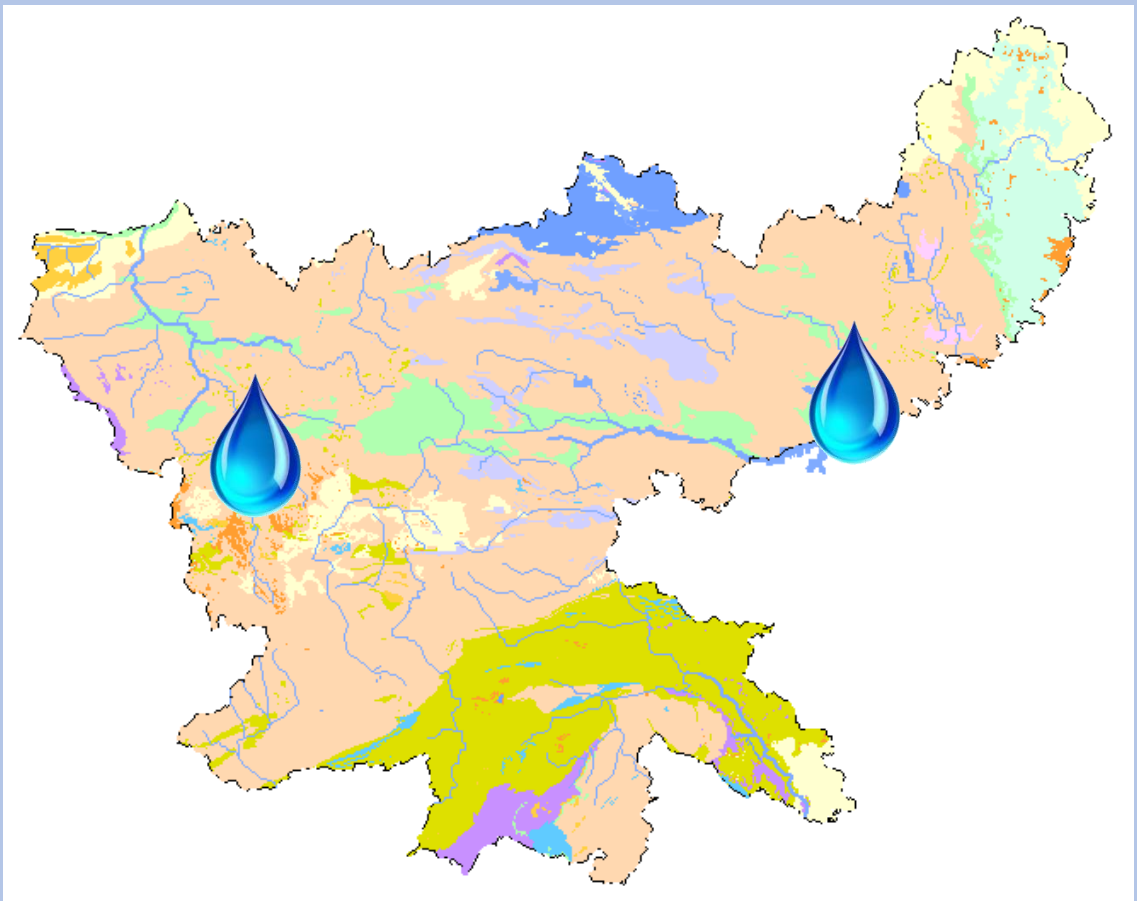
Technical Report Series

REPORT ON
DYNAMIC GROUND WATER RESOURCE ESTIMATION OF JHARKHAND (2022)

Central Ground Water Board
State Unit Office, Ranchi
Mid-Eastern Region, Patna
Dept of Water Resources,
River Development & Ganga Rejuvenation
Ministry of Jal Shakti
Government of India

Ground Water Directorate
Water Resources Department, Ranchi
Government of Jharkhand



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CGWB, SUO, RANCHI/ MER, PATNA
January, 2023

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Prashant Kumar, IAS
Secretary
Department of Water Resources
Government of Jharkhand

FOREWORD

Jharkhand state, having geographical area of 79714 Sq.km, is endowed with vast and rich natural resources. Agriculture is the main stay for the 80% of rural population of the state. Despite good rainfall in the state, the surface water availability to agriculture is not sufficient due to inadequate storage facilities etc. Ever increasing demand of water for Agriculture, Industries and Drinking purpose has resulted in the greater dependence on ground water. Estimation of the annually replenishable or the dynamic ground water resources at regular interval is thus necessary for its proper planning and management.

The present assessment has been done considering the community development blocks as assessment unit and assessment year 2022. Besides this, for first time present assessment of ground water has also included for urban areas first time. The present assessment of ground water has been carried out following the recommendations and methodology of "**Ground Water Estimation Committee (GEC) 2015"** and using **IN-GRES software**.

I put on record my appreciation for the work done by a dedicated team of scientists of Central Ground Water Board, State Unit Office, Ranchi, Mid-Eastern Region Patna and officers from Ground Water Directorate, Water Resources Department, Government of Jharkhand, under overall supervision of State Level Committee (SLC) in bringing out this report. I hope this report will be of great use to the administrators, planners and other stakeholders dealing with ground water.

19/05/23

(Prashant Kumar)
Secretary,
Water Resource Department
Government of Jharkhand

PREFACE

Sustainable management of Ground Water resource has become a challenge nowadays owing to increased demands of increasing population, growing urbanization and rapid industrialization combined with rising agricultural production. Therefore, the assessment of ground water resources is carried out at periodic intervals to determine the ground water scenario in the state of Jharkhand.

The ground water resource estimation, 2022 has been assessed considering the community development blocks as assessment unit and considering 2021-22 as water year. Ground Water Resource of the state has been computed block wise and then summarized district-wise. The present assessment has been carried out following the recommendations and methodology of "Ground Water Estimation Committee (GEC) 2015" and using IN-GRES software. For the first time, assessment of replenishable resource of four urban areas namely Ranchi, Jamshedpur, Dhanbad and Daltenganj has been carried out.

As per Ground Water Resources assessment, total replenishable Ground Water Resources as on 2022 is 6.20 BCM. Annual Extractable Ground Water Resource of Jharkhand state has been found to be 5.69 BCM. The annual ground water draft in the state is 1.78 BCM with irrigation draft of 0.93 BCM, Domestic draft 0.65 BCM and Industrial draft 0.21 BCM. The Stage of Ground Water Extraction of the state is 31.35 %. The net ground water available for future development is 3.92 BCM. Five units namely Bermo, Baliapur, Chitrapur, Golmuri cum Jugsalai blocks and Jamshedpur urban have been categorized as Over-exploited. Topchanchi, Ramgarh, Silli, Jainagar blocks and Ranchi urban and Dhanbad urban have been categorized as Critical and 11 blocks have been categorized as Semi-Critical. District wise highest Stage of development has been observed in Dhanbad district (75.08%) and lowest in West Singhbhum district (9.93%).

The assessment work is a joint exercise of Central ground Water Board, State unit Office, Ranchi and Groundwater Directorate, Water Resource Department, Govt. of Jharkhand. The effort taken by all, particularly Dr. Anukaran Kujur, Scientist-B, Dr. Sudhanshu Shekhar, Scientist-D, & Sh. Atul Beck, Asstt. Hydrogeologist, CGWB, SUO, Ranchi under overall guidance of Sh. B. K. Oraon, Regional Director are praise worthy. The present document will help the policy makers in evolving policy directives for ground water development and management in the state.

17/05/23

(R.R Shukla)

Head of Office

Central Ground Water Board, MER, Patna

Place: Patna

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND FOR RE-ESTIMATION OF THE GROUND WATER RESOURCE OF THE STATE OF JHARKHAND

The state of Jharkhand was carved out from erstwhile Bihar state on 15th November, 2000. The state covers the southern hilly part of the state of Bihar, spanning between 83°30' and 87°35' longitude and 21°55' and 25°15' latitude, covering an area of 79714 SqKm. The state of Bihar, West Bengal, Chattisgarh and Orissa bound the state Jharkhand in its north, east, west and south respectively. The state is divided into 24 districts and 260 community development blocks. Population of the state as per census 2011 is 32827461, of which about 26% of total population is tribal. Total rural population is 25004031 while urban population is 7823430. The population density varies from 160 persons per square km in Simdega to 1192 person per square km in Dhanbad district, with the overall of the state to be 415 persons per square km. Some of the important urban centres are Ranchi, Jamshedpur, Bokaro, Dhanbad, Hazaribagh, Daltonganj, Deoghar etc. A district statistical profile of the state is tabulated in **Table 1.1**. Administrative map of the state is given in **Plate-1**.

Ground Water has emerged as an important component of the socio-economic development in the state of Jharkhand as the dependency on ground water is increasing rapidly. Entire rural domestic water supply and about $1/6^{th}$ of the urban water supply is being catered from ground water at present. The increase in dependency on ground water for irrigation is also manifested in surge in number of ground water abstraction structures in the recent past. However, due to wide variation in rock types, topography, climate and water use, ground water potential differs from place to place. The need for judicious and planned use of ground water is emphasized at various forums as the extraction of ground water is increasing at an alarming pace. This is particularly evident in some urban areas of the state. Hence ground water resources of Jharkhand urgently need a proper management guideline. Therefore, proper planning and management of ground water development in a state in a judicious and socio-economically equitable manner, principally depends on proper quantification of ground water resources and on assessment of status of ground water development.

Earlier exercises (1998 for undivided Bihar, 2004, 2009, 2011, 2013, 2017& 2020) aimed to make an estimate of dynamic ground water resources considering recharge, draft for various uses and balance ground water resource available for further development. The methodologies utilised in

those exercises, as recommended by Govt. of India, were GEC-1984 initially and later using GEC-1997 and 2015.

The present assessments (2022) have been carried out, through ***IN-GRES,*** the purpose built software developed by IIT Hyderabad and powered by Vassar Labs.IN-GRES software modules , were used in Computations which is based on GEC 2015 methodology.In contrast, present exercise aims to make a picture of entire water resource of the State, by estimating dynamic ground water resources. The Ground water resources have been estimated as on 2022 considering 2021-22 as the ground water year.

Table 1.1 District statistical profile of the state

Sl. No.	District	Total Area (Sq. Km.)	Community Development block	Population			Population Density (Pers. /Sq. Km)
				Rural	Urban	Total	
1	Bokaro	2859	9	1078686	983644	2062330	721
2	Chatra	3932	12	979932	62954	1042886	265
3	Deoghar	2551	10	1233712	258361	1492073	585
4	Dhanbad	2252	9	1124093	1560394	2684487	1192
5	Dumka	3716	10	1231264	90178	1321442	356
6	East Singhbhum	3633	11	1019328	1274591	2293919	631
7	Garhwa	4045	19	1190114	69670	1259784	311
8	Giridih	5085	13	2237450	208024	2445474	481
9	Godda	2111	9	1249230	64419	1313649	622
10	Gumla	5347	12	972061	16211	988272	185
11	Hazaribagh	4310	16	1459188	275307	1734495	402
12	Jamtara	1804	6	715296	75746	791042	438
13	Khunti	2600	6	486903	44982	531885	204
14	Koderma	1497	6	575013	141246	716259	478
15	Latehar	3613	9	675120	51858	726978	201
16	Lohardaga	1492	7	404379	57411	461790	309
17	Pakur	1806	6	832910	6751	839661	465
18	Palamau	4517	20	1713866	226003	1939869	429
19	Ramgarh	1396	6	530488	418955	949443	680
20	Ranchi	4963	18	1656858	1257335	2914193	587
21	Sahebganj	1702	9	990901	159666	1150567	676
22	Saraikela - Kharsawan	2725	9	806301	258746	1065047	391
23	Simdega	3752	10	556634	42944	599578	160
24	West Singhbhum	7222	18	1284304	218034	1502338	208
	State Summary	**78930**	**260**	**25004031**	**7823430**	**32827461**	**416**

1.2 CONSTITUTION OF STATE LEVEL COMMITTEE FOR GROUND WATER RESOURCE ESTIMATION

Based on resolution no.T-13014/1/2019-GW dated 8.2.2022 (**Annexure-IA**) of Ministry of Jal Shakti, Dept of Water Resources, River Development and Ganga Rejuvenation, Govt. of India, a Committee was constituted for the State of Jharkhand for ground water resource re-estimation by notificationno.3/PMC/Misc-168 (Part-1)/2009-208, dated 15.3.2022 and corrigendum 3/PMC/Misc-168 (Part-1)/2009-250, dated 5.4.2022by the Govt. of Jharkhand (**Annexure-IB**). The constituted Committee has the following members:

1.	Secretary, Water Resource Department., Govt. of Jharkhand, Ranchi	**Chairman**
2.	Engineer-in-Chief II, Water Resources Department, Govt. of Jharkhand, Ranchi	Member
3.	Chief Engineer, Minor Irrigation Department, Govt. of Jharkhand, Ranchi	Member
4.	Director, Agriculture Department. Govt. of Jharkhand, Ranchi	Member
5.	Director, PMU, Drinking Water and Sanitation Department, Govt. of Jharkhand, Ranchi	Member
6.	Director, Industry Department. Govt. of Jharkhand, Ranchi	Member
7.	General Manager, NABARD, Ranchi	Member
8.	Director, Ground Water Directorate, Water Resources Department, Govt. of Jharkhand	Member
9.	Representative of Urban Development (Secretary) Department, Govt. of Jharkhand	Member
10.	Director, Jharkhand Space Application Centre, Ranchi or representative	Member
11.	Director, Directorate of Geology. Govt. of Jharkhand, Ranchi	Member
12.	Director, Indian Meteorological Department, Govt. of India, Ranchi	Member
13.	Director, Panchayati Raj Dept, Govt of Jharkhand, Ranchi	Member
14.	Representative of VC, Birsa Agriculture University, Ranchi	Member
15.	Regional Director, CGWB, Mid-Eastern Region, Patna	Member Secretary

1.3 BRIEF OUTLINE OF THE PROCEEDINGS OF THE RESOURCES ESTIMATION INCLUDING OUTCOME OF VARIOUS MEETINGS

First meeting of the State Level Committee of re-assessment of Groundwater resource of Jharkhand for the year 2022 was held on 6.4.2022 in the conference hall of Water Resources Department, Government of Jharkhand, Ranchi under Chairmanship of Shri Prashant Kumar, Secretary, Water Resources Dept, Govt. of Jharkhand. Major agendas discussed were briefing

about Data Requirements and timelines for finalization of Estimation of Ground water Resources as on March 2022.A presentation on Ground Water Resources Assessment- 2020 (Dynamic) and Data Requirements and timelines for finalization of Estimation of Ground water Resources as on March 2022 was made by Dr. Sudhanshu Shekhar, Scientist-D, CGWB, SUO, Ranchi before the committee members. Final Report on Dynamic Ground Water Resources – 2020, jointly prepared by CGWB & State Ground Water Dept, Govt of Jharkhand was released by Secretary, Water Resources Department, Govt. of Jharkhand. In the meeting it was suggested that assessment for static ground water resources of confined aquifer should also be done. Assumptions and Limitations should be mentioned clearly. Special studies for Groundwater Resources assessment of 2022 for rainshadow areas including Palamu and Garhwa districts should be considered. Minutes of the meeting has been given in **Annexure 1C**.

The Second and final meeting of the State level committee for re-estimation of ground water resources as on March-2022 was held on 30.8.2022, at Ranchi under Chairmanship of Shri Prashant Kumar, Secretary, Water Resources Dept, Govt of Jharkhand. Sh.T.B.N.Singh, RD, MER, Patna and Member Secretary briefed about the ground water estimation methodology. Sh. Rajeev Ranjan Shukla, Scientist-E & OIC, SUO, Ranchi also explained about the occurrence of Ground Water in hard rock terrain like Jharkhand. A presentation on Dynamic Ground Water Resources Assessment- 2022 was made by Dr. Sudhanshu Shekhar, Scientist-D, CGWB, SUO, Ranchi before the committee members. Chairman, State Level Committee finally approved the assessment of replenishable ground water resources of Jharkhand state jointly prepared by CGWB, SUO, Ranchi and Ground Water Directorate, WRD, Jharkhand. Minutes of the meeting has been given in **Annexure 1D**.

CHAPTER 2

HYDROGEOLOGICAL CONDITIONS OF THE STATE

2.1 GEOLOGY

The state of Jharkhand exhibits a long geological history, ranging from Archaean to Recent in geological timescale. The state is also blessed with substantial mineral resources like copper, iron, coal, bauxite, kyanite; mica etc. The generalized geological succession of the state is presented in **Table 2.1**.

Table 2.1 General Stratigraphic sequences of geological formations in Jharkhand State

Age	Formation	Broad Lithology
Quaternary	Alluvial deposits	Sand, clay, silt and occasional gravel
Tertiary	Dhalbhumgarh Gravel beds	Sandstone, conglomerate, clay-stone, gravel
Upper Jurassic to Lower Cretaceous	Rajmahal Volcanics	Basalt flows with inter-trappean sedimentary beds
Upper Jurassic toCarboniferous	Gondwana Supergroup	Sandstone, shale, clay, conglomerate with coal beds
Lower Cambrian to Proterozoic	VindhyanSupergroup	Sandstone, dolomite, chart, shale *etc.*
Proterozoic	Rocks of Singhbhum-Greenstone-Granite domain, basic volcanics and Chhotanagpur Gneiss Granulite Complex including BMB	Granites, granite-gneiss, schists, phyllites, dolomites, basic and ultrabasic lavas, amphibolites
Archaean	Older Metamorphic Gneiss, Older Metamorphic Tonalite Gneiss	Gneiss, schists, arenites, amphibolites

The entire terrain of Jharkhand can be classified into two broad geological entities with distinct different geological history. First one is the Archaean cratonic mass of Singhbhum, with large sedimentary basins along with number of volcano-sedimentary sequences. The second one is the Chhotanagpur Gneissic Complex represented dominantly by gneissic country with older vestiges of Granulites, large number of intra-cratonic sedimentary basins including Gondwana sedimentation and episodic magmatism of diverse nature. The Precambrian igneous and metamorphic rocks occupy nearly 84% of the total geographical area. Volcanic rocks, which are basic type and belong to Rajmahal volcanics of Upper Jurassic to Lower Cretaceous age and Dalma volcanics of Precambrian age, cumulatively covers about 7% of the total geographical area. The sedimentary rocks belong to Gondwana Supergroup and Vindhyan System also covers about 6%

area of the state. Alluvium and Tertiary sediments covers only about 2% area. The area coverages under different litho-units are given in **Table 2.2**. District-wise distribution of various rock types in Jharkhand is given in **Table 2.3**.

Table 2.2 Area coverage by different litho-units

Sl. No.	Rock type	Area coverage (%)
1.	Alluvium & Tertiary sediments	2.5
2.	Laterites	0.1
3.	Gondwana Supergroup	4.2
4.	Vindhyan Supergroup	1.8
5.	Volcanic rocks	7.0
6.	Precambrian gneisses, granites, schists and phyllites	84.4

Table 2.3 District-wise distribution of different rock types

Formations	Districts
Archaean–Proterozoic Granite-gneiss, Schists, Phyllites, Granites, Amphibolites, Basic and Ultra-basic Lavas	Parts of Gumla, Ranchi,Khunti, Simdega, Lohardaga, East & West Singhbhum, Chatra, Koderma, Hazaribagh, Deoghar, Giridih, Dumka, Godda & Jamtara
Vindhyans	Parts of Garhwa and Palamu
Gondwanas	Parts of Hazaribagh, Chatra, Giridih, Dhanbad, Deoghar, Dumka Palamu and Sahebganj, Pakur and Godda
Rajmahal Trap	Parts of Sahebganj, Pakur, Dumka and Godda
Tertiary Deposits	Parts of East Singhbhum
Quaternary Deposits	Parts of Godda, Palamu, Sahebganj and Pakur

2.2 HYDROMETEOROLOGY

The state of Jharkhand experiences a humid tropical climate. Summer season starts from March and continues up to 2nd week of June. Monsoon sets in June and continues up to September. Winter spans between Octobers to February in a year.

2.2.1 Temperature

Usually January is the coldest month with an average mean maximum and minimum temperature of 26.2^{0}C and 9.0^{0}C respectively. The temperature starts rising from February, and

attains its maximum in May, often exceeding 42^{0}C. The average monthly minimum and maximum temperatures during this month are 23.44 and 41.27^{0}C respectively.

2.2.2 Humidity

Humidity varies considerably in different seasons. Higher values are observed in the months of July to September, attaining peak in August with the monthly mean maximum and minimum humidity of 87.9 and 78.1% respectively. After September there is a gradual decline in humidity until April when it remains lowest. During this month, the mean monthly maximum humidity is 50.26%.

2.2.3 Rainfall

The amount and distribution of rainfall have a strong bearing on the state economy as the agricultural activity is mainly dependent on rainfall. In addition, rainfall is the main source of ground water recharge in the entire state. The annual normal rainfall for the state is 1301 mm. District-wise; it ranges from 1528 mm at Pakur to 1084.1 mm at Godda. District wise distribution of normal annual rainfall is given in **Table2.4**. The analysis of isohyets of mean annual rainfall indicates that in major part of the state, the rainfall remains between 1200 and 1400 mm/year. Major part of the annual downpour is from the south-western monsoon, which sets in the second week of June. This monsoon rainfall accounts for about 83% of the total annual rainfall of the state. District wise percentage of monsoon rainfall ranges from 79.13% in Dumka to as high as 87.98% at Chatra.

Table 2.4 District-wise Normal Rainfall of Jharkhand State (1940-1990)

Sl. No.	Name of the Districts	Normal Annual Rainfall (mm)	Normal Monsoon Rainfall (mm)
1.	Bokaro	1259.6	1040.2
2.	Chatra	1206.3	1061.3
3.	Deoghar	1220.7	993.3
4.	Dhanbad	1295.6	1074.7
5.	Dumka	1422.5	1125.6
6.	East Singhbhum	1403.4	1136.4
7.	Garhwa	1210.3	1047.7
8.	Giridih	1215.6	1024.2
9.	Godda	1084.1	883.6
10.	Gumla	1460.9	1208.5
11.	Hazaribagh	1251.2	1040.5
12.	Jamtara	1447.4	1182.5
13.	Khunti	1323.2	1086.4

Sl. No.	Name of the Districts	Normal Annual Rainfall (mm)	Normal Monsoon Rainfall (mm)
14.	Koderma	1115.9	940.7
15.	Latehar	1237.2	1061.3
16.	Lohardaga	1194.3	985.3
17.	Pakur	1528.0	1215.3
18.	Palamau	1169.4	1014.5
19.	Ramgarh	1251.2	1040.5
20.	Ranchi	1323.2	1086.4
21.	Sahebganj	1410.6	1153.9
22.	Saraikela	1307.6	1068.7
23.	Simdega	1506.5	1317.0
24.	West Singhbhum	1351.6	1083.8

2.3 DESCRIPTION OF HYDROGEOLOGIC UNITS

Based on the hydrogeological setup, ground water conditions and aquifer hydraulic parameters, the state can broadly be divided into three hydrogeological units.

(1) Fissured Formation

(2) Semi-consolidated formation

(3) Porous formation

Fissured formations are hard and compact rocks where ground water occurs only within secondary porosities or in overlying weathered mantle. On the other hand, rocks of Gondwana Super group, belongs to semi-consolidation formations, where in many places the rocks are friable and have significant primary porosity; however, with depth it becomes insignificant. Porous formation represents unconsolidated rocks, where ground water occurs within the primary porosity only. The alluvial deposits, valley fill deposits and the Tertiary beds of East Singhbhum district occurring in the south-eastern corner of the state are considered as Porous formation**.** The principal aquifer map has been presented in **Plate-2.** Different rock types belonging to different hydrogeological units are given below:

i) Fissured Formation

1. Granite Gneiss, Schist, Phyllites and other rocks belong to CGGC and Archaean cratonic mass of Singhbhum;
2. Rocks belong to Vindhyan Supergroup; and
3. Rajmahal Trap.

ii) Semi-consolidated formation

1. Gondwana Supergroup

iii) Porous formation

1. Laterite;
2. Tertiary deposits; and
3. Alluvial and valley fill deposit

2.3.1 Igneous & Metamorphic Rocks of Precambrian Age and Archaean Cratonic Mass

This is the major rock type of the state covering nearly 85 percent of the geographical area of the state. In these rock types, ground water occurs within the weathered zone and underlain secondary porosities like fractures, joints ad fissures. The thickness of weathered zone ranges generally between 10-25 m, but in localized patches, it exceeds even 30m. The weathered zone is a good repository of ground water; however, exploratory wells by CGWB revealed that the secondary porosities below the weathered zones also form potential aquifers. The deep fracture zones (generally below 40m bgl) are exploited particularly in urban areas. Common ground water abstraction structures are open dug wells and shallow bore wells and rarely deep bore wells. In general 2 – 4 sets with a maximum of 8 sets of fracture zones may be encountered within 200m bgl.

Yield of exploratory wells range from negligible up to 151 m^3/hr. Hydraulic parameters in different formations of Jharkhand state are given in **Table 2.5**. Hydrogeological conditions and Ground water potentials in different formations in Jharkhand state is given in **Table 2.6.** Yield varies most widely in Deoghar district (0.60 – 151 m^3/hr) with a drawdown variation of 3.6 to 30.0m. High variation of yield is also observed for districts like Dumka, Dhanbad and Hazaribagh. However, by and large, yield remains below 30m^3/hr in granites and gneisses, and below 15 m^3/hr in schists, phyllites and other litho-units of volcano-sedimentary sequence. Draw-down varies from 02 – 46m, but in most of the cases limited within 20 m**.** Transmissivity values ranges from 0.9-186 m^2/day. Storativity data indicates that at deeper level the ground water occurs under confined to semi-confined condition. The dug wells generally tap the weathered zone and if needed top 2-3 m of basement rocks. Dug wells tapping granite and gneiss have a discharge of 5-10 m^3/hr.

2.3.2 Vindhyan Supergroup

The Vindhyan rocks do not form potential aquifer system as such. They are exposed in parts of Palamau and Garhwa districts over a limited area. Ground water occurs within the secondary porosities like fractures and joints. The Vindhyan sandstones, when fractured, bear a good ground water potentiality in comparison to the shales. The boreholes tapping the fracture

zones of lower Vindhyans, between 50 and 75 mbgl, around Bhawnathpur area, shows more potentiality, with the recorded yield as high as 13 – 18 m^3/hr.

2.3.3 Volcanic Rocks

The volcanic rocks occur in the north-eastern part of the state covering parts of Sahebganj, Pakur and Godda districts and in south-eastern part covering parts of East, West Singhbhum and Saraikela districts. Out of these areas, volcanic formations have been extensively exploited in the north-eastern part of the state (known as Rajmahal Traps) covering mainly Sahebganj and Pakur and parts of Dumka & Godda districts. In the Rajmahal traps, a series of flows are horizontally laid in a stack. In an individual flow, the lowest part remains massive, this grades upwards into vesicular variety. The thickness of individual flow varied from 20 – 70m, having an average of 23m. Thin inter-trappean beds are also present between the flows. In most of the cases, vesicles act as aquifers. The fissures, joints and fractures below the weathered zone have been found to be quite productive. The fractures are tapped between 15-120 m, where the cumulative yield ranges between 6 to 51 m^3/hr but generally it remains within 20 m^3/hr. The transmissivity values ranges from 3 to 176 m^2/day. The storativity value indicates semi-confined to confined mode of ground water occurrence at deeper levels. CGWB well at Amrapara (depth 92.5 m) turned out to be an auto flow well having hydraulic head at 1.55 m agl.

2.3.4 Gondwana Supergroup

The sediments belonging to Gondwana Supergroup are semi-consolidated in nature where ground water occurs within inter-granular pore spaces as well as within the secondary porosities like fractures and joints. These formations are exposed as patches in the districts of Hazaribagh, Dhanbad, Giridih, Bokaro, Ranchi, Dumka, Jamtara, Latehar, Godda and Garhwa districts. The drilling data, of CGWB and other agencies involved in the ground water investigation, indicate that ground water occur in semi-confined to locally confined at deeper level and unconfined condition at shallow level. At places, auto flow condition is encountered. The shallow aquifer zone includes weathered zone (8 to 20m thick) and the underlying fractures. Shallow bore wells tapping fracture zones within 60m bgl are common ground water structures in the area. In deeper aquifer zone, CGWB exploratory drillings encountered 2 to 3 fractures within 200m bgl with an average discharge of about 20 m3/hr. However, CMPDIL (1992) has identified 5 confined aquifer system in the Barakar formation containing coal seams in Lalmatia sector, based on geological and hydrogeological consideration. The thickness of aquifer ranges from 10-70 m and the cumulated yield ranges from 50-135 m3/hr, however discharge of individual aquifer ranges from 10-60 m3/hr

in general. Out of 5 confined aquifers, Aquifer–III, up to the depth of 50m is most potential capable of yield of 40-60 m3/hr of water under free flowing condition.

2.3.5 Laterites and Tertiary Sediments

Tertiary deposits occur in Chakulia-Bahragora-Dhalbhumgarh tract of East Singhbhum district. Exploratory drilling by CGWB indicates potential aquifer system within 133 m bgl encountering 04 granular zones. The cumulative yield ranges from 18 to 78 m^3/hr. The transmissivity ranges from 208 to 570 m^2/day. Water level ranges from 3.6m to 23 m bgl. Dug wells of 15 to 20 m deep and shallow tube wells of 40 to 50m depths are also used as ground water abstraction structures in this formation in the state.

