DOCUMENT

FOR

PUBLIC HEARING

OF
WADEGAON O.C. MANGANESE ORE MINE
(3.97 ha)
AT
VILLAGE : WADEGAON, TEHSIL : RAMTEK, DIST. NAGPUR

PROPONENT

Mr. Shakeel Ahmed Aqueel Husain
Aqueel Mansion, Teen Nal Chowk,
Old Bhandara Road, Itwari, Nagpur

Consultant

Enviro Techno Consult Private Limited
68, Mahakali Nagar 2, Near Manewada Square
Nagpur 440 024

Accredited By QCI/ NABET for EIA
Listed at Sl. No. 73, dated May 09, 2016

May 2016

Executive summary

Proponent Mr. Shakeel Ahmed Aqueel Husain of Nagpur has been granted a 3.97 ha lease area near village Wadegaon in Ramtek Tehsil of Nagpur district by State Government for manganese ore mining.

Ministry of Mines G.O.I. vide their letter no. 5/8/2003-M.IV dated 29th March 2006 had conveyed approval of mining lease (ML) of 3.97 ha for 20 years.

I.B.M. had granted approvals for mining plan and scheme for the period 2015-2017.

Mr. Shakeel Ahmed Aqueel Husain has been granted another lease (2.49 ha) near Wadegaon itself. These leases are contiguous.

Manganese is an essential input to steel. There are many ferro alloy, & steel plants around Nagpur. Mining at Wadegaon will ensure cost effective supply of manganese to these industries.

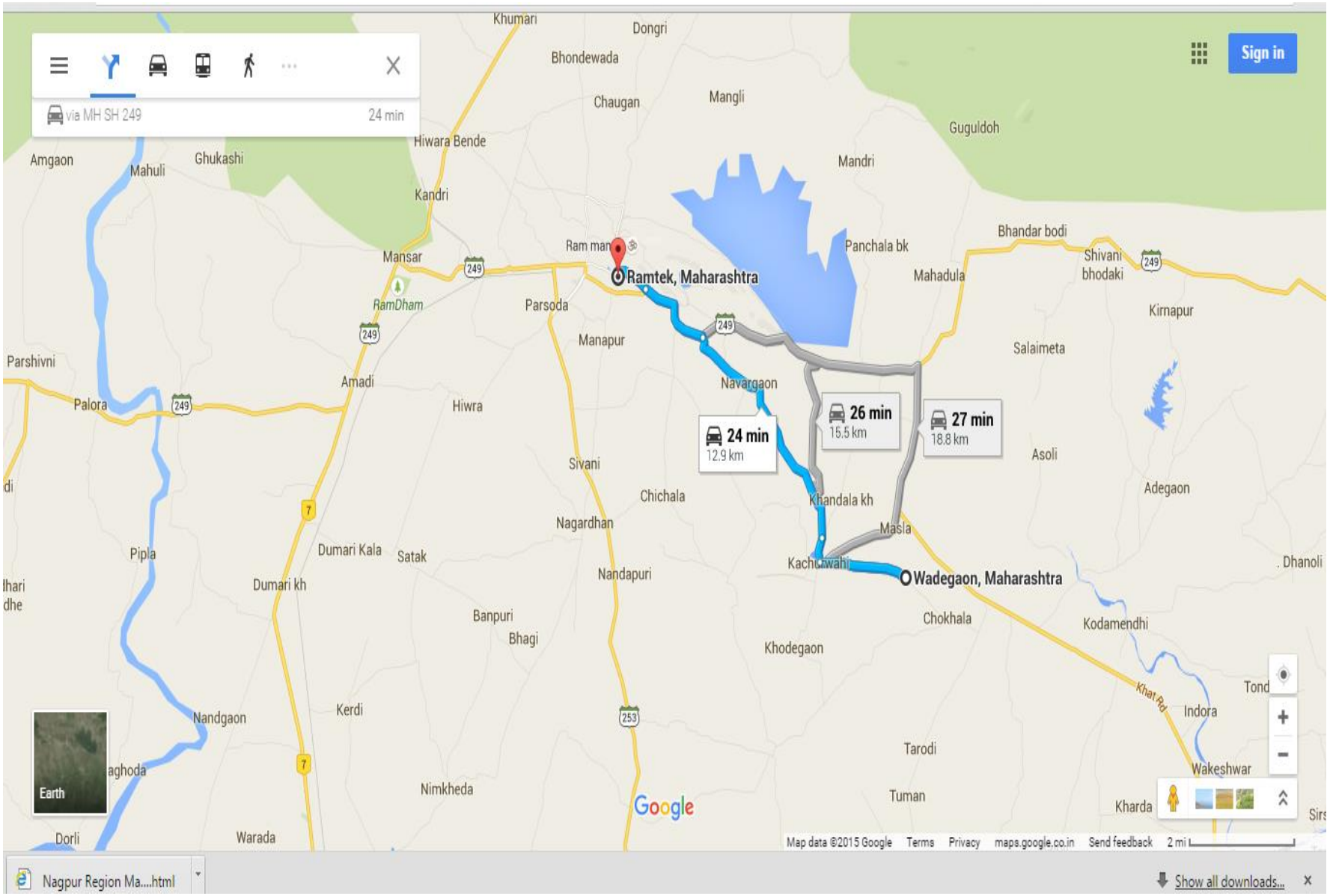
Lease is not a forest area and Maharashtra Government vide their letter MMN-1001/C.R.282/IND-9 dated 05-08-2006 had asked for approved mining plan.

Geographical location of this lease is shown in **Figure 1**. Khasra number & coordinates of this lease is given below.

Khasra no	Latitude	Longitude
53-3.97 ha	21°19’35.965”:21°19’45.068” N	79° 24’ 01.371”: 79°24’ 12.833” E

Lease is included in S.O.I. Topo sheet No. 55 O/7 and is shown in **Figure 2**. Elevation is 302 m MSL and is a relatively flat terrain. This is a private revenue land. There is a pit of 140x60x8 m to NE of lease area.

FIGURE 1



GEOGRAPHICAL LOCATION OF LEASE

FIGURE 2

WADEGAON SITE ON SURVEY OF INDIA TOPO SHEET No. 55 O/7

Project brief :

This proposal is for O.C. mechanized mining of manganese's @ 6,300 TPY. Presentation to SEAC (117th meeting) for TOR was made on 29th December 2015 for TOR.SEAC members have also inspected the site on 6th January 2016.

Baseline environmental study was conducted during winter season (January 11 – April 10, 2016) as per relevant items of standard TOR prescribed by MOEF & CC for mining projects&those implied in the minutes of SEAC meeting mentioned above.

Field data within core zone and buffer zone was collected /generated for AAQ, water quality, hydrogeology, flora &fauna and socio economic status.

