



Comprehensive Report on:

**Groundwater Condition in  
both core and buffer  
zone of Miragpur  
Manganese Mine,  
Khairlangi Block, Balaghat  
District, Madhya Pradesh**

Sneha Rai

Comprehensive Report on:

# Groundwater Condition in both core and buffer zone of Miragpur Manganese Mine, Khairlangi Block, Balaghat District, Madhya Pradesh

[Report submitted for obtaining NOC form CGWA under Section 5 of the Environment (Protection) act,  
1986 (29 of 1986) as per the new notification no 2941 of 24<sup>th</sup> Sept 2020]



M/s D P Rai, Nanhka, 10 East High Court Road, Ramdaspet, Nagpur-440010 Maharashtra,  
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By MRCATM - March 2022

# Executive summary

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An Underground Mine of Manganese Ore of M/s D P Rai is located at coordinate 21°37'56.9"N 79°49'56.2"E of village Miragpur, Balaghat district Madhya Pradesh adjacent to the State Maharashtra boarder. The mine was established in March 2006. The mine was previously developed as an open cast mine for ore extraction since April 2016. It is proposed to extend and expand the existing o/c workings in the strike direction to the east and west both and the Pit will be further deepened. The present study is made for obtaining and NOC from CGWA for extraction of maximum 68KLD groundwater during mining operation as per the approved mine plan. The mine discharge will remain below 100 KLD during all future expansion of mining operation during next 5 -10 years. The present report is based on the hydrogeological investigation made within core zone and its 10km radius buffer zone for assessment of impact of dewatering of groundwater by the mine and will be submitted to CGWA for obtaining renewal of NOC.

The study area falls under Wanganga river subbasin of Godavari basin and comprises of parts of Khairlangi Block of MP and Bhandara block of Maharashtra both falls under safe blocks as per the report on Dynamic Groundwater Resource of India, published by CGWB in 2019-20. The study area is having largely one geological formation, Mansar Group of rocks of Proterozoic quartzite mica schist in the area. These are constituting hard rock aquifer of phreatic nature. The Thickness of aquifer is about 12-17m. The 24.288 ha mine lease area is located near water divide and having radiating flow direction, but no river/stream generates from this area. The av annual groundwater level in the core zone remain 6m bgl in comparison to 5m level of buffer zone. Groundwater quality is fresh and potable in both core and buffer zone area and TDS remains below 1900 ppm varies from 150 to 1900 ppm in the study area.

As per the approved mine plan the dewatering of groundwater maximum 68KLD was obtained but the quantum of water generates as mine discharge remain largely below this limit around 8KLD in general. The water generated during mining processes containing heavy silt load. The entire water is reused in maintaining the green belt/horticulture and dust suppression within the ML area and for mining operation. Rainwater is harvested within the ML area through construction of water conservation pond. Roof top Rainwater harvesting structure is proposed as per building bylaw. The annual conservation through RWH&AR is about 0.14ham at present and will increase due to construction of rooftop RWH structure.

There is limited long term impact of groundwater dewatering by Miragpur mine on the study area, Thus the study recommend NOC may be provided for next 5 yr with maximum 68 KLD extraction from groundwater system as mine discharge.



## Acknowledgments and Certificate

Impact assessment and report preparation work as per the CGWA guideline was entrusted to MRCAWTM, Manav Rachna as accredited Groundwater Institution of CGWA by M/s D P Rai Nagpur is thankfully acknowledged.

Discussions with Mr. Abhishek Rai, Chairman cum Managing Director, regarding the history of mine establishment and its process of mining of Mn ore has helped us in understanding the process well and plan our investigations according to scope of work is gratefully acknowledged. Help rendered by Shri Sudhakar Chande, Manager & Mr. Himanshu, Geologist in every stage of planning and execution, investigations in and around plant area and report preparation is thankfully acknowledged. He also provided all the available relevant data and records many of them are reproduced in this report and forms part of annexure section.

At mine level, during days of field investigation we have received warm welcome and all hospitality and requisite support from mine team. We thankfully acknowledge Shri Sudhakar Chande Mines Manager and his team for their cooperation.

The report has been prepared by Ms Sheha Rai, Asstt Prof MRCAWTM and Sandeep Kumar RA MRCAWTM under the supervision of Prof (Dr) Arunangshu Mukherjee, Director MRCAWTM. Ms Alifia Ibkar, RAMRCAWTM helped Mr Sandeep Kumar in the field work and data collection.

It is to certify that MRCAWTM have investigated the area of Pandharwani Mine Khairlangi Balaghat and based on actual data collected from field and literature survey done, has prepared the report as per the format of CGWA.

(Dr Arunangshu Mukherjee)  
Director, MRCAWTM

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## Comprehensive Report on Groundwater Condition in both core and buffer zone of Pendharwani Manganese Mine, Khairlangi Block, Balaghat District, Madhya Pradesh

[Report submitted for obtaining NOC form CGWA under Section 5 of the Environment (Protection) act, 1986 (29 of 1986) as per the new notification no 2941 of 24<sup>th</sup> Sept 2020]

### Format for Impact Assessment Report as per the CGWA Norms

| SNo         | Point of Report  | Reply Enclosed                      |
|-------------|--|-------------------------------------|
| <b>[1.]</b> | Brief about the proposed project giving location details, coordinates, google/ toposheet maps, etc. demarcating the project area   | <b>Yes [Chapter-1]</b>              |
| <i>1.1</i>  | <i>Land Use Land Cover of the surrounding area, Percentage of LULC categories</i>  | <b>Yes</b>                          |
| <i>1.2</i>  | <i>Topography and drainage.</i>  | <b>Yes</b>                          |
| <i>1.3</i>  | Details of wetlands [Highlight protected wetlands / Ramsar sites / NLCP lakes/ other important wetlands in terms of dependencies of local communities if any]  | <b>Not Applicable</b>               |
| <b>[2]</b>  | Ground water situation in and around the project area including water level and quality data and maps along with quality issues, if any. In case of mines, ground water conditions in both core and buffer zone should be described. | <b>Yes [Chapter-2]</b>              |
| <i>2.1</i>  | Brief geology of the area  | <b>Yes</b>                          |
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|             | 2.2.1 Aquifer description [type, depth, storativity, permeability and porosity]  | <b>Yes</b>                          |
|             | 2.2.2 Ground water flow and aquifer interaction<br>[flow direction, Ground water – surface water connectivity]   | <b>Yes</b>                          |
|             | 2.2.3 Ground water level trend analysis<br>[pre – monsoon and post – monsoon] for 10 years   | <b>Yes</b>                          |
|             | 2.2.4 Hydrograph of the water level for 10 years   | <b>Yes</b>                          |
|             | 2.2.5 Predicted water level declines for affected aquifers<br>[Ground water modeling]  | <b>Not Required</b><br>as per norms |

|      |  |                   |
|------|--|-------------------|
|      | 2.2.6 Ground water quality [pre - monsoon and post – monsoon]  | Yes               |
|      | 2.2.7 Water quality of nearby water bodies   | Yes               |
| [3.] | Details of the tubewells/ borewells proposed to be constructed. This includes the aquifer parameters, drilling depth, diameter, tentative lithological log, details of pump to be lowered, H.P. of pump, tentative discharge of tubewells/ borewells, etc. Locations to be marked on the site plan/ map. | Yes [Chapter-2,3] |
| [4.] | Details of Geophysical studies carried out in and around the project area. Ground water resources computation of the block in which the project falls  | Yes [Chapter-4]   |
|      | 4.1 Results of Geophysical analysis [vertical electrical sounding (VES), horizontal profiling and imaging, transient electromagnetism method (TEM)] etc  | Yes               |
| [5.] | Approved Mine plan in case   | Yes ( Chapter-5)  |
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| [6.] | Proposed usage of pumped water in case of infrastructure dewatering projects.  | Yes ( Chapter-6)  |
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| 6.2  | <i>Recharge</i>  | Yes               |
| 6.3  | <i>Runoff to stream</i>  | Yes               |
| 6.4  | <i>Benefitted area</i>   | Yes               |

| SNo  | Point of Report   | Reply Enclosed     |
|------|---|--------------------|
| 6.5  | Dust suppression, Green belt development etc  | Yes                |
| [7.] | Comprehensive assessment of the impact on the ground water regime in and around the project area highlighting the risks and proposed management strategies proposed to overcome any significant environmental issues. | Yes [Chapter-4]    |
| 7.1  | Impact on surface water sources   | Yes ( Chapter – 7) |
| 7.2  | <i>Impact on groundwater sources</i>  | Yes                |
|      | <i>7.2.1. A description of the impacts on environmental values that have occurred, or</i>   | Yes                |

|              |   |                        |
|--------------|---|------------------------|
|              | <i>are likely to occur, because of any past ground water abstraction.</i>   |                        |
|              | <i>7.2.2 An assessment of the likely impacts on environment that will occur, or are likely to occur, because of the ground water abstraction for a five years period starting on the consultation day for the report; and over the projected life of the resource project area, affected area and radius of influence in case of dewatering</i> | <b>Yes</b>             |
| <b>7.3</b>   | <i>Socio-Economic Aspects:</i>  | <b>Yes</b>             |
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|              | <i>7.3.2 Dependency on sources of water [surface or sub-surface]</i>  | <b>Yes</b>             |
|              | <i>7.3.3 Ground water uses [e.g. irrigation (irrigation method, number of watering) water supply etc.]</i>  | <b>Yes</b>             |
|              | <i>7.3.4 Improvement / decline in agricultural yield in last 5 years and likely impact after NOC</i>  | <b>Yes</b>             |
|              | <i>7.3.5 Impact of proposed / existing project on local communities [based on local interactions (interactions must be with stakeholders like fishermen community, farmers etc.)]</i>   | <b>Yes</b>             |
| <b>[8.]</b>  | Proposed measures for disposal of waste water by industries drawing saline water.   | <b>Not Applicable</b>  |
| <b>[9.]</b>  | Measures to be adopted for water conservation which includes recycling, reuse, treatment, etc. This includes the water balance chart being adopted by the firm along with details of water conservation methods to be adopted.  | <b>Yes [Chapter-3]</b> |
|              | <i>Brief write up along with capacity and flow chart of Sewage Treatment Plants / Effluent Treatment Plants / Combined Effluent Treatment Plants existing/ proposed within the project.</i>   | <b>Yes</b>             |
|              | <i>Details of water conservation measures to be adopted to reduce/save the groundwater.</i>   | <b>Yes</b>             |
|              | <i>- Total water balance chart showing the usage of water for various processes.</i>  | <b>Yes</b>             |
| <b>[10.]</b> | Any other details pertaining to the project.  | <b>Annexure (s)</b>    |

# Report on: Hydrogeological Investigation and Impact Assessment Report for Miragpur Manganese Ore Mine Balaghat District, MP

## Introduction

The report is prepared as per the format prescribed by CGWA for impact assessment study, the Introductory chapter comprises the following subtitle for describing its

- 1.1 Objectives
- 1.2 Scope of the study
- 1.3 Project description-Plant, process, product and location
- 1.4 Land Use Land Cover and percentage of LULC categories
- 1.5 Topography and drainage.

### 1.1 Objective

The Central Government had constituted the Central Ground Water Board as Authority vide notification number S.O. 38 (E), dated the 14th January, 1997 to exercise powers under sub section (3) of section 3 of the Environment (Protection) act, 1986 (29 of 1986) for the purposes of regulation and control of Ground Water Management and Development. The Authority has been regulating ground water development and management by way of issuing 'No Objection Certificates' for ground water extraction to industries or infrastructure projects or Mining Projects etc., and framed and issued guidelines in this connection from time to time. The entire process of grant of No Objection Certificate shall be online through a web based application system. The latest guideline issued by Gazette Notification no 2941 on 24th September 2020 supersedes all earlier guidelines issued by the Central Ground Water Authority (CGWA). CGWA vide email dated 21st Nov 2020 and 13th Jan 2021 instructed the M/s D.P. Rai, Nagpur, Maharashtra to submit Impact assessment report along with undertaking for processing their application for regularization of groundwater abstraction for mining. There by M/s D.P. Rai, Nagpur, Maharashtra engaged Dr Arunangshu Mukherjee, CGWA Accredited Groundwater Professional vide email dated 30<sup>th</sup> Dec 2021 to carry out the hydro geological investigation along with impact assessment study incorporating socio-economic assessment study on groundwater regime due to withdrawal/ dewatering groundwater by **Miragpur Manganese Ore Mine, Balaghat** M/s D.P. Rai, Nagpur, Maharashtra as per the prescribed format of CGWA.

## 1.2 Scope of Study

The scope of study includes hydrological study around mine and providing certificated report along with providing guidance on techno-legal aspects and compliance for obtaining NOC for CGWA as per latest guidelines. Detailed hydrogeological investigations within core and buffer zones (10km radius study area) of **Miragpur Manganese Ore Mine, Balaghat** leased to M/s D.P. Rai, Nagpur, Maharashtra and assessment of impact of mining on groundwater regime in the study area which covers parts of Khairlanji block/tehsil, Balaghat district of Madhya Pradesh and some villages of Bhandara district, Maharashtra. As the mine is generating only 8m<sup>3</sup>/day discharge thus groundwater modeling is not required along with impact assessment report for this case as per the CGWA guideline.

## 1.3 Project description

M/s D.P. Rai, Nagpur, is a partnership firm registered under Indian Partnership Act, 1932. Miragpur Manganese ore mine is engaged in the mining activities since decades. Miragpur mine having an area of 24.288 ha & 4.339 ha. Presently mining is through underground method. Existing open pit size-4180 m<sup>2</sup> as on 1-04-2016- This is the Main Pit which was proposed to be extended along strike towards the western lease boundary and depth extension proposed up 330 MRL. The surface elevation at 24.288 ha & 4.339 ha mine lease area varies between 345 and 342 m amsl. The firm is well equipped with tools qualified personnel and required plans. Miragpur Mine is an underground mine for proposal of production of Mn ore of 1300 tons/Yr. Mn ore band, running from (N200W to S200E) direction with an average thickness of ore is 8 (Eight) meters. Dip of the ore body is approx. 250 towards (SW).

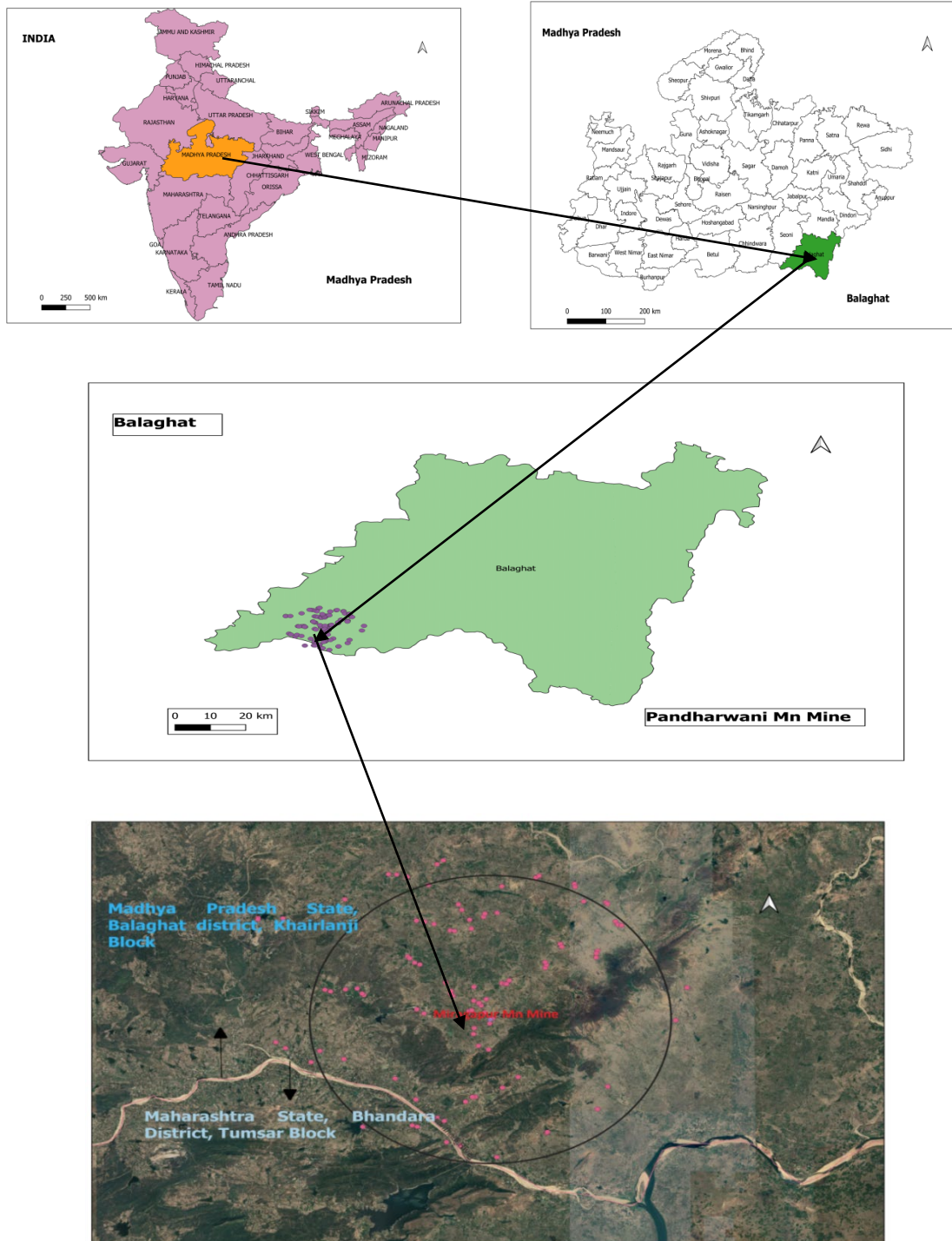
## Location

Miragpur Manganese Ore Mine is located in Miragpur village, Tehsil Khairlanji, District Balaghat, Madhya Pradesh. Miragpur village is situated in the south west portion in Balaghat district, Madhya Pradesh. The study area falls under survey of India toposheet no F44N14. Miragpur mine is situated 50km from Balaghat Town and 25 km from Khairlanji tehsil headquarters and 130 km from Nagpur railway station. Mining lease area is surrounded by the agriculture land and small hillocks of weathered soil. Many shallow depths abounded open cast mines pits are present within the study area. The opening of Miragpur underground mine is located at coordinate 21°37'56.9"N 79°49'56.2"E (**Fig1.1**).The lease area of underground mine is not located within 10km radius of National Park /Wild Life Sanctuary / Protected area and don't falls under Coastal Regulation Zone (CRZ).

## 1.4 Land use and Land cover (LULC) change in the study area:

The total area of the Miragpur mine is 24.288 Ha (242800 m<sup>2</sup>) & 4.339 ha. The mine is situated in outer part of the Miragpur village surrounded by hills and forest area. The land use of the mining area is given in **Table no 1.1** and the percentage has been represented through a pie diagram in **Fig 1.2**. The nearest village is Jatapur Khappa located 0.8 km Comparison of LULC

during 2015 and 2021 within the 10 kms radius of mine area show marginal changes in agriculture use, forest cover, built up area, as shown in figs and tables -1.2 & 1.3, however area under water body has increased from 60 ha to 124 ha due to accumulation of water into some abandon mine pit sand due to construction of water conservation structures in the area.



**Fig 1.1: Location map of Miragpur Mn Mine, Balaghat district, Madhya Pradesh**



Fig 1.2: Google image showing Miragpur Mn Mine

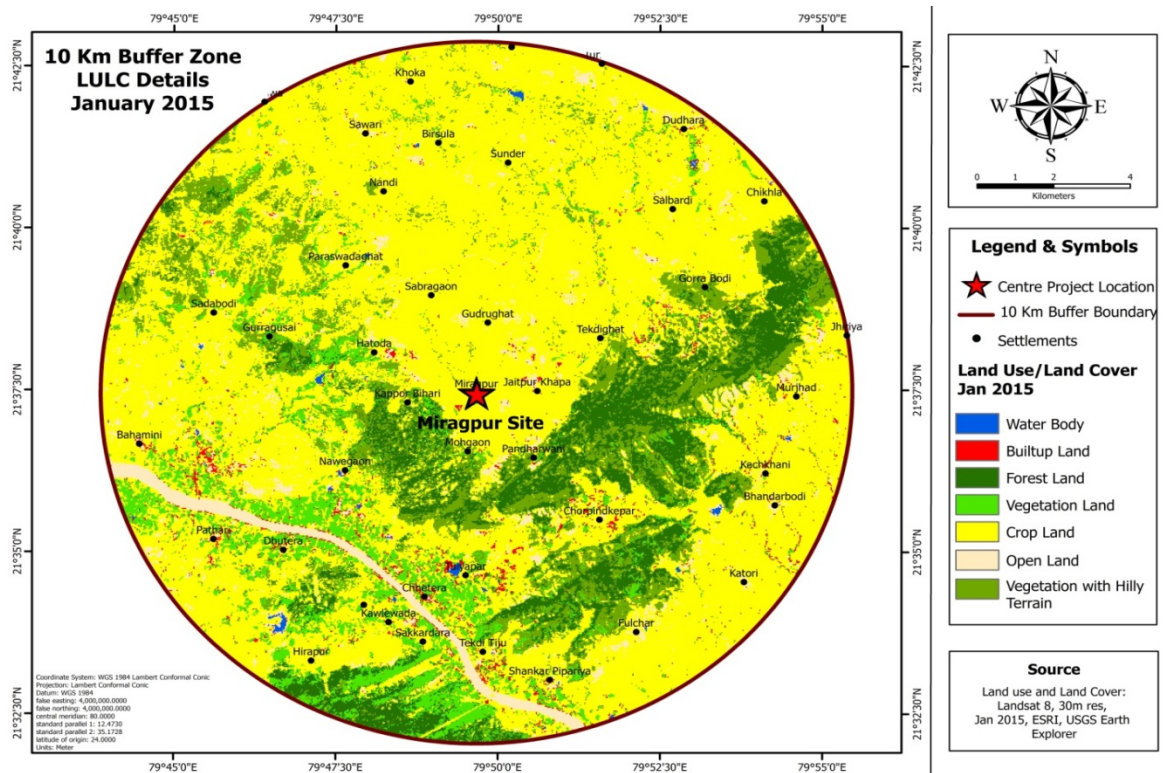
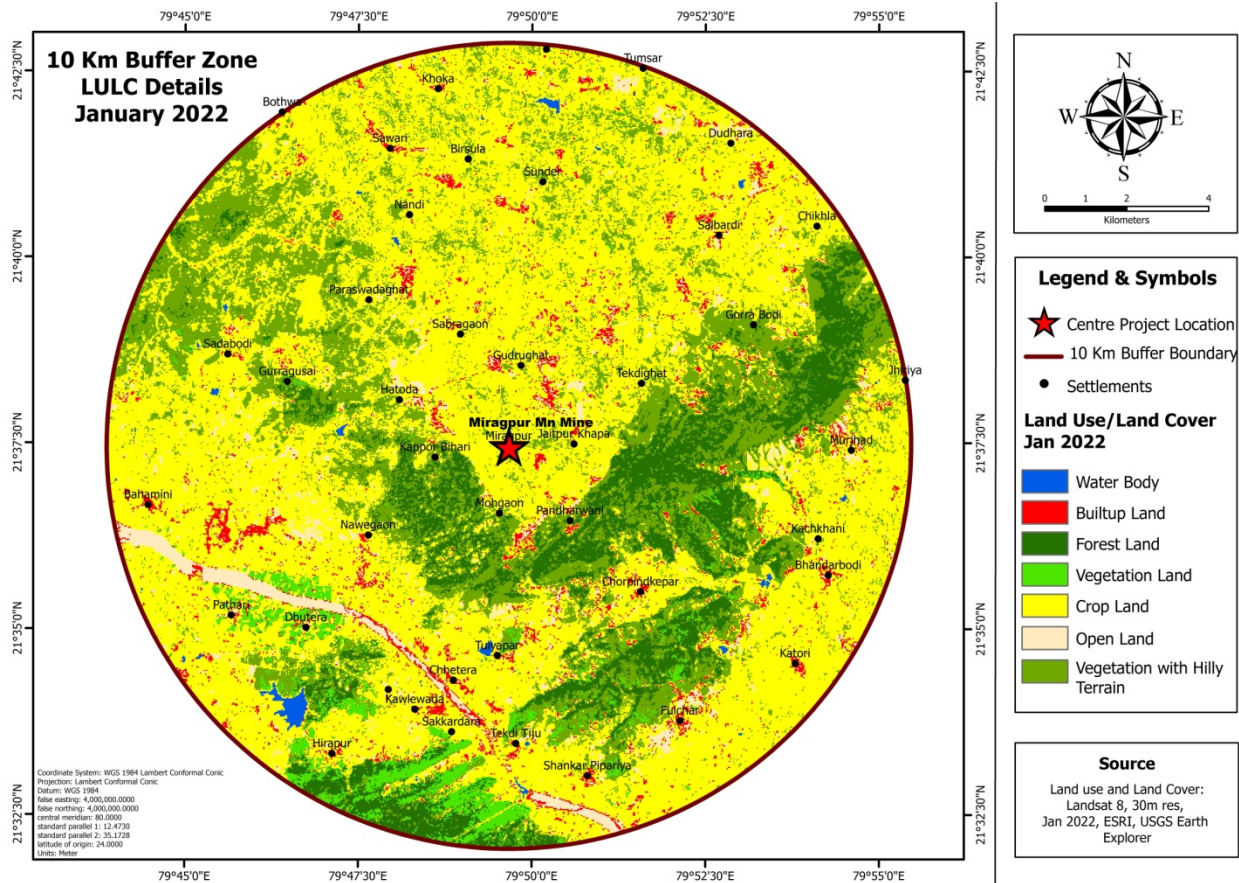


Fig 1.3: Map showing LULC of Miragpur Mn Mine of 10km buffer zone (Jan 2015)



**Fig 1.4: Map showing LULC of Miragpur Mn Mine of 10km buffer zone (Jan 2022)**

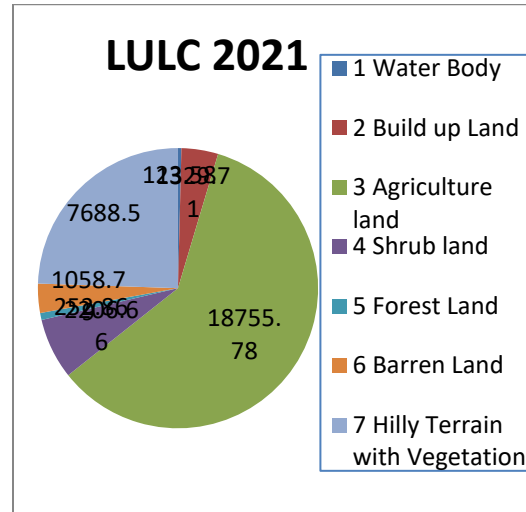
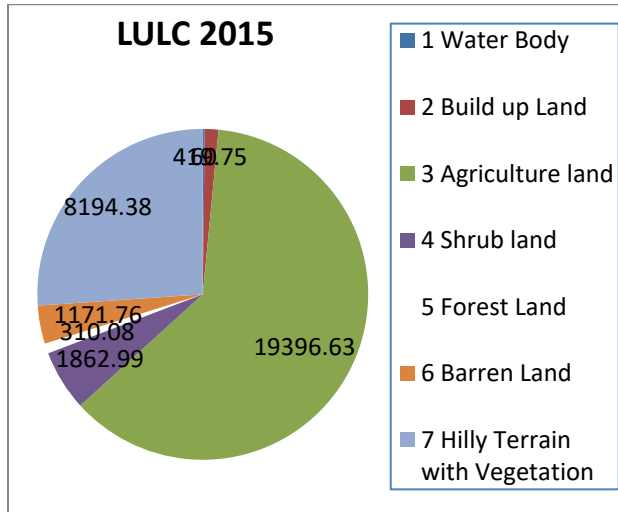


