



**Odisha
Coal and
Power
Limited**

Odisha Coal and Power Limited
(A Government of Odisha Company)
CIN: U10100OR20155GC018623
Website : www.ocpl.org.in

Letter No. OCPL/ 451

Date: 14-05-2022

To,

The Joint Director(s)
Regional Office, Eastern Region (ERO)
Ministry of Environment, Forest & Climate Change
A-3, Chandrasekharpur, Bhubaneswar-751023

Sub: Submission of Half Yearly Compliance Report of the Environmental Clearance conditions of Manoharpur Open Cast Coal Mine Project (8.00 MTPA) of Odisha Coal & Power Limited located in IB valley, Dist. Sundargarh, Odisha.

Ref: (i) EC letter No. J-11015/139/2008-IA.II (M) dated 21.02.2014
(ii) EC transfer order vide letter no. J-11015/139/2008-IA.II (M)Pt. file dt. 30.12.2015

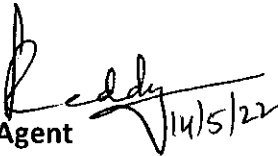
Dear Sir,

In reference to the notification issued by MoEF&CC vide letter S.O. 5845 (E) dated 26.11.2018 and Environmental Clearance as referred above in respect of Manoharpur Open Cast Coal Mine (8.00 MTPA) of Odisha Coal & Power Limited located in IB valley, Dist. Sundargarh, Odisha, please find enclosed herewith Half Yearly Compliance Report in soft copy (by email) as well as hard copy for the period of October 2021 to March 2022.

As per MoEF&CC (ERO) letter dated 11.05.2020, the scanned copy of report is being submitted to their good office at the given email address (roez.bsr-mef@nic.in).

This is for your kind information and needful action at your end.

Yours Faithfully


Agent

(Manoharpur Coal Mine Project)

Copy to:

1. The Scientist ('E' & Regional Directorate), Central Pollution Control Board, South end Conclave, Block 502, 5th & 6th Floors, 1582 Razidanga Main Road, Kolkata-700107.
2. The Member Secretary, State Pollution Control Board, Odisha, Paribesh Bhawan, A/118, Nilkanthnagar, Unit VIII, Bhubaneswar 751012

HALF YEARLY COMPLIANCE REPORT

For

Environmental Conditions

October 2021 – March 2022

MANOHARPUR OPENCAST COAL MINE



Odisha Coal & Power Limited,
Zone-A, Ground Floor,
Fortune Tower, Bhubaneswar-751023, Odisha
Web: www.ocpl.org.in

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ENVIRONMENTAL CLEARANCE(EC) COMPLIANCE REPORT

PROJECT NAME - MANOHARPUR OPENCAST COAL MINE PROJECT

EC letter No. J-11015/139/2008-IA.II (M) dated 21.02.2014 and

EC Transfer Order - EC-No. J-11015 / 139/2008-IA.II (M) Pt. file Dated 30TH December 2015

(EC Amendment letter No. EC-No. J-11015 / 139/2008-IA.II (M) Pt. file Dated 06TH November 2019)

Period of Compliance Report – October 2021 to March 2022

Sr. No.	EC Letter Condition	Compliance												
SPECIFIC CONDITIONS														
i.	The maximum production from the mine at any given time shall not exceed the limit as prescribed in the EC.	<p>The rated maximum production capacity of the mine is 8.00MTPA as per the approved Mining Plan (Rev II). Hence, the limit shall not exceed as prescribed in EC.</p> <p>Mine development work were started w.e.f. 01.11.2018 and coal production started from 10.10.2019. Thereafter, due to evacuation constraints, coal dispatch started w.e.f. 14.12.2019 from mine end to Kanika Railway Siding of MCL. The coal production during the last 3 FY (i.e. 2019-20, 2020-21, 2021-22) is as per following:</p> <table border="1"> <thead> <tr> <th>Financial (FY)</th><th>Year</th><th>Coal Production</th></tr> </thead> <tbody> <tr> <td>2019-20</td><td></td><td>1 MT</td></tr> <tr> <td>2020-21</td><td></td><td>2.00 MT</td></tr> <tr> <td>2021-22</td><td></td><td>5.25 MT</td></tr> </tbody> </table>	Financial (FY)	Year	Coal Production	2019-20		1 MT	2020-21		2.00 MT	2021-22		5.25 MT
Financial (FY)	Year	Coal Production												
2019-20		1 MT												
2020-21		2.00 MT												
2021-22		5.25 MT												
ii.	Environmental clearance to the proposal is subject to obtaining clearance under the wildlife (Protection) Act, 1972 from the Standing Committee of National Board for Wildlife, as applicable	<p>Not Applicable. The proposed Manoharpur coal mine project does not fall within 10km of National park/sanctuary and as such clearance from National Board of Wildlife is not required for the said project.</p> <p>However, the Site Specific Wildlife Conservation Plan of this project has been approved by Principal Chief Conservator of Forests (PCCF-WL) & Chief Wildlife Warden (CWW), Odisha which is under implementation. The details of amount spent on various activities identified in the approved plan has already been submitted to your good office along with half yearly post EC compliance report vide letter dt. 22.11.2021 (Kindly refer Annexure 1).</p>												
iii.	The OB should be kept in ML area and there should be no OB dumps at the end of mining.	As per the approved Mine Plan & Mine Closure Plan (Revision – II), total 3 nos. of OB dumps will be acquired in non-												

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		<p>coal bearing area by OCPL. Major portion of the overburden (86%) will be utilized in back filling.</p> <p>Currently, the generated OB from the mining operation is being stored at External OB dump 1 (NW) and OB dump 3 (SE) as per approved Mining Plan.</p>
iv.	The land for OB dumping should be made ready for original use after mine closure.	Not Applicable because the OB dump spread over the land will be stabilized by vegetation and planation of native & fruit bearing species over it and the same forever.
v.	All the sandstone taken out during mining should be utilized for house construction and given free of cost to locals.	<p>The technical study for availability and suitability of utilization of sandstone taken out during mining has been conducted by a reputed institute i.e. National Institute of Technology (NIT), Rourkela.</p> <p>As per the conclusion of the report; the OB material i.e. sandstone does not confirm to the specifications of the construction grade sand stone required for house construction. The copy of report in this regard is attached as Annexure 1.</p>
vi.	Since the mining area is total forest land, the sandstones should not be dumped as OB.	<p>Efforts will be made to comply with the conditions. Further, the sand stones generated due to mining, will be reused for the following purpose:</p> <ol style="list-style-type: none"> 1. Preparation of haul road to avoid dust pollution 2. Toe of the dump to prevent runoff and fall of OB material. 3. Base layers in inpit dumping to improve the stability of back filling
vii.	Fly ash dumping is not permitted` in mine void.	Presently, Fly ash is not being dumped. If any situation arises which requires fly ash dumping; then proper scientific studies will be carried out and necessary permissions, if required will be obtained from competent authorities prior to dumping.

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iii.	The leachability study may be carried out for chromium, arsenic and mercury that may be present in fly ash.	The required leachability study shall be carried out and the test result of same will be submitted to MOEF & CC for obtaining necessary permission before commencement of fly ash disposal, if required, in Manoharpur Coal Mine Project.
ix.	The CSR amount should be Rs.4 crores in initial 3 years, and thereafter it should be Rs 5/T of coal/annum till the end of the life of project with the escalation factor every year coal production.	This is being complied. CSR / peripheral development activities already carried out in the vicinity of the project area. The year wise expenditure is attached as Annexure 2 for your kind reference.
x.	The CSR activity, which had already been carried out by proponent, be audited by a 3 rd Party. The audit should be carried out by a reputed agency.	Noted. The CSR audit has already been conducted by reputed agency M/s GEOENVITECH (Research and Consultancy Services Pvt. Ltd.) which is empaneled with Govt. of Odisha.
xi.	The proponent shall come back to the Committee for its washery proposal for further consideration.	Noted & will be complied, if applicable.
xii.	Coal transportation from mine to railway siding by conveyor belt and from siding to TPP by MGR through SILO loading of the wagons	<p>Presently, coal is being transported through the siding located inside the project area to captive power plant (i.e. 2 x 660 MW each of OPGC located Ib Thermal Power Station, Banaharpali) via dedicated rail corridor (MGR). As the CHP is not commissioned presently, loading is being done through the wharf wall siding located inside the project area.</p> <p>Apart from the above, OCPL has also transported the coal from mine end to ACB Siding through road as an interim arrangement because MGR was under initial phase of operation which has been stopped.</p> <p>Further, the excess coal is being sold at the pit head to different consumers.</p>
xiii.	The embankment constructed along the river boundary shall be of suitable dimensions and critical patches shall be strengthened by stone pitching on the river front side and stabilized with plantation so as to withstand the peak water flow and prevent mine inundation.	There is no river in and around the project area. One seasonal nalla i.e. Garia Nalla passes through the coal block which will be diverted outside the coal block after 7 th year of mine operation. Strong embankment, stone pitching will be provided along the diverted nalla to withstand the peak water flow and prevent mine inundation.

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iv.	There shall be no overflow of OB into the river and into the agricultural fields and massive plantation of native species shall be taken up in the area between the river and the project.	<p>As mentioned above, there is no river in the vicinity of project site except seasonal Garia Nalla. There is no overflow of OB into agricultural fields & Nalla.</p> <p>Plantation of approx. 8534 nos. of trees comprises local native species have been carried out till the FY 2021-22 in and around the mine area by protecting the existing trees inside the project area i.e. safety zone etc. The area covered under plantation is about 19.985 Hac. The list of plantation carried out during the FY 2019-20; 2020-21 and 2021-22 has already been submitted to your good office along with half yearly post EC compliance report vide letter dt. 22.11.2021 (<i>Kindly refer Annexure 3</i>). Also, the grass plantation was carried out on slope of the dump during pre-monsoon season to stabilize the dump slope which will control/reduce the chance of overflow of OB.</p>
xv.	OB shall be stacked at two earmarked external OB dumpsite(s) only. The ultimate slope of the dump shall not exceed 28°. Monitoring & management of existing reclaimed dumpsites shall continue until the vegetation becomes self-sustaining. Compliance status shall be submitted to the Ministry of Environment & Forests and its Regional office located at Bhopal on yearly basis.	<p>The overburden from the mine is being stored at their earmarked location and also dump design as given in approved Mining Plan (Revision II) and slope stability report is being followed.</p> <p>Currently, the dumps are in active stage. However, dump portion in North, East and to some extent in south of OB dump 1 has been stabilized and planned for reclamation through planation over it. However, backfilling of excavated area has been started from 3rd year of operation i.e. 2021-22 which is under initial phase and later on the same will be reclaimed as per the approved Mine Closure Plan.</p>
xvi.	<p>Catch drains and siltation ponds of appropriate size shall be constructed to arrest silt and sediment flows from soil, OB and mineral dumps. The water so collected shall be utilized for watering the mine area, roads, green belt development, etc.</p> <p>The drains shall be regularly de-silted and maintained properly.</p> <p>Garland drains (size, gradient and length) and sump capacity shall be designed keeping 50% safety margin over and above the peak sudden rainfall and maximum discharge in the area</p>	<p>Siltation pond followed by garland / catch drain around the mine area, external OB dump and coal stock yard etc. has been provided to arrest the flows from OB dump /coal stock yard. The drains are being regularly de-silted during the pre and post monsoon season and have been maintained properly.</p> <p>One sump of sufficient capacity has been provided within the mine to cater the peak sudden rainfall and</p>

	adjoining the mine site. Sump capacity shall also provide adequate retention period to allow proper settling of silt material.	discharge/seepage from adjoining areas. The water so collected in sump is being utilized for watering the mine area, roads, green belt development, etc.
ivii.	Dimension of the retaining wall at the toe of the dumps and OB benches within the mine to check run-off and siltation shall be based on the rainfall data.	As mentioned above in Point no. xv; presently, OB dumps are in the active stage except few portion which will be stabilized through plantation. The provision of retaining wall will be provided towards the stabilized portion of OB dump 1.
xviii.	Crushers at the CHP of adequate capacity for the expansion project shall be operated with high efficiency bag filters, water sprinkling system shall be provided to check fugitive emissions from crushing operations, conveyor system, haulage roads, transfer points, etc.	Currently, the construction of CHP is also on full swing. Hence, the compliance will be done when CHP becomes operational.
xix.	Drills shall be wet operated.	is being complied.
xx.	The project authorities shall undertake regular repairing and tarring of roads used for mineral transportation. A 3-tier green belt comprising of a mix of native species shall be developed all along the major approach roads.	Being complied.
xxi.	Controlled blasting shall be practiced with use of delay detonators and only during daytime. The mitigative measures for control of ground vibrations and to arrest the fly rocks and boulders shall be implemented.	Services of CSIR-CIMFR has been taken for scientific design of Blast parameter to reduce ground vibration. The recommendations of study are being implemented during blasting.
xxii.	A progressive afforestation plan shall be implemented covering an area of 512.584 ha at the end of mining, which includes reclaimed external OB dump (193.478 ha), internal dump (257.11 ha), and green belt (61.996 ha) and in township located outside the lease by planting native species in consultation with the local DFO/Agriculture Department. The density of the trees shall be around 2500 plants per ha. Massive plantation shall be carried out in open spaces in and around the mine and a 3-tier avenue plantation along the main approach roads to the mine.	Areas will be afforested including reclaimed areas etc. and native species of plantation will be decided in consultation with DFO/Agriculture department. Technical and Biological reclamation plan as per approved Mine Plan (Rev II) has already been submitted to your good office. The plantation has been carried out in vacant spaces on the occasion of "World Environment Day (5 th June) and during the monsoon season within the project area i.e. Safety zone, bank of Garia nalla, CHP area etc. The list comprises details of plantation has already been submitted to your good office vide letter dt. 22.11.2021 [kindly refer Annexure 3 as mentioned above in Point no. (xiv)].
xxiii.	An estimated 61.73 M Cum of OB will be generated during the entire life of the mine. Out of which 29.23 Mm ³ of OB will be dumped in four external OB dump in non-coal bearing area.	As per the approved Mine Plan & Mine Closure Plan (Revision – II), total 3 nos. of OB dumps will be acquired in non-coal

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	<p>The maximum height of external OB dump for hard OB will not exceed 30 m each. The maximum slope of the dump shall not exceed 28°.</p> <p>Monitoring and management of reclaimed dump sites shall continue till the vegetation becomes self-sustaining and compliance status shall be submitted to MOEF and its Regional Office on yearly basis.</p>	<p>bearing area by OCPL out of which 2 nos. OB dumps are in active stage.</p> <p>Complied</p> <p>Compliance & Status report is being submitted regularly to MoEF &CC and its Regional office along with the half yearly post EC compliance report.</p> <p>Also, kindly refer the point no. xv as mentioned above.</p>
xxiv.	Of the total quarry area of ha, the backfilled quarry area of 489 ha shall be reclaimed with plantation and a void of 162 ha which is proposed to be converted into a water body, shall be gently sloped and the upper benches shall be terraced and stabilized with plantation/afforestation by planting native plant species in consultation with the local DFO/Agriculture Department. The density of the trees shall be around 2500 plants per ha	Back filled area will be reclaimed with plantation as per the Approved Mine Closure Plan (Rev II). Density of trees will be 2500/ha. Water body (reservoir) will be gently sloped. Plantation of native species will be done with consultation of DFO/Agriculture department.
xxv.	The proponent should prepare restoration and reclamation plan for the degraded area. The land be used in a productive and sustainable manner.	Will be complied as specified in approved Mining Plan (Rev II).
xxvi.	Compensatory Ecological & Restoration of waste land, other degraded land and OB dumps in lieu of breaking open the land be carried out	Will be complied as specified in approved Mining Plan (Rev II).
xxvii.	The mining should be phased out in sustainable manner. No extra over burden dumps are permitted.	Noted and being complied as per approved Mining Plan (Rev II).
xxviii.	No groundwater shall be used for mining operations.	Being complied. Mine seepage collected in sump is being reused for sprinkling purpose.
xxix.	Regular monitoring of groundwater level and quality shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality in May. Data thus collected shall be submitted to the Ministry of Environment & Forests and to the Central Pollution Control Board quarterly within one month of monitoring.	Monitoring of groundwater level and quality has been carried out by establishing a network of existing dug wells and construction of new piezometers outside the Manoharpur Coal Mine Block. The monitoring of ground water level as prescribed in conditions is being carried out in surrounding villages and other locations as no bore well is constructed inside the project area due to non-availability of ground water. The water level monitoring report in this regard for the Month of May and August 2021 has already been submitted to your good office vide letter dt. 22.11.2021 (kindly refer Annexure 4). Further, the GW level

