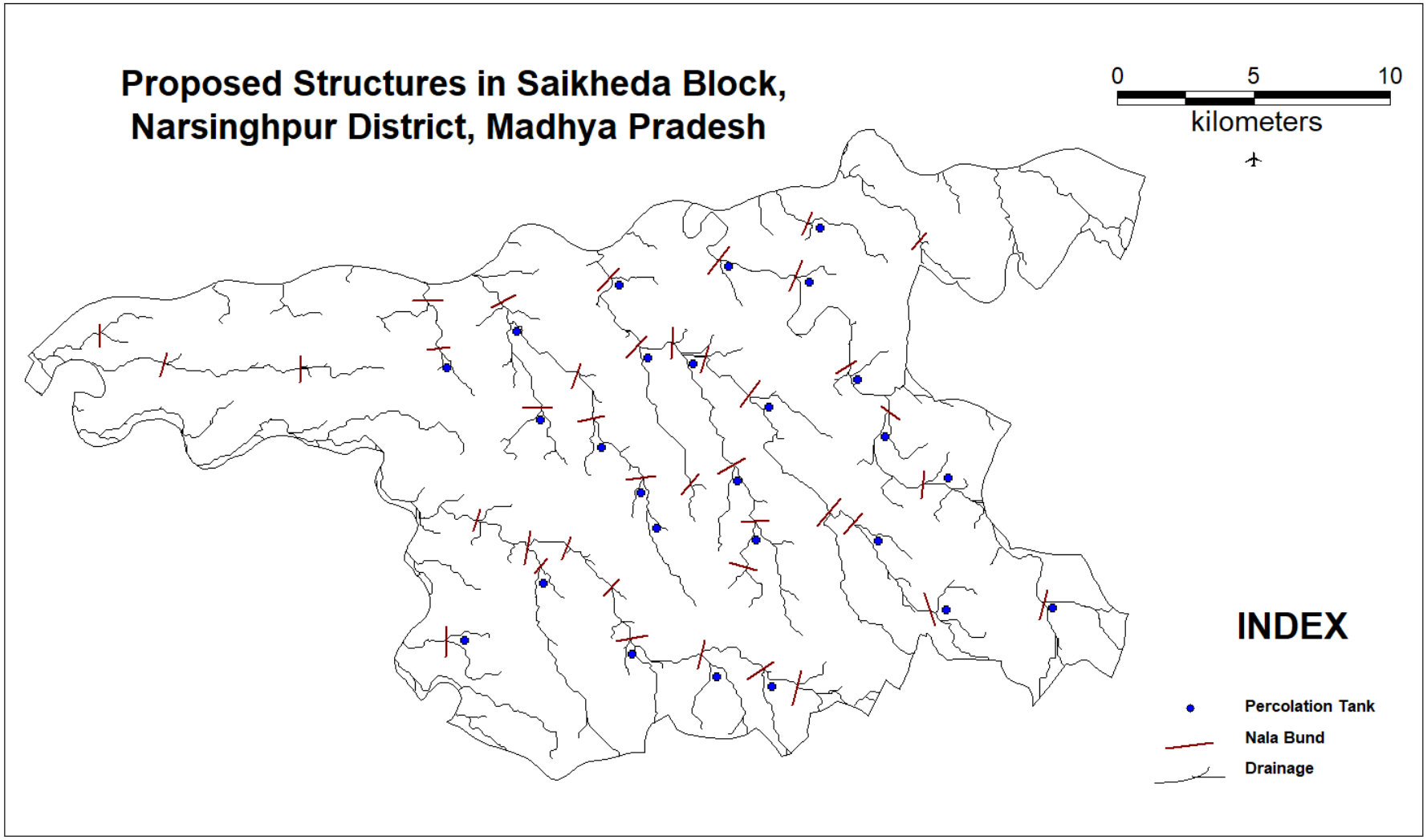
Ground Water Resources	
Shallow Aquifer	
Dynamic Resources (MCM)	183.87
Instorage-Resources (MCM)	86.47
Total Resources (MCM)	**270.34**
GW Draft (MCM)	31.92
Deeper Aquifer	
Static Resources (MCM)	2251.58
GW Draft (MCM)	92.28
Total GW Resources (MCM)	**2521.92**
Total Ground Water Draft (MCM)	**124.2**

Financial Outlay Plan of Narsinghpur Block		
Type of Structures	Number	Cost in Crores
Percolation Tanks	26	**5.2**
Recharge shaft/ Tube well	52	**2.6**
NB/ CD/ CP	181	**18.1**
Village Pond/Tank	103	**2.06**
Total		**27.96**

Impact

Block	Net Ground Water Availability in mcm	Existing Gross Ground Water Draft for All Uses in mcm	Stage of Ground Water Development in %	Ground water saved by Sprinklar irrigation	Additional recharge created by AR in mcm	Net Groundwater availability after intervention of AR Structures in mcm	Additional recharge created after utilisation of 60% of net gw available from intervention of AR	Gross Ground Water Draft for All Uses in adopting sprinkler irrigation & Existing	Additional area irrigated by GW after intervention in sq.km.	Stage of Develop -ment after interventions
Sai-kheda	**183.87**	**124.20**	**67.55**	**15.16**	**25.88**	**209.75**	**15.53**	**124.57**	**38.82**	**59.39**

Fig 33: Proposed Structures (Percolation tank and Nala bund/Check dams) in Saikheda Block, Narsinghpur District, Madhya Pradesh



ANNEXURE-I

Salient detail of Bore Wells

S. N.	Location	Latitude (Degree/ Minutes/ Seconds)	Longitude (Degree/ Minutes/ Seconds)	Year of Construction	Topo Sheet No.	Depth Drilled (mbgl)	Depth of Construction (mbgl)	Major Lithology encountered	Static Water Level (mbgl)	Discharge (Lps)	Drawdown (m)	T (m^2/day)	S	EC (m□/cm)
1	2	3	4	5		6	7	8	12	13	14	15	16	17
1	AMGAON	22º 52'	79º 04'		55 M/1	134.72		0-113.00 Alluvium 113.00-134.72 Gondwanas						
2	AMGAON	22º 51'	79º 04'		55 M/1	368.23		0-108.00 Alluvium 108.00-364.00 Gondwana Dolomite at 364						
3	BACHHAI	22º 54' 26"	79º 18' 20"	1997 - 93	55 C/3	215.35	50	0-55.00 Alluvium 55.00-215.00 Gondwanas Basement not met	3.85	612	22.09		0.42 x 10^{-4}	931
4	BAHORIPAR	22º 55'	79º 18'		55 N/5	95.1								
5	BAMHANWARA	22º 51'	78º 58'		55 J/13	67.97	65.5	0-66.75 Alluvium Granite at 66.75	19.62	946.00	4.54	9.88 x10^2		899
6	BARCHHI	22º 48'	78º 43'		55 J/9	72.54	69.49	72.542 Alluvium	8.19	1146.00	15.12	1.40 x10^3		
7	BASANPANI	22º 57'	79º 24'		55 N/5	226.77		0-110.00 Alluvium 110.00-226.77 Gondwana						