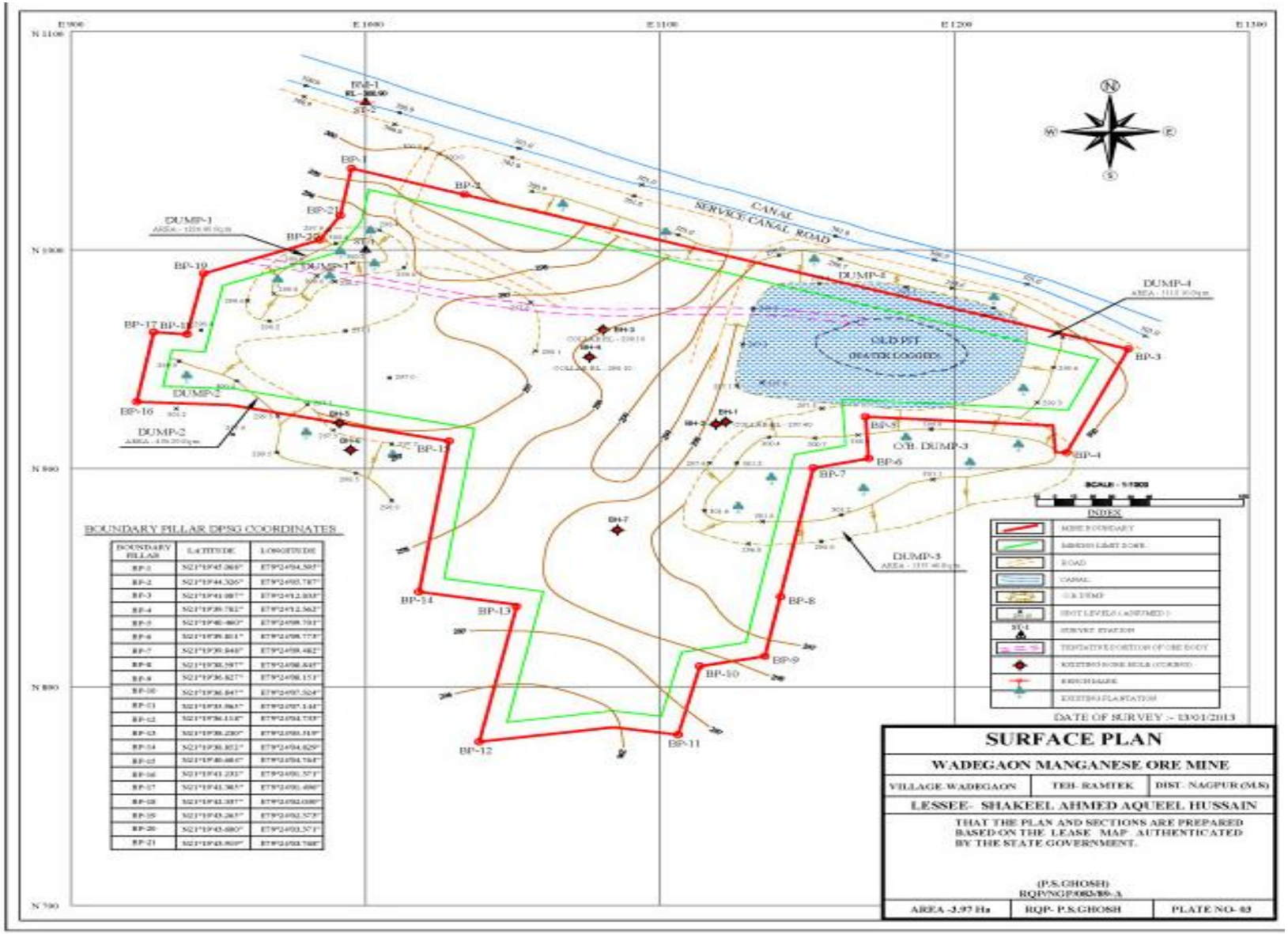
Quality of ore at Wadegaon deposits is acceptable to domestic markets e.g. Bhilai Steel Plant, ferro alloys units in Kanhan & Chandrapur area. Available ore with manganese contents between 25 to 40 per cent with iron (6-9%) and silica (8-11 per cent) is acceptable to these industries. Deposits from surrounding area have been worked since the 19th century. There are four old dumps and water-logged pit in the lease area.

Reserves calculated by the RQP are

Deposits, T	25,200
Probable, T	23,625
Proposed mining @ T/y	6,300
Recovery, %	90
Mine life, years	4
Ore quality,% Manganese Iron Silica	 25-40 6 8.11

IBM has been informed that there has been no mining till Dec. 2012 over the lease for want of permission. There are four dumps within the lease area. Also there is a pit within this lease as shown in **Figure 3**.

FIGURE 3



SURFACE PLAN OF LEASE SHOWING EXISTING PIT

During execution of the project, existing pit in the lease will be deepened. There will not be any bench in the over burden.

Proposed production is given below :

Year	Bench	Ore	Soil/ OB	Production, T	Ore: OB
2015-2016 & 2016-2017	Top MRL	295	298		
	Bottom MRL	292	295		
	ROM, m^3	1800	4,800	6,300	1:2

In situ excavation is proposed. Total excavation in two years will be 13,200 m^3. OB/SB/IB will be 9,600 m^3. About 3,600 m^3 ore will be available and rejects will be 180 m^3.

Lease is a part of waste land. Babool and some thorny bushes are seen. River Sur flows from NW of lease to E-SE at about 0.5 km. There are no water bodies in the lease. There is no forest. There is one old abandoned magazine in the area and will not be used.

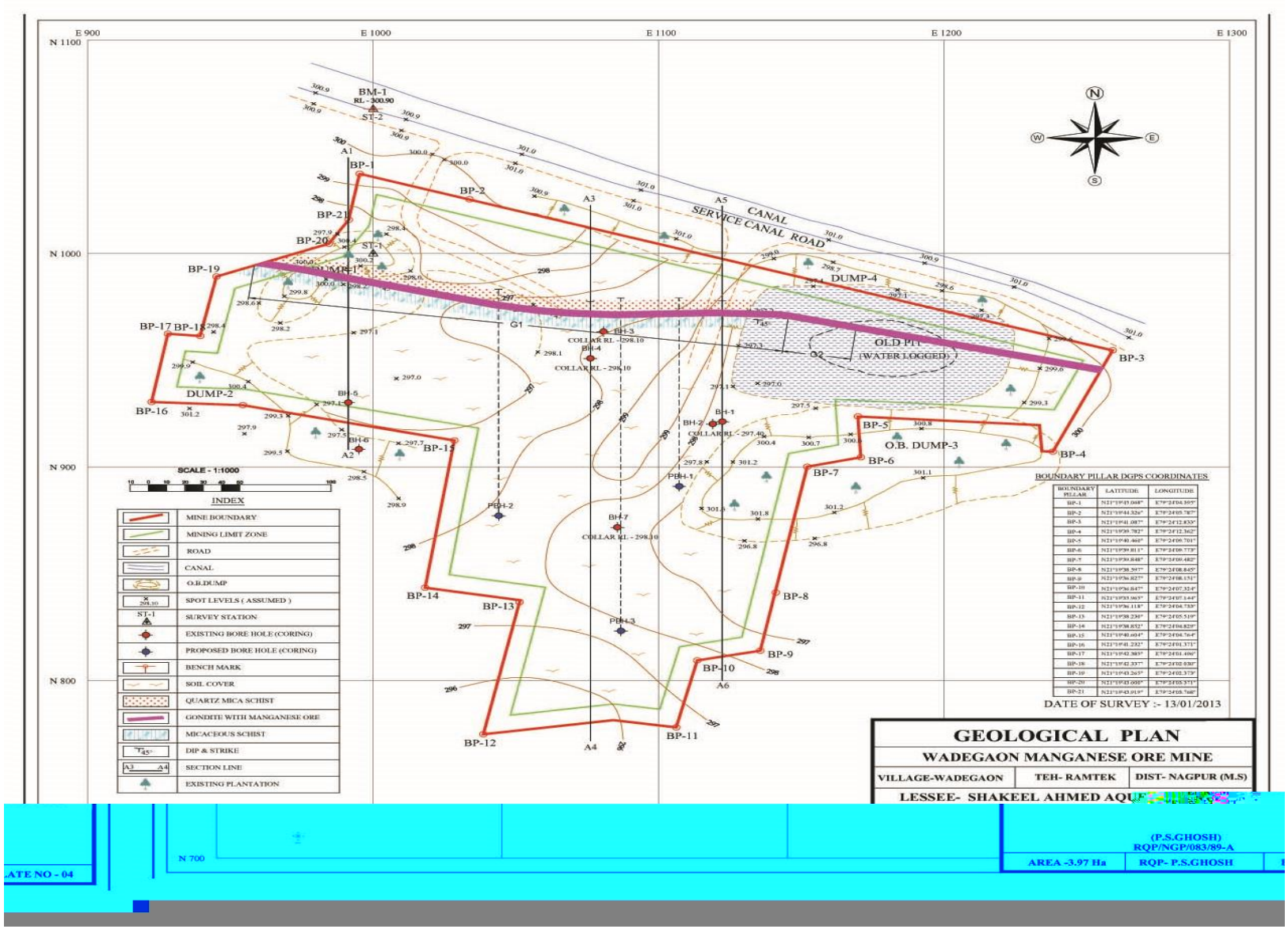
There is no soil cover over the proposed work area.