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		<p>monitoring carried out during January 2022 is attached herewith as Annexure 3 for your ready reference.</p> <p>Also, the ground water quality is being monitored regularly on monthly basis in 2 villages i.e. Dulinga and Parmanandpur located in buffer zone. The copy of same for the month of May and August 2021 has already been submitted to your good office along with half yearly post EC compliance report vide letter dt. 22.11.2021 (<i>kindly refer Annexure 4</i>). Further, the GW quality monitored during January 2022 at village Dulinga and Parmanandpur is attached as Annexure 4.</p>
xxx.	The Company shall put up artificial groundwater recharge measures for augmentation of groundwater resource in case monitoring indicates a decline in water table. The project authorities shall meet water requirement of nearby village(s) in case the village wells go dry due to dewatering of mine	<p>Permanent recharge pond of 4000 m³ (approx.) capacity has been provided within the project area to recharge the ground water table of the adjoining areas.</p> <p>The siltation pond followed by Garland drains will also help in retaining the rain water and recharge of ground water table.</p> <p>Further, the drinking water supply through tankers will be provided to nearby villages during the summer season.</p>
xxxi.	Sewage treatment plant shall be installed in the existing colony. ETP shall also be provided for workshop and CHP wastewater.	<p>Installation of sewage treatment plant (STP) in mine colony to treat the generated domestic waste water is under progress. The STP treated water will be reused in horticulture development within the colony. ETP has also been installed to treat the waste water generated from vehicle washing in workshop area.</p>
xxxii.	Besides carried out regular periodic health checkup of their workers, 10% of the workers identified from workforce engaged in active mining operations shall be subjected to health checkup for occupational diseases and hearing impairment, if any, through an specialized agency/institution within the District/State and the results reported to this Ministry and to DGMS	Being complied with as per applicable guidelines of The Mines Rules, 1955.
xxxiii.	There are 370 PDFs and 385 PAFs. Land oustees shall be compensated as per the norms laid out R&R Policy of CIL or the National R&R Policy or R&R Policy of the State Government whichever is higher	Complied as per the provisions of Odisha R&R Policy, 2006.



x xiv.	For monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery (on scale of 1:5000) of the core zone and buffer zone, from the start of the project until end of mine life shall be prepared once in 3 years (for any one particular season which is consistent in the time series), and the report submitted to MOEF and its concerned Regional Office.	The land use / land cover study for core zone & buffer zone of Manoharpur Coal Mine Project has been carried out during the year 2018 and the report has also been prepared by M/s Geosys Enterprise Solutions Private Limited, Hyderabad, Telangana. The copy of report showing the detailed land use / land cover study using the Remote Sensing Technique and GIS has been submitted to your good office along with post EC compliance report vide letter dated 26.11.2020 (Refer Annexure 4). Further, the land use study for 2021 has carried out by M/s Geosys Enterprise Solutions Private Limited, Hyderabad, Telangana. The copy of same is attached as Annexure 5 .
xxv.	A detail final Mine Closure Plan along with details of Corpus Fund shall be submitted to the Ministry of Environment & Forests within 6 months of grant of Environmental Clearance	The approved Mine Plan and Mine Closure Plan (Rev II) has been submitted to MoEF&CC on dated 08.05.2018. Further, the Mining Plan & Mine Closure Plan (Rev-III), has been approved on 26-09-2019 by MoC for 16 MTPA which includes the expansion of Manoharpur Coal Mine towards its Dipside. The environmental clearance (EC) application for the proposed expansion from 8 to 16 MTPA has already been submitted to MoEF&CC as per the approved Mining Plan (Rev-III). Also, MoEF&CC has approved the Terms of Reference (ToR) vide letter dt. 29.04.2020 for further EIA/EMP study. Accordingly, the final EIA/EMP study report has been prepared & submitted to MoEF&CC followed the successful public hearing for EC appraisal and the same in under progress.
xxxvi.	The project authorities shall in consultation with the Panchayats of the local villages and administration identify socio-economic and welfare measures under CSR to be carried out over the balance life of the mine	As mentioned above in Point no. (ix), CSR activities are being carried out in consultation with concerned Panchayat /local administration.
xxvii.	The proponent should implement the assurances given during the Public Hearing	Assurance given during the Public Hearing is being implemented in the vicinity of project area.
xxviii.	Corporate Environment Responsibility:	Environment policy has been approved by Board and it is in place.

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	<p>The Company shall have a well laid down Environment Policy approved by the Board of Directors.</p> <p>The Environment Policy shall prescribe for standard operating process/procedures to bring into focus any infringements/deviation/violation of the environmental or forest norms/conditions</p> <p>The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished</p> <p>To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the company and/or shareholders or stakeholders at large</p>	<p>Will be complied with.</p> <p>There is an environment management cell comprises of technical qualified persons who is taking care of all environmental compliances of clearances and monitoring. The cell is headed by Head of Company through Mine Agent.</p>
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GENERAL CONDITIONS

i.	No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.	Prior approval will be obtained, if applicable.
ii.	No change in calendar plan of production for quantum of mineral coal shall be made.	Agreed and will be complied in line of guidelines of MoEF&CC. Further, if there is any change in calendar plan of production of coal, due permission/approval shall be obtained from competent authority.
iii.	Four ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for PM ₁₀ , PM _{2.5} , SO ₂ and NO _x monitoring. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc carried out at least once in six months.	<p>The monthly environmental monitoring including ambient air quality is being carried out regularly in the core zone (4 locations) as well as in the buffer zone (4 locations) by MoEF&CC/NABL/OSCPB accredited laboratory M/s Visiontek Consultancy Services Pvt. Ltd. for PM₁₀, PM_{2.5}, SO_x, and NO_x and the copy of same is being submitted regularly to Odisha State Pollution Control Board (OSPCB). The latest monitoring report for the month of March 2022 showing the results of pollutants i.e. PM₁₀, PM_{2.5}, SO_x, NO_x and CO for is attached as Annexure 6.</p> <p>Also, the monitoring of heavy metals such as Hg, As, Ni, Cd, Cr etc. has been carried out on six monthly basis in December month 2021 for core zone and buffer zone. The test results show that monitored parameters are well within the permissible limits as prescribed by MoEF&CC and test report in this regard is attached as Annexure 7.</p>

iv.	Data on ambient air quality (PM10, PM2.5, SO2 and NOx) and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly submitted to the Ministry including its concerned Regional Office and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories recognized under the EPA rules, 1986 shall be furnished as part of compliance report.	Kindly refer the Point no. iii (General Condition) as mentioned above.
v.	Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs	<p>Complied.</p> <p>The noise quality monitoring is being carried out regularly on monthly basis at various places of core zone and buffer zone and adequate measures are followed to control the noise level below 85 dBA in the working environment. The latest noise quality monitoring report for the month of March 2022 is attached herewith as Annexure 8.</p> <p>Also, workers engaged in blasting and drilling operations, operation of HEMM, etc. have been provided with proper PPE's i.e. ear plugs/muffs, helmet, safety shoe etc.</p>
vi.	Industrial Wastewater (workshop and wastewater from the mine) shall be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May 1993 and 31st December 1993 or as amended from time to time before discharge. Oil and grease trap shall be installed before discharge of workshop effluents	Effluent Treatment Plant (ETP) consisting of oil & grease trap has been provided at workshop. The treated water obtained from ETP is being reused / recycle for the vehicle washing purpose.
vii.	Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.	Is being Complied
viii.	Monitoring of environmental quality parameters shall be carried out through a laboratory recognized under EPA Rules, 1986	The environmental monitoring is being carried out as mentioned above in Point no. iii (General Condition).
ix.	Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety and health aspects.	Agreed and is being complied with.
x.	Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed and records maintained thereof. The quality of environment due to outsourcing and the health	Initial Medical Examination (IME) of the workers is being complied carried out as per applicable norms of Coal Mine Rules.

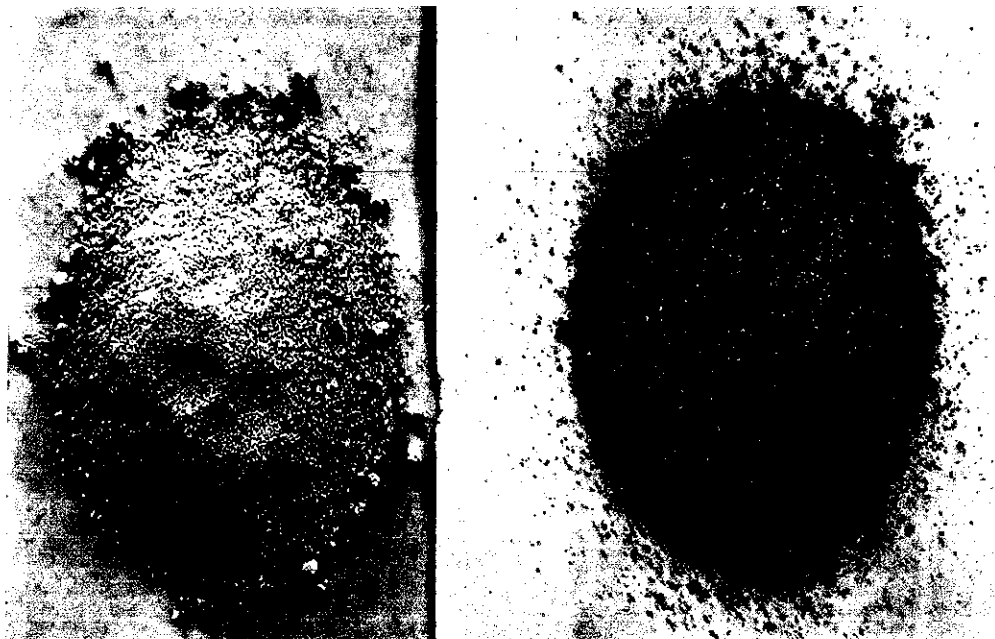
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	and safety issues of the outsourced manpower should be addressed by company while outsourcing.	Further, periodically occupational health checkup of workers will be taken up in near future. The health & safety issues of the out sourced man power are duly addressed in Notice Inviting Tender (NIT) and in Work orders.
xi.	A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company.	An environment management cell comprising of technical qualified personnel has been working in the organization who is directly reporting to the Head of Company through Mine Agent.
xii.	The funds earmarked for environmental protection measures shall be kept in separate account and shall not be diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its concerned Regional Office.	Year-wise expenditure incurred on environmental protection measures has already been submitted for the period of FY 2018-19, 2019-20 & 2020-21 along with post EC compliance report vide letter dated 06.11.2020.
xiii.	The Project authorities shall advertise at least in two local newspapers widely circulated around the project, one of which shall be in the vernacular language of the locality concerned within seven days of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution Control Board and may also be seen at the website of the Ministry of Environment & Forests at http://envfor.nic.in	Complied.
xiv.	A copy of the environmental clearance letter shall be marked to concern Panchayat/Zila Parishad, Municipal Corporation or Urban local body and local NGO, if any, from whom any suggestion/representation has been received while processing the proposal. A copy of the clearance letter shall also be displayed on company's website	Complied.
xv.	A copy of environmental clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industry Sector and Collector's Office/Tehsildar's Office for 30 days	Complied
xvi.	The clearance letter, shall be uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions shall also be uploaded by the project authorities on their website and updated at least once every six months so as to bring the same in public	The environmental clearance letter along with compliance status of stipulated conditions has been uploaded on company website which can be seen at the following link: http://ocpl.org.in/Environment.asp

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	domain. The monitoring data of environmental quality parameter (air, water, noise and soil) and critical pollutant such as PM10, PM2.5, SO2 and Nox (ambient) and critical sectoral parameters shall also be displayed at the entrance of project premises and mine office and in corporate office and on company's website	
ivii.	The project proponent shall submit six monthly compliance reports on status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the Ministry, respective Zonal Offices of CPCB and the SPCB.	Being Complied in confirmation to notification issued by MOEF&CC vide letter no. S.O. 5845 (E) dated 26.11.2018 and MoEF&CC (ERO) vide letter no. File No : 106-12/EPE dated 11.05.2020.
xviii.	The Regional Office of this Ministry located in the Region shall monitor compliance of the stipulated conditions. The Project authorities shall extend full cooperation to the office(s) of the Regional Office by furnishing the requisite data/information/monitoring reports.	Project authorities will extend full cooperation to the Ministry Regional Office.
xix.	The environmental statement for each financial year ending 31 March in Form V is mandated to be submitted by the project proponent for the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be uploaded on the company's website along with the status of compliance of EC conditions and shall be sent to the respective Regional Offices of the MoEF by e-mail.	Being Complied.

FEASIBILITY TEST FOR PROCESSING OF COAL MINE OVERBURDEN MATERIAL INTO CONSTRUCTION GRADE M-SAND



Department of Mining Engineering
NATIONAL INSTITUTE OF TECHNOLOGY

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March 2022

INVESTIGATION STATEMENT

The scientific work documented in this report titled **"FEASIBILITY TEST FOR PROCESSING OF COAL MINE OVERBURDEN MATERIAL INTO CONSTRUCTION GRADE M-SAND"** is being carried out by the National Institute of Technology–Rourkela at the request of ODISHA COAL AND POWER LIMITED(OCPL).

This report is classified as confidential and is meant for the internal use of the organization to which it is submitted. This report, in full or in part thereof, can neither be quoted nor published anywhere by anybody other than the investigators. It should not be communicated / circulated to other agencies other than the concerned government departments. National Institute of Technology - Rourkela reserves the right to publish the results of the present study.



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FEASIBILITY TEST FOR PROCESSING OF COAL MINE OVERBURDEN MATERIAL INTO CONSTRUCTION GRADE M-SAND

INTRODUCTION

This report present results of laboratory experiments of the manually crushed coal overburden materials collected from the open cast mine of Manoharpur Coal Mine Project (OCPL). Locally available natural river sand specimen was also tested as reference for some of the cases. Fig. 1 presents physical appearances of manually crushed coal overburden material and locally available natural river sand.