2.3.6 Younger Alluvium

The Younger Alluvium deposits are confined in patches and occur, mainly in the districts Godda, Sahebganj, Pakur, Palamu and East Singhbhum. Except these, they occur as small patches in Latehar, Palamau, Deoghar and Garhwa districts. In Godda and Sahebganjthe alluvial deposits confined in northern and eastern part of the districts and merges with the Indo – Gangetic Plain. At some places these occur as valley fill deposits. The shallow aquifer is of good potential and dug wells, hand pumps and shallow tube wells are the common ground water structures. The depth of dug wells in general ranges between 10 – 15 m bgl while the depth of shallow tube wells varies between 20 – 40 m bgl. Hydraulic parameters of deeper aquifer are not available as CGWB has not carried out exploratory drilling in the alluvial areas so far. The data collected from different agencies indicate that discharge may go upto 40 m^3/hr if sufficient thickness of aquifer is available.

Table 2.5 Hydraulic parameters in different geological formations of Jharkhand State (Source: CGWB)

Formation	Depth drilled(m)	No. of fractures	SWL(m bgl)	Discharge (m^3/hr)	Draw-Down(m)	T(m^2/day)	S
Granite Gneiss	209	1-8	1.50-4.37	Negligible -151	1.68-45.84	0.9 - 186.0	$1.4x10^{-2}$ - $1.01x10^{-5}$
Rajmahal Traps	170.3	2-5	1.55-1.36	1.10 - 51.6	3.67-36.00	17.0 - 176.0	$1.4x10^{-4}$ to $7.3x10^{-5}$
Gondwana Sediments	198.5	2-4	3.30-17.90	0.9 - 4.5	16.50	3.0 - 4.5	$1.3x10^{-2}$ - $6.1x\ 10^{-5}$
Tertiary Sediments	133.0	2-4	3.63-23.04	18.0-78.0	10.98-14.44	208.0-570.10	$1.3\ x\ 10^{-3}$

Table 2.6 Hydrogeological conditions and Ground water potentials in different formations in Jharkhand state

HG. Fm.	Age Group	Lithology	Hydrogeological condition	Ground Water Potential
POROUS FORMATION	Quaternary	ALLUVIUM – clay, silt, gravel, pebbles, calc. concretions	Ground Water occurs under unconfined to locally semi-confined condition. Water level 2-10 m bgl. Multi-layered sandy aquifer down to depth of 80 m below ground.	Moderately low yield potential upto 40m^3/hr.
		ALLUVIUM – very limited thickness, clay, silt, sand	Thickness of deposit 5 to 20 m in general. Ground water occurs under unconfined condition	Very limited yield prospect, up to 10 m^3/hr
	Pleistocene – Tertiary	LATERITES – primary and secondary lithomarge	Thickness varies from 5 to 40 m. Ground water occurs under unconfined condition.	Very limited yield prospect. Generally within 10 m^3/hr.
		TERTIARY DEPOSITS – sand, silt, clay, pebble, gravel	Thickness of deposit up to 130m. Multi-layered sandy aquifer, ground water under semi-confined condition. Water level 4 – 23 m bgl.	Moderate yield potential up to 80 m^3/hr.
SEMI – CONSOLIDATED FORMATION	L. Carboniferous - Early Cretaceous	GONDWANA – silt stone, clay stone, grit, sandstone, shale, conglomerate including intrusive	Ground Water within weathered zone under unconfined condition and at deeper level within primary and secondary porosity under semi – confined to confined condition	Limited yield potentialupto 30m^3/hr.Subject to proper well location and construction,
FISSURED FORMATION	Lower Jurassic - Early Cretaceous	RAJMAHAL BASALT – basalt flows with inter-trappeans of fine grained sediments	Ground Water restricted to weathered zone under unconfined condition and fractures /joints /vesicular zones at depth down to 130 m bgl under semi-confined condition. Water level generally within 10 m bgl, localized auto flow condition.	Very limited yield potential upto 20 m^3/hr subject to proper well designing
	Proterozoic - Early Cambrian	VINDHYAN – quartzite, conglomerate, limestone, sandstone, dolomite, shale	Ground Water restricted to weathered zone under unconfined condition and semi-confined condition at deeper fractures / joints. Water level generally between 4 and 10 m bgl.	Very limited yield potential upto 20 m^3/hr subject to proper well designing
	Proterozoic - Archaean	SINGHBHUM GRANITE, CHHOTANAGPUR GNEISSIC COMPLEX – variety of gneisses and granites	Ground Water restricted to weathered zone under unconfined condition and within deeper fractures/ joints down to 199 m under unconfined to semi-confined condition. Water level generally varies	Limited yield.Generallywithin 30 m^3/hr, subject to proper well designing.

HG. Fm.	Age Group	Lithology	Hydrogeological condition	Ground Water Potential
			widely, up to 25 m bgl.	
		VOLCANO SEDIMENTARY SEQUENCE – schists, phyllites, basic and acidic intrusive	Ground Water restricted to weathered zone under unconfined condition and within deeper fractures/ joints down to 140 m under semi – confined condition. Water level varies between 5 and 20 m bgl in general.	Very limited yield potential. Generally within 15 m^3/hr, subject to proper well designing.

2.4 GROUND WATER LEVEL CONDITIONS

Ground Water level in the state of Jharkhand varies considerably depending upon the terrain, hydrogeological conditions. Central Ground Water Board is monitoring 452 hydrograph network stations four times in a year viz., January 1stto 10th, May 20th to 30th, August 20th to 30th and November 1stto 10th. All the monitoring stations are open dug wells and piezometers. The depth to water level map for post-monsoon (2021) has been shown in **Plate -3.**

Pre-monsoon season (May, 2021)

Due to pandemic of covid-19, pre-monsoon depth to water level were measured only from 119 wells (out of 452 existing wells) in limited district.

Post-monsoon season (November, 2021)

A total of 205 GWMW has been monitored during post-monsoon period in November 2021. Depth to water level contouring were prepared based on the range of water level data viz. 0-2, 2-5, 5-10, 10-20, 20-40 and > 40 m bgl.

Minimum and the maximum depth to water levels have been recorded as 0.35 m bgl and 10.09 m bgl in Pakur and Hazaribagh district respectively. Out of 205 wells 145 (68%) of water level ranges 2 - 5 m bgl which covers almost entire Jharkhand State. The water level in the range of 5-10 m bgl has been observed in the 33 wells (19%). Ground water level of 0 – 2 m bgl depth range has been observed only in 26 wells (13%) at different locations. Only 3 wells (1%) have shown water level more than 10 m bgl**.**

Fluctuation between Pre- and Post-monsoon season

Due to covid-19 pandemic in 2021, pre-monsoon data were not sufficient to compare with post monsoon data of 2021.

Fluctuation between Decadal Mean and Pre-monsoon Water level

Due to covid-19 pandemic, pre-monsoon data were not sufficient to compare with post monsoon data of 2021.

Fluctuation between Decadal Mean and Post-monsoon Water level

The fluctuation of water level between November Mean and November 2021 has been carried out on the basis of available Mean water level data (198 wells) of November for last 10 years (2011-2020) with the present water level data for Jharkhand.

The fluctuation of water level of November 2021 with respect to decadal mean water level of November 2011 to November 2020 shows rise in 150 wells (76%) and fall in 48 wells (24%) out of 198 wells analysed.132 wells show rise within 0 to 2 m ,17 wells show rise in water level within 2 to 4m. 45 (23%) and 3 (2%) wells shows fall in water level within 0 to 2 m and 2 to 4m respectively.

However, overall, regional fluctuation of water level in the entire state is mainly restricted within 2 m only, which is normal phenomenon, and no abnormal rise or fall in water level is observed except in few localized well.

2.5 GROUND WATER QUALITY

The chemical quality of groundwater is dependent on the source of water and on the course over which it flow. Ground water carries a higher mineral content than surface water due to the slow circulation and longer period of contact with the rocks formation. In order to assess the chemical quality of ground water of phreatic aquifers of Jharkhand state ground water samples have been analysed for major 15 parameters viz. EC, pH, HCO_3, CO_3, Cl, TH, Ca, Mg, K, Na, F, SiO_2, PO_4 and NO_3. The chemical analysis data of ground water samples collected (132) during the period May 2021.

Due to lock down situation during covid-19 pandemic, limited (only 6 districts- Ranchi, Bokaro, Hazaribagh, Gumla. Lohardaga, Ramgarh) samples have been collected during the year 2021-2022. Analyses of collected ground water samples reveals that Ground water samples throughout the state are found to be slightly alkaline in nature as the pH mostly varies between 7.20-8.23. The quality of ground water in most of part of the state is potable with low mineral contents having electrical conductance varying from 124.8 (Irgaon at Lohardaga, Khunti) to 2060 (at Pindrajora, Chas, Bokaro) µS/cm at 25^0c. In general, The ground water are found to be suitable for drinking and irrigation purposes. Only one sample is having electrical conductivity greater than 2000 µS/cm. Spatially, EC remain in the range of 400-1000 µS/cm in major part of the sampled area of the state EC contour map has been presented in **Plate-4**. In most of the samples the concentration of chloride is within the desirable limit for drinking water point of view (250 mg/l). Concentration of chloride in ground water >250 mg/l is found in five number of samples in Bokaro and Hazaribagh district.

Thus, it is observed that the quality of ground water in shallow aquifers in above mentioned six districts is suitable for drinking, irrigation and industrial purposes except in arsenic & fluoride infested areas.

Table 2.7 Salient Statistical Parameter of Chemical Constituents in Ground Water of Jharkhand State

Constituents	Maximum	Minimum	Average	Standard Deviation
EC µS/cm	2060	124	715	414
pH (mg/l)	8.23	7.2	7.69	0.24
HCO_3 (mg/l)	537	12	149	102
Cl (mg/l)	437	11	91	74
Ca (mg/l)	178	10	60	37
Na (mg/l)	246	0.86	51	38
Mg (mg/l)	109	1.22	19	15
K (mg/l)	50.10	0.75	8.98	8.87

Previous study of CGWB reveals that fluoride is found beyond permissible limit in 57 blocks of 12 districts namely Bokaro, Dhanbad, Garhwa, Giridih, Godda, Khunti, Koderma, Pakur, Palamu, Ranchi and Sahebganj. Nitrate were found in 15 blocks of 11 districts namely Deoghar, Dhanbad, East-Singhbhum , Giridih, Jamtara, Latehar, Pakur, Palamu, Ramgarh, Saraikela-Kharsawan and West-Singhbhum and Arsenic were found beyond permission in 3 blocks of Sahebganj district.

CHAPTER 3

GROUND WATER RESOURCES ESTIMATION METHODLOGY -2015

Fundamental basis for good ground water management is a clear understanding of aquifers, and the status of ground water accumulation and movement in these aquifers. Methodology outlined by Ground Water Estimation Committee – 1997 (GEC-1997) has been the basis of ground water assessment in the country for last two decades. Experience gained during this period has highlighted the need to update the existing methodology of ground water resource assessment. The Government of India to form Ground Water Estimation Committee in 2015 to review the existing methodology. The Committee submitted its final recommendations in 2017. This updated methodology is popularly known as **GEC-15 methodology**. The methodology has incorporated a number of changes compared to the recommendation of GEC – 1997. The major changes are:

- The revised methodology GEC-2015 recommends aquifer wise ground water resource assessment to which demarcation of lateral as well as vertical extent and disposition of different aquifers is pre-requisite.
- It is proposed that Total Availability of Ground Water in an assessment unit may be represented by sum of Total Availability in the Principal Aquifer (Mostly Unconfined Aquifer) along with in-storage resources, Total Availability in Semi-Confined Aquifers; and Total Availability in Confined Aquifers.
- It has also recommended that ground water resources may be assessed to a depth of 100m in hard rock areas and 300m in soft rock areas till the aquifer geometry is completely established throughout the country through aquifer mapping.
- It recommends estimation of replenishable and in-storage ground water resources for both unconfined and confined aquifers.
- GEC 2015 methodology stressed about estimation of base flow in the ground water balance equation wherever possible. Moreover, it has also suggested that Base flow assessment should be carried out in consultation with Central Water Commission in order to avoid any duplicity in the estimation of total water availability in a river basin.
- In categorization of assessment units, it separated Stage of Ground Water Development and groundwater level trend.
- This methodology recommends that after the assessment is done, a quality flag may be added to the assessment unit for parameters salinity, fluoride and arsenic.

- In hilly areas, where surface and sub-surface runoff is high and generally water level data is missing, it is difficult to compute the various components of water balance equation. Hence, it is recommended that if spring discharge data is available, the same may be assessed as a proxy for 'ground water resources' in hilly areas.
- GEC 2015 methodology suggested computation of recharge during flood.
- Keeping in view of the rapid change in ground water extraction, GEC-2015 recommends resources estimation once in every three years.

3.1 CHANGES IN GROUND WATER BALANCE EQUATION

GEC - 2015 methodology suggested a modified GW Balance equation, introducing components of A. Recharge from stream channels; B. Vertical inter-aquifer flow; C. Lateral flow along the aquifer system (through flow); D. Transpiration; and E .Evaporation. The groundwater Balance equation changed

From

$\Delta S = R_{RF} + R_C + R_{SWI} + R_{GWI} + R_{TP} + R_{WCS} - D_G$ **(As was in GEC – 97)**

To

$\Delta S = R_{RF} + R_{STR} + R_C + R_{SWI} + R_{GWI} + R_{TP} + R_{WCS} \pm VF \pm LF - G_E - T - E - B$ **(As is in GEC – 2015)**

where,

ΔS – Change in storage

R_{RF} – Rainfall recharge

R_{STR} – Recharge from stream channels

R_C – Recharge from canals

R_{SWI} – Recharge from surface water irrigation

R_{GWI} – Recharge from ground water irrigation

R_{TP} – Recharge from Tanks & Ponds

R_{WCS} – Recharge from water conservation structures

VF – Vertical inter aquifer flow

LF – Lateral flow along the aquifer system (throughflow)

G_E – Ground Water Extraction

D_G – Gross Ground Water Draft

However, in the present methodology of groundwater resources assessment (GEC-2015), in dynamic component, similar to GEC-97, two approaches have been recommended namely water

level fluctuation (WLF) and rainfall infiltration (RIF) method. The water level fluctuation method is based on concept of storage change due to difference between various input and output components. Input refers to recharge from rainfall and other sources and subsurface inflow into the used assessment. Output refers to ground water draft, ground water evapotranspiration, base-flow to streams and subsurface outflow from the unit. Since the data on subsurface in outflow are not readily available, it is advantageous to adopt the unit for ground water assessment as basin/ sub-basin/ watershed, as the inflow / outflow across these bound may be taken as negligible. In general, watershed has been taken as the basic unit of the ground water resource assessment in hard rock areas. In case of alluvium area, administrative base can also be taken as the assessment unit. In each assessment unit, hilly areas having more than 20 % slopes are to be deleted from the total area to get the area suitable for recharge, except where estimation through spring data is possible. Further, areas where the quality of ground water is beyond the usable limits should be identified and handled separately. The remaining area after deleting the hilly parts separating the area with poor ground water quality is to be delineated into command, non-Command and poor groundwater quality areas. Ground water assessments in command and non–command areas are done separately for monsoon and non-monsoon seasons. The description of utilised Ground Water Resource Estimation Methodology (GEC'15) vis-à-vis brief procedure followed in the present ground water assessment is discussed in detail in subsequent chapters.

3.2 STAGE OF GROUND WATER EXTRACTION

Stage of ground water extraction for an assessment unit/sub-unit has to be computed using the following relation:

Stage of Ground Water Extraction(%)	**=**	**Existing Gross Ground Water Extraction for All Uses x 100** / **Annual Extractable Ground Water Resources**

3.3 CATEGORIZATION OF ASSESSMENT UNIT/SUB-UNIT

In contrast to GEC-97, GEC-2015 suggests categorization of assessment units/sub-units based on the stage of ground water extraction and further validate it based on of ground water level trend during pre-monsoon and post-monsoon intervals. However it retained GEC-97 nomenclature of four categories viz., 'Safe', 'Semi-critical', 'Critical' and 'Over-exploited'. Recommended categorization of GEC-2015 is tabulated in **Table 3.1**.

If the ground water resource assessment and the trend of long term water levels contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data. The mismatch conditions are given tabulated in **Table 3.2**.

Table 3.1 Criteria adopted for the Categorization

Sl No.	Stage of Ground Water Extraction (%)	Categorization
1.	≤ 70%	Safe
2.	>70% and ≤90%	Semi Critical
3.	>90% and ≤100%	Critical
4.	>100%	Over Exploited

Table 3.2 Validation of SOGWE against Ground water level trend

SOGWE	Ground Water Level Trend	Remarks
≤70%	Significant decline in trend in both pre-monsoon and post-monsoon	Not acceptable and needs reassessment
>100%	No significant decline in both pre-monsoon and post-monsoon long term trend	Not acceptable and needs reassessment

In case, the mismatch persists even after reassessment, the sub-unit may be categorized based on Stage of Ground Water Extraction of the reassessment. However, the sub unit should be flagged for strengthening of observation well network and parameter estimation.

CHAPTER 4
PROCEDURE FOLLOWED IN THE PRESENT ASSESSMENT INCLUDING ASSUMPTIONS AND PARAMETER ESTIMATION

Estimation of ground water resources has been carried out based on the methodology recommended by the Ground Water Estimation Committee, 2015 (GEC -2015).The present assessments of 2022 have been carried out, through ***IN-GRES,*** the purpose built software developed by IIT Hyderabad and powered by Vassar Labs.**IN-GRES** software modules were used in Computations which is based on GEC 2015 methodology. Salient features of adaptation of the methodology and norms adopted in this exercise are detailed below.

4.1 GROUND WATER ASSESSMENT UNIT

Since the required data in respect of different parameters and variables are not available to carry out the computations on watershed basis in hard rock terrain as recommended in the GEC 2015 methodology, 'Community development block' or 'Block' and four urban area has been taken as the unit for ground water assessment in the State. There are 24 districts in the state, which are further divided into 259 community development blocks. In addition Four Urban centre Ranchi, Dhanbad, Jamshedpur and Medininagar has also been included in assessment of Ground water resources for 2022. District-wise break-up of area coverage is given in **Table 4.1**.

Sub-Units:

As per the recommendations of GEC 2015 methodology, the present assessment was done taking into consideration the following sub-units:

a) **Hilly area:** Areas with more than 20% slope have been excluded for the estimation. Hilly areas represent about 25% of the total geographical area of the state. Excluding the hilly areas, about 6045252 ha area of the State is considered as suitable for ground water recharge and development.
b) **Command area:** Areas fall under command of major/medium surface water schemes.
c) **Non-command area:** Areas do not fall under command of major/medium surface water schemes. Assessment has been carried out separately for command and non-command areas within an assessment unit (block)

In the following cases, where the sub-units could not be identified distinctly, assessment has been done taking the 'Block' as a single unit:

i) In case the command area falling in a block constitutes less than 25% or more than 75% of the total geographical areas of the block.

ii) Whenever the canal seepage data for any block under command area is not available.

iii) Command area is <100 ha.

d) **Poor ground water quality area:** Computation of recharge in areas with salinity is to be done separately. As such, in the state of Jharkhand, there is no poor quality ground water area.

4.2 GROUND WATER YEAR

The estimation was done considering 2021-22 as the ground water year with ground water resource position as on 2022. A year has been divided into monsoon and non-monsoon periods. The state of Jharkhand receives rainfall from Southwest monsoon spanning between June to October. Remaining seven months has been considered as non-monsoon period.

Table 4.1 District-wise Area Coverage of Assessment Sub-units

Sl. No.	District	Areal extent (in hectares)				
		Total Area	Hilly Area	GW Worthy Area	Command Area	Non-Command Area
1	Bokaro	285938	23495	262443	577	261866
2	Chatra	393189	67102	326087	779	325308
3	Deoghar	255105	64407	190698	84	190614
4	Dhanbad	225247	49278	175969	748	175221
5	Dumka	371643	90276	281367	10078	271289
6	East Singhbhum	363335	112342	250993	494	250499
7	Garhwa	404475	112832	291643	6590	285053
8	Giridih	508490	68411	440079	180	439899
9	Godda	211109	44707	166402	4948	161454
10	Gumla	534726	127611	407115	3786	403329
11	Hazaribagh	431046	78384	352662	2341	350321
12	Jamtara	180429	82083	98346	0	98346
13	Khunti	260017	93012	167005	2712	164293
14	Koderma	149670	58768	90902	0	90902
15	Latehar	361261	122748	238513	820	237693
16	Lohardaga	149246	21683	127563	1437	126126
17	Pakur	180559	52800	127759	1115	126644
18	Palamau	451659	104315	347344	6722	340622
19	Ramgarh	139565	28298	111267	122	111145
20	Ranchi	496266	123913	372353	3817	368536
21	Sahebganj	170205	55796	114409	709	113700
22	Saraikela - Kharsawan	272455	65416	207039	3164	203875
23	Simdega	375229	66169	309060	1067	307993
24	West Singhbhum	722220	133986	588234	3846	584388
State Total		**7893084**	**1847832**	**6045252**	**56136**	**5989116**

4.3 GROUND WATER RECHARGE

The recharge assessment is estimated as the sum total of the change in storage, recharge and draft. The estimation is essentially based on the ground water balance equation which is stated in general terms for any specific as follows:

Input – Output = Change in storage

Details of the ground water balance equation have already been discussed in Sec. 3.1. The estimation has been done separately for monsoon and non-monsoon periods.

4.3.1 Recharge from Rainfall during Monsoon Season

Recharge from monsoon rainfall has been estimated separately for command and non-command areas. Recharge has been computed using both water level fluctuation methods as well as rainfall infiltration factor method. For comparison of figures obtained from the above two methods, percent deviation has been computed and the recharge has been calculated according to the recommended methodology.

Computation of monsoon recharge by Water Table Fluctuation method (WTFM):

As recommended by GEC'15, the recharge from rainfall during monsoon by water table fluctuation method has been estimated using the following equation:-

$$\mathbf{R_{rf} = \Delta S + G_E - R_o \pm IAT + O_D}$$

where,

R_{rf} = Recharge from rainfall;

ΔS = Change in ground water storage = (Water level Fluctuation x Area x Specific Yield between pre- and post-monsoon periods);
$\Delta S = \Delta h \times A \times S_Y$

G_E = Ground water Extraction;

R_o = Recharge from various sources;(i.e.$R_{STR}+R_{SWI}+R_{GWI}+R_{TP}+R_{WCS}$) (Discussed in Sec. 3.1.)

IAT = Inter- / intra- aquifer transfer (i.e. ± VF ± LF) (Discussed in Sec. 3.1.)

O_D = Other Discharges (i.e. T + E + B) (Discussed in Sec. 3.1.)

For computation of change in ground water storage, average pre-monsoon (April/May, 2019) and post-monsoon (Nov., 2019) water level data of the block/sub-unit has been considered. The specific yield values used for different formations are given in **Table4.2**.

Monsoon recharge from rainfall computed by this method has been normalized with reference to the normal monsoon rainfall following the procedure recommended by GEC'15 using the relation:

$$\mathbf{R_{rf}\ (normal, WTFM) = NMR \times R_{rf} / AMR}$$

where,

R_{rf} (normal, WTFM) = Normalized rainfall recharge during monsoon estimated by WTFM approach;

NMR = Normal monsoon rainfall;

R_{rf} = Computed rainfall recharge;

AMR = Actual monsoon rainfall in the year of assessment, 2016.

Computation of monsoon recharge from rainfall by Rainfall Infiltration Factor Method (RIFM):

Rainfall recharge during monsoon has also been estimated considering normal monsoon rainfall data (**Table 2.4**) and rainfall infiltration factors adopted (**Table 4.2)**, using the relation:

$$\mathbf{R_{rf}(monsoon) = RFIF \times A \times (R - a)/1000}$$

where,

R_{rf} = Monsoon recharge from rainfall estimated by RIF approach (in ha-m);

A = Area of unit/sub-unit (in ha);

RFIF = Rainfall Infiltration Factor;

R = monsoon rainfall (in mm);

a = Minimum threshold value above which rainfall induces ground water recharge (in mm).

As per GEC'15, 10% of Normal annual rainfall has been taken as minimum rainfall threshold and 3000 mm as maximum rainfall limit.

The two values of the monsoon rainfall recharge R_{rf} (normal, WTFM) and R_{rf} (normal, RIFM) have been compared to find the *Percent Deviation* (PD) using the following relation:-

$$\mathbf{PD = ((R_{rf}(normal, WTFM) - R_{rf}(normal, WTFM)) \times 100 / R_{rf}(normal, RIFM)}$$

After computation of PD, the values of monsoon rainfall recharge to be adopted for the assessment R_{rf}(monsoon) have been determined as recommended in the GEC'97:

i) If $-20 \leq PD \leq +20$, then R_{rf} (monsoon) = R_{rf} (normal, WTF)

ii) If $PD \leq -20$, then R_{rf} (monsoon) = 0.8 x R_{rf} (normal, RIF)

iii) If $PD \leq +20$, then R_{rf} (monsoon) = 1.2 x R_{rf} (normal, RIF)

4.3.2 Recharge from Rainfall during Non-Monsoon Season

As recommended by GEC'15 methodology, the rainfall recharge during the non-monsoon period is only to be considered if the normal non-monsoon rainfall is greater than 10% of the normal annual rainfall. In the State of Jharkhand the normal non-monsoon rainfall has been found

to be greater than 10% of the normal annual rainfall in all cases and the corresponding recharge has been estimated using the following relation.

$$R_{rf}(\text{Non-monsoon}) = RFIF \times A \times (R - a)/1000$$

where,

R_{rf} = Non-monsoon recharge from rainfall (in ha-m);
A = Area of unit/sub-unit (in ha);
RFIF = Rainfall Infiltration Factor;
R = Non-monsoon rainfall (in mm);
a = Minimum threshold value above which rainfall induces ground water recharge (in mm).Considered at 10% of normal non-monsoon rainfall in present exercise.

4.3.3 Norms used for Recharge and Specific Yield

A part of the rainfall percolates downward to join the ground water body. However, the quantity depends on the terrain type and underlying rock type. In absence of any experimental data on Rainfall Infiltration Factor and specific yield, norms as suggested by GEC' 15methodology, has been suitably adopted for the state (**Table 4.2A & 4.2B**) which are in accordance with earlier estimations. In presence of more than one formation / lithology within a single assessment unit, norm values have been averaged based upon area proportion, using GIS software.