Lithological sequence in the lease is soil is followed by micaceous schist with Pegmatite, manganese ore with Gondite and calcarious schist with quartzite.

Manganese is exposed in the old pit towards NE. Strike of ore body is E-W and dip is 42^o-45^o. Average thickness is about 20 m.

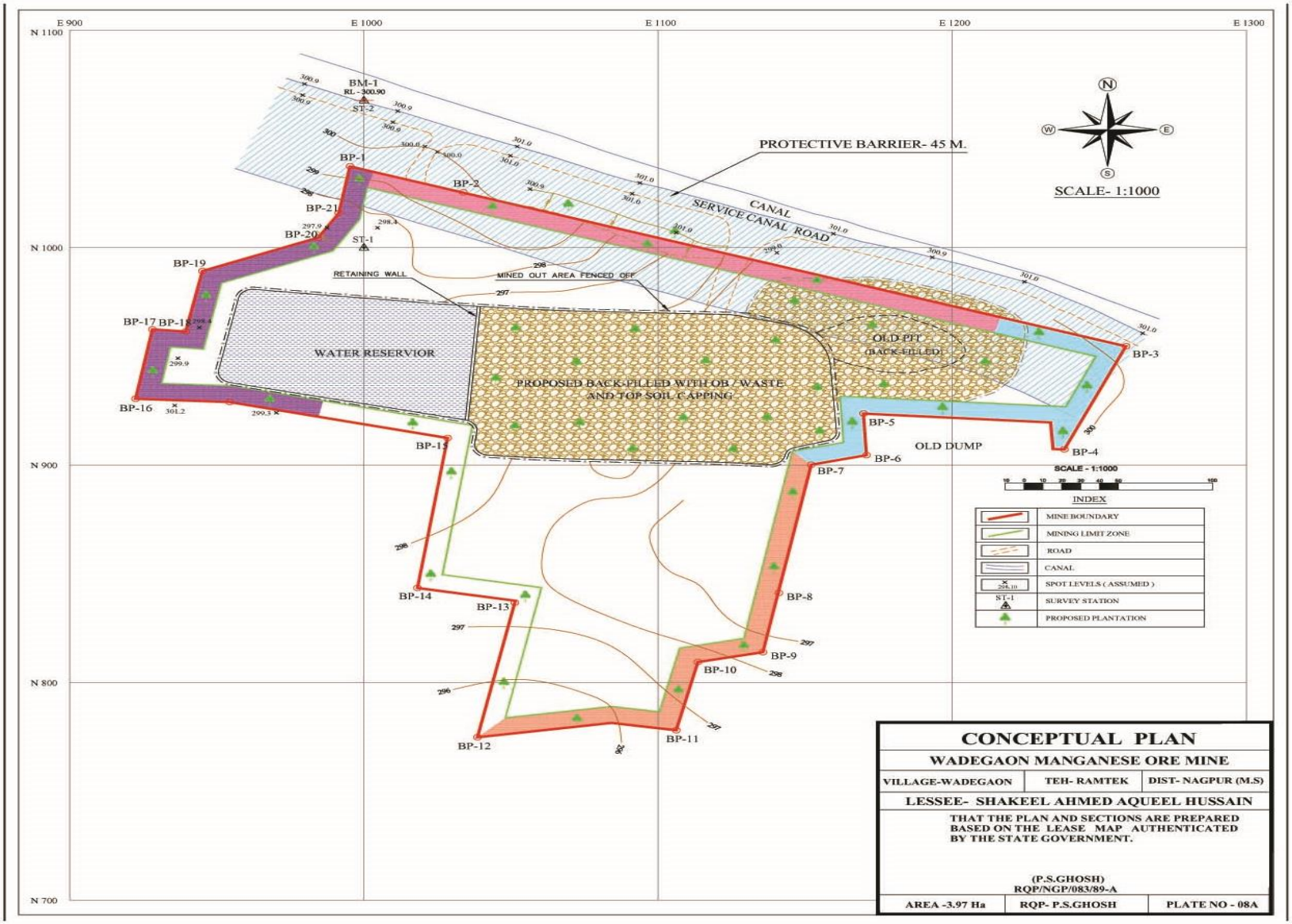
Geological plan & Conceptual plan of the lease is given in **Figures 4-5.**

FIGURE 4



GEOLOGICAL PLAN

FIGURE 5



CONCEPTUAL PLAN

Mining method:

Open cast mechanized mining will be carried out from south of the existing pit. It will proceed to the north. There will not be soil generation since existing pit will be deepened. Drilling and blasting as per DGMS norms is proposed. Facility for crushing ore to buyer's specification is proposed.

Water accumulated during rains will be pumped out. Compressed air wagon/DTH drills (65/83mm diameter). Hole depth will be 6 m. Ore will be loaded mechanically. Ultimate depth of pit will be 30 m below ground level. Pit slope will be 60 degrees.

Proposed working in the first two years will include i) excavation 6600 m^3 , ii) ROM 1890 m^3 (ore 1800 & rejects 90 m^3) and SB/OB/IB will be 4800 m^3. Material rejects would @ 315 m^3. Rejects will be i) excavated material without useful material, ii)chemically sub grade material which is unacceptable in market or containing undesirable constituents.