8	BASENDHI	22º 58'	79º 07'		55 N/1	212.42	162	0-176.00 Alluvium 176.00-300.00 Gondwana State at 300	21.06	1567	7.18	7.40 x10^{2}	1.42 x 10^{-4}	580
9	BASURIA	22º 47'	78º 41'		55 J/9	115.52	105.07	0-109.00 Alluvium 109.00-115.52 Gondwanas	7.85	3042.00	6.51	2.10 x10^{3}		
10	BEDU	22º 56'	79º 24'		55 N/5	220.07	158	Conglomerate at 226.70-71.00 71.00-201.78 Gondwana shale at 201.78	16.83	435	19.48	1.35 x10^{2}		704
11	BHAINSA	22º 50'	78º 48'		55 J/13	112.18	103.34	0-112.187 Alluvium	17.5	2259.00	5.33	1.20 x10^{3}		
12	BHAORJHIR	23º 01'	78º 56'		55 I/16	83.97	70.82	0- 81.00 Alluvium Metamorphics at 81.00	11.26	941	6.18	3.06 x10^{2}		556
13	BIKRAMPUR SHALLOW	23º 05'	79º 35'		55 M/12	140.5	86	0-14.00 Alluvium 14.00-153.40 Gondwana Gnessis at 153.40	11.8	111	22.67	1.96 x10^{1}	3.26 x 10^{-4}	736
14	BIKRAMUR DEEP	23º 05'	79º 35'		55 M/12	133			10.95	665	19.25	1.35 x10^{2}		
15	BILTHARI	23º 03'	78º 58'		55 I/16	59.4	45	0- 59.00 Alluvium	23.26	753.00	5.58	1.07 x10^{3}		727
16	CHHEMAKACHHAR	22º 47'	78º 41'		55 J/9	84.13	62.49	0-84.132 Alluvium Boulder bed at 84.13	11.2	2844.00	6.4	1.80 x10^{4}		
17	CHIRAHA KALAN	22º 57'	78º 48'		55 J/13	133.2	105.72	Alluvium	5.01	2406.00	9.88	4.10 x10^{2}		

18	DABKIA	23º 01'	79º 34'		55 M/12	189.32	139	0-73.00 Alluvium 73.00-112.93 Gondwana Chlorite schist at 112.9	6.19	612	5.53	2.61 $x10^{2}$		587
19	DEORI	22º 55'	78º 55'		55 J/13	146.91	146.91	0-105.00 Alluvium 105.00-146.91 Gondwanas						
20	DETPON	22º 56'	78º 38'		55 J/9	108.51	102.64	Alluvium	13.44	2333.00	7.59	7.80 $x10^{2}$		
21	DHAMNA DEEP	23º 01'	79º 15'		55 M/8	190.61	162	0-166.00 Alluvium 166.00-185.5 Gondwanas Dolamite at 185.5	19.38	2025	6.3	8.29 $x10^{2}$	4.35 x 10^{-4}	
22	DHAMNA SHALLOW	23º 01'	79º 15'		55 M/8	190.61	48.1		13.87	473	17.89	4.51 $x10^{1}$		646
23	DOBHI	23º 06'	78º 55'		55 I/16	76.5	65.53	0- 63.83 Alluvium Dolomite at 63.83	18.5	1541	8.8	1.09 $x10^{3}$		
24	DUDHWARA	22º 56' 00"	78º 55' 30"		55 J/13	167.95		0-126.00 Alluvium 126.00-167.95 Gondwanas						
25	DUNGARIA	23º 01'	78º 57'		55 I/16	81.69	65.53	0- 77.11 Alluvium Metamorphics at 77.11	65.53	1750	17.45	2.71 $x10^{2}$		1252
26	GADARWARA	22º 55'	78º 47'		55 J/13	269.44	102.84	0-122.00 Alluvium 122.00-268.83 Gondwanas Qartzite at 268.83	16.71	2406.00	7.23	1.20 $x10^{3}$		
27	GADARWARA	22º 55'	78º 47'	03.02.02	55 J/13	200.15	159	Alluvium	25	269				

28	GHAGROLA	22º 47'	78º 49'		55 J/13	281.03		0-34.00 Alluvium 34.00-261.03 Gondwanas						
29	IMALIA	22º 54'	78º 49'		55 J/13	252.68	147.45	0-146.00 Alluvium 146.00-252.68 Gondwanas	20.52	816.00	7.53	4.20 $x10^2$		
30	JAIKHERA	22º 53'	78º 40'		55 J/9	121.92	100.47	0-101.00 Alluvium 101.00-121.92 Gondwanas	8.59	2676.00	12.19	1.40 $x10^3$		
31	JAWARA	23º 53'	78º 45'		55 J/13	119.18	14.92	0-119.187 Alluvium	14.31	2220.00	7.26	5.90 $x10^2$		
32	JHAJHANKHERA	22º 53'	78º 44'		55 J/9	154.23	43.78	0-95.00 Alluvium 95.00-154.23 Gondwanas	9	1608.00	10.8	6.30 $x10^2$		
33	JHAKHURPA	22º 52'	79º 15'		55 N/5	541.57	37	0-34.50 Alluvium State at 34.50	2.48	189	14.77	8.33 $x10^1$		606
34	JHIRIA	22º 58'	78º 39'		55 J/9	220.22	135	0-133.00Alluvium 133.00-218.22 Gondwana limestone at 218.22	12.8	2680.00	9.5	7.22 $x10^2$	4.30 x 10^{-4}	527
35	KAMOD	23º 03'	79º 27'		55 M/8	223.35	160	0-77.00 Alluvium 77.00-233.35 Gondwana	9.94	624.5	16.19	1.41 $x10^2$	4.00 x 10^{-4}	998
36	KARAPGAON	22º 53'	78º 59'		55 J/13	225.55		0-91.00 Alluvium 91.00-225.56 Gondwana						
37	KARCHI	23°9’	79°28’	27.02.02		157	147	Alluvium gondwana clay at 98.5	12.5	12				

38	KARELI	22º 56'	79º 04'		55 N/1	278.89		0-141.00 Alluvium 141.00-278.89 Gondwana						
39	KASIKHERI	23º 05'	78º 59' 30"		55 I/16	48.92	38.53	0-47.25 Alluvium Dolomite at 47.25	8.75	3330	4.25	2.40 $x10^3$		
40	KATHOTIA	22º 57'	79º 00'		55 N/1	226.16	149.5	0-116.00 Alluvium 116.00-226.16 Gondwana	18.62	1279.5	8.95	3.81 $x10^2$	3.06 x 10^{-4}	730
41	KAURIA	22º 56'	78º 49'		55 J/13	147.22	109.73	0 - 133.20 Alluvium 0 - 116.00 Alluvium 116.00 - 147.22 Gondwana	20.85	1740.00	5.94	8.60 $x10^2$		
42	KHAIRI	22º 50'	78º 50'		55 J/13	104.85	96.63	0-104.37 Alluvium	11.53	2016.00	10.15	8.40 $x10^2$	1.42 x 10^{-3}	671
43	KHAIRI	22º 58'	79º 03'		55 N/1	274.3	72	0-71.00 Alluvium 71.00-273.00 Gondwanas Archean shale at 273	14.63	1612.50	7.57	4.77 $x10^2$		
44	KHAIRIKALAN	23º 00'	78º 47'		55 I/16	135.94	125.72	0-135.94 Alluvium	17.78	2520.00	5.85	1.20 $x10^3$		
45	KHAMARIA	22º 54'	78º 39'		55 J/9	97.81	79.55	Alluvium	9.77	2314.00	6.76	9.50 $x10^2$		
46	KHERUA	22º 51'	78º 41'		55 J/9	292.48	69.8	0-97.00 Alluvium 97.00-275.54 Gondwanas Phyllite at 275.54	5.87	2916.00	7.34	1.50 $x10^3$		
47	LAKHA	22º 57'	78º 54'		55 J/13	162.61		0-181.00 Alluvium 181.00-162.61 Gondwanas						