Table-4.2A. Norms Recommended for the specific Yield

NORMS RECOMMENDED FOR THE SPECIFIC YIELD							
Sr. No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
1	Alluvium	AL01	Younger Alluvium (Clay/Silt/Sand/ Calcareous concretions)	Quaternary	10	8	12
2	Alluvium	AL02	Pebble / Gravel/ Bazada/ Kandi	Quaternary	16	12	20
3	Alluvium	AL03	Older Alluvium (Silt/Sand/Gravel/Lithomargic clay)	Quaternary	6	4	8
4	Alluvium	AL04	Aeolian Alluvium (Silt/ Sand)	Quaternary	16	12	20
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay)	Quaternary	10	8	12
6	Alluvium	AL06	Valley Fills	Quaternary	16	12	20
7	Alluvium	AL07	Glacial Deposits	Quaternary	16	12	20
8	Laterite	LT01	Laterite / Ferruginous concretions	Quaternary	2.5	2	3
9	Basalt	BS01	Basic Rocks (Basalt) - Weathered, Vesicular or Jointed	Mesozoic to Cenozoic	2	1	3

NORMS RECOMMENDED FOR THE SPECIFIC YIELD							
Sr. No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
10	Basalt	BS01	Basic Rocks (Basalt) - Massive Poorly Jointed	Mesozoic to Cenozoic	0.35	0.2	0.5
11	Basalt	BS02	Ultra Basic - Weathered, Vesicular or Jointed	Mesozoic to Cenozoic	2	1	3
12	Basalt	BS02	Ultra Basic - Massive Poorly Jointed	Mesozoic to Cenozoic	0.35	0.2	0.5
13	Sandstone	ST01	Sandstone/Conglomerate	Upper Palaeozoic to Cenozoic	3	1	5
14	Sandstone	ST02	Sandstone with Shale	Upper Palaeozoic to Cenozoic	3	1	5
15	Sandstone	ST03	Sandstone with shale/ coal beds	Upper Palaeozoic to Cenozoic	3	1	5
16	Sandstone	ST04	Sandstone with Clay	Upper Palaeozoic to Cenozoic	3	1	5
17	Sandstone	ST05	Sandstone/Conglomerate	Proterozoic to Cenozoic	3	1	5
18	Sandstone	ST06	Sandstone with Shale	Proterozoic to Cenozoic	3	1	5
19	Shale	SH01	Shale with limestone	Upper Palaeozoic to Cenozoic	1.5	1	2
20	Shale	SH02	Shale with Sandstone	Upper Palaeozoic to Cenozoic	1.5	1	2
21	Shale	SH03	Shale, limestone and sandstone	Upper Palaeozoic to Cenozoic	1.5	1	2
22	Shale	SH04	Shale	Upper Palaeozoic to Cenozoic	1.5	1	2
23	Shale	SH05	Shale/Shale with Sandstone	Proterozoic to Cenozoic	1.5	1	2
24	Shale	SH06	Shale with Limestone	Proterozoic to Cenozoic	1.5	1	2
25	Limestone	LS01	Miliolitic Limestone	Quarternary	2	1	3
26	Limestone	LS01	KarstifiedMiliolitic Limestone	Quarternary	10	5	15
27	Limestone	LS02	Limestone / Dolomite	Upper Palaeozoic to Cenozoic	2	1	3
28	Limestone	LS02	KarstifiedLimestone / Dolomite	Upper Palaeozoic to Cenozoic	10	5	15
29	Limestone	LS03	Limestone/Dolomite	Proterozoic	2	1	3
30	Limestone	LS03	KarstifiedLimestone/Dolomite	Proterozoic	10	5	15

NORMS RECOMMENDED FOR THE SPECIFIC YIELD							
Sr. No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
31	Limestone	LS04	Limestone with Shale	Proterozoic	2	1	3
32	Limestone	LS04	KarstifiedLimestone with Shale	Proterozoic	10	5	15
33	Limestone	LS05	Marble	Azoic to Proterozoic	2	1	3
34	Limestone	LS05	KarstifiedMarble	Azoic to Proterozoic	10	5	15
35	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.) - Weathered , Jointed	Mesozoic to Cenozoic	1.5	1	2
36	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.)-Massive or Poorly Fractured	Mesozoic to Cenozoic	0.35	0.2	0.5
37	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	3	2	4
38	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5
39	Schist	SC01	Schist - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
40	Schist	SC01	Schist - Massive, Poorly Fractured	Azoic to Proterozoic	0.35	0.2	0.5
41	Schist	SC02	Phyllite	Azoic to Proterozoic	1.5	1	2
42	Schist	SC03	Slate	Azoic to Proterozoic	1.5	1	2
43	Quartzite	QZ01	Quartzite - Weathered, Jointed	Proterozoic to Cenozoic	1.5	1	2
44	Quartzite	QZ01	Quartzite - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.3	0.2	0.4
45	Quartzite	QZ02	Quartzite - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
46	Quartzite	QZ02	Quartzite- Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4

NORMS RECOMMENDED FOR THE SPECIFIC YIELD							
Sr. No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
47	Charnockite	CK01	Charnockite - Weathered, Jointed	Azoic	3	2	4
48	Charnockite	CK01	Charnockite - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
49	Khondalite	KH01	Khondalites, Granulites - Weathered, Jointed	Azoic	1.5	1	2
50	Khondalite	KH01	Khondalites, Granulites - Mssive, Poorly Fractured	Azoic	0.3	0.2	0.4
51	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Weathered, Jointed	Azoic	1.5	1	2
52	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
53	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
54	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
55	Gneiss	GN02	Gneiss -Weathered, Jointed	Azoic to Proterozoic	3	2	4
56	Gneiss	GN02	Gneiss-Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
57	Gneiss	GN03	Migmatitic Gneiss - Weathered, Jointed	Azoic	1.5	1	2
58	Gneiss	GN03	Migmatitic Gneiss - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
59	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	2	1	3
60	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5

NORMS RECOMMENDED FOR THE SPECIFIC YIELD							
Sr. No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
61	Intrusive	IN02	Ultrabasics (Epidiorite, Granophyre etc.) - Weathered, Jointed	Proterozoic to Cenozoic	2	1	3
62	Intrusive	IN02	Ultrabasics (Epidiorite, Granophyre etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5

Table-4.2B. Norms Recommended for the Rainfall Infiltration Factor

NORMS RECOMMENDED FOR THE RAINFALL INFILTRATION FACTOR							
Sl.No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
1	Alluvium	AL01	Younger Alluvium (Clay/Silt/Sand/ Calcareous concretions)	Quaternary	22	20	24
2	Alluvium	AL02	Pebble / Gravel/ Bazada/ Kandi	Quaternary	22	20	24
3	Alluvium	AL03	Older Alluvium (Silt/Sand/Gravel/Lithomargic clay)	Quaternary	22	20	24
4	Alluvium	AL04	Aeolian Alluvium (Silt/ Sand)	Quaternary	22	20	24
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay) -East Coast	Quaternary	16	14	18
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay) - West Coast	Quaternary	10	8	12
6	Alluvium	AL06	Valley Fills	Quaternary	22	20	24
7	Alluvium	AL07	Glacial Deposits	Quaternary	22	20	24
8	Laterite	LT01	Laterite / Ferruginous concretions	Quaternary	7	6	8
9	Basalt	BS01	Basic Rocks (Basalt) - Vesicular or Jointed	Mesozoic to Cenozoic	13	12	14
9	Basalt	BS01	Basic Rocks (Basalt) - Weathered	Mesozoic to Cenozoic	7	6	8
10	Basalt	BS01	Basic Rocks (Basalt) - Massive Poorly Jointed	Mesozoic to Cenozoic	2	1	3
11	Basalt	BS02	Ultra Basic - Vesicular or Jointed	Mesozoic to Cenozoic	13	12	14
11	Basalt	BS02	Ultra Basic - Weathered	Mesozoic to Cenozoic	7	6	8
12	Basalt	BS02	Ultra Basic - Massive Poorly Jointed	Mesozoic to Cenozoic	2	1	3
13	Sandstone	ST01	Sandstone/Conglomerate	Upper Palaeozoic to Cenozoic	12	10	14
14	Sandstone	ST02	Sandstone with Shale	Upper Palaeozoic to Cenozoic	12	10	14
15	Sandstone	ST03	Sandstone with shale/ coal beds	Upper Palaeozoic to Cenozoic	12	10	14

NORMS RECOMMENDED FOR THE RAINFALL INFILTRATION FACTOR							
Sl.No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
16	Sandstone	ST04	Sandstone with Clay	Upper Palaeozoic to Cenozoic	12	10	14
17	Sandstone	ST05	Sandstone/Conglomerate	Proterozoic to Cenozoic	6	5	7
18	Sandstone	ST06	Sandstone with Shale	Proterozoic to Cenozoic	6	5	7
19	Shale	SH01	Shale with limestone	Upper Palaeozoic to Cenozoic	4	3	5
20	Shale	SH02	Shale with Sandstone	Upper Palaeozoic to Cenozoic	4	3	5
21	Shale	SH03	Shale, limestone and sandstone	Upper Palaeozoic to Cenozoic	4	3	5
22	Shale	SH04	Shale	Upper Palaeozoic to Cenozoic	4	3	5
23	Shale	SH05	Shale/Shale with Sandstone	Proterozoic to Cenozoic	4	3	5
24	Shale	SH06	Shale with Limestone	Proterozoic to Cenozoic	4	3	5
25	Limestone	LS01	Miliolitic Limestone	Quarternary	6	5	7
27	Limestone	LS02	Limestone / Dolomite	Upper Palaeozoic to Cenozoic	6	5	7
29	Limestone	LS03	Limestone/Dolomite	Proterozoic	6	5	7
31	Limestone	LS04	Limestone with Shale	Proterozoic	6	5	7
33	Limestone	LS05	Marble	Azoic to Proterozoic	6	5	7
35	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.) - Weathered, Jointed	Mesozoic to Cenozoic	7	5	9
36	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.)-Massive or Poorly Fractured	Mesozoic to Cenozoic	2	1	3
37	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	11	10	12
38	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
39	Schist	SC01	Schist - Weathered, Jointed	Azoic to Proterozoic	7	5	9
40	Schist	SC01	Schist - Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
41	Schist	SC02	Phyllite	Azoic to Proterozoic	4	3	5
42	Schist	SC03	Slate	Azoic to Proterozoic	4	3	5

NORMS RECOMMENDED FOR THE RAINFALL INFILTRATION FACTOR							
Sl.No	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
43	Quartzite	QZ01	Quartzite - Weathered, Jointed	Proterozoic to Cenozoic	6	5	7
44	Quartzite	QZ01	Quartzite - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
45	Quartzite	QZ02	Quartzite - Weathered, Jointed	Azoic to Proterozoic	6	5	7
46	Quartzite	QZ02	Quartzite- Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
47	Charnockite	CK01	Charnockite - Weathered, Jointed	Azoic	5	4	6
48	Charnockite	CK01	Charnockite - Massive, Poorly Fractured	Azoic	2	1	3
49	Khondalite	KH01	Khondalites, Granulites - Weathered, Jointed	Azoic	7	5	9
50	Khondalite	KH01	Khondalites, Granulites - Mssive, Poorly Fractured	Azoic	2	1	3
51	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Weathered, Jointed	Azoic	7	5	9
52	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Massive, Poorly Fractured	Azoic	2	1	3
53	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Weathered, Jointed	Azoic to Proterozoic	7	5	9
54	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
55	Gneiss	GN02	Gneiss -Weathered, Jointed	Azoic to Proterozoic	11	10	12
56	Gneiss	GN02	Gneiss-Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
57	Gneiss	GN03	Migmatitic Gneiss - Weathered, Jointed	Azoic	7	5	9
58	Gneiss	GN03	Migmatitic Gneiss - Massive, Poorly Fractured	Azoic	2	1	3
59	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	7	6	8
60	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
61	Intrusive	IN02	Ulrta Basics (Epidiorite, Granophyre etc.) - Weathered, Jointed	Proterozoic to Cenozoic	7	6	8
62	Intrusive	IN02	Ulrta Basics (Epidiorite, Granophyre etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3

4.3.4 Recharge from Sources other than Rainfall

In addition to the major recharge from rainfall, there are several other factors contributing towards recharge to ground water. The following such factors are considered in the present estimation separately for monsoon (June to September) and non-monsoon seasons (October to May)

a) Return flow from Ground water Irrigation (R_{GWI}) and Surface water Irrigation (R_{SWI})

Recharge due to applied surface water and ground water irrigation has been estimated based on the formulae suggested in GEC'15.

$$R_{SWI} = AD \times Days \times RFF$$

$$R_{GWI} = GE_{IRR} \times RFF$$

where,

R_{SWI} = Recharge due to applied surface water irrigation

R_{GWI} = Recharge due to applied ground water irrigation

AD = Average Discharge

Days =Number of days water is discharged to the Fields

RFF = Return Flow Factor

GE_{IRR} = Ground Water Extraction for Irrigation

RFF = Return Flow Factor

The computation involves the following steps:

i) Separate estimation for both the cases. Irrigation water applied by ground water irrigation is considered same as the gross ground water draft for irrigation. For estimation of irrigation water applied by surface water irrigation sources from the data on potential created under different crops by surface irrigation schemes and the average crop water requirements is utilised;

ii) Estimation of irrigated area separately under paddy and non-paddy;

iii) Estimation of average depth to water level below ground level;

iv) Estimation of return flow factors for the concerned assessment unit/sub-unit on the basis of results of steps (ii) & (iii) and **Table 4.3** in terms of the guidelines of GEC'15;

v) Estimation of the recharge from ground water irrigation from the results of steps (i) and (iv).

Table 4.3 Return Flow Factors for applied Irrigation water

DTW	Ground Water		Surface Water	
m bgl	Paddy	Non Paddy	Paddy	Non Paddy
<=10	45	25	50	30
11	43.3	23.7	48.3	28.7

DTW	Ground Water		Surface Water	
m bgl	Paddy	Non Paddy	Paddy	Non Paddy
12	41.7	22.3	46.7	27.3
13	40	21	45	26
14	38.3	19.7	43.3	24.7
15	36.7	18.3	41.7	23.3
16	35	17	40	22
17	33.3	15.7	38.3	20.7
18	31.7	14.3	36.7	19.3
19	30	13	35	18
20	28.3	11.7	33.3	16.7
21	26.7	10.3	31.7	15.3
22	25	9	30	14
23	23.3	7.7	28.3	12.7
24	21.7	6.3	26.7	11.3
>=25	20	5	25	10
				(as % of gross draft)

b) Recharge from Canal Seepage (R_C)

In ground water resource estimation, recharge through seepage from canals has been considered for those blocks or parts of blocks falling under command areas of irrigation schemes. There is no major canal irrigation system working in the state. As per the present status of different irrigation schemes, 39 schemes are working, out of which 03 are medium irrigation scheme (irrigating more than 2000 ha) and remaining all are minor irrigation schemes. The seepage from canals has been assessed by working out the wetted perimeters of six irrigation schemes. Seepage factor has been worked out relating the unit-irrigated area versus seepage from canals in those six irrigation schemes. This factor (0.017) has been applied to all 39 surface water irrigation schemes. Due to non-availability of the current GW year data, the figures on seepage from canals, as were adopted during the previous assessment have been considered for the present assessment.

c) Recharge from Tanks, Ponds and Water Conservation Structures (R_{TP} and R_{WCS})

The rate of seepage from tanks has been considered at 1.4 mm/day. The total seepage been worked out separately for monsoon and non-monsoon periods. During monsoon period average areas under water spread in tanks have been considered as 60% of the tank. During non – monsoon season, the average area under water spread is taken as 20% of water spread during monsoon season. For water conservation structures, number of fillings has been considered as two (02).

d) Recharge from Coal Mine Dewatering Return flow (R_M)

In ground water resource estimation, recharge through return flow from colliery dewatering has been estimated separately for monsoon and non-monsoon periods. Field data indicate that there is an average of 30% and 45% return flow in monsoon and non-monsoon periods respectively. In the context of annual draft of 100 ham per colliery, there is 38 ham of return flow.

e) Recharge from Lateral Flow along the aquifer and Vertical Inter Aquifer Flow

Lateral flow across boundaries should be considered as the assessment has been carried out based on administrative block boundary. However, in absence of assessment unit –wise estimate of transmissivity values, the same has been considered as zero. Vertical Inter Aquifer Flow has not been estimated as aquifer geometry and aquifer parameters are not known for all assessment units of the State.

f) Recharge / Discharge from Base Flow and Stream Recharge

As the present assessment has been carried out based on administrative block boundary, and not based on watershed, each assessment unit does not have stream gauge station. The matter has been discussed among committee members and no earlier assessment unit-wise database could be located.

g) Recharge / Discharge from Evaporation and Transpiration

As per GEC'15 suggestion, considering average water level of the State mostly greater than 01 m bgl, evaporation losses from the aquifer has been taken as zero. In the same line, average water level of the State being greater than 3.5 m bgl, transpiration has also been taken as zero.

4.3.5 Computation of Total Annual Ground Water Recharge

Total annual recharge has been computed as arithmetic sum of recharge from rainfall and recharge from sources other than rainfall. Mathematically it may be expressed as

$$R = R_{rf} + R_C + (R_T + R_{WCS}) + (R_{SW} + R_{GW}) + R_M$$

4.3.6 Annual Extractable Ground Water Resource (EGR)

As base flow contribution to the ecological flow of rivers is not determined in this exercise, as per GEC'15 guideline, it has been assumed that unaccounted natural discharge is taking place. This has been taken care of by assigning a value for the unaccounted discharge ranging between 5 to 10% of the total annual recharge as per the criteria recommended by GEC'15:

i) 5%: if the recharge from rainfall has been computed by Water Table Fluctuation method.

ii) 10%: if the recharge from rainfall has been computed by Rainfall Infiltration Factor method.

The balance will account for Annual Extractable Ground Water Resources (EGR).

4.4 GROUND WATER EXTRACTION

The ground water draft or extraction has been calculated block-wise considering Irrigation, Domestic and Industrial uses of groundwater. Gross ground water draft represents ground water extraction from all ground water structures during monsoon as well as non-monsoon period. Computationally, Ground water draft has been assessed as follows:

$$\mathbf{GE_{ALL} = GE_{IRR} + GE_{DOM} + GE_{IND}}$$

where,

GE_{ALL} =Ground water extraction for all uses
GE_{IRR} =Ground water extraction for irrigation
GE_{DOM} =Ground water extraction for domestic uses
GE_{IND} = Ground water extraction for industrial uses

4.4.1 Ground Water Extraction for Irrigation (GE_{IRR})

The annual irrigation draft has been computed by multiplying the number of different types of ground water abstraction structures by their respective unit drafts. In present estimation, projected values of final 5th MI Census data have been utilized considering 2% annual growth rate.

District-wise numbers of different types of ground water abstraction structures as per final 5th MI Census and projected number of wells are given in **Table 4.4**.The Table 4.4 indicates that Dug wells are the major structure for irrigation in the state. In view of electrification in minor-irrigation sector, unit drafts of wells have been estimated based upon sample field surveys. For dug wells, considered unit draft value varies from 0.25 to 0.8 ham/yr depending upon rock type in hard rock areas and 01 ham/yr in alluvium areas. Unit drafts of shallow tube-well and deep tube-well are considered 1.5 ham/yr and 20 ham/yr respectively. Of the annual draft, 20% has been taken as monsoon draft and 80% as non-monsoon draft. Range of utilised unit drafts are given in **Table 4.5**.

Table 4.4 District-wise Number and Type of Groundwater Abstraction structures

Sl. No.	District	Number of Structures (5th MI Census) (2012-13)		
		DW	STW	DTW
1	Bokaro	4673	25	5
2	Chatra	10834	33	6
3	Deoghar	11656	77	11
4	Dhanbad	4646	61	8
5	Dumka	13466	27	29
6	East Singhbhum	1069	301	105
7	Garhwa	8313	336	712
8	Giridih	14747	363	437
9	Godda	6050	37	48
10	Gumla	8676	40	10
11	Hazaribagh	18477	36	958
12	Jamtara	4089	246	10
13	Khunti	5022	139	6
14	Koderma	4435	90	89
15	Latehar	8917	73	12
16	Lohardaga	6422	33	2
17	Pakur	1925	55	36
18	Palamau	11289	61	94
19	Ramgarh	5001	32	4
20	Ranchi	18985	117	204
21	Sahebganj	1718	110	49
22	Saraikela - Kharsawan	1688	34	17
23	Simdega	3328	3	0
24	West Singhbhum	2497	108	9
	State Total	**177923**	**2437**	**2861**

Table 4.5 Unit Draft based on Structure

Type of Structure	Season	Unit Draft (ham/yr)
Dug Well (DW)	Monsoon	0.05 - 0.20
	Non-Monsoon	0.20 - 0.80
Shallow Tube Well (STW)	Monsoon	0.3
	Non-Monsoon	1.2
Deep Tube Well (DTW)	Monsoon	4
	Non-Monsoon	16

4.4.2 Ground Water Extraction for Domestic Use (GE_{DOM})

Ground water draft to meet up the domestic water need has been worked out based on population of 2011 (Census, 2011). Population for the year 2020 has been calculated by applying the growth rate on 2011 census figures. For rural population, the per capita consumption has been considered at 55 LPCD with 100% dependability on ground water. In urban areas, per capita consumption is 135 LPCD. Population figures have been further projected to 2022 with 2.24% annual growth rate. It is considered that the water consumption for livestock is met up from surface water. Drafts during monsoon and non-monsoon periods have been estimated separately considering the 5 months of June to October as monsoon period and the rest7 months as non-monsoon period.

4.4.3Ground Water Extraction for Industrial Use (GE_{IND})

In the present estimation, coal-mining industry in Jharkhand has been identified as a major groundwater dewatering source through their activity. Hence, coal-mining activity has been assessed and proper water-balancing has been formulated based on field data and integrated into the estimation process. Impact of coal mining on ground water regime largely depends on mine geometry, ground water recharge potential and aquifer parameters of the formations. Field data indicate that there is an average annual draft of103 ham of groundwater for each colliery. This may be further broken down to 46.97 ham and 56.73 ham draft for monsoon and non-monsoon seasons respectively. Considering these field values, drafts of 44 ham and 56 ham for monsoon and non-monsoon seasons respectively has been considered for this estimation purpose.

In view of non-availability of complete data on coal mining/industries area 25% excess value on estimated extraction for industrial use has been considered. In addition to above, draft figure and recharge structure, proposed by industries where NOC has been issued by CGWA has also been considered in estimation.

4.5ALLOCATION FOR FUTURE GROUND WATER DEMAND FOR DOMESTIC PURPOSE

Allocation for future groundwater demand has been computed as per GEC-15 methodology for a projected population with the target year of 2025. Considered dependence on groundwater is at 50% (i.e. 0.5 as fractional load on groundwater).Computation has been carried out for each assessment unit based on GEC-15 recommended empirical relation as given below

Alloc = 22 X N X L_g

Where, Alloc =Allocation for domestic water requirement (in mm per year)

N = Population density in the unit in thousands per sq. km.

L_g = Fractional load on ground water for domestic water supply (≤1.0)

4.6 ADDITIONAL ANNUAL POTENTIAL RESOURCES

Additional annual potential resource has not been calculated for the State of Jharkhand as the state does not have any flood –prone area, water-logged and shallow water level area. The State also does not have any database on spring location and discharges.

4.7 ASSESSMENT OF IN-STORAGE / STATIC GROUND WATER RESOURCES

Computation of Static / In-storage ground water resources has been carried out following GEC'15 methodology. However, the prerequisite of the estimation is detailed information of aquifer thickness and specific yield of the aquifer material. During current exercise, though spatial distribution of specific yield of the aquifer material was known, information about spatial distribution of aquifer thickness is incomplete. Hence, an average depth of 30 m has been considered for entire State. Computations have been carried out following:

$$\mathbf{SGWR = A \times (Z_2 - Z_1) \times S_Y}$$

where,

SGWR = Static or in-storage Ground Water Resources
A = Area of the Assessment Unit
Z_2 = Bottom of Unconfined Aquifer
Z_1 = Pre-monsoon water level
S_Y = Specific Yield in the In storage Zone

4.8 GROUND WATER RESOURCE ASSESSMENT OF DEEPER AQUIFER SYSTEMS

GEC-15 highlights that assessment of ground water resources of deeper aquifer systems (Semi-confined and confined) has crucial importance. However, in absence of detail database in this regard for the entire State, assessment has not been carried out for deeper aquifer.

4.9 TOTAL GROUND WATER AVAILABILITY

Total Ground Water Availability of an assessment unit has been computed as the Sum of Dynamic Ground Water Resources, Static/in-storage ground water resources in the unconfined aquifer, and dynamic ground water resources of the Confined aquifers and Semi confined aquifers and In-storage resources of the Confined aquifers and semi confined aquifers of the unit.

CHAPTER 5

COMPUTATION OF GROUND WATER RESOURCES ESTIMATION OF THE STATE

Ground Water resource of the Jharkhand State (2022) has been computed according to the methodology of GEC-2015. For recharge estimation, ground water worthy areas has been considered which is also named as ground water assessment areas. These areas exclude the hills and areas under backwater of tanks and dams. About 25% of the state geographical area has been demarcated as hills (> 20% slope). Ground Water resource of the state has been computed block-wise and then summarised district-wise. District-wise summary are given in **Annexure II A** and **II B**. Block-wise computations are given in **Annexure III A to III F**.

5.1 ASSESSMENT (SUB-UNIT-WISE) METHOD ADOPTED FOR COMPUTING RAINFALL RECHARGE DURING MONSOON SEASON (WLFM/RIFM)

In all the assessment units, sub-unit-wise computation of rainfall recharge during monsoon has been computed using both Water Level Fluctuation method (WLFM) and Rainfall Infiltration method (RIFM). Percent Deviation (PD) factor was calculated by the two methods and monsoon rainfall recharge has been considered. It has been observed that, in majority of the cases, results of rainfall infiltration method (RIFM) are selected over results of water table fluctuation method (WLFM) as per computed PD factors.

5.2 TOTAL REPLENISHABLE GROUND WATER RESOURCES OF THE STATE

Total Annual Ground Water Recharge of the Jharkhand State as on 2022 is 6.20 BCM. Considering natural discharge of0.51 BCM, Annual Extractable Ground Water resource for the State of Jharkhand is 5.69BCM. The Ground Water Extraction in the State of the Jharkhand is 1.78 BCM. Ground Water Extraction for Irrigation is 0.93 BCM, However0.65 BCM is drawn to meet up the drinking water demand and remaining 0.21 BCM is Ground Water Extraction for industrial processes. The average Stage of Ground Water Extraction as on 2022 is 31.35 %. The Annual Ground Water allocation for Domestic use as on 2025 is 0.65BCM. and Net Ground Water Availability for Future use is 3.92 BCM.

Monsoon has an overwhelming control over recharge of Jharkhand state. Monsoon rainfall contributes about 79.35% of total recharge, non-monsoon rainfall contributes another 7.7% of total recharge and12.95% of the total recharge is from the sources other than rainfall like recharge as return seepage from irrigation and from water harvesting structures. Summary of

Dynamic Groundwater Resource Assessment (2022) has been tabulated in **Table 5.1**. Relative contribution of principal components of Total Annual Ground Water Recharge is shown in **Fig. 5.1**.

Table 5.1 State Summary of Dynamic Groundwater Resource Assessment (2022)

	Dynamic GW Resource	
	(BCM)	(ham)
Annual ground water recharge	6.20	620230
Total Natural Discharges	0.51	50998
Annual Extractable Ground Water Resource	5.69	569231
Current Annual Ground Water Extraction for 'All Uses'	1.78	178434
Current Annual GW Extraction for Irrigation	0.93	92782
Current Annual GW Extraction for Domestic uses	0.65	64609
Current Annual GW Extraction for Industrial uses	0.21	21042
Stage of Ground WaterExtraction (%)	31.35 %	
Annual Ground Water allocation for Domestic use as on 2025	0.65	64948
Net Ground Water Availability for Future use	3.92	392055

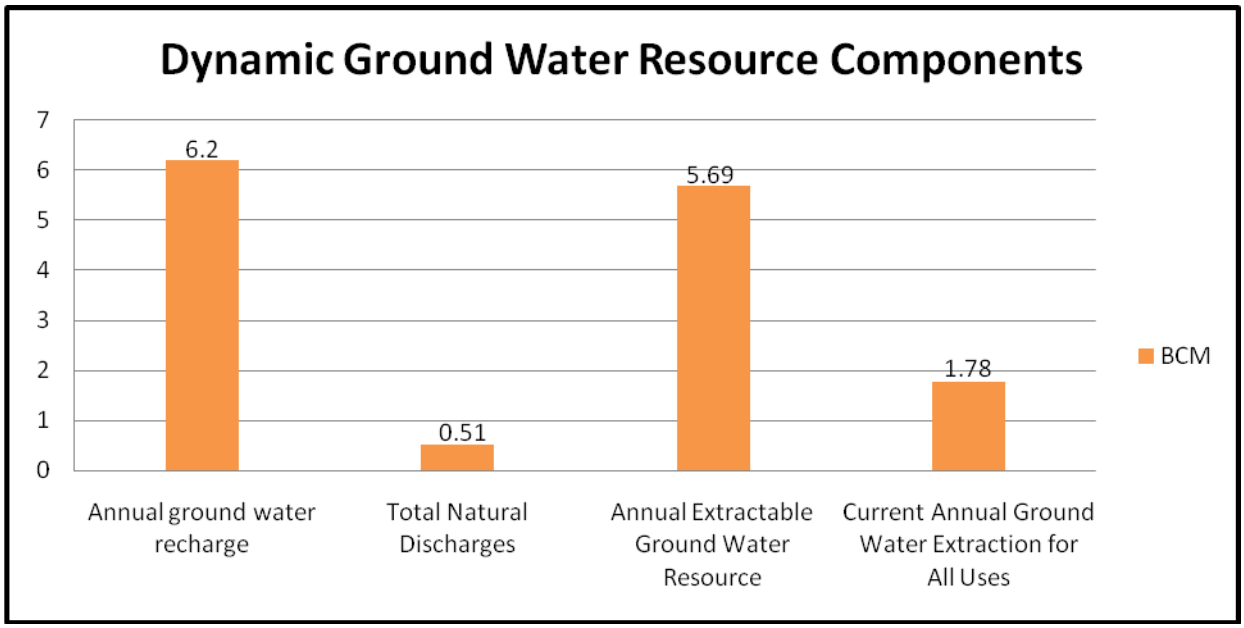

Fig. 5.1 Relative contribution of principal components of Total Annual Ground Water Recharge

5.3 SPATIAL VARIATION OF THE GROUND WATER RECHARGE, EXTRACTIONAND DEVELOPMENT

Depending upon underlying geological formation, hydrogeological characteristics, rainfall scenario and land-use pattern the State shows a high degree of variation in groundwater

recharge, extraction and development among the assessment units / sub-units. Even when aggregated to district level, the variations are significant.

5.3.1. Variation in Ground water Recharge

Total Annual Ground Water Recharge in the State is ***6.20 BCM***. Considering the natural discharge as ***0.51 BCM***, Annual Extractable Ground Water Resource for the state of Jharkhand is ***5.69 BCM***. Volumetrically ground water recharge is highest in West Singhbhum district and lowest in Koderma district. However, unit-area recharge is highest at Bokaro district and lowest at Garhwa district. Deviation of unit-area monsoon rainfall recharge from unit-area total recharge among districts shows recharge is mostly dominated by storage parameters of the aquifer, rainfall infiltration factor and fluctuation of water level. District-wise details of various components of Recharge is tabulated in **Table 5.2** and graphically represented in **Fig. 5.2**.