Water requirement will be about 10 m^3 for drinking and dust control. Existing well will be adequate for drinking water and mine pit water will be used for dust control.

About 50 persons will be required. Unskilled workers will be 25-30 and will be drawn from nearby villages. People in this area being aware of requirements of O.C. mining activities, local employment is feasible.

It is proposed to start mining after EC is granted. Mining will be carried out as per the approved mining scheme during the years 2015-2017.

Cost estimates are likely to vary with market conditions. Present status is given below :

Item	Rs. In lakhs
Asset (Office, rest shelter, store guard room, plant & machinery etc.)	170.00
Working capital margin	30.00
Preoperative	2.50
MSEDCL charges	2.50
Fixtures	1.00

Base line environment :

Base line environmental quality was studied in the area within 10 km radius in order to predict impacts, if any on air quality, on water quality & hydrology, land use and the socio-economic status due to proposed mining. Findings are presented in the order air including noise, aquatic, terrestrial and socio-economic environment.

Base line air quality :

Micrometeorology :

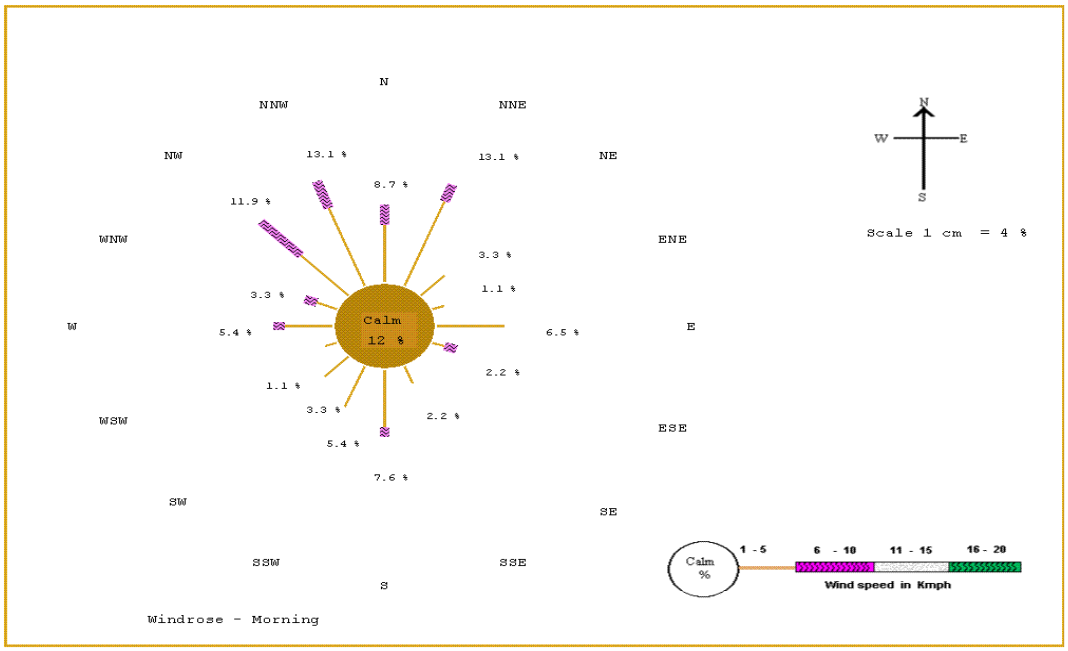
Annual average of wind speed = 5-6 Km / hour (1.39-1.67 m/sec).

Average annual relative humidity = 60 per cent.

Average annual rainfall (past 20 years) =1083.9 mm /year.

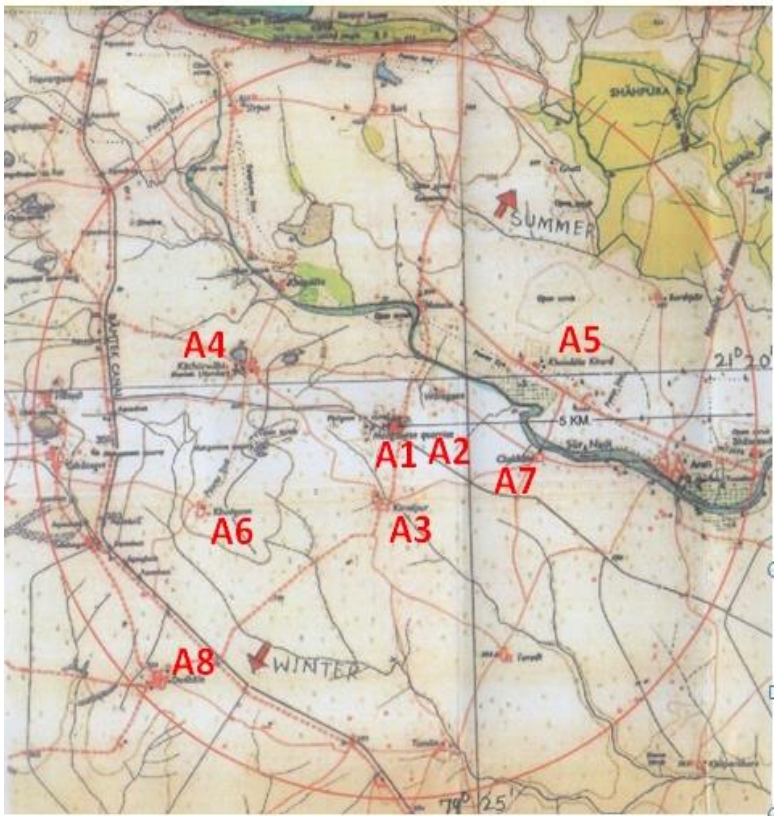
Wind velocities & directions during monitoring period enabled the following wind rose is given in **Figure 6**.

FIGURE 6



Monitoring period- wind rose

Air quality sampling stations as per wind rose are shown in following **Figure 7**.



AIR QUALITY MONITORING STATIONS

Sample code	Sampling station
A1	Lease area-3.97 ha
A2	Lease area-2.49 ha
A3	Kirnapur
A4	Kachurwahi
A5	Khandalakhurd
A6	Khodgaon
A7	Chichala
A8	Dudhhala

- Predominant pollutant during mining operations- particulates matter.
- There are no industries/ vehicular emissions in the buffer zone.
- Particulate matter concentrations at these stations are given below.

Particulate matter concentrations

A1 – Mine lease area -3.97 ha	PM_{10} (µg/m^3)	$PM_{2.5}$(µg/m^3)
Minimum	43.7	7.3
Maximum	58.3	12.7
Average	51.8	9.4
98 percentile	58.3	12.2
A2 –Wadegaon lease area -2.49 ha		
Minimum	33.6	7.0
Maximum	52.3	11.2
Average	44.0	9.0
98 percentile	52.1	11.0
A3 –Kirnapur		
Minimum	34.2	6.2
Maximum	56.4	11.2
Average	42.8	8.0
98 percentile	56.4	10.8
A4 –Kachurwahi		
Minimum	46.5	8.2
Maximum	63.6	12.2
Average	55.3	10.0
98 percentile	63.5	11.9
A5 –Khandalakhurd		
Minimum	40.8	6.6
Maximum	67.2	14.1
Average	51.5	10.2
98 percentile	66.0	13.9
A6 –Khodgaon		
Minimum	50.2	8.9
Maximum	55.6	13.2
Average	52.6	10.9
98 percentile	55.2	13.0
A7 –Chichala		
Minimum	31.2	9.8
Maximum	48.6	15.8
Average	38.8	12.6
98 percentile	47.8	15.6
A8 –Dudhhala		
Minimum	34.3	6.8
Maximum	57.2	11.3
Average	44.3	8.6
98 percentile	56.6	11.0

Observations-

There are no industrial sources within 10km radius of the site. Emissions are only due to domestic and agriculture activities. Average PM_{10}, $PM_{2.5}$, SO_2 and NOx values were respectively 31.2-67.2, 6.2-15.8, 5.1-8.4 and 6.1-11.7 µg/m^3.There are no sensitive receptors like hospitals, schools or any ecosystems. Ambient air quality is typical of rural setting.