48	LOHARI	23º 00'	79º 19'		55 M/8	226.16	163	0-159.00 Alluvium 159.00-198.73 Gondwanas State at 198.73	11.09	1029	5.09	2.10 $x10^{2}$		734
49	MANAGAON DEEP	22º 58'	79º 24'		55 N/5	198.73	160	0-160.00 Alluvium 106.00-198.12 Gondwanas State at 198.12	13.35	530	23.62	9.94 $x10^{1}$	7.11 x 10^{-5}	
50	MANAGAON SHALLOW	22º 58'	79º 24'		55 N/5	198.73	100.59		8.92	761	21	3.36 $x10^{1}$	2.58 x 10^{-6}	1468
51	MEHGAWAN	23º 05'	78º 57'		55 I/16	62.18	43.31	0- 56.03 Alluvium Dolomite at 56.03	18.17	2712	5.98	2.40 $x10^{3}$		
52	MOTHEGAON	22º 56'	79º 00'		55 N/1	205.74	31	0-137.00 Alluvium 137.00-203.00 Gondwana Granite at 203	2.02	883	9.7	1.08 $x10^{2}$		739
53	NANDNER	22º 53'	78º 42'		55 J/9	122.22	112.98	0-73.00 Alluvium 73.00-122.22 Gondwanas	10.69	2244.00	14.02	4.40 $x10^{2}$		
54	NARSINGHPUR	22º 57'	79º 11'		55 N/1	217.93		0-126.00 Alluvium 126.00-217.63 Gondwana Limestone at 217.63						
55	NARSINGHPUR	22º 57'	79º 12'			145.15	130	Alluvium gondwana clay at 98.5	28.5	12				
56	NAYAGAON	22º 58'	78º 52'		55 J/13	213.97	166	0-190.00 Alluvium 190.00-213.97 Gondwanas Qartzite at 213.97	13.56	1009.00	5.04	8.86 $x10^{2}$		655

57	NIWARI	22º 52'	79º 08'		55 N/1	343		0-25.00 Alluvium 25.00-318.00 Gondwana						
58	NONI	23º 06'	79º 25'		55 M/8	130.5	106	0-104.00 Alluvium 104.00-119.00 Gondwana Schist at 119	20.35	760	8.02	2.65 $x10^2$		742
59	PANSI DEEP	22º 55'	79º 17'		55 N/5	123		0-199.00 Alluvium 199.00-226.17 Gondwana	20.24	420	13.73	9.24 $x10^1$		
60	PANSI SHALLOW	22º 55'	79º 17'		55 N/5	226.17	56.6		12	167	13.45	1.17 $x10^1$		592
61	PINDRAI	23º 01'	79º 29'		55 M/8	276.5		0-60.00 Alluvium 60.00-248.11 Gondwana state at 248.11						
62	PIPARIA II	22º 57'	79º 05'		55 N/1	213.97		0-178.00 Alluvium 178.00-213.97 Gondwanas						
63	PONRAR	22º 50'	78º 39'		55 J/9	307.03	113	0-116.00 Alluvium 116.00-298.3 Gondwanas Archean shale at 298	6.06	3145.00	12.08	2.07 $x10^5$		458
64	RAIPUR	22º 50'	78º 53'		55 J/13	263.04	104	0-34.00 Alluvium 34.00-256.00 Gondwanas Archean shalt at 256	21.08	2816.00	6.36	1.62 $x10^3$		

65	RAMNIWARI	23º 01'	79º 30'		55 M/8	154.2	123.5	0-14.00 Alluvium 14.00-153.40 Gondwana Gnessis at 153.40	8.19	776	9.76	3.15 $x10^{2}$		693
66	SADUMAR	22º 59'	78º 52'		55 J/13	155.57	131	0- 154.94 Alluvium Metamorphics at154.9	16.59	1925	8.03	7.48 $x10^{2}$	1.15 x 10^{-3}	647
67	SAINKHERA	22º 57'	78º 34'		55 J/9	82.3		Alluvium shale at 81.99	15	2700.00	3.66			
68	SAMNAPUR	22º 54'	79º 17'		55 N/5	270.32	88	0-95.10 Alluvium Conglomerate at 45.0	3.67	708	26.73	3.98 $x10^{1}$		820
69	SARRA	23º 08'	78º 49'		55 I/16	44.6	37.5	0- 44.37 Alluvium Dolomite at 44.37	7.11	606.00	15.64	2.35 $x10^{1}$	2.01 x 10^{-6}	668
70	SASBAHO	22º 54'	79º 08'		55 N/1	309.98		0-67.00 Alluvium 67.00-309.00 Gondwana Limestone at 309						
71	SIMARIA	22º 52'	79º 00'		55 N/1	53.64	38.5	0- 49.00 Alluvium Metamorphics at 49.00	4.52	1134	3.81	1.10 $x10^{3}$		729
72	SINGHPUR	22º 53'	79º 11'		55 N/1	403.25	195	0-116.00 Alluvium 116.00-403.00 GondwanaState at 403	15.17	761	18.24	6.36 $x10^{1}$		819
73	SUKHAKHERI	22º 49'	79º 03'		55 J/13	252.06	56.46	0-56.00 Alluvium 56.00-251.00 Gondwanas Granite at 251	11.8	1722.00	7.98	6.40 $x10^{2}$		

74	SUKRI	22º 49'	78º 48'		55 J/13	198.5	113.81	0-116.00Alluvium 116.00-193.12 Gondwana limestone at 193.12	18.84	2142.00	6.25	9.60 x10^2		
75	SURIA	22º 58'	78º 52'		55 J/13	228.9		0-176.00 Alluvium 176.00-222.50 Gondwanas Qartzite at 222.50						
76	TINDNI	22º 53'	79º 28'		55 N/5	71.54	64	0-62.00 Alluvium Quartzite at 62.00	22.73	776	4.15	6.60 x10^2		692
77	TUMRA	22º 58'	78º 32'		55 J/9	33.51	81.68	Alluvium	15.1	2352.00	4.17	3.30 x10^3		

ANNEXURE-II

LOCATION DETAILS OF EXPLRATION BORE WELLS

S.N.	Blocks	Location	Latitude	Longitude	Altitude (m)
1	CHANWARPATHA	BILTHARI	23.05	78.97	335
2	CHANWARPATHA	KASIKHERI	23.08	78.99	345
3	CHANWARPATHA	SARRA	23.13	78.82	338
4	CHANWARPATHA	MEHGAWAN	23.08	78.95	345
5	CHANWARPATHA	BHAORJHIR	23.02	78.93	337
6	CHANWARPATHA	DUNGARIA	23.02	78.95	346
7	CHANWARPATHA	KATHOTIA	22.95	79.00	357
8	CHANWARPATHA	DOBHI	23.10	78.92	342
9	CHANWARPATHA	KAURIA	22.93	78.82	349
10	CHANWARPATHA	SADUMAR	22.98	78.87	346
11	CHANWARPATHA	NAYAGAON	22.97	78.87	348
12	CHANWARPATHA	CHIRAHA KALAN	22.95	78.80	337
13	CHANWARPATHA	KHAIRIKALAN	23.00	78.78	341
14	CHANWARPATHA	DEORI	22.92	78.92	358
15	CHANWARPATHA	DUDHWARA	22.93	78.93	359
16	CHANWARPATHA	LAKHA	22.95	78.90	355
17	CHANWARPATHA	MOTHEGAON	22.93	79.00	360
18	CHICHLI	BAMHANWARA	22.85	78.97	370
19	CHICHLI	PONRAR	22.83	78.65	351
20	CHICHLI	KHERUA	22.85	78.68	350
21	CHICHLI	RAIPUR	22.83	78.88	360
22	CHICHLI	BARCHHI	22.80	78.72	363

23	CHICHLI	BASURIA	22.78	78.68	361
24	CHICHLI	SUKRI	22.82	78.80	360
25	CHICHLI	GHAGROLA	22.78	78.82	369
26	CHICHLI	KARAPGAON	22.88	78.98	370
27	CHICHLI	KHAIRI	22.83	78.83	345
28	CHICHLI	SIMARIA	22.87	79.00	371
29	GOTEGAON	TINDNI	22.88	79.47	442
30	GOTEGAON	RAMNIWARI	23.02	79.50	370
31	GOTEGAON	MANAGAON DEEP	22.97	79.40	373
32	GOTEGAON	BIKRAMPUR SHALLOW	23.08	79.58	368
33	GOTEGAON	BEDU	22.93	79.40	383
34	GOTEGAON	DABKIA	23.02	79.57	385
35	GOTEGAON	LOHARI	23.00	79.32	363
36	GOTEGAON	KAMOD	23.05	79.45	364
37	GOTEGAON	BASANPANI	22.95	79.40	380
38	GOTEGAON	NONI	23.10	79.42	356
39	GOTEGAON	PINDRAI	23.02	79.48	370
40	KARELI	BASENDHI	22.97	79.12	345
41	KARELI	KHAIRI	22.97	79.05	346
42	KARELI	BHAINSA	22.83	78.80	357
43	KARELI	AMGAON	22.87	79.07	365
44	KARELI	AMGAON	22.85	79.07	368
45	KARELI	KARELI	22.93	79.07	362
46	KARELI	NIWARI	22.87	79.13	359
47	KARELI	PIPARIA II	22.95	79.08	355