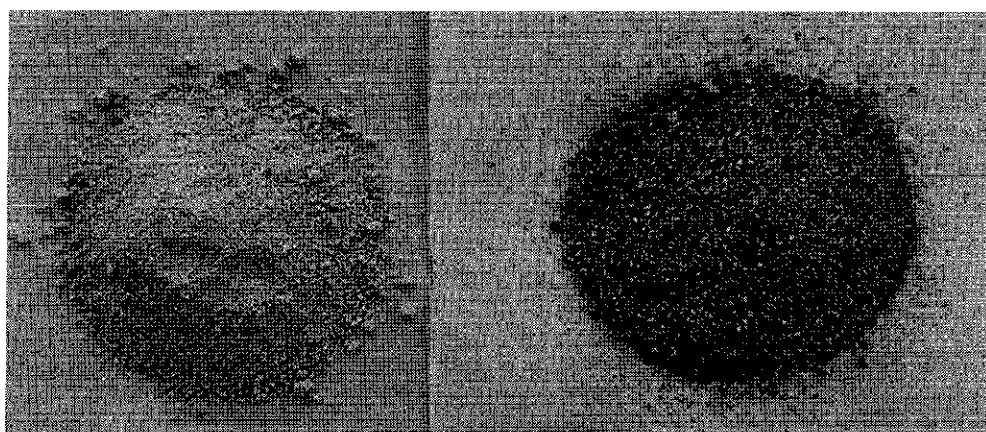


Fig. 1: Physical appearances of manually crushed coal overburden material and locally available natural river sand.

SCOPE OF STUDIES

The scope of the experimental program is limited to the following:

1. Determination of Particle Size (a) Sieve analysis, (b) Determination of materials finer than 75-micron
2. Estimation of (a) coal and Lignite, (b) Clay, Fine Silt and Fine Dust (Sedimentation Method), (c) Organic impurities
3. Determination of Specific Gravity, Density, Voids, Absorption, and Bulking
4. Determination of Soundness
5. Determination of crushing strength of cement mortar specimen
6. Determination of Potential Alkali Reactivity of Cement-Aggregate Combinations
7. Petrographic Examination

TESTS CONDUCTED

All the above tests (including preparation of test specimens) are conducted following relevant Indian Standards as required by IS 383 (2016). The test results are presented in Tables 1-10 and Fig. 2.

Table 1: Sieve analysis result as per Indian Standard IS: 2386 (Part I) – 1963

Sieve Size (mm)	Percentage Passing	Zone III of IS383:2016
10.00	100	100
4.75	100	90-100
2.36	98.08	85-100
1.18	92.73	75-100
0.60	63.08	60-79
0.30	19.18	12-40
0.15	4.28	0-10

Table 2: Materials finer than 75-micron (in %) as per Indian Standard IS: 2386 (Part II) – 1963

Collected OBM	Natural Sand
9.0	2.7

Table 3: Coal and Lignite (in %) as per Indian Standard IS: 2386 (Part II) – 1963

Collected OBM	Natural Sand
0.11	0

Table 4: Clay, Fine Silt and Fine Dust (in %) as per Indian Standard IS: 2386 (Part II) – 1963

Collected OBM	Natural Sand
9.04	2.73

Table 5: Organic impurities as per IS: 2386 (Part II) – 1963

The test conducted as per Cl. 6.2 of Indian Standard IS: 2386 (Part II) – 1963 reveals no harmful organic compound is present in the collected OBM.

Table 6: Specific gravity, density, voids, absorption, and bulking as per IS: 2386 (Part III) – 1963

Parameter	Collected OBM	Natural Sand
Specific Gravity	2.53	2.60
Density (kg/l)	1.59	1.65
Void (%)	38.69	37.00
Water Absorption (%)	1.69	0.80
Bulking (%)	15.61	23.1

Table 7: Soundness value (average loss of mass after 5 cycle) as per IS: 2386 (Part V) – 1963

Collected OBM
4.61%

Note: Tested with sodium sulphate (Na_2SO_4)

Table 8: Average crushing strength as per IS: 2386 (Part VI) – 1963

	Collected OBM	Natural Sand
At 7 days (MPa)	21.50	19.33
At 28 days (MPa)	26.67	29.33

Table 9: Average expansion (%) at 16 days after casting (Alkali Aggregate Reaction)

Collected OBM	Natural Sand
0.016	0.018
innocuous	innocuous

Note: Accelerated mortar bar method is followed as per Cl. 5.6 (3) of IS 383: 2016

Table 10: X-ray Fluorescence Analysis Results (Petrographic Examination)

Constituents	Amount in percentage (%)	
	Collected OBM	Natural Sand
LOI	8.31	4.36
ZrO ₂	0.11	0.36
NiO	0.06	-
Fe ₂ O ₃	1.18	9.38
TiO ₂	1.93	2.73
K ₂ O	0.87	2.05
P ₂ O ₅	0.24	0.14
SiO ₂	61.64	60.44
Al ₂ O ₃	25.40	10.59
MgO	0.26	0.96
CaO	-	7.93
Cr ₂ O ₃	-	-
MnO	-	0.07
Na ₂ O	-	0.72
SO ₃	-	0.28
ZnO	-	-

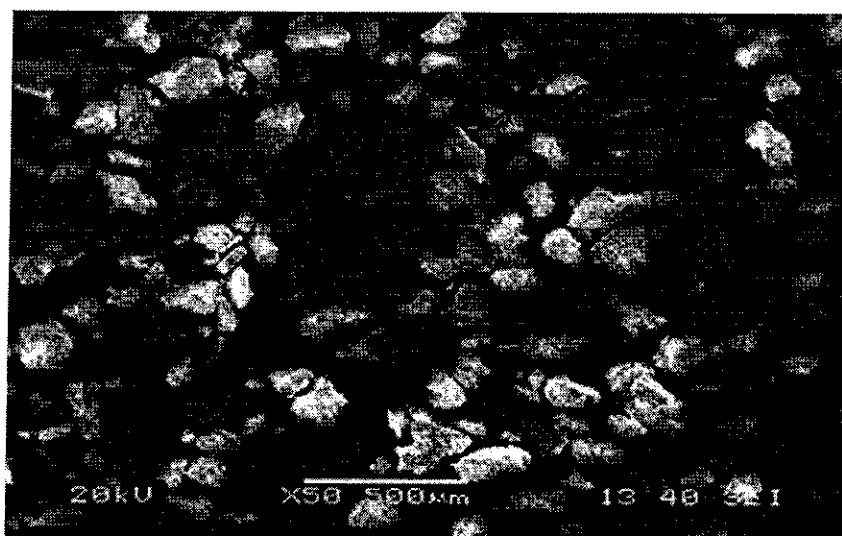


Fig. 2. Microscopic view of Collected OBM

RESULTS AND ANALYSIS


1. The collected OBM sample conform with the grading zone III of IS 383:2016.
2. Percentage of coal and lignite evaluated as per Indian Standard IS: 2386 (Part II) – 1963 are found to be within the acceptable limits of IS 383 (2016). Also, no harmful organic compound is observed in the specimens tested.
3. **The maximum quantity of clay, fine silt and fine dust exceeds the limits specified (intended for use of aggregate in concrete) in Table 2 of IS 383 (2016). Contents of the concerned Table 2 about the Limits of Deleterious Materials (Clause 5.2.1) is represented in ANNEXURE-A.**
4. Specific gravity, density, voids, and bulking of the coal overburden materials collected from all the four open cast mines is found to be in close proximity with that of natural sand.
5. The water absorption capacity of the collected samples is higher than that of natural sand. However, this is within the maximum permissible limit (3%) of water absorption in fine aggregates as per BS EN 1992-3:2006.
6. The soundness test reveals that the average loss of mass after 5 cycle for the tested specimens are within the acceptable limits of IS 383 (2016).
7. Average crushing strength of the tested cement mortar specimen prepared using the coal overburden materials at 7-day is found to be higher than that prepared with natural river sand. However, the results of the 28-day compressive strength contradict this conclusion.
8. Accelerated mortar bar test of all the specimen indicates innocuous behavior for alkali-aggregate reaction.
9. X-ray Fluorescence test result reveals that Kaolinite and Quartz is the primary compounds present in both of the tested samples.

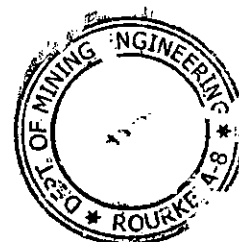
CONCLUSION

The OB material does not conform to the specifications of construction grade sand stone required for house construction.

ACKNOWLEDGEMENT

Cooperation the officials of the Manoharpur Coal Mine Project-OCPL in the field investigations, sample collection etc is thankfully acknowledged. BTech/M.Tech/PhD scholars of Mining Engineering department helped in testing, analysis of the data and preparation of the report. Prof P K Sarkar of Civil Engg. department extended his support for conducting the tests.


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ANNEXURE-A.

CONTENTS OF THE CONCERNED TABLE 2 ABOUT THE LIMITS OF DELETERIOUS MATERIALS (CLAUSE 5.2.1) OF IS 383 (2016)

IS 383 : 2016

Table 2 Limits of Deleterious Materials
(Clause 5.2.1)

Sl No.	Deleterious Substance	Method of Test, Ref to	Fine Aggregate Percentage by Mass, Max			Coarse Aggregate Percentage by Mass, Max		
			Uncrushed	Crushed/ Mixed	Manufactured	Uncrushed	Crushed	Manufactured
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Coal and lignite	IS 2386 (Part 2)	1.00	1.00	1.00	1.00	1.00	1.00
ii)	Clay lumps	IS 2386 (Part 2)	1.00	1.00	1.00	1.00	1.00	1.00
iii)	Materials finer than 75 µm IS Sieve	IS 2386 (Part 1)	3.00	15.00 (for crushed sand) 12.00 (for mixed sand) see Note 1)	10.00	1.00	1.00	1.00
iv)	Soft fragments	IS 2386 (Part 2)	—	—	—	3.00	—	3.00
v)	Shale	(see Note 2)	1.00	—	1.00	—	—	—
vi)	Total of percentages of all deleterious materials (except mica) including Sl No. (i) to (v) for col 4, 7 and 8 and Sl No. (i) and (ii) for col 5, 6 and 9	—	5.00	2.00	2.00	5.00	2.00	2.00

NOTES

1 The sands used for blending in mixed sand shall individually also satisfy the requirements of Table 2. The uncrushed sand used for blending shall not have material finer than 75 µm more than 3.00 percent.

2 When the clay stones are harder, platy and fissile, they are known as shales. The presence and extent of shales shall be determined by petrography at the time of selection and change of source.

3 The presence of mica in the fine aggregate has been found to affect adversely the workability, strength, abrasion resistance and durability of concrete. Where no tests for strength and durability are conducted, the mica in the fine aggregate may be limited to 1.00 percent by mass. Where tests are conducted to ensure adequate workability, satisfactory strength, permeability and abrasion (for wearing surfaces), the mica up to 3.00 percent by mass for muscovite type shall be permitted. In case of presence of both muscovite and biotite mica, the permissible limit shall be 5.00 percent maximum by mass. This is subject to total deleterious materials (including mica) being limited to 8.00 percent by mass for col 4 and 5.00 percent for col 5.

Till a method is included in IS 2386 (Part 2), for determination of mica content, suitable methodology may be used for the same. Normally, petrographic density separation and wind blowing methods can be used.

4 The aggregate shall not contain harmful organic impurities [tested in accordance with IS 2386 (Part 2)] in sufficient quantities to affect adversely the strength or durability of concrete. A fine aggregate which fails in the testing of organic impurities may be used, provided that, when tested for the effect of organic impurities on the strength of mortar, the relative strength at 7 and 28 days, reported in accordance with IS 2386 (Part 6) is not less than 95 percent.

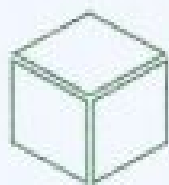
Manoharpur Coal Mine Project, Tehsil Hemgir, Dist. Sundergarh, Odisha

ANNEXURE 2

Year wise Expenditure Detail on CSR / Peripheral Development

Sl.No	Sectors	OPGC	OCPL							Total Expenditure on CSR / Peripheral Development
		2008-2015	2015-2016	2016-2017	2017-2018	2018-19	2019-20	2020-21	2021-22 (Till March'22)	
1	Health	16922646	95000	225900	414000	412309	243562	279352	16000	
2	Education		1290000	1244300	1326500	912000	300000	0	0	
3	Skill Development			2151263	1854000	1925170	2143354	1338985	0	
4	Socio-Culture		168000	100560	305000	565000	150000	25000	60,000	
5	Sports		226000		117800	140000	95000	40000	0	
6	Rural Infrastructure		0	3114404	3791751	2340609	1969011	3188081	30,00,000	
7	Livelihood		0	0	0		0	0	0	
8	Water Sanitation		0	0	330000	440000	169000	0	8,22,260	
9	Public Relation		0	0	0	64000	0	0	0	
10	Environment		0	0	0	0	0	0	97,000	
	Total	1,69,22,646	17,79,000	68,36,427	81,39,051	67,99,088	50,69,927	48,71,418	39,95,260	5,44,12,817

Note: Rs. 16922646 expenditure submitted by OPGC to OCPL



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ANNEXURE 3

BUFFER ZONE

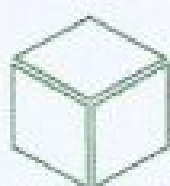
GROUND WATER LEVEL REPORT JANUARY-2022

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh

Sl. No.	Date of Monitoring	Sampling Location	Location Co-ordinates	Source	Water Level in meters
1	24.01.2022	Paramanandapur Village	21° 57' 18.1116" N 83° 45' 56.8764" E	Open well	2.35
2	24.01.2022	Kathapali Village	21° 56' 26.8044" N 83° 46' 8.9724" E	Open well	3.60
3	24.01.2022	Dulanga Village	21° 56' 44.7468" N 83° 47' 54.978" E	Open well	3.84
4	24.01.2022	Sangamuda Village	21° 57' 40.59" N 83° 47' 37.6404" E	Open well	1.86
5	24.01.2022	Kalamegha Village	21° 56' 54.6036" N 83° 50' 32.9892" E	Open well	2.96
6	24.01.2022	Sarbahal Village	21° 58' 20.5824" N 83° 48' 37.5408" E	Open well	4.63



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- &
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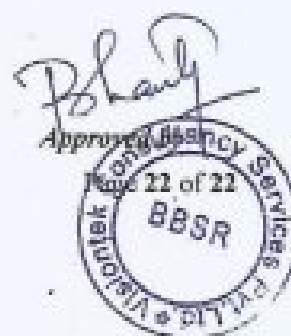
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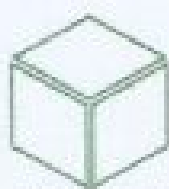
STUDY AREA

GROUND WATER LEVEL REPORT JANUARY-2022

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh

SL No.	Date of Monitoring	Sampling Location	Location Co-ordinates	Source	Water Level in meters
1	22.01.2022	HD 02 PW	21.95678° N 83.73626° E	Bore hole	18.81
2	22.01.2022	HD 02 OW	21.95674° N 83.74595° E	Bore hole	19.87
3	22.01.2022	HD 04 PW	21.94017° N 83.77429° E	Bore hole	1.90
4	22.01.2022	HD 04 OW	21.94038° N 83.77423° E	Bore hole	2.01





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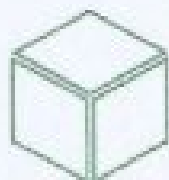
Date: 06.02.2022

GROUND WATER QUALITY REPORT JANUARY-2022 (BUFFER ZONE)

ANNEXURE 4

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Name of the Location : Ground Water-1: Tube well at Paramanandpur Village
4. Location Co-ordinates : GW-1: 21° 57' 15.4476" N, 83° 45' 54.144" E
5. Date of Sampling : 07.01.2022
6. Date of Receiving : 08.01.2022
7. Date of Analysis : 08.01.2022 to 14.01.2022
8. Sample Collected By : VCSPL Representative