Table 5.2 District-wise details of various components of GW Recharge (in BCM)

District	Rainfall Recharge - Monsoon	Rainfall Recharge - Non-Monsoon	Recharge from Other Sources	Total Annual GW Recharge	Total Extractable Ground Water Recharge
Bokaro	0.2649	0.0249	0.0252	0.3151	0.2896
Chatra	0.2392	0.0062	0.0405	0.2859	0.2610
Deoghar	0.1191	0.0145	0.0271	0.1607	0.1498
Dhanbad	0.1847	0.0168	0.0625	0.2640	0.2447
Dumka	0.1807	0.0338	0.0447	0.2593	0.2363
East Singhbhum	0.2368	0.0284	0.0282	0.2934	0.2672
Garhwa	0.2525	0.0105	0.0474	0.3104	0.2855
Giridih	0.3382	0.0229	0.0556	0.4166	0.3848
Godda	0.1606	0.0190	0.0279	0.2075	0.1893
Gumla	0.2961	0.0326	0.0171	0.3457	0.3169
Hazaribagh	0.2554	0.0249	0.0460	0.3263	0.2960
Jamtara	0.0591	0.0083	0.0232	0.0905	0.0833
Khunti	0.0964	0.0120	0.0140	0.1224	0.1127
Koderma	0.0491	0.0044	0.0100	0.0635	0.0591
Latehar	0.1866	0.0152	0.0441	0.2459	0.2284
Lohardaga	0.1618	0.0148	0.0110	0.1875	0.1722
Pakur	0.1762	0.0296	0.0233	0.2291	0.2105
Palamau	0.2664	0.0110	0.0888	0.3662	0.3368

District	Rainfall Recharge - Monsoon	Rainfall Recharge - Non-Monsoon	Recharge from Other Sources	Total Annual GW Recharge	Total Extractable Ground Water Recharge
Ramgarh	0.0845	0.0084	0.0218	0.1146	0.1085
Ranchi	0.2961	0.0333	0.0591	0.3885	0.3599
Sahebganj	0.2172	0.0240	0.0431	0.2843	0.2584
Saraikela - Kharsawan	0.1453	0.0168	0.0132	0.1753	0.1577
Simdega	0.2183	0.0084	0.0120	0.2386	0.2200
West Singhbhum	0.4300	0.0574	0.0236	0.5110	0.4635

5.3.2 Variation in Ground water Extraction

Existing Ground Water Extraction for "All Uses" for the state is ***1.78 BCM***. Of this, Ground Water Extraction for Irrigation is ***0.93 BCM***, ***0.65 BCM*** is drawn to meet up the drinking water demand and remaining ***0.21 BCM***is Ground Water Extraction for industrial processes. Volumetrically, highest total draft is in Dhanbad district and lowest is in Lohardaga district. On the other hand, unit-area total draft is highest at Dhanbad district but lowest in Simdega district. If individual components of draft are considered then unit-area ground water extraction for irrigation is highest at Ranchi district and lowest in Saraikela-Kharsawan district; unit-area ground water extraction for domestic purposes is highest at Dhanbad district and lowest in Simdega district and unit-area ground water extraction for industrial uses is highest at Dhanbad district and lowest in Lohardaga district. This shows control of population density, industrial activity including mining and agricultural activity on ground water draft component. The analysis shows that districts namely Dhanbad, Bokaro, Giridih, Hazaribagh, Palamu and Ranchi are main contributor of ground water extraction in the state due to industrial, mining, agricultural and urban population. Total 1.78 BCM annual ground water extraction of the state covering twenty four (24) districts, these six districts (Dhanbad, Bokaro, Giridih, Hazaribagh, Palamu and Ranchi) contribute 0.8175 BCM, which is about 45.92% of the total.

Table 5.3 District-wise details of various components of GW Extraction (in BCM)

District	Irrigation	Domestic	Industrial
Bokaro	0.0239	0.0438	0.0206
Chatra	0.0611	0.0193	0.0087
Deoghar	0.0486	0.0287	0.0000
Dhanbad	0.0260	0.0589	0.0988
Dumka	0.0375	0.0245	0.0002
East Singhbhum	0.0186	0.0499	0.0076
Garhwa	0.0753	0.0233	0.0006
Giridih	0.0902	0.0457	0.0096
Godda	0.0187	0.0242	0.0026
Gumla	0.0379	0.0180	0.0001
Hazaribagh	0.0785	0.0332	0.0047
Jamtara	0.0228	0.0148	0.0001
Khunti	0.0239	0.0099	0.0001
Koderma	0.0247	0.0139	0.0005
Latehar	0.0511	0.0135	0.0011
Lohardaga	0.0183	0.0087	0.0001
Pakur	0.0191	0.0153	0.0003
Palamau	0.0709	0.0366	0.0022
Ramgarh	0.0143	0.0200	0.0296
Ranchi	0.0958	0.0611	0.0169
Sahebganj	0.0221	0.0219	0.0005
Saraikela-Kharsawan	0.0110	0.0210	0.0053
Simdega	0.0203	0.0111	0.0000
West Singhbhum	0.0171	0.0286	0.0003

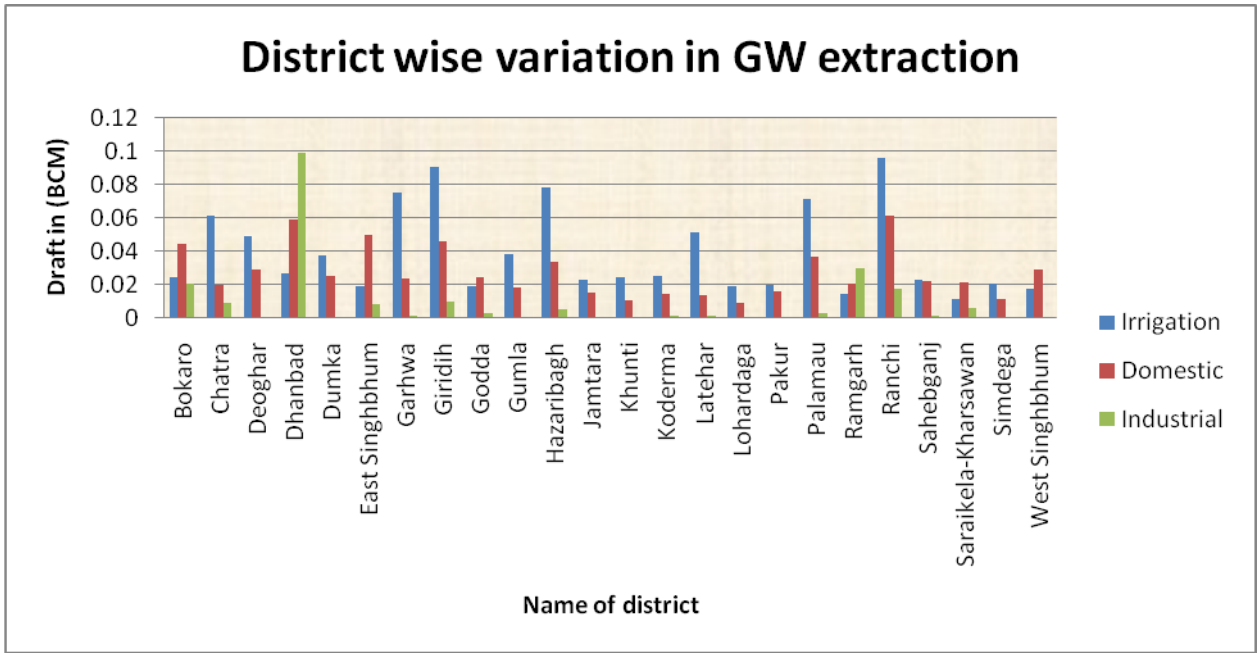

Fig. 5.2 District-wise variation in various components of GW extraction in Jharkhand

5.3.3 Variation in Ground water Development and Future Allocation

Stage of Ground Water Extraction for the state is **31.35%.** Maximum stage of ground water extraction has been observed in Dhanbad District (75.08 %) and lowest in West Singhbhum District (9.93 %).It is observed that stages of ground water extraction, even within broadly similar hydrogeological set up, are highly irregular. Very high stage of ground water extraction is mainly concentrated in areas of industrial and mining activity or high agricultural activity. The year-wise district level Stage of Ground Water Extraction of Jharkhand State has been tabulated in **Table 5.4** and presented in **Fig 5.3.**

Table 5.4 District-wise and Year-wise variation of SOD / SOGWE (in %) (2009 to 2022)

District			Stage of Development / Stage of Ground Water Extraction									
	2009		2011		2013		2017		2020		2022	
Bokaro	31.00	%	34.50	%	46.37	%	48.79	%	43.87	%	30.51	%
Chatra	35.00	%	35.60	%	31.82	%	30.20	%	35.04	%	34.15	%
Deoghar	33.00	%	34.90	%	21.43	%	42.25	%	52.13	%	51.62	%
Dhanbad	52.00	%	55.80	%	76.66	%	76.30	%	67.12	%	75.08	%
Dumka	27.00	%	27.89	%	31.96	%	24.26	%	22.14	%	26.35	%
East Singhbhum	21.00	%	22.70	%	19.67	%	19.90	%	23.38	%	28.49	%
Garhwa	35.00	%	36.15	%	12.13	%	25.44	%	33.17	%	34.74	%
Giridih	36.00	%	23.69	%	16.52	%	26.65	%	34.14	%	37.8	%
Godda	39.00	%	44.99	%	16.05	%	20.82	%	20.63	%	24.03	%

Gumla	26.00	%	27.85	%	12.85	%	11.91	%	15.42	%	17.68	%
Hazaribagh	39.00	%	42.04	%	12.80	%	35.17	%	37.37	%	39.34	%
Jamtara	27.00	%	28.46	%	29.75	%	30.98	%	41.04	%	45.3	%
Khunti	28.00	%	29.47	%	22.45	%	23.13	%	25.56	%	30.09	%
Koderma	33.00	%	35.70	%	27.73	%	38.35	%	56.72	%	66.1	%
Latehar	26.00	%	27.53	%	16.24	%	29.12	%	28.32	%	28.75	%
Lohardaga	40.00	%	41.01	%	10.00	%	13.74	%	14.79	%	15.77	%
Pakur	14.00	%	14.80	%	20.27	%	19.95	%	13.85	%	16.46	%
Palamau	32.00	%	34.44	%	23.37	%	28.68	%	31.47	%	32.58	%
Ramgarh	39.00	%	39.91	%	63.41	%	70.53	%	55.32	%	58.8	%
Ranchi	40.00	%	47.52	%	26.63	%	33.34	%	41.50	%	48.3	%
Sahebganj	22.00	%	29.13	%	13.79	%	16.79	%	15.22	%	17.21	%
Saraikela - Kharsawan	12.00	%	23.21	%	20.15	%	19.73	%	19.53	%	23.62	%
Simdega	27.00	%	17.11	%	9.81	%	9.12	%	12.36	%	14.31	%
West Singhbhum	9.00	%	11.88	%	10.14	%	14.12	%	8.81	%	9.93%	%

Stage of Ground Water Extraction/stage of Ground Water Development if compared over the years shows as follows:-

2004	**2009**	**2011**	**2013**	**2017**	**2020**	**2022**
20.67	30.00	32.30	22.56	27.73	29.13	31.35

The main reason for this is change in MI Census. Earlier estimations (2009& 2011) based on 3rd MI Census (2001-02) and its projected figures. However availability of 4th MI Census (2006-07) figures show a drastic decrease in number of agricultural wells which is very much reflected by decrease in irrigation draft of 1.32 BCM in 2011 to 0.63 BCM during 2013 estimation. In the estimation of 2017, 2020& 2022, 5th MI Census (2012-13) with subsequent projection has been used. Temporal variation of district level Stage of Ground Water Extraction is presented in **Fig-5.5**

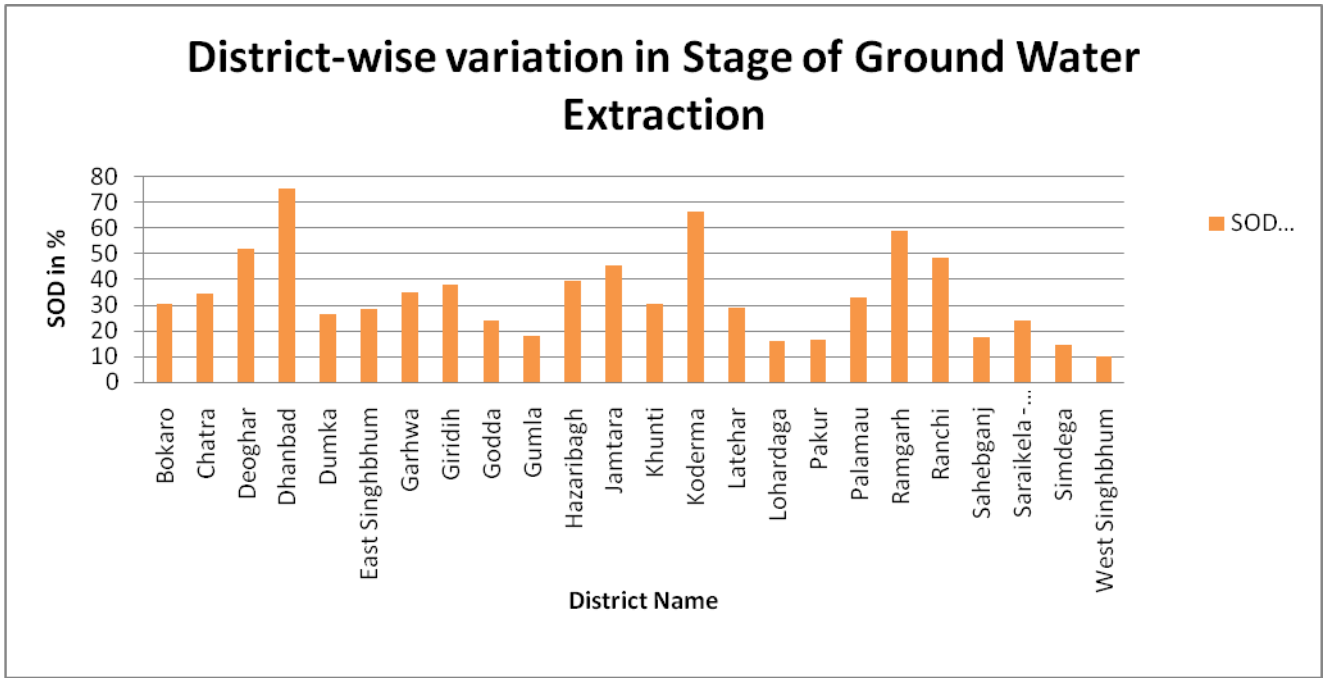

Fig. 5.3 District-wise variation of Stage of Ground Water Extraction

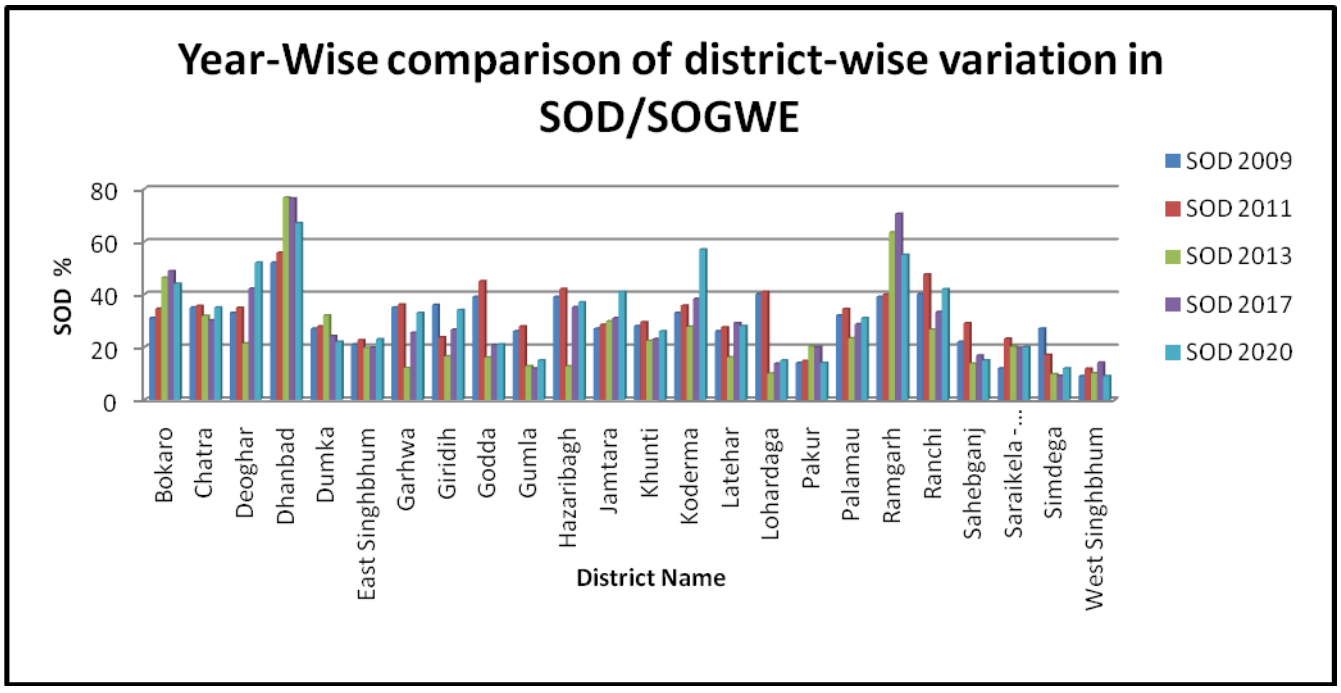

Fig. 5.4 Year-wise district-level variation of Stage of Ground Water Extraction

Variation in allocation for future ground water demand is mostly dependent on population growth and hence upon present population. Present day high population areas or urban centres influenced computation of annual allocation for future ground water demand for Domestic & Industrial water supply for 2025. However use of state average of growth rate for the entire area

somewhat controlled the scenario. District-wise variation in future groundwater availability for development is presented in **Fig. 5.5**.

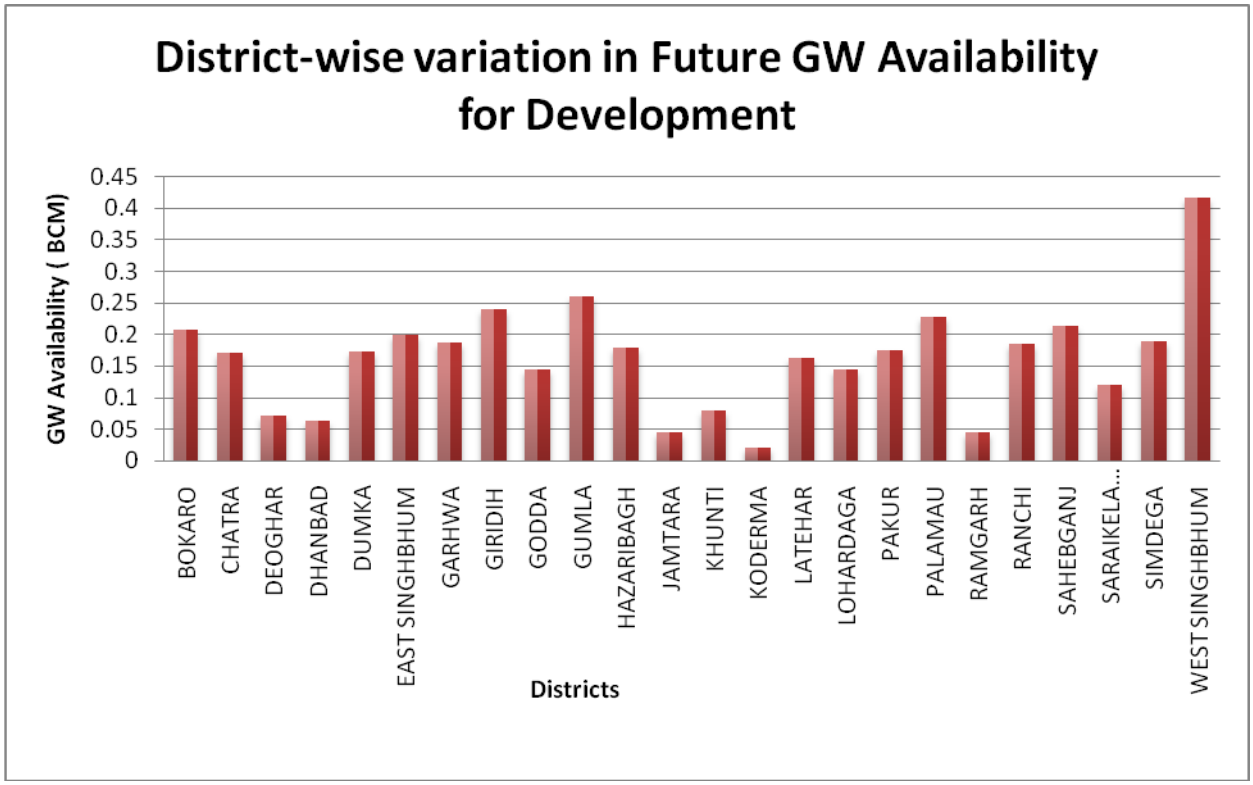

Fig. 5.5 District-wise variation in Future GW Availability for Development

5.3.4 Categorization of Blocks/Urban units

In present estimation, a total numbers of 259 administrative units and Four Urban centres are assessed. Based on stage of ground water development and long term pre- and post- monsoon water level trend, assessed administrative units are categorised as per categorisation scheme given in **Table 3.1**. Out of 263 assessment units, represented by 259CD Blocks and 4 urban centres, 05 units are categorized as *'Over Exploited'*, 06 units categorized as *'Critical'*, 11 units categorized as *'Semi Critical'* and rest 241 units are categorized as*'Safe'*.A district level summary of categorization is given in **Table 5.5**.

Table 5.5 Summary of Assessment Units and Sub-units and Categorization

Sl	Name of the district	No of Asessment Units	***Over-Explited***	***Critical***	**Semi Critical**	**Safe**	**Total No. of Quality Affected Blocks**
1	Bokaro	9	1	0	**0**	8	3
2	Chatra	12	0	0	0	12	0
3	Deoghar	10	0	0	3	7	3
4	Dhanbad	9	1	2	**2**	**4**	3
5	Dumka	10	0	0	0	10	0
6	East Singhbhum	12	2	0	0	10	2
7	Garhwa	19	0	0	1	18	13
8	Giridih	13	0	0	1	12	3
9	Godda	9	0	0	0	9	5
10	Gumla	12	0	0	0	12	6
11	Hazaribagh	16	0	0	1	15	0
12	Jamtara	6	0	0	0	6	1
13	Khunti	6	0	0	0	6	2
14	Koderma	6	0	1	1	4	5
15	Latehar	9	0	0	0	9	1
16	Lohardaga	7	0	0	0	7	0
17	Pakur	6	0	0	0	6	4
18	Palamau	21	0	0	0	21	12
19	Ramgarh	6	1	1	0	4	2
20	Ranchi	19	0	2	2	15	3
21	Sahebganj	9	0	0	0	9	5
22	Saraikela - Kharsawan	9	0	0	0	9	1
23	Simdega	10	0	0	0	10	0
24	West Singhbhum	18	0	0	0	18	1
	State Total	**263**	**5**	**6**	**11**	**241**	**75**

Present exercise resulted into changes in block-wise categorization reflecting temporal variation in ground water recharge/discharge/draft pattern. Earlier estimation (2020) categorized 15 blocks other than ‘Safe’ out of 259 assessed blocks. In contrast, present estimation categorized 22 units other than ‘Safe’ out of 263 assessment units. The status of categorization for blocks other than ‘Safe’ in the State as per present estimation is given in **Table 5.6**. Assessment unit

wise categorisation has been given in **Annexure III E**. The thematic map showing annual replenishable ground water resources and map showing categorisation of assessment units/blocks has been presented in **Plate-5.**

Based on categorization of the units, 241 units have been categorized as safe while other 22units fall into different categories. Five units namely Bermo (136.56 %) of Bokaro district, Baliapur (114.36%) of Dhanbad district, Chitarpur (103.47%) of Ramgarh District & Golmuri-cum-Jugasalai (142.03%) and Jamshedpur Urban (123.87 %) of East Singhbhum district fall into over-exploited category with stage of ground water extraction more than 100 %. Dhanbad Urban and Topchanchi block in Dhanbad district , Ramgarh block of Ramgarh District, Ranchi Urban and Silli block in Ranchi district, Jainagar block in Koderma districyt fall into critical category while other 11 blocks namely Karon, Sarwan & Sonaraithadi (Deoghar district), Dhanbad and Gobindpur (Dhanbad district), Bhawnathpur (Garhwa district), Giridih (Giridih district), Daru (Hazaribagh District), Khelari & Ormanjhi(Ranchi), Koderma (Koderma District) fall in semi-critical category.

High stage of development is due industrialisation and Mining activity in Bermo, Chitarpur, Ramgarh, Baliapur, Topchanchi, Khelari and due to urbanisation in Golmuri-cum Jugsalai, Jamshedpur urban, Ranchi Urban, Dhanbad urban and due to agricultural activities in Silli blocks of Jharkhand state.

Table 5.6 List of blocks categorised other than *'Safe'* in Jharkhand State based on Dynamic Groundwater Resource Assessment (2022)

Sl.	District		Assessment Unit	SOD %	Category
1	Bokaro	**1**	Bermo	136.56	Over Exploited
2	Dhanbad	**1**	Baliapur	114.36	Over Exploited
		2	Dhanbad Urban	94.52	Critical
		3	Topchanchi	91.93	Critical
		4	Dhanbad	86.72	Semi-Critical
		5	Gobindpur	80.32	Semi-Critical
3	Deoghar	**1**	Sarwan	77.53	Semi-Critical
		2	Sonaraitharhi	75.58	Semi-Critical
		3	Karon	71.89	Semi-Critical
4	East Singbhum	**1**	Golmuri-cum Jugsalai (Jamshedpur)	142.03	Over Exploited
		2	Jamshedpur Urban	123.87	Over Exploited
5	Garhwa	**1**	Bhawnathpur	76.01	Semi-Critical
6	Giridih	**1**	Giridh	79.25	Semi-Critical
7	Hazaribagh	**1**	Daru	74.67	Semi-Critical

8.	Koderma	**1**	Jainagar	91.08	Critical
		2	Koderma	80.09	Semi-Critical
9	Ramgarh	**1**	Chitarpur	103.47	Over Exploited
		2	Ramgarh	94.29	Critical
10	Ranchi	**1**	Silli	97.01	Critical
		2	Ranchi Urban	94.90	Critical
		3	Khelari	86.52	Semi-Critical
		4	Ormanjhi	84.04	Semi-Critical

5.4 COMPARISON WITH EARLIER DYNAMIC GROUND WATER RESOURCES ESTIMATES

It has been observed that significant change in Total Annual Ground Water Recharge of the State has occurred, which increases from 6.15 bcm (2020)to 6.20bcm(2022) i.eas compared to the earlier estimation in the year 2020. Annual Extractable Ground Water resource after deducting natural discharge component also increased from 5.64bcm to 5.69bcm. Ground Water Extraction for Irrigation has increased from 0.92bcmto 0.93bcm. On the other hand, Ground Water Extraction for Domestic and Industry has changed from 0.71bcm to 0.86bcm. The marginal increase in recharge and increase in groundwater extraction resulted in change of average Stage of Ground Water Extraction of the State from 29.13 % to 31.35%.However, present estimation resulted into changes in assessment unit categorization reflecting temporal variation in ground water recharge/discharge/draft pattern. Earlier estimation (2020) categorized 15 blocks other than 'Safe' out of 259 assessed blocks. In contrast, present estimation categorized 22 assessment units other than 'Safe' out of 263 assessed units. Comparison of Salient features of Ground Water Resources of Jharkhand for the years 2004, 2009, 2011, 2013, 2017, 2020& 2022 are presented in **Table 5.7**.

Table 5.7 Comparison of Salient features of Ground Water Resources of Jharkhand for the years 2004, 2009, 2011, 2013, 2017, 2020& 2022

Descriptions	2004	2009	2011	2013	2017	2020	2022	Change w.r.t 2020
Total Annual Ground Water Recharge	5.58	5.96	6.31	6.56	6.21	6.15	6.20	-0.05
Provision for Natural Discharges	0.33	0.55	0.55	0.57	0.52	0.5	0.51	-0.01
Net Annual Ground Water Availability(Annual Extractable Ground Water Resources)	5.25	5.41	5.76	5.99	5.69	5.64	5.69	-0.05
Gross Ground Water Draft for irrigation	0.71	1.17	1.32	0.63	0.80	0.92	0.93	-0.01

Descriptions	2004	2009	2011	2013	2017	2020	2022	Change w.r.t 2020
Gross Ground Water Draft for domestic	0.38	0.44	0.52	0.50	0.56	0.51	0.65	-0.14
Gross Ground Water Draft for All uses	1.09	1.61	1.86	1.35	1.58	0.20	1.78	-1.58
Net Annual Ground Water Availability for 'All Future Uses'	4.16	3.80	3.90	4.64	4.13	1.64	3.92	-2.28
Stage of Ground Water Development (%)	21 %	30 %	32.3 %	22.42 %	27.73 %	**29.13%**	**31.35%**	-2.22%

(Resource figures are in BCM)

The reasons for the above mentioned changes are summarized below:

1. Change in groundwater recharge is a balance of increase in storage space i.e. higher fluctuation of water level and rainfall received. For a low permeability aquifer system, as mostly gneissic rocks underlie the area, groundwater scenario is dominated by pre-monsoon falling trend and post-monsoon flat/minor falling trend depending upon the rainfall scenario. Hence, resource position of the state is mostly controlled by monsoon rainfall.
2. Groundwater recharge also been better estimated in the present exercise by assignment of refined storage parameters of the aquifer and rainfall infiltration factor to individual assessment units/sub-units, as the aquifer parameters has been assigned through GIS technique and further modified suitably based on land-use pattern. However, parameter values of aquifer units are same in GWRE-2020 and 2022.
3. Present estimation used 5th MI Census as base. 5th MI Census was carried out in 2012-13, hence, its' consequent projection up to 2022 have been utilized.
4. In this exercise, final population figures from Census 2011 have been used as base. Census 2011 population figures have further projected to 2022 as per decadal growth rate;
5. In present exercise draft figure and recharge structure, proposed by industries where NOC has been issued by CGWA, has been considered. In absence of complete data regarding industry in Jharkhand, some escalation figure has been assumed which has been added in industrial draft.
6. Categorisation of individual assessment unit is dependent on one or more of the causes mentioned above. Results indicate that for units categorised other than *'Safe* High stage of

development is due industrialisation and Mining activity in Bermo, Chitarpur, Ramgarh, Baliapur, Topchanchi, Khelari and due to urbanisation in Golmuri-cum Jugsalai, Jamshedpur urban, Ranchi Urban, Dhanbad urban and due to agricultural activities in Silli blocks of Jharkhand state.