48	KARELI	SASBAHO	22.90	79.13	441
49	NARSINGHPUR	JHAKHURPA	22.87	79.25	381
50	NARSINGHPUR	BACHHAI	22.91	79.31	377.6
51	NARSINGHPUR	DHAMNA SHALLOW	22.92	79.30	374
52	NARSINGHPUR	PANSI DEEP	22.92	79.28	376
53	NARSINGHPUR	SAMNAPUR	22.90	79.28	373
54	NARSINGHPUR	SINGHPUR	22.88	79.18	360
55	NARSINGHPUR	DHAMNA DEEP	23.02	79.25	357
56	NARSINGHPUR	NARSINGHPUR	22.95	79.18	357
57	SAIKHERA	JHAJHANKHERA	22.88	78.73	347
58	SAIKHERA	IMALIA	22.90	78.82	345
59	SAIKHERA	KHAMARIA	22.90	78.65	336
60	SAIKHERA	NANDNER	22.88	78.70	343
61	SAIKHERA	TUMRA	22.97	78.53	320
62	SAIKHERA	DETPON	22.93	78.63	338
63	SAIKHERA	JAWARA	22.88	78.75	350
64	SAIKHERA	GADARWARA	22.92	78.78	349
65	SAIKHERA	JAIKHERA	22.88	78.67	335
66	SAIKHERA	JHIRIA	22.97	78.65	330
67	SAIKHERA	SAINKHERA	22.95	78.57	322

ANEXURE-III

LITHOLOGS DETAILS Of EXPLRATION BORE WELLS

Bore	Depth 1	Depth2	Lithology	Comments
AMGAON	0	108	Aquiclude1	Alluvium
AMGAON	108	364	Aquiclude1	Gondwana
AMGAON	364	368	Granite/Gneiss	Dolomite
BACHHAI	0	30	Aquiclude1	Alluvium
BACHHAI	30	42	Aquiclude2	Alluvium
BACHHAI	42	48	Aquifer2	Alluvium
BACHHAI	48	55	Aquiclude2	Alluvium
BACHHAI	55	215	Aquiclude2	Gondwana
BAMHANWARA	0	3	Black Cotton Soil	Black Cotton Soil
BAMHANWARA	3	28	Aquiclude1	Clay
BAMHANWARA	28	39	Aquifer2	Sand
BAMHANWARA	39	42	Aquiclude2	Clay with Gravel
BAMHANWARA	42	49	Aquifer2	Gravel with Sand
BAMHANWARA	49	63	Aquiclude2	Clay with Gravel
BAMHANWARA	63	67	Aquifer2	Gravel
BAMHANWARA	67	68	Aquiclude2	Granite/Gneiss
BARCHHI	0	32	Aquiclude1	Alluvium
BARCHHI	32	69	Aquifer2	Alluvium
BARCHHI	69	72	Aquiclude2	Alluvium
BASANPANI	0	30	Aquiclude1	Alluvium
BASANPANI	30	110	Aquiclude2	Alluvium
BASANPANI	110	227	Aquiclude2	Gondwana
BASENDHI	0	11	Aquiclude1	clay with kankar
BASENDHI	11	14	Aquiclude1	Sand with Clay
BASENDHI	14	23	Aquifer1	Gravel with Sand
BASENDHI	23	41	Aquiclude2	Clay
BASENDHI	41	98	Aquifer2	Gravel with Sand
BASENDHI	98	113	Aquifer2	Gravel
BASENDHI	113	175	Aquiclude2	Clay with Gravel
BASENDHI	113	203	Aquiclude2	Clay I
BASENDHI	203	211	Aquifer2	Gravel with Sand
BASENDHI	211	300	Aquiclude2	Clay with Gravel
BASENDHI	300	312	Granite/Gneiss	Granite/Gneiss
BASURIA	0	29	Aquiclude1	Alluvium
BASURIA	29	66	Aquifer2	Alluvium
BASURIA	66	86	Aquiclude2	Alluvium
BASURIA	86	92	Aquifer2	Alluvium

BASURIA	92	99	Aquiclude2	Alluvium
BASURIA	99	105	Aquifer2	Alluvium
BASURIA	105	109	Aquiclude2	Alluvium
BASURIA	109	115	Aquiclude2	Gondwana
BEDU	0	3	Black Cotton Soil	Black Cotton Soil
BEDU	3	5	Aquifer1	Sand
BEDU	5	62	Aquiclude1	clay with kankar
BEDU	62	71	Aquifer2	Gravel
BEDU	71	86	Aquiclude2	clay with kankar
BEDU	86	104	Aquiclude2	Gravel with clay
BEDU	104	132	Aquiclude2	Clay
BEDU	132	141	Aquiclude2	Gravel with Clay
BEDU	141	202	Aquiclude2	Clay I
BEDU	202	220	Granite/Gneiss	Shale
BHAINSA	0	30	Aquiclude1	Alluvium
BHAINSA	30	44	Aquiclude2	Alluvium
BHAINSA	44	103	Aquifer2	Alluvium
BHAINSA	103	112	Aquiclude2	Alluvium
BHAORJHIR	0	5	Black Cotton Soil	Black Cotton Soil
BHAORJHIR	5	35	Aquiclude1	Clay
BHAORJHIR	35	40	Aquifer2	Sand
BHAORJHIR	40	51	Aquiclude2	Clay
BHAORJHIR	51	69	Aquiclude2	Sand with Clay
BHAORJHIR	69	77	Aquiclude2	Clay
BHAORJHIR	77	81	Aquiclude2	Clay
BIKRAMPUR Deep	0	11	Black Cotton Soil	Black Cotton Soil
BIKRAMPUR Deep	11	14	Aquiclude1	Clay
BIKRAMPUR Deep	14	16	Aquiclude1	Clay with Sand
BIKRAMPUR Deep	16	61	Aquiclude1	Clay
BIKRAMPUR Deep	61	68	Aquifer2	Gravel
BIKRAMPUR Deep	68	72	Aquiclude2	Clay
BIKRAMPUR Deep	72	75	Aquifer2	Gravel
BIKRAMPUR Deep	75	79	Aquiclude2	Clay
BIKRAMPUR Deep	79	84	Aquifer2	Sand
BIKRAMPUR Deep	84	87	Aquiclude2	Clay
BIKRAMPUR Deep	87	128	Aquiclude2	Gravel
BIKRAMPUR Deep	128	136	Aquiclude2	Clay I
BIKRAMPUR Deep	136	140	Granite/Gneiss	Granite/Gneiss
BILTHARI	0	27	Aquiclude1	clay with kankar
BILTHARI	27	39	Aquifer2	Sand
BILTHARI	39	46	Aquifer2	Gravel with Sand
BILTHARI	46	59	Aquiclude2	Clay
CHHEMAKACHHAR	0	27	Aquiclude1	Alluvium