Sl. No.	Name of the Parameters	Unit	Testing Method	Standard as per IS 10500:2012, Amend. 2015 & 2018(Acceptable Limit)	Analysis Result
					GW-1
1.	pH (at 25 °C)	---	APHA 4500H ⁺ B	6.5-8.5	6.97
2.	Color	Hazen	APHA 2120 B,C	5.0 (max)	<5
3.	Odor	---	APHA 2150 B	Agreeable	Agreeable
4.	Taste	---	APHA 2160 C	Agreeable	Agreeable
5.	Turbidity	NTU	APHA 2130 B	1.0 (max)	<1.0
6.	Residual Free Chlorine	mg/l	APHA 4500 Cl ⁻ B	0.2 (min)	0.26
7.	Total Dissolved Solids	mg/l	APHA 2540 C	500.0(max)	281.0
8.	Electrical Conductivity	µS/cm	APHA 2510 C	---	416.5
9.	Total Alkalinity as CaCO ₃	mg/l	APHA 2320 B	200(max)	62.0
10.	Total Hardness as CaCO ₃	mg/l	APHA 2340 C	200(max)	88.0
11.	Calcium as Ca	mg/l	APHA 3500 Ca B	75(max)	29.4
12.	Magnesium as Mg	mg/l	APHA 3500Mg B	30(max)	3.5
13.	Chloride as Cl	mg/l	APHA 4500Cl ⁻ B	250(max)	25.5
14.	Fluoride as F	mg/l	APHA 4500 F ⁻ C, D	1.0(max)	0.21
15.	Sulphide	mg/l	APHA 4500 -S.D	0.05(max)	ND
16.	Sulphate as SO ₄	mg/l	APHA 4500 SO ₄ ⁻ E	200(max)	11.8
17.	Nitrate as NO ₃	mg/l	APHA 4500 NO ₃ ⁻ B	45(max)	1.17
18.	Ammonical Nitrogen as NH ₃ -N	mg/l	APHA 4500 NH ₃ C	0.5(max)	BDL
19.	Hexavalent Chromium as Cr ⁶⁺	mg/l	APHA 3500 Cr ⁶⁺ B	---	BDL
20.	Phenolic Compounds as C ₆ H ₅ OH	mg/l	APHA 5530-B, D	0.001(max)	BDL
21.	Cyanide as CN	mg/l	APHA 4500 CN ⁻ C E	0.05(max)	BDL
22.	Sodium as Na	mg/l	APHA 3500 Na, B	---	6.2
23.	Potassium as K	mg/l	APHA 3500K, B	---	4.5
24.	Copper as Cu	mg/l	APHA 3111 B	0.05(max)	BDL



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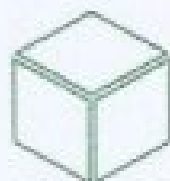
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25.	Iron as Fe	mg/l	APHA 3111 B	1.0(max)	0.24
26.	Manganese as Mn	mg/l	APHA 3111 B	0.1(max)	BDL
27.	Mercury as Hg	mg/l	APHA 3112 B	0.001(max)	BDL
28.	Cadmium as Cd	mg/l	APHA 3111 B	0.003(max)	BDL
29.	Selenium as Se	mg/l	APHA 3500 Se C	0.01(max)	BDL
30.	Arsenic as As	mg/l	APHA 3500 As	0.01(max)	BDL
31.	Lead as Pb	mg/l	APHA 3111 B	0.01(max)	BDL
32.	Zinc as Zn	mg/l	APHA 3111 B	5.0(max)	0.21
33.	Nickel as Ni	mg/l	APHA 3111 B	0.02(max)	BDL
34.	Total Chromium as Cr	mg/l	APHA 3111 B	0.05(max)	BDL
35.	Boron as B	mg/l	APHA 4500 B, B	0.5(max)	BDL
36.	Silver as Ag	mg/l	APHA 3111 B	0.1(max)	BDL
37.	Barium as Ba	mg/l	APHA 3111 B	0.7(max)	BDL
38.	Aluminium as Al	mg/l	APHA 3500 Al B	0.2(max)	BDL
39.	Anionic detergent as MBAS	mg/l	APHA 5540 C	1.0(max)	ND
40.	Mineral Oil	mg/l	APHA 5220 B	0.5(max)	ND
41.	Total Coliform	MPN/100ml	APHA 9221 B	Shall not be detectable in any 100 ml	<1.1
42.	EColi	MPN/100ml	APHA 9221 E	Shall not be detectable in any 100 ml	Absent
43.	Fecal Coliform	MPN/100ml	APHA 9221 F	---	<1.1
44.	Pesticides	mg/l	APHA 6630 C	---	Absent

BDL Value: Cu <0.02mg/l, Al <0.1mg/l, B <0.1mg/l, Ba <0.1mg/l, Mn<0.03mg/l, Hg<0.002 mg/l, Cd <0.01 mg/l, Se <0.001 mg/l, As <0.004 mg/l, Pb<0.01mg/l, Ni<0.05 mg/l, Cr <0.03mg/l, NH₄-N< 0.1mg/l, Cr⁶⁺<0.01mg/l, Phenol <0.03mg/l, CN <0.01mg/l, Ag<0.1mg/l, TC & FC : MPN/100 ml < 1.1 (0-0-0)



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Ref:Envlab/21/R-1502

Date: 06.02.2022

GROUND WATER QUALITY REPORT JANUARY-2022

(BUFFER ZONE)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Name of the Location : Ground Water-2: Tube Well at Dulanga Village
4. Location Co-ordinates : GW-2: 21° 56' 46.1832" N, 83° 47' 55.3164" E
5. Date of Sampling : 08.01.2022
6. Date of Receiving : 09.01.2022
7. Date of Analysis : 09.01.2022 to 14.01.2022
8. Sample Collected By : VCSPL Representative

Sl. No.	Name of the Parameters	Unit	Testing Method	Standard as per IS 10500:2012, Amnd. 2015 & 2018 (Acceptable Limit)	Analysis Result
					GW-2
1.	pH (at 25 °C)	---	APHA 4500H ⁺ B	6.5-8.5	7.37
2.	Color	Hazen	APHA 2120 B,C	5.0 (max)	<5
3.	Odor	---	APHA 2150 B	Agreeable	Agreeable
4.	Taste	---	APHA 2160 C	Agreeable	Agreeable
5.	Turbidity	NTU	APHA 2130 B	1.0 (max)	<1.0
6.	Residual Free Chlorine	mg/l	APHA:4500 Cl ⁻ B	0.2 (min)	0.24
7.	Total Dissolved Solids	mg/l	APHA 2540 C	500.0(max)	312.0
8.	Electrical Conductivity	µS/cm	APHA 2510 C	---	483.7
9.	Total Alkalinity as CaCO ₃	mg/l	APHA 2320 B	200(max)	76.0
10.	Total Hardness as CaCO ₃	mg/l	APHA 2340 C	200(max)	104.0
11.	Calcium as Ca	mg/l	APHA 3500 Ca B	75(max)	31.6
12.	Magnesium as Mg	mg/l	APHA 3500Mg B	30(max)	6.1
13.	Chloride as Cl	mg/l	APHA 4500Cl ⁻ B	250(max)	30.5
14.	Fluoride as F	mg/l	APHA 4500 F ⁻ C, D	1.0(max)	0.24
15.	Sulphide	mg/l	APHA 4500 -S.D	0.05(max)	ND
16.	Sulphate as SO ₄	mg/l	APHA 4500 SO ₄ ⁻² E	200(max)	18.7
17.	Nitrate as NO ₃	mg/l	APHA 4500 NO ₃ ⁻ B	45(max)	1.35
18.	Ammonical Nitrogen as NH ₄ -N	mg/l	APHA 4500 NH ₄ ⁺ C	0.5(max)	BDL
19.	Hexavalent Chromium as Cr ⁺⁶	mg/l	APHA 3500 Cr ⁶⁺ B	--	BDL
20.	Phenolic Compounds as C ₆ H ₅ OH	mg/l	APHA 5530-B, D	0.001(max)	BDL
21.	Cyanide as CN	mg/l	APHA 4500 CN ⁻ C E	0.05(max)	BDL
22.	Sodium as Na	mg/l	APHA 3500 Na, B	---	6.7
23.	Potassium as K	mg/l	APHA 3500K, B	---	4.8
24.	Copper as Cu	mg/l	APHA 3111 B	0.05(max)	BDL
25.	Iron as Fe	mg/l	APHA 3111 B	1.0(max)	0.31



Visiontek Consultancy Services Pvt. Ltd.

(Committed For Better Environment)

Certified for : ISO 9001:2015, ISO 14001:2015, ISO 45001:2018 (OH&S), ISO/IEC 17025:2017

Accredited by : NABET-A Grade, MOEF & CC/CPCB & SPCB-A Grade

- Infrastructure Engineering
- Water Resource Management
- Environmental & Social Study

- Surface & Sub-Surface Investigation
- Quality Control & Project Management
- Renewable Energy

- Agricultural Development
- Information Technology
- Public Health Engineering

- Mine Planning & Design
- Miscral/Sub-Soil Exploration
- Waste Management Services

Laboratory Services
Environment Lab
Food Lab
Material Lab
Soil Lab
Microbial Lab
&
Microbiology Lab

26.	Manganese as Mn	mg/l	APHA 3111 B	0.1(max)	BDL
27.	Mercury as Hg	mg/l	APHA 3112 B	0.001(max)	BDL
28.	Cadmium as Cd	mg/l	APHA 3111 B	0.003(max)	BDL
29.	Selenium as Se	mg/l	APHA 3500 Se C	0.01(max)	BDL
30.	Arsenic as As	mg/l	APHA 3500 As	0.01(max)	BDL
31.	Lead as Pb	mg/l	APHA 3111 B	0.01(max)	BDL
32.	Zinc as Zn	mg/l	APHA 3111 B	5.0(max)	0.28
33.	Nickel as Ni	mg/l	APHA 3111 B	0.02(max)	BDL
34.	Total Chromium as Cr	mg/l	APHA 3111 B	0.05(max)	BDL
35.	Boron as B	mg/l	APHA 4500 B, B	0.5(max)	BDL
36.	Silver as Ag	mg/l	APHA 3111 B	0.1(max)	BDL
37.	Barium as Ba	mg/l	APHA 3111 B	0.7(max)	BDL
38.	Aluminium as Al	mg/l	APHA 3500 Al D	0.2(max)	BDL
39.	Anionic detergent as MBAS	mg/l	APHA 5540 C	1.0(max)	ND
40.	Mineral Oil	mg/l	APHA 5220 B	0.5(max)	ND
41.	Total Coliform	MPN/100ml	APHA 9221 B	Shall not be detectable in any 100 ml	<1.1
42.	EColi	MPN/100ml	APHA 9221 E	Shall not be detectable in any 100 ml	Absent
43.	Faecal Coliform	MPN/100ml	APHA 9221 F	---	<1.1
44.	Pesticides	mg/l	APHA 6630 C	---	Absent

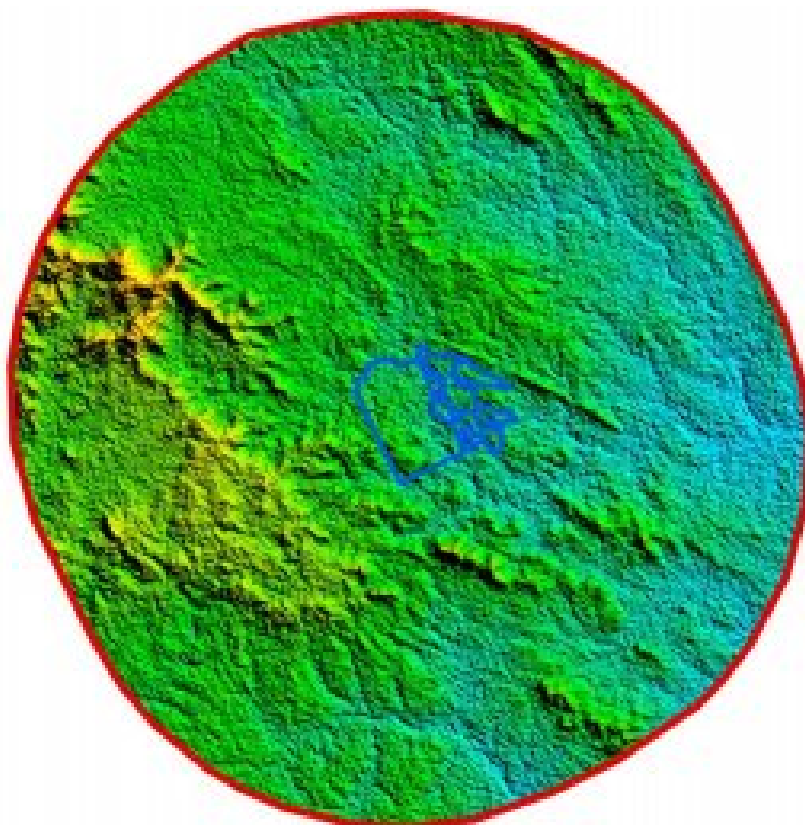
BDL Value: Cu <0.02mg/l, Al <0.1mg/l, B <0.1mg/l, Ba <0.1mg/l, Mn <0.05mg/l, Hg <0.002 mg/l, Cd <0.01 mg/l, Se <0.001 mg/l, As <0.004 mg/l, Pb <0.01mg/l, Ni <0.05 mg/l, Cr <0.05mg/l, NH₃-N < 0.1mg/l, Cr⁶⁺ <0.01mg/l, Phenol <0.05mg/l, CN <0.01mg/l, Ag <0.1mg/l, TC & FC: MPN/100 ml < 1.1 (0-0-0)



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Report on Land Use / Land Cover Study of Core & Buffer Zone of Manoharpur Coal Mine Project

Project Location: Manoharpur, Sundargarh District, Odisha.
Year of Study: 2021



Prepared for:



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Contracted by:



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Hyderabad-500016, Telangana.

REPORT ON

Manoharpur Coal Mine Project

Project Location: Manoharpur, Sundargarh & Jharsuguda District, Odisha State.

1. Introduction

The knowledge of land use and land cover is important for many planning and management activities as it is considered an essential element for modeling and understanding the earth system.

The term land use relates to the human activity or economic function associated with a specific piece of land, while the term land cover relates to the type of feature present on the surface of the earth (Lillesand and Kiefer, 2000).

Land cover maps are presently being developed from local to national to global scales. The use of panchromatic and medium scale aerial photographs to map land use has been an accepted practice since the 1940s. More recently, small scale aerial photographs and satellite images have been utilized for land use and land cover mapping. The satellite remote sensing technology has found its acceptance worldwide for rapid resource assessment and monitoring, particularly in the developing world. National Aeronautical and Space Administration (NASA) of USA has made most significant contributions with satellite based remote sensing techniques. Since 1972, after the Landsat-1 was launched, remote sensing technology and its application has undergone a tremendous change in terms of sensing development, aerial flights with improved sensors, satellite design development and operations including data reception, processing, interpretation, and utilization of satellite images.

All these advancements have widened the applicability of remotely sensed data in various areas, like forest cover, vegetation type mapping, and their changes on a regional scale. If satellite data is judiciously used along with the enough ground data, it is possible to carry out detailed forest inventories, monitoring of land use, and vegetation cover at various scales.