5.5 DYNAMIC GROUND WATER AVAILABILITY OF THE STATE

The Dynamic Ground Water Resources of Jharkhand state as on 2022 has been estimated as 5.69 BCM. The district wise Dynamic resource of Jharkhand is given in **Table 5.8.**The same has been represented in **Fig. 5.6**.

Table 5.8 District-wise Dynamic Groundwater Resource of Jharkhand

Sl. No.	District	Dynamic Resource (bcm)
1	Bokaro	0.2896
2	Chatra	0.2610
3	Deoghar	0.1498
4	Dhanbad	0.2447
5	Dumka	0.2363
6	East Singhbhum	0.2672
7	Garhwa	0.2855
8	Giridih	0.3848
9	Godda	0.1893
10	Gumla	0.3169
11	Hazaribagh	0.2960
12	Jamtara	0.0833
13	Khunti	0.1127
14	Koderma	0.0591
15	Latehar	0.2284
16	Lohardaga	0.1722
17	Pakur	0.2105
18	Palamau	0.3368
19	Ramgarh	0.1085
20	Ranchi	0.3599
21	Sahebganj	0.2584
22	Saraikela - Kharsawan	0.1577
23	Simdega	0.2200
24	West Singhbhum	0.4635
State Total		**5.6923**

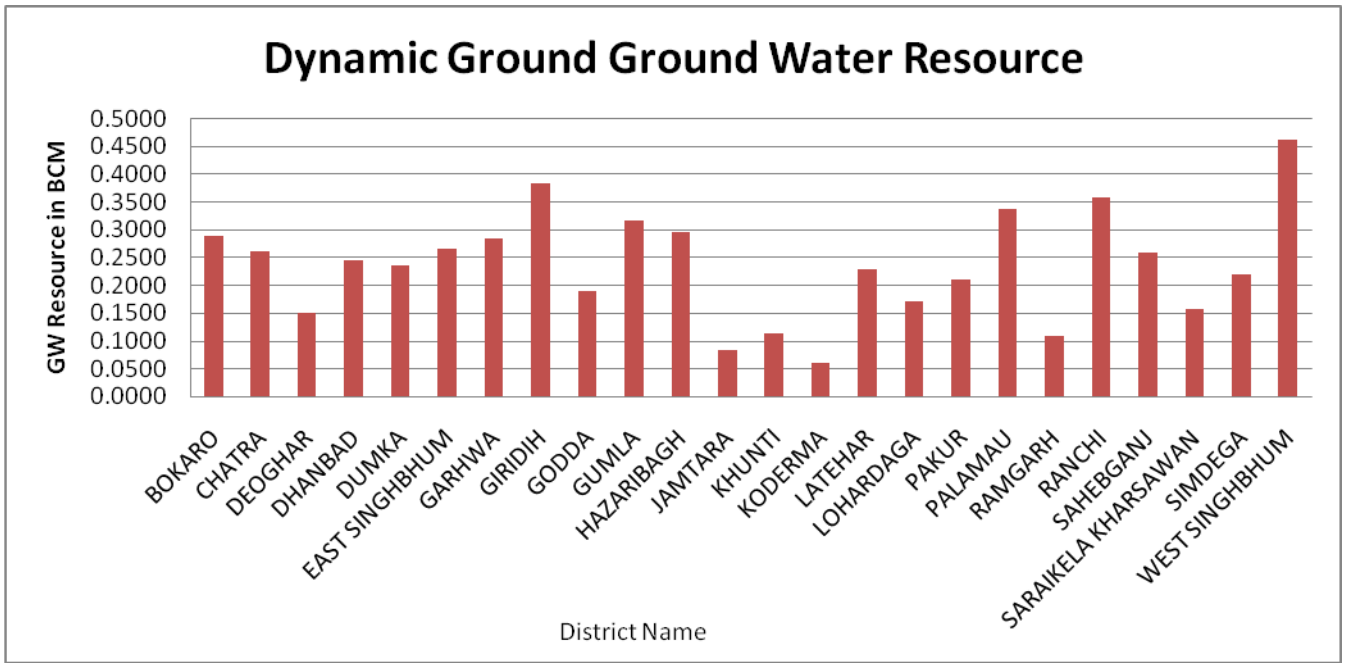

Fig- 5.6. Dynamic Ground Water Resources of Jharkhand

5.6 ASSUMPTIONS AND LIMITATIONS

1. In this exercise, final population figures from Census 2011 have been used as base. Census 2011 population figures have further projected to 2022 as per decadal growth rate;
2. In the present estimation, 5th MI Census, 2012-13, was used as base, hence, its' consequent projection up to 2022 have been utilized.
3. The Hydrological parameters have used as per GEC, methodology 2015
4. In absence of complete data regarding industries/Mines in Jharkhand 25% escalation figure has been assumed which has been added in industrial draft.
5. In the present exercise 2022, only Dynamic Ground Water Resources of Jharkhand has been assessed.

Chapter-6

SUM UP

- The re-estimation of ground water resources of Jharkhand as on March-2022 has been jointly made by Central Ground water Board, State Unit office, Ranchi/Mid-Eastern Region, Patna with State Ground Water Directorate, Water Resources Dept. Govt. of Jharkhand
- In present estimation a total numbers of 263 assessment units (259 blocks and 4 urban centres- Ranchi urban, Dhanbad urban, Medininagar urban and Jamshedpur urban) have been assessed.
- The estimation is based on Ground Water Estimation methodologies as per GEC-2015.The most of the blocks has been assessed using RIF(Rainfall Infiltration Factor) method in comparison to WLF(Water Level Fluctuation) method
- Total Replenishable Ground Water Resource as on March 2022 has been assessed as ***6.20 BCM***. Considering natural discharge of ***0.51 BCM***, Annual extractable Ground Water Resources for the state of Jharkhand has been assessed as **5.69** ***BCM***.

- Current Annual Ground Water draft in the state of the Jharkhand has been assessed as ***1.78 BCM*** with Irrigation draft of ***0.93 BCM***, industrial draft of **0.21 BCM** and ***0.65 BCM*** is drawn to meet up the drinking water demand. The average Stage of Ground Water Extraction as on March 2020 is **31.35 %**.

- The net ground water availability for future use is 3.92 ***BCM***. Annual GW Allocation for Domestic Use as on 2025 is **0.65 BCM**. Monsoon has got an overwhelming control over recharge of Jharkhand state.

- Based on categorization of the assessment units, 241 units have been categorized as safe while other 22 units fall into different categories. Five units namely Bermo (136.56 %) of Bokaro district, Baliapur (114.36%) of Dhanbad district, Chitarpur (103.47%) of Ramgarh District & Golmuri-cum-Jugasalai (142.03%) and Jamshedpur Urban (123.87 %) of East Singhbhum district fall into over-exploited category with stage of ground water extraction more than 100 %. Dhanbad Urban and Topchanchi block in Dhanbad district , Ramgarh block of Ramgarh District, Ranchi Urban and Silli block in Ranchi district, Jainagar block in Koderma dsitrict fall into critical category while other 11 blocks namely Karon, Sarwan & Sonaraithadi (Deoghar district), Dhanbad and Gobindpur (Dhanbad district), Bhawnathpur (Garhwa district), Giridih (Giridih district),

Daru (Hazaribagh District), Khelari & Ormanjhi (Ranchi), Koderma (Koderma District) fall in semi-critical category.

- Present exercise resulted into changes in block-wise categorization reflecting temporal variation in ground water recharge/discharge/draft pattern. Results indicate that High stage of development is due industrialisation and Mining activity in Bermo, Chitarpur, Ramgarh, Baliapur, Topchanchi, Khelari and due to urbanisation in Golmuri-cum Jugsalai, Jamshedpur urban, Ranchi Urban, Dhanbad urban and due to agricultural activities in Silli blocks of Jharkhand state.

- The quality tagging of Fluoride and Arsenic affected blocks has also been done along with resources assessment of the blocks of the Jharkhand state.

T-13014/1/2019-GW Section

1153/11

2464688/2022/GW Section

(TO BE PUBLISHED IN THE GAZETTE OF INDIA PART-I, SECTION -I)

No. T-13014/1/2019-GW Section
Government of India
Ministry of JAL SHAKTI
Department of Water Resources, River Development & Ganga Rejuvenation
****

Shram Shakti Bhavan, Rafi Marg,
New Delhi, Dated: 08.02.2022

RESOLUTION

Sub: Constitution of Central Level Expert Group (CLEG) for periodic re-assessment of ground water resources of the country.

The State-wise annual assessment of Dynamic Ground Water Resources for the entire country are made based on the methodology and norms recommended by Ground Water Resources Estimation Committee (GEC) 1997 and 2015. There are changes in ground water scenario in various parts of the country because of various interventions by Government/public. Groundwater being a dynamic resource, its periodic assessment in the country can help the policy makers/planners to take suitable timely intervention for sustainable management of this precious resource. Accordingly, a Central Level Expert Group (CLEG) is hereby constituted for over-all supervision of the assessment of ground water resources in the entire country for each Water Year. The composition and Terms of Reference of the Expert Group are as follows:-

1. **Composition:**

S.No	Designation and Name of Department	Committee
1.	Chairman, CGWB	**Chairman**
2.	Member(RM), CWC	**Member**
3.	Member (CGWA), CGWB	**Member**
4.	Director, NIH, Roorkee or representative	**Member**
5.	Joint Secretary, Ministry of Agriculture & Farmer Welfare or his nominee.	**Member**
6.	Joint Secretary, Department of Drinking Water Supply & Sanitation, Ministry of Jal Shaktior his nominee.	**Member**
7.	Joint Secretary, Ministry of Housing and Urban Affairs or his nominee.	**Member**
8.	Representative of Department of Civil Engg., Indian Institute of Technology-Hyderabad	**Member**
9.	Member(South), CGWB	**Member Secretary**

The assessment of 'Dynamic Ground Water Resources' is carried out jointly by Central Ground Water Board and State Nodal/Ground Water Departments under the guidance of State Level Committee (SLC) of each State/UT and overall supervision of Central Level Expert Group (CLEG). Further, the states shall submit the information with the CLEG as per their requirement for compilation of National Ground Water Resource Assessment.

2. Terms of Reference: –

i. To ensure the assessment of annual ground water recharge of the States in coordination with the respective SLC. The Committee will work on ground water assessments for water year (June to May) in accordance with the approved latest methodology and will adopt improved procedures and practices wherever possible for the sake of achieving greater accuracy of assessment.

ii. To supervise the estimation of status of utilization of the annual extractable ground water resource as in specified water year to be carried by the respective SLC.

iii. To supervise compilation of a National level report on assessment of ground water resources and status of its utilization as in the specific reference year.

iv. Any other aspect relevant to the terms referred in TOR above.

3. Time frame:-

The Committee will submit its report as per the timelines prescribed by the Ministry from time to time.

4. **Expenditure**

Expenditure on account of TA/DA to official Members of the Expert Group will be met from the source from which they draw their salaries and that of non-official Members (if any), will be borne by the Central Ground Water Board as per Govt. norms.

These issues with the approval of competent authority.

(Ashish Kumar)
Director (GW)

आशीष कुमार/ASHISH KUMAR
निदेशक/Director
जल संसाधन, नदी विकास एवं गंगा संरक्षण मन्त्रालय
Ministry of Water Resources, River Development & Ganga Rejuvenation
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi-110001

ORDER

Ordered that the Resolution be published in the Gazette of India for general information.

T-13014/1/2019-GW Section

2464658/2022/GW Section

Ordered that a copy of the Resolution published be communicated to this Ministry for record.

(Ashish Kumar)
Director (GW)

आशीष कुमार/ASHISH KUMAR
निदेशक/Director
जल संसाधन, नदी विकास एवं गंगा संरक्षण मन्त्रालय
Ministry of Water Resources, River Development & Ganga Rejuvenation
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi-110001

To
The Manager,
Government of India Press,
Faridabad (Haryana).

Copy to:

1. PS to Minister (JAL SHAKTI)
2. PS to MoS (JAL SHAKTI)
3. PS to MoS (JAL SHAKTI)
4. Sr PPS to Secretary (DoWR, RD & GR)
5. PPS to Joint Secretary (IC & GW)
6. All members concerned.
7. Chairman, CGWB, Faridabad.
8. Member (S), CGWB and Member Secretary of the CLEG, CGWB, CHQ, Faridabad for information and necessary action.

Copy also to:
NIC for uploading the Resolution on Ministry's website.

Annexure-IB

Government of Jharkhand.
Water resources Department.

Lt. No:- 3/PMC/Misc-168(Part-1)/2009..... /Ranchi/Dt-.....

Order

Subject- Constitution of State Level Committee (SLC) for Estimation of Ground water Resources of Jharkhand as on 31st March 2022

The last assessment of the State wise annual ground water recharge for the entire country was made as on 31st March 2020, based on methodology adopted by Ground water Estimation Committee-2015 with improvement incorporated in Methodology. Since then there have been changes in ground water scenario because of various interventions carried out by different government agencies and because of variations in rainfall pattern due to various factors. A central Level expert Group (CLEG) has been constituted on 8.2.2022 for periodic re-assessment of groundwater resources of the country.

With a view to re-estimate ground water resources of Jharkhand as on 31st March 2022, a state level committee is constituted with the following composition.

1. Composition

1	Secretary, Water Resource Department., Govt. of Jharkhand, Ranchi	**Chairman**
2	Engineer-in-Chief II, Water Resources Department, Govt. of Jharkhand, Ranchi	Member
3	Chief Engineer, Minor Irrigation Ranchi, Water Resource Department Govt. of Jharkhand, Ranchi	Member
4	Director, Agriculture Department. Govt. of Jharkhand, Ranchi	Member
5	Director, PMU, Drinking Water and Sanitation Department, Govt. of Jharkhand, Ranchi	Member
6	Director, Industry Department. Govt. of Jharkhand, Ranchi	Member
7	General Manager, NABARD, Ranchi	Member
8	Director, Ground Water Directorate, Water Resources Department, Govt. of Jharkhand	Member
9	Representative of Urban Development Department, Govt. of Jharkhand	Member
10	Director, Jharkhand Space Application Centre, Ranchi or representative	Member
11	Director, Directorate of Geology. Govt. of Jharkhand, Ranchi	Member
12	Director, Indian Meteorological Department,	Member

	Govt. of India, Ranchi	
13	Director, Panchayati Raj Department, Govt. of India, Ranchi	Member
14	Representative of VC, Birsa Agriculture University, Ranchi	Member
15	Regional Director, CGWB, Mid-Eastern Region, Patna	Member Secretary

The committee may Co-opt any other Member(S) /Special Invitee(S) , if necessary

2. Terms of Reference: The broad terms of reference of the committee would be as follows:-

i) Re-assessment of annual ground water recharge of the state in accordance with the Ground Water Resources Estimation Methodology-2015(GEC-2015)with improvement incorporated in Methodology .

ii) To estimate the status of utilization of the annual extractable ground water resource.

3. Time Frame: The committee will submit its report on or before 28.2.2023

4. Expenditure: The expenditure on account of TA/DA to official members of the committee will be met from the source from which they draw their salaries

The order will be implemented from the date of issue

Sd-
Joint Secretary (Eng.)
Water Resources Department.
Jharkhand.

Lt. No.- 3/PMC/Misc-168 (Part-I)/2009...208 **/Ranchi/Dt.-** 15/03/2022

Copy to: All members of the State Level Committee.

15.03.22

Joint Secretary (Eng.)
Water Resources Department.
Jharkhand.

Minutes of the meeting of State Level Committee on Re-Assessment of Ground Water Resources for Jharkhand as on March 2022 held under the chairmanship of Secretary, Water Resources Department–cum–Chairman, State Level committee, Jharkhand in the conference Hall, Nepal House Secretariat, Ranchi on 06.04.2022 at 12.00 PM.

The list of the members and participants present in the meeting annexed as Annexure-I.

All the participants in the meeting were welcomed by Er. R. S. Tigga, Engineer–in–Chief II, Water Resources Department. The meeting of State Level Committee on Re-Assessment of Ground Water Resources for Jharkhand as on March 2022 commenced thereafter. The meeting began with the introduction of the participants, Shri Prashant Kumar, Secretary, Water Resources Department, Government of Jharkhand emphasized on the importance and necessity of assessment of ground water resources of the state. A presentation on Assessment of Dynamic Ground Water Resources Jharkhand-2020, data requirement and timelines for the assessment as on March 2022 was made by Dr. Sudhanshu Shekhar, Scientist–D, CGWB, SUO, Ranchi before the committee members. The methodology of assessment of Dynamic Ground Water Resources was also deliberated in the presentation.

Questions were raised by Secretary Water Resource Department and Chairman of the Committee/Engineer–in–Chief II, Water Resources Department/Shri Abhishek Anand Director, IMD, Ranchi/Shri M. Kumar, Deputy Director, Mines & Geology Department, Jharkhand and other members regarding assessment of Ground Water Resources as on March 2022 which was satisfactorily answered by Dr. Sudhanshu Shekhar, Scientist-D, CGWB, SUO, Ranchi. Various points of report on Assessment of Dynamic Ground Water Resources as on March 2022 was discussed with the Secretary, Water Resources Department–cum–Chairman, State Level committee, Jharkhand, Committee members and participants present. Final Report on Dynamic Ground Water Resources of Jharkhand as on March 2020, which was jointly prepared

Ann 1

by CGWB, SUO, Ranchi and Ground Water Directorate, Water Resources Department, Jharkhand was then released by the Secretary, Water Resources Department, Government of Jharkhand–cum–Chairman, State Level committee, Jharkhand.

The main points/suggestions of the meeting are as follows:-

1. Chairman suggested that in addition to Dynamic Ground Water Resources, the Assessment of Unconfined aquifer and Assessment for Static Ground Water Resources of confined aquifer should also be done.
2. It was also suggested that assumptions and limitations should be mentioned clearly in the final report of Dynamic Ground Water Resources.
3. The data required may be acquired from Water Resources Department, Department of Industries, Agriculture, JSAC, Statistics, IMD, Jharkhand etc. It was resolved that all the concerned Department will provide all the available data required for Ground Water Resource Assessment of Jharkhand as on March 2022.

   Data of 6th Minor Irrigation Census will be provided by Water Resource Department, Government of Jharkhand after its publication by Government of India.
4. During the discussion the Chairman of the committee suggested that under National Hydrology Project, every block of Jharkhand should be covered with Piezometer/DWLR for measurement of the shallow/deep water levels.
5. Shri Manoj Kumar, Dy. Director, Mines and Geology, Department suggested to check/verify the data of water level below 2.0 m from ground level in the Singhbhum Shear zone during pre-monsoon 2019.
6. It was informed that Silli block of Ranchi district falls in the semi-critical category in GWRA-2020. Chairman of the Committee suggested, that the data of Silli block may be verified/validated from Water Resource Department, Minor Irrigation Wing.

7. Special study for Ground Water Resource Assessment of 2022 for rain shadow areas including Palamu and Garhwa districts should be considered.
8. Chairman Suggested that Chief Engineer, CDO, Water Resources Department should be included in this committee.

The meeting ended with vote of thanks.

(Prashant Kumar)
Secretary,
Water Resources Department,
Government of Jharkhand.
–Cum–
Chairman,
State Level committee,
Jharkhand.

Minutes of the second and final State Level Committee meeting for approval of assessment of Ground Water Resources for Jharkhand State as on March-2022 held on 30.08.2022 at 12.30 PM.

The list of the members and participants present in the meeting is annexed as Annexure-I.

The second and final meeting of State Level Committee was held in the conference Hall, Nepal House Secretariat, Ranchi on 30.08.2022 under the Chairmanship of Shri. Prashant Kumar, IAS, Secretary, Water Resources Department, Govt. of Jharkhand-cum-Chairman of the State Level Committee to finalise the assessment of replenishable Ground Water Resources of the Jharkhand State (as on March 2022) jointly prepared by CGWB, SUO, Ranchi and Ground Water Directorate, WRD, Jharkhand.

The meeting began with the welcome of Chairman and the members of the committee by Shri T.B.N.Singh, Regional Director, CGWB, MER, Patna-cum-Member Secretary of the committee. After the introduction of the members of the committee, Shri TBN Singh, briefed about the ground water estimation methodologies and subsequent improvement incorporated in each methodologies with time and GEC-2015 in particular. It was stated that the estimation of Ground water resources assessment of Jharkhand for 2022 has been jointly carried out by CGWB, SUO, Ranchi and Ground Water Directorate, WRD, Jharkhand. The estimation has been done through IN-GRESS software developed by IIT Hyderabad and VASAR labs.

A presentation on the salient aspects of the present assessment of Replenishable/Dynamic ground water Resources Assessment of Jharkhand -2022 was made by Dr.Sudhanshu Shekhar, Scientist-D CGWB, SUO, Ranchi. Different recharge and draft components for resource calculation was deliberated along with the methodology. Shri. R. R. Shukla Scientist E and OIC, SUO, CGWB, Ranchi also explained about the occurrence of ground water in hard rock terrain like Jharkhand. The committee members were asked to give their opinions and suggestions. Various points raised by Committee members on ground water resources assessment are as follows.

- Present assessments have been carried out for total 263 assessment units (259 Community Development blocks and 4 urban areas).
- Total Annual Ground Water Recharge as on March 2022 has been assessed as 6.20 BCM, considering natural discharge of 0.51 BCM, Annual extractable Ground Water Resources 5.69 BCM, Gross Ground Water draft for all uses 1.78 BCM (Irrigation draft 0.93 BCM, domestic draft 0.65 BCM, Industrial draft 0.21). The average Stage of Ground Water Extraction for the State of Jharkhand is assessed as 31.35 %. The net ground water availability for future use is 3.92 BCM. Annual GW Allocation for Domestic Use as on 2025 is 0.65 BCM.
- As per Ground Water Resource Assessment-2022, out of 263 assessment units assessed, 241 units under safe category, 11 units under semi-critical, 06 units under critical (Dhanbad urban & Topchachi, Dhanbad district, Ramgarh, Ramgarh district, Silli & Ranchi urban, Ranchi district, Jainagar, Koderma district) and 05 units comes under over exploited (Bermo, Bokaro district, Baliapur, Dhanbad district, Chitarpur, Ramgarh district, Golmuri cum Jugsalai & Jamshedpur urban, E Singhbhum district).
- Limitations in resource assessment due to inadequacy of data, norms and assumption were also discussed. It was decided by the members of the committee that the entire concerned department would provide all the available data timely for next Ground Water resource assessment which is to be assessed annually.
- Shri. Manoj Kumar, Dy. Director, Mines & Geology suggested that State Pollution Control Board should also be in the State Level Committee for next assessment of Replenishable Ground Water Resources.
- Shri. Ashok Kumar, Chief Engineer, Water Resource Department Government of Jharkhand and Shri. Abhishek Anand, Director, India Meteorological department Ranchi,

Annex-I D

Government of India suggested that limitations in Ground Water resource assessment should also be incorporated in the report. The suggestion was agreed upon for the same.

- Shri. Arun Kumar Rai, Nodal Officer Minor Irrigation, Water Resources Department suggested that density of the water level monitoring stations must be enhanced in water scares district of Palamu and Garhwa for future assessment of replenishable ground water resources.
- Member from WRD suggested for obtaining some basic data from JSAC, Ranchi.
- Committee members suggested that in addition to replenishable/dynamic Ground Water Resource Assessment of unconfined aquifer, assessment for static ground water resources of semi-confined and confined aquifer should also be done in future.
- The committee members agreed upon quality tagging of ground water contaminated blocks (Fluoride, Arsenic and Nitrate affected) along with resources assessment of the blocks of the Jharkhand state.
- The members agreed upon the resource assessment exercise carried out jointly by Groundwater Directorate, Govt. of Jharkhand and Central Ground Water Board, SUO, Ranchi. However, member suggested that more number of monitoring station for ground water level should be used in future resource estimation.
- The Chairman, State Level Committee, finally approved the assessment of Replenishable Groundwater Resources of the Jharkhand State (as on March 2022) jointly prepared by CGWB, SUO, Ranchi and Ground water Directorate, WRD, Jharkhand.
- The meeting ended with vote of thanks to the Chair and to the Committee Members.

18/10/22

Prashant Kumar
Secretary, Water Resources Department,
Govt. of Jharkhand.

Annexure-I

The list of the members and participants present in the second and final State Level Committee Meeting for approval of Assessment of Ground Water Resources for Jharkhand State as on March-2022 held on 30.08.2022 at 12.30 PM.