CHHEMAKACHHAR	27	62	Aquifer2	Alluvium
CHHEMAKACHHAR	62	84	Aquiclude2	Alluvium
CHHEMAKACHHAR	84	85	Aquiclude2	Boulder bed
CHIRAHA KALAN	0	30	Aquiclude1	Alluvium
CHIRAHA KALAN	30	59	Aquiclude2	Alluvium
CHIRAHA KALAN	59	105	Aquifer2	Alluvium
CHIRAHA KALAN	105	133	Aquiclude2	Alluvium
DABKIA	0	18	Aquiclude1	clay with kankar
DABKIA	18	31	Aquiclude1	Clay with Sand
DABKIA	31	36	Aquifer2	sand with Gravel
DABKIA	36	47	Aquiclude2	Clay with sand
DABKIA	47	51	Aquifer2	Sand
DABKIA	51	64	Aquiclude2	Clay
DABKIA	64	73	Aquifer2	Sand
DABKIA	73	80	Aquiclude2	Clay
DABKIA	80	99	Aquifer2	Gravel with Sand
DABKIA	99	105	Aquiclude2	Clay
DABKIA	105	137	Aquifer2	Gravel with Sand
DABKIA	137	140	Aquiclude2	Clay I
DEORI	0	30	Aquiclude1	Alluvium
DEORI	30	105	Aquiclude2	Alluvium
DEORI	105	147	Aquiclude2	Gondwanas
DETPON	0	10	Aquiclude1	Alluvium
DETPON	10	31	Aquifer1	Alluvium
DETPON	31	53	Aquiclude1	Alluvium
DETPON	53	62	Aquifer2	Alluvium
DETPON	62	68	Aquiclude2	Alluvium
DETPON	68	98	Aquifer2	Alluvium
DETPON	98	109	Aquiclude2	Alluvium
DHAMNA DEEP	0	19	Aquiclude1	Clay
DHAMNA DEEP	19	23	Aquifer1	Sand
DHAMNA DEEP	23	26	Aquifer1	Gravel
DHAMNA DEEP	26	60	Aquiclude2	Clay
DHAMNA DEEP	60	95	Aquifer2	Sand
DHAMNA DEEP	95	112	Aquifer2	Gravel
DHAMNA DEEP	112	116	Aquiclude2	Clay I
DHAMNA DEEP	116	119	Aquifer2	Gravel
DHAMNA DEEP	119	128	Aquifer2	Sand I
DHAMNA DEEP	128	132	Aquiclude2	Clay with Gravel
DHAMNA DEEP	132	146	Aquiclude2	Gravel
DHAMNA DEEP	146	186	Aquiclude2	Clay with Gravel
DHAMNA DEEP	186	191	Aquiclude2	Gravel
DHAMNA DEEP	191	193	Granite/Gneiss	Granite/Gneiss

DOBHI	0	32	Aquiclude1	Alluvium
DOBHI	32	65	Aquifer2	Alluvium
DOBHI	65	76	Aquiclude2	Dolomite
DUDHWARA	0	30	Aquiclude1	Alluvium
DUDHWARA	30	126	Aquiclude2	Alluvium
DUDHWARA	126	168	Aquiclude2	Gondwana
DUNGARIA	0	14	Aquiclude1	Clay
DUNGARIA	14	21	Aquiclude1	Gravel with clay
DUNGARIA	21	39	Aquiclude1	Clay
DUNGARIA	39	42	Aquifer2	Sand
DUNGARIA	42	63	Aquifer2	Gravel with Sand
DUNGARIA	63	74	Aquiclude2	Gravel with Clay
DUNGARIA	74	77	Aquifer2	Gravel
GADARWARA	0	31	Aquiclude1	Alluvium
GADARWARA	31	56	Aquifer2	Alluvium
GADARWARA	56	59	Aquiclude2	Alluvium
GADARWARA	59	69	Aquifer2	Alluvium
GADARWARA	69	97	Aquiclude2	Alluvium
GADARWARA	97	103	Aquifer2	Alluvium
GADARWARA	103	122	Aquiclude2	Alluvium
GADARWARA	122	268	Aquiclude2	Gondwana
GADARWARA	268	269	Granite/Gneiss	Qartzite
GHAGROLA	0	34	Aquiclude1	Alluvium
GHAGROLA	34	261	Aquiclude2	Gondwana
IMALIA	0	38	Aquiclude1	Alluvium
IMALIA	38	43	Aquifer2	Alluvium
IMALIA	43	111	Aquiclude2	Alluvium
IMALIA	111	117	Aquifer2	Alluvium
IMALIA	117	138	Aquiclude2	Alluvium
IMALIA	138	147	Aquifer2	Alluvium
IMALIA	147	253	Aquiclude2	Gondwana
JAIKHERA	0	27	Aquiclude1	Alluvium
JAIKHERA	27	33	Aquifer2	Alluvium
JAIKHERA	33	56	Aquiclude2	Alluvium
JAIKHERA	56	100	Aquifer2	Alluvium
JAIKHERA	100	122	Aquiclude2	Gondwana
JAWARA	0	30	Aquiclude1	Alluvium
JAWARA	30	41	Aquifer2	Alluvium
JAWARA	41	45	Aquiclude2	Alluvium
JAWARA	45	48	Aquifer2	Alluvium
JAWARA	48	55	Aquiclude2	Alluvium
JAWARA	55	58	Aquifer2	Alluvium
JAWARA	58	89	Aquiclude2	Alluvium

JAWARA	89	100	Aquifer2	Alluvium
JAWARA	100	105	Aquiclude2	Alluvium
JAWARA	105	114	Aquifer2	Alluvium
JAWARA	114	119	Aquiclude2	Alluvium
JHAJHANKHERA	0	13	Aquiclude1	Alluvium
JHAJHANKHERA	13	19	Aquifer1	Alluvium
JHAJHANKHERA	19	32	Aquiclude1	Alluvium
JHAJHANKHERA	32	44	Aquifer2	Alluvium
JHAJHANKHERA	44	95	Aquiclude2	Alluvium
JHAJHANKHERA	95	154	Aquiclude2	Gondwana
JHAKHURPA	0	13	Aquiclude1	Clay
JHAKHURPA	13	17	Aquifer1	Sand
JHAKHURPA	17	22	Aquifer1	Gravel
JHAKHURPA	22	25	Aquiclude1	Clay
JHAKHURPA	25	28	Aquifer1	Sand
JHAKHURPA	28	32	Aquifer1	Gravel
JHAKHURPA	32	35	Aquiclude2	Clay
JHAKHURPA	35	50	Aquiclude2	Gravel
JHIRIA	0	11	Aquiclude1	Clay
JHIRIA	11	16	Aquifer1	Sand
JHIRIA	16	23	Aquiclude1	Clay
JHIRIA	23	42	Aquifer2	Sand
JHIRIA	42	51	Aquiclude2	Clay
JHIRIA	51	63	Aquifer2	Sand
JHIRIA	63	65	Aquiclude2	Clay
JHIRIA	65	99	Aquifer2	Gravel with Sand
JHIRIA	99	101	Aquiclude2	Clay I
JHIRIA	101	116	Aquifer2	Gravel with Sand
JHIRIA	116	123	Aquiclude2	Clay I
JHIRIA	123	132	Aquifer2	Sand I
JHIRIA	132	161	Aquiclude2	Clay I
JHIRIA	161	215	Aquiclude2	Gravel
JHIRIA	215	218	Aquiclude2	Clay II
JHIRIA	218	220	Granite/Gneiss	Granite/Gneiss
KAMOD	0	7	Aquiclude1	Clay
KAMOD	7	13	Aquiclude1	Sand with Clay
KAMOD	13	22	Aquifer1	Sand
KAMOD	22	32	Aquiclude1	Clay
KAMOD	32	46	Aquifer2	Sand
KAMOD	46	62	Aquiclude2	Clay
KAMOD	62	77	Aquifer2	Sand
KAMOD	77	80	Aquiclude2	Clay
KAMOD	80	86	Aquifer2	Sand