M/s Odisha Coal and Power Ltd is holding a mining lease of Manoharpur Coal Mine Project with EC No. J-11015/139/2008-IA-II(M) Project for an area of 977.875 Ha at Sundargarh District, Odisha State. Now the Odisha Coal and Power Ltd, is preparing Environmental Impact Assessment Study and Environment Compliance Report to maintain Environmental Clearance for coal mining in the Project area from Ministry of Environment Forest and Climate Change (MOEFCC), Government of India. Out of the Mining Lease area 977.875 Ha, the present study is conducted for 965.01 Ha as the remaining 12.865 Ha is not utilized.

M/s BGR Mining & Infra Ltd, is appointed by Odisha Coal and Power Ltd, as mine operator to develop and operate Manoharpur Coal mine project for a period of 10 years wide mining services agreement dated 31.08.2018.

M/s Geosys Enterprise Solutions Private Limited is an Indian company providing world-class Enterprise Geographic Information System (GIS) solutions thereby helping businesses, governments and private organizations to make timely, informed and mission-critical decisions by leveraging the power of geography.

2. Scope of the Study

The objective of the present study is to prepare the Essential (Thematic) Maps to be provided to the Ministry of Environment Forest and Climate Change as part of the EIA/EMP and Environment Compliance Report, for maintaining the Environmental Clearance (EC), as per Environmental Impact Assessment Guidance Manual.

Scope of the Project Includes:

Digital image processing of Core zone (project area) & Buffer zone (10 Km. radius around periphery of the project) for coal mining projects, using Remote Sensing Technique and GIS to study the present land use pattern and prepare land use / land cover maps.

3. Location of the Project

The mine is covered in Manoharpur Village, Hemgir Tehasil, Sundargarh District, Odisha State. The location of the Mining lease area falls under Survey of India Toposheet No F44R13 the geographical co-ordinates of the lease area as follows:

North-West Corner: 21°57'46.98"N (Latitude), 83°45'51.71"E (Longitude)

South-East Corner: 21°56'48.488"N (Latitude), 83°47'42.485"E (Longitude)

The 10km buffer Zone of the Manoharpur Coal Mine Project is falling in F44L12, F44L16, F44R9 and F44R13 SOI Toposheets. The buffer zone is covered in Sundargarh & Jharsugda District of Odisha State. Location Map shown in Figure 1

4. Tools and Resources

To meet the project requirements, Geosys has acquired the following satellite data for the study area from National Remote Sensing Centre, Hyderabad.

For 10km Buffer Zone:

Satellite:	IRS Resourcesat2A
Sensor:	LISS IV FX
Path:	104
Row:	057
Spatial Resolution:	5.8m
Date of pass:	17-Mar-2021

Satellite:	IRS Cartosat-3
Sensor:	MX
Strip Number:	9
Scene Number:	25
Spatial Resolution:	1.10m
Date of pass:	04-May-2021

For Core Zone Multispectral Data:

Satellite:	IRS Resourcesat2A
Sensor:	LISS IV FX
Path:	104
Row:	057
Spatial Resolution:	5.8m
Date of pass:	24-Oct-2021

High resolution Panchromatic Data:

Satellite:	IRS Cartosat-3
Sensor:	MX
Strip Number:	9
Scene Number:	25
Spatial Resolution:	1.10m
Date of pass:	04-May-2021

The Cartosat-3 MX imagery for the core zone is shown in the Fig 4 and the data of RS2 LISS IV is shown in Fig 3.

5. Limitations

The limitations of Remote Sensing, Image Processing, Geographical Information Systems, cartography and GPS are applicable in this study.

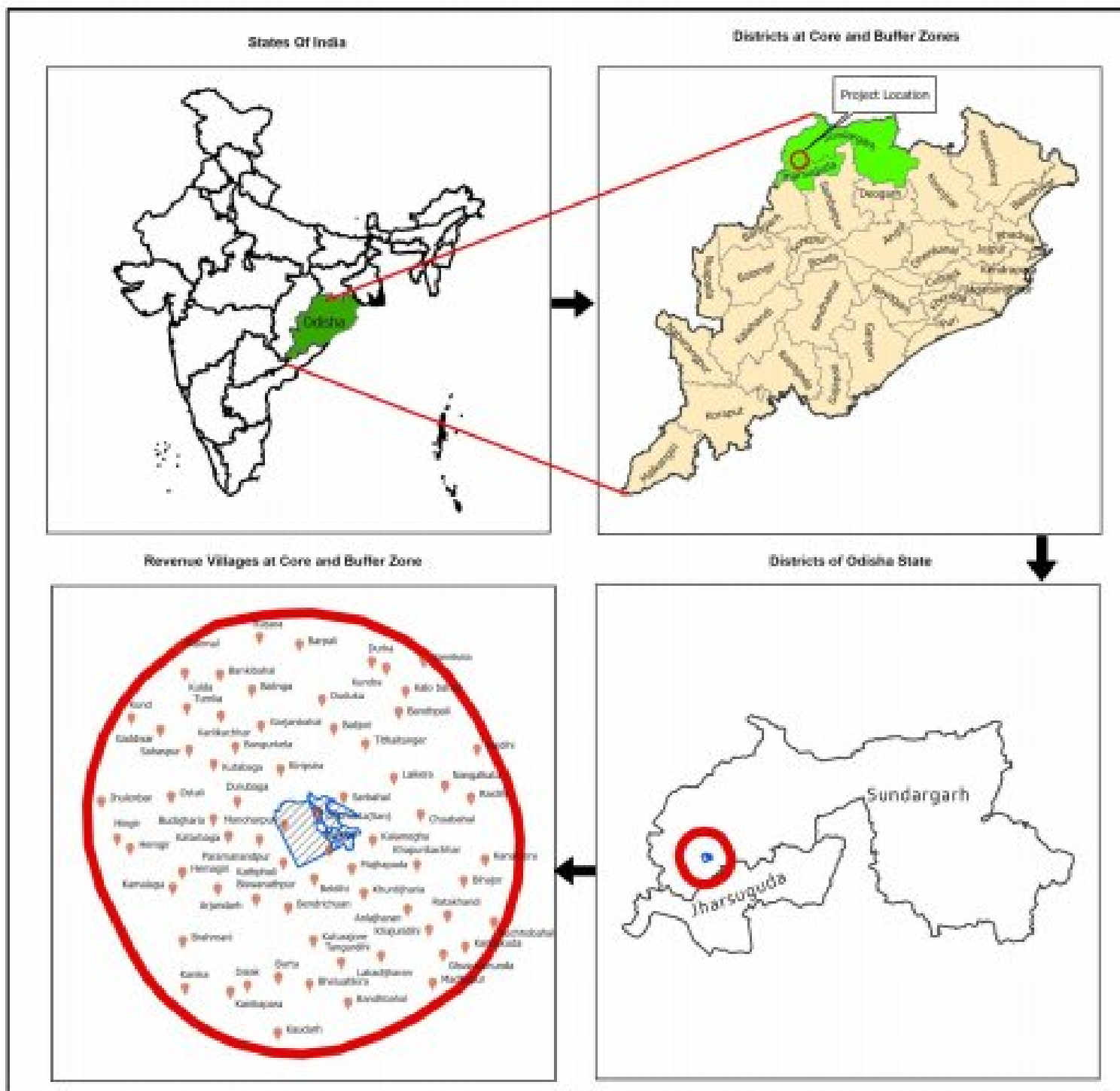
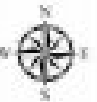


Fig 1: Location Map of the Buffer Zone and Core Zone

Location Map of Manoharpur Coal Mine Project



Legend

- Mine Boundary
- 10 Kms Buffer Boundary

Client:



ODISHA COAL AND POWER LTD

Prepared By:

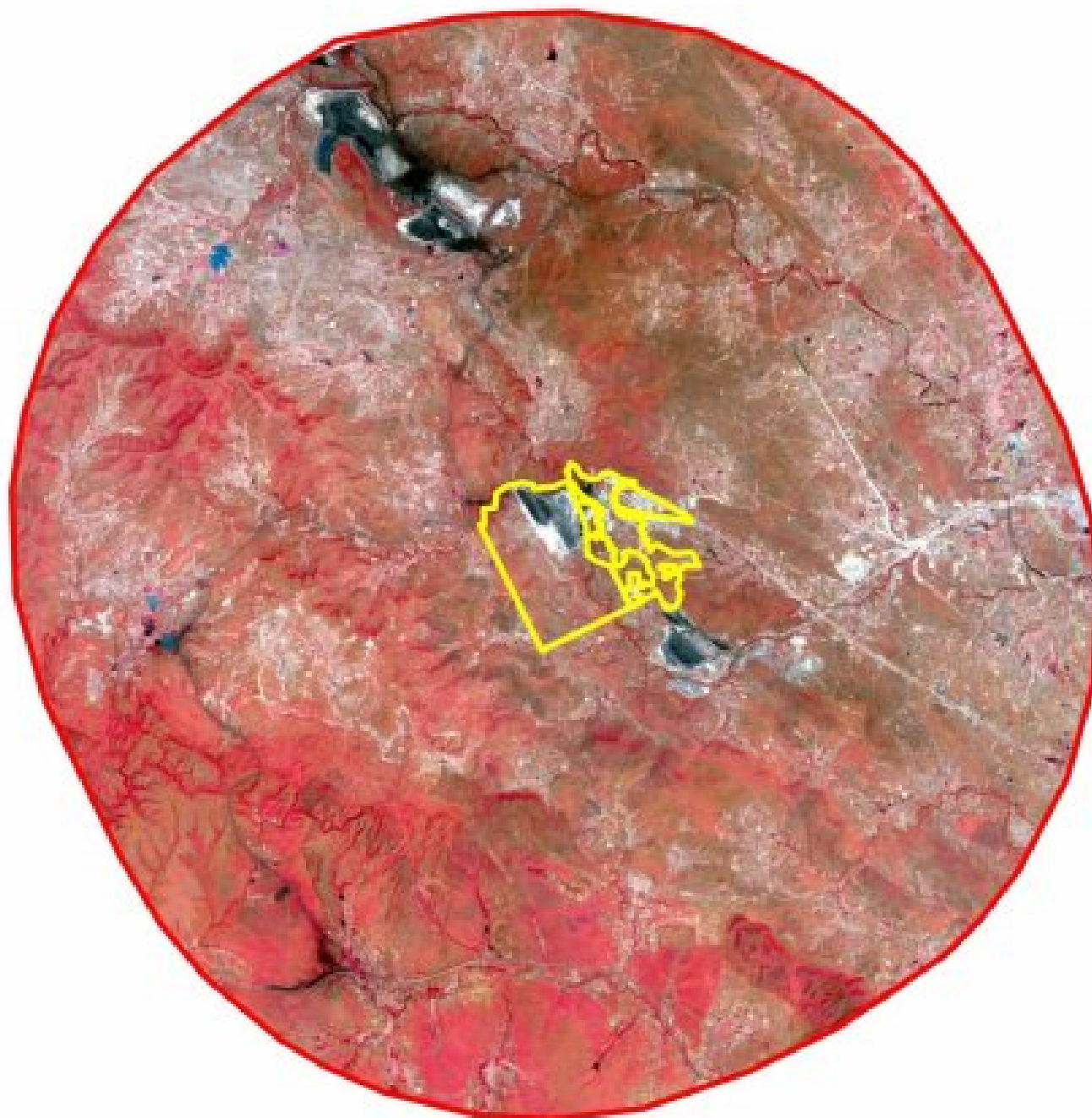


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(ISO - 9001 - 2015 Certified)

83°40'0"E 83°45'0"E 83°50'0"E

22°0'0"N

21°55'0"N



Buffer Zone Of Manoharpur Coal Mine Project

Legend

- 10 Kms Buffer Boundary
- Mine Boundary



0 1.5 3 6
Kilometers

Satellite Data Details:

Satellite: IRS Cartosat-3
Sensor: MX
Strip Number: 9
Scene Number: 25
Spatial Resolution: 1.10m
Date of pass: 04-May-2021
And
Satellite: Resourcesat 02
Sensor: LISS IV FX
Path: 104
Row: 057
Spatial Resolution: 5.8m
Date of Pass: 17th Mar 2021

Client:



ODISHA COAL AND POWER LTD

Prepared By:



GEOSYS ENTERPRISE SOLUTIONS PRIVATE LIMITED
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Fig 2 : Resourcesat 02 LISS-IV FX Image Of Core Zone And Buffer Zone