**Table 1.1 LULC 2015 of Study Area**

| Sr.no                                | LULC Type                     | Area (Ha)       |
|--------------------------------------|-------------------------------|-----------------|
| 1                                    | Water Body                    | 123.58          |
| 2                                    | Build up Land                 | 1329.71         |
| 3                                    | Agriculture land              | 18755.78        |
| 4                                    | Shrub land                    | 2206.66         |
| 5                                    | Forest Land                   | 252.86          |
| 6                                    | Barren Land                   | 1058.79         |
| 7                                    | Hilly Terrain with Vegetation | 7688.5          |
| <b>Total Area (10km Buffer zone)</b> |                               | <b>31415.88</b> |

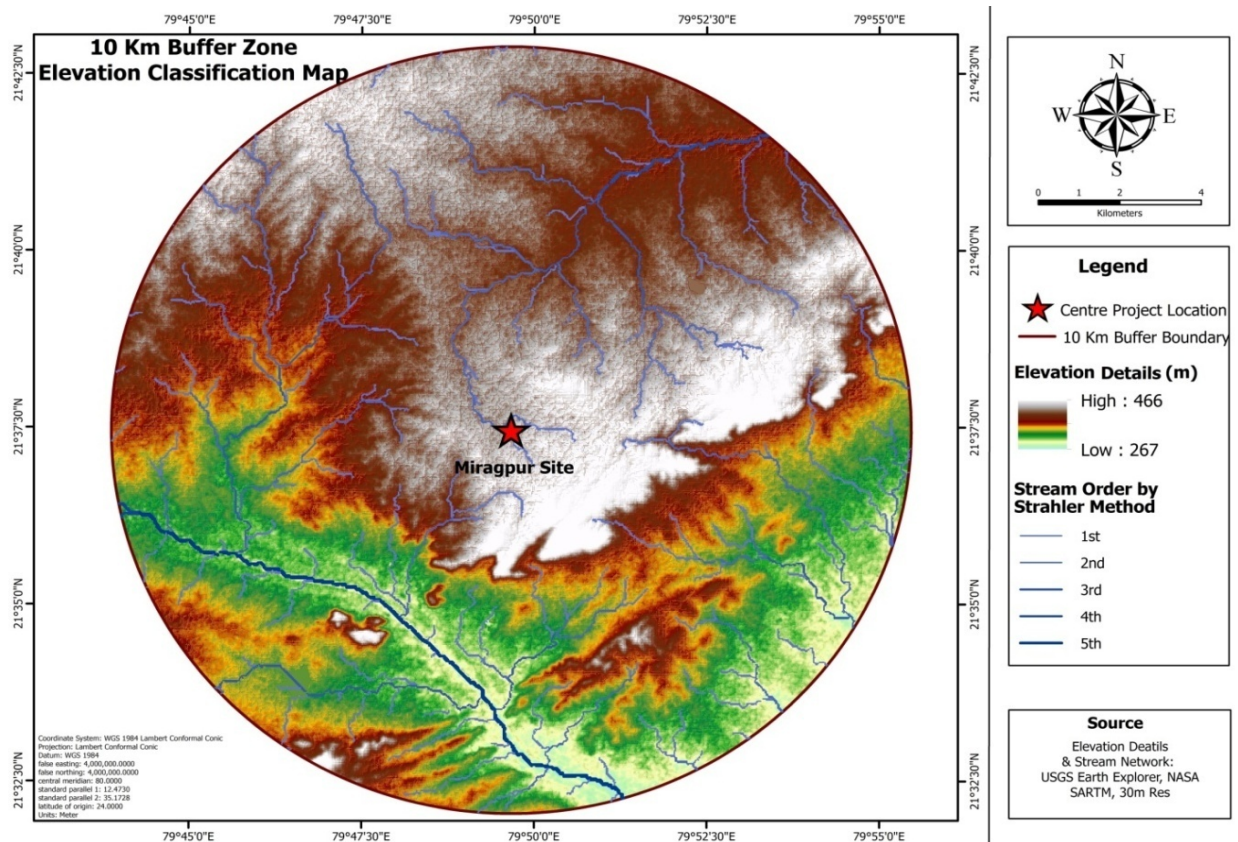
**Table 1.2 LULC 2021 of Study Area**

| Sr.no                                | LULC Type                     | Area (Ha)       |
|--------------------------------------|-------------------------------|-----------------|
| 1                                    | Water Body                    | 60              |
| 2                                    | Build up Land                 | 419.75          |
| 3                                    | Agriculture land              | 19396.63        |
| 4                                    | Shrub land                    | 1862.99         |
| 5                                    | Forest Land                   | 310.08          |
| 6                                    | Barren Land                   | 1171.76         |
| 7                                    | Hilly Terrain with Vegetation | 8194.38         |
| <b>Total Area (10km Buffer zone)</b> |                               | <b>31415.59</b> |

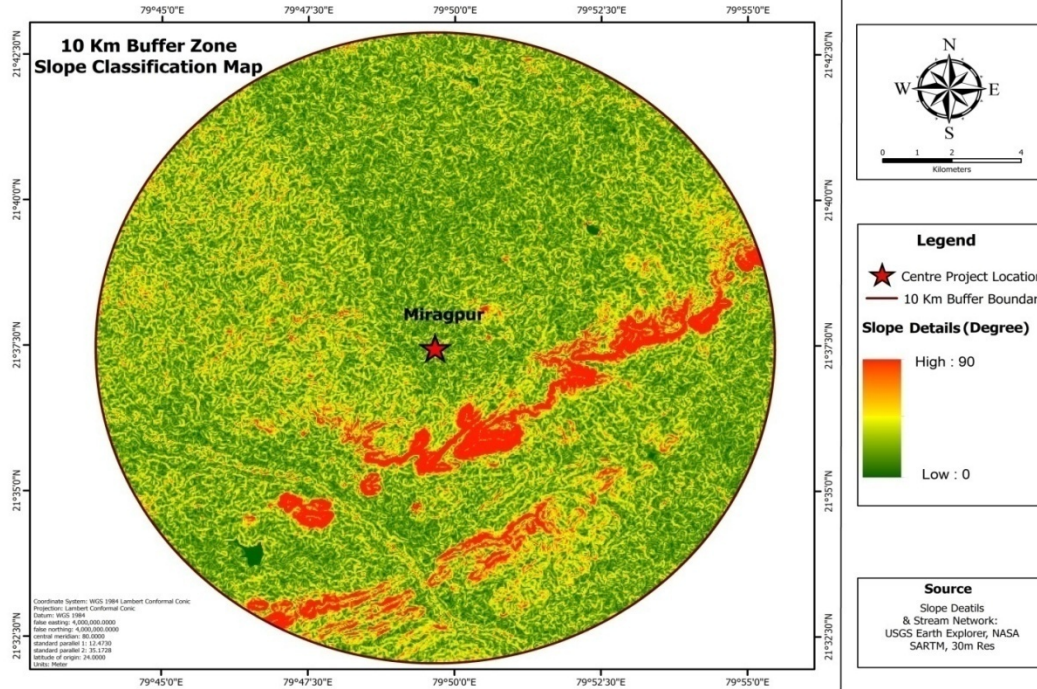


**1.5 Topography and Drainage:** The Miragpur mine belongs to Mansar Formation of Sausar Series. The Terrain is almost flat having some exposed rocks. The highest elevation is 466m amsl and lowest elevation is 267m amsl. The digital elevation model presented in Fig 1.5. The gradient of the study area has been measured by remote sensing data using elevation map in Fig 1.6. The western part and southern half of study area having southerly slope whereas the central (including mine area) and northeastern part having northeasterly slope. The area south of Bawanthadi River is having northerly slope.

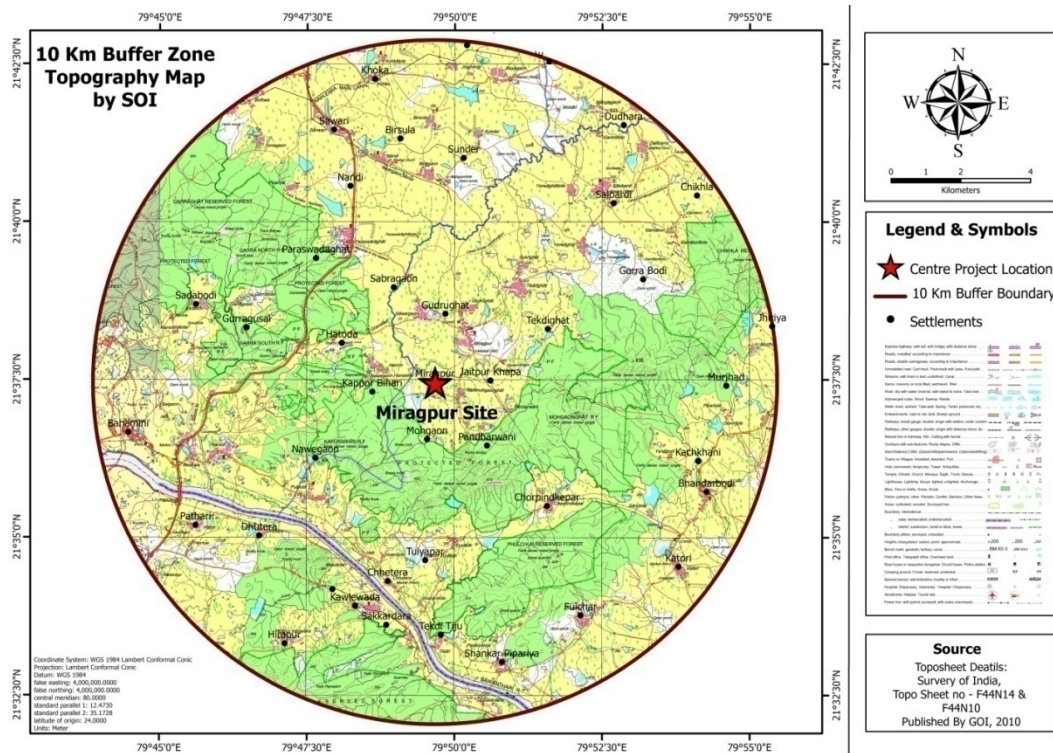
**Drainage:** There is no water body and Nallah in the lease area. At a distance of 8km NW direction a seasonal river called Bawanthadi flows in E-W direction. Bawanthadi is a tributary of river Wainganga of Godavari basin. Wainganga river entering Balaghat district from its Northwestern part from the Seoni district, creates the boundary between Sehoni and Balghat district and flowing south through the lowlands, it enter the Bhandara district. The Rajiv Sagar (Bawanthadi) interstate irrigation project, between the states of Madhya Pradesh and Maharashtra, envisages construction of a dam across river Bawanthadi. It has been constructed near village Kudwa in Katangi Tehsil of Balaghat district, M.P. and village Sitekasa of Tumsar Tehsil of Bhandara district, Maharashtra.



**Fig 1.5: Digital elevation map in 10km buffer zone.**



**Fig 1.6: Slope map of Miragpur Mn mine in 10km buffer zone**



**Fig 1.7: Topography Map map in 10km buffer zone.**

## 2. Groundwater Situations

Large part of the study area belongs to Khairlanji block which is located in Southwestern part of Balaghat District Madhya Pradesh. Ground water is the main source of drinking as well as domestic purpose. However, the requirement of water in irrigation and agriculture is fulfilled mainly by river as well as rainwater. The rainwater also is the main source for recharge of groundwater of the area. The following major subtopics that are covered in this particular chapter are:

- 2.1 Geology and Geomorphology
- 2.2. Climate and Rainfall pattern
- 2.3 Groundwater regime monitoring
- 2.4 Long term groundwater trend
- 2.5 Groundwater resources
- 2.6 Groundwater quality

### 2.1. Geology and Geomorphology

Manganese deposit of Madhya Pradesh – Maharashtra belongs to Sausar Group of rocks, displayed in accurate shape band which runs over 200 km. from Ukwa in M.P. to Kachidhana via Tumsar-Bhandara & Nagpur dist. of Maharashtra. Mansar Formation of Sausar Group is folded and re-folded and thrust by many cycles of deformations. Sausar sequence is rested over rocks of Gneissic complex with unconformity. Dolomites, Limestone, Mica Schist, quartzite, Biotite Granulite are the rock types associated with this series. Mica Schist, quartz mica schist along with Manganese have been made exposed in mine area by previous opencast activities. Mica Schist is coarse to fine grain rock with fish skin luster.

Geological Formation in the Study area

- **Alluvium soil:** On the basis of field study it has been observed that the lateritic soil is found with brown to red color. The average thickness of the soil is cover is 3m in study area.
- **Mica Schist with Quartzite:** It has been observed that the formation in the study area is trend in ENE-WSW and the trend of Manganese ore body is NNW-SSW. Mica Schist is coarse to fine grained with fish skin luster. Mica Schist is crenulated, filled with needles of stretched vitreous quartz. Quartz associated with schist is thick vitreous but crushed at places due to deformation.
- **Manganese ore with Gondite:** Manganese ore in Miragpur mine belong to Mansar Formation. Manganese ore is dark steel grey with Braunite as principal mineral associated with other oxide and silicate. The trend of the manganese ore deposit is mostly NNE-SSW and the angle of dip is varying from about 75° to 80°.

The manganese deposit of the Balaghat district, M.P., founds as NNE-SSW to ENE-WSW trending conformable bands in the form of lenses of varying sizes, enclosed within the metasedimentary sequence of Sausar Group of rocks of Precambrian age (Banerjee, et. al. 2007). The Madhya Pradesh-Maharashtra manganese belt is the largest manganese ore deposits of India which are intensely deformed and metamorphosed varies from green schist facies to upper amphibolite facies with gradual increase in the grade of metamorphism from East to West The regionally metamorphosed syngenetic sedimentary bodies of manganese ores in the Sausar Group of Balaghat district, Madhya Pradesh exhibit a definite trend in the formation and transformation of manganese oxide phases with progressive metamorphism. A regional trend is clearly noticeable from the paragenesis of Ore minerals in the manganese ore bodies from different metamorphic zones. Braunite forms at a very low temperature, appearing in the chlorite zone of regional metamorphism, and it continues in stable form right up to the sillimanite zone. Bixbyite as a high temperature mineral appears first in biotite zone and also appears in the sillimanite and almandine zone in the Balaghat

### Stratigraphic succession of Sausar group (Bandyopadhyay, et. al., 1995)

| FORMATION              | LITHOLOGY  |
|------------------------|--|
| Bichua Formation       | Dolomite, Marble, Calc silicate gneiss schist.   |
| Junewani Formation     | Metapelite (Mica Schist), Quartzite, granulite, biotite-Gneiss (Reworked basement).                                  |
| Charboli Formation     | Quartzite, feldspathic Schists, Gneisses, Autoclastic Quartz, Conglomerate.  |
| Mansar Formation       | Metapelite (mica-schists and gneisses), graphitic Schists, Phyllite quartzite, major manganese deposits and gondite. |
| Lohangi Formation      | Calc-Silicate Schists and gneisses, marble, Manganese deposits.  |
| Sitasaongi Formation   | Quartz mica Schists, Feldspathic Schists, mica gneiss, Quartzite, Conglomerate.                                      |
| -----Unconformity----- |  |
| Tirodi Gneiss          | Biotite gneiss, Amphibolite, Calc-Silicate Gneiss (Tirodi Gneiss), Granulites, Mica Feldspathic Schists.             |
| Older Metamorphics     | Charnockite, Orthogneisses and Granite Biotite Gneisses, hornblende Gneisses, Amphibolites and calcgranulites        |

**Geomorphology:** Morphologically the area having Alluvial plains, intermonnate valleys, denudational hills and peneplains. Natural levees can be seen in the bank of Bawanthadi River. Strems are showing dendritic pattern, drainage density is modarate.

### 2.2 Climate and Rainfall:

The mining area is situated in Khairlanji block of Balaghat district, but the study area covers the southwestern part of Balaghat district and northern part Tumsar block of Bhandara district in Maharashtra State, India. The nearest Meteorological station is at Satona (Hydromet Division,

IMD), which is located around 60 kms from the study area. Therefore, the data collected from IMD Satna and from the state data of Madhya Pradesh and Maharashtra have been considered to discuss the climate and rainfall of the study area (Table 2.1 to 2.4)

### **Winds**

The wind velocity is higher during the pre-monsoon period as compared to post monsoon period. The maximum wind velocity 7.7 km/hr observed during the month of June and minimum 3.9 km/hr during the month of December.

### **Temperature**

The Climate of the district is sub- tropical or moderate characterized by a hot summer and general dryness except during the southwest monsoon season. The cold season usually begins from the month of December and continues to February. December is the coldest month with mean minimum temperature of around 8°C The winter is followed by the summer season which starts from March and continues to the middle of June having mean daily maximum temperature of 43°C in the month of May. The period from the middle of June to September is the southwest monsoon which is followed by the post monsoon or transition period in the months of October and November.

### **Humidity**

The relative humidity is maximum during the southwest monsoon which ranges between 70-75%, it is comparatively drier in the rest of the year. The driest part of the year is the summer season, when relative humidity is less 34%. May is the driest month of the year.

### **Rainfall**

Rain fall is the major source of the water of the area is discussed. The area is characterized by semi-arid type of climate, which is mainly having moderate dryness except during the monsoonal months. The normal annual rainfall of Balaghat district is 1471.6 mm. Balaghat district receives maximum rainfall during southwest monsoon period i.e. June to September and a very little rainfall during north-east monsoon (October to December). in the wake of thunderstorms and western disturbances. Thus, surplus water for ground water recharge is available only during the southwest monsoon period.

| Table 2.1 Decadal Rainfall in Balaghat District (Source: WRIS online portal) 2011-2020 |                      |               |      |                      |               |                       |
|--|----------------------|---------------|------|----------------------|---------------|-----------------------|
| Year   | Actual Rainfall (mm) | Deviation (%) | Year | Actual Rainfall (mm) | Deviation (%) | Average Rainfall (mm) |
| 2011   | 1131.59              | -1.69         | 2016 | 1055.89              | -8.27         | 1151.14               |
| 2012   | 1067.65              | -7.25         | 2017 | 908.02               | -21.11        |                       |
| 2013   | 1481.32              | 28.68         | 2018 | 1036.58              | -9.95         |                       |
| 2014   | 1154.34              | 0.27          | 2019 | 1263.39              | 9.75          |                       |
| 2015   | 1018.4               | -11.53        | 2020 | 1394.22              | 21.11         |                       |

| Table 2.2 District wise average Annual Rainfall of and Departure(%) from Normal rainfall |                                |                                 |                           |  |   |
|--|--------------------------------|---------------------------------|---------------------------|--|---|
| District   | Normal rainfall (mm) 1980-2010 | Average rainfall (mm) 2011-2020 | Actual rainfall (mm) 2021 | Departure (%) in 2021 from Normal Rainfall | Departure (%) in 2021 from Average Rainfall |
| Balaghat   | 1471.6                         | 1151.14                         | 1062.69                   | -27.7                                      | -7.03                                       |

| Table 2.3-Monthly rainfall of 5 years in mm |          |        |          |        |          |        |          |        |          |        |          |        |          |        |          |        |           |     |         |      |      |       |
|---|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|-----------|-----|---------|------|------|-------|
| Year  | January  |        | February |        | March    |        | April    |        | May      |        | June     |        | July     |        | August   |        | September |     | October | Nov  | Dec  |       |
|   | Rainfall | % Dep. | Rainfall | % Dep. | Rainfall | % Dep. | Rainfall | % Dep. | Rainfall | % Dep. | Rainfall | % Dep. | Rainfall | % Dep. | Rainfall | % Dep. |           |     |         |      |      |       |
| 2013  | 18.4     | -37    | 5.8      | -71    | 37.4     | 220    | 6.4      | 36     | 2.6      | -52    | 124.1    | 0      | 800.6    | 155    | 276.3    | -16    | 195.1     | 7   | 4.9     |      |      |       |
| 2014  | 0        |        | 0        | -100   | 34.2     | 192    | 24.2     | 415    | 25       | 363    | 53.8     | -57    | 378.7    | 20     | 209.6    | -36    | 50.2      | -72 | 3.6     |      |      |       |
| 2015  | 0        |        | 71       | 253    | 21.6     | 85     | 0.6      | -67    | 1        | -81    | 145.1    | 17     | 146.9    | -53    | 176.4    | -46    | 172.9     | -5  | 0       |      |      |       |
| 2016  | 0.9      | -97    | 8.5      | -58    | 0.3      | -97    | 3        | -36    | 7.7      | 43     | 205.5    | 65     | 206.9    | -34    | 212.5    | -35    | 101.1     | -44 | 4.1     |      |      |       |
| 2017  | 12.9     | -59    | 0        |        | 1.4      | -88    | 3.8      | -19    | 14.5     | 169    | 25.8     | -79    | 207.6    | -34    | 192.5    | -42    | 152       | -16 | 220.4   |      |      |       |
| Ave.  | 6.44     |        | 17.06    |        | 18.98    |        | 7.6      |        | 10.2     |        | 110.9    |        | 348.14   |        | 213.46   |        | 139.26    |     | 46.6    | 12.6 | 1.76 | 932.9 |

Table 2.4 Average Monthly Meteorological Data of study area ( source: IMD)

| Month    | Temperature (°C) |      | Rel. Humidity (%) |         | Vapour Pressure (hpa) |         | Mean Wind Speed (Km/hr) | Average Rainfall (mm) (2012-16) | Cloud Amount (oktas) |         |
|----------|------------------|------|-------------------|---------|-----------------------|---------|-------------------------|---------------------------------|----------------------|---------|
|          | Min.             | Max. | Morning           | Evening | Morning               | Evening |                         |                                 | Morning              | Evening |
| January  | 4                | 29.2 | 60                | 48      | 10.15                 | 10.1    | 4                       | 6.44                            | 1.2                  | 1.3     |
| February | 6.6              | 33.1 | 51                | 37      | 10.95                 | 10.8    | 5.6                     | 17.06                           | 1                    | 1       |
| March    | 11.4             | 38.6 | 41                | 27      | 11.36                 | 10.5    | 5.8                     | 18.98                           | 1.1                  | 1.2     |
| April    | 16.9             | 42.6 | 34                | 22      | 12.9                  | 12.7    | 7.5                     | 7.6                             | 1.2                  | 1.5     |
| May      | 22.3             | 45   | 45                | 26      | 18.6                  | 14.9    | 7.6                     | 10.16                           | 1.3                  | 1.4     |

|           |      |      |    |    |      |      |     |        |     |     |
|-----------|------|------|----|----|------|------|-----|--------|-----|-----|
| June      | 23.1 | 41.8 | 59 | 49 | 25.7 | 24.5 | 8.1 | 110.86 | 4   | 4.6 |
| July      | 22.8 | 37   | 79 | 71 | 28.9 | 29.8 | 7.9 | 348.14 | 5.8 | 5.8 |
| August    | 22.4 | 33.5 | 80 | 72 | 29.7 | 28.9 | 7.1 | 213.46 | 5.7 | 5.9 |
| September | 21.6 | 33.8 | 79 | 71 | 27.9 | 27.8 | 6.9 | 139.26 | 4.3 | 5   |
| October   | 14.1 | 33.7 | 67 | 60 | 21.8 | 22.3 | 4.5 | 46.6   | 2.3 | 2.4 |
| November  | 8    | 31.8 | 56 | 51 | 16.3 | 14.1 | 3.3 | 12.6   | 1.3 | 0.9 |
| December  | 5    | 29.5 | 59 | 45 | 10.8 | 10.5 | 3.8 | 1.76   | 1   | 1   |

## 2.3 Groundwater regime monitoring

The study area comprises 10km radius zone in Miragpur Manganese mine that fall largely under Khairlanji block, Balaghat district, Madhya Pradesh and partly in Tumsar Tehsil of Bhandara district, Maharashtra. Detailed hydrogeological study of both core zone and buffer zone of mine area is carried out. The study area having single aquifer formed in hard rock comprises Quartz Mica Schist. Total groundwater extraction from the Miragpur mine is 8KLD is through pump. Dug well are used for drinking and domestic purpose.

### 2.2.1 Detailed study of core and buffer zone

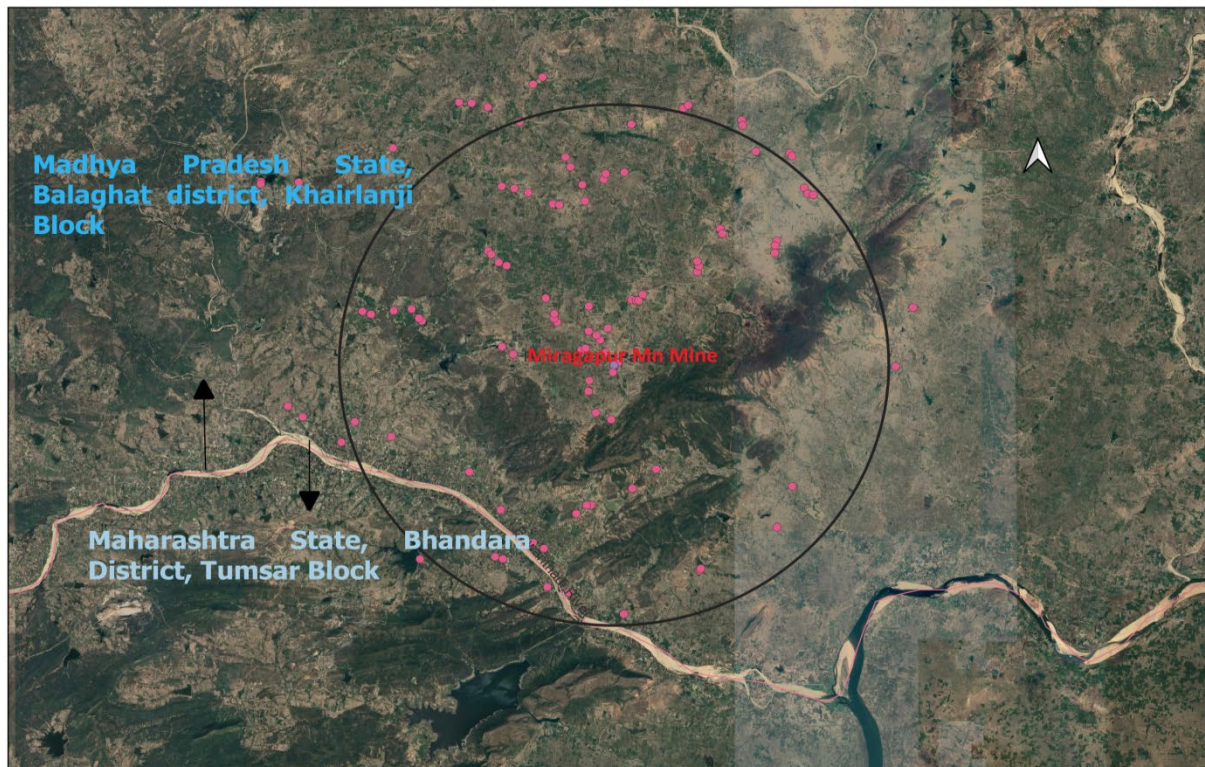
Major source of the water in the study area is south-west monsoon and very small contribution from north- east monsoon during winter. As per the field study it has been observed that in the study area groundwater is withdrawal from dug well and hand pump. Most of dug wells in study area having depth 4 to 8 m ground water. It varies during summer between 5m to 10m and 2.5m to 6.0m in winter. It has been observed that the borewells are often 20 to 40m in depth. Ground water is lying in weathered part of hard rock aquifer. Hard rock's comprise in the study area is Sausar sequence rested over rocks of Gneissic complex with unconformity. Dolomites, Limestone, Mica Schist, quartzite, Biotite Granulite are the rock types associated with this series. The movement of the ground water in deeper rocks is controlled by the nature, size opening and continuity of joints & fracture present in them. Wells in hard rock generally yield 50 to 70 m<sup>3</sup> /day of all the rock types. Schist, phyllite and their variants form very poor aquifers yielding 10 to 30 m<sup>3</sup> /day for heavy drawdown. Well inventory of study area in Pre Monsoon (Feb 2022) period showing water level varies within the range from 1.4 m to 8m bgl (Table 2.5).