KAMOD	86	92	Aquiclude2	Clay
KAMOD	92	104	Aquifer2	Gravel
KAMOD	104	107	Aquiclude2	Clay I
KAMOD	107	113	Aquifer2	Gravel with Sand
KAMOD	113	123	Aquiclude2	Clay I
KAMOD	123	129	Aquifer2	Sand I
KAMOD	129	138	Aquiclude2	Clay I
KAMOD	138	150	Aquifer2	Sand I
KAMOD	150	153	Aquiclude2	Clay I
KAMOD	153	159	Aquifer2	Sand I
KAMOD	159	223	Aquiclude2	Clay II
KARAPGAON	0	5	Black Cotton Soil	Black Cotton Soil
KARAPGAON	5	27	Aquiclude1	Clay
KARAPGAON	27	35	Aquifer1	Gravel
KARAPGAON	35	42	Aquiclude2	Clay
KARAPGAON	42	49	Aquifer2	Gravel
KARAPGAON	49	54	Aquiclude2	Clay
KARAPGAON	54	59	Aquifer2	Gravel
KARAPGAON	59	63	Aquiclude2	Clay
KARAPGAON	63	85	Aquifer2	Gravel
KARAPGAON	85	88	Aquifer2	Sand with Clay
KARAPGAON	88	91	Aquifer2	Gravel
KARAPGAON	91	93	Aquiclude2	Clay
KARAPGAON	93	97	Aquifer2	Sand with Clay
KARAPGAON	97	116	Aquiclude2	Clay
KARAPGAON	116	118	Aquifer2	Gravel
KARAPGAON	118	165	Aquiclude2	Clay I
KARAPGAON	165	168	Aquifer2	Gravel
KARAPGAON	168	225	Aquiclude2	Clay II
KARELI	0	30	Aquiclude1	Alluvium
KARELI	30	141	Aquiclude2	Alluvium
KARELI	141	279	Aquiclude2	Gondwana
KASIKHERI	0	22	Aquiclude1	Alluvium
KASIKHERI	22	35	Aquifer1	Alluvium
KASIKHERI	35	47	Aquiclude2	Alluvium
KASIKHERI	47	49	Granite/Gneiss	Dolomite
KATHOTIA	0	14	Aquiclude1	Clay
KATHOTIA	14	17	Aquifer1	sand with Gravel
KATHOTIA	17	47	Aquiclude1	Clay with Gravel
KATHOTIA	47	53	Aquifer2	sand with Gravel
KATHOTIA	53	55	Aquifer2	Sand
KATHOTIA	55	62	Aquiclude2	Clay
KATHOTIA	62	63	Aquifer2	Sand

KATHOTIA	63	70	Aquiclude2	Clay
KATHOTIA	70	77	Aquiclude2	Clay with Gravel
KATHOTIA	77	96	Aquiclude2	Clay
KATHOTIA	96	116	Aquifer2	Gravel
KATHOTIA	116	119	Aquiclude2	Clay I
KATHOTIA	119	123	Aquifer2	Gravel
KATHOTIA	123	127	Aquiclude2	Gravel with clay
KATHOTIA	127	146	Aquiclude2	Clay I
KATHOTIA	146	161	Aquifer2	Gravel
KATHOTIA	161	169	Aquiclude2	Clay I
KATHOTIA	169	180	Aquiclude2	Clay with Gravel
KATHOTIA	180	205	Aquiclude2	Clay II
KATHOTIA	205	207	Aquiclude2	Clay with Gravel
KATHOTIA	207	226	Aquiclude2	Clay II
KAURIA	0	46	Aquiclude1	Alluvium
KAURIA	46	51	Aquifer2	Alluvium
KAURIA	51	68	Aquiclude2	Alluvium
KAURIA	68	84	Aquifer2	Alluvium
KAURIA	84	96	Aquiclude2	Alluvium
KAURIA	96	110	Aquifer2	Alluvium
KAURIA	110	116	Aquiclude2	Alluvium
KAURIA	116	147	Aquiclude2	Gondwana
KHAIRI	0	4	Black Cotton Soil	Black Cotton Soil
KHAIRI	4	11	Aquifer1	Sand
KHAIRI	11	18	Aquiclude1	Clay
KHAIRI	18	21	Aquifer1	Gravel
KHAIRI	21	25	Aquiclude1	Gravel with clay
KHAIRI	25	28	Aquiclude1	Clay
KHAIRI	28	42	Aquifer2	Sand
KHAIRI	42	46	Aquifer2	Gravel
KHAIRI	46	49	Aquifer2	Sand
KHAIRI	49	53	Aquiclude2	Clay
KHAIRI	53	56	Aquifer2	Sand
KHAIRI	56	67	Aquiclude2	Clay
KHAIRI	67	70	Aquifer2	sand with Gravel
KHAIRI	70	134	Aquiclude2	Clay I
KHAIRI	134	141	Aquifer2	Sand I
KHAIRI	141	151	Aquiclude2	Clay I
KHAIRI	151	158	Aquifer2	Sand I
KHAIRI	158	162	Aquiclude2	Clay I
KHAIRI	162	172	Aquifer2	Sand I
KHAIRI	172	176	Aquiclude2	Clay I
KHAIRI	176	179	Aquifer2	Sand I

KHAIRI	179	186	Aquiclude2	Clay I
KHAIRI	186	197	Aquifer2	Sand I
KHAIRI	197	207	Aquiclude2	Sand with Clay
KHAIRI	207	230	Aquiclude2	Clay II
KHAIRI	230	233	Aquifer2	Sand II
KHAIRI	233	237	Aquiclude2	Clay II
KHAIRI	237	246	Aquifer2	Sand II
KHAIRI	246	266	Aquiclude2	Clay II
KHAIRI	266	273	Aquiclude2	Gravel
KHAIRI	273	274	Granite/Gneiss	Shale
KHAIRIKALAN	0	41	Aquiclude1	Alluvium
KHAIRIKALAN	41	57	Aquifer2	Alluvium
KHAIRIKALAN	57	60	Aquiclude2	Alluvium
KHAIRIKALAN	60	85	Aquifer2	Alluvium
KHAIRIKALAN	85	110	Aquiclude2	Alluvium
KHAIRIKALAN	110	126	Aquifer2	Alluvium
KHAIRIKALAN	126	136	Aquiclude2	Alluvium
KHAMARIA	0	26	Aquiclude1	Alluvium
KHAMARIA	26	35	Aquifer2	Alluvium
KHAMARIA	35	52	Aquiclude2	Alluvium
KHAMARIA	52	79	Aquifer2	Alluvium
KHAMARIA	79	98	Aquiclude2	Alluvium
KHERUA	0	24	Aquiclude1	Alluvium
KHERUA	24	30	Aquifer1	Alluvium
KHERUA	30	59	Aquifer2	Alluvium
KHERUA	59	64	Aquiclude2	Alluvium
KHERUA	64	70	Aquifer2	Alluvium
KHERUA	70	97	Aquiclude2	Alluvium
KHERUA	97	275	Aquiclude2	Gondwana
KHERUA	275	292	Granite/Gneiss	Phyllite
LAKHA	0	30	Aquiclude1	Alluvium
LAKHA	30	163	Aquiclude2	Alluvium
LAKHA	163	181	Aquiclude2	Gondwana
LOHARI	0	3	Black Cotton Soil	Black Cotton Soil
LOHARI	3	28	Aquiclude1	Clay
LOHARI	28	46	Aquifer2	Gravel
LOHARI	46	80	Aquiclude2	Clay
LOHARI	80	95	Aquifer2	Gravel
LOHARI	95	98	Aquiclude2	Clay
LOHARI	98	119	Aquifer2	Gravel with Sand
LOHARI	119	138	Aquiclude2	Clay I
LOHARI	138	144	Aquiclude2	Clay with Gravel
LOHARI	144	150	Aquiclude2	Clay I