1. Shri. R.S. Tigga , Engineer in Chief,Water Resources Department , Govt. of Jharkhand
2. Shri. Abhishek Anand ,.Director, Meteorological Centre ,Ranchi,IMD, Govt. of India
3. Shri. Ashok Kumar, Chief Engineer, Water Resources Department , Govt. of Jharkhand
4. Shri. John Anil Malto , Director,Ground Water Directorate , Water Resources Department , Govt. of Jharkhand
5. Shri. Surendra Kumar ,Minor ,Ranchi, Water Resources Department , Govt. of Jharkhand
6. Shri. Arun kumar Rai ,Nodal Officer, MI, Water Resources Department , Govt. of Jharkhand
7. Shri. Manoj Kumar,Dy.Director,Department of Geology and Mining, Govt. of Jharkhand
8. Shri. Jay Nigam,Dy.GeneralManager,NABARD, Govt. of India
9. Shri. Gautam Sinha,Ex.Engineer,RMC, Govt. of Jharkhand
10. Shri. Ashim Ranjan Ekka, Dy.Director(E)), Directorate of Agriculture, Govt. of Jharkhand
11. Smt. S.P. Kujur,Joint Secretary,Panchayati Raj, Govt. of Jharkhand
12. Shri. G.S.Lakra, Ex.Engineer, Water Resources Department , Govt. of Jharkhand
13. Shri. Awadh Pandey, JE, Water Resources Department , Govt. of Jharkhand
14. Shri. Ajay Kumar Pandey, AE, Water Resources Department , Govt. of Jharkhand
15. Shri. A.S.Surin, A.E,planning &Design, Water Resources Department , Govt. of Jharkhand
16. Shri. G.S.Sahapati, Junior Scientist, JSAC, Govt. of Jharkhand
17. Shri. T.B.Singh , Regional Director, CGWB, MER, Patna
18. Shri. R. R. Shukla, Sc E&OIC, State Unit Office,CGWB, Ranchi
19. Dr. S.Shekhar, Sc D, State Unit Office,CGWB, Ranchi
20. Smt. Sulekha Bhaya, Sc B, State Unit Office,CGWB, Ranchi
21. Dr. Anukaran Kujur, Sc B, State Unit Office,CGWB, Ranchi
22. Shri. Atul Beck, Astt. Hydrogeologist, State Unit Office,CGWB, Ranchi
23. Shri. Md.Shadman, Astt. Hydrogeologist, State Unit Office,CGWB, Ranchi

Annexure II (A)

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF JHARKHAND, DISTRICT - WISE (2022) (in ham)

S.NO	District	Monsoon Season		Non-Monsoon Season		Total Annual Ground Water Recharge	Total Natural Discharges	Annual Extractable Ground Water Resource
		Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources			
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)
1	BOKARO	26492.83	1458.23	2491.48	1064.96	31507.5	2552.12	28955.38
2	CHATRA	23924.07	2121.11	615.62	1932.44	28593.24	2492.33	26100.91
3	DEOGHAR	11905.05	1352.72	1453.81	1354.58	16066.16	1083.07	14983.09
4	DHANBAD	18474.67	3133.05	1675.71	3116.58	26400.01	1934.22	24465.8
5	DUMKA	18072.79	2852.28	3381.78	1619.3	25926.15	2295.38	23630.77
6	EAST SINGHBHUM	23683.53	1469.56	2836.78	1350.14	29340.01	2624.34	26715.67
7	GARHWA	25245.76	2399.02	1051.99	2343.56	31040.33	2485.74	28554.59
8	GIRIDIH	33815.68	3009.81	2291.7	2546.32	41663.51	3179.96	38483.55
9	GODDA	16061.81	1757.05	1899.42	1032.54	20750.82	1817.95	18932.86
10	GUMLA	29607.86	707.35	3257.62	998.65	34571.48	2878.74	31692.74
11	HAZARIBAGH	25540.27	2124.46	2488.63	2478.76	32632.12	3029.74	29602.38
12	JAMTARA	5908.03	1368.34	827.22	947.7	9051.29	723.21	8328.08
13	KHUNTI	9644.48	658.81	1201.58	738.68	12243.55	975.87	11267.68
14	KODERMA	4911.11	374.86	444.05	623.1	6353.12	438.78	5914.34
15	LATEHAR	18657.39	2498.15	1522.63	1915.24	24593.41	1758.1	22835.31
16	LOHARDAGA	16179.86	505.26	1478.73	590.3	18754.15	1536.5	17217.65
17	PAKUR	17618.97	1425.7	2956.84	908.5	22910.01	1859.12	21050.89
18	PALAMAU	26639.99	6359.2	1100.21	2515.88	36615.28	2931.45	33683.83
19	RAMGARH	8451.39	1055.57	836.24	1121.48	11464.68	610.68	10854
20	RANCHI	29606.56	2608.08	3327.75	3302.63	38845.02	2852.86	35992.16
21	SAHEBGANJ	21717.52	2920.8	2398.89	1390.49	28427.7	2586.5	25841.2
22	SARAIKELA KHARSAWAN	14533.06	791.54	1675.59	525.2	17525.39	1752.55	15772.83
23	SIMDEGA	21826.05	569.18	837.59	626.96	23859.78	1856.46	22003.32
24	WEST SINGHBHUM	42995.44	1443.17	5742.08	914.79	51095.48	4742.87	46352.61
Total(Ham)		**491514.17**	**44963.3**	**47793.94**	**35958.78**	**620230.19**	**50998.54**	**569231.64**
Total (Mcm)		**4915.14**	**449.63**	**477.94**	**359.59**	**6202.30**	**509.99**	**5692.32**
Total(Bcm)		**4.92**	**0.45**	**0.48**	**0.36**	**6.2**	**0.51**	**5.69**

Annexure II (B)

ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF JHARKHAND, DISTRICT - WISE (2022) (in ham)

S.NO	State/Union Territories	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for Domestic use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
			Irrigation	Industrial	Domestic	Total			
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	**BOKARO**	28955.38	2393	2057.92	4383.14	8834.06	4406.13	20653.26	30.51
2	**CHATRA**	26100.91	6112	869.94	1930.34	8912.29	1940.46	17178.49	34.15
3	**DEOGHAR**	14983.09	4861.25	0	2872.61	7733.85	2887.67	7234.17	51.62
4	**DHANBAD**	24465.8	2598	9882.08	5889.85	18369.94	5920.74	6259.39	75.08
5	**DUMKA**	23630.77	3749.75	23.62	2452.79	6226.16	2465.65	17391.75	26.35
6	**EAST SINGHBHUM**	26715.67	1860	758.04	4994.22	7612.3	5020.41	19912.21	28.49
7	**GARHWA**	28554.59	7531.88	60.53	2327.61	9920.02	2339.79	18622.39	34.74
8	**GIRIDIH**	38483.55	9022.88	955.96	4566.26	14545.08	4590.2	23914.52	37.8
9	**GODDA**	18932.86	1869	258.6	2421.71	4549.3	2434.43	14370.85	24.03
10	**GUMLA**	31692.74	3789.5	12.54	1800.64	5602.65	1810.09	26080.63	17.68
11	**HAZARIBAGH**	29602.38	7851.38	470.25	3322.84	11644.48	3340.24	17940.51	39.34
12	**JAMTARA**	8328.08	2280.25	10.16	1482.62	3773.01	1490.39	4547.3	45.3
13	**KHUNTI**	11267.68	2385	12.59	992.98	3390.57	998.18	7871.9	30.09
14	**KODERMA**	5914.34	2468.88	50.31	1390.32	3909.5	1397.61	1997.54	66.1
15	**LATEHAR**	22835.31	5109	105.74	1350.86	6565.59	1357.96	16262.61	28.75
16	**LOHARDAGA**	17217.65	1833.5	8.17	874.21	2715.87	878.78	14497.2	15.77
17	**PAKUR**	21050.89	1911.5	28.46	1525.24	3465.22	1533.24	17577.67	16.46
18	**PALAMAU**	33683.83	7094.5	217.36	3662.34	10974.22	3681.55	22690.4	32.58
19	**RAMGARH**	10854	1428.25	2958.23	1995.57	6382.07	2006.04	4475.02	58.8
20	**RANCHI**	35992.16	9584.63	1694.99	6106.3	17385.9	6138.3	18574.24	48.3
21	**SAHEBGANJ**	25841.2	2207	50.29	2189.06	4446.34	2200.55	21383.37	17.21
22	**SARAIKELA KHARSAWAN**	15772.83	1099.5	527.18	2099.43	3726.1	2110.44	12035.73	23.62
23	**SIMDEGA**	22003.32	2034	0	1114.24	3148.24	1120.1	18849.21	14.31
24	**WEST SINGHBHUM**	46352.61	1707.5	29.84	2864.63	4601.97	2879.66	41735.6	9.93
	Total(Ham)	569231.64	92782.13	21042.79	64609.8	178434.73	64948.61	392055.96	31.35
	Total(Mcm)	5692.3164	927.8213	210.4279	646.098	1784.3473	649.4861	3920.5596	31.35
	Total(Bcm)	5.69	0.93	0.21	0.65	1.78	0.65	3.92	31.35

Annexure III A

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS % ARE IN JHARKHAND (2022)												
			Safe		Semi-Critical		Critical		Over-Exploited		Saline	
S.No	States / Union Territories	Total No. of Assessed Units	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%
1	**JHARKHAND**	263	241	91.63	11	4.18	6	2.28	5	1.9	-	-
	Total States	263	241	91.63	11	4.18	6	2.28	5	1.9	-	-
	Grand Total	263	241	91.63	11	4.18	6	2.28	5	1.9	-	-

Annexure III B

CATEGORIZATION AREA % of DYNAMIC GROUND WATER RESOURCES OF JHARKHAND, 2022												
S.No	Name of District	Total No. of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
			No	%	No.	%	No.	%	No.	%	No.	%
1	GODDA	9	9	100	-	-	-	-	-	-	-	-
2	GIRIDIH	13	12	92.31	1	7.69	-	-	-	-	-	-
3	SIMDEGA	10	10	100	-	-	-	-	-	-	-	-
4	GARHWA	19	18	94.74	1	5.26	-	-	-	-	-	-
5	PAKUR	6	6	100	-	-	-	-	-	-	-	-
6	RAMGARH	6	4	66.67	-	-	1	16.67	1	16.67	-	-
7	SAHEBGANJ	9	9	100	-	-	-	-	-	-	-	-
8	DUMKA	10	10	100	-	-	-	-	-	-	-	-
9	EAST SINGHBHUM	12	10	83.33	-	-	-	-	2	16.67	-	-
10	BOKARO	9	8	88.89	-	-	-	-	1	11.11	-	-
11	CHATRA	12	12	100	-	-	-	-	-	-	-	-
12	DEOGHAR	10	7	70	3	30	-	-	-	-	-	-
13	DHANBAD	9	4	44.44	2	22.22	2	22.22	1	11.11	-	-
14	GUMLA	12	12	100	-	-	-	-	-	-	-	-
15	HAZARIBAGH	16	15	93.75	1	6.25	-	-	-	-	-	-
16	JAMTARA	6	6	100	-	-	-	-	-	-	-	-
17	KHUNTI	6	6	100	-	-	-	-	-	-	-	-
18	KODERMA	6	4	66.67	1	16.67	1	16.67	-	-	-	-
19	LATEHAR	9	9	100	-	-	-	-	-	-	-	-
20	LOHARDAGA	7	7	100	-	-	-	-	-	-	-	-
21	PALAMAU	21	21	100	-	-	-	-	-	-	-	-
22	RANCHI	19	15	78.95	2	10.53	2	10.53	-	-	-	-
23	SARAIKELA KHARSAWAN	9	9	100	-	-	-	-	-	-	-	-
24	WEST SINGHBHUM	18	18	100	-	-	-	-	-	-	-	-
Total		**263**	**241**	**91.63**	**11**	**4.18**	**6**	**2.28**	**5**	**1.9**	**-**	**-**

Annexure IIIC

ANNUAL EXTRACTABLE RESOURCE OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES, 2022												
			Safe		Semi-Critical		Critical		Over-Exploited		Saline	
S.No	State/Union Territories	Total Annual Extractable Resource of Assessed Units (in mcm)	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%
1	**JHARKHAND**	5692.32	5285.92	92.86	215.09	3.78	129.67	2.28	61.64	1.08	-	-
	Total States	5692.32	5285.92	92.86	215.09	3.78	129.67	2.28	61.64	1.08	-	-
	Grand Total	5692.32	5285.92	92.86	215.09	3.78	129.67	2.28	61.64	1.08	-	-

Annexure IIID

DYNAMIC GROUND WATER RESOURCES OF JHARKHAND, 2022												
			Safe		Semi-Critical		Critical		Over-Exploited		Saline	
S.No	Name of District	Total Annual Extractable Resource of Assessed Units (in mcm)	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%
1	**GODDA**	189.33	189.33	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	**GIRIDIH**	384.84	355.16	92.29	29.67	7.71	0.00	0.00	0.00	0.00		
3	**SIMDEGA**	220.03	220.03	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
4	**GARHWA**	285.55	256.43	89.80	29.11	10.20	0.00	0.00	0.00	0.00		
5	**PAKUR**	210.51	210.51	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
6	**RAMGARH**	108.54	97.16	89.52	0.00	0.00	7.69	7.09	3.69	3.40		
7	**SAHEBGANJ**	258.41	258.41	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
8	**DUMKA**	236.31	236.31	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
9	**EAST SINGHBHUM**	267.16	237.70	88.97	0.00	0.00	0.00	0.00	29.46	11.03		
10	**BOKARO**	289.55	274.44	94.78	0.00	0.00	0.00	0.00	15.11	5.22		
11	**CHATRA**	261.01	261.01	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
12	**DEOGHAR**	149.83	122.69	81.88	27.14	18.12	0.00	0.00	0.00	0.00		
13	**DHANBAD**	244.66	85.99	35.15	89.60	36.62	55.68	22.76	13.39	5.47		

14	**GUMLA**	316.93	316.93	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
15	**HAZARIBAGH**	296.02	286.68	96.84	9.34	3.16	0.00	0.00	0.00	0.00		
16	**JAMTARA**	83.28	83.28	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
17	**KHUNTI**	112.68	112.68	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
18	**KODERMA**	59.14	42.76	72.30	8.09	13.67	8.30	14.03	0.00	0.00		
19	**LATEHAR**	228.35	228.35	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
20	**LOHARDAGA**	172.18	172.18	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
21	**PALAMAU**	336.84	336.84	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
22	**RANCHI**	359.92	279.79	77.74	22.13	6.15	58.00	16.12	0.00	0.00		
23	**SARAIKELA KHARSAWAN**	157.73	157.73	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
24	**WEST SINGHBHUM**	463.53	463.53	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
	Total States	5692.32	5285.92	92.86	215.09	3.78	129.67	2.28	61.64	1.08		
	Grand Total	5692.32	5285.92	92.86	215.09	3.78	129.67	2.28	61.64	1.08		

Annexure IIIE

AREA OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES IN JHARKHAND (2022)

S.No	States / Union Territories	Total Recharge Worthy Area of Assessed Units (in sq km)	Recharge Worthy Area (in sq km)	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
				Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%
1	**JHARKHAND**	60646.73	60646.73	56945.2	93.9	2169.13	3.58	1068.48	1.76	463.92	0.76	-	-
	Total States	60646.73	60646.73	56945.2	93.9	2169.13	3.58	1068.48	1.76	463.92	0.76	-	-
	Grand Total	60646.73	60646.73	56945.2	93.9	2169.13	3.58	1068.48	1.76	463.92	0.76	-	-

Annexure IIIF

DYNAMIC GROUND WATER RESOURCES OFJHARKHAND, 2022, JHARKHAND												
			Safe		Semi-Critical		Critical		Over-Exploited		Saline	
S.No	Name of District	Total Recharge Worthy Area of Assessed Units (in sq.km)	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%
1	**GODDA**	1664.02	1664.02	100.00	0.00	0	0.00	0.00	0.00	0.00		
2	**GIRIDIH**	4400.79	4061.93	92.30	338.86	7.7	0.00	0.00	0.00	0.00		
3	**SIMDEGA**	3090.6	3090.60	100.00	0.00	0	0.00	0.00	0.00	0.00		
4	**GARHWA**	2916.43	2709.66	92.91	206.77	7.09	0.00	0.00	0.00	0.00		
5	**PAKUR**	1277.59	1277.59	100.00	0.00	0	0.00	0.00	0.00	0.00		
6	**RAMGARH**	1112.67	970.80	87.25	0.00	0	89.57	8.05	52.41	4.71		
7	**SAHEBGANJ**	1144.09	1144.09	100.00	0.00	0	0.00	0.00	0.00	0.00		
8	**DUMKA**	2813.67	2813.67	100.00	0.00	0	0.00	0.00	0.00	0.00		
9	**EAST SINGHBHUM**	2509.93	2279.02	90.80	0.00	0	0.00	0.00	230.91	9.20		
10	**BOKARO**	2624.43	2531.79	96.47	0.00	0	0.00	0.00	92.64	3.53		
11	**CHATRA**	3260.87	3260.87	100.00	0.00	0	0.00	0.00	0.00	0.00		
12	**DEOGHAR**	1906.98	1566.58	82.15	340.40	17.85	0.00	0.00	0.00	0.00		
13	**DHANBAD**	1976.73	881.62	44.60	635.32	32.14	339.21	17.16	120.58	6.10		
14	**GUMLA**	4071.15	4071.15	100.00	0.00	0	0.00	0.00	0.00	0.00		
15	**HAZARIBAGH**	3526.62	3421.88	97.03	104.74	2.97	0.00	0.00	0.00	0.00		
16	**JAMTARA**	983.46	983.46	100.00	0.00	0	0.00	0.00	0.00	0.00		
17	**KHUNTI**	1670.05	1670.05	100.00	0.00	0	0.00	0.00	0.00	0.00		
18	**KODERMA**	909.02	620.95	68.31	176.17	19.38	111.90	12.31	0.00	0.00		
19	**LATEHAR**	2385.13	2385.13	100.00	0.00	0	0.00	0.00	0.00	0.00		
20	**LOHARDAGA**	1275.63	1275.63	100.00	0.00	0	0.00	0.00	0.00	0.00		
21	**PALAMAU**	3473.44	3473.44	100.00	0.00	0	0.00	0.00	0.00	0.00		
22	**RANCHI**	3743.08	3026.28	80.85	269.13	7.19	447.30	11.95	0.00	0.00		
23	**SARAIKELA KHARSAWAN**	2028.01	2028.01	100.00	0.00	0	0.00	0.00	0.00	0.00		
24	**WEST SINGHBHUM**	5882.34	5882.34	100.00	0.00	0	0.00	0.00	0.00	0.00		
	Total	**60646.73**	**57062.51**	**94.09**	**2074.12**	**3.42**	**1006.74**	**1.66**	**497.30**	**0.82**		

Annexure IV A

CATEGORISATION OF ASSESSMENT UNIT, 2022, JHARKHAND							
S.NO	**Name of District**	**S.NO**	**Name of Semi-Critical Assessment Units**	**S.NO**	**Name of Critical Assessment Units**	**S.NO**	**Name of Over-Exploited Assessment Units**
1	BOKARO					1	BERMO
2	DEOGHAR	1	KARON				
		2	SARWAN				
		3	SONARAITHADHI				
3	DHANBAD	1	GOBINDPUR	1	TOPCHANCHI	1	BALIAPUR
		2	DHANBAD	2	DHANBAD URBAN		
4	EAST SINGHBHUM					1	GOLMURI CUM JUGSALAI
						2	JAMSHEDPUR URBAN
5	GARHWA	1	BHAWANATHPUR				
6	GIRIDIH	1	GIRIDIH				
7	HAZARIBAGH	1	DARU				
8	KODERMA	1	KODERMA	1	JAINAGAR		
9	RAMGARH			1	RAMGARH	1	CHITARPUR
10	RANCHI	1	KHELARI	1	SILLI		
		2	ORMANJHI	2	RANCHI URBAN		

ABSTRACT			
Total No. of Assessed Units	**Number of Semicritical Assessment Units**	**Number of Critical Assessment Units**	**Number of Over Exploited Assessment Units**
263	11	6	5

Annexure IV B

QUALITY PROBLEMS IN ASSESSMENT UNITS, 2022, JHARKHAND							
S.NO	**Name of District**	**S.NO**	**Name of Assessment Units affected by Fluoride**	**S.NO**	**Name of Assessment Units affected by Arsenic**	**S.NO**	**Name of Assessment Units affected by Salinity**
ABSTRACT							
Total No. of Assessed Units		**Number of Assessment Units affected by Fluoride**		**Number of Assessment Units affected by Arsenic**		**Number of Assessment Units affected by Salinity**	
263		57		3		0	

Annexure VA

State-Wise Summary of Category of Assessment Units Improved Or Deteriorated From 2020 To 2022 Assessment				
S.No	**Name of States / Union Territories**	**Number of Assessment Units Improved**	**Number of Assessment Units Deteriorated**	**Number of Assessment Units With No Change**
1	**JHARKHAND**	4	10	249

Annexure VB

COMPARISON OF CATEGORIZATION OF ASSESSMENT UNITS (2020 AND 2022), JHARKHAND									
S.No	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%)2020	Categorization in2020	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%) 2022	Categorization in 2022	Remark
1	DEOGHAR	KARON	53.29380764	safe	DEOGHAR	KARON	71.89087128	semi_critical	Deteriorated
2	DEOGHAR	SARWAN	56.71553428	safe	DEOGHAR	SARWAN	77.52827249	semi_critical	Deteriorated
3	DHANBAD	BALIAPUR	92.8361175	critical	DHANBAD	BALIAPUR	114.3583958	over_exploited	Deteriorated
4	DHANBAD	GOBINDPUR	69.35455651	safe	DHANBAD	GOBINDPUR	80.32001704	semi_critical	Deteriorated
5	GIRIDIH	GIRIDIH	62.25153999	safe	GIRIDIH	GIRIDIH	79.24808736	semi_critical	Deteriorated
6	KODERMA	JAINAGAR	61.8107255	safe	KODERMA	JAINAGAR	91.07698242	critical	Deteriorated
7	KODERMA	KODERMA	68.68436305	safe	KODERMA	KODERMA	80.0860715	semi_critical	Deteriorated
8	RAMGARH	CHITARPUR	84.13124383	semi_critical	RAMGARH	CHITARPUR	103.4661387	over_exploited	Deteriorated
9	RAMGARH	RAMGARH	83.46876972	semi_critical	RAMGARH	RAMGARH	94.28816556	critical	Deteriorated
10	RANCHI	ORMANJHI	60.19110936	safe	RANCHI	ORMANJHI	84.04316364	semi_critical	Deteriorated
11	BOKARO	CHAS	81.66679835	semi_critical	BOKARO	CHAS	50.24599047	safe	Improved
12	DHANBAD	TOPCHANCHI	115.5725155	over_exploited	DHANBAD	TOPCHANCHI	91.9277925	critical	Improved
13	RAMGARH	MANDU	71.6858039	semi_critical	RAMGARH	MANDU	60.11899892	safe	Improved
14	RANCHI	KANKE	75.39257343	semi_critical	RANCHI	KANKE	46.53255304	safe	Improved

Annexure VIA

Block wise details of Ground water resources of Jharkhand

Sl.no.	State	District	Block	Recharge Worthy Area (ha)	Hilly area	Geographical Area (ha)	Annual Ground water Recharge (ham)	Environmental Flows (ham)	Annual Extractable Ground water Resource (ham)	Domestic	Industrial	Irrigation	Total (Extraction)	Stage of Ground Water Extraction (%)	Categorization of Assessment Unit	Net Annual Ground Water Availability for Future Use (ham)	Quality Tagging
1	JHARKHAND	BOKARO	BERMO	9270	812	10082	1679.1	167.91	1511.19	465.93	1577.75	20	2063.68	136.56	Over-exploited	0	
2	JHARKHAND	BOKARO	CHANDANKIYARI	34848	2626	37474	3058.99	152.95	2906.04	424.68	9.74	378	812.41	27.96	safe	2091.41	Fluoride
3	JHARKHAND	BOKARO	CHANDRAPURA	12424	1088	13512	959.72	95.98	863.74	294.29	155.98	106.5	556.77	64.46	safe	305.43	
4	JHARKHAND	BOKARO	CHAS	54095	3300	57395	4264.18	213.21	4050.97	1844.91	29.04	161.5	2035.45	50.25	safe	2005.85	Fluoride
5	JHARKHAND	BOKARO	GUMIA	56439	8631	65070	12301.42	1230.15	11071.27	484.77	250	641	1375.77	12.43	safe	9692.95	
6	JHARKHAND	BOKARO	JARIDIH	19627	1636	21263	3384.79	338.48	3046.31	209.46	27.1	54.75	291.31	9.56	safe	2753.9	
7	JHARKHAND	BOKARO	KASMAR	18327	1202	19529	1209.23	120.93	1088.3	162.96	0	370.25	533.21	48.99	safe	554.23	
8	JHARKHAND	BOKARO	NAWADIH	28600	2292	30892	2444.02	122.2	2321.82	253.8	4.58	305	563.38	24.26	safe	1757.11	
9	JHARKHAND	BOKARO	PETERBAR	28813	1908	30721	2206.05	110.31	2095.74	242.33	3.74	356	602.08	28.73	safe	1492.38	Fluoride
10	JHARKHAND	CHATRA	CHATRA	27557	10728	38285	1913.12	95.65	1817.47	306.41	0	434	740.41	40.74	safe	1075.45	
11	JHARKHAND	CHATRA	GIDHAUR	13658	3074	16732	1511.49	151.15	1360.34	74.11	0	404.5	478.62	35.18	safe	881.33	
12	JHARKHAND	CHATRA	HUNTERGANJ	42763	8130	50893	4080.04	408	3672.04	339.76	0	1422	1761.76	47.98	safe	1908.5	
13	JHARKHAND	CHATRA	ITKHORI	15044	2200	17244	1210.42	121.04	1089.38	135.71	0	508	643.71	59.09	safe	444.96	
14	JHARKHAND	CHATRA	KANHACHATTI	18653	7262	25915	1897.38	189.74	1707.64	114.13	0	231	345.13	20.21	safe	1361.91	
15	JHARKHAND	CHATRA	KUNDA	21853	6714	28567	1506.68	150.67	1356.01	54.37	0	239	293.37	21.63	safe	1062.36	
16	JHARKHAND	CHATRA	LAWALONG	33628	6285	39913	2385.02	238.5	2146.52	91.56	0	234	325.56	15.17	safe	1820.48	
17	JHARKHAND	CHATRA	MAYURHUND	11164	1633	12797	942.84	94.29	848.55	106.72	0	470	576.73	67.97	safe	271.26	
18	JHARKHAND	CHATRA	PATHALGODA	12515	1183	13698	895.35	89.53	805.82	57.11	0	386.5	443.61	55.05	safe	361.91	
19	JHARKHAND	CHATRA	PRATAPPUR	31730	5843	37573	2243.51	112.19	2131.32	217.74	0	447.5	665.24	31.21	safe	1464.93	
20	JHARKHAND	CHATRA	SIMARIA	46890	5182	52072	3183.4	159.17	3024.23	195.38	0	903	1098.37	36.32	safe	1924.84	

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21	JHARKHAND	CHATRA	TANDWA	50632	8868	59500	6823.99	682.4	6141.59	237.33	869.94	432.5	1539.78	25.07	safe	4600.56	
22	JHARKHAND	DEOGHAR	DEOGHAR	32745	12204	44949	2821.38	141.07	2680.31	760.62	0	453.375	1213.98	45.29	safe	1462.34	
23	JHARKHAND	DEOGHAR	DEVIPUR	21361	4954	26315	1546.02	77.3	1468.72	193.83	0	396	589.82	40.16	safe	877.89	
24	JHARKHAND	DEOGHAR	KARON	9748	5267	15015	929.78	92.97	836.81	159.84	0	441.75	601.59	71.89	Semi-critical	234.38	
25	JHARKHAND	DEOGHAR	MADHUPUR	19821	4783	24604	1683.72	84.18	1599.54	381.86	0	445.25	827.11	51.71	safe	770.42	Nitrate
26	JHARKHAND	DEOGHAR	MARGOMUNDA	10528	5689	16217	894.03	44.7	849.33	157.09	0	278.75	435.84	51.32	safe	412.67	
27	JHARKHAND	DEOGHAR	MOHANPUR	23713	11682	35395	1587.65	79.38	1508.27	318.49	0	469.25	787.74	52.23	safe	718.86	Nitrate
28	JHARKHAND	DEOGHAR	PALOJORI	24298	6000	30298	1937.82	96.9	1840.92	292.11	0	658.125	950.25	51.62	safe	889.13	
29	JHARKHAND	DEOGHAR	SARATH	23006	8782	31788	2579.68	257.96	2321.72	306.52	0	581.625	888.15	38.25	safe	1431.96	Nitrate
30	JHARKHAND	DEOGHAR	SARWAN	14223	2817	17040	1162.3	116.23	1046.07	164.38	0	646.625	811	77.53	Semi-critical	234.21	
31	JHARKHAND	DEOGHAR	SONARAITHADHI	11255	2229	13484	923.78	92.38	831.4	137.86	0	490.5	628.37	75.58	Semi-critical	202.31	
32	JHARKHAND	DHANBAD	BAGHMARA	22696	4416	27112	2705.5	135.27	2570.23	679.04	843.51	199.5	1722.05	67	safe	844.62	
33	JHARKHAND	DHANBAD	BALIAPUR	12117	3000	15117	1487.24	148.73	1338.52	268	1142.22	120.5	1530.71	114.36	Over-exploited	0.81	Fluoride
34	JHARKHAND	DHANBAD	CHIRKUNDA	35994	7889	43883	3900.1	195	3705.1	881.17	107.74	362	1350.91	36.46	safe	2349.57	
35	JHARKHAND	DHANBAD	DHANBAD	43807	2922	46729	7348.42	734.84	6613.58	60.53	5589.44	85	5734.98	86.72	Semi-critical	878.28	Fluoride
36	JHARKHAND	DHANBAD	DHANBAD URBAN	21704	900	22604	3448.84	344.88	3103.96	2933.99	0	0	2933.99	94.52	critical	154.59	
37	JHARKHAND	DHANBAD	GOBINDPUR	23283	9651	32934	2470.27	123.52	2346.75	461.68	1153.73	269.5	1884.91	80.32	Semi-critical	459.42	
38	JHARKHAND	DHANBAD	PURBI TUNDI	7686	4401	12087	671.87	33.6	638.27	91	0	97.5	188.5	29.53	safe	449.3	
39	JHARKHAND	DHANBAD	TOPCHANCHI	12927	7000	19927	2593.69	129.68	2464.01	329.67	1045.45	890	2265.11	91.93	critical	197.17	Nitrate
40	JHARKHAND	DHANBAD	TUNDI	17459	9999	27458	1774.08	88.7	1685.38	184.78	0	574	758.78	45.02	safe	925.63	
41	JHARKHAND	DUMKA	DUMKA	29981	7899	37880	2177.28	217.74	1959.54	429.89	23.16	457.75	910.8	46.48	safe	1046.49	
42	JHARKHAND	DUMKA	GOPIKANDER	20260	1800	22060	1570.56	157.05	1413.51	76.19	0	87.75	163.94	11.6	safe	1249.18	