**Table 2.5: Well inventory data of Dug wells of Core and buffer zone of Pandharwani Mine**

(Lat & Long data are as per GPS reading, DO, EC, pH, and TDS measured on site using calibrated Hanna portable equipment during Feb 2022).

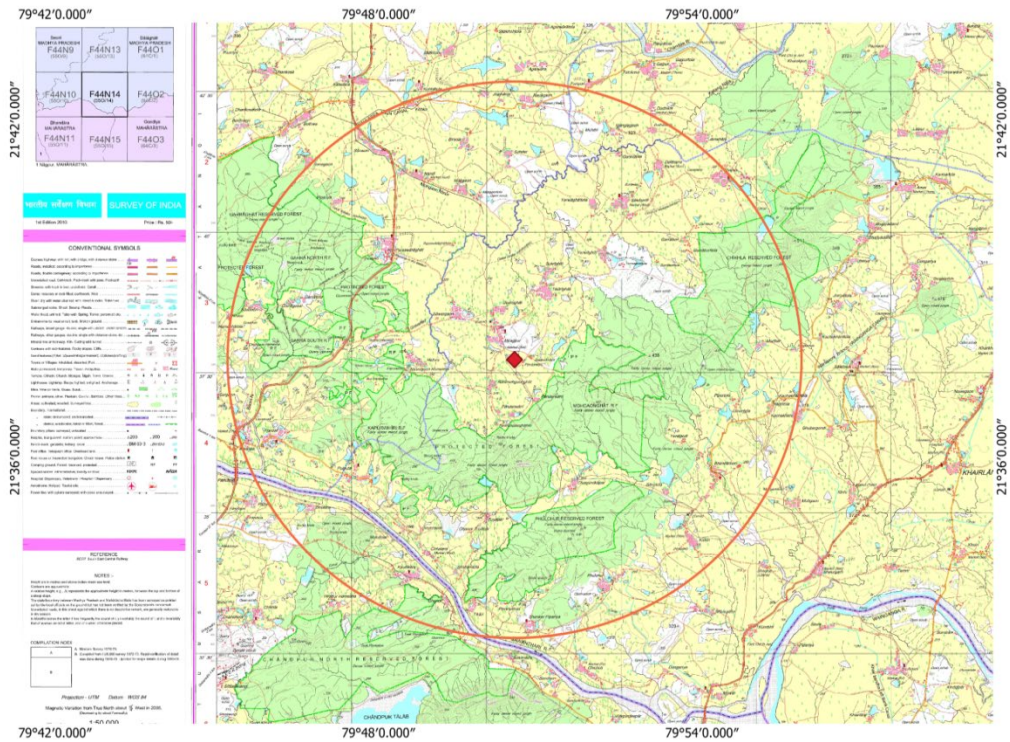
| S. N.                      | Village                            | Latitude | Longitude | Elevation (m amsl) | Water Level (m) | Diameter (m) | Depth (m) | DO (mg/l) | EC (μS) | pH  | TDS (ppm) |
|----------------------------|------------------------------------|----------|-----------|--------------------|-----------------|--------------|-----------|-----------|---------|-----|-----------|
| <b>Core Zone of Mine</b>   |                                    |          |           |                    |                 |              |           |           |         |     |           |
| 1                          | Sukdighat                          | 21.64861 | 79.848755 | 342.09             | 7               | 2.7          | 8.5       | 4.53      | 1560    | 7.2 | 650       |
| 2                          | Sukdighat                          | 21.64824 | 79.851071 | 353.48             |                 |              |           |           | 2550    | 7.3 | 1230      |
| 3                          | Sukdighat                          | 21.65027 | 79.852384 | 346.06             | 6.7             | 2.5          | 8.75      |           | 1990    | 7.8 | 1050      |
| 4                          | Pandharwani Mine lease             | 21.62827 | 79.844225 | 344.4              | 5               | 3            | 9.25      | 3.8       | 300     | 7.4 | 150       |
| 5                          | Ranimohgaon                        | 21.61919 | 79.834619 | 329.81             | 6               | 2            | 8.25      | 4.03      | 1050    | 7.5 | 510       |
| 6                          | Gudhrughat                         | 21.64652 | 79.834762 | 340.56             | 4.2             | 1.5          | 8.50      | 5.3       | 580     | 7.9 | 280       |
| 7                          | Sabargaon                          | 21.64262 | 79.823377 | 342.44             | 6.5             | 2            | 9.0       | 2.6       | 3800    | 6.8 | 1900      |
| 8                          | Paraswadaghat                      | 21.65951 | 79.807917 | 338.8              | 7               | 2.5          | 9.9       | 7.2       | 1005    | 7.3 | 520       |
| <b>Buffer Zone of Mine</b> |                                    |          |           |                    |                 |              |           |           |         |     |           |
| 9                          | Birsula                            | 21.6943  | 79.827105 | 351.11             | 4.5             | 2            | 8.0       |           | 1080    | 7.7 | 560       |
| 10                         | Sitakhor                           | 21.71768 | 79.816533 | 341.65             | 5               | 2            | 8.60      |           | 540     | 7.4 | 260       |
| 11                         | Katedara                           | 21.71186 | 79.792357 | 342.87             | 4               | 1.5          | 7.55      |           | 880     | 7.5 | 440       |
| 12                         | Tirodi                             | 21.68626 | 79.739922 | 332.9              | 4.5             | 2            | 8.0       |           | 720     | 7.1 | 310       |
| 13                         | Bamani                             | 21.61442 | 79.736391 | 306.33             | 3.5             | 2            | 7.0       |           | 820     | 7.1 | 444       |
| 14                         | Bonkatta                           | 21.60287 | 79.753879 | 286.6              | 6               | 1.4          | 8.25      |           | 910     | 7.1 | 440       |
| 15                         | Garragussai                        | 21.64557 | 79.776808 | 301.68             | 4.3             | 2.1          | 7.85      |           | 1111    | 6.7 | 560       |
| 16                         | Garragussai                        | 21.64505 | 79.770978 | 306.13             | 5.1             | 2            | 6.8       |           | 1720    | 7.2 | 900       |
| 17                         | Sadabodi                           | 21.6439  | 79.763553 | 309.29             | 4.4             | 1.5          | 8.25      |           | 1360    | 7.4 | 680       |
| 18                         | Garragussai                        | 21.64269 | 79.779196 | 307.21             |                 |              |           |           | 710     | 8   | 190       |
| 19                         | Churiya Par                        | 21.57994 | 79.830656 | 296.62             | 4.5             | 1.5          | 8.55      |           | 1050    | 7.5 | 490       |
| 20                         | Kawlewada (Near Bawanthadhi river) | 21.56613 | 79.804115 | 283.19             | 6               | 1.5          | 8.8       |           | 830     | 7.3 | 360       |
| 21                         | Katori                             | 21.5756  | 79.896254 | 279.11             | 4.2             | 1.5          | 7.90      |           | 1870    | 7.4 | 940       |
| 22                         | Gorra Bodhi                        | 21.66599 | 79.895665 | 331.16             | 4.8             | 2            | 9.0       | 4.2       | 680     | 7.4 | 320       |
| 23                         | Chikhla                            | 21.66357 | 79.895535 | 333.95             | 6               | 2.8          | 8.5       | 2.05      | 1220    | 7.5 | 620       |
| 24                         | Chikhla                            | 21.68264 | 79.906358 | 332.58             | 8               | 2            | 9.5       | 3.61      | 1910    | 6.9 | 960       |



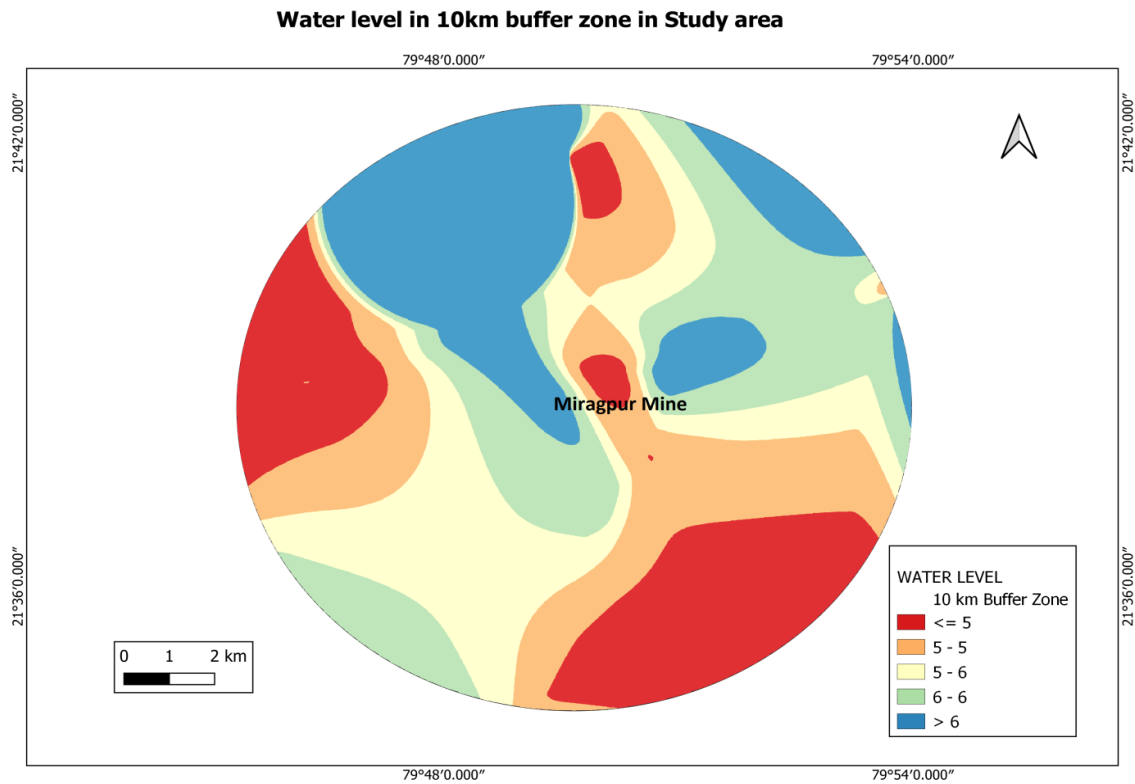
**Fig 2.1:** Map showing study area divided by state boundary of Madhya Pradesh and Maharashtra. Note the location of Miragpur Mn Mine at center and position of other villages on google image along with prominent roads. Inventory of wells of these villages are carried out under groundwater regime monitoring.



**Fig2.2:** Key map showing Tube well, Dug well and Borewell locations within the mine of Miragpur Mn Mine on google image and photo graph of measuring groundwater parameter.

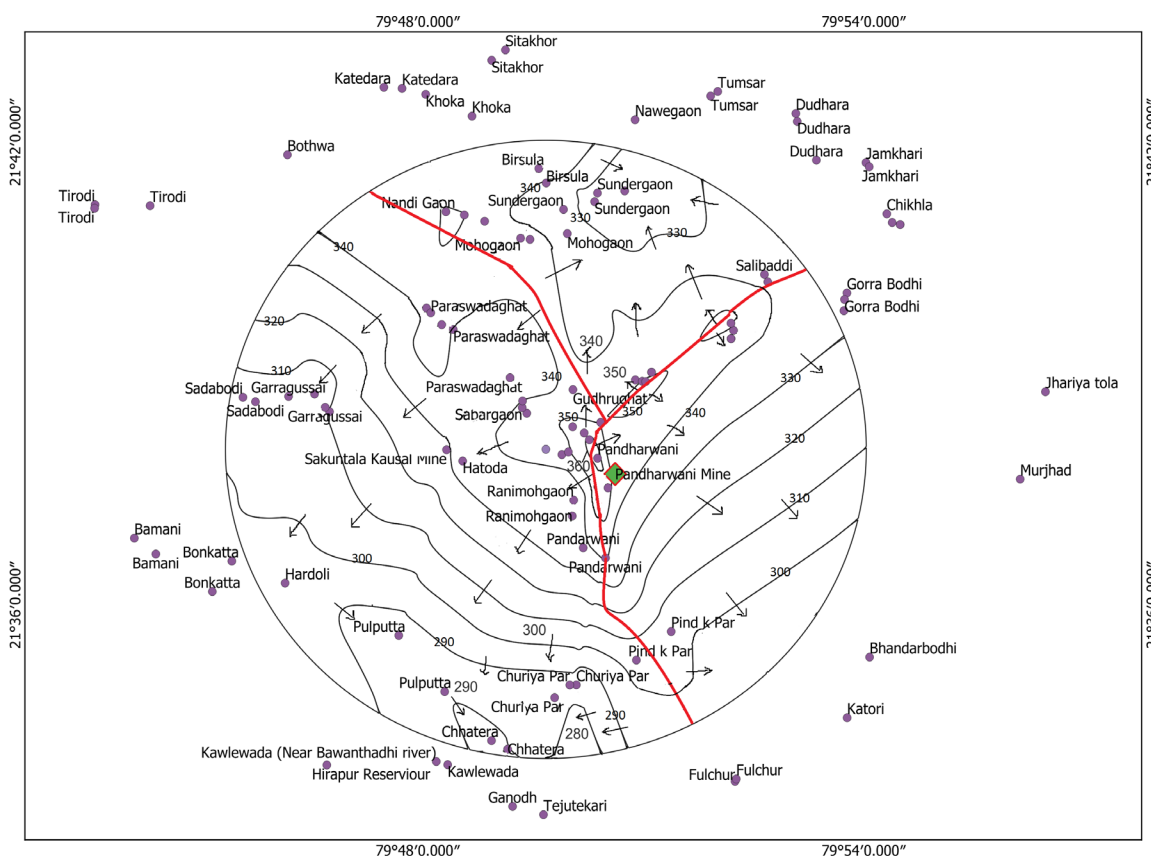


**Fig 2.3: Topography of study area. Note the position of project area within the study area.**



**Fig: 2.4 DTW map of core and Buffer zone of Miragpur Mn Mine**

**Groundwater Flow:** The groundwater contour map generated using the intense monitoring in core and buffer zone of mining is depicted in **Fig 2.5**. The map showing clear cut development of groundwater divide running through the mine area. The GW flow direction largely coincides with the surface water flow direction as shown in fig 1.5. Thus mine is on groundwater divide and any dewatering from mine will not effects significantly the flow direction of groundwater of the area.

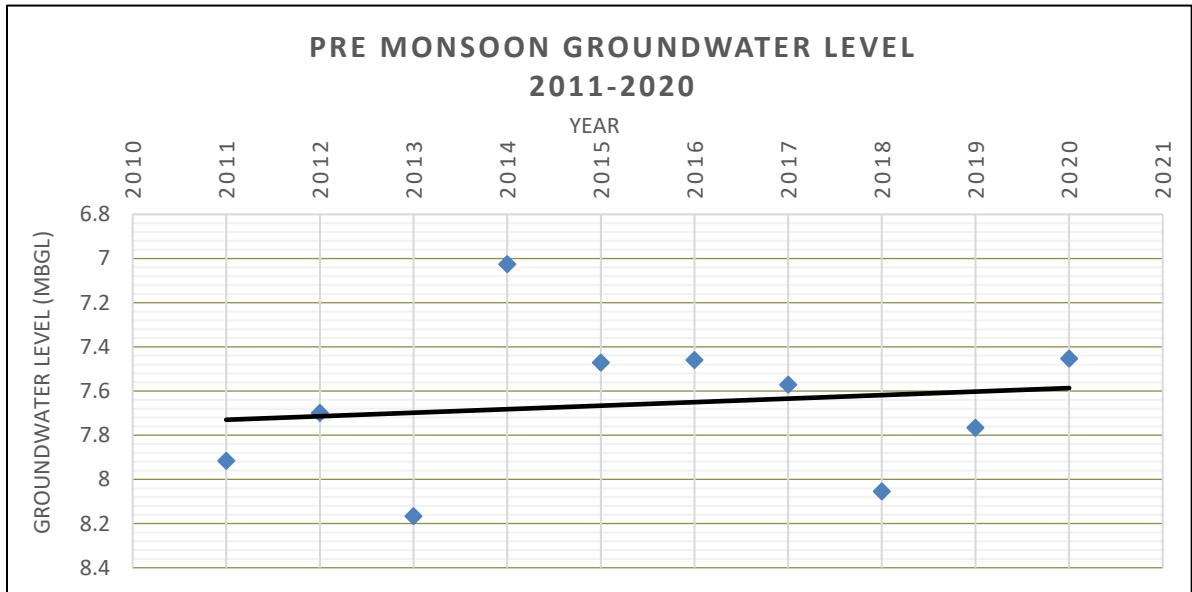
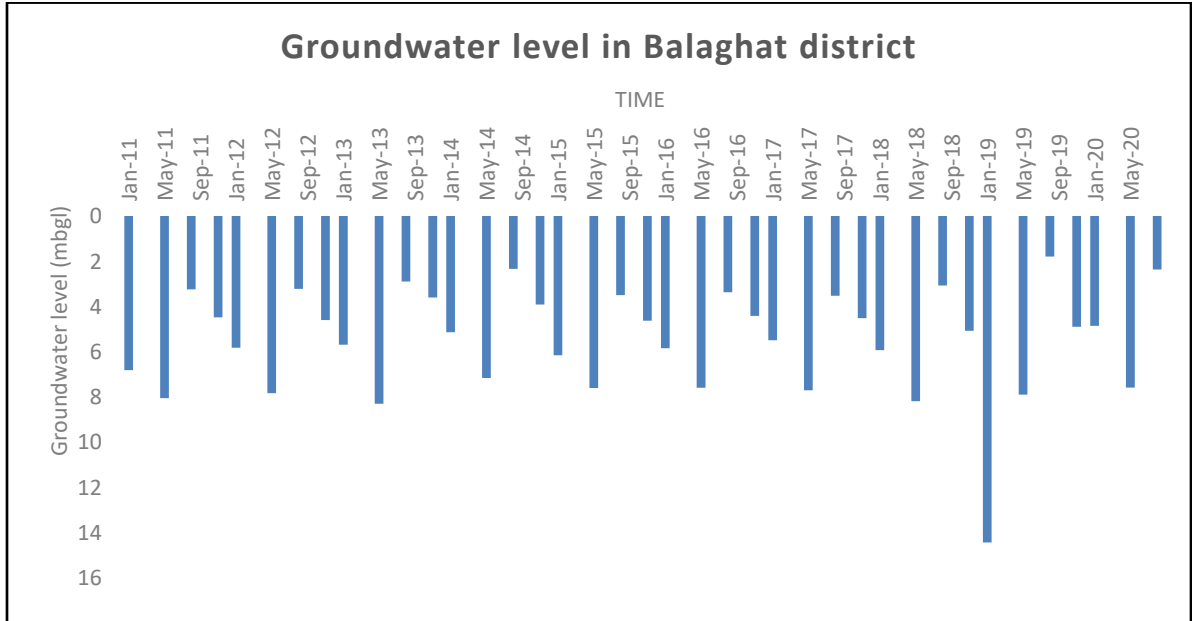


**Fig 2.5 Groundwater contour map of Miragpur mine area.**  
**INDEX-**Red line shows groundwater divide, arrows indicating groundwater flow direction, values indicate groundwater elevation (m amsl), dots indicate data point used for generation of GW contour, buffer zone is marked by 10km radius circle. Note the mine position (green box) situated near GW divide.

#### 2.4. Long term groundwater trend

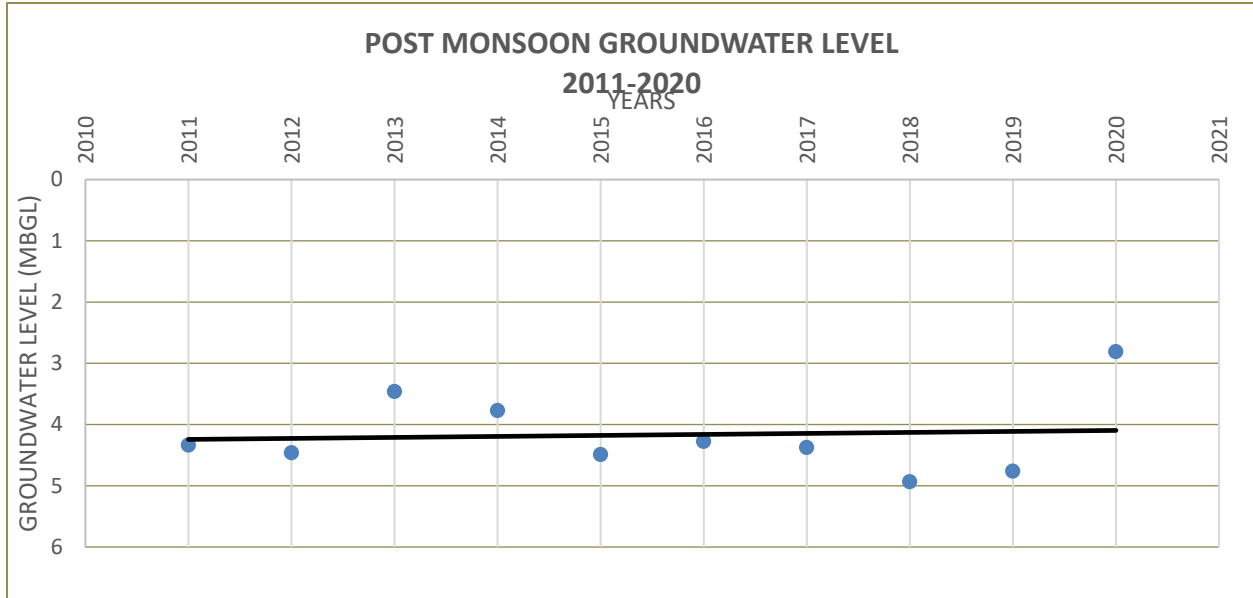
The study area comprises 10km radius zone in Miragpur Manganese mine that largely fall under Khairlanji block, Balaghat district, Madhya Pradesh and partly to Tumsar Tehsil of Bhandara district, Maharashtra. The source of ground water such as dug well; hand pump and pond are used for domestic, irrigation and drinking in the core

zone villages. Out of 23 observation location of dug well, it has been observed that the water level (Pre monsoon 2022) of more than 10 villages around the buffer zone and core zone area is varying from 4 to 8m bgl. Long term trend analysis of data obtained from CGWB shows no significant change-rise or fall as depicted in **Fig 2.6 and 2.7.**



**Fig 2.6: Long term well hydrograph of wells of Balaghat district, Madhya Pradesh (source: WRIS online portal)**

**2.3.1 Dynamic Groundwater Resource of study area:** The groundwater resource as estimated by CGWB (2020) is presented in the table 2.6 for two blocks of MP and Maharashtra and are in safe category.



**Fig 2.7:** Long term pre monsoon groundwater level tend in Balaghat district showing slightly increasing trend

**Table: 2.6** Block wise dynamic groundwater resources of Kharlangi, MP and Tumsar, Mahara

| Sr no                | State                          | District                                       | Assessment Unit Name | Assessment Unit Type   | Recharge from Rainfall-MON                                 | Recharge from Other Sources-MON      | Recharge from Rainfall-NM                       | Recharge from Other Sources-NM | Total Annual Ground Water Recharge (Ham) |
|----------------------|--------------------------------|--|----------------------|------------------------|--|--------------------------------------|---|--------------------------------|--|
| 1                    | Madhya Pradesh                 | Balaghat                                       | Kharlangi            | Block                  | 5218   | 314                                  | 534.26  | 318                            | 6384.26                                  |
| 2                    | Maharashtra                    | Bhandara                                       | Tumsar               | Block                  | 4666.057   | 1079.197                             | 95.083  | 2387.81                        | 8228.14                                  |
| Assessment Unit Name | Total Natural Discharges (Ham) | Annual Extractable Ground Water Resource (Ham) | Irrigation Use (Ham) | Total Extraction (Ham) | Annual GW Allocation for for Domestic Use as on 2025 (Ham) | Stage of Ground Water Extraction (%) | Categorization (OE/Critical/Semi critical/Safe) |                                |  |
| Kharlangi            | 430.0                          | 5954.26  | 1643                 | 1987                   | 388.00   | 33.371                               | Safe  |                                |  |
| Tumsar               | 411.4                          | 7816.74  | 3123.72              | 3744.41                | 680.53   | 47.903                               | Safe  |                                |  |

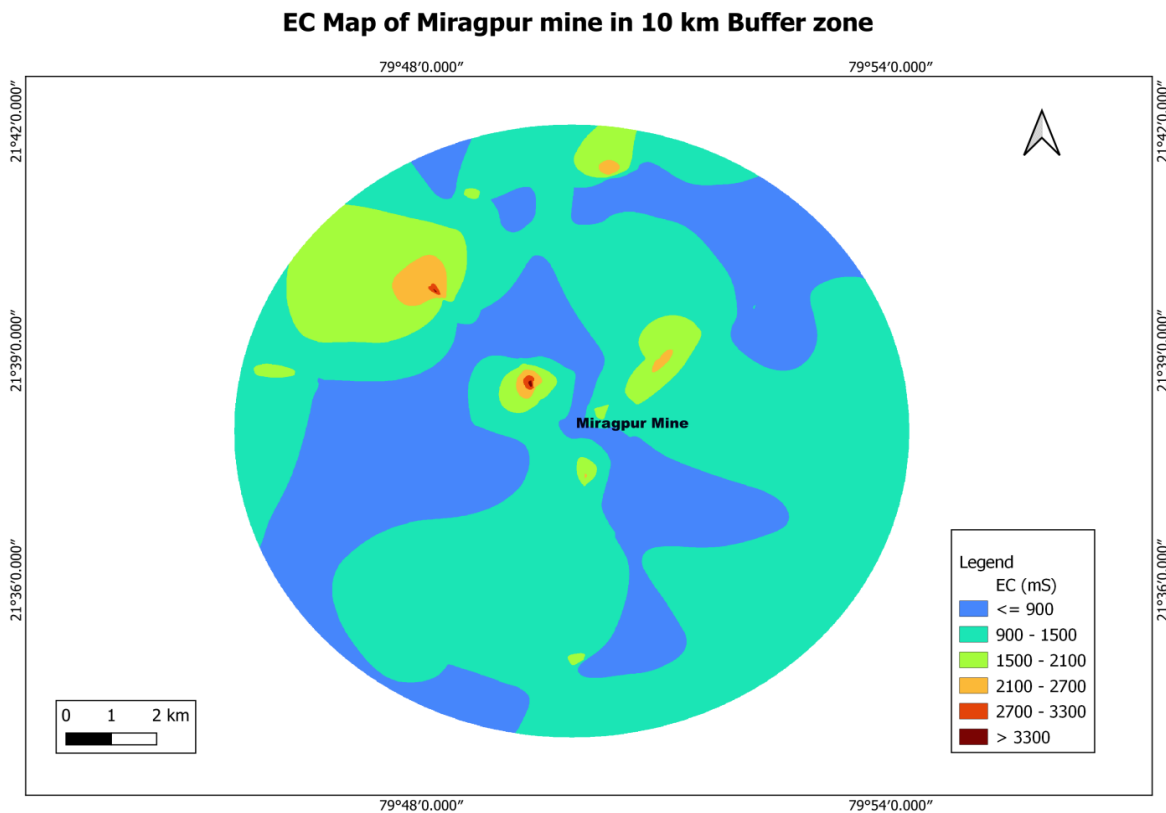
## 2.5 Groundwater Quality

Based on the above study, different ground water parameters were computed, which include pH, TDS, EC, DO, Temperature. Ground water in study area is potable with pH ranging 6.4 to 8.5 and total dissolved solid (TDS) ranging from 120 to 1900 ppt and EC ranging from 300 to 3800  $\mu\text{S}$ . ( Fig 2.8 and 2.9)

Groundwater quality in the study area is fresh and all major and trace elements are found within the BIS 10500 permissible limit. Thus is suitable for all domestic, industrial and irrigational use. The general parameters of groundwater in study area as analyses are given in Table 2.5. The comparison of data reveals that the area mining (Project Area) is having less TDS).