LOHARI	150	159	Aquiclude2	Clay with Gravel
LOHARI	159	199	Aquiclude2	Clay I
LOHARI	199	226	Granite/Gneiss	Shale
MANAGAON DEEP	0	2	Black Cotton Soil	Black Cotton Soil
MANAGAON DEEP	2	30	Aquiclude1	Clay
MANAGAON DEEP	30	45	Aquiclude2	
MANAGAON DEEP	45	53	Aquifer2	Gravel
MANAGAON DEEP	53	60	Aquiclude2	Clay
MANAGAON DEEP	60	71	Aquifer2	Sand
MANAGAON DEEP	71	79	Aquiclude2	Clay
MANAGAON DEEP	79	87	Aquifer2	Sand
MANAGAON DEEP	87	93	Aquiclude2	Clay
MANAGAON DEEP	93	105	Aquifer2	Sand I
MANAGAON DEEP	105	120	Aquiclude2	Clay I
MANAGAON DEEP	120	123	Aquifer2	Gravel
MANAGAON DEEP	123	147	Aquiclude2	Clay I
MANAGAON DEEP	147	151	Aquifer2	Gravel
MANAGAON DEEP	151	156	Aquifer2	Sand I
MANAGAON DEEP	156	160	Aquiclude2	Clay I
MANAGAON DEEP	160	167	Aquifer2	Sand I
MANAGAON DEEP	167	198	Aquiclude2	Clay I
MANAGAON DEEP	198	199	Granite/Gneiss	Shale
MEHGAWAN	0	31	Aquiclude1	Alluvium
MEHGAWAN	31	42	Aquifer2	Alluvium
MEHGAWAN	42	56	Aquiclude2	Alluvium
MEHGAWAN	56	62	Granite/Gneiss	Dolomite
MOTHEGAON	0	3	Black Cotton Soil	Black Cotton Soil
MOTHEGAON	3	21	Aquiclude1	Clay
MOTHEGAON	21	28	Aquifer2	Gravel
MOTHEGAON	28	60	Aquiclude2	Clay
MOTHEGAON	60	63	Aquifer2	Gravel
MOTHEGAON	63	74	Aquiclude2	Clay
MOTHEGAON	74	77	Aquifer2	Gravel
MOTHEGAON	77	88	Aquiclude2	Clay
MOTHEGAON	88	137	Aquifer2	Gravel
MOTHEGAON	137	203	Aquiclude2	Clay II
MOTHEGAON	203	206	Granite/Gneiss	Granite/Gneiss
NANDNER	0	28	Aquiclude1	Alluvium
NANDNER	28	32	Aquifer2	Alluvium
NANDNER	32	35	Aquiclude2	Alluvium
NANDNER	35	42	Aquifer2	Alluvium
NANDNER	42	58	Aquiclude2	Alluvium
NANDNER	58	61	Aquifer2	Alluvium

NANDNER	61	68	Aquiclude2	Alluvium
NANDNER	68	76	Aquifer2	Gondwana
NANDNER	76	87	Aquiclude2	Gondwana
NANDNER	87	90	Aquifer2	Gondwana
NANDNER	90	102	Aquiclude2	Gondwana
NANDNER	102	113	Aquifer2	Gondwana
NANDNER	113	122	Aquiclude2	Gondwana
NARSINGHPUR	0	30	Aquiclude1	Alluvium
NARSINGHPUR	30	126	Aquiclude2	Alluvium
NARSINGHPUR	126	217	Aquiclude2	Gondwana
NARSINGHPUR	217	218	Granite/Gneiss	Limestone
NAYAGAON	0	3	Black Cotton Soil	Black Cotton Soil
NAYAGAON	3	14	Aquiclude1	Clay
NAYAGAON	14	28	Aquifer1	Gravel
NAYAGAON	28	42	Aquiclude2	Clay
NAYAGAON	42	49	Aquifer2	Gravel
NAYAGAON	49	81	Aquiclude2	Clay
NAYAGAON	81	119	Aquifer2	Gravel
NAYAGAON	119	130	Aquiclude2	Clay I
NAYAGAON	130	147	Aquifer2	Sand I
NAYAGAON	147	161	Aquiclude2	Clay with Sand
NAYAGAON	161	168	Aquifer2	Gravel with Sand
NAYAGAON	168	190	Aquiclude2	Clay with sand
NAYAGAON	190	214	Aquiclude2	Clay II
NIWARI	0	40	Aquiclude1	Clay
NIWARI	30	40	Aquiclude2	Clay I
NIWARI	40	78	Aquiclude2	Clay with Gravel
NIWARI	78	119	Aquiclude2	Clay I
NIWARI	119	152	Aquiclude2	Clay with Gravel
NIWARI	152	169	Aquiclude2	Clay I
NIWARI	169	186	Aquifer2	Sand I
NIWARI	186	262	Aquiclude2	Clay with Sand
NIWARI	262	296	Aquiclude2	Clay with Gravel
NIWARI	296	305	Aquiclude2	Clay II
NIWARI	305	314	Aquiclude2	Clay with Gravel
NIWARI	314	318	Aquiclude2	Clay II
NONI	0	5	Black Cotton Soil	Black Cotton Soil
NONI	5	31	Aquiclude1	Clay
NONI	31	41	Aquifer2	Sand
NONI	41	68	Aquiclude2	Clay
NONI	68	88	Aquifer2	Sand
NONI	88	103	Aquifer2	Gravel
NONI	103	124	Aquiclude2	Clay I

NONI	124	129	Aquifer2	Gravel
NONI	129	130	Granite/Gneiss	Granite/Gneiss
PANSI DEEP	0	3	Black Cotton Soil	Black Cotton Soil
PANSI DEEP	3	7	Aquifer1	Sand
PANSI DEEP	7	10	Aquifer1	Gravel
PANSI DEEP	10	16	Aquiclude1	Clay
PANSI DEEP	16	28	Aquifer1	Sand
PANSI DEEP	28	34	Aquiclude1	Clay
PANSI DEEP	34	43	Aquiclude2	Clay with Gravel
PANSI DEEP	43	83	Aquiclude2	Clay
PANSI DEEP	83	92	Aquifer2	Gravel
PANSI DEEP	92	107	Aquiclude2	Clay I
PANSI DEEP	107	119	Aquifer2	Gravel
PANSI DEEP	119	226	Aquiclude2	Clay II
PINDRAI	0	30	Aquiclude1	Alluvium
PINDRAI	30	60	Aquiclude2	Alluvium
PINDRAI	60	248	Aquiclude2	Gondwana
PINDRAI	248	276	Granite/Gneiss	Slate
PIPARIA II	0	30	Aquiclude1	Alluvium
PIPARIA II	30	178	Aquiclude2	Alluvium
PIPARIA II	178	214	Aquiclude2	Gondwana
PONRAR	0	3	Black Cotton Soil	Black Cotton Soil
PONRAR	3	14	Aquifer1	Sand
PONRAR	14	21	Aquiclude1	Clay
PONRAR	21	32	Aquifer1	sand with Gravel
PONRAR	32	35	Aquiclude2	Clay
PONRAR	35	60	Aquifer2	Gravel
PONRAR	60	63	Aquiclude2	Clay
PONRAR	63	67	Aquifer2	Gravel
PONRAR	67	81	Aquifer2	Sand
PONRAR	81	88	Aquifer2	Gravel
PONRAR	88	105	Aquifer2	Sand I
PONRAR	105	116	Aquifer2	Gravel
PONRAR	116	298	Aquiclude2	Clay II
PONRAR	298	306	Aquifer2	Sand II
PONRAR	306	307	Granite/Gneiss	Shale
RAIPUR	0	5	Black Cotton Soil	Black Cotton Soil
RAIPUR	5	14	Aquiclude1	Clay
RAIPUR	14	19	Aquifer1	Sand
RAIPUR	19	34	Aquifer1	Gravel
RAIPUR	34	41	Aquiclude2	Clay
RAIPUR	41	54	Aquifer2	Gravel
RAIPUR	54	56	Aquiclude2	Clay