Ambient noise:

Four stations from AAQ monitoring stations were selected for monitoring noise levels. Recorded values are given below :

	N1 Mine lease area	N2 Kirnapur	N3 Kachurwahi	N4 Khandala khurd
Range	39.8-47.2	40.0-59.5	39.9-63.8	34.4-55.4
Ld	43.8	54.4	56.4	49.6
Ln	42.2	50.2	40.8	39.5
Ldn	48.8	57.5	55.0	49.6

Aquatic environment:

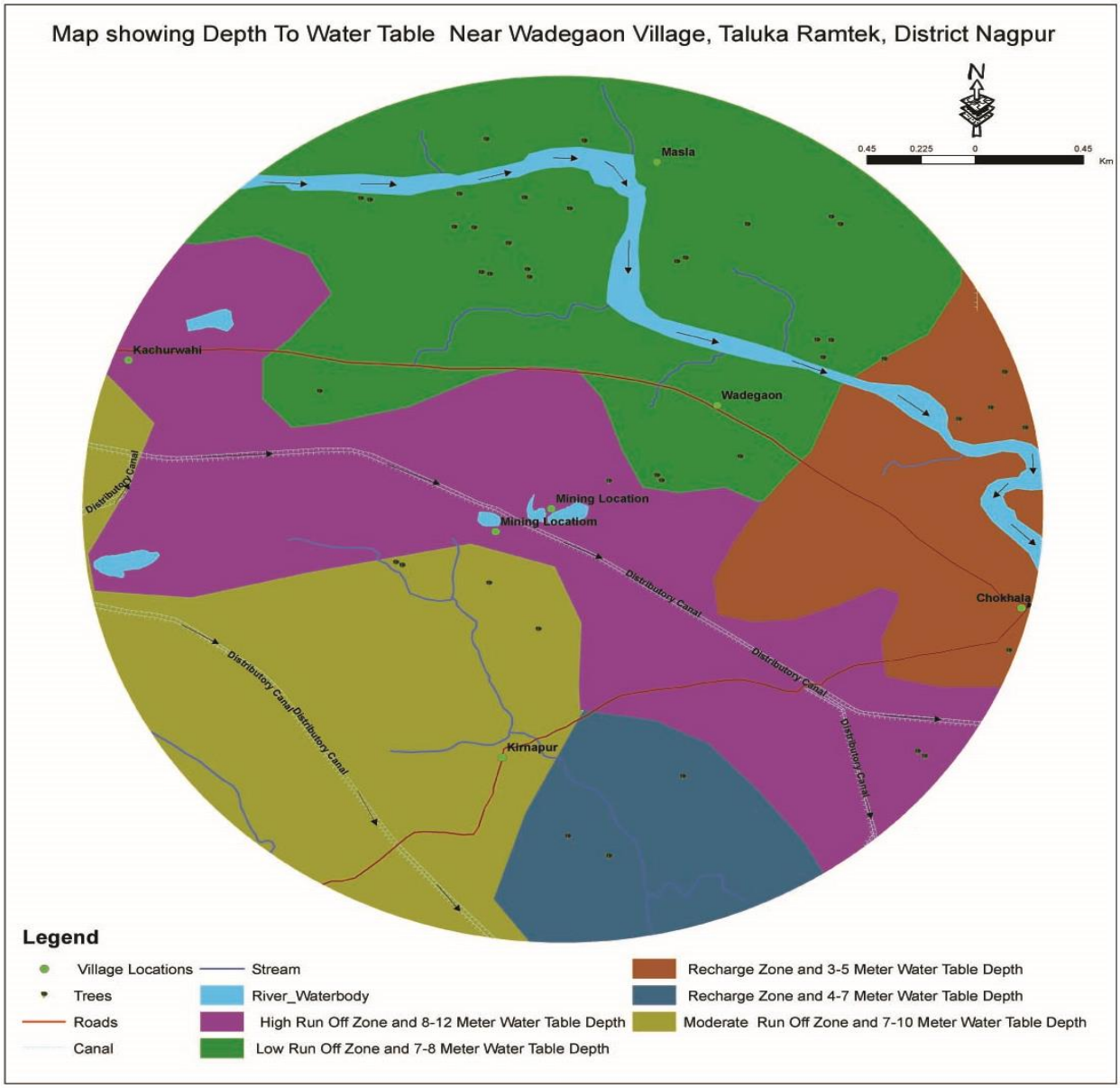
-Following satellite imagery shown in **Figure 8** below shows depth to water table in the buffer zone. Lease lies in high run off zone. Ground water table is 8-10 m bgl.

-Estimated run off from lease by rational method = 0.03 m^3/sec during rainfall

-Surface sources are Khindsi lake at 9 km, river Sur 1.5 km& canal.