### 2.4.1. Groundwater quality of Mining area

Groundwater quality has been analyzed by collecting groundwater samples of existing tube well in study area. The groundwater test result through NABL accredited Lab show low in TDS in the range of 402 mg/l and all other parameters well within permissible range as shown in table 2.5.





### TDS map of Miragpur mine in 10km Buffer Zone

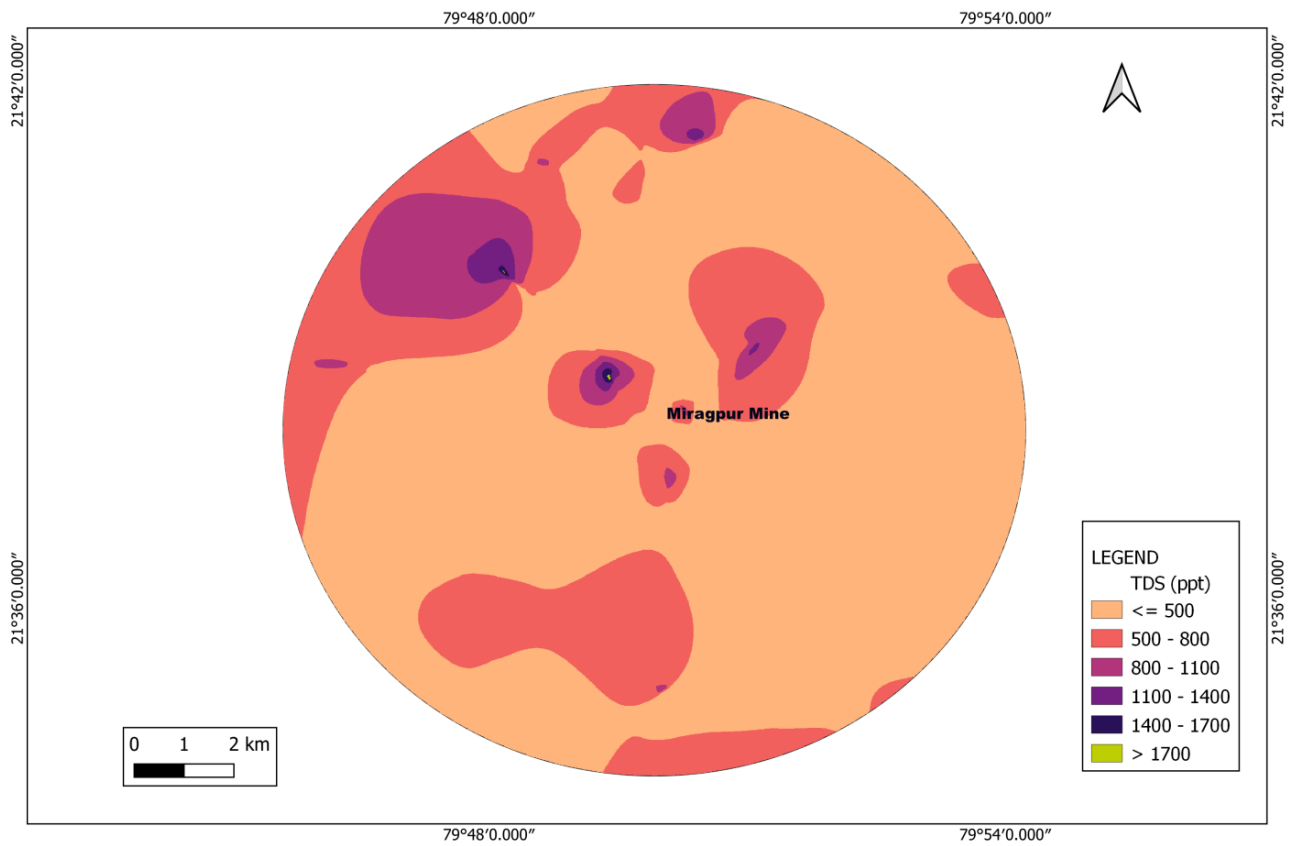


Fig 2.9: TDS map of study area



# Creative Enviro Services



Accredited Organisation by National Accreditation Board for Testing and Calibration Laboratories (NABL), National Accreditation Board for training And Education (NABET) and ISO 9001:2015, ISO 14001:2004, OHSAS 18001:2007

Cert No.: TC-6872

## TEST REPORT

|   |   |
|---|---|
| Name & Address of the Customer<br>To,<br><b>M/s D.P. RAI</b><br><b>"NANHAKA" 10, EAST HIGH COURT ROAD,</b><br><b>RAMDASPERTH, NAGPUR (MS)</b> | <b>ULR No: TC687218000000109P</b><br>Despatch No: <b>2023</b><br>Issue Date : 13/07/2021<br>Client Ref: Nil<br>Date : Nil |
| Qty : 1 No. x 1 litre   | <b>Date of Collection</b> : 25/06/2021  |
| Method of test : APHA 23 <sup>rd</sup> edition  | <b>Date of Receipt</b> : 01/07/2021   |
| Packing :- Plastic bottle   | <b>Period of testing</b> :  |
| <b>Sample Condition at receipt: packed</b>  | <b>Method of sampling</b> : BIS/3025  |
| Sample Particulars: Ground Water  | <b>Sample tested as received</b> : OK   |
| Sample collected by: CES Representative   | <b>Page no.</b>   |
| <b>No. of Sample - 18</b>   | <b>Serial No. of Sample</b> 109/7   |

| Sr. No | Test Parameters                     | Unit      | Method No.              | Pandarwani Mine<br>(109/7) |
|--------|-------------------------------------|-----------|-------------------------|----------------------------|
| 1      | pH                                  | -         | 4500 H+B                | 7.52                       |
| 2      | Conductivity                        | µmhos/cm  | 2510 B                  | 986.10                     |
| 3      | Turbidity                           | NTU       | 2130 B                  | 4.20                       |
| 4      | Total Solid                         | mg/lit    | 2540 B                  | 487.00                     |
| 5      | Total Dissolved Solid               | mg/lit    | 2540 C                  | 402.00                     |
| 6      | Total suspended solid               | mg/lit    | 2540 D                  | 85.00                      |
| 7      | Total Alkalinity                    | mg/lit    | 2320 B                  | 126.00                     |
| 8      | Total Hardness as CaCO <sub>3</sub> | mg/lit    | 2340 C                  | 428.00                     |
| 9      | Ca Hardness as CaCO <sub>3</sub>    | mg/lit    | 3500 B                  | 212.00                     |
| 10     | Mg Hardness as CaCO <sub>3</sub>    | mg/lit    | 3500 B                  | 216.00                     |
| 11     | *Calcium as Ca                      | mg/lit    | 3500 B                  | 84.96                      |
| 12     | *Magnesium as Mg                    | mg/lit    | 3500 B                  | 52.48                      |
| 13     | Sulphates as SO <sub>4</sub>        | mg/lit    | 4500- SO <sub>4</sub> E | 94.58                      |
| 14     | Chlorides as Cl                     | mg/lit    | 4500-Cl- E              | 131.96                     |
| 15     | Iron as Fe                          | mg/lit    | 3500- Fe E              | <0.05                      |
| 16     | Nitrate as NO <sub>3</sub>          | mg/lit    | 4500-NO <sub>3</sub> D  | 19.58                      |
| 17     | Nitrite as NO <sub>2</sub> -N       | mg/lit    | 4500- NO <sub>2</sub> B | <0.10                      |
| 18     | Phosphate as P                      | mg/lit    | 4500-PD                 | <0.10                      |
| 19     | Fluoride as F                       | mg/lit    | 4500- F D               | <0.10                      |
| 20     | Copper as Cu                        | mg/lit    | 3500-Cu B               | <0.10                      |
| 21     | Chromium as Cr <sup>6+</sup>        | mg/lit    | 3500-Cr <sup>6+</sup> B | <0.10                      |
| 22     | *Coliform                           | MPN/100ml | IS:15185                | <2.00                      |
| 23     | Manganese as Mn                     | mg/lit    | 3500- Mn B              | <0.20                      |

For Creative Enviro Services

Authorized Signatory

42, Doorsanchar Nagar, Near Savoy Complex, E-8 Extension, Gulmohar, Bhopal 462 039 (M.P.)  
Telephone : 0755-4299319, Fax : 0755-4243510, Mobile : 9425009319

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# Creative Enviro Services

Accredited Organisation by National Accreditation Board for Testing and Calibration Laboratories (NABL), National Accreditation Board for training And Education (NABET) and ISO 9001:2015, ISO 14001:2004, OHSAS 18001:2007



Cert No.: TC-6872

## TEST REPORT

|  |  |
|--|--|
| Name & Address of the Customer<br>To,<br>M/s D.P. RAI<br>"NANHAKA" 10, EAST HIGH COURT ROAD,<br>RAMDASPERTH, NAGPUR (MS) | ULR No: TC68721800000109P 2073<br>Despatch No:<br>Issue Date : 13/07/2021<br>Client Ref: Nil<br>Date : Nil |
| Qty : 1 No. x 1 litre  | Date of Collection : 25/06/2021  |
| Method of test : APHA 23 <sup>rd</sup> edition   | Date of Receipt : 01/07/2021   |
| Packing :- Plastic bottle  | Period of testing :  |
| Sample Condition at receipt: packed  | Method of sampling : BIS/3025  |
| Sample Particulars: Ground Water   | Sample tested as received : OK   |
| Sample collected by: CES Representative  | Page no.   |
| No. of Sample - 18   | Serial No. of Sample 109/7   |

| Sr. No | Test Parameters      | Unit   | Method No.     | Pandarwani Mine<br>(109/7) |
|--------|----------------------|--------|----------------|----------------------------|
| 24     | Zinc as Zn           | mg/lit | 3111-Zn B      | <0.05                      |
| 25     | Total Chromium       | mg/lit | 3500-Cr* B     | <0.05                      |
| 26     | Cadmium as Cd        | mg/lit | 3111-Cd B      | <0.05                      |
| 27     | Lead as Pb           | mg/lit | 3111-Pb B      | <0.05                      |
| 28     | Mercury as Hg        | mg/lit | 3112- Hg B     | <0.01                      |
| 29     | Nickel as Ni         | mg/lit | 3111-Ni B      | <0.05                      |
| 30     | Arsenic as As        | mg/lit | 3114-As B      | <0.05                      |
| 31     | Sodium Na            | mg/lit | 3500- Na B     | 34.67                      |
| 32     | Potassium K          | mg/lit | 3500- K B      | 4.53                       |
| 33     | Boron as B           | mg/lit | 4500-B B       | <0.1                       |
| 34     | Selenium as Se       | mg/lit | 3114-Se B      | <0.05                      |
| 35     | COD                  | mg/lit | 5220 B         | <4.00                      |
| 36     | BOD (3 day 27degree) | mg/lit | IS 3025, P- 44 | <2.00                      |

For Creative Enviro Services

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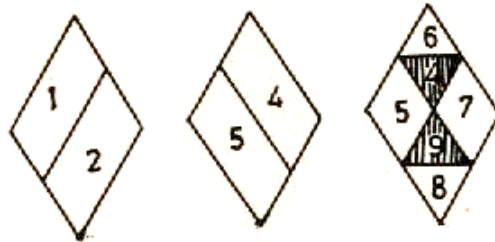
Email: creativelab.bpl@gmail.com, creative.bpl@gmail.com, Websearch : www.creativeenviroservices.com

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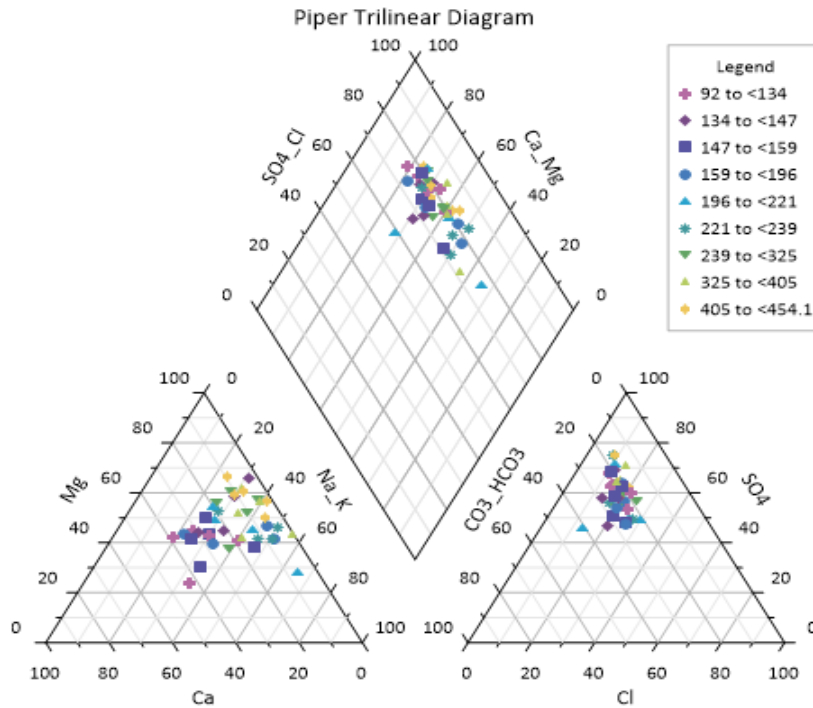
Table 2.7: Analytical results of groundwater samples collected in Pandharwani mine

**Water Quality Data in Piper Trilinear Diagram:** Different graphical methods can be adopted for representing geochemical variation which gives a better insight into the groundwater quality monitoring. One such efficient method of representation is plotting of Hill Piper Trilinear diagram in which data are plotted in two triangle fields and one diamond field. The diamond is then classified under various categories emphasizing their characteristics. ( Fig 2.10 and 2.11)



**Fig 2.10:** Sub-divisions of the diamond field

On the basis of data collection from CGWB report (2019-2020). It has been observed that out of 41 samples are concentrated in Area 6 indicating that: Non-carbonate hardness exceeds 50% i.e.,  $Ca + Mg - (SO_4 + Cl + NO_3)$ . Few samples come under Area 4 representing strong acids ( $SO_4 + Cl + NO_3$ ) exceed weak acids ( $CO_3 + HCO_3$ ). Only 2 samples can be noticed under Area 7: Non-carbonate alkali exceeds 50% i.e.,  $Na + K - (SO_4 + Cl + NO_3)$ .



**Fig: 2.11** Distribution of water samples in Piper Trilinear Diagram

**USSL Diagram:** The United States Salinity Laboratory (USSL) (1954) and Wilcox (1955) established standards for irrigation water quality classification. The Fig.7.5 is a simple scatter chart of sodium hazard (SAR) on the Y-axis versus salinity hazard (EC) on the X-axis. Using the SAR and the EC value of 41 water samples of Balaghat area determines the quality classification of the water.

Based on the EC, irrigation water can be classified into four categories; include:

- I. Low-salinity water (C<sub>1</sub>) can be used for irrigation with most crops on most soils with little likelihood that **soil salinity** will develop.
- II. Medium-salinity water (C<sub>2</sub>) can be used if a moderate amount of leaching occurs. Plants with moderate salt-tolerance can be grown in most cases without special practices for salinity control.
- III. High-salinity water (C<sub>3</sub>) cannot be used on soils, special management for salinity control may be required and plants with good salt tolerance should be selected.
- IV. Very high salinity water (C<sub>4</sub>) is not suitable for irrigation under ordinary conditions.

**Sodium Adsorption Ratio:** High sodium in irrigation water reduces the permeability of soil. The USSL diagram based on SAR divided to four categories included:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

- I. Low-sodium water (S<sub>1</sub>) can be used for irrigation on almost all soils.
- II. Medium-sodium water (S<sub>2</sub>) will present an appreciable sodium hazard in certain fine-textured soils. This water may be used on coarse-textured or organic soils with good permeability.
- III. High-sodium water (S<sub>3</sub>) may produce harmful levels of exchangeable sodium in most soils and will require special soil management.
- IV. Very high sodium water (S<sub>4</sub>) is generally unsatisfactory for irrigation unless special action is taken, such as addition of gypsum to soil (Lyerly and Longenecker, 1957).

### Data Analysis:

On the basis of samples collected from the study area, it can be observed that out of 41 samples of Pre and Post Monsoon 2019, most of the samples are concentrated under C2S1, C2S2 and C3S2 categories indicating low to medium sodium hazards with medium to high salinity. Out of these, few samples are scattered under C3S3 and C3S4 categories representing high salinity with high sodium hazard and high salinity with very high sodium hazard respectively (Fig 2.12).

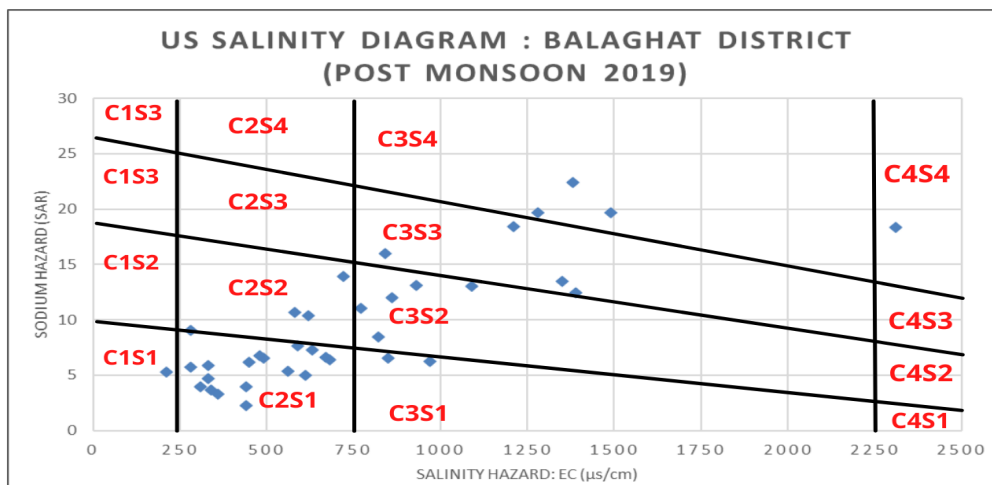
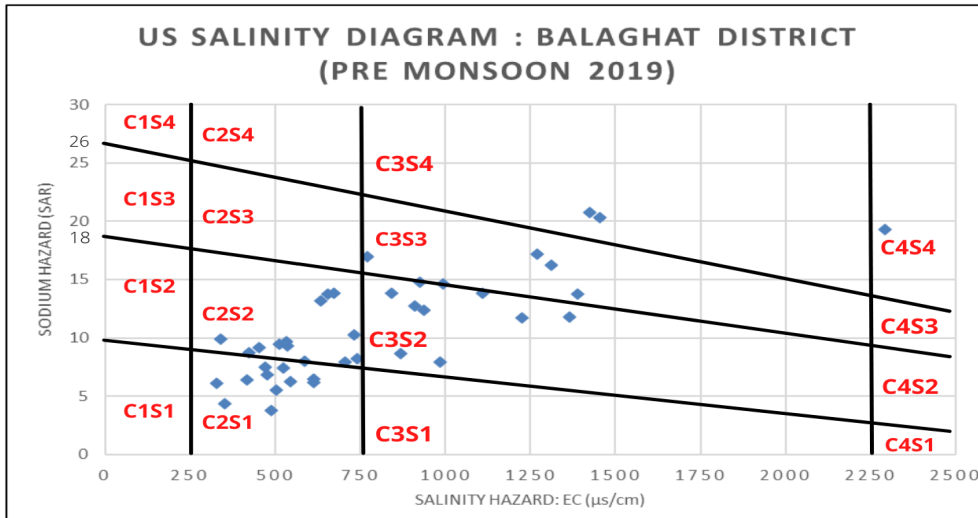


Fig: 2.12 US Salinity diagram of Pre Monsoon 2019 and Post Monsoon 2019, Balaghat

## 3. Details of bore well proposed to be constructed

### 3.1. Proposed Piezometer with Automatic water Recorder

A piezometer with automatic water level recorder has been proposed with using standard design near to mine office within the lease area. The coordinate of the proposed point is 21.632513, 79.832085. The Automatic water level recorder has been proposed in exiting piezometer well for the purpose of continuous monitoring of water fluctuation and continuous data acquisition.



**Fig 3.1: Proposed Piezometer with automatic water recorder**

## 4. Geophysical Survey of Study area

Surface geophysical investigation involving resistivity survey was taken up in the area covering nearly 1.5 line km area. Five VES (vertical Electrical sounding) was conducted to know the subsurface geohydrological condition in the core zone. The data so obtained is interpreted for use in combination with lithologs obtained during exploratory drilling carried out for ore.

### 4.1 Geophysical Studies in an around the Mine area

Geophysical/Vertical Electrical Sounding is a technique to delineate the weathered, fractured zone and hydro geological suitability. VES technique is effective to delineate the hard terrain. Geophysical / VES investigation has been carried out at five locations in an around the mine area. Schlumberger electrode configuration in the study area has been conducted to delineate the distribution of subsurface rocks. The usual practice in the field is to apply an electrical direct current (DC) between two electrodes implanted in the ground and to measure the difference of potential between two additional electrodes that do not carry current. Total five numbers of VES (VES 1 to VES 5) have been carried out at site for detection of ground water in alluvium zone of subsurface and different type of rocks. All the data sheets are given below with tabulated interpretation & recommendations.

#### RESISTIVITY SURVEY

## GROUND WATER INVESTIGATION

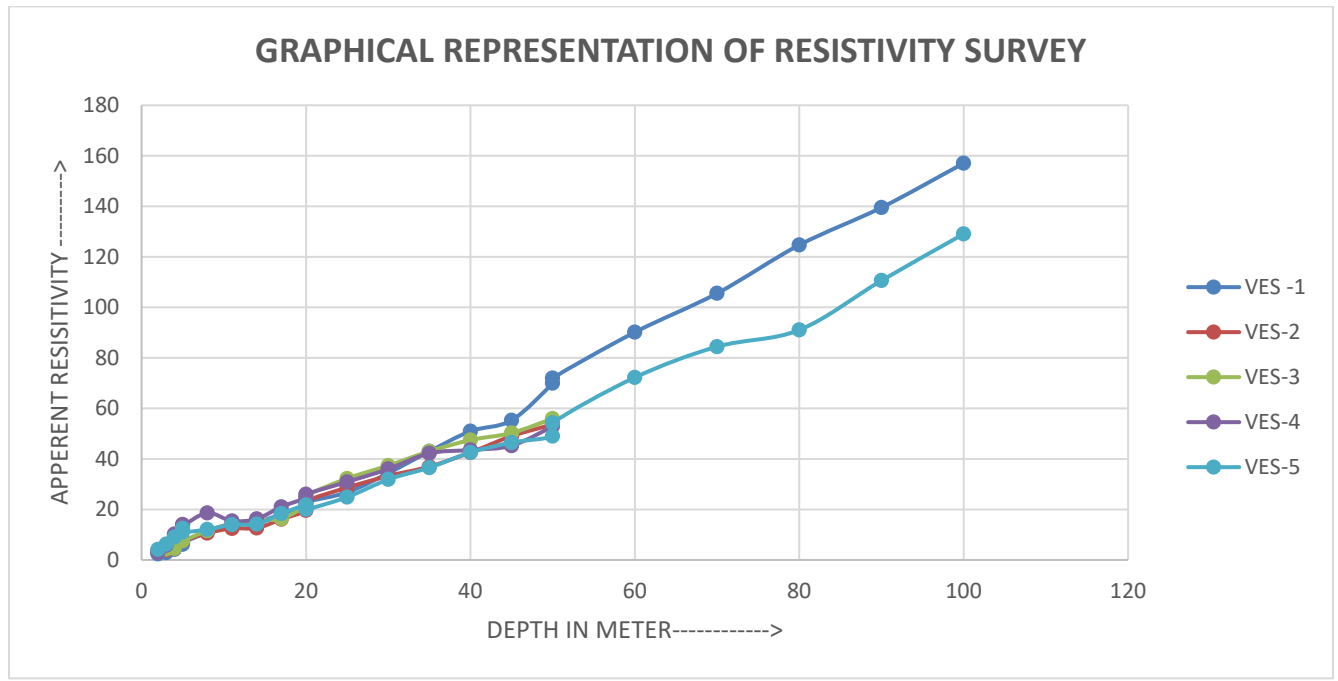
### DATA SHEET DEPTH PROBE SCHLUBERGER ELECTRODE CONFIGURATION

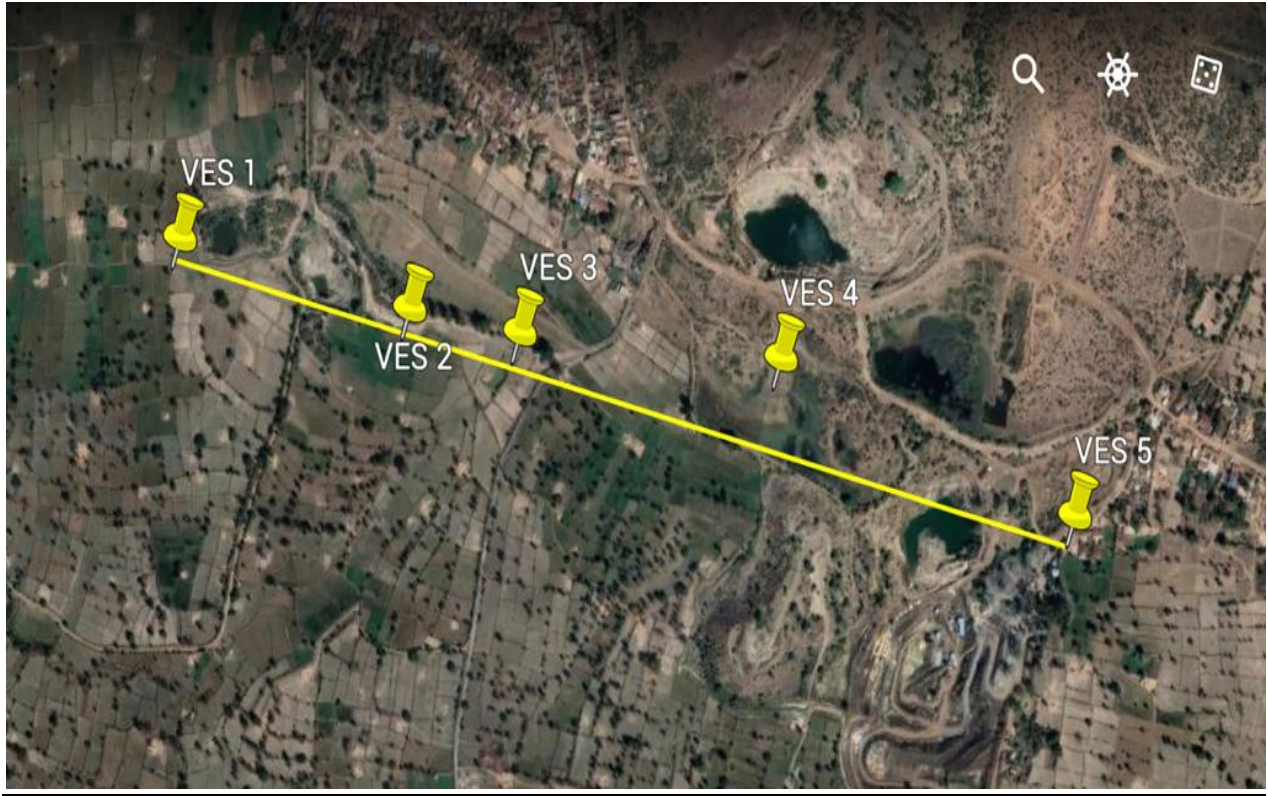
#### ❖ FROM VES-1 TO VES-5

| S.N | AB/2<br>(in<br>Mtr) | MN/2<br>(in<br>Mtr) | VES-1<br>APPARENT<br>RESISTIVITY<br>(OHM -Mtr) | VES-2<br>APPARENT<br>RESISTIVITY<br>(OHM -Mtr) | VES-3<br>APPARENT<br>RESISTIVITY<br>(OHM -Mtr) | VES-4<br>APPARENT<br>RESISTIVITY<br>(OHM -Mtr) | VES-5<br>APPARENT<br>RESISTIVITY<br>(OHM -Mtr) |
|-----|---------------------|---------------------|--|--|--|--|--|
| 1.  | 2                   | 1                   | 2.42   | 3.47   | 3.14   | 2.98   | 4.17   |
| 2.  | 3                   | 1                   | 2.91   | 3.93   | 4.28   | 5.84   | 6.24   |
| 3.  | 4                   | 1                   | 4.17   | 4.52   | 4.52   | 10.27  | 9.02   |
| 4.  | 5                   | 1                   | 6.21   | 7.83   | 8.21   | 14.05  | 12.55  |
| 5.  | 5                   | 2                   | 6.85   | 7.51   | 7.58   | 13.55  | 11.01  |
| 6.  | 8                   | 2                   | 10.83  | 10.64  | 11.59  | 18.61  | 12.06  |
| 7.  | 11                  | 2                   | 13.68  | 12.49  | 14.51  | 15.43  | 13.96  |
| 8.  | 14                  | 2                   | 14.92  | 12.66  | 15.83  | 16.28  | 14.17  |
| 9.  | 17                  | 2                   | 18.13  | 16.11  | 16.34  | 21.04  | 18.35  |