RAIPUR	56	59	Aquifer2	Gravel
RAIPUR	59	61	Aquiclude2	Clay
RAIPUR	61	84	Aquifer2	Gravel
RAIPUR	84	89	Aquifer2	Sand
RAIPUR	89	94	Aquiclude2	Clay
RAIPUR	94	109	Aquifer2	Sand I
RAIPUR	109	116	Aquiclude2	Clay I
RAIPUR	116	125	Aquifer2	Sand I
RAIPUR	125	131	Aquiclude2	Clay I
RAIPUR	131	137	Aquifer2	Sand I
RAIPUR	137	163	Aquiclude2	Clay I
RAIPUR	163	172	Aquifer2	Gravel
RAIPUR	172	180	Aquiclude2	Clay I
RAIPUR	180	186	Aquifer2	Gravel
RAIPUR	186	252	Aquiclude2	Clay II
RAIPUR	252	256	Granite/Gneiss	Shale
RAIPUR	256	263	Granite/Gneiss	Granite/Gneiss
RAMNIWARI	0	3	Black Cotton Soil	Black Cotton Soil
RAMNIWARI	3	30	Aquiclude1	Clay
RAMNIWARI	30	52	Aquiclude2	Clay I
RAMNIWARI	52	56	Aquifer2	Gravel
RAMNIWARI	56	59	Aquiclude2	Clay
RAMNIWARI	59	82	Aquifer2	Gravel
RAMNIWARI	82	103	Aquiclude2	Clay
RAMNIWARI	103	111	Aquifer2	Gravel
RAMNIWARI	111	113	Aquiclude2	Clay I
RAMNIWARI	113	119	Aquifer2	Gravel
RAMNIWARI	119	122	Aquiclude2	Clay I
RAMNIWARI	122	150	Aquifer2	Gravel
RAMNIWARI	150	153	Aquiclude2	Clay I
RAMNIWARI	153	154	Granite/Gneiss	Granite/Gneiss
SADUMAR	0	3	Black Cotton Soil	Black Cotton Soil
SADUMAR	3	18	Aquifer1	Sand
SADUMAR	18	30	Aquiclude1	Clay
SADUMAR	30	39	Aquiclude2	Clay I
SADUMAR	39	56	Aquifer2	Sand
SADUMAR	56	67	Aquiclude2	Clay
SADUMAR	67	87	Aquifer2	Sand
SADUMAR	87	94	Aquiclude2	Clay
SADUMAR	94	106	Aquifer2	Sand I
SADUMAR	106	116	Aquiclude2	Clay I
SADUMAR	116	128	Aquifer2	Sand I
SADUMAR	128	155	Aquiclude2	Clay I

SADUMAR	155	156	Granite/Gneiss	Granite/Gneiss
SAINKHERA	0	30	Aquiclude1	Alluvium shale
SAINKHERA	30	82	Aquiclude2	Alluvium shale
SAMNAPUR	0	5	Aquiclude1	Clay
SAMNAPUR	5	11	Aquifer1	Sand
SAMNAPUR	11	23	Aquiclude1	Clay
SAMNAPUR	23	30	Aquifer1	Sand
SAMNAPUR	30	39	Aquiclude2	Clay
SAMNAPUR	39	49	Aquifer2	Gravel
SAMNAPUR	49	54	Aquiclude2	Clay
SAMNAPUR	54	57	Aquifer2	Gravel
SAMNAPUR	57	83	Aquiclude2	Clay
SAMNAPUR	83	90	Aquifer2	Gravel
SAMNAPUR	90	94	Aquiclude2	Clay
SAMNAPUR	94	96	Aquifer2	Gravel
SAMNAPUR	96	117	Aquiclude2	Clay I
SAMNAPUR	117	120	Aquifer2	Sand I
SAMNAPUR	120	269	Aquiclude2	Clay II
SAMNAPUR	269	270	Granite/Gneiss	Shale
SARRA	0	16	Aquiclude1	Clay
SARRA	16	17	Aquifer1	Sand
SARRA	17	29	Aquiclude1	Clay
SARRA	29	34	Aquifer1	Sand
SARRA	34	39	Aquiclude2	Clay
SARRA	39	44	Aquifer2	Sand
SASBAHO	0	30	Aquiclude1	Clay
SASBAHO	30	63	Aquiclude2	Clay
SASBAHO	63	67	Aquifer2	Sand
SASBAHO	67	119	Aquiclude2	Clay I
SASBAHO	119	126	Aquifer2	Gravel
SASBAHO	126	130	Aquiclude2	Clay I
SASBAHO	130	137	Aquifer2	Sand I
SASBAHO	137	159	Aquiclude2	Clay I
SASBAHO	159	161	Aquifer2	Sand I
SASBAHO	161	164	Aquifer2	Gravel
SASBAHO	164	168	Aquifer2	Sand I
SASBAHO	168	181	Aquifer2	Gravel
SASBAHO	181	209	Aquiclude2	Clay II
SASBAHO	209	213	Aquifer2	Gravel
SASBAHO	213	253	Aquiclude2	Clay II
SASBAHO	253	260	Aquifer2	Gravel
SASBAHO	260	267	Aquiclude2	Sand with Clay
SASBAHO	267	277	Aquifer2	Gravel with Sand

SASBAHO	277	286	Aquifer2	Sand II
SASBAHO	286	296	Aquifer2	Gravel with Sand
SASBAHO	296	309	Aquiclude2	Clay II
SASBAHO	309	310	Granite/Gneiss	Granite/Gneiss
SIMARIA	0	3	Black Cotton Soil	Black Cotton Soil
SIMARIA	3	10	Aquifer2	Gravel with Sand
SIMARIA	10	14	Aquifer2	Sand
SIMARIA	14	35	Aquifer2	Gravel
SIMARIA	35	49	Aquiclude2	Clay
SIMARIA	49	54	Granite/Gneiss	Granite/Gneiss
SINGHPUR	0	12	Aquiclude1	Clay
SINGHPUR	12	17	Aquifer1	Sand
SINGHPUR	17	30	Aquiclude1	Clay with Sand
SINGHPUR	30	75	Aquiclude2	Clay I
SINGHPUR	75	79	Aquifer2	Sand
SINGHPUR	79	124	Aquiclude2	Clay with sand
SINGHPUR	124	137	Aquiclude2	Gravel with clay
SINGHPUR	137	148	Aquifer2	Sand I
SINGHPUR	148	196	Aquiclude2	Gravel with Clay
SINGHPUR	196	212	Aquiclude2	Clay II
SINGHPUR	212	218	Aquifer2	Sand II
SINGHPUR	218	242	Aquiclude2	Clay II
SINGHPUR	242	252	Aquifer2	Sand II
SINGHPUR	252	276	Aquiclude2	Clay II
SINGHPUR	276	285	Aquiclude2	Sand with Clay
SINGHPUR	285	295	Aquiclude2	Clay II
SUKHAKHERI	0	39	Aquiclude1	Alluvium
SUKHAKHERI	39	56	Aquifer2	Alluvium
SUKHAKHERI	56	251	Aquiclude2	Gondwana
SUKHAKHERI	251	252	Granite/Gneiss	Granite
SUKRI	0	44	Aquiclude1	Alluvium
SUKRI	44	66	Aquifer2	Alluvium
SUKRI	66	76	Aquiclude2	Alluvium
SUKRI	76	114	Aquifer2	Alluvium
SUKRI	114	116	Aquiclude2	Alluvium
SUKRI	116	193	Aquiclude2	Gondwana
SUKRI	193	198	Granite/Gneiss	limestone
SURIA	0	30	Aquiclude1	Alluvium
SURIA	30	176	Aquiclude2	Alluvium
SURIA	176	222	Aquiclude2	Gondwana
SURIA	222	229	Granite/Gneiss	Quartzite
TINDNI	0	6	Black Cotton Soil	Black Cotton Soil
TINDNI	6	22	Aquiclude1	Clay

TINDNI	22	28	Aquifer1	Sand
TINDNI	28	44	Aquiclude2	Clay
TINDNI	44	54	Aquifer2	Sand
TINDNI	54	62	Aquifer2	Gravel
TINDNI	62	71	Granite/Gneiss	Granite/Gneiss
TUMRA	0	42	Aquiclude1	Alluvium
TUMRA	42	79	Aquifer2	Alluvium
TUMRA	79	82	Aquiclude2	Alluvium