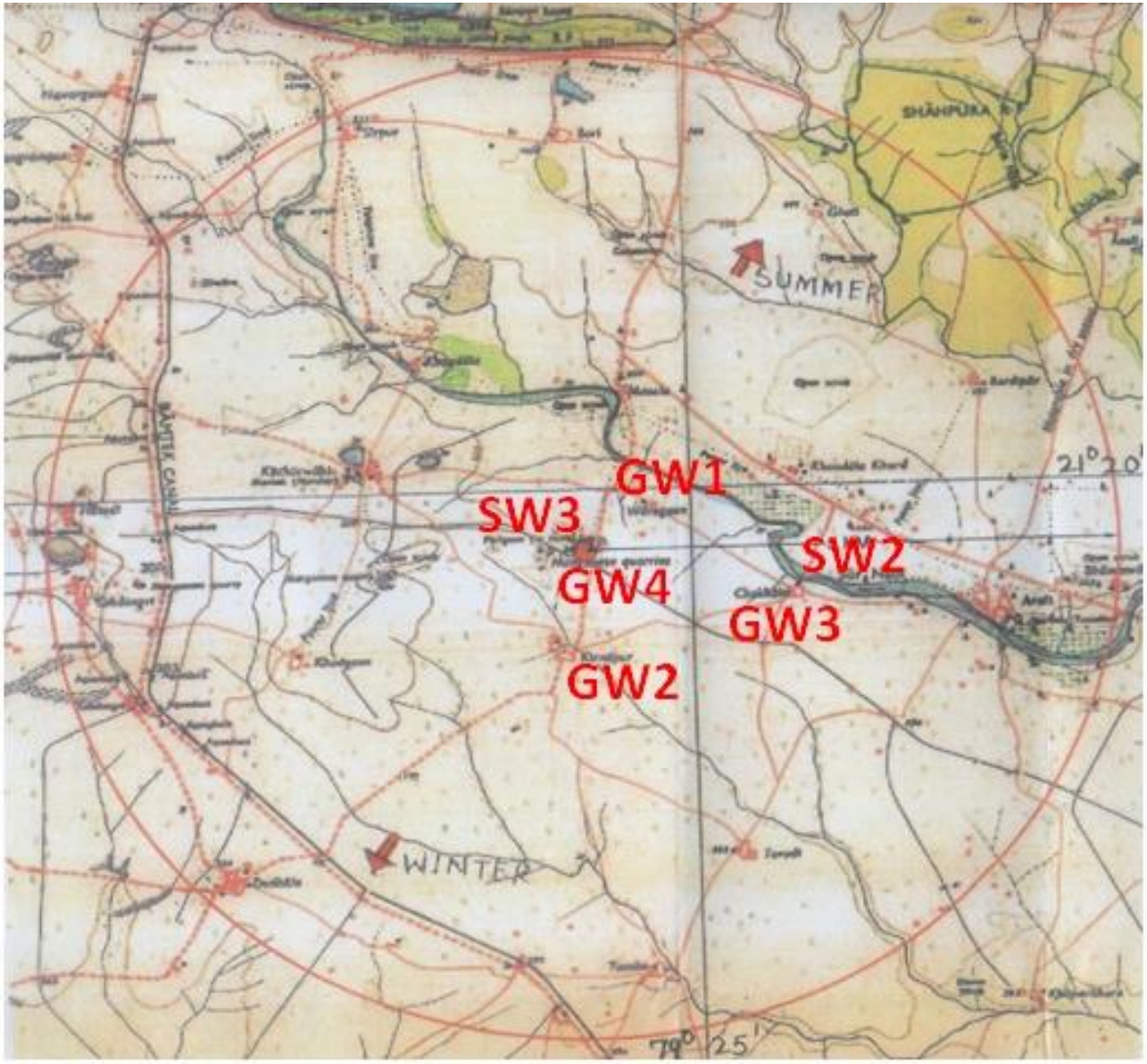
-Flows in the river and canal was negligible to nil.

FIGURE 8



Seven samples of surface & ground water were collected and analysed and the result is given below and the sampling stations are depicted in **Figure 9.**

FIGURE 9



Sample code	Sampling station
SW1	Khindsi lake
SW2	Sur river
SW3	Canal water
GW1	Village Wadegaon
GW2	Village Kirnapur
GW3	Village Chichala
GW4	Pit water

SW : Surface water
GW : Ground water

WATER QUALITY SAMPLING STATIONS

Surface water quality

Sr. No	Parameters	Unit	IS-10500-1991		Sampling stations		
			Desir-able	Permissible	SW 1 Khindsi lake	SW2 Sur river	SW 3 Canal water
	Items relating to preservation of living environment						
1.	Ambient Temperature	°C			27.0	27.0	28.0
2.	Colour	Hazen	05	25	SM	SM	SM
3.	Odour		UO	UO	UO	UO	UO
4.	Taste		AG	AG	AG	AG	AG
5.	Turbidity	NTU	05	10	25.0	30.0	8.0
6.	pH		6.5-8.5	NR	7.9	8.0	7.9
7.	Dissolved oxygen	mg/L	*	*	5.8	6.1	5.6
8.	BOD	mg/L	*	*	4.8	5.2	5.8
9.	COD	mg/L	*	*	12.8	15.4	14.8
10.	Electrical conductance	µS	*	*	135.0	132.0	260.0
11	T. Dissolved Solids	mg/L	500	2000	95.0	97.0	120.0
12.	T. Suspended Solids	mg/L	*	*	15.0	14.0	12.0
13.	Alkalinity as $CaCO_3$	mg/L	200	600	24.0	28.0	38.0
14.	Hardness as $CaCO_3$	mg/L	300	600	108.0	104.0	128.0
15.	Calcium as Ca	mg/L	75	200	34.0	32.0	70.0
16.	Magnesium as Mg	mg/L	30	100	9.0	8.0	7.0
17.	Chlorides as Cl	mg/L	250	1000	70.0	18.0	25.0
18.	Sulphate as SO_4	mg/L	200	400	7.0	7.5	8.0
19.	Nitrate as NO_3	mg/L	45	100	0.8	0.6	1.2
20.	Fluoride as F	mg/L	1.0	1.5	0.2	0.15	0.2
21.	Iron as Fe	mg/L	0.3	1.0	0.1	0.1	BDL
22.	Copper as Cu	mg/L	0.05	1.5	BDL	BDL	BDL
23.	Zinc as Zn	mg/L	5.0	15	0.02	0.02	BDL
24.	Manganese as Mn	mg/L	0.1	0.3	0.1	BDL	BDL
25	Boron	mg/L	1.0	5.0	BDL	BDL	BDL
26.	Oil & Grease	mg/L	0.01	0.05	NIL	NIL	NIL
27.	Coliforms	MPN/ 100ml	--	--	460	150	460
28.	Cadmium	mg/L	0.01	NR	BDL	BDL	BDL
29.	Lead	mg/L	0.05	NR	BDL	BDL	BDL
30.	Chromium	mg/L	0.05	NR	BDL	BDL	BDL
31.	Arsenic	mg/L	0.05	NR	BDL	BDL	BDL
32.	Pesticides	mg/L	ABSENT	0.001	ABSENT	ABSENT	ABSENT

NR : No Relaxation * : No specific limit prescribed CL : Colourless
UO : Unobjectionable AG : Agreeable BDL : Below detectable level