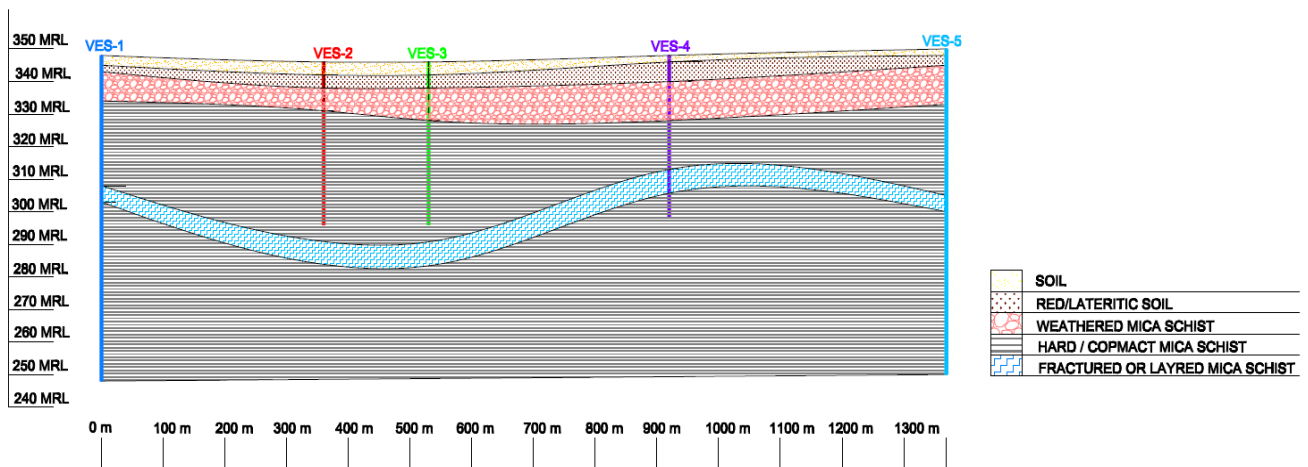


|     |     |    |        |       |       |       |        |
|-----|-----|----|--------|-------|-------|-------|--------|
| 10. | 20  | 2  | 21.46  | 19.59 | 21.77 | 24.57 | 21.77  |
| 11. | 20  | 5  | 22.97  | 23.20 | 25.32 | 26.03 | 20.02  |
| 12. | 25  | 5  | 26.76  | 28.65 | 32.23 | 30.91 | 24.88  |
| 13. | 30  | 5  | 34.36  | 33.26 | 37.38 | 36.01 | 31.88  |
| 14. | 35  | 5  | 42.97  | 36.94 | 42.97 | 42.22 | 36.56  |
| 15. | 40  | 5  | 50.96  | 42.55 | 47.50 | 43.54 | 42.55  |
| 16. | 45  | 5  | 55.29  | 49.00 | 50.26 | 45.23 | 46.49  |
| 17. | 50  | 5  | 69.97  | 53.65 | 55.98 | 52.87 | 48.98  |
| 18. | 50  | 10 | 72.00  |       |       |       | 54.28  |
| 19. | 60  | 10 | 90.16  |       |       |       | 72.24  |
| 20. | 70  | 10 | 105.55 |       |       |       | 84.44  |
| 21. | 80  | 10 | 124.68 |       |       |       | 91.04  |
| 22. | 90  | 10 | 139.52 |       |       |       | 110.61 |
| 23. | 100 | 10 | 157.05 |       |       |       | 129.06 |





### GRAPHICAL REPRESENTATION OF REISTIVITY SURVEY



# VES -1

## RESISTIVITY SURVEY

# GROUND WATER INVESTIGATION

## DATA SHEET DEPTH PROBE SCHLUBERGER ELECTRODE CONFIGURATION

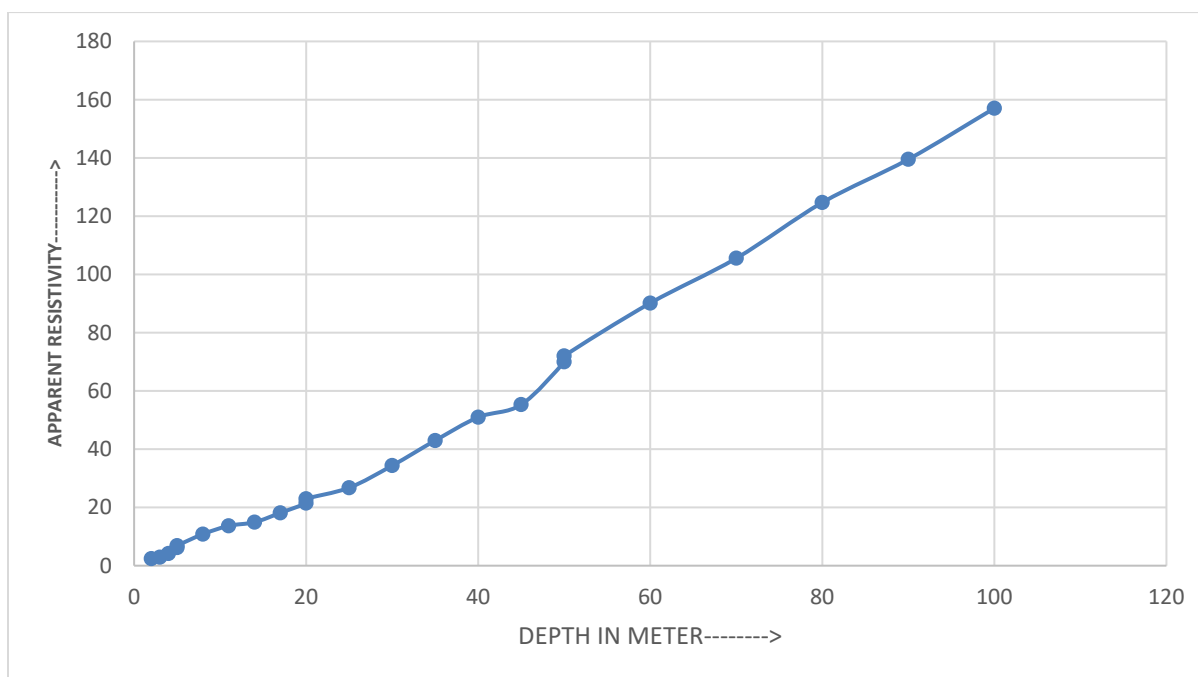
- ❖ LOCATION – IN MIRAGPUR MINE (24 HACT)
- ❖ LAT - 21°37'55.78"N      LONG - 79°49'54.35"E

| S.N | AB/2<br>(in<br>Mtr) | MN/<br>2<br>(in<br>Mtr) | SPACIN<br>G<br>FACTOR<br>K | MEASURED<br>RESISTANCE<br>(R- OHMS) 1 | APPARENT<br>RESISTIVI<br>TY<br>(OHM -Mtr) |
|-----|---------------------|-------------------------|----------------------------|---------------------------------------|---|
| 1.  | 2                   | 1                       | 4.71                       | 0.513                                 | 2.42                                      |
| 2.  | 3                   | 1                       | 12.56                      | 0.232                                 | 2.91                                      |
| 3.  | 4                   | 1                       | 23.56                      | 0.177                                 | 4.17                                      |
| 4.  | 5                   | 1                       | 37.69                      | 0.165                                 | 6.21                                      |
| 5.  | 5                   | 2                       | 16.49                      | 0.416                                 | 6.85                                      |
| 6.  | 8                   | 2                       | 47.12                      | 0.230                                 | 10.83                                     |
| 7.  | 11                  | 2                       | 91.89                      | 0.148                                 | 13.68                                     |
| 8.  | 14                  | 2                       | 150.8                      | 0.099                                 | 14.92                                     |
| 9.  | 17                  | 2                       | 223.84                     | 0.081                                 | 18.13                                     |
| 10. | 20                  | 2                       | 311.02                     | 0.069                                 | 21.46                                     |
| 11. | 20                  | 5                       | 117.81                     | 0.195                                 | 22.97                                     |
| 12. | 25                  | 5                       | 188.50                     | 0.142                                 | 26.76                                     |
| 13. | 30                  | 5                       | 274.89                     | 0.125                                 | 34.36                                     |
| 14. | 35                  | 5                       | 376.99                     | 0.114                                 | 42.97                                     |
| 15. | 40                  | 5                       | 494.8                      | 0.103                                 | 50.96                                     |
| 16. | 45                  | 5                       | 628.32                     | 0.088                                 | 55.29                                     |
| 17. | 50                  | 5                       | 777.54                     | 0.090                                 | 69.97                                     |
| 18. | 50                  | 10                      | 376.99                     | 0.191                                 | 72.00                                     |
| 19. | 60                  | 10                      | 549.78                     | 0.164                                 | 90.16                                     |
| 20. | 70                  | 10                      | 753.98                     | 0.140                                 | 105.55                                    |
| 21. | 80                  | 10                      | 989.6                      | 0.126                                 | 124.68                                    |

|     |     |    |      |       |        |
|-----|-----|----|------|-------|--------|
| 22. | 90  | 10 | 1257 | 0.111 | 139.52 |
| 23. | 100 | 10 | 1555 | 0.101 | 157.05 |

## VES -1

GRAPH B/W APPARENT RESISTIVITY & DEPTH



### PROBABLE SUB SURFACE LITHOLOG

| S,N. | Sub surface data (litho-log) expected                  | Depth below Ground Level (m) |     |
|------|--|------------------------------|-----|
|      |  | from                         | to  |
| 1.   | Probability of Soil                                    | 0                            | 3   |
| 2.   | Probability of red laterite soil                       | 3                            | 5   |
| 3.   | Probability of yellow soil or weathered Mica Schist    | 5                            | 14  |
| 4.   | Probability of hard & dense Mica schist                | 14                           | 40  |
| 5.   | Probability of fractured, layered, jointed Mica schist | 40                           | 45  |
| 6.   | Probability of hard compact Mica Schist                | 45                           | 100 |

# VES -2

## RESISTIVITY SURVEY

# GROUND WATER INVESTIGATION

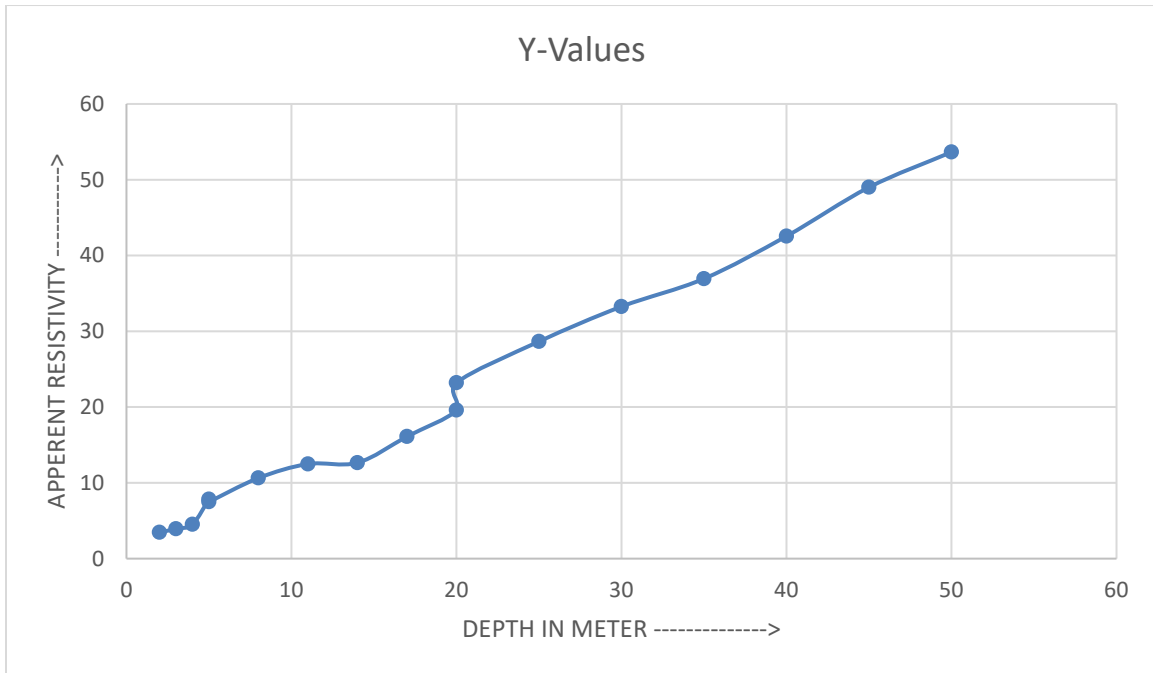
## DATA SHEET DEPTH PROBE SCHLUBERGER ELECTRODE CONFIGURATION

- ❖ LOCATION – NEAR KALA GADDA (OLD PIT)
- ❖ LAT - 21°37'52.40"N      LONG - 79°50'6.30"E

| S.N | AB/2<br>(in<br>Mtr) | MN/<br>2<br>(in<br>Mtr) | SPACIN<br>G<br>FACTOR<br>K | MEASURED<br>RESISTANCE<br>(R- OHMS) 1 | APPARENT<br>RESISTIVI<br>TY<br>(OHM -Mtr) |
|-----|---------------------|-------------------------|----------------------------|---------------------------------------|---|
| 1.  | 2                   | 1                       | 4.71                       | 0.738                                 | 3.47                                      |
| 2.  | 3                   | 1                       | 12.56                      | 0.313                                 | 3.93                                      |
| 3.  | 4                   | 1                       | 23.56                      | 0.192                                 | 4.52                                      |
| 4.  | 5                   | 1                       | 37.69                      | 0.208                                 | 7.83                                      |
| 5.  | 5                   | 2                       | 16.49                      | 0.456                                 | 7.51                                      |
| 6.  | 8                   | 2                       | 47.12                      | 0.226                                 | 10.64                                     |
| 7.  | 11                  | 2                       | 91.89                      | 0.136                                 | 12.49                                     |
| 8.  | 14                  | 2                       | 150.8                      | 0.084                                 | 12.66                                     |
| 9.  | 17                  | 2                       | 223.84                     | 0.072                                 | 16.11                                     |
| 10. | 20                  | 2                       | 311.02                     | 0.063                                 | 19.59                                     |
| 11. | 20                  | 5                       | 117.81                     | 0.197                                 | 23.20                                     |
| 12. | 25                  | 5                       | 188.50                     | 0.152                                 | 28.65                                     |
| 13. | 30                  | 5                       | 274.89                     | 0.121                                 | 33.26                                     |
| 14. | 35                  | 5                       | 376.99                     | 0.098                                 | 36.94                                     |
| 15. | 40                  | 5                       | 494.8                      | 0.086                                 | 42.55                                     |
| 16. | 45                  | 5                       | 628.32                     | 0.078                                 | 49.00                                     |
| 17. | 50                  | 5                       | 777.54                     | 0.069                                 | 53.65                                     |

# VES -2

GRAPH B/W APPARENT RESISTIVITY & DEPTH



## PROBABLE SUB SURFACE LITHOLOG

| S,N. | Sub surface data<br>(litho log) expected            | Depth below Ground Level (m) |    |
|------|---|------------------------------|----|
|      |   | from                         | to |
| 1.   | Probability of Soil                                 | 0                            | 4  |
| 2.   | Probability of red laterite soil                    | 4                            | 8  |
| 3.   | Probability of yellow soil or weathered Mica Schist | 8                            | 15 |
| 4.   | Probability of hard compact Mica Schist             | 15                           | 50 |

# VES -3

## RESISTIVITY SURVEY

# GROUND WATER INVESTIGATION

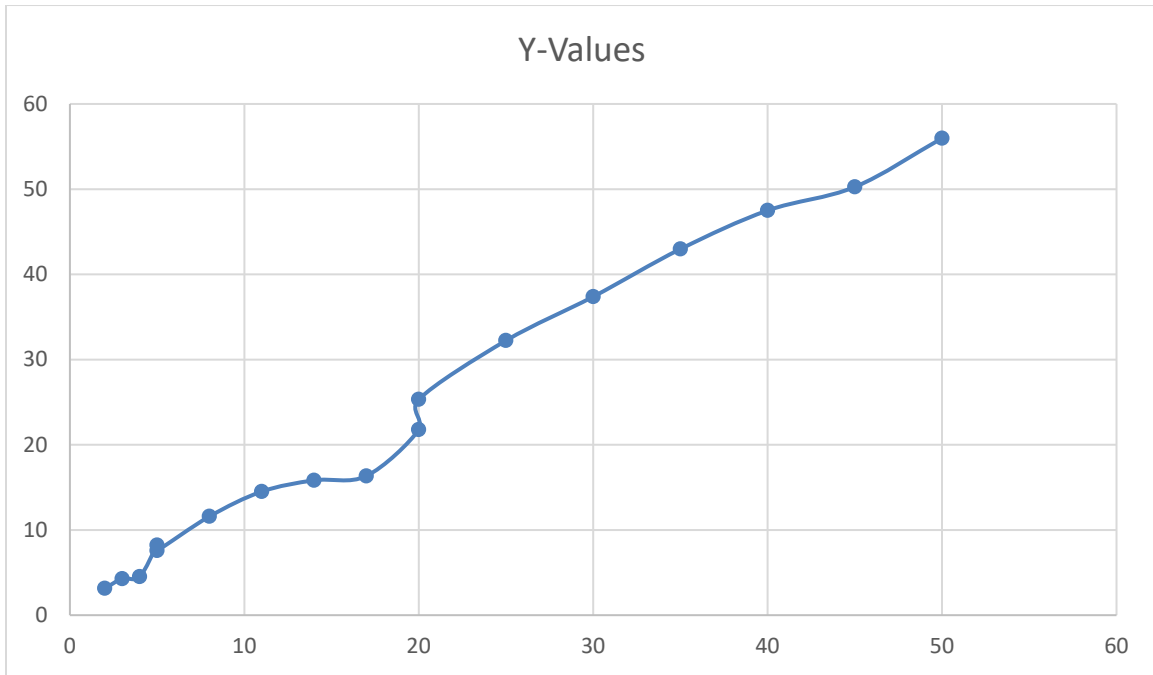
## DATA SHEET DEPTH PROBE SCHLUBERGER ELECTRODE CONFIGURATION

- ❖ LOCATION – NEAR MIRAGPUR TO RANI MOHGAON ROAD
- ❖ LAT - 21°37'51.10"N      LONG - 79°50'12.10"E

| S.N | AB/2<br>(in<br>Mtr) | MN/<br>2<br>(in<br>Mtr) | SPACIN<br>G<br>FACTOR<br>K | MEASURED<br>RESISTANCE<br>(R- OHMS) 1 | APPARENT<br>RESISTIVI<br>TY<br>(OHM -Mtr) |
|-----|---------------------|-------------------------|----------------------------|---------------------------------------|---|
| 1.  | 2                   | 1                       | 4.71                       | 0.668                                 | 3.14                                      |
| 2.  | 3                   | 1                       | 12.56                      | 0.341                                 | 4.28                                      |
| 3.  | 4                   | 1                       | 23.56                      | 0.192                                 | 4.52                                      |
| 4.  | 5                   | 1                       | 37.69                      | 0.218                                 | 8.21                                      |
| 5.  | 5                   | 2                       | 16.49                      | 0.460                                 | 7.58                                      |
| 6.  | 8                   | 2                       | 47.12                      | 0.246                                 | 11.59                                     |
| 7.  | 11                  | 2                       | 91.89                      | 0.158                                 | 14.51                                     |
| 8.  | 14                  | 2                       | 150.8                      | 0.105                                 | 15.83                                     |
| 9.  | 17                  | 2                       | 223.84                     | 0.073                                 | 16.34                                     |
| 10. | 20                  | 2                       | 311.02                     | 0.070                                 | 21.77                                     |
| 11. | 20                  | 5                       | 117.81                     | 0.215                                 | 25.32                                     |
| 12. | 25                  | 5                       | 188.50                     | 0.171                                 | 32.23                                     |
| 13. | 30                  | 5                       | 274.89                     | 0.136                                 | 37.38                                     |
| 14. | 35                  | 5                       | 376.99                     | 0.114                                 | 42.97                                     |
| 15. | 40                  | 5                       | 494.8                      | 0.096                                 | 47.50                                     |
| 16. | 45                  | 5                       | 628.32                     | 0.080                                 | 50.26                                     |
| 17. | 50                  | 5                       | 777.54                     | 0.072                                 | 55.98                                     |

# VES -3

GRAPH B/W APPARENT RESISTIVITY & DEPTH



## PROBABLE SUB SURFACE LITHOLOG

| S,N. | Sub surface data<br>(litho log) expected            | Depth below Ground Level (m) |    |
|------|---|------------------------------|----|
|      |   | from                         | to |
| 1.   | Probability of Soil                                 | 0                            | 4  |
| 2.   | Probability of red laterite soil                    | 4                            | 8  |
| 3.   | Probability of yellow soil or weathered Mica Schist | 8                            | 18 |
| 4.   | Probability of hard compact Mica Schist             | 18                           | 50 |



# VES -4

## RESISTIVITY SURVEY

# GROUND WATER INVESTIGATION

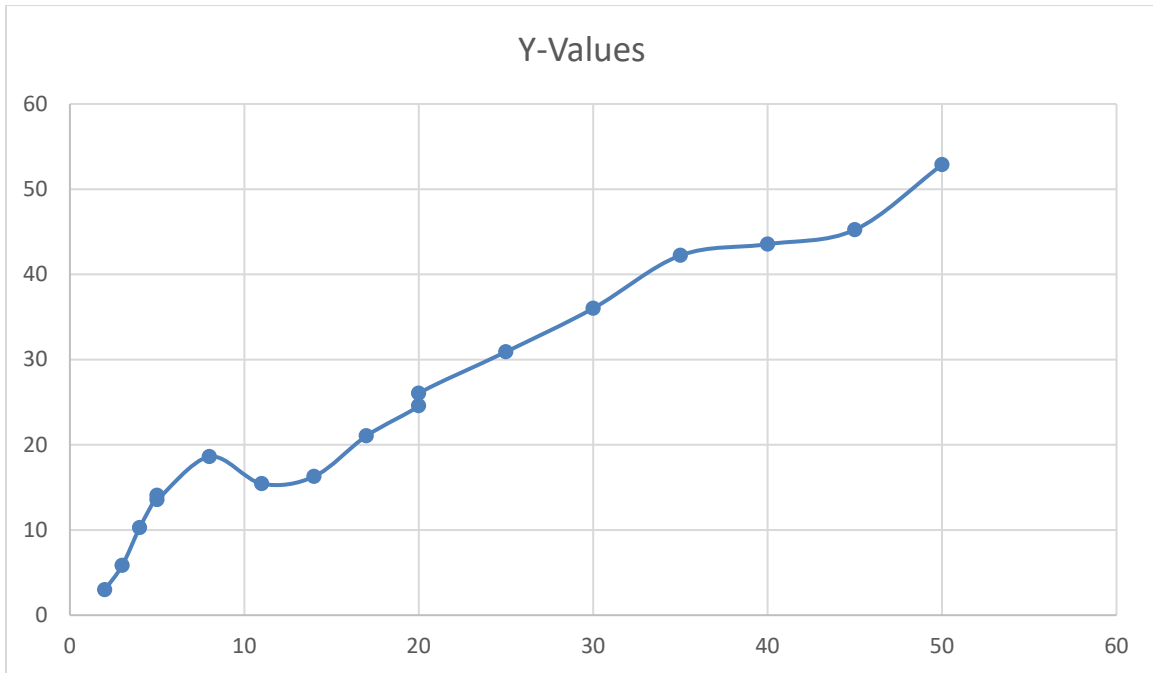
## DATA SHEET DEPTH PROBE SCHLUBERGER ELECTRODE CONFIGURATION

- ❖ LOCATION – NEAR CHOPRA MINE
- ❖ LAT - 21°37'49.45"N      LONG - 79°50'25.70"E

| S.N | AB/2<br>(in<br>Mtr) | MN/<br>2<br>(in<br>Mtr) | SPACIN<br>G<br>FACTOR<br>K | MEASURED<br>RESISTANCE<br>(R- OHMS) 1 | APPARENT<br>RESISTIVI<br>TY<br>(OHM -Mtr) |
|-----|---------------------|-------------------------|----------------------------|---------------------------------------|---|
| 1.  | 2                   | 1                       | 4.71                       | 0.633                                 | 2.98                                      |
| 2.  | 3                   | 1                       | 12.56                      | 0.465                                 | 5.84                                      |
| 3.  | 4                   | 1                       | 23.56                      | 0.436                                 | 10.27                                     |
| 4.  | 5                   | 1                       | 37.69                      | 0.373                                 | 14.05                                     |
| 5.  | 5                   | 2                       | 16.49                      | 0.822                                 | 13.55                                     |
| 6.  | 8                   | 2                       | 47.12                      | 0.395                                 | 18.61                                     |
| 7.  | 11                  | 2                       | 91.89                      | 0.168                                 | 15.43                                     |
| 8.  | 14                  | 2                       | 150.8                      | 0.108                                 | 16.28                                     |
| 9.  | 17                  | 2                       | 223.84                     | 0.094                                 | 21.04                                     |
| 10. | 20                  | 2                       | 311.02                     | 0.079                                 | 24.57                                     |
| 11. | 20                  | 5                       | 117.81                     | 0.221                                 | 26.03                                     |
| 12. | 25                  | 5                       | 188.50                     | 0.164                                 | 30.91                                     |
| 13. | 30                  | 5                       | 274.89                     | 0.131                                 | 36.01                                     |
| 14. | 35                  | 5                       | 376.99                     | 0.112                                 | 42.22                                     |
| 15. | 40                  | 5                       | 494.8                      | 0.088                                 | 43.54                                     |
| 16. | 45                  | 5                       | 628.32                     | 0.072                                 | 45.23                                     |
| 17. | 50                  | 5                       | 777.54                     | 0.068                                 | 52.87                                     |