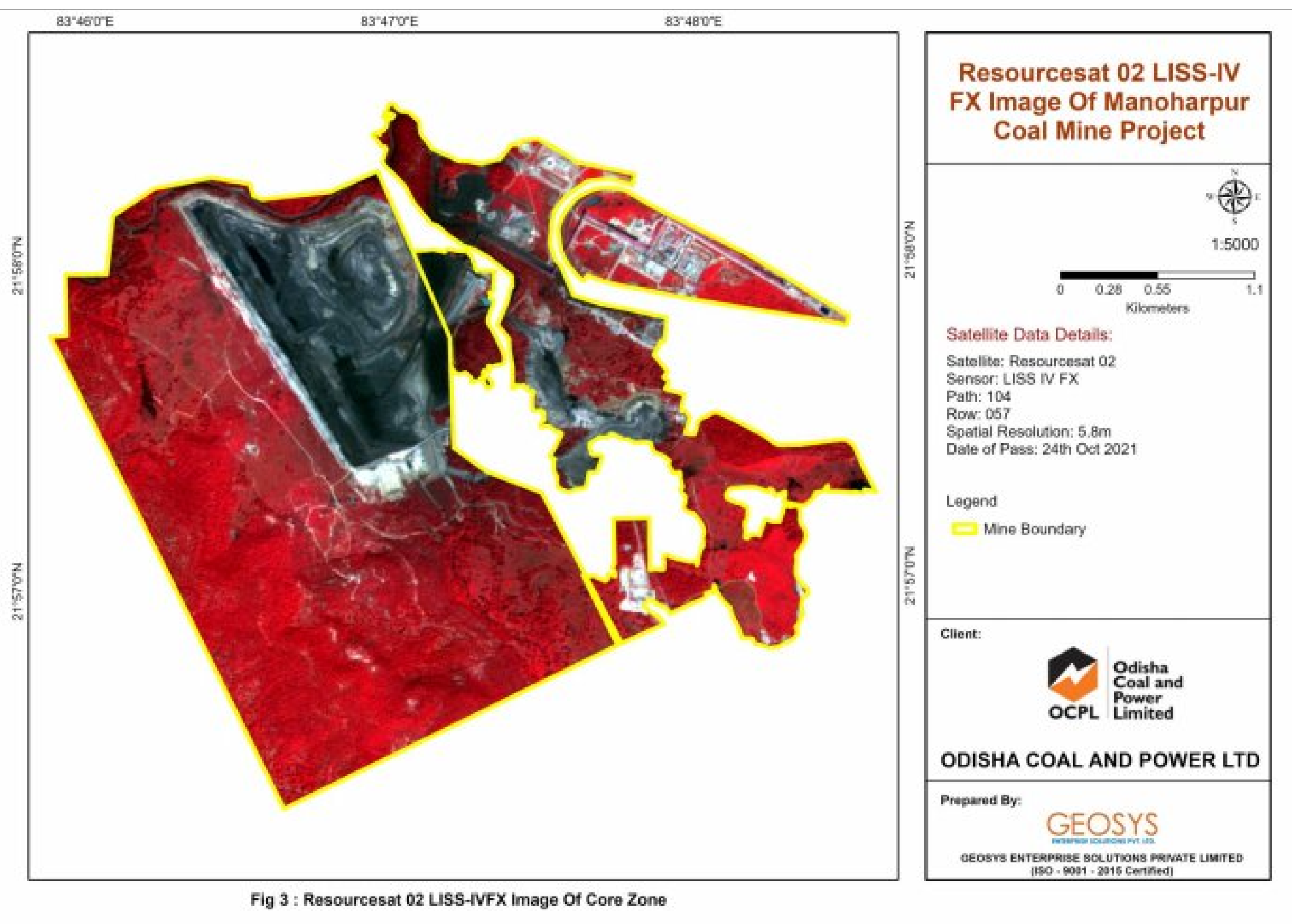
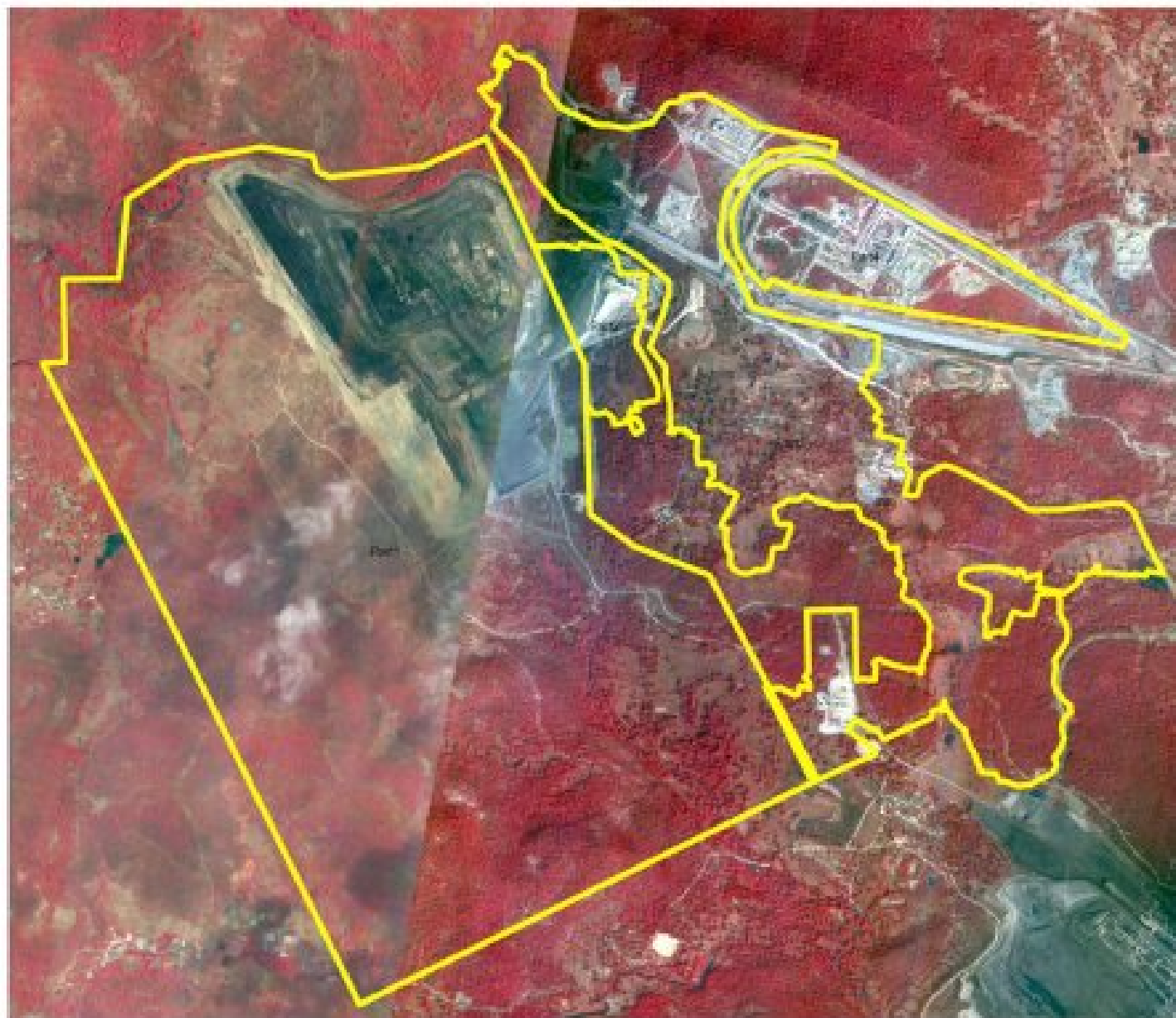


Fig 3 : Resourcesat 02 LISS-IVFX Image Of Core Zone

83°46'E

83°47'E

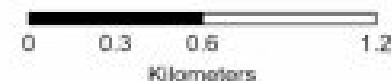
83°48'E



Cartosat 03 MX Image Of Core Zone Of Manoharpur Coal Mine Project



1:5000



Satellite Data Details:

Satellite: Cartosat 03
Sensor: MX
Strip Number: 9
Scene Number: 25
Spatial Resolution: 1.10m
Date of pass: 04- May-2021

Legend

Mine Boundary

Client:



Odisha
Coal and
Power
Limited

ODISHA COAL AND POWER LTD

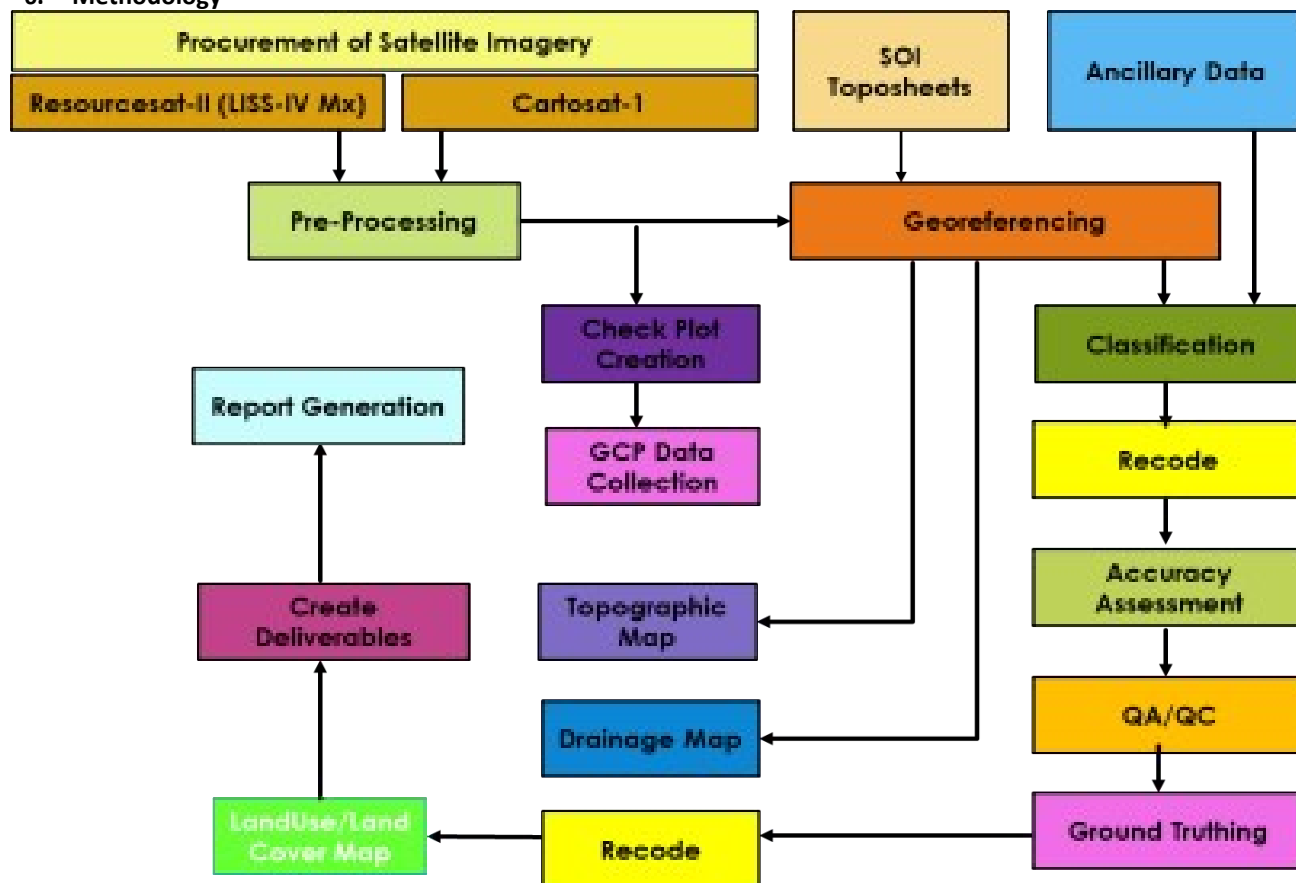
Prepared By:

GEO SYS
ENTERPRISE SOLUTIONS PVT. LTD.

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Fig 4 : Cartosat 03 MX Image Of Core Zone

6. Methodology



6.1 Preprocessing of data

The Digital Image Processing has been performed using ArcGIS Desktop and ArcGIS Pro software tools.

The IRS Resourcesat2 LISS IV Multispectral imagery have been geometrically corrected with respect to the Survey of India Toposheets. To carry out the geo-referencing, ground control points (GCPs) were identified on the maps and raw satellite data. The coefficients for two co-ordinate transformation equations were computed based on polynomial regression between GCPs on map and satellite data.

This IRS Resourcesat2 LISS IV Multispectral satellite data has been used for the Land Use Land Cover Analysis of Core and Buffer Zone. The satellite imagerys were analyzed digitally by the method of Classification with necessary Ground trothing using the reference map as well as Trimble Catalyst.

The coordinates of the boundary were collected using the Trimble catalyst to demarcate the mine boundary, during GCP collection phase.

Visual image interpretation technique of classification was applied for doing the Land use Landcover map. It is a process of identifying what we see on the images and communicates the information obtained from these images to others for evaluating their significance.

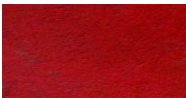

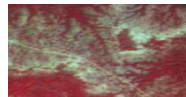
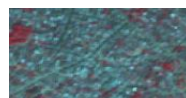






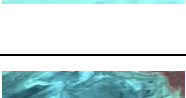
The visual interpretation methodology was used for the study area. This comprises of the following six major steps: -

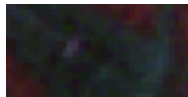


1. Selection and acquisition of data
2. Pre-field Interpretation
3. Ground data collection and verification
4. Post-field Interpretation and Modification
5. Computation of area
6. Final cartographic Map preparation.

Reconnaissance of the area under study is a prerequisite for any kind of attempt in mapping natural resources of the earth. The preliminary survey of the area has assisted in acquainting with the various kinds of classes of LULC types present in the field and subsequently helped in adopting a suitable classification scheme and.

Interpretation key for the final map generation. A classification scheme was developed for the study area following Anderson et al. (1967). A final Interpretation key for the various classes was prepared using spectral characteristics of classes and field knowledge. The interpretation key for LULC classification is given in Table 1.

Table 1: Image Interpretation techniques for Mining of final interpretation key

S.no	LULC Class	Tone	Texture	Shape	Spectral Signature	Description
1	Dense Forest	Dark Red to Light Red	Rough	Irregular		Tree Cover (If Forest Canopy Density>40%)
2	Open Forest	Light Red	Smooth	Irregular		Tree Cover (If Forest Canopy Density is between 10-40%)
3	Scrub	Light Red or Pinkish Red	Coarse	Varying		Bushy Vegetation with shrubs or scattered Trees (If Forest Canopy density<10%)
4	Settlements	Cyan	Rough	Irregular		Urban and Rural Areas
5	Water Bodies	Dark Blue or Light Blue	Smooth	Irregular/Regular		Rivers, Streams and Ponds
6	Plantations	Blackish Red to Dark Red	Medium Smooth/ Medium Coarse	Irregular/Regular/R ectangular		Mature or Young Plants
7	Single Crop	Pinkish or Light Green or Light Blue or Light Cyan	Medium Smooth	Regular		Crops/Current Fallow Lands surrounded by small to Medium Size Settlements
8	Double Crop	Dark Red to Light Red	Medium Smooth	Regular		Crops Lands surrounded by small to Medium Size Settlements
9	Fallow Land	Light Cyan or Whitish	Medium Smooth	Regular		Fields without any Crop surrounded by small to Medium Size Settlements
10	Barren Land	Light Blue or Light Cyan	Smooth	Irregular		Areas are sparse, stunted and contain limited biodiversity
11	Mining area	Light Blue or Light Cyan	Smooth	Irregular		Place where Mining Operations are taken.

12	Coal dump	Dark Grey or Black	Smooth	Irregular		Place where the Coal is Dumped
13	Quarry sump	Dark Blue or Light Blue	Smooth	Irregular		Water slogged in Mining Area
14	Green Belt	Blackish Red to Dark Red	Medium Smooth/ Medium Coarse	Irregular/ Regular		Mature or Young Plants grown in a Mining area

Classification and on-screen digitization were done in ArcGIS Desktop and ArcGIS Pro software. Finally, a polygon map was generated where each polygon represented a distinct class. The classes were then assigned to their respective attributes. Ground truth verification was done by using Trimble Catalyst during field visit. Trimble Catalyst readings included Crop, Fallow Land, Plantation, Forest, Land with / without scrub, Barren Land, Mining area, Built-up land, Water Bodies, Roads and other important and identifiable Landuse/landcover classes of Manoharpur Coal Mine Project, Sundargarh District, Odisha. are recorded and brought into GIS platform. It was found that points were very accurate in the satellite image. Finally, the area statistics of different categories of LULC and color-coded classified map of Manoharpur Coal Mine Project was generated.

Land use / Land cover Classification for buffer zone

Digital image processing was carried out to delineate various land use/ land cover categories in 10 km buffer Zone viz. built up area, crop lands, forests, scrubs, land with or without scrub, water bodies by assigning necessary training sets, which were identified based on tone, texture, size, shape pattern and location information. Necessary care has been taken to identify proper land use class, where there is conflict between signatures of various classes. The interpreted map was verified on ground at limited points and final land use/land cover map was prepared.

7. Various Land Use Classes considered

The Core and buffer zone are classified into different land use classes. The definitions of various land use classes are given below.

Table 1.1 Core Area Classes

S. No.	Major Land Use	Sub-class	Definition
1	Mining Area	Quarry Area	A quarry is a place from which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate has been excavated from the ground.
		Coal dump	Coal seam which have been dumped from mining excavation.
		Quarry sump	Many quarries naturally fill with water after abandonment and become sump. Others are made into landfills.
		Roads	A road is a thoroughfare, route, or way on land between two places that has been paved or otherwise improved to allow travel by foot or some form of conveyance, including a motor vehicle, cart, bicycle, or horse.
		Service buildings	Buildings where mining administrative operations occur.
2	Agriculture	Crop Land	Land devoted to agriculture, the systematic and controlled use of other forms of life—particularly the rearing of livestock and production of crops—to produce food for humans.
		Fallow Land	A piece of land that is normally used for farming but that is left with no crops on it for a season to let it recover its fertility is an example of land that would be described as fallow.
3	Waste Land	Barren Land	Land without any usage and without scrubs and sometimes they are rocky exposed areas.
4	Forest Land	Dense Forest	Forests with canopy coverage between 40%-70%
		Open Forest	Forests with tree canopy coverage between 10%-40%
5	Water Body		The oceans, rivers, streams, lakes, tanks, reservoirs, canals etc. will be identified in this class.
6	Settlements		The habitations are like villages/ colonies/ Industries will be shown in this class.