Ground water quality

Sr. No.	Parameters	Unit	IS-10500-1991		Sampling stations			
			Desirable Limits	Permissible Limits	GW1 Village Wadegaon open dug well	GW2 Village Kirnapur Hand pump	GW3 Village Chichala Bore well water	GW4 Pit water
	Items relating to preservation of living environment							
1.	Ambient Temperature	°C			28.5	27.0	28.0	27.5
2.	Colour	Hazen	05	25	CL	CL	CL	CL
3.	Odour		UO	UO	UO	UO	UO	UO
4.	Taste		AG	AG	AG	AG	AG	AG
5.	Turbidity	NTU	05	10	<1	<1	<1	<1
6.	pH		6.5-8.5	NR	7.7	7.2	8.2	7.5
7.	Dissolved oxygen	mg/L	*	*	**3.5**	1.5	1.8	0.8
8.	BOD	mg/L	*	*	<2	<2	<2	<2
9.	COD	mg/L	*	*	<5	<5	<5	<5
10.	Electrical conductance	µS	*	*	910.0	730.0	570.0	810.0
11	T. Dissolved Solids	mg/L	500	2000	624.0	550.0	395.0	575.0
12.	T. Suspended Solids	mg/L	*	*	3.0	8.0	<1	<1
13.	Alkalinity as $CaCO_3$	mg/L	200	600	60.0	346.0	260.0	504.0
14.	Hardness as $CaCO_3$	mg/L	300	600	384.0	340.0	204.0	536.0
15.	Calcium as Ca	mg/L	75	200	98.0	75.0	43.0	119.0
16.	Magnesium as Mg	mg/L	30	100	25.0	37.0	23.0	57.0
17.	Chlorides as Cl	mg/L	250	1000	80.0	40.0	31.0	113.0
18.	Sulphate as SO_4	mg/L	200	400	15.0	10.0	15.0	15.0
19.	Nitrate as NO_3	mg/L	45	100	3.5	1.7	2.5	3.2
20.	Fluoride as F	mg/L	1.0	1.5	0.2	0.2	0.2	0.2
21.	Iron as Fe	mg/L	0.3	1.0	0.2	0.2	0.15	0.12
22.	Copper as Cu	mg/L	0.05	1.5	BDL	BDL	BDL	BDL
23.	Zinc as Zn	mg/L	5.0	15	0.05	0.02	0.05	0.05
24.	Manganese as Mn	mg/L	0.1	0.3	< 0.1	0.2	0.1	0.1
25	Boron	mg/L	1.0	5.0	BDL	BDL	BDL	BDL
26.	Oil & Grease	mg/L	0.01	0.05	NIL	NIL	NIL	NIL
27.	Coliforms	MPN/ 100ml	--	--	1500	0	0	0
28.	Cadmium	mg/L	0.01	NR	BDL	BDL	BDL	BDL
29.	Lead	mg/L	0.05	NR	BDL	BDL	BDL	BDL
30.	Chromium	mg/L	0.05	NR	BDL	BDL	BDL	BDL
31.	Arsenic	mg/L	0.05	NR	BDL	BDL	BDL	BDL
32.	Pesticides	mg/L	ABSENT	0.001	ABSENT	ABSENT	ABSENT	ABSENT

NR : No Relaxation * : No specific limit prescribed CL : Colourless
UO : Unobjectionable AG : Agreeable BDL : Below detectable level

Observations on water quality :

- Transmission of Pench irrigation project water this water through canal is not expected to alter water quality. Canal is lined and there is no probability of loss of water by seepage or the vice versa, unless it is damaged.
- There is no perpetual release of water .Normally it is released during rabi and kharif seasons.
- River Sur is a typical seasonal river in a semi-arid zone. There is no fishing.
- Chemical quality water in Khindsi, Sur-river and canal is identical.
- Presence of coliforms is normal because these are natural sources
- All these sources can be used for drinking water supply after disinfection.
- Conductivity and thus dissolved solids in ground water & in mine pit sample were higher because ground water remains in contact with soil/ores/minerals etc. for longer periods.
- Lower D.O. in hand pump and bore well samples was less because ground water is cut off from air. Dug well is probably contaminated because D.O. was lower.
- Manganese in water is within permissible limits probably because ore at Wadegaon is present as oxides/carbonate which are only sparingly soluble.

Hydrogeology:

-Ground water exploration in Ramtek Tehsil carried by CGWB report shows

Depth, m bgl	SWL, m bgl	Discharge, litres/sec	Draw-down, meter
68.75-214.75	4.69-5.05	0.14-4.43	3.42-18.44

-Average annual rainfall since 2002 till 2011 is 1017.3mm.

-Area beyond lease is characterized by hilly area and hard rock (basalt, granite, gneisses, schists, quartz).

-Fluctuation in post and pre monsoon period is 1.99 m.

-Ramtek tehsil , as per CGWB is categorized as " safe" .

Terrestrial environment:

-Distribution of land use within 10 km

Description	Area, ha
Agricultural Land-Kharif Crop	19221.47
Agricultural Land-More than two crop	53.71
Agricultural Land-Rabi Crop	1721.82
Agricultural Land-Two crop area	1323.91
Agricultural Land-Zaid Crop	2159.27
Agricultural Land-Current Fallow	38.94
Built Up-(Rural)	161.70
Forest-Deciduous -Dense	18.87
Forest-Deciduous -Open	69.02
Forest-Scrub Forest	2.85
Forest-Tree Clad Area- Dense	1705.51
Wastelands-Dense scrub	574.22
Wastelands-Open scrub	688.04
Water bodies-Canal	2893.60
Water bodies-Reservoir/Tanks	549.09
Water bodies-River/Stream	218.00
Total	31400.00

Soil samples were collected from mining lease and an adjoining field. Samples from three depths (0-30; 30-60;60-90 cm) were collected. Their physical and chemical characteristics are given in following tables.

Physical characteristics of soil

Parameters	Lease			Agriculture land		
	0-30	30 -60	60-90	0-30	30 -60	60-90
Gravel, %	6.2	6.7	6.1	4.5	4.8	4.1
Sand,%	58.4	56.2	51.0	31.7	30.0	30.2
Silt,%	14.2	14.6	13.4	26.7	28.2	23.4
Clay,%	27.4	29.2	35.6	41.6	41.8	46.4
Texture,	Sandy clay	Sandy clay loam	Sandy clay loam	Clayey	Clayey	Clayey
B.D., g/m^3	1.62	1.71	1.55	1.67	1.64	1.64
Permeability, mm/sec.	16.7	16.5	14.4	9.2	8.7	8.1
Water retention capacity,						
1/3 bar	34.6	38.3	39.4	42.3	42.6	42.8
15 bar	26.2	27.4	28.6	30.7	31.4	31.2

Chemical properties of soil

Parameters	Lease			Agriculture land		
	0-30	30 -60	60-90	0-30	30 -60	60-90
pH	7.5	6.9	6.7	7.9	7.8	7.8
Conductivity, mS	0.06	0.04	0.04	0.28	0.32	0.36
CEC, m eq./ 100g	9.16	6.78	11.34	28.72	29.40	32.60
Exchangeable Ca^{++}& Mg^{++}, m eq./ 100g	5.54	5.00	10.56	12.84	13.74	15.68
Exchangeable K, m eq./ 100g	0.10	0.05	0.05	0.42	0.47	0.42
Organic carbon,%	0.54	0.32	0.28	0.78	0.56	0.43
Available N, kg/ha	362.4	220.4	132.6	324.6	270.8	200.6
Available P kg/ha	16.5	14.2	12.8	21.8	18.3	17.5

Socio economic status:

There are 14 villages in the buffer zone. Details of population, number of households, distribution of main workers, workers in agriculture and in other miscellaneous activities were collected. These villages are electrified and

communication facilities are satisfactory. Health services and other medical facilities are satisfactory. Education and communication facilities are good. There is an engineering college at Ramtek.

Environmental impacts:

Probable impacts of proposed mining have been predicted based on intensity of activity summarized below.