# VES -4

GRAPH B/W APPARENT RESISTIVITY & DEPTH



## PROBABLE SUB SURFACE LITHOLOG

| S,N. | Sub surface data<br>(litho-log) expected               | Depth below Ground Level (m) |    |
|------|--|------------------------------|----|
|      |  | from                         | to |
| 1.   | Probability of Soil                                    | 0                            | 2  |
| 2.   | Probability of red laterite soil                       | 2                            | 8  |
| 3.   | Probability of yellow soil or weathered Mica Schist    | 8                            | 20 |
| 4.   | Probability of hard & dense Mica schist                | 20                           | 35 |
| 5    | Probability of fractured, layered, jointed Mica schist | 35                           | 45 |
| 6.   | Probability of hard compact Mica Schist                | 45                           | 50 |

# VES -5

## RESISTIVITY SURVEY

# GROUND WATER INVESTIGATION

## DATA SHEET DEPTH PROBE SCHLUBERGER ELECTRODE CONFIGURATION

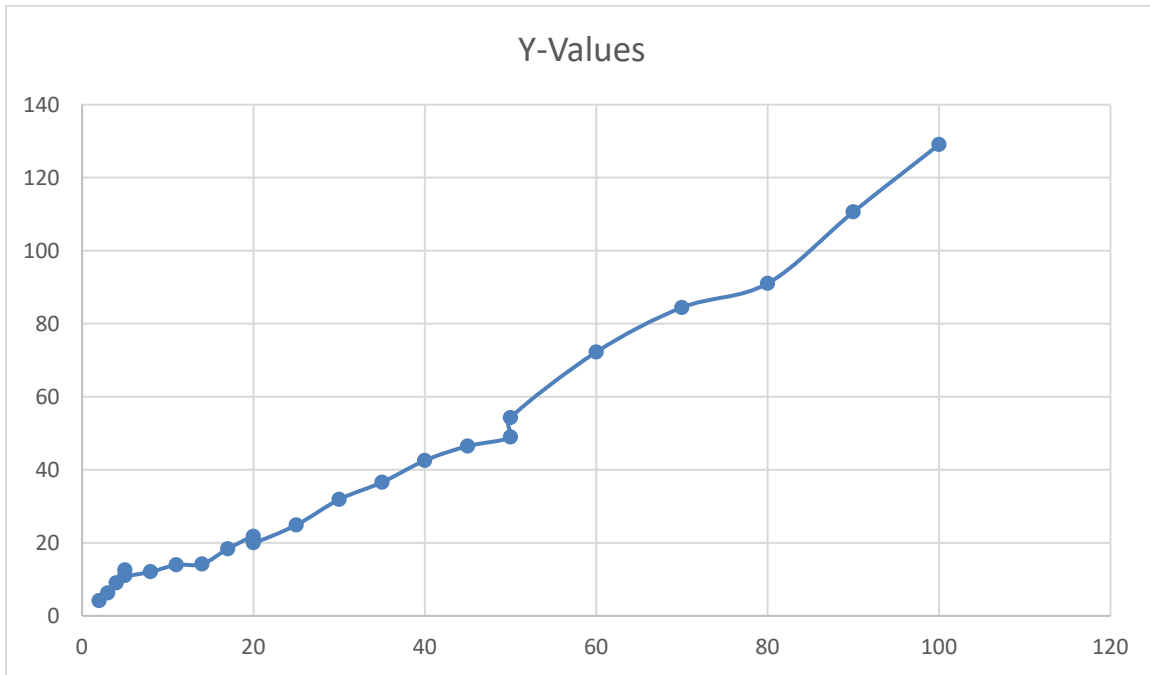
- ❖ LOCATION – IN FRONT OF PANDHARWANI MINE GATE
- ❖ LAT - 21°37'42.45"N      LONG - 79°50' 40.75"E

| S.N | AB/2<br>(in<br>Mtr) | MN/<br>2<br>(in<br>Mtr) | SPACIN<br>G<br>FACTOR<br>K | MEASURED<br>RESISTANCE<br>(R- OHMS) 1 | APPARENT<br>RESISTIVI<br>TY<br>(OHM -Mtr) |
|-----|---------------------|-------------------------|----------------------------|---------------------------------------|---|
| 1.  | 2                   | 1                       | 4.71                       | 0.887                                 | 4.17                                      |
| 2.  | 3                   | 1                       | 12.56                      | 0.497                                 | 6.24                                      |
| 3.  | 4                   | 1                       | 23.56                      | 0.383                                 | 9.02                                      |
| 4.  | 5                   | 1                       | 37.69                      | 0.333                                 | 12.55                                     |
| 5.  | 5                   | 2                       | 16.49                      | 0.668                                 | 11.01                                     |
| 6.  | 8                   | 2                       | 47.12                      | 0.256                                 | 12.06                                     |
| 7.  | 11                  | 2                       | 91.89                      | 0.152                                 | 13.96                                     |
| 8.  | 14                  | 2                       | 150.8                      | 0.094                                 | 14.17                                     |
| 9.  | 17                  | 2                       | 223.84                     | 0.082                                 | 18.35                                     |
| 10. | 20                  | 2                       | 311.02                     | 0.070                                 | 21.77                                     |
| 11. | 20                  | 5                       | 117.81                     | 0.170                                 | 20.02                                     |
| 12. | 25                  | 5                       | 188.50                     | 0.132                                 | 24.88                                     |
| 13. | 30                  | 5                       | 274.89                     | 0.116                                 | 31.88                                     |
| 14. | 35                  | 5                       | 376.99                     | 0.097                                 | 36.56                                     |
| 15. | 40                  | 5                       | 494.8                      | 0.086                                 | 42.55                                     |
| 16. | 45                  | 5                       | 628.32                     | 0.074                                 | 46.49                                     |
| 17. | 50                  | 5                       | 777.54                     | 0.063                                 | 48.98                                     |
| 18. | 50                  | 10                      | 376.99                     | 0.144                                 | 54.28                                     |
| 19. | 60                  | 10                      | 549.78                     | 0.131                                 | 72.24                                     |
| 20. | 70                  | 10                      | 753.98                     | 0.112                                 | 84.44                                     |
| 21. | 80                  | 10                      | 989.6                      | 0.092                                 | 91.04                                     |

|     |     |    |      |       |        |
|-----|-----|----|------|-------|--------|
| 22. | 90  | 10 | 1257 | 0.088 | 110.61 |
| 23. | 100 | 10 | 1555 | 0.083 | 129.06 |

## VES -5

GRAPH B/W APPARENT RESISTIVITY & DEPTH



### PROBABLE SUB SURFACE LITHOLOGY

| S,N. | Sub surface data (litho-log) expected                  | Depth below Ground Level (m) |     |
|------|--|------------------------------|-----|
|      |  | from                         | to  |
| 1.   | Probability of Soil                                    | 0                            | 2   |
| 2.   | Probability of red laterite soil                       | 2                            | 5   |
| 3.   | Probability of yellow soil or weathered Mica Schist    | 5                            | 17  |
| 4.   | Probability of hard & dense Mica schist                | 17                           | 45  |
| 5.   | Probability of fractured, layered, jointed Mica schist | 45                           | 50  |
| 6.   | Probability of hard compact Mica Schist                | 50                           | 100 |

## 5. Approved Mine Plan

### 5.1: Year Wise Mine plan Including Excavation Depth, Area and Mine Seepage

Miragpur Manganese mine is located in Miragpur village, Tehsil Khairlanji, District Balaghat, Madhya Pradesh. Miragpur village is in south west portion in Balaghat district, Madhya Pradesh. The total lease area of Miragpur Mine is 24.288 ha & 4.339 ha. It extracts Mn by underground methods.

**Method of Mining:** Stopping is the opening of large underground rooms, or stope, by the excavation of ore. Stopping is practiced in underground mineral mining when the surrounding rock is strong enough to permit the drilling, blasting, and removal of ore without caving. Existing open pit size-4180 m<sup>2</sup> as on 1-04-2016- This is the Main Pit which was proposed to be extended along strike towards the western lease boundary and depth extension proposed up 330MRL

**The u/g mining of ore-deposits in the Lease area is divided in two phases.**

- i) **PHASE-1:**-consists of mining in the area already explored by drilling. This part of lease shall have (a) Open cast workings and (b) U/G workings below the UPD of open cast workings.
- ii) **PHASE-2:**-During Phase-1 workings, exploration will be carried out by drilling as proposed in the remaining area still unexplored. When exploration yields positive result and ore-reserves are established, further development and stopping will follow in the Phase-2.

**Table 5.1: Details of Earlier Approved Mining Plans / Schemes of Mining**

| <b>Date and reference of last approved MP/SOM/RMP/MMP</b> |  |   |  |                                     |
|---|--|---|--|-------------------------------------|
| Sl. No.   | Type of document & rule under which prepared | Approval letter No. & date              | Lease area for which approval given (ha) | Proposal from –to (period of years) |
| 1.  | Mining Plan                                  | BGT/Mn/MPLN/907/NGP<br>Dated 30-11-2005 | Lease area:<br>24.288ha                  | 2006-07 to 2010-11                  |
| 2.  | Scheme of Mining                             | -                                       | Lease area:<br>24.288ha                  | 2011-12 to 2015-16                  |
| 3   | Modification in approved Mining Plan         | BGT/Mn/MPLN/907/NGP<br>Dated 11-03-2016 | Lease area:<br>24.288ha                  | 2016-17 to 2020-21                  |

**Details of last modifications if any (for the previous approved period) of approved MP/SOM, indicating date of approval, reason for modification**

|                                      |                   |   |           |            |                    |
|--------------------------------------|-------------------|---|-----------|------------|--------------------|
| Modification in Approved Mining Plan | 17(3) of MCR,2016 | i)Increase in Production<br>ii)Lease period extension from 20 to 50 years | 24.288 Ha | 03-11-2016 | 2016-17 to 2020-21 |
|--------------------------------------|-------------------|---|-----------|------------|--------------------|

The formation of the area belongs to Mansar formation of Sausar Group of Mesoproterozoic in age. Lease area is explored by present pit up to MRL 350 and 1323 meter of exploratory drilling comprising 21 bore holes. Exploration proved “Mn” “Ore Body” of 8.0 meter average thickness.

**5.2 Year wise proposal and achievement from the mine is given in table below**

| Proposal period | Proposal         |                               |                         |                              |                |                                   |
|-----------------|------------------|-------------------------------|-------------------------|------------------------------|----------------|-----------------------------------|
|                 | Year             | Soil/murrum<br>m <sup>3</sup> | Waste<br>m <sup>3</sup> | Total O.B.<br>m <sup>3</sup> | Mineral mt.    | SR= OB :<br>ore in m <sup>3</sup> |
|                 |                  |                               |                         |                              | Manganese(ROM) |                                   |
| 2016-17         | 17521.00         | 58916.00                      | 58916.00                | 68572.00                     | Nil            |                                   |
| 2017-18         | 12000.00         | 33949.00                      | 33949.00                | 58432.80                     | Nil            |                                   |
| 2018-19         | 29853.00         | 33949.00                      | 33949.00                | 39602.5                      | Nil            |                                   |
| 2019-20         | 29853.00         | 33949.00                      | 33949.00                | 79590                        | Nil            |                                   |
| 2020-21         | 29853.00         | 33949.00                      | 33949.00                | 124691                       | Nil            |                                   |
| <b>Total</b>    | <b>119080.00</b> | <b>194712</b>                 | <b>194712</b>           | <b>370888.30</b>             |                |                                   |

| Proposal period | Achievement |                               |                         |                                 |                    |                                   |
|-----------------|-------------|-------------------------------|-------------------------|---------------------------------|--------------------|-----------------------------------|
|                 | Year        | Soil/murrum<br>m <sup>3</sup> | Waste<br>m <sup>3</sup> | Total<br>O.B.<br>m <sup>3</sup> | Mineral mt.        | SR= OB :<br>ore in m <sup>3</sup> |
|                 |             |                               |                         |                                 | Manganese(RO<br>M) |                                   |
| 2016-17         | -           | -                             | -                       | -                               | 328                | Nil                               |
| 2017-18         | -           | -                             | -                       | -                               | 1231               | Nil                               |
| 2018-19         | -           | -                             | -                       | -                               | 1087               | Nil                               |
| 2019-20         | -           | -                             | -                       | -                               | 104                | Nil                               |
| 2020-21         | -           | -                             | -                       | -                               | Awaited            | Nil                               |
| <b>Total</b>    | -           | -                             | -                       | -                               | <b>2750</b>        |                                   |

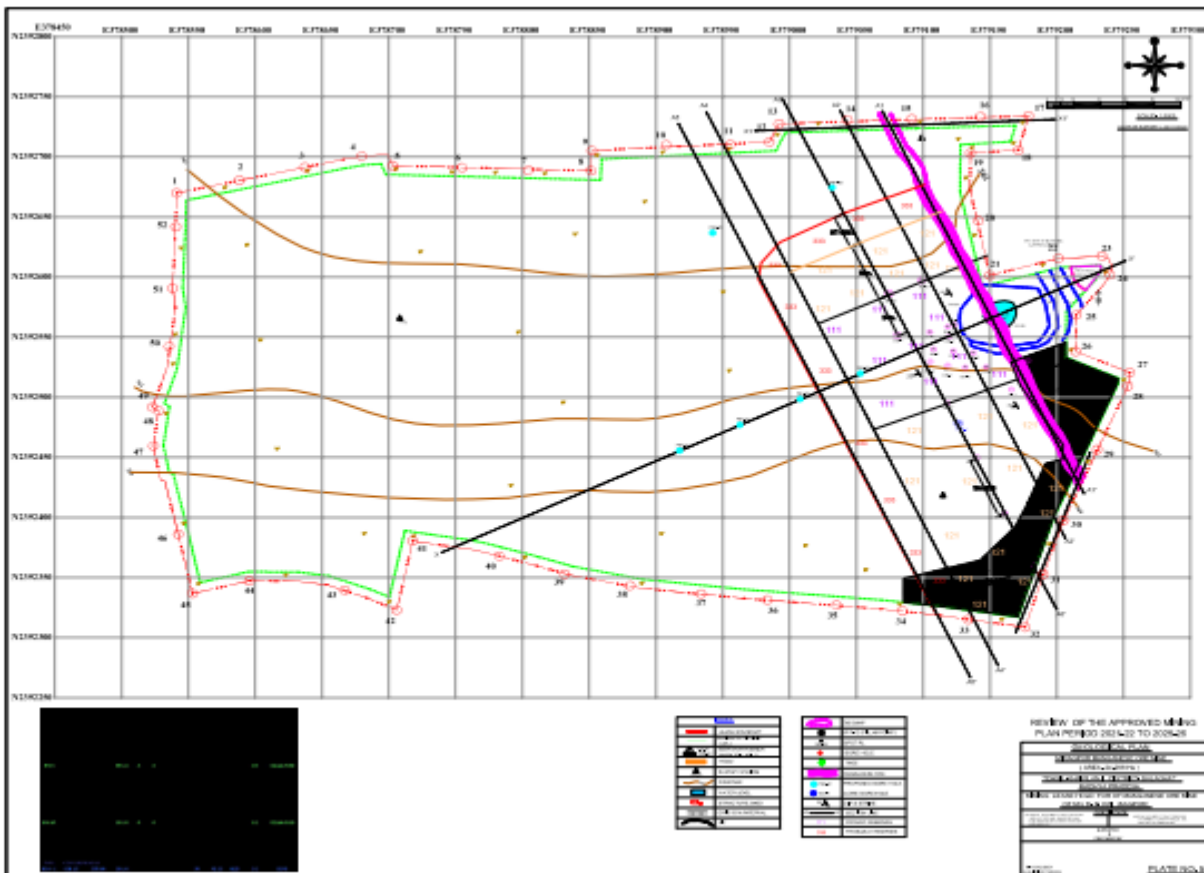


Fig 5.1 Approved Mine plan of Miragpur Mine, Khairlangi Balaghaat



Fig 5.2 Mining phase of drilling at Miragpur mine



## 6. Use of water obtained from mine dewatering

As per the approved mine plan the Miragpur mine has a discharge of 8 KLD or 8m<sup>3</sup>/day The entire water is utilize as per the Table 6.1.

| Table 6.1 Water utilization in Miragpur mine ( Area = 24.288 ha) |                  |                                 |                | Table 6.1a. Water utilization in Miragpur mine ( Area = 4.339 ha) |                  |                                 |                |
|--|------------------|---------------------------------|----------------|---|------------------|---------------------------------|----------------|
| Sr.no  | Purposes         | Environmental Clearance (68KLD) |                | Sr.no   | Purposes         | Environmental Clearance (4 KLD) |                |
|  |                  | Actual Discharge                | Proposed (KLD) |   |                  | Actual Discharge                | Proposed (KLD) |
| 1  | Dust suppression | 8 KLD                           | 10             | 1   | Dust suppression | 0 KLD                           | 1              |
| 2  | Green belt       |                                 | 10             | 2   | Green belt       |                                 | 1              |
| 3  | Domestic         |                                 | 6              | 3   | Domestic         |                                 | 1              |
| 4  | Drilling         |                                 | 10 (Utilized)  | 4   | Drilling         |                                 | 1              |
| 5  | Sand Stowing     |                                 | 20             | <b>Total</b>  |                  |                                 |                |
| <b>Total</b>   |                  |                                 | <b>56</b>      |   |                  |                                 |                |

6.1 For Drinking – The mine discharge is not used for drinking. Drinking water for the mine is obtained from existing dug well within ML area.

6.2 Irrigation- During monsoon small quantity of water is released from storage tank for irrigation. However, 10KLD mine discharge is used for maintaining green belt.

6.3 Recharge- The mine discharge after three step of de-siltation is stored in a recharge cum storage pond of nearly 0.15ha with a depth of av 1.5m thus having storage capacity of 0.25ham nearly 25% can be taken as recharge from this tank

6.4 Runoff to stream- No discharge is released to any stream from the Miragpur mine.

6.5 Benefitted area- Nearby villagers of village Miragpur

6.6 Dust suppression, green belt development- as shown in table 8KLD is used for this purpose.

## 7. Comprehensive assessment of the impact on the ground water regime

Comprehensive assessment of the impact on the ground water regime in and around the project area highlighting the risks and proposed management strategies proposed to overcome any significant environmental issues.

The present phase of Miragpur Mine is an underground mine for proposal of production of Mn ore of 1300 tons/Yr. There is one existing pit. Total 21 bore holes have been drilled as per last approved plan. No fresh reserves are estimated, reserves are kept as per last approved plan. Existing open pit size-4180 m<sup>2</sup> as on 1-04-2016- This is the Main Pit which was proposed to be extended along strike towards the western lease boundary and depth extension proposed up 330 MRL. The surface elevation at 24.288 ha mine lease area varies between 345 and 342 m amsl. It is proposed to extend and expand the existing o/c workings in the strike direction to the east and west both and the Pit will be further deepened. However, beyond the existing pit in the east and west direction, there is virgin ground where surface RL is 360/361MRL. There exist no natural surface water drainage/ nala/stream within the mine lease area. Groundwater occurrence is restricted only to the phreatic aquifer developed in the weathered zones of quartz mica schist, the host rock. The extracted groundwater from mine is fully utilized for mining operation and maintaining green belt within ML area after de-siltation at three levels. As such there is no significant impact of mining on groundwater regime in this hard rock terrain as the radius of influence is very much restricted due to high heterogeneity.



**Fig 7.1** Tube well and mine pit within mine lease area of the mine

**7.1. Impaction surface water sources**– The Miragpur Mine is situated on a local high within a regional low as depicted in the Fig 7.2. No nala/stream exists or generates from ML area of Miragpur mine. The ML area is not situated within any wetland zone and not part of any national

park etc. Other existing small ponds/ water bodies within core and buffer zone has been investigated and the water quality is found normal.

**7.1.1 Diversion** of existing channels [constructed dam/barrages/weir/canals/hydro-electric projects] – No existing channel, constructed dam/barrages/weir/canals/hydro-electric projects etc need to be diverted due to the project. Thus 7.1.1 is not applicable.

**7.1.2 Change in land use** [change in flood plain, lotic & lentic systems etc.]-No nala/stream/ river exist or generates from ML area of Pandharwani mine. The ML area is not situated within any wetland zone thus change in land use in flood plain, lotic & lentic systems etc is not applicable.

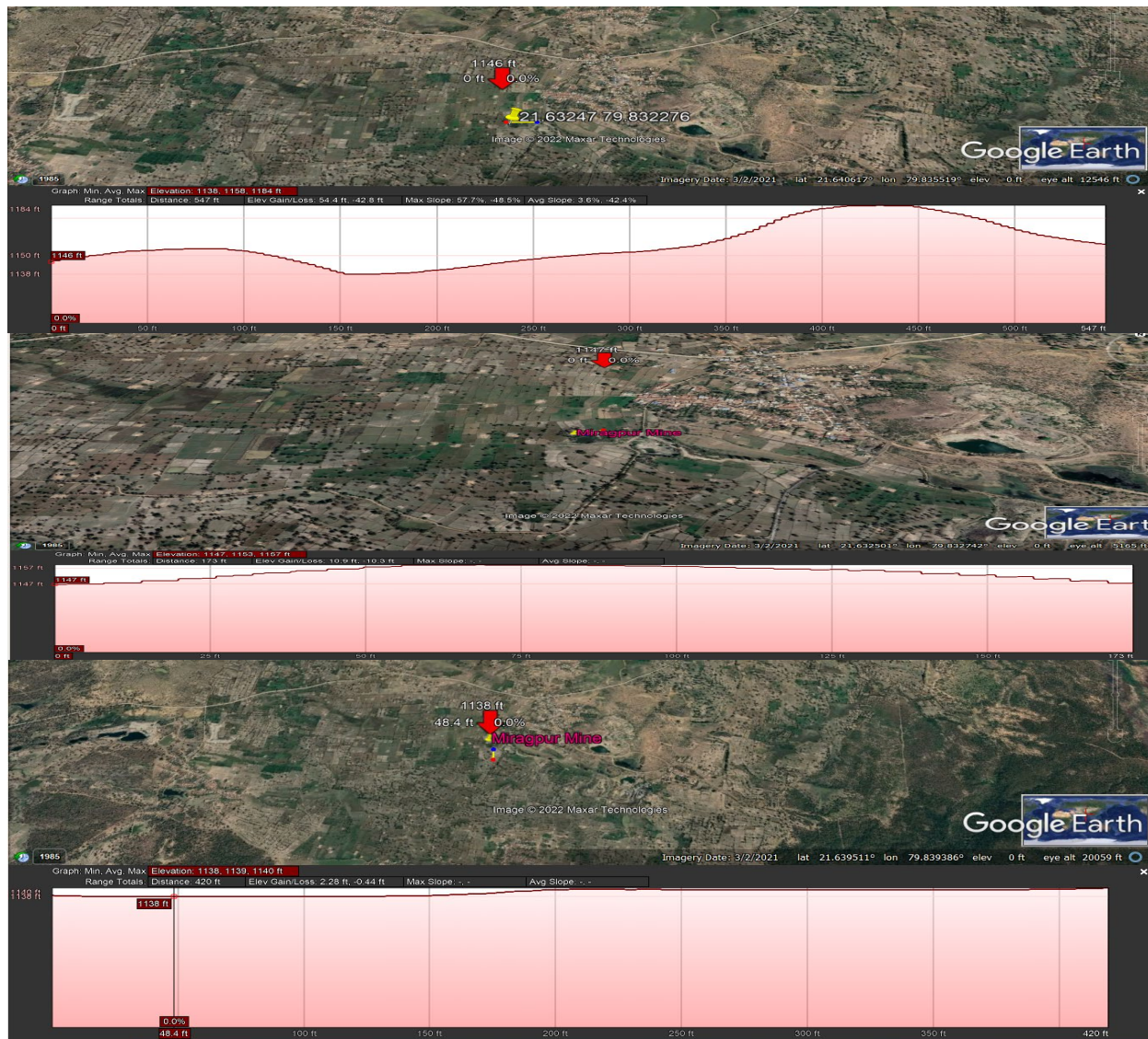


Fig 7.2 Google elevation profile of study area around Miragpur Mine from three direction.

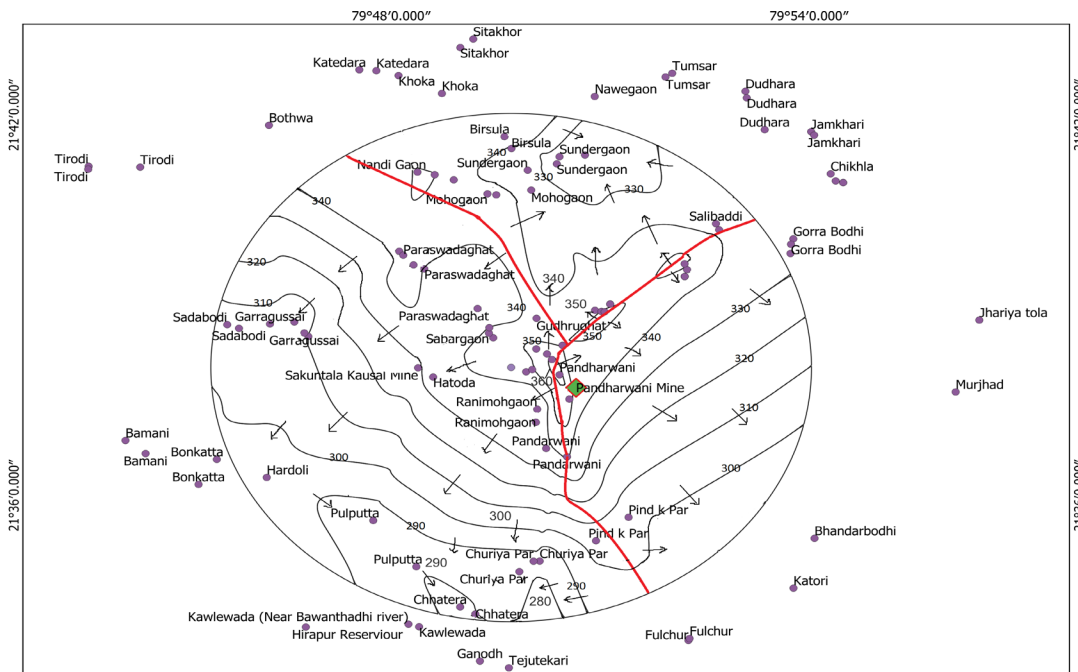
**7.1.3 Current & Potential threats-** The ML area is situated onto a water divide from where no nala stream is generating nor any spring ever exist in the area. However, due to moderate rainfall of >1150mm with about 70 rainy days good quantum of runoff (~ 7.7ham/yr) generates from the area as calculated considering about 45% runoff coefficient-

$$24.288 \text{ ha} \times 1.151 \text{ m} \times 0.45 = 12.57 \text{ ham/yr.}$$

Garland drains are existing to channelize the generated runoff for impounding the water into a water conservation tank. Runoff collected within the pre-existing abandon opencast pit of Pandharwani mine lease area is also gainfully utilized for conservation. It is observed that the core zone having average groundwater level 6m bgl in comparison to that of buffer zone av 5m bgl. This can be due to the higher surface elevation of core zone, which is found av. 342 m amsl, in comparison to buffer zone of 315m amsl. To negotiate any potential threat of groundwater

decline in the core zone area rainwater harvesting involving abandon mine pits and ponds are in practice.