Table 1.2 Buffer Area Classes

S. No.	Major Land Use	Sub-class	Definition
1	Agriculture	Single Crop	The areas where farmers practice cultivation in a year.
		Fallow Land	The areas not cultivated in current year/ years.
		Plantation	The private areas with horticulture/other plantations
2	Forest cover	Dense Forest	Forests with canopy coverage between 40%-70%
		Open Forest	Forests with tree canopy coverage between 10%-40%
3	Waste Land	Land with / without scrub	Generally waste lands-non-agriculture and non-forest areas covered with or without scrubs.
4	Others	Mining area	The areas, where the mining activity is being carried out/ has been done are shown in this class.
		Industrial Establishments	Means an office building, factory, arena, shop or office, and any land, buildings and structures appertaining thereto
		Built-up land	The habitations are like villages/ colonies/ Industries will be shown in this class.
		Water Bodies	The oceans, rivers, streams, lakes, tanks, reservoirs, canals etc. will be identified in this class.
		Roads	A road is a thoroughfare, route, or way on land between two places that has been paved or otherwise improved to allow travel by foot or some form of conveyance, including a motor vehicle, cart, bicycle, or horse.

8. Land Use Land Cover Details of Buffer Zone

The satellite imagery of the study area around 10 Km from mine site (Core zone boundary) as captured by satellite. The Land use land cover in this study area is given here below.

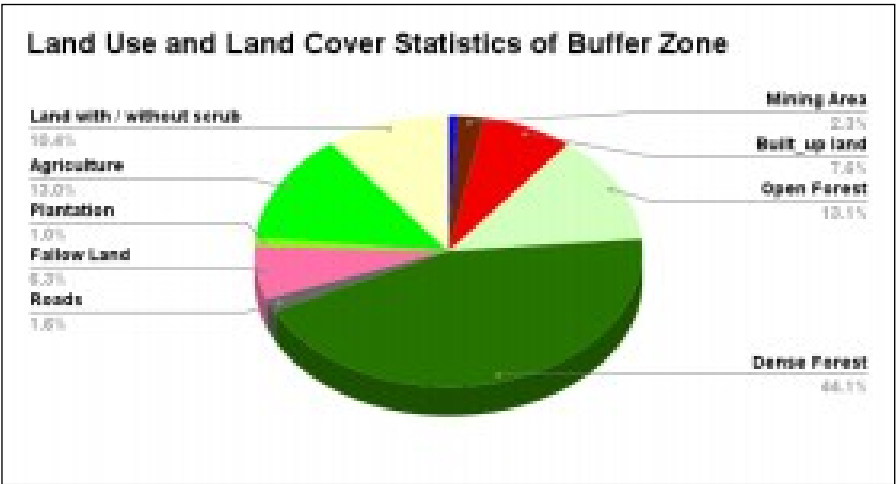
Table 1.3: Land use Land Cover details of 10km Buffer zone

Land Use Land Cover Class	Area of Class	
	Area in Ha	Percentage of Usage
Water Bodies	275.13	0.65
Mining Area	960.52	2.27
Built_up land	3226.52	7.62
Open Forest	5529.38	13.06
Dense Forest	18668.54	44.08
Roads	675.86	1.60
Fallow Land	2660.89	6.28
Plantation	437.59	1.03
Agriculture	5524.88	13.05
Land with / without scrub	4389.22	10.36
Total Area	42,348.53	100

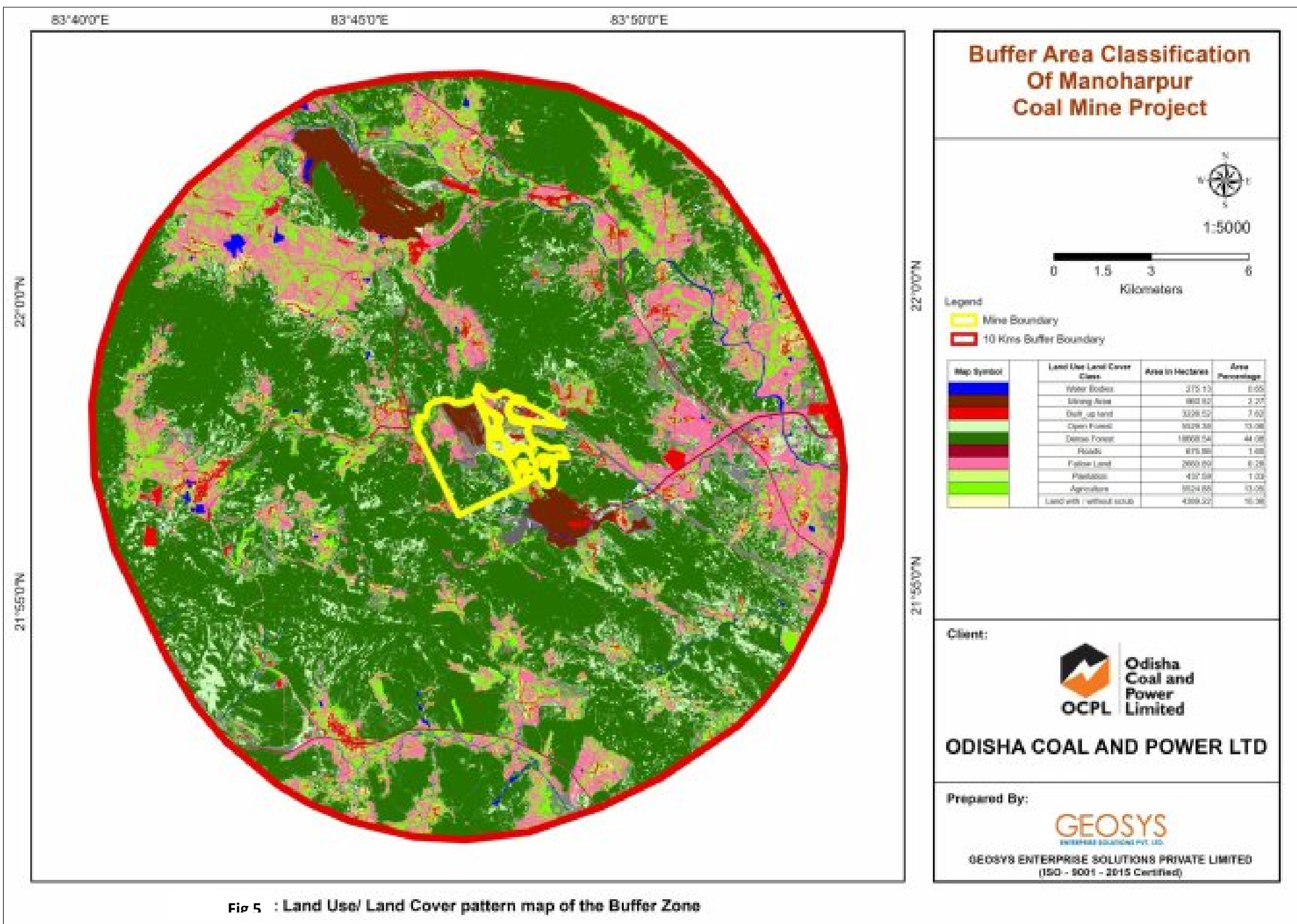
Results for Buffer Area

The visual interpretation of the satellite data with the ground truth was used to map different categories of land use/ land cover (LULC) for Buffer Area Fig.8 shows the LULC map of Manoharpur Coal Mine Project for Buffer Area. Area statistics of different categories of Buffer Area of land use/ land cover is also given in Table 1.1.

Ten categories of LULC were classified in Buffer Area are shown in Table 1.2. Dense Forest covers the major proportion (44.1%) of Manoharpur Coal Mine Project. The forest type of this region belongs to Reserved Forest. Other land use categories included Forest, settlement, water bodies and wasteland. Agriculture covers 13% of the total area. Agriculture and Forest is the major source of livelihood economy. Human settlements occupy 7.6% of the total area and are sparsely distributed. Water bodies occupy 0.98% across the Buffer zone of Manoharpur Coal Mine Project. Few ponds were also found scattered in and around the villages.



Pie chart of Fig 6: Land use Land Cover details of 10km Buffer zone



Land Use Land Cover Study of Core Mine Area

The Satellite data of the core zone of 977.875 Ha has been presented. The classified data of the Mine core zone. The extents of various Land Use/Land Cover classes pertaining to the study area.

Table 1.4: Land use Land Cover details of Core zone

Land Use Land Cover Class	Area of Sub Class	Area of Class
	Area in Ha	Percentage of Usage
Coal Stockyard	8.92	0.92
OverBurden Dump	39.98	4.14
Plantation_OB Dump	1.69	0.18
Plantations_Scrub	79.18	8.21
Quarry Area	94.53	9.80
Roads	25.88	2.68
Service Buildings	29.20	3.03
Water Bodies	9.43	0.98
Agriculture Crop Land	153.48	15.90
Agriculture Fallow Land	15.59	1.62
Settlements	2.70	0.28
Barren Land	0.38	0.04
Broken Area	22.88	2.37
Dense Forest	260.45	26.99
Open Forest	220.72	22.87
Un utilized Area	12.865	1.32
Total	977.875	100.00

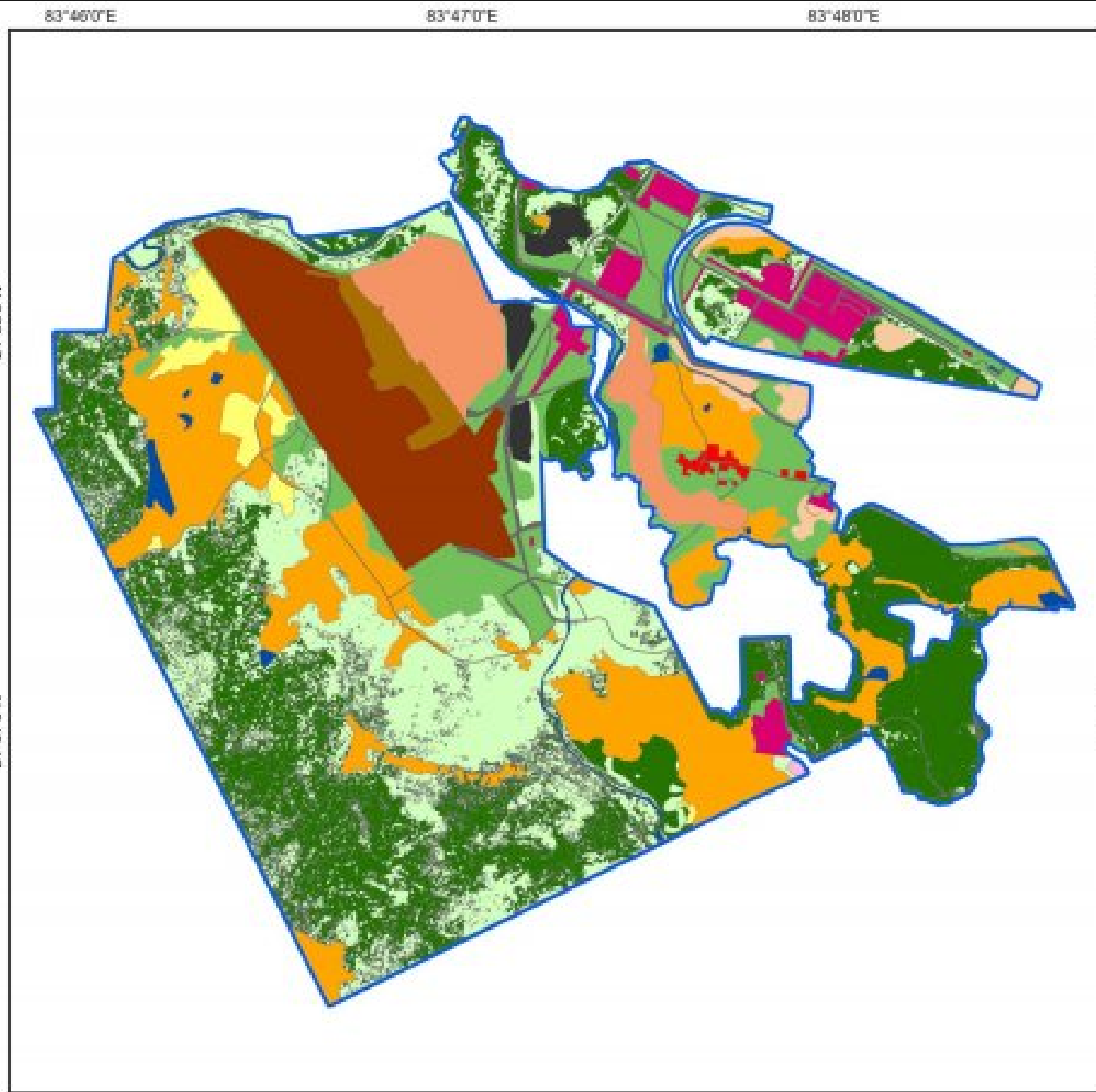
Results for Core Area

Fig. 7 Shows the LULC map of Manoharpur Mine Project for Core Area. Area statistics of different categories of Core Area of land use/ land cover is also given in Table 1.4.

Sixteen categories of LULC were classified in Core Area are shown in Table 1.1.

Forest Area constitutes the major proportion of Manoharpur Coal Mine Project. Other land use categories included water bodies covers 0.98% of the total area, Agriculture covers 15.90% of total area, Fallow Land 1.62%, Forest covers 49.86% of total area of total area, Build-up covers 3.03% of total area and Road covers 2.68% of the total area, Coal Stockyard covers 0.92%, Over Burden Dump Covers 4.14% , Quarry Area 9.80% of the total area.

Out of the Mining Lease area 977.875 Ha, the present study is conducted for 965.01 Ha as the remaining 12.865 Ha is not utilized.



Core Area Classification Of Manoharpur Coal Mine Project



1:5000

0 0.28 0.55 1.1
Kilometers

Legend

— Mine Boundary

Map Symbol	Land Use/Land Cover Class	Area in Hectares	Area Percentage
	Coal Stockyard	10.32	1.00
	Other Overburden Dumps	11.36	1.10
	Overburden Dump	46.81	4.60
	Plantations, Roads	98.20	9.65
	Quarry Area	81.49	8.01
	Roads	10.86	2.17
	Service Buildings	17.28	2.82
	Water Bodies	0.41	0.08
	Agriculture Crop Land	148.13	15.40
	Agriculture Fallow Land	15.57	1.61
	Settlements	2.76	0.28
	Barren Land	0.38	0.04
	Boulding area Under reclamation	12.56	1.30
	Dense Forest	258.25	26.87
	Open Forest	117.94	12.54

Client:



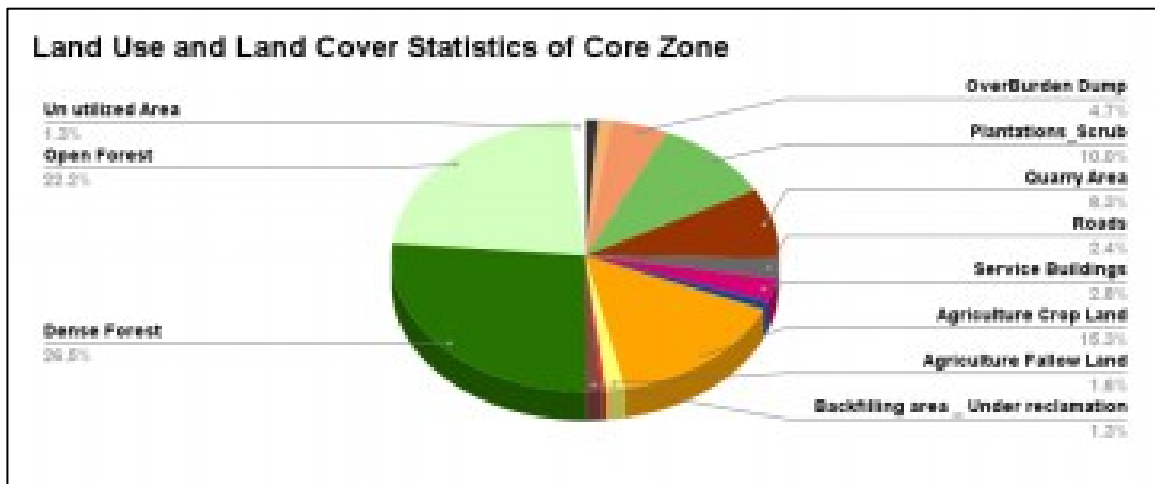
ODISHA COAL AND POWER LTD

Prepared By:



GEOSYS ENTERPRISE SOLUTIONS PRIVATE LIMITED
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Fig 6 Land Use/ Land Cover pattern map of the Core Zone



Pie chart of Fig 7: Land use Land Cover details of Core zone

Accuracy Assessment

The classified land use/land cover types were validated with the help of an extensive Trimble Catalyst aided field survey. The ground reference data were compared with the classified map and the accuracy was quantitatively assessed. The overall accuracy of the classified map was calculated using the following formula (Rashid et al., 2013):

$$p = \frac{n}{N} \times 100$$

Where p is the Classification accuracy.

n is the number of Points correctly classified in the Image.