- Mining rate @ 21 tonnes per day
- Soil generation will be negligible since existing pit would be deepened.
- In situ excavation would be @ 22 m^3 /day (13,200 m^3 in 2 years)
- OB/SB/IB would be 15 m^3 /day (9,600 m^3 in 2 years)
- Ore volume = 6 m^3/d ; Reject volume = 0.6 m^3/d
- Ultimate depth of pit would be 30m b.g.l.
- Mine road dimensions will be 100 m length & width 10 m.
- R & R is not involved
- Employment to 20 persons

Impact of mining on canal

Probable impacts of mining operations on canal can be a) physical damage, b) changes in flow pattern of water and c) changes in water quality.

a) Physical damage:

Mining will be carried out by deepening the existing pit. Distance of the pit from canal was measured again during the survey and is 20 m from core mining activity. Blasting at the bottom of pit at 15 m will not affect the canal structure which is 12 m vertically above the pit. Vibration waves normally travel horizontally and PPV at the canal bottom will not cause any damage. Moreover mining will proceed from south of the pit.

Rule No 127 of metallic ferrous mine rules states that working shall not be vertically below any water body or at any spot within 15 m horizontal distance from the water body.

In the present case active mine working will be beyond 50 m.

b) Canal flow

There is hard rock between the bottom of pit and the canal. Visual survey of the canal within and beyond leases showed that it is a lined structure. Enquiry with irrigation department also confirmed this. A few farmers seem to have attempted to avail of the flowing canal water for irrigation. In other words pilferage of water is common. Percolation from canal is not possible.

c) Water quality:

Addition of mine pit water to canal is not proposed. Hence water quality will remain unaltered. Project proponent will ensure proper lining to the stretch of canal along the leases.

Mine –pit water

Pit would occupy about 2.6 ha area. Rainfall in the area is about 1000 mm/year. Therefore there is a probability that about 26 m^3 water is collected during rainy season.

Water requirement during operational phase would be 3 m^3 per day for drinking and about 2 m^3 per day for dust control. The existing well near the site will be used for domestic water requirement and the stored pit water for dust control.

This existing well will be the observation well and a record of water level in the well during pre & post monsoon season will be maintained.

Terrestrial environment :

There is no residential colony or structure over the lease. Site preparation is not necessary. Tree felling will not be required. Therefore there will not be any adverse impact on land.

Ambient air quality :

Impact of mining on ambient air quality has been predicted and the ground level concentration have been plotted in **Figure 10**. There would not be any adverse impact on AAQ.

ISOPLETH - GLCs CONCENTRATIONS

GROUND WATER QUALITY

Sr. No.	Parameters	Unit	IS-10500-1991		Sampling stations			
			Desirable Limits	Permissible Limits	GW1 Village Wadegaon open dug well	GW2 Village Kirnapur Hand pump	GW3 Village Chichala Bore well water	GW4 Pit water
	Items relating to preservation of living environment							
1.	Ambient Temperature	°C			28.5	27.0	28.0	27.5
2.	Colour	Hazen	05	25	CL	CL	CL	CL
3.	Odour		UO	UO	UO	UO	UO	UO
4.	Taste		AG	AG	AG	AG	AG	AG
5.	Turbidity	NTU	05	10	<1	<1	<1	<1
6.	pH		6.5-8.5	NR	7.7	7.2	8.2	7.5
7.	Dissolved oxygen	mg/L	*	*	**3.5**	1.5	1.8	0.8
8.	BOD	mg/L	*	*	<2	<2	<2	<2
9.	COD	mg/L	*	*	<5	<5	<5	<5
10.	Electrical conductance	µS	*	*	910.0	730.0	570.0	810.0
11	T. Dissolved Solids	mg/L	500	2000	624.0	550.0	395.0	575.0
12.	T. Suspended Solids	mg/L	*	*	3.0	8.0	<1	<1
13.	Alkalinity as $CaCO_3$	mg/L	200	600	60.0	346.0	260.0	504.0
14.	Hardness as $CaCO_3$	mg/L	300	600	384.0	340.0	204.0	536.0
15.	Calcium as Ca	mg/L	75	200	98.0	75.0	43.0	119.0
16.	Magnesium as Mg	mg/L	30	100	25.0	37.0	23.0	57.0
17.	Chlorides as Cl	mg/L	250	1000	80.0	40.0	31.0	113.0
18.	Sulphate as SO_4	mg/L	200	400	15.0	10.0	15.0	15.0
19.	Nitrate as NO_3	mg/L	45	100	3.5	1.7	2.5	3.2
20.	Fluoride as F	mg/L	1.0	1.5	0.2	0.2	0.2	0.2
21.	Iron as Fe	mg/L	0.3	1.0	0.2	0.2	0.15	0.12
22.	Copper as Cu	mg/L	0.05	1.5	BDL	BDL	BDL	BDL
23.	Zinc as Zn	mg/L	5.0	15	0.05	0.02	0.05	0.05
24.	Manganese as Mn	mg/L	0.1	0.3	< 0.1	0.2	0.1	0.1
25	Boron	mg/L	1.0	5.0	BDL	BDL	BDL	BDL
26.	Oil & Grease	mg/L	0.01	0.05	NIL	NIL	NIL	NIL
27.	Coliforms	MPN/ 100ml	--	--	1500	0	0	0
28.	Cadmium	mg/L	0.01	NR	BDL	BDL	BDL	BDL
29.	Lead	mg/L	0.05	NR	BDL	BDL	BDL	BDL
30.	Chromium	mg/L	0.05	NR	BDL	BDL	BDL	BDL
31.	Arsenic	mg/L	0.05	NR	BDL	BDL	BDL	BDL
32.	Pesticides	mg/L	ABSENT	0.001	ABSENT	ABSENT	ABSENT	ABSENT

NR : No Relaxation * : No specific limit prescribed CL : Colourless
UO : Unobjectionable AG : Agreeable BDL : Below detectable level

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Physical characteristics of soil

Parameters	Lease			Agriculture land		
	0-30	30 -60	60-90	0-30	30 -60	60-90
Gravel, %	6.2	6.7	6.1	4.5	4.8	4.1
Sand,%	58.4	56.2	51.0	31.7	30.0	30.2
Silt,%	14.2	14.6	13.4	26.7	28.2	23.4
Clay,%	27.4	29.2	35.6	41.6	41.8	46.4
Texture,	Sandy clay	Sandy clay loam	Sandy clay loam	Clayey	Clayey	Clayey
B.D., g/m^3	1.62	1.71	1.55	1.67	1.64	1.64
Permeability, mm/sec.	16.7	16.5	14.4	9.2	8.7	8.1
Water retention capacity,						
1/3 bar	34.6	38.3	39.4	42.3	42.6	42.8
15 bar	26.2	27.4	28.6	30.7	31.4	31.2

Chemical properties of soil

Parameters	Lease			Agriculture land		
	0-30	30 -60	60-90	0-30	30 -60	60-90
pH	7.5	6.9	6.7	7.9	7.8	7.8
Conductivity, mS	0.06	0.04	0.04	0.28	0.32	0.36
CEC, m eq./ 100g	9.16	6.78	11.34	28.72	29.40	32.60
Exchangeable Ca^{++}& Mg^{++}, m eq./ 100g	5.54	5.00	10.56	12.84	13.74	15.68
Exchangeable K, m eq./ 100g	0.10	0.05	0.05	0.42	0.47	0.42
Organic carbon,%	0.54	0.32	0.28	0.78	0.56	0.43
Available N, kg/ha	362.4	220.4	132.6	324.6	270.8	200.6
Available P kg/ha	16.5	14.2	12.8	21.8	18.3	17.5

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