**7.2 Impact on groundwater sources**– The Miragpur mine lease area is in Khairlangi block of Balaghat district, MP which is categorized under safe category (Stage of GW Extraction 33%) by the latest estimation carried out by CGWB (2020). The groundwater levels measured in study area remain shallow (4-8m) throughout the year with 2-3m fluctuation. The area is part of hard rock terrain and consist only phreatic aquifer developed over the weathered zone of quartz mica schist. The thickness of the weathered zone is restricted to top 12-17 m as observed along open case mine pits and by geophysical investigations. Both dug wells and hand pumps are tapping this phreatic aquifer. Bore wells are scanty having a depth of maximum 30m tapping weathered zone and occasional fractures. Existing open pit size-4180 m<sup>2</sup>. This is the Main Pit which was proposed to be extended along strike towards the western lease boundary and depth extension proposed up 330MRL. From the bottom of Open cast working of Incline shafts were proposed for development u/g ore body. Little water extracted from mine as mine discharge (8KLD) is mainly the seepage from phreatic zone through pre-existing exploratory holes within mine tunnel or from wall seepage from top. The phreatic aquifer zone is protected and recharged by construction of rainwater harvesting ponds and through abandon open case pits in the core zone of mining.

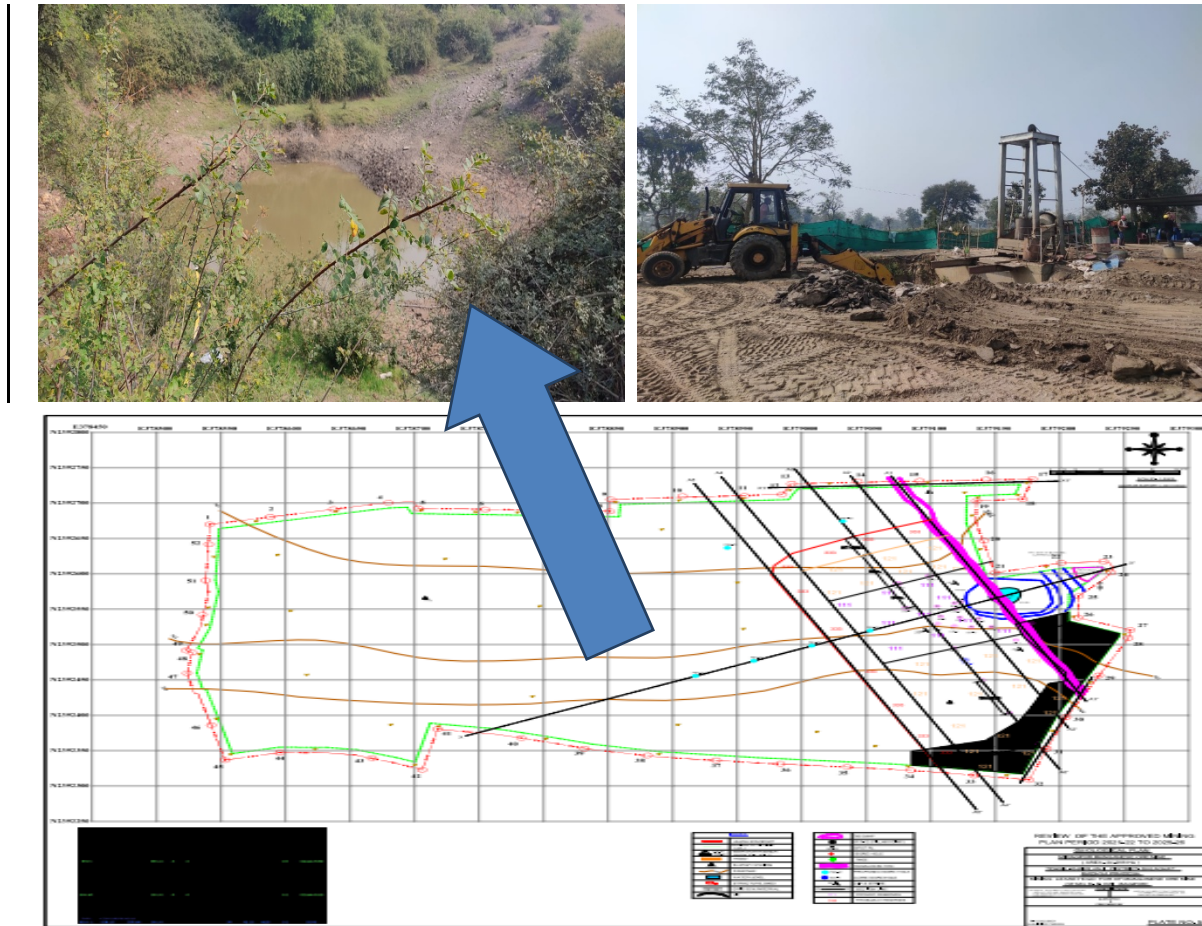


**Fig 7.3 Groundwater contour map of Miragpur mine area.**

**INDEX**-Red line shows groundwater divide, arrows indicating groundwater flow direction, values indicate groundwater elevation (m amsl), dots indicate data point used for generation of GW contour, buffer zone is marked

occur, because of any past ground water abstraction. Existing open pit size-4180 m<sup>2</sup> as on 1-04-2016- This is the Main Pit which was proposed to be extended along strike towards the western lease boundary and depth extension proposed up 330MRL. As such, o/c workings are restricted to a depth of 14m at 347 MRL in view of the land degradation as the area is agricultural land and

locals resist it. From the bottom of Open cast working of Incline shafts were proposed for development u/g ore body. It is proposed to extend and expand the existing o/c workings in the strike direction to the east and west both and the Pit will be further deepened. However, beyond the existing pit in the east and west direction, there is virgin ground where surface RL is 360/361MRL. The pit so developed is presently used as first settling pit for mine discharge. All runoff generated within the pit of abandon OC mine thus also collected and stored at final conservation pond. It was observed in the LULC map that area covered under water body has increased from 60 ha to 123ha (Table 1.2).



**7.4** Existing abandon open cast mine pit and water harvesting pit near Miragpur mine (photo March 2022) and mine plan. Note the bottom of OC pit in plan and photo shown by arrow.

7.2.2 An assessment of the likely impacts on environmental that will occur, or are likely to occur, because of the ground water abstraction for a five-year period starting on the consultation day for the report; and over the projected life of the resource project area, affected area and radius of influence. The Miragpur mining lease was granted to M/s D.P. Rai in the year 2006 for 20 year over an area of 24.288 ha & 4.339 ha (As per mine plan). Existing open pit mine have an area

4180 m<sup>2</sup> up to MRL 350 and 1323 meter of exploratory drilling comprising 21 bore holes. It is proposed to extend and expand the existing o/c workings in the strike direction to the east and west both and the Pit will be further deepened. However, beyond the existing pit in the east and west direction, there is virgin ground where surface RL is 360/361MRL. It is proposed to start u/g mining as soon as minimum cover required for u/g mining is achieved. O/C workings are completed in the second year (ending 2022-23). U/G workings will be commenced from 347MRL (UPD) in the year 2023-24 & continue for three years (2023-24,2024-25 & 2025-26) & Conceptual period.

### 7.3. Socio-Economic Aspects:

#### 7.3.1 Settlements and population dynamics around project area

The study area comes under rural. There exists about 35 villages in the study area and their details are given in Table 7.1 and 7.2.

| Table 7.1 Crop production details of Balaghat District Madhya Pradesh in kharif and Rabi |               |       |                   |       |
|--|---------------|-------|-------------------|-------|
|  | Kharif        |       | Rabi              |       |
| Sr. no   | Crops         | (Ha)  | Crops             | ( Ha) |
| 1  | Rice          | 244.9 | Linseed           | 19.0  |
| 2  | Minor Millets | 12.8  | Wheat             | 18.4  |
| 3  | Pigeonipea    | 7.1   | Chickpea          | 10.4  |
| 4  | Maize         | 05.6  | Rapeseed/ mustard | 7.30  |

There is no impact of groundwater withdrawal by Miragpur Mn Mine on the study area, study can recommend NOC may be extended for next 5 yr with existing 8KLD extractions from groundwater system.

**7.3.2 Dependency** on sources of water [surface or sub-surface] the area by and large depends on rainfed agriculture with supportive irrigation. Surface water irrigation using canal water is the main source of irrigation within the buffer zone. Local canals network is developed using the water of minor irrigation projects like Hirapur, Tirodi, Sitalgarh and Sadabodi Dam/Reservoirs. Water bodies developed on abandon mine pits are also used as sources of water for irrigation along with some dug wells. Drinking water is mainly catered by groundwater through dug wells and hand pumps. Industrial use of water in the study area is largely remains within the mining sector. Several open cast and underground mine lease area exist within the study area. Mine discharge is the main source of water for mining operation. No other significant industrial use exists in the area.

**Table 7.2 Population data of study area in parts of Khairlanji, Tirodi and Lalbarra blocks**

| S. No. | Location              | House | Total Population | Male | Female | Area (Ha) |
|--------|-----------------------|-------|------------------|------|--------|-----------|
| 1      | Bhandarbodhi          | 838   | 3520             | 1690 | 1830   | 1412.2    |
| 2      | Birsula               | 186   | 2620             | 1309 | 1311   | 363.3     |
| 3      | Bonkatta              | 852   | 3403             | 1741 | 1662   | 195.3     |
| 4      | Chhatera              | 430   | 1746             | 893  | 853    | 422.6     |
| 5      | Chikhla               | 607   | 2316             | 1166 | 1150   | 873.3     |
| 6      | Churiya Par           | 249   | 960              | 484  | 476    | 606.1     |
| 7      | Dudhara               | 285   | 984              | 492  | 492    | 257.2     |
| 8      | Fulchur               | 489   | 1858             | 891  | 967    | 742.3     |
| 9      | Garragussai           | 119   | 498              | 242  | 246    | 221.1     |
| 10     | Goorabodi             | 239   | 761              | 392  | 369    | 352.2     |
| 11     | Gudhrughat            | 452   | 1732             | 830  | 902    | 403.8     |
| 12     | Hardoli               | 732   | 3126             | 1523 | 1603   | 704.6     |
| 13     | Hatoda                | 328   | 1333             | 664  | 669    | 483.55    |
| 14     | HirapurReservio<br>ur | 134   | 507              | 241  | 266    | 302       |
| 15     | Jamkhari              | 172   | 554              | 259  | 295    | 311.6     |
| 16     | Katedara              | 319   | 1415             | 733  | 712    | 466.1     |
| 17     | Katori                | 701   | 2726             | 1365 | 1361   | 932       |
| 18     | Kawlewada             | 571   | 2179             | 1067 | 1112   | 541.34    |
| 19     | Khoka                 | 280   | 1269             | 635  | 634    | 283.12    |
| 20     | Miragpur              | 389   | 1418             | 712  | 706    | 328.2     |
| 21     | Mohogaon              | 401   | 1477             | 746  | 731    | 378.42    |
| 22     | Murjhad               | 216   | 907              | 450  | 457    | 448.71    |
| 23     | Nandi Gaon            | 426   | 1848             | 923  | 925    | 447.1     |
| 24     | Nawegaon              | 322   | 1340             | 659  | 681    | 282.9     |
| 25     | Pandarwani            | 190   | 711              | 332  | 379    | 281.1     |
| 26     | Paraswadaghat         | 662   | 2583             | 1230 | 1353   | 889.47    |
| 27     | Pind k Par            | 460   | 1927             | 949  | 978    | 593.42    |
| 28     | Pulputta              | 613   | 2691             | 1332 | 1359   | 697.7     |
| 29     | Sabargaon             | 434   | 1533             | 748  | 785    | 547.83    |
| 30     | Sadabodi              | 181   | 721              | 354  | 367    | 208.83    |
| 31     | Salibardi             | 771   | 2839             | 1375 | 1464   | 870.3     |
| 32     | Shankar<br>Pipariya   | 452   | 1559             | 776  | 783    | 465.9     |
| 33     | Sukdighat             | 295   | 1207             | 606  | 601    | 438.2     |
| 34     | Tekadighat            | 409   | 1594             | 768  | 826    | 646.9     |
| 35     | Tumsar                | 201   | 766              | 379  | 387    | 213.6     |



**7.3.3 Ground water uses** [e.g. irrigation (irrigation method, number of watering) water supply etc.] Groundwater plays secondary role in irrigation in the study area. The main crop is kharif uses supportive irrigation largely through canals of minor irrigation projects. Mine out pits locally also support the crop water requirement. Dug well fitted with electrical pumps are used to support kharif and rabi crops in the area. The unit draft of dug wells varies from 0.0027 to 0.036 mcm/ year. Mine discharge is being used for horticulture within core and buffer zone.

#### **7.3.4 Improvement / decline in agricultural yield in last 5 years and likely impact after NOC**

The average agriculture yield has not changed in last 5 year. The area is of hard rock terrain and the aquifer is quartz mica schist having radius of influence less than 500m as observed the mine core area. So, no likely negative impact of NOC is inferred. Rather LULC shows increase of water body area may provide additional irrigation source

#### **7.3.5 Impact of existing project on local communities** [based on local interactions (interactions must be with stakeholders like fishermen community, farmers etc.)]

M/s D.P. Rai, Nagpur, is a partnership firm registered under Indian Partnership Act, 1932. Miragpur Manganese mine is engaged in the mining activities since decades. Miragpur Manganese mine is located in Miragpur village, Tehsil Khairlanji, District Balaghat, Madhya Pradesh. It extracts Mn by both underground. The industry has provided employment to the region. The groundwater withdrawal of maximum 8KLD has not created any adverse impact on the groundwater regime of the area. The average water level in study area in pre monsoon period is 5 to 10 m and 2.5 to 6 m during monsoon period. The biggest advantage of the study area is that a seasonal river called Bawanthadi flow in monsoon period of July to October that protects the area from any adverse impact on groundwater. Further the Miragpur Mn mine has taken up the rainwater harvesting and artificial recharge structure in the lease area. LULC data shows marginal decline in cultivated land in the 10km radius. However, as a whole no complain is observed.

## 8. Proposed measures for disposal of wastewater by mine drawing saline water.

The water in the study area including mine discharge is fresh and the TDS is ranges between 150 and 1900 ppm in general so disposal of saline water not applicable.

## 9.0 Water Conservation

**Measures to be adopted for water conservation which includes recycling, reuse, treatment, etc. This includes the water balance chart being adopted by the firm along with details of water conservation methods to be adopted. - Brief write up along with capacity and flow chart of Sewage Treatment Plants / Effluent Treatment Plants / Combined Effluent Treatment Plants existing/ proposed within the project. - Details of water conservation measures to be adopted to reduce/ save the ground water. - Total water balance chart showing the usage of water for various processes.**

The entire mine discharge (8KLD) is consumed for various mine operation/dust suppression/plantation-horticultural use (Table 9.1).The mine discharge except high suspended particle is fresh. No sewage treatment plant /effluent treatment plan is in operation, or it is required for mine discharge.

Water conservations can be proposed for enhanced by including efficient measures of water use for mining and domestic consumption, effective reuse and recycles of water and treated water, adoption of appropriate rainwater harvesting and artificial recharge methods. It is therefore following sub topics are incorporated in this chapter.

9.1 Water use and water balance

9.2 RWH and Artificial Recharge

### 9.1 Water use and water balance

Miragpur Manganese mine is engaged in the mining activities since decades. Water is being used for dust suppression, greenbelt, domestic drilling and sand stowing purposes shown in the table no 3.1

## 9.2. Rainwater Harvesting & Artificial recharge:

Miragpur mine having an area of 24.288ha & 4.339 ha and land use is discussed in chapter 1.4 and table 1.1. The mine has taken up concentrated effort conserve each drop of rain water that the campus receives annually. Storm water garland drain has been constructed all along the mining area, office and staff quarter. A mine pit is also constructed along the mine for collection of mine discharge water and rainwater. The mine pit is having an area of 0.14 ha (1400m<sup>2</sup>) and depth of 3m. The mine pit having total storage capacity is 0.42 ha (4200m<sup>2</sup>). The collected water is again used in agriculture purposes of the surrounding areas. The run-off co-efficient has been taken 85% here. The recharge structures are shown below

**Recharge Water= Area x normal rain fall x runoff coefficient**

$$Q = 4200 \times 1.471 \times 0.5 = 3089.1 \text{ m}^3$$

| Table9.1 Water utilization in Miragpur mine ( Area = 24.288 ha) |                  |                                 |                |
|---|------------------|---------------------------------|----------------|
| Sr.no   | Purposes         | Environmental Clearance (68KLD) |                |
|   |                  | Actual Discharge                | Proposed (KLD) |
| 1   | Dust suppression | 8 KLD                           | 10             |
| 2   | Green belt       |                                 | 10             |
| 3   | Domestic         |                                 | 6              |
| 4   | Drilling         |                                 | 10 (Utilized)  |
| 5   | Sand Stowing     |                                 | 20             |
| <b>Total</b>  |                  |                                 | <b>56</b>      |

| Table9.1a. Water utilization in Miragpur mine ( Area = 4.339 ha) |                  |                                 |                |
|--|------------------|---------------------------------|----------------|
| Sr.no  | Purposes         | Environmental Clearance (4 KLD) |                |
|  |                  | Actual Discharge                | Proposed (KLD) |
| 1  | Dust suppression | 0 KLD                           | 1              |
| 2  | Green belt       |                                 | 1              |
| 3  | Domestic         |                                 | 1              |
| 4  | Drilling         |                                 | 1              |
| <b>Total</b>   |                  |                                 | <b>4</b>       |



Fig 9.2 Design of proposed rooftop rain water harvesting structure

**Table 9.2 Ponds and water bodies of study area**

| S. N. | Location             | Latitude | Longitude | Elevation | EC ( $\mu$ S) | pH  | TDS (ppt) | DO (mg/l) | Water body         |
|-------|----------------------|----------|-----------|-----------|---------------|-----|-----------|-----------|--------------------|
| 1     | Pandharwani          | 21.63169 | 79.840268 | 364.51    | 540           | 8.1 | 120       | 6.2       | Pit Mine           |
| 2     | Goorabodi            | 21.65752 | 79.870229 | 343       | 580           | 8.1 | 250       | 9.4       | Pond               |
| 3     | Yerwaghat            | 21.65932 | 79.870783 | 335.56    | 950           | 7.3 | 320       | 5.88      | Pond               |
| 4     | Gorra Bodhi          | 21.66741 | 79.89621  | 337.4     | 780           | 8.2 | 280       | 4.8       | Pond               |
| 5     | Chikhla              | 21.68219 | 79.908152 | 343.59    | 980           | 8.2 | 320       | 6.2       | Pond               |
| 6     | Nandi Gaon           | 21.68292 | 79.814956 | 342.53    | 850           | 8.1 | 320       | 10.34     | Pond               |
| 7     | Mohogaon             | 21.68023 | 79.8335   | 334.1     | 790           | 8.5 | 335       | 6.46      | Pond               |
| 8     | Sundergaon           | 21.68946 | 79.846363 | 320.15    | 790           | 8.1 | 250       | 6.9       | Pond               |
| 9     | Khoka                | 21.71033 | 79.801737 | 346.83    | 450           | 8.4 | 310       | 5.9       | Pond               |
| 10    | Tirodi               | 21.68648 | 79.727579 | 358.18    | 440           | 7.3 | 160       | 2.7       | MOIL Reservoir     |
| 11    | SakuntalaKausal Mine | 21.63351 | 79.806412 | 328.59    | 610           | 8.1 | 310       | 4.79      | Mine Pit           |
| 12    | Churiya Par          | 21.5827  | 79.835526 | 280.27    | 640           | 8.3 | 220       | 4.93      | Pond               |
| 13    | HirapurReservoir     | 21.56538 | 79.779562 | 299.59    | 550           | 8.1 | 160       | 6.1       | Reservoir          |
| 14    | Fulchur              | 21.56236 | 79.871388 | 294.63    | 910           | 8.4 | 350       | 5.77      | Pond               |
| 15    | Miragpur mine        | 21.63247 | 79.832276 | 344.78    | 630           | 8.1 | 320       | 5.48      | Recharge pit       |
| 16    | Pandharwani Mine     | 21.62528 | 79.84262  | 360.09    | 450           | 8.3 | 150       | 6.9       | Recharge structure |

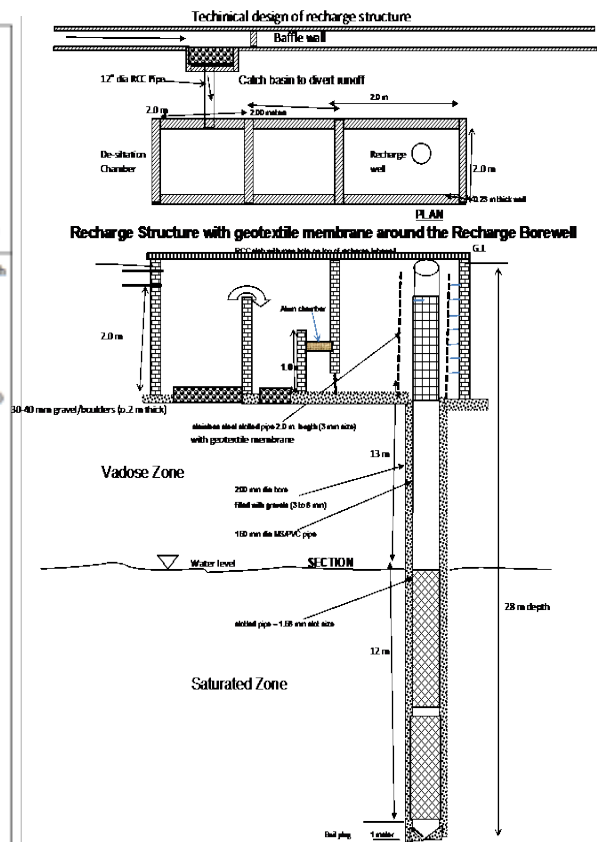
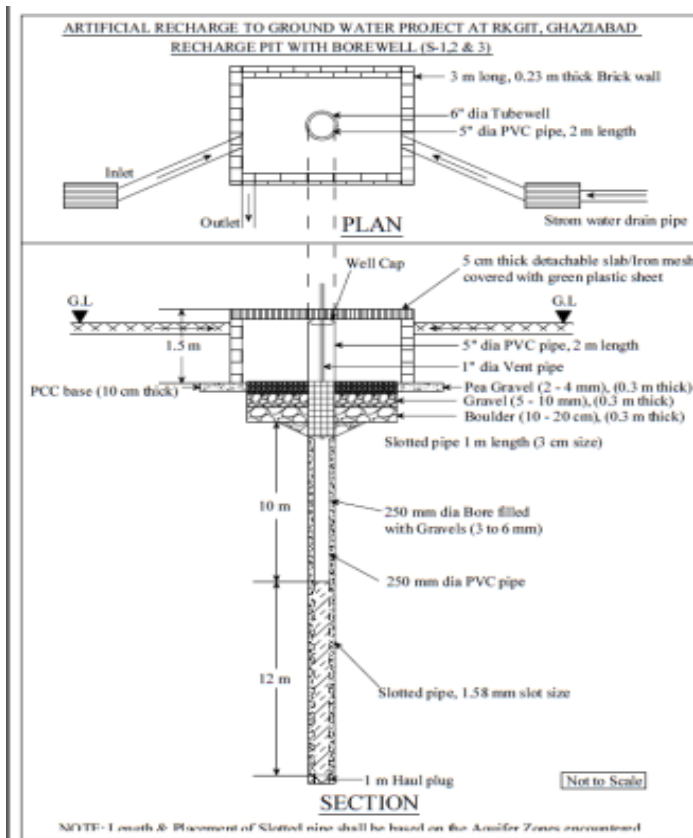
### 9.3. Monitoring, Measurement and Capacity building

Monitoring and measurements of several parameters are part of water conservation strategy towards the motive of efficient management of water. The withdrawal of groundwater is regularly monitored and measured from the existing dug well. The water level is found at 5-10 m bgl in pre-monsoonal period, which varies from 2.5-6 m bgl in the monsoonal period. The Miragpur mine conducts regular capacity building of its maintenance staff that monitors and measures and keeping record of various data related to water use and water conservation. The workers have been trained for keeping record and onward submission of data as per the requirement.

For monitoring of groundwater level in the area of Miragpur mine, Balaghat as per the guideline of CGWA, a piezometer has to be constructed at the area. The installation of piezometer is proposed exclusively for monitoring of groundwater level deploying automatic water level recorder with telemetric arrangement of data transmission.

#### Proposed Roof top rainwater harvesting structure

A roof top rainwater harvesting is proposed using standard design as given below for mine office and associated building at the mine core zone by drilling of 30m deep 6" dia bore well ( Fig 9.2) in addition to existing recharge structure (Fig 9.1).



## 10. Any other details pertaining to the project

Manganese ore-Manganese ore horizon comprising of mostly manganese ore and manganiferous quartzite of Mansar Formation. The manganese ore is massive in nature containing mainly psilomelane. Mn ore band, running from (N200W to S200E) direction with an average thickness of ore is 8 (Eight) meters. Dip of the ore body is approx. 250 towards (SW).