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43	JHARKHAND	DUMKA	JAMA	36090	2500	38590	2958.49	147.94	2810.55	249.88	0.45	814.25	1064.58	37.88	safe	1744.66	
44	JHARKHAND	DUMKA	JARMUNDI	21635	18308	39943	1928.7	192.87	1735.83	346.87	0	834.5	1181.37	68.06	safe	552.64	
45	JHARKHAND	DUMKA	KATHIKUND	22821	7799	30620	2588.73	258.88	2329.85	129.42	0	117.5	246.93	10.6	safe	2082.24	
46	JHARKHAND	DUMKA	MASALIA	36719	9301	46020	2867.84	286.78	2581.06	225.59	0	278.25	503.84	19.52	safe	2076.03	
47	JHARKHAND	DUMKA	RAMGARH	36241	11899	48140	3750.7	375.07	3375.63	289.63	0	354.75	644.38	19.09	safe	2729.73	
48	JHARKHAND	DUMKA	RANISHWAR	22552	12108	34660	1722.56	86.99	1635.57	184.14	0	60.75	244.89	14.97	safe	1389.72	
49	JHARKHAND	DUMKA	SARAIYAHAT	13611	16199	29810	1292.05	65.14	1226.91	283.07	0	488.75	771.82	62.91	safe	453.6	
50	JHARKHAND	DUMKA	SHIKARIPARA	41457	2463	43920	5069.24	506.92	4562.32	238.11	0	255.5	493.61	10.82	safe	4067.46	
51	JHARKHAND	EAST SINGHBHUM	BAHARAGORA	28555	4953	33508	6969.57	696.95	6272.62	277.21	1.78	873.5	1152.49	18.37	safe	5118.68	
52	JHARKHAND	EAST SINGHBHUM	BORAM	12167	12408	24575	1081.11	54.05	1027.06	125	0	77	202	19.67	safe	824.41	
53	JHARKHAND	EAST SINGHBHUM	CHAKULIA	38168	4608	42776	4064.34	406.44	3657.9	237.35	0	313.5	550.85	15.06	safe	3105.81	
54	JHARKHAND	EAST SINGHBHUM	DHALBHUMGARH	11253	6360	17613	1023.41	51.17	972.24	112.17	0	160.5	272.67	28.05	safe	698.98	
55	JHARKHAND	EAST SINGHBHUM	DUMARIA	22049	9621	31670	1790.3	179.03	1611.27	112.53	0	35	147.52	9.16	safe	1463.16	
56	JHARKHAND	EAST SINGHBHUM	GHATSILA	22222	12413	34635	1645.56	164.56	1481	262.04	40.35	108.25	410.64	27.73	safe	1068.99	
57	JHARKHAND	EAST SINGHBHUM	GOLMURI CUM JUGSALAI	7404	13115	20519	708.73	70.87	637.86	185.87	627.85	92.25	905.98	142.03	Over-exploited	0	Nitrate
58	JHARKHAND	EAST SINGHBHUM	GURABANDHA	15729	8891	24620	1659.33	82.97	1576.36	77.88	0	13.5	91.39	5.8	safe	1484.56	
59	JHARKHAND	EAST SINGHBHUM	JAMSHEDPUR URBAN	12920	0	12920	2429.55	121.48	2308.07	2859.01	0	0	2859.01	123.87	Over-exploited	0	
60	JHARKHAND	EAST SINGHBHUM	MUSABANI	16599	7900	24499	792.75	79.28	713.47	226.62	0	34	260.62	36.53	safe	451.66	Nitrate
61	JHARKHAND	EAST SINGHBHUM	PATAMDA	18110	18468	36578	1278.82	127.89	1150.93	150.1	0	147.5	297.61	25.86	safe	852.53	
62	JHARKHAND	EAST SINGHBHUM	POTKA	45817	13605	59422	5896.54	589.65	5306.89	368.44	88.07	5	461.52	8.7	safe	4843.43	
63	JHARKHAND	GARHWA	BARDIHA	3602	6168	9770	493.75	24.68	469.07	68.7	0	104.5	173.2	36.92	safe	295.51	

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64	JHARKHAND	GARHWA	BHANDARIA	53018	13100	66118	4731.45	473.14	4258.31	119.71	0	425.25	544.95	12.8	safe	3712.74	Fluoride
65	JHARKHAND	GARHWA	BHAWANATHPUR	20981	7707	28688	3234.69	323.47	2911.22	158	4.65	2050.25	2212.9	76.01	Semi-critical	697.5	Fluoride
66	JHARKHAND	GARHWA	BISHUNPURA	6158	1765	7923	1376.38	68.82	1307.56	58.4	0	204.75	263.15	20.13	safe	1044.11	
67	JHARKHAND	GARHWA	CHINIA	24783	3800	28583	1628.65	81.43	1547.22	70.33	0	66	136.33	8.81	safe	1410.52	Fluoride
68	JHARKHAND	GARHWA	DANDA	2049	1137	3186	231.65	23.16	208.49	32.34	0	37	69.34	33.26	safe	138.98	
69	JHARKHAND	GARHWA	DANDAI	10233	3600	13833	784.73	39.23	745.5	115.31	0	242.5	357.81	48	safe	387.09	Fluoride
70	JHARKHAND	GARHWA	DHURKI	16255	4891	21146	1077.06	107.7	969.36	100.47	0	261	361.47	37.29	safe	607.37	Fluoride
71	JHARKHAND	GARHWA	GARHWA	17591	9764	27355	1838.15	183.82	1654.33	395.52	55.88	228.5	679.9	41.1	safe	972.35	Fluoride
72	JHARKHAND	GARHWA	KANDI	12943	4755	17698	2513.99	125.7	2388.29	33.55	0	277	310.55	13	safe	2077.57	Fluoride
73	JHARKHAND	GARHWA	KETAR	11266	4139	15405	2252.75	225.28	2027.47	92.05	0	539.625	631.67	31.16	safe	1395.32	
74	JHARKHAND	GARHWA	KHARAONDHI	11108	3000	14108	1261.24	63.06	1198.18	93.24	0	696.5	789.74	65.91	safe	407.95	
75	JHARKHAND	GARHWA	MAJHIAON	5215	8932	14147	783.98	78.4	705.58	140.56	0	233	373.57	52.95	safe	331.27	Fluoride
76	JHARKHAND	GARHWA	MERAL	17287	9100	26387	1998.12	199.81	1798.31	236.01	0	261.5	497.51	27.67	safe	1299.56	Fluoride
77	JHARKHAND	GARHWA	RAMKANDA	17171	5014	22185	1215.41	121.54	1093.87	80.51	0	162	242.52	22.17	safe	850.93	Fluoride
78	JHARKHAND	GARHWA	RAMNA	11986	3435	15421	1310.26	131.02	1179.24	127.84	0	487.5	615.34	52.18	safe	563.23	Fluoride
79	JHARKHAND	GARHWA	RANKA	27027	15716	42743	1929.17	96.53	1832.64	163.88	0	162.5	326.38	17.81	safe	1505.4	Fluoride
80	JHARKHAND	GARHWA	SAGMA	7674	2309	9983	756.64	37.84	718.8	55.05	0	330.5	385.55	53.64	safe	332.96	
81	JHARKHAND	GARHWA	UNTARI	15296	4500	19796	1622.26	81.11	1541.15	186.14	0	762	948.14	61.52	safe	592.03	Fluoride
82	JHARKHAND	GIRIDIH	BAGODAR	27983	766	28749	2414.25	241.43	2172.82	286.34	0	162	448.34	20.63	safe	1722.98	
83	JHARKHAND	GIRIDIH	BENGABAD	36154	4101	40255	3277.52	327.75	2949.77	277.47	0	703.375	980.85	33.25	safe	1967.46	Nitrate
84	JHARKHAND	GIRIDIH	BIRNI	27997	4001	31998	2198.5	110.02	2088.48	306.91	0	853	1159.91	55.54	safe	926.96	
85	JHARKHAND	GIRIDIH	DEORI	35876	6505	42381	3459.25	173.15	3286.1	330.59	0	508.25	838.84	25.53	safe	2445.52	
86	JHARKHAND	GIRIDIH	DHANWAR	34771	470	35241	3303.65	165.18	3138.47	490.01	8.63	1285.75	1784.4	56.86	safe	1351.5	
87	JHARKHAND	GIRIDIH	DUMRI	34158	8900	43058	3034.78	303.48	2731.3	419.88	15.22	474.5	909.6	33.3	safe	1819.49	

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88	JHARKHAND	GIRIDIH	GANDE	32910	3700	36610	3188.38	318.84	2869.54	317.12	0	358.875	675.99	23.56	safe	2191.89	
89	JHARKHAND	GIRIDIH	GAWAN	35175	7781	42956	3930.22	196.51	3733.71	210.03	0	2030.375	2240.4	60	safe	1492.21	
90	JHARKHAND	GIRIDIH	GIRIDIH	38141	1000	39141	3123.27	156.17	2967.1	783.02	910.23	658.125	2351.37	79.25	Semi-critical	611.63	Fluoride
91	JHARKHAND	GIRIDIH	JAMUA	38548	9299	47847	3721.54	186.2	3535.34	491.86	0	1044.75	1536.6	43.46	safe	1996.16	
92	JHARKHAND	GIRIDIH	PIRTANR	38245	11041	49286	3568.55	356.86	3211.69	198.35	0	411.375	609.73	18.98	safe	2600.92	
93	JHARKHAND	GIRIDIH	SARIA	27266	746	28012	2366.99	236.7	2130.29	282.46	21.88	293.625	597.97	28.07	safe	1530.84	
94	JHARKHAND	GIRIDIH	TISRI	32855	10101	42956	4076.61	407.67	3668.94	172.21	0	238.875	411.08	11.2	safe	3256.96	Fluoride
95	JHARKHAND	GODDA	BASANTRAI	8149	738	8887	1695.32	84.78	1610.54	169.25	0	92.75	261.99	16.27	safe	1347.66	
96	JHARKHAND	GODDA	BOARIJOR	25990	8400	34390	3616	361.59	3254.4	250.54	242.95	208.25	701.74	21.56	safe	2551.34	Fluoride
97	JHARKHAND	GODDA	GODDA	29930	5600	35530	4194.14	419.41	3774.73	524.69	5.93	325.25	855.87	22.67	safe	2916.11	Fluoride
98	JHARKHAND	GODDA	MAHAGAMA	12955	3000	15955	2299.68	114.98	2184.7	363.99	9.71	111.25	484.95	22.2	safe	1697.84	Fluoride
99	JHARKHAND	GODDA	MEHERMA	9962	3001	12963	1454.46	145.45	1309.01	265.21	0	112.5	377.71	28.85	safe	929.91	
100	JHARKHAND	GODDA	PATHARGAMA	13989	1267	15256	1735.12	173.51	1561.61	209.49	0	173.75	383.24	24.54	safe	1177.27	Fluoride
101	JHARKHAND	GODDA	POREYAHAT	35205	11800	47005	2472.11	247.21	2224.9	339.58	0	515	854.58	38.41	safe	1368.54	Fluoride
102	JHARKHAND	GODDA	SUNDERPAHARI	24979	7700	32679	2130.96	213.1	1917.86	118.57	0	152.25	270.82	14.12	safe	1646.42	
103	JHARKHAND	GODDA	THAKURGHANTI	5243	3201	8444	1153.03	57.92	1095.11	180.4	0	178	358.4	32.73	safe	735.76	
104	JHARKHAND	GUMLA	ALBERT EKKA	16232	4669	20901	1168.66	116.87	1051.79	56.01	0	276.5	332.51	31.61	safe	718.98	
105	JHARKHAND	GUMLA	BASIA	33816	6460	40276	3346.94	334.7	3012.24	146.22	0	322.125	468.34	15.55	safe	2543.13	
106	JHARKHAND	GUMLA	BHARNO	24244	5941	30185	1476.93	147.69	1329.24	115.51	0	10.875	126.38	9.51	safe	1202.26	
107	JHARKHAND	GUMLA	BISHUNPUR	41105	19930	61035	2934.04	293.4	2640.64	112.87	0.44	402.5	515.82	19.53	safe	2124.23	Fluoride, Nitrate
108	JHARKHAND	GUMLA	CHAINPUR	35608	14736	50344	2534.27	253.43	2280.84	102.5	0	174.75	277.24	12.16	safe	2003.06	Fluoride, Nitrate

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109	JHARKHAND	GUMLA	DUMRI	28861	8302	37163	2062.21	206.22	1855.99	88.99	0	130.125	219.11	11.81	safe	1636.41	Fluoride
110	JHARKHAND	GUMLA	GHAGHRA	42608	10406	53014	4850.11	242.54	4607.57	212.85	7.59	645.5	865.94	18.79	safe	3740.51	Fluoride
111	JHARKHAND	GUMLA	GUMLA	36891	17083	53974	3256.14	325.62	2930.52	303.42	4.51	553.25	861.18	29.39	safe	2067.75	Fluoride
112	JHARKHAND	GUMLA	KAMDARA	27687	8781	36468	2023.35	202.33	1821.02	174.78	0	403.875	578.65	31.78	safe	1241.45	
113	JHARKHAND	GUMLA	PALKOT	42978	14757	57735	4188.91	418.9	3770.01	146.45	0	206.25	352.71	9.36	safe	3416.53	
114	JHARKHAND	GUMLA	RAIDIH	42648	8448	51096	3195.07	159.77	3035.3	129.4	0	262.875	392.27	12.92	safe	2642.35	
115	JHARKHAND	GUMLA	SISAI	34437	8098	42535	3534.85	177.27	3357.58	211.63	0	400.875	612.5	18.24	safe	2743.97	Fluoride, Nitrate
116	JHARKHAND	HAZARIBAGH	BARHI	27499	9118	36617	1969.38	196.94	1772.44	251.74	19.57	764.875	1036.18	58.46	safe	734.95	
117	JHARKHAND	HAZARIBAGH	BARKAGAON	38988	5800	44788	3875.88	387.58	3488.3	251.1	43.01	433.25	727.36	20.85	safe	2759.62	
118	JHARKHAND	HAZARIBAGH	BARKATHA	22810	5293	28103	1694.6	169.46	1525.14	221.45	0	720.25	941.71	61.75	safe	582.26	
119	JHARKHAND	HAZARIBAGH	BISHNUGARH	28084	13616	41700	1999.79	199.98	1799.81	290.08	9.44	840	1139.52	63.31	safe	658.77	
120	JHARKHAND	HAZARIBAGH	CHALKUSHA	12100	2807	14907	854.58	85.45	769.13	94.31	0.44	145	239.75	31.17	safe	528.89	
121	JHARKHAND	HAZARIBAGH	CHAUPARAN	39540	8562	48102	5321.51	532.15	4789.36	296.61	5.03	697	998.63	20.85	safe	3789.18	
122	JHARKHAND	HAZARIBAGH	CHURCHU	16708	3432	20140	1521.98	76.1	1445.88	101.78	90.59	521.25	713.61	49.35	safe	731.74	
123	JHARKHAND	HAZARIBAGH	DARI	12072	2480	14552	1081.23	108.13	973.1	159.3	41.15	374.125	574.56	59.04	safe	397.71	
124	JHARKHAND	HAZARIBAGH	DARU	11020	1793	12813	983.64	49.18	934.46	94.74	0	603	697.73	74.67	Semi-critical	236.24	
125	JHARKHAND	HAZARIBAGH	HAZARIBAGH	24128	2099	26227	2481.19	248.12	2233.07	638.59	30.48	472.625	1141.69	51.13	safe	1088.03	
126	JHARKHAND	HAZARIBAGH	ICHAK	24217	4451	28668	1635.82	163.58	1472.24	204.33	0	423.125	627.46	42.62	safe	843.71	
127	JHARKHAND	HAZARIBAGH	KATKAMDAG	13246	3060	16306	1257.03	125.71	1131.32	157.93	25.79	357.25	540.98	47.82	safe	589.51	
128	JHARKHAND	HAZARIBAGH	KATKAMSANDI	24419	5640	30059	1684.41	168.45	1515.96	206.04	11.5	375.75	593.3	39.14	safe	921.58	
129	JHARKHAND	HAZARIBAGH	KEREDARI	29446	6046	35492	4106.94	410.7	3696.24	165.47	193.27	508.875	867.61	23.47	safe	2827.77	
130	JHARKHAND	HAZARIBAGH	PADMA	11257	1400	12657	946.22	47.31	898.91	101.45	0	120	221.45	24.64	safe	676.93	

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131	JHARKHAND	HAZARIBAGH	TATIJHARIA	17128	2787	19915	1217.92	60.9	1157.02	87.93	0	495	582.94	50.38	safe	573.62	
132	JHARKHAND	JAMTARA	FATEPUR	13563	14546	28109	1357.32	135.73	1221.59	162.37	0	576.375	738.75	60.47	safe	481.99	
133	JHARKHAND	JAMTARA	JAMTARA	17267	15608	32875	1478.2	73.91	1404.29	412.75	4.44	195.75	612.94	43.65	safe	789.19	
134	JHARKHAND	JAMTARA	KUNDAHIT	7770	22104	29874	856.15	85.61	770.54	153.78	0	272.25	426.03	55.29	safe	343.7	Nitrate
135	JHARKHAND	JAMTARA	NALA	27665	13719	41384	2364.96	236.49	2128.47	244.11	0	288	532.11	25	safe	1595.08	
136	JHARKHAND	JAMTARA	NARAYANPUR	23088	7977	31065	2159.82	107.99	2051.83	296.98	0	691.25	988.22	48.16	safe	1062.06	
137	JHARKHAND	JAMTARA	VIDYASAGAR	8993	8129	17122	834.84	83.48	751.36	212.63	5.71	256.625	474.96	63.21	safe	275.28	
138	JHARKHAND	KHUNTI	ERKI	29999	21501	51500	2045.3	204.53	1840.77	145.96	0	272.625	418.59	22.74	safe	1421.41	
139	JHARKHAND	KHUNTI	KARRA	27745	23000	50745	1890.28	189.03	1701.25	197.57	0	526.5	724.07	42.56	safe	976.14	Fluoride
140	JHARKHAND	KHUNTI	KHUNTI	35413	9987	45400	2711.35	135.57	2575.78	249.26	3.33	246.375	498.96	19.37	safe	2075.52	
141	JHARKHAND	KHUNTI	MURHU	26103	14297	40400	1846.39	184.64	1661.75	154.83	0.09	461.375	616.3	37.09	safe	1044.64	Fluoride
142	JHARKHAND	KHUNTI	RANIA	20344	6399	26743	1491.62	149.17	1342.45	71.27	0	536.125	607.4	45.25	safe	734.68	
143	JHARKHAND	KHUNTI	TORPA	27401	17828	45229	2258.61	112.93	2145.68	174.08	9.18	342	525.25	24.48	safe	1619.51	
144	JHARKHAND	KODERMA	CHANDWARA	22206	683	22889	1517.52	75.87	1441.65	153.8	11.25	804.625	969.67	67.26	safe	471.18	Fluoride
145	JHARKHAND	KODERMA	DOMCHANCH	18793	14011	32804	1212.97	60.65	1152.32	237.51	13.21	216	466.73	40.5	safe	684.34	
146	JHARKHAND	KODERMA	JAINAGAR	14057	4362	18419	921.71	92.17	829.54	237.77	0	517.75	755.52	91.08	critical	72.77	Fluoride
147	JHARKHAND	KODERMA	KODERMA	14634	14378	29012	898.47	89.84	808.63	455.25	25.85	166.5	647.6	80.09	Semi-critical	158.64	Fluoride
148	JHARKHAND	KODERMA	MARKACHHO	10837	5334	16171	602.4	60.24	542.16	171.01	0	104.75	275.76	50.86	safe	265.5	Fluoride
149	JHARKHAND	KODERMA	SATGAWAN	10375	20000	30375	1200.05	60.01	1140.04	134.97	0	659.25	794.22	69.67	safe	345.11	Fluoride
150	JHARKHAND	LATEHAR	BALUMATH	25848	9303	35151	2803.32	140.17	2663.15	161.22	82.39	535	778.6	29.24	safe	1883.71	
151	JHARKHAND	LATEHAR	BARIATU	24811	8929	33740	2149.97	214.99	1934.98	108.84	0	537.5	646.34	33.4	safe	1288.06	
152	JHARKHAND	LATEHAR	BARWADIH	30933	12603	43536	2480.84	124.05	2356.79	184.49	6.6	940	1131.09	47.99	safe	1224.73	Nitrate
153	JHARKHAND	LATEHAR	CHANDWA	39886	18900	58786	4624.25	231.22	4393.03	204.36	16.75	771.5	992.61	22.6	safe	3399.35	

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154	JHARKHAND	LATEHAR	GARU	14098	8200	22298	1157.85	115.78	1042.07	54.83	0	624	678.83	65.14	safe	362.95	
155	JHARKHAND	LATEHAR	HERHANG	18529	6668	25197	1725.43	86.27	1639.16	62.72	0	193.5	256.23	15.63	safe	1382.6	
156	JHARKHAND	LATEHAR	LATEHAR	24439	20445	44884	2406.69	240.67	2166.02	279.48	0	825.5	1104.97	51.01	safe	1059.58	
157	JHARKHAND	LATEHAR	MAHUADANR	35583	28200	63783	4854.08	485.41	4368.67	135.35	0	379	514.36	11.77	safe	3853.59	
158	JHARKHAND	LATEHAR	MANIKA	24386	9500	33886	2390.98	119.54	2271.44	159.56	0	303	462.56	20.36	safe	1808.04	
159	JHARKHAND	LOHARDAGA	BHANDRA	14127	1939	16066	2492.07	124.6	2367.47	103.79	5.63	332.25	441.65	18.65	safe	1925.28	
160	JHARKHAND	LOHARDAGA	KARRO	8943	1285	10228	1651.97	165.2	1486.77	68.58	0	159	227.59	15.31	safe	1258.82	
161	JHARKHAND	LOHARDAGA	KISKO	21074	4256	25330	3238.49	323.84	2914.65	99.54	1.92	241.5	342.96	11.77	safe	2571.17	
162	JHARKHAND	LOHARDAGA	KURU	19550	2191	21741	2433.57	121.68	2311.89	153.64	0	301.25	454.89	19.68	safe	1856.2	
163	JHARKHAND	LOHARDAGA	LOHARDAGA	13444	2724	16168	3286.1	328.61	2957.49	266.04	0	375.75	641.79	21.7	safe	2314.31	
164	JHARKHAND	LOHARDAGA	PESHRAR	32330	6137	38467	1852.4	92.62	1759.78	56.25	0	108	164.25	9.33	safe	1595.23	
165	JHARKHAND	LOHARDAGA	SENHA	18095	3151	21246	3799.55	379.95	3419.6	126.36	0.63	315.75	442.74	12.95	safe	2976.19	
166	JHARKHAND	PAKUR	AMRAPARA	20529	6800	27329	3013.59	301.36	2712.23	118.25	0	174.5	292.76	10.79	safe	2418.85	Fluoride
167	JHARKHAND	PAKUR	HIRANPUR	15160	1800	16960	2183.77	218.37	1965.4	152.28	0	211	363.28	18.48	safe	1601.32	
168	JHARKHAND	PAKUR	LITIPARA	18905	22400	41305	2650.51	265.05	2385.46	191.45	0	54.5	245.95	10.31	safe	2138.51	Fluoride
169	JHARKHAND	PAKUR	MAHESHPUR	35193	9700	44893	8637.46	431.87	8205.59	378.29	0.41	952	1330.7	16.22	safe	6872.9	Nitrate
170	JHARKHAND	PAKUR	PAKUR	16071	6100	22171	3296.37	329.64	2966.73	488.32	28.05	339	855.37	28.83	safe	2108.8	
171	JHARKHAND	PAKUR	PAKURIA	21901	6000	27901	3128.31	312.83	2815.48	196.65	0	180.5	377.16	13.4	safe	2437.29	Fluoride
172	JHARKHAND	PALAMAU	BISHRAMPUR	17120	5736	22856	1987.66	198.76	1788.9	218.42	0	67	285.42	15.96	safe	1502.34	Fluoride
173	JHARKHAND	PALAMAU	CHAINPUR	51969	14171	66140	3574.43	357.44	3216.99	424.62	18.14	633	1075.76	33.44	safe	2139	Fluoride
174	JHARKHAND	PALAMAU	CHHATARPUR	32503	9817	42320	2288.51	114.43	2174.08	267.08	0	794	1061.08	48.81	safe	1111.6	Fluoride
175	JHARKHAND	PALAMAU	DALTONGANJ	12502	780	13282	2100.99	210.1	1890.89	147.2	35.48	590.5	773.18	40.89	safe	1116.94	Fluoride
176	JHARKHAND	PALAMAU	HAIDERNAGAR	6749	3514	10263	1889.03	188.91	1700.12	134.08	0	41	175.08	10.3	safe	1524.33	Nitrate
177	JHARKHAND	PALAMAU	HARIHARGANJ	9802	2160	11962	755.33	37.77	717.56	142.18	8.89	185	336.07	46.84	safe	380.75	Fluoride
178	JHARKHAND	PALAMAU	HUSAINABAD	18254	9506	27760	3550	355	3195	313.2	0	282.5	595.7	18.64	safe	2597.66	

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179	JHARKHAND	PALAMAU	LESLIEGANJ	14573	2600	17173	1723.26	172.33	1550.93	181.52	0	590.5	772.02	49.78	safe	777.96	Fluoride
180	JHARKHAND	PALAMAU	MANATU	21150	8380	29530	1688.53	84.43	1604.1	84.86	0	483	567.87	35.4	safe	1035.78	Fluoride
181	JHARKHAND	PALAMAU	MEDINAGAR URBAN	2358	0	2358	1447.63	144.77	1302.86	297.18	0	0	297.18	22.81	safe	1004.12	
182	JHARKHAND	PALAMAU	MOHAMMED GANJ	6718	3499	10217	1626.62	162.66	1463.96	85.7	0	308	393.7	26.89	safe	1069.81	
183	JHARKHAND	PALAMAU	NAWABAZAR	12347	3729	16076	826.85	41.54	785.31	91.18	0	197	288.18	36.7	safe	496.65	
184	JHARKHAND	PALAMAU	NAWADIH	17205	5765	22970	1465.26	73.27	1391.99	133.67	125	112.5	371.16	26.66	safe	1020.13	
185	JHARKHAND	PALAMAU	PANDU	11230	2759	13989	829.7	82.97	746.73	122.95	0	142	264.96	35.48	safe	481.12	Fluoride
186	JHARKHAND	PALAMAU	PANDWA	14283	3355	17638	1705.72	85.28	1620.44	85.05	0	306.5	391.55	24.16	safe	1228.45	
187	JHARKHAND	PALAMAU	PANKI	32208	10300	42508	3044.24	152.21	2892.03	285.9	0	987.5	1273.4	44.03	safe	1617.13	Fluoride
188	JHARKHAND	PALAMAU	PATAN	25506	5992	31498	2646.36	264.64	2381.72	243.67	29.85	457	730.52	30.67	safe	1649.92	Fluoride
189	JHARKHAND	PALAMAU	PIPRA	8398	1851	10249	633.56	63.36	570.2	65.91	0	118	183.91	32.25	safe	385.95	
190	JHARKHAND	PALAMAU	SATBARWA	10535	3400	13935	702.37	35.12	667.25	120.3	0	282	402.3	60.29	safe	264.32	Fluoride
191	JHARKHAND	PALAMAU	TARHASI	10704	4242	14946	1348.12	67.41	1280.71	147.24	0	421	568.24	44.37	safe	711.69	
192	JHARKHAND	PALAMAU	UTARIOR	11230	2759	13989	781.11	39.05	742.06	70.43	0	96.5	166.94	22.5	safe	574.75	
193	JHARKHAND	RAMGARH	CHITARPUR	4681	1889	6570	388.11	19.4	368.71	148.28	148.21	85	381.49	103.47	Over-exploited	0	
194	JHARKHAND	RAMGARH	DULMI	8085	3264	11349	748.63	74.87	673.76	119.97	0	183.5	303.47	45.04	safe	369.66	
195	JHARKHAND	RAMGARH	GOLA	27165	6893	34058	2526.9	126.35	2400.55	271.34	71.93	446	789.27	32.88	safe	1609.86	
196	JHARKHAND	RAMGARH	MANDU	34896	9340	44236	4116.8	205.84	3910.96	536.85	1457.38	357	2351.23	60.12	safe	1556.91	Nitrate
197	JHARKHAND	RAMGARH	PATRATU	28440	3683	32123	2874.47	143.73	2730.74	550.99	1077.28	203	1831.27	67.06	safe	896.58	Nitrate
198	JHARKHAND	RAMGARH	RAMGARH	8000	3229	11229	809.77	40.49	769.28	368.14	203.44	153.75	725.34	94.29	critical	42.01	
199	JHARKHAND	RANCHI	ANGARA	29959	10199	40158	2416.93	241.69	2175.24	204.23	1.89	501.125	707.24	32.51	safe	1466.93	
200	JHARKHAND	RANCHI	BERO	23529	5276	28805	3992.16	399.22	3592.94	204.83	8.82	891.5	1105.14	30.76	safe	2486.73	
201	JHARKHAND	RANCHI	BUNDU	19919	6500	26419	1590.92	79.55	1511.37	164.15	0	233.5	397.65	26.31	safe	1112.86	
202	JHARKHAND	RANCHI	BURMU	26602	5475	32077	1764.46	176.45	1588.01	162.81	0	256.5	419.31	26.4	safe	1167.85	

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203	JHARKHAND	RANCHI	CHANHO	21185	6100	27285	1485.68	148.56	1337.12	194.71	0	531.75	726.46	54.33	safe	609.64	
204	JHARKHAND	RANCHI	ITKI	8135	1824	9959	2126.03	106.3	2019.73	90.66	0.94	206.75	298.36	14.77	safe	1720.89	
205	JHARKHAND	RANCHI	KANKE	18709	10759	29468	2446.33	122.43	2323.9	392.9	328.21	360.25	1081.37	46.53	safe	1240.47	
206	JHARKHAND	RANCHI	KHELARI	10809	2225	13034	916.49	45.83	870.66	178.68	500	74.625	753.31	86.52	Semi-critical	116.42	
207	JHARKHAND	RANCHI	LAPUNG	22286	7800	30086	1830.02	91.5	1738.52	114.2	0	630	744.2	42.81	safe	993.72	
208	JHARKHAND	RANCHI	MANDAR	20122	3700	23822	2877.88	143.89	2733.99	232.89	0	594.75	827.64	30.27	safe	1905.12	
209	JHARKHAND	RANCHI	NAGRI	8041	2059	10100	1883.85	94.2	1789.65	118.18	2.19	250.125	370.5	20.7	safe	1418.53	
210	JHARKHAND	RANCHI	NAMKUM	26186	12200	38386	2631.61	131.58	2500.03	213.73	643.62	837	1694.35	67.77	safe	804.56	Fluoride
211	JHARKHAND	RANCHI	ORMANJHI	19012	3800	22812	1490.96	149.09	1341.87	173.93	5.07	948.75	1127.75	84.04	Semi-critical	213.21	Fluoride
212	JHARKHAND	RANCHI	RAHE	12877	5028	17905	827.64	82.76	744.88	97.65	0	94.875	192.53	25.85	safe	551.84	
213	JHARKHAND	RANCHI	RANCHI URBAN	30585	0	30585	3360.25	336.03	3024.22	2869.87	0.08	0	2869.94	94.9	critical	139.23	
214	JHARKHAND	RANCHI	RATU	8378	1722	10100	1409.8	70.49	1339.31	98.14	190.19	153.5	441.83	32.99	safe	896.96	
215	JHARKHAND	RANCHI	SILLI	19575	9384	28959	2922.14	146.1	2776.04	214.5	13.55	2465	2693.05	97.01	critical	81.86	Fluoride
216	JHARKHAND	RANCHI	SONAHATU	18837	8075	26912	1291.16	129.12	1162.04	139.92	0	414	553.92	47.67	safe	607.39	
217	JHARKHAND	RANCHI	TAMAR	29562	21787	51349	1580.71	158.07	1422.64	240.3	0.43	140.625	381.35	26.81	safe	1040.03	
218	JHARKHAND	SAHEBGANJ	BARHAIT	23682	7200	30882	3824.74	382.48	3442.26	245.41	13.36	104	362.78	10.54	safe	3078.2	Fluoride
219	JHARKHAND	SAHEBGANJ	BARHARWA	13525	5200	18725	4561.38	456.14	4105.24	335.72	13.78	174.5	524	12.76	safe	3579.48	
220	JHARKHAND	SAHEBGANJ	BORIO	9374	16800	26174	2140.91	214.09	1926.82	181.8	7.26	125.5	314.55	16.32	safe	1611.31	Fluoride
221	JHARKHAND	SAHEBGANJ	MANDRO	5352	7000	12352	1406.26	140.63	1265.63	137.03	0	342.5	479.53	37.89	safe	785.38	
222	JHARKHAND	SAHEBGANJ	PATHNA	14316	2000	16316	2470.93	123.55	2347.38	148.41	0	125	273.41	11.65	safe	2073.19	
223	JHARKHAND	SAHEBGANJ	RAJMAHAL	9693	3000	12693	2654.99	132.75	2522.24	323.37	4.76	63.5	391.63	15.53	safe	2128.91	Arsenic ,Fluoride
224	JHARKHAND	SAHEBGANJ	SAHEBGANJ	16627	700	17327	4801.78	480.18	4321.6	351.73	0.01	741.5	1093.23	25.3	safe	3226.52	Arsenic ,Fluoride
225	JHARKHAND	SAHEBGANJ	TALJHARI	3727	12096	15823	916.83	91.69	825.14	138.25	0	107	245.24	29.72	safe	579.18	

Sl.no.	State	District	Block	Recharge Worthy Area (ha)	Hilly area	Geographical Area (ha)	Annual Ground water Recharge (ham)	Environmental Flows (ham)	Annual Extractable Ground water Resource (ham)	Domestic	Industrial	Irrigation	Total (Extraction)	Stage of Ground Water Extraction (%)	Categorization of Assessment Unit	Net Annual Ground Water Availability for Future Use (ham)	Quality Tagging
226	JHARKHAND	SAHEBGANJ	UDHUA	18113	1800	19913	5649.88	564.99	5084.89	327.34	11.13	423.5	761.97	14.98	safe	4321.2	Arsenic
227	JHARKHAND	SARAIKELA KHARSAWAN	ADITYAPUR (GAMHARIA)	23767	7430	31197	2144.24	214.42	1929.81	684.94	260.45	104	1049.39	54.38	safe	876.83	
228	JHARKHAND	SARAIKELA KHARSAWAN	Chandil	27069	10304	37373	2010.89	201.09	1809.8	317.74	87.59	65	470.33	25.99	safe	1337.81	
229	JHARKHAND	SARAIKELA KHARSAWAN	GOBINDPUR	32409	13433	45842	3600.52	360.05	3240.47	247.41	0	121.75	369.17	11.39	safe	2870	
230	JHARKHAND	SARAIKELA KHARSAWAN	ICHAGARH	23512	3666	27178	1692.86	169.29	1523.57	150.51	0	76.625	227.13	14.91	safe	1295.65	
231	JHARKHAND	SARAIKELA KHARSAWAN	KHARSAWAN	17074	6209	23283	1345.44	134.55	1210.89	160.55	21.24	139.875	321.66	26.56	safe	888.39	
232	JHARKHAND	SARAIKELA KHARSAWAN	KUCHAI	29340	9063	38403	2356.88	235.69	2121.19	116.5	0	142.875	259.36	12.23	safe	1861.22	
233	JHARKHAND	SARAIKELA KHARSAWAN	KUKRU	11507	2184	13691	840.17	84.02	756.15	95.95	0	34.875	130.82	17.3	safe	624.83	
234	JHARKHAND	SARAIKELA KHARSAWAN	NIMDIH	19065	4437	23502	1432.15	143.22	1288.93	142.43	125	55.125	322.56	25.03	safe	965.62	
235	JHARKHAND	SARAIKELA KHARSAWAN	SERAIKELA	19058	8690	27748	2102.24	210.22	1892.02	183.41	32.9	359.375	575.68	30.43	safe	1315.38	Nitrate
236	JHARKHAND	SIMDEGA	BANO	47177	7800	54977	3453.97	172.7	3281.27	145.73	0	165	310.73	9.47	safe	2969.77	
237	JHARKHAND	SIMDEGA	BANSJOR	13480	2970	16450	945.95	94.59	851.36	46.22	0	30.5	76.72	9.01	safe	774.4	
238	JHARKHAND	SIMDEGA	BOLBA	17249	11614	28863	1270.54	127.06	1143.48	55.76	0	176	231.76	20.27	safe	911.43	
239	JHARKHAND	SIMDEGA	JALDEGA	35089	7731	42820	2477.63	247.76	2229.87	116.43	0	242.5	358.93	16.1	safe	1870.32	
240	JHARKHAND	SIMDEGA	KERSAI	16022	8918	24940	1138.99	113.9	1025.09	71.03	0	51.5	122.53	11.95	safe	902.19	
241	JHARKHAND	SIMDEGA	KOLEBIRA	38336	5400	43736	3229.12	161.46	3067.66	129.11	0	300	429.11	13.99	safe	2637.87	
242	JHARKHAND	SIMDEGA	KURDEG	16850	9380	26230	1240.08	124	1116.08	86.91	0	125.5	212.41	19.03	safe	903.21	
243	JHARKHAND	SIMDEGA	PAKARDANR	26765	3366	30131	1877.06	187.71	1689.35	67.93	0	123	190.93	11.3	safe	1498.06	
244	JHARKHAND	SIMDEGA	SIMDEGA	39677	4990	44667	3907.29	195.37	3711.92	236.71	0	250	486.71	13.11	safe	3223.97	
245	JHARKHAND	SIMDEGA	THETHAITANGAR	58415	4000	62415	4319.15	431.91	3887.24	158.4	0	570	728.41	18.74	safe	3157.99	
246	JHARKHAND	WEST SINGHBHUM	ANANDPUR	24689	6917	31606	1331.58	133.15	1198.43	80.43	0	66	146.43	12.22	safe	1051.58	
247	JHARKHAND	WEST SINGHBHUM	BANDGAON	31108	15900	47008	2563.56	256.35	2307.21	157.71	0	190.5	348.21	15.09	safe	1958.18	Nitrate

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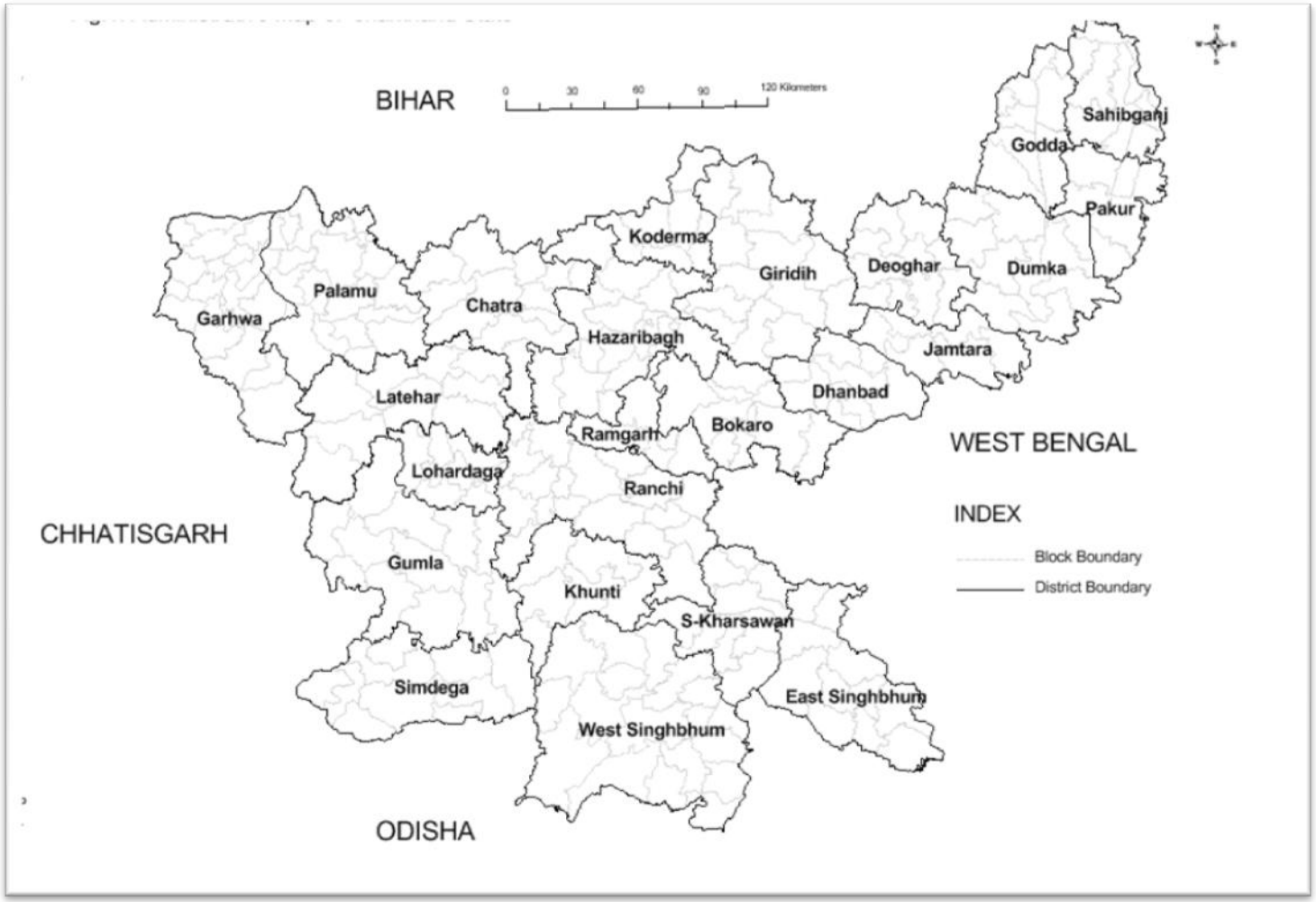
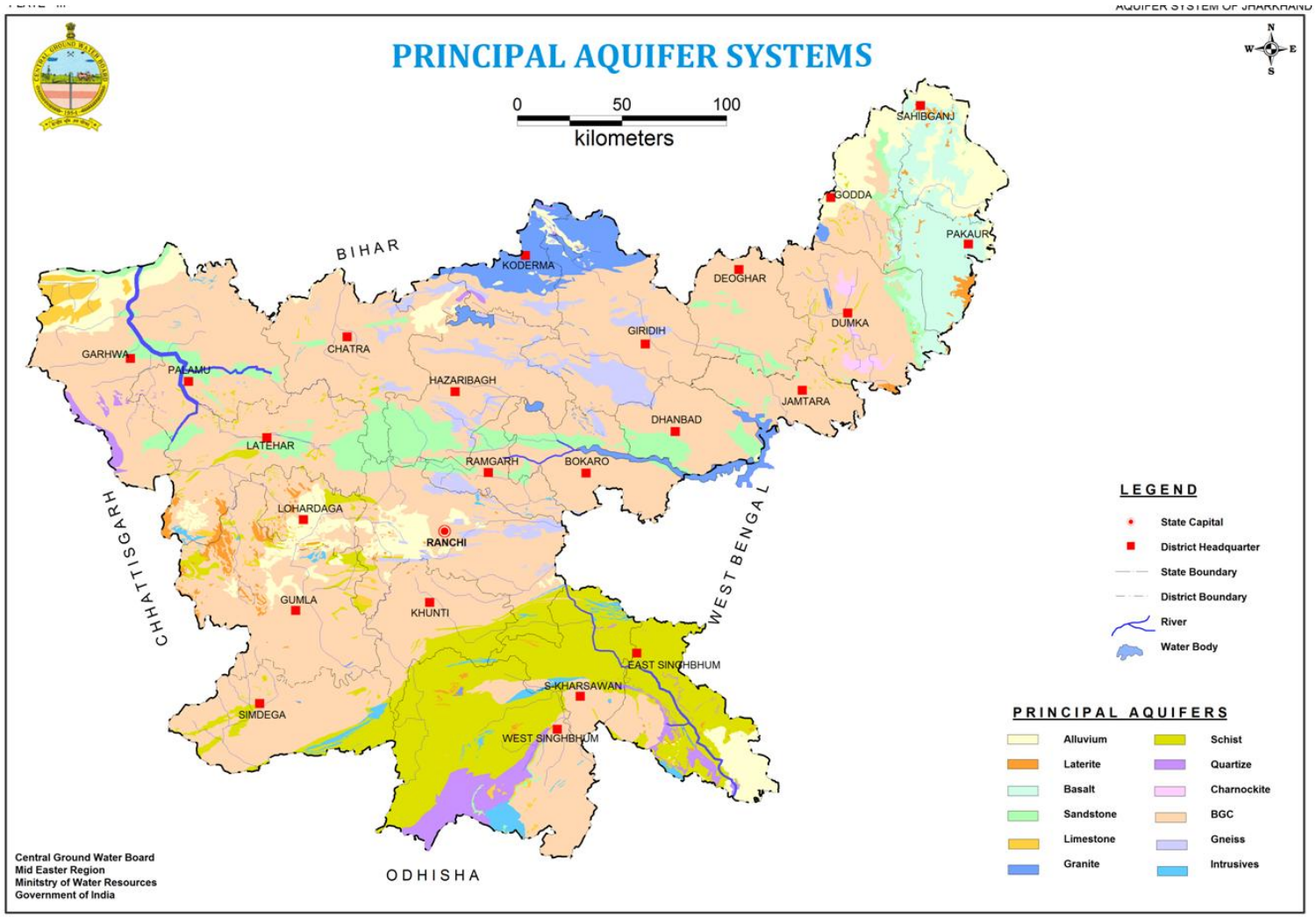
248	JHARKHAND	WEST SINGHBHUM	CHAIBASA	15472	5900	21372	1700.55	170.05	1530.5	328.28	1	68.5	397.78	25.99	safe	1131	
249	JHARKHAND	WEST SINGHBHUM	CHAKRADHARPUR	24869	13126	37995	2656.85	265.69	2391.16	395.76	0.73	190	586.49	24.53	safe	1802.59	
250	JHARKHAND	WEST SINGHBHUM	GOELKERA	45474	9464	54938	4574.32	457.43	4116.89	134.06	0	66	200.06	4.86	safe	3916.12	
251	JHARKHAND	WEST SINGHBHUM	GUDRI	35755	5893	41648	1868.91	186.89	1682.02	69.34	0	57.5	126.83	7.54	safe	1554.83	
252	JHARKHAND	WEST SINGHBHUM	HATGAMARIA	26114	4244	30358	2874.78	287.48	2587.3	121.76	0	24.5	146.26	5.65	safe	2440.4	
253	JHARKHAND	WEST SINGHBHUM	JAGANNATHPUR	23396	7600	30996	1093.85	109.38	984.47	187.46	0	13.5	200.96	20.41	safe	782.52	
254	JHARKHAND	WEST SINGHBHUM	JHINKPANI	10059	2298	12357	1364.86	136.49	1228.37	106.03	13.33	170.5	289.87	23.6	safe	937.94	
255	JHARKHAND	WEST SINGHBHUM	KHUNTPANI	30399	11000	41399	4478	447.8	4030.2	150.42	0	147.5	297.91	7.39	safe	3731.51	
256	JHARKHAND	WEST SINGHBHUM	KUMARDUNGI	25786	3538	29324	3535.4	353.54	3181.86	100.25	0	78.5	178.75	5.62	safe	3002.58	
257	JHARKHAND	WEST SINGHBHUM	MAJHGAON	24423	3000	27423	2635.02	132	2503.02	131.52	0	131	262.52	10.49	safe	2239.81	
258	JHARKHAND	WEST SINGHBHUM	MANJHARI	27202	4160	31362	3656.55	365.66	3290.89	123.98	0	34.5	158.48	4.82	safe	3131.76	
259	JHARKHAND	WEST SINGHBHUM	MANOHARPUR	90561	5554	96115	5815.82	581.58	5234.24	171.47	14.78	239.5	425.75	8.13	safe	4807.59	
260	JHARKHAND	WEST SINGHBHUM	NOAMUNDI	42221	20299	62520	2755.33	275.54	2479.79	241.16	0	65	306.17	12.35	safe	2172.35	
261	JHARKHAND	WEST SINGHBHUM	SONUA	35297	5969	41266	2166.99	216.69	1950.3	140.72	0	91	231.72	11.88	safe	1717.84	
262	JHARKHAND	WEST SINGHBHUM	TANTNAGAR	16503	3600	20103	1319.74	131.98	1187.76	115.75	0	53	168.75	14.21	safe	1018.4	
263	JHARKHAND	WEST SINGHBHUM	TONTO	58906	5524	64430	4703.37	235.17	4468.2	108.52	0	20.5	129.03	2.89	safe	4338.6	
total				6064673	1848732	7913405	620230.19	50998.54	569231.64	64609.8	21042.79	92782.13	178434.73	31.35		392055.96	

Plate-1



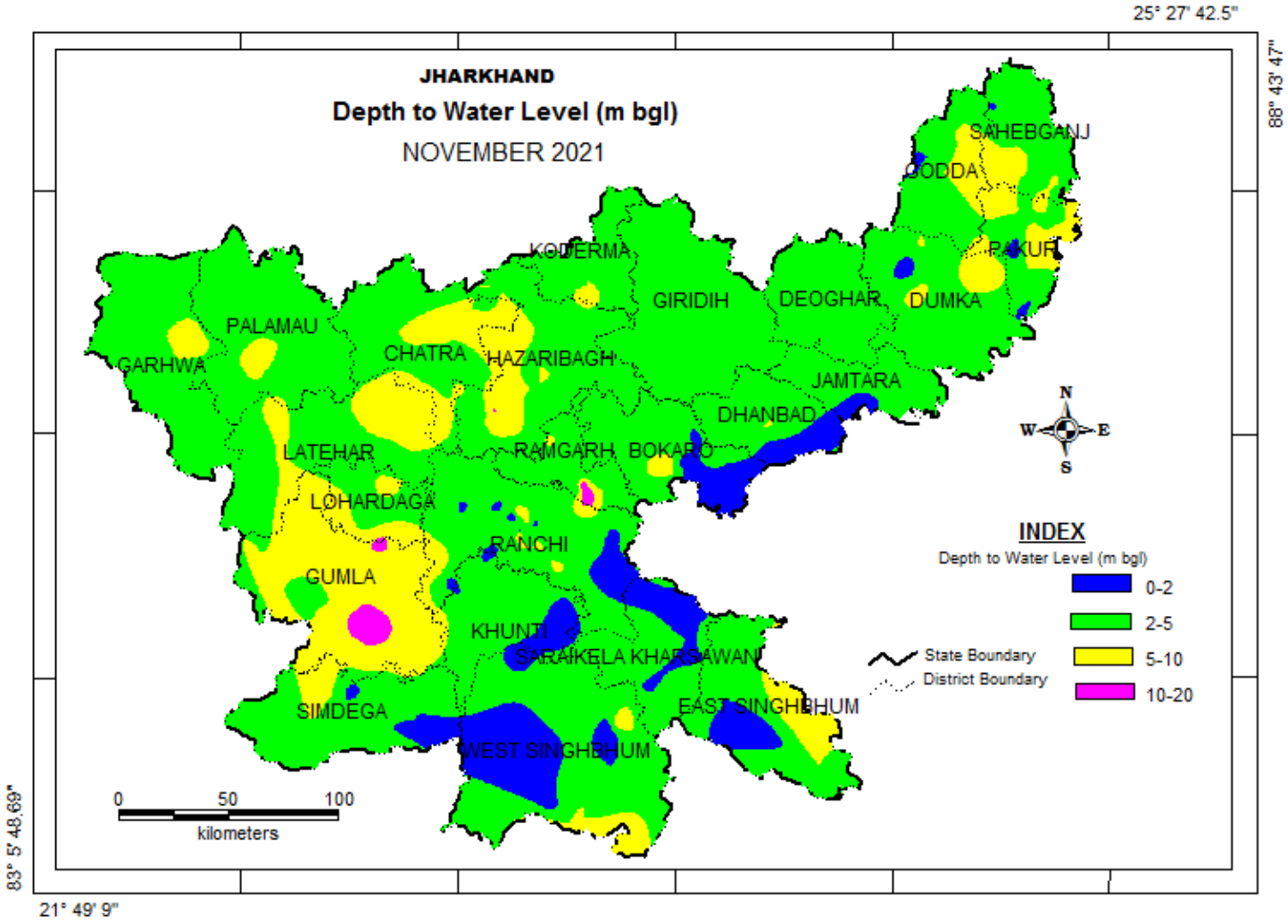
Administrative map of Jharkhand

Plate -2



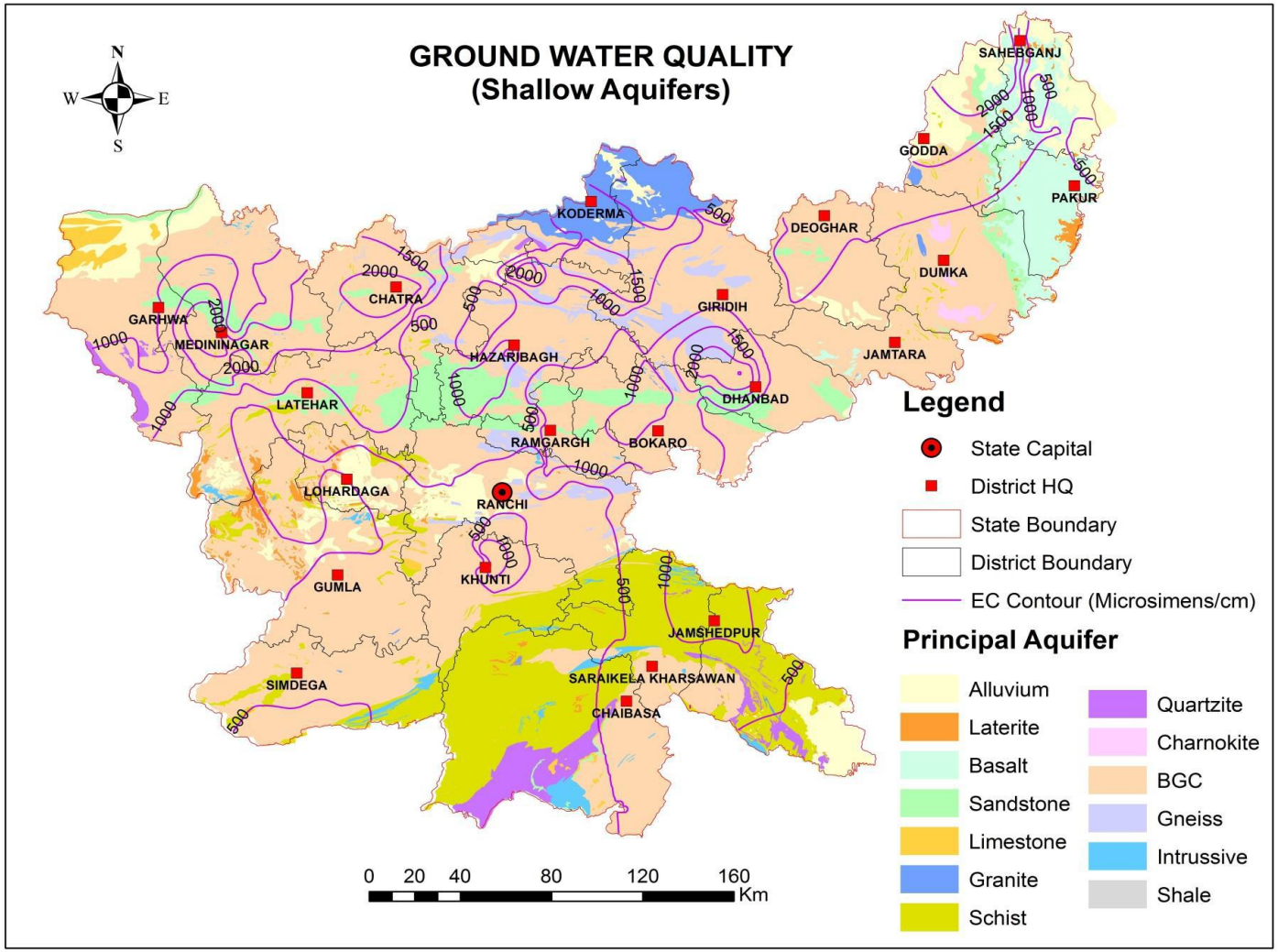
Principal Aquifer System in Jharkhand

Plate -3



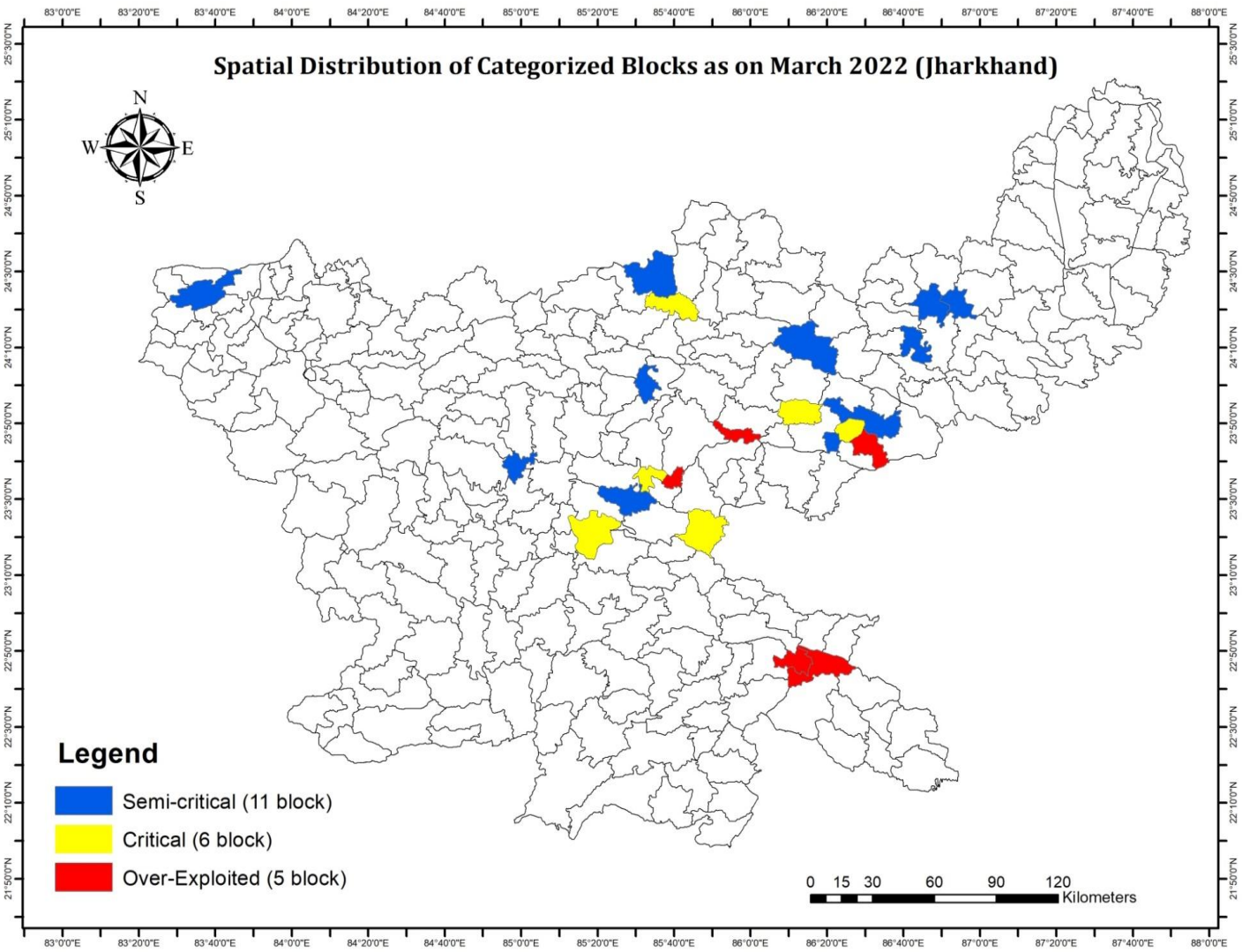
Depth to Water level post-monsoon (Nov.-2021)

Plate -4



Quality map of EC in Jharkhand

Plate -5



Categorization of Assessment Unit in Jharkhand