**Annexure-1 DATASET PANDHARWANIAREA, BALAGHAT**

| S. N. | Location    | Latitude  | Longitude | Elevation | EC (mS) | pH  | TDS (ppt) | Water Level (m) | Diameter (m) | DO (mg/l) | Type of water body |
|-------|-------------|-----------|-----------|-----------|---------|-----|-----------|-----------------|--------------|-----------|--------------------|
| 1     | Pandharwani | 21.631688 | 79.840268 | 364.51    | 540     | 8.1 | 120       |                 |              | 6.2       | Pit Mine           |
| 2     | Miragpur    | 21.635695 | 79.838438 | 363.08    | 1700    | 6.8 | 860       |                 |              | 6.54      | Hand Pump          |
| 3     | Miragpur    | 21.637156 | 79.837283 | 355.2     | 1690    | 7.2 | 850       |                 |              |           | Hand Pump          |
| 4     | Miragpur    | 21.639436 | 79.840974 | 349.52    | 1420    | 7.5 | 230       |                 |              | 2.38      | Hand Pump          |
| 5     | Sukdighat   | 21.648613 | 79.848755 | 342.09    | 1560    | 7.2 | 650       | 7               | 2.7          | 4.53      | Dug well           |
| 6     | Sukdighat   | 21.648322 | 79.850303 | 351.71    | 1830    | 7.2 | 920       |                 |              | 2.72      | Hand Pump          |
| 7     | Sukdighat   | 21.648242 | 79.851071 | 353.48    | 2550    | 7.3 | 1230      |                 |              |           | Dug well           |
| 8     | Sukdighat   | 21.650272 | 79.852384 | 346.06    | 2100    | 7.1 | 1000      |                 |              | 2.4       | Hand Pump          |
| 9     | Sukdighat   | 21.650272 | 79.852384 | 346.06    | 1990    | 7.8 | 1050      | 6.7             | 2.5          |           | Dug well           |
| 10    | Goorabodi   | 21.657518 | 79.870229 | 343.65    | 1105    | 7.5 | 220       |                 |              | 2.5       | Hand Pump          |
| 11    | Goorabodi   | 21.657518 | 79.870229 | 343       | 580     | 8.1 | 250       |                 |              | 9.4       | Pond               |
| 12    | Goorabodi   | 21.657518 | 79.870229 | 343.56    | 1250    | 7.2 | 300       |                 |              | 3.05      | Hand Pump          |
| 13    | Yerwaghat   | 21.65932  | 79.870783 | 335.56    | 950     | 7.3 | 320       |                 |              | 5.88      | Pond               |
| 14    | Goorabodi   | 21.66087  | 79.870203 | 353.74    | 740     | 7.1 | 370       |                 |              |           | Hand Pump          |
| 15    | Salibardi   | 21.671405 | 79.877707 | 336.32    | 680     | 6.5 | 150       |                 |              |           | Hand Pump          |
| 16    | Salibardi   | 21.669789 | 79.878459 | 335.46    | 650     | 7   | 250       |                 |              |           | Hand Pump          |
| 17    | Gorra Bodhi | 21.667408 | 79.89621  | 337.4     | 780     | 8.2 | 280       |                 |              | 4.8       | Pond               |
| 18    | Gorra Bodhi | 21.665994 | 79.895665 | 331.16    | 680     | 7.4 | 320       | 4.8             | 2            | 4.2       | Dug well           |
| 19    | Chikhla     | 21.66357  | 79.895535 | 333.95    | 1220    | 7.5 | 620       | 6               | 2.8          | 2.05      | Dug well           |
| 20    | Chikhla     | 21.684507 | 79.905157 | 328.48    | 1450    | 7.2 | 720       |                 |              |           | Hand               |

|    |                |           |           |        |      |     |      |     |     |       |           |
|----|----------------|-----------|-----------|--------|------|-----|------|-----|-----|-------|-----------|
|    |                |           |           |        |      |     |      |     |     |       | Pump      |
| 21 | Chikhla        | 21.682636 | 79.906358 | 332.58 | 1910 | 6.9 | 960  | 8   | 2   | 3.61  | Dug well  |
| 22 | Chikhla        | 21.682192 | 79.908152 | 343.59 | 980  | 8.2 | 320  |     |     | 6.2   | Pond      |
| 23 | Chikhla        | 21.682192 | 79.908152 | 343.59 | 530  | 7.8 | 260  |     |     |       | Hand Pump |
| 24 | Miragpur       | 21.638487 | 79.8347   | 353.81 | 650  | 7.3 | 320  |     |     |       | Hand Pump |
| 25 | Sabargaon      | 21.641404 | 79.824406 | 343.13 | 1780 | 6.4 | 890  |     |     |       | Hand Pump |
| 26 | Sabargaon      | 21.642618 | 79.823377 | 342.44 | 3800 | 6.8 | 1900 | 6.5 | 2   | 2.6   | Dug well  |
| 27 | Sabargaon      | 21.644069 | 79.823462 | 340.76 | 2960 | 6.9 | 1480 |     |     |       | Hand Pump |
| 28 | Paraswadagh at | 21.649093 | 79.820654 | 328.59 | 660  | 7.5 | 320  |     |     |       | Hand Pump |
| 29 | Paraswadagh at | 21.659513 | 79.807917 | 338.8  | 1005 | 7.3 | 520  | 7   | 2.5 | 7.2   | Dug well  |
| 30 | Paraswadagh at | 21.660558 | 79.80533  | 351.76 | 910  | 7.8 | 450  |     |     |       | Hand Pump |
| 31 | Paraswadagh at | 21.664135 | 79.801919 | 340.53 | 2680 | 7.1 | 1340 |     |     |       | Hand Pump |
| 32 | Paraswadagh at | 21.66312  | 79.802876 | 343.89 | 3630 | 6.8 | 1820 |     |     |       | Hand Pump |
| 33 | Nandi Gaon     | 21.684963 | 79.806272 | 339.63 | 600  | 7.7 | 300  |     |     |       | Hand Pump |
| 34 | Nandi Gaon     | 21.684272 | 79.810401 | 339.84 | 1920 | 6.9 | 970  |     |     |       | Hand Pump |
| 35 | Nandi Gaon     | 21.682917 | 79.814956 | 342.53 | 850  | 8.1 | 320  |     |     | 10.34 | Pond      |
| 36 | Mohogaon       | 21.679234 | 79.823017 | 339.12 | 530  | 7.7 | 260  |     |     |       | Hand Pump |
| 37 | Mohogaon       | 21.678983 | 79.825131 | 346.41 | 1360 | 7.2 | 690  |     |     |       | Hand Pump |
| 38 | Mohogaon       | 21.68023  | 79.8335   | 334.1  | 790  | 8.5 | 335  |     |     | 6.46  | Pond      |
| 39 | Sundergaon     | 21.68713  | 79.839619 | 326.1  | 720  | 7.3 | 360  |     |     |       | Hand Pump |
| 40 | Sundergaon     | 21.689001 | 79.840266 | 326.3  | 2640 | 6.7 | 1330 |     |     |       | Hand Pump |
| 41 | Sundergaon     | 21.685458 | 79.832651 | 333.14 | 890  | 7.3 | 440  |     |     |       | Hand Pump |
| 42 | Sundergaon     | 21.689457 | 79.846363 | 320.15 | 790  | 8.1 | 250  |     |     | 6.9   | Pond      |
| 43 | Nawegaon       | 21.704839 | 79.848695 | 333.17 | 1590 | 7.2 | 790  |     |     |       | Hand Pump |
| 44 | Tumsar         | 21.70996  | 79.865638 | 332.46 | 1730 | 7.2 | 860  |     |     |       | Hand Pump |
| 45 | Tumsar         | 21.710944 | 79.867237 | 329.69 | 1390 | 7.3 | 690  |     |     |       | Hand Pump |
| 46 | Dudhara        | 21.706201 | 79.884752 | 316.42 | 700  | 7.2 | 340  |     |     |       | Hand Pump |

|    |                      |           |           |        |      |     |      |      |     |      |                |
|----|----------------------|-----------|-----------|--------|------|-----|------|------|-----|------|----------------|
| 47 | Dudhara              | 21.704471 | 79.885074 | 328.17 | 760  | 7.3 | 380  |      |     |      | Hand Pump      |
| 48 | Dudhara              | 21.696104 | 79.889369 | 314.15 | 720  | 7.6 | 240  |      |     |      | Hand Pump      |
| 49 | Jamkhari             | 21.695575 | 79.900478 | 321.87 | 1280 | 7.4 | 640  |      |     |      | Hand Pump      |
| 50 | Jamkhari             | 21.694672 | 79.901208 | 319.15 | 1020 | 7.4 | 390  |      |     |      | Hand Pump      |
| 51 | Gudhrughat           | 21.64652  | 79.834762 | 340.56 | 580  | 7.9 | 280  | 4.2  | 1.5 | 5.3  | Dug well       |
| 52 | Birsula              | 21.691179 | 79.828772 | 334.89 | 1020 | 7.4 | 540  |      |     |      | Hand Pump      |
| 53 | Birsula              | 21.694301 | 79.827105 | 351.11 | 1080 | 7.7 | 560  | 4.5  | 2   |      | Dug well       |
| 54 | Sitakhori            | 21.717681 | 79.816533 | 341.65 | 540  | 7.4 | 260  | 5    | 2   |      | Dug well       |
| 55 | Sitakhori            | 21.719929 | 79.81962  | 340.24 | 680  | 7.3 | 340  |      |     |      | Hand Pump      |
| 56 | Khoka                | 21.705623 | 79.812121 | 347.08 | 820  | 7.7 | 310  | 1.45 |     |      | Borewell       |
| 57 | Khoka                | 21.710329 | 79.801737 | 346.83 | 450  | 8.4 | 310  |      |     | 5.9  | Pond           |
| 58 | Katedara             | 21.711607 | 79.796432 | 340.47 | 1040 | 7.2 | 340  |      |     |      | Hand Pump      |
| 59 | Katedara             | 21.711856 | 79.792357 | 342.87 | 880  | 7.5 | 440  | 4    | 1.5 |      | Dug well       |
| 60 | Bothwa               | 21.697268 | 79.770729 | 352.42 | 1430 | 7.1 | 740  |      |     |      | Hand Pump      |
| 61 | Tirodi               | 21.686482 | 79.727579 | 358.18 | 440  | 7.3 | 160  |      |     | 2.7  | MOIL Reservoir |
| 62 | Tirodi               | 21.685706 | 79.727475 | 334.49 | 840  | 7.4 | 320  |      |     |      | Hand Pump      |
| 63 | Tirodi               | 21.686257 | 79.739922 | 332.9  | 720  | 7.1 | 310  | 4.5  | 2   |      | Dug well       |
| 64 | Bamani               | 21.614417 | 79.736391 | 306.33 | 820  | 7.1 | 444  | 3.5  | 2   |      | Dug well       |
| 65 | Bamani               | 21.610979 | 79.741213 | 290.99 | 1600 | 7   | 800  |      |     |      | Hand Pump      |
| 66 | Bonkatta             | 21.602868 | 79.753879 | 286.6  | 910  | 7.1 | 440  | 6    | 1.4 |      | Dug well       |
| 67 | Bonkatta             | 21.609446 | 79.758254 | 295.86 | 1250 | 6.9 | 620  |      |     |      | Hand Pump      |
| 68 | Garragussai          | 21.641741 | 79.780165 | 310.59 | 740  | 6.9 | 220  |      |     |      | Hand Pump      |
| 69 | Garragussai          | 21.645568 | 79.776808 | 301.68 | 1111 | 6.7 | 560  | 4.3  | 2.1 |      | Dug well       |
| 70 | Garragussai          | 21.645046 | 79.770978 | 306.13 | 1720 | 7.2 | 900  | 5.1  | 2   |      | Dug well       |
| 71 | Sadabodi             | 21.644859 | 79.760747 | 305.02 | 1410 | 7.2 | 710  |      |     |      | Hand Pump      |
| 72 | Sadabodi             | 21.643897 | 79.763553 | 309.29 | 1360 | 7.4 | 680  | 4.4  | 1.5 |      | Dug well       |
| 73 | Garragussai          | 21.642687 | 79.779196 | 307.21 | 710  | 8   | 190  |      |     |      | Dug well       |
| 74 | SakuntalaKausal Mine | 21.633512 | 79.806412 | 328.59 | 610  | 8.1 | 310  |      |     | 4.79 | Mine Pit       |
| 75 | Hatoda               | 21.631088 | 79.810027 | 336.75 | 550  | 7.5 | 220  |      |     |      | Hand Pump      |
| 76 | Ranimohgaon          | 21.622631 | 79.83492  | 329.12 | 2210 | 7.2 | 1005 |      |     |      | Hand           |



|     |   |           |           |        |      |          |      |     |     |      |           |
|-----|---|-----------|-----------|--------|------|----------|------|-----|-----|------|-----------|
|     |   |           |           |        |      |          |      |     |     |      | Pump      |
| 77  | Ranimohgaon                                 | 21.61919  | 79.834619 | 329.81 | 1050 | 7.5      | 510  | 6   | 2   | 4.03 | Dug well  |
| 78  | Pandarwani                                  | 21.61232  | 79.837064 | 337.82 | 990  | 7.2      | 450  |     |     |      | Hand Pump |
| 79  | Pandarwani                                  | 21.61013  | 79.842064 | 341.23 | 880  | 7.2      | 380  |     |     |      | Hand Pump |
| 80  | Pind k Par                                  | 21.594223 | 79.856797 | 302.82 | 1050 | 7.3      | 460  |     |     |      | Hand Pump |
| 81  | Pind k Par                                  | 21.58805  | 79.848991 | 304.45 | 630  | 7.4      | 230  |     |     |      | Hand Pump |
| 82  | Churiya Par                                 | 21.582704 | 79.835526 | 280.27 | 640  | 8.3      | 220  |     |     | 4.93 | Pond      |
| 83  | Churiya Par                                 | 21.582679 | 79.834056 | 285.04 | 1960 | 7.5      | 980  |     |     |      | Hand Pump |
| 84  | Churiya Par                                 | 21.579936 | 79.830656 | 296.62 | 1050 | 7.5      | 490  | 4.5 | 1.5 |      | Dug well  |
| 85  | Chhatera                                    | 21.568803 | 79.820107 | 279.78 | 850  | 7.6      | 430  |     |     |      | Hand Pump |
| 86  | Chhatera                                    | 21.57065  | 79.816498 | 275.29 | 690  | 7.3      | 290  |     |     |      | Hand Pump |
| 87  | Pulputta                                    | 21.581237 | 79.805994 | 280    | 888  | 7.3      | 340  |     |     |      | Hand Pump |
| 88  | Pulputta                                    | 21.593379 | 79.795693 | 283.87 | 1280 | 7.8      | 640  |     |     |      | Hand Pump |
| 89  | Hardoli                                     | 21.6047   | 79.770202 | 293.23 | 680  | 7.3      | 320  |     |     |      | Hand Pump |
| 90  | HirapurReser<br>viour                       | 21.565377 | 79.779562 | 299.59 | 550  | 8.1      | 160  |     |     |      | Reservoir |
| 91  | Kawlewada<br>(Near<br>Bawanthadhi<br>river) | 21.566132 | 79.804115 | 283.19 | 830  | 7.3      | 360  | 6   | 1.5 |      | Dug well  |
| 92  | Kawlewada                                   | 21.565443 | 79.806668 | 284.96 | 740  | 7.8      | 370  |     |     |      | Hand Pump |
| 93  | Ganodh                                      | 21.556435 | 79.821225 | 280.44 | 1160 | 7.2      | 580  |     |     |      | Hand Pump |
| 94  | Tejutekari                                  | 21.554654 | 79.828149 | 272.35 | 1580 | 7.3<br>3 | 800  |     |     |      | Hand Pump |
| 95  | Shankar<br>Pipariya                         | 21.547736 | 79.846168 | 276    | 2000 | 7.3      | 1000 |     |     |      | Hand Pump |
| 96  | Fulchur                                     | 21.561858 | 79.871117 | 293.72 | 2580 | 7.3      | 1290 |     |     |      | Hand Pump |
| 97  | Fulchur                                     | 21.562363 | 79.871388 | 294.63 | 910  | 8.4      | 350  |     |     | 5.77 | Pond      |
| 98  | Katori                                      | 21.5756   | 79.896254 | 279.11 | 1870 | 7.4      | 940  | 4.2 | 1.5 |      | Dug well  |
| 99  | Bhandarbodh<br>i                            | 21.588696 | 79.901293 | 277.19 | 890  | 7.5      | 320  |     |     |      | Hand Pump |
| 100 | Murjhad                                     | 21.627167 | 79.935067 | 285.51 | 1020 | 7.4      | 250  |     |     |      | Hand Pump |
| 101 | Jhariya tola                                | 21.646052 | 79.94073  | 301.22 | 890  | 7.4      | 430  |     |     |      | Hand      |

|     |                   |           |           |        |     |     |     |   |   |      |                    |
|-----|-------------------|-----------|-----------|--------|-----|-----|-----|---|---|------|--------------------|
|     |                   |           |           |        |     |     |     |   |   |      | Pump               |
| 102 | Miragpur mine     | 21.63247  | 79.832276 | 344.78 | 630 | 8.1 | 320 |   |   | 5.48 | Recharge pit       |
| 103 | Miragpur Handpump | 21.633039 | 79.83373  | 348.97 | 710 | 7.6 | 350 |   |   |      | Hand Pump          |
| 104 | Pandharwani Mine  | 21.628271 | 79.844225 | 344.4  | 300 | 7.4 | 150 | 5 | 3 | 3.8  | Dug well           |
| 105 | Pandharwani Mine  | 21.628271 | 79.844225 | 344.4  | 680 | 7.3 | 340 |   |   | 2.44 | Hand Pump          |
| 106 | Pandharwani Mine  | 21.625276 | 79.84262  | 360.09 | 450 | 8.3 | 150 |   |   | 6.9  | Recharge structure |

**Buffer Zone**

| S. N. | Location         | Latitude         | Longitude        | Elevation     | EC (mS)    | pH         | TDS (ppt)  | Water Level (m) | DO (mg/l) | Type of water body |
|-------|------------------|------------------|------------------|---------------|------------|------------|------------|-----------------|-----------|--------------------|
| 1     | Goorabodi        | 21.657518        | 79.870229        | 343.65        | 1105       | 7.5        | 220        |                 | 2.5       | Hand Pump          |
| 2     | Goorabodi        | 21.657518        | 79.870229        | 343.56        | 1250       | 7.2        | 300        |                 | 3.05      | Hand Pump          |
| 3     | Goorabodi        | 21.66087         | 79.870203        | 353.74        | 740        | 7.1        | 370        |                 |           | Hand Pump          |
| 4     | Salibardi        | 21.671405        | 79.877707        | 336.32        | 680        | 6.5        | 150        |                 |           | Hand Pump          |
| 5     | Salibardi        | 21.669789        | 79.878459        | 335.46        | 650        | 7          | 250        |                 |           | Hand Pump          |
| 6     | Chikhla          | 21.684507        | 79.905157        | 328.48        | 1450       | 7.2        | 720        |                 |           | Hand Pump          |
| 7     | Chikhla          | 21.682192        | 79.908152        | 343.59        | 530        | 7.8        | 260        |                 |           | Hand Pump          |
| 8     | Paraswadaghat    | 21.649093        | 79.820654        | 328.59        | 660        | 7.5        | 320        |                 |           | Hand Pump          |
| 9     | Paraswadaghat    | 21.660558        | 79.80533         | 351.76        | 910        | 7.8        | 450        |                 |           | Hand Pump          |
| 10    | Paraswadaghat    | 21.664135        | 79.801919        | 340.53        | 2680       | 7.1        | 1340       |                 |           | Hand Pump          |
| 11    | Paraswadaghat    | 21.66312         | 79.802876        | 343.89        | 3630       | 6.8        | 1820       |                 |           | Hand Pump          |
| 12    | Nandi Gaon       | 21.684963        | 79.806272        | 339.63        | 600        | 7.7        | 300        |                 |           | Hand Pump          |
| 13    | Nandi Gaon       | 21.684272        | 79.810401        | 339.84        | 1920       | 6.9        | 970        |                 |           | Hand Pump          |
| 14    | Mohogaon         | 21.679234        | 79.823017        | 339.12        | 530        | 7.7        | 260        |                 |           | Hand Pump          |
| 15    | Mohogaon         | 21.678983        | 79.825131        | 346.41        | 1360       | 7.2        | 690        |                 |           | Hand Pump          |
| 16    | Sundergaon       | 21.68713         | 79.839619        | 326.1         | 720        | 7.3        | 360        |                 |           | Hand Pump          |
| 17    | Sundergaon       | 21.689001        | 79.840266        | 326.3         | 2640       | 6.7        | 1330       |                 |           | Hand Pump          |
| 18    | Sundergaon       | 21.685458        | 79.832651        | 333.14        | 890        | 7.3        | 440        |                 |           | Hand Pump          |
| 19    | Nawegaon         | 21.704839        | 79.848695        | 333.17        | 1590       | 7.2        | 790        |                 |           | Hand Pump          |
| 20    | Tumsar           | 21.70996         | 79.865638        | 332.46        | 1730       | 7.2        | 860        |                 |           | Hand Pump          |
| 21    | Tumsar           | 21.710944        | 79.867237        | 329.69        | 1390       | 7.3        | 690        |                 |           | Hand Pump          |
| 22    | Dudhara          | 21.706201        | 79.884752        | 316.42        | 700        | 7.2        | 340        |                 |           | Hand Pump          |
| 23    | Dudhara          | 21.704471        | 79.885074        | 328.17        | 760        | 7.3        | 380        |                 |           | Hand Pump          |
| 24    | Dudhara          | 21.696104        | 79.889369        | 314.15        | 720        | 7.6        | 240        |                 |           | Hand Pump          |
| 25    | Jamkhari         | 21.695575        | 79.900478        | 321.87        | 1280       | 7.4        | 640        |                 |           | Hand Pump          |
| 26    | Jamkhari         | 21.694672        | 79.901208        | 319.15        | 1020       | 7.4        | 390        |                 |           | Hand Pump          |
| 27    | Birsula          | 21.691179        | 79.828772        | 334.89        | 1020       | 7.4        | 540        |                 |           | Hand Pump          |
| 28    | Sitakhor         | 21.719929        | 79.81962         | 340.24        | 680        | 7.3        | 340        |                 |           | Hand Pump          |
| 29    | <b>Khoka</b>     | <b>21.705623</b> | <b>79.812121</b> | <b>347.08</b> | <b>820</b> | <b>7.7</b> | <b>310</b> | <b>145</b>      |           | <b>Borewell</b>    |
| 30    | Katedara         | 21.711607        | 79.796432        | 340.47        | 1040       | 7.2        | 340        |                 |           | Hand Pump          |
| 31    | Bothwa           | 21.697268        | 79.770729        | 352.42        | 1430       | 7.1        | 740        |                 |           | Hand Pump          |
| 32    | Tirodi           | 21.685706        | 79.727475        | 334.49        | 840        | 7.4        | 320        |                 |           | Hand Pump          |
| 33    | Bamani           | 21.610979        | 79.741213        | 290.99        | 1600       | 7          | 800        |                 |           | Hand Pump          |
| 34    | Bonkatta         | 21.609446        | 79.758254        | 295.86        | 1250       | 6.9        | 620        |                 |           | Hand Pump          |
| 35    | Garragussai      | 21.641741        | 79.780165        | 310.59        | 740        | 6.9        | 220        |                 |           | Hand Pump          |
| 36    | Sadabodi         | 21.644859        | 79.760747        | 305.02        | 1410       | 7.2        | 710        |                 |           | Hand Pump          |
| 37    | Hatoda           | 21.631088        | 79.810027        | 336.75        | 550        | 7.5        | 220        |                 |           | Hand Pump          |
| 38    | Pind k Par       | 21.594223        | 79.856797        | 302.82        | 1050       | 7.3        | 460        |                 |           | Hand Pump          |
| 39    | Pind k Par       | 21.58805         | 79.848991        | 304.45        | 630        | 7.4        | 230        |                 |           | Hand Pump          |
| 40    | Churiya Par      | 21.582679        | 79.834056        | 285.04        | 1960       | 7.5        | 980        |                 |           | Hand Pump          |
| 41    | Chhatera         | 21.568803        | 79.820107        | 279.78        | 850        | 7.6        | 430        |                 |           | Hand Pump          |
| 42    | Chhatera         | 21.57065         | 79.816498        | 275.29        | 690        | 7.3        | 290        |                 |           | Hand Pump          |
| 43    | Pulputta         | 21.581237        | 79.805994        | 280           | 888        | 7.3        | 340        |                 |           | Hand Pump          |
| 44    | Pulputta         | 21.593379        | 79.795693        | 283.87        | 1280       | 7.8        | 640        |                 |           | Hand Pump          |
| 45    | Hardoli          | 21.6047          | 79.770202        | 293.23        | 680        | 7.3        | 320        |                 |           | Hand Pump          |
| 46    | Kawlewada        | 21.565443        | 79.806668        | 284.96        | 740        | 7.8        | 370        |                 |           | Hand Pump          |
| 47    | Ganodh           | 21.556435        | 79.821225        | 280.44        | 1160       | 7.2        | 580        |                 |           | Hand Pump          |
| 48    | Tejutekari       | 21.554654        | 79.828149        | 272.35        | 1580       | 7.33       | 800        |                 |           | Hand Pump          |
| 49    | Shankar Pipariya | 21.547736        | 79.846168        | 276           | 2000       | 7.3        | 1000       |                 |           | Hand Pump          |
| 50    | Fulchur          | 21.561858        | 79.871117        | 293.72        | 2580       | 7.3        | 1290       |                 |           | Hand Pump          |
| 51    | Bhandarbodhi     | 21.588696        | 79.901293        | 277.19        | 890        | 7.5        | 320        |                 |           | Hand Pump          |
| 52    | Murjhad          | 21.627167        | 79.935067        | 285.51        | 1020       | 7.4        | 250        |                 |           | Hand Pump          |
| 53    | Jhariya tola     | 21.646052        | 79.94073         | 301.22        | 890        | 7.4        | 430        |                 |           | Hand Pump          |

**CORE ZONE**

|    |                   |           |           |        |      |     |      |  |      |           |
|----|-------------------|-----------|-----------|--------|------|-----|------|--|------|-----------|
| 1  | Ranimohgaon       | 21.622631 | 79.83492  | 329.12 | 2210 | 7.2 | 1005 |  |      | Hand Pump |
| 2  | Miragpur Handpump | 21.633039 | 79.83373  | 348.97 | 710  | 7.6 | 350  |  |      | Hand Pump |
| 3  | Pandharwani Mine  | 21.628271 | 79.844225 | 344.4  | 680  | 7.3 | 340  |  | 2.44 | Hand Pump |
| 4  | Miragpur          | 21.639436 | 79.840974 | 349.52 | 1420 | 7.5 | 230  |  | 2.38 | Hand Pump |
| 5  | Miragpur          | 21.635695 | 79.838438 | 363.08 | 1700 | 6.8 | 860  |  | 6.54 | Hand Pump |
| 6  | Miragpur          | 21.637156 | 79.837283 | 355.2  | 1690 | 7.2 | 850  |  |      | Hand Pump |
| 7  | Miragpur          | 21.638487 | 79.8347   | 353.81 | 650  | 7.3 | 320  |  |      | Hand Pump |
| 8  | Pandarwani        | 21.61232  | 79.837064 | 337.82 | 990  | 7.2 | 450  |  |      | Hand Pump |
| 9  | Pandarwani        | 21.61013  | 79.842064 | 341.23 | 880  | 7.2 | 380  |  |      | Hand Pump |
| 10 | Sukdighat         | 21.648322 | 79.850303 | 351.71 | 1830 | 7.2 | 920  |  | 2.72 | Hand Pump |
| 11 | Sukdighat         | 21.650272 | 79.852384 | 346.06 | 2100 | 7.1 | 1000 |  | 2.4  | Hand Pump |
| 12 | Sabaragaon        | 21.641404 | 79.824406 | 341.13 | 780  | 6.4 | 890  |  |      | Hand Pump |
| 13 | Sabaragaon        | 21.644069 | 79.823482 | 340.76 | 2960 | 6.9 | 1480 |  |      | Hand Pump |