N of points checked in the field.

7. Topography

1) Source of Information

Survey of India Toposheets F44L12, F44L16, F44R9 and F44R13 has been used for the topography studies. In topography map of buffer zone contours, drainage pattern, Roads, settlements, water bodies and forest boundaries has been shown.

2) Study Results

The 10km buffer zone from the core zone boundary i.e. mine lease area of Manoharpur Coal Mine Project is mostly plain area, the elevation values range between -200m to 480m. There is hilly terrain in the South - East and South - West parts of the buffer zone.

The buffer zone covers the reserved forests namely Garjanpaharh Reserve Forest and Punjipaharh Reserve Forest. Balijori Reserve Forest, Makarachata Reserve Forest, Chhengapahar Reserve Forest and Basundhara River are passing through the buffer zone.

The buffer zone is covered with 1- 4th order streams.

Hemgir and Kanika are the major Settlements that are covered in the 10km buffer zone. The South- East Railway main line is passing in the buffer zone.

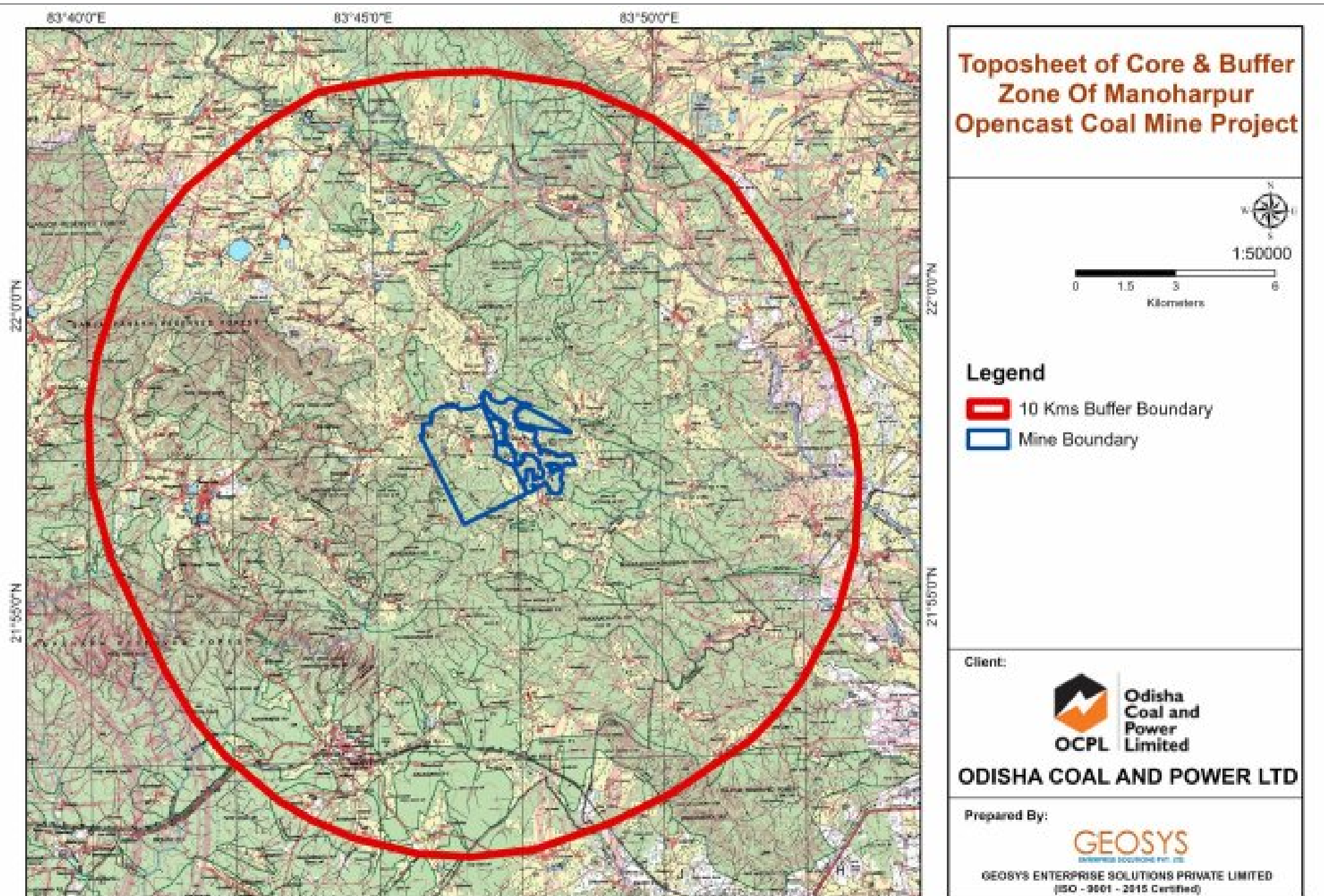
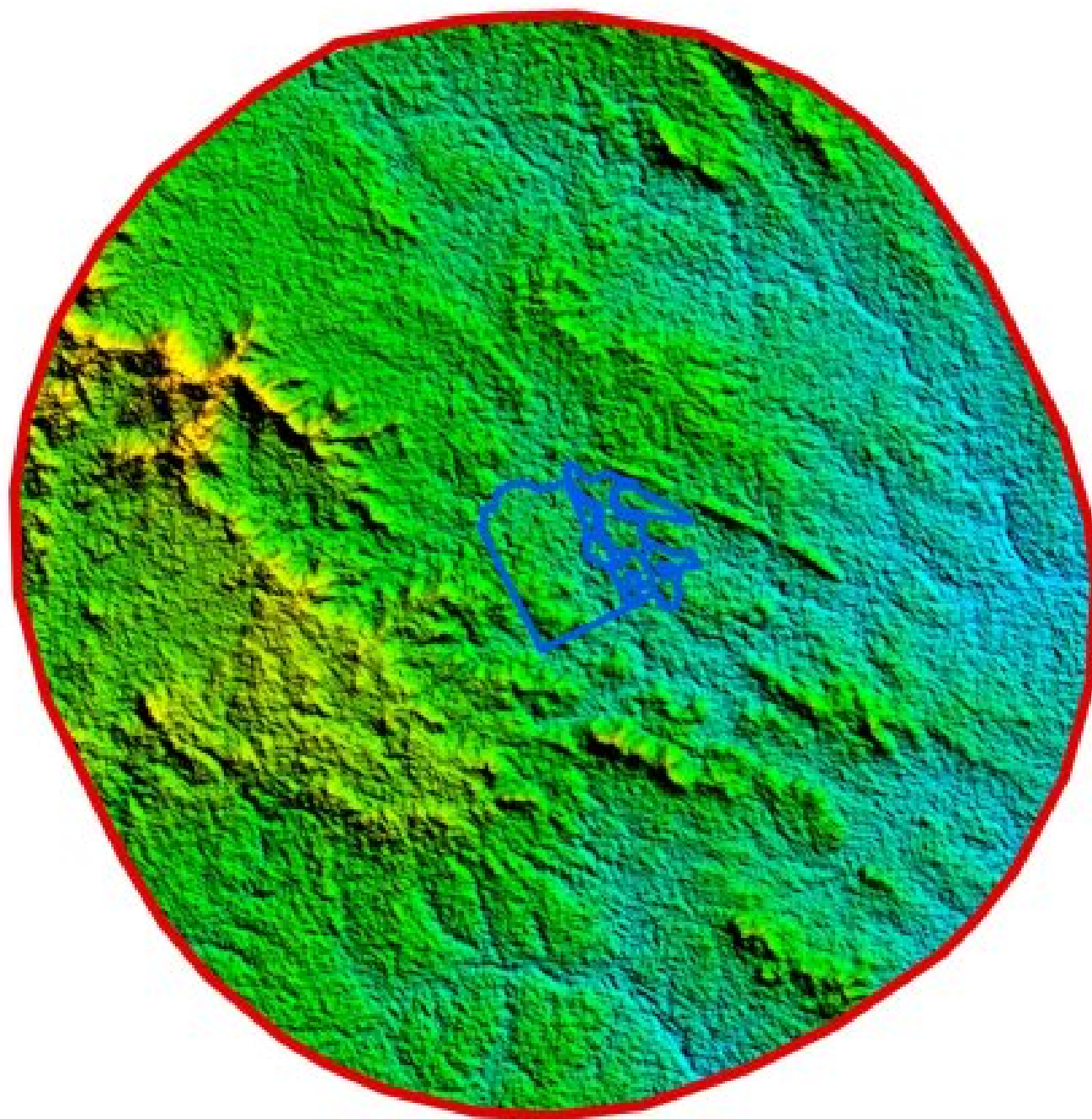


Fig 7 Toposheet of Core & Buffer Zone

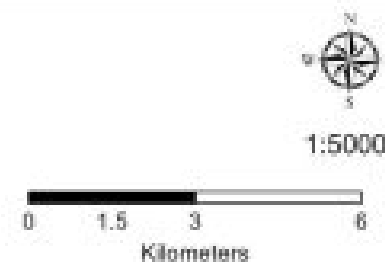
83°40'0"E 83°45'0"E 83°50'0"E

22°0'0"N

21°55'0"N



Digital Elevation Model Of Core & Buffer Zone Of Manoharpur Coal Mine Project



Legend

— Mine Boundary

Client:



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Prepared By:

GEO SYS
ENTERPRISE SOLUTIONS PVT. LTD.

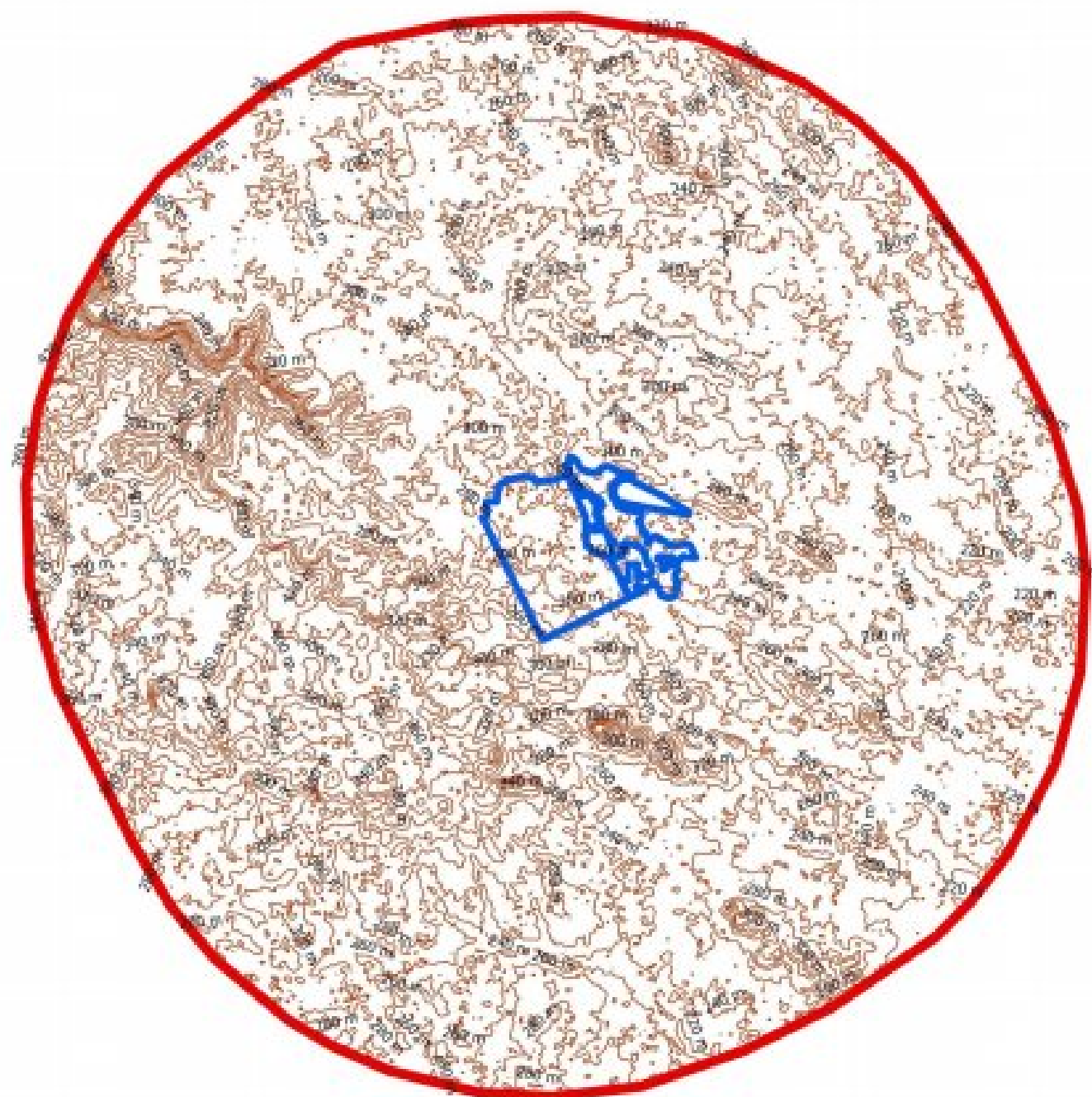
GEO SYS ENTERPRISE SOLUTIONS PRIVATE LIMITED
(ISO - 9001 - 2015 Certified)

Fig 8 : DEM For Core & Buffer Zone

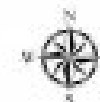
83°40'0"E

83°45'0"E

83°50'0"E



Contour Map of Core & Buffer Zone Of Manoharpur Coal Mine Project



1:25000



Contour Interval 20 meters

Legend

- Mine Boundary
- 10 Kms Buffer Boundary
- Contours

Client:



**Odisha
Coal and
Power
Limited**

ODISHA COAL AND POWER LTD

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ENTERPRISE SOLUTIONS PRIVATE LIMITED

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Fig 9 : Contour Map Of Core & Buffer Zone With 20 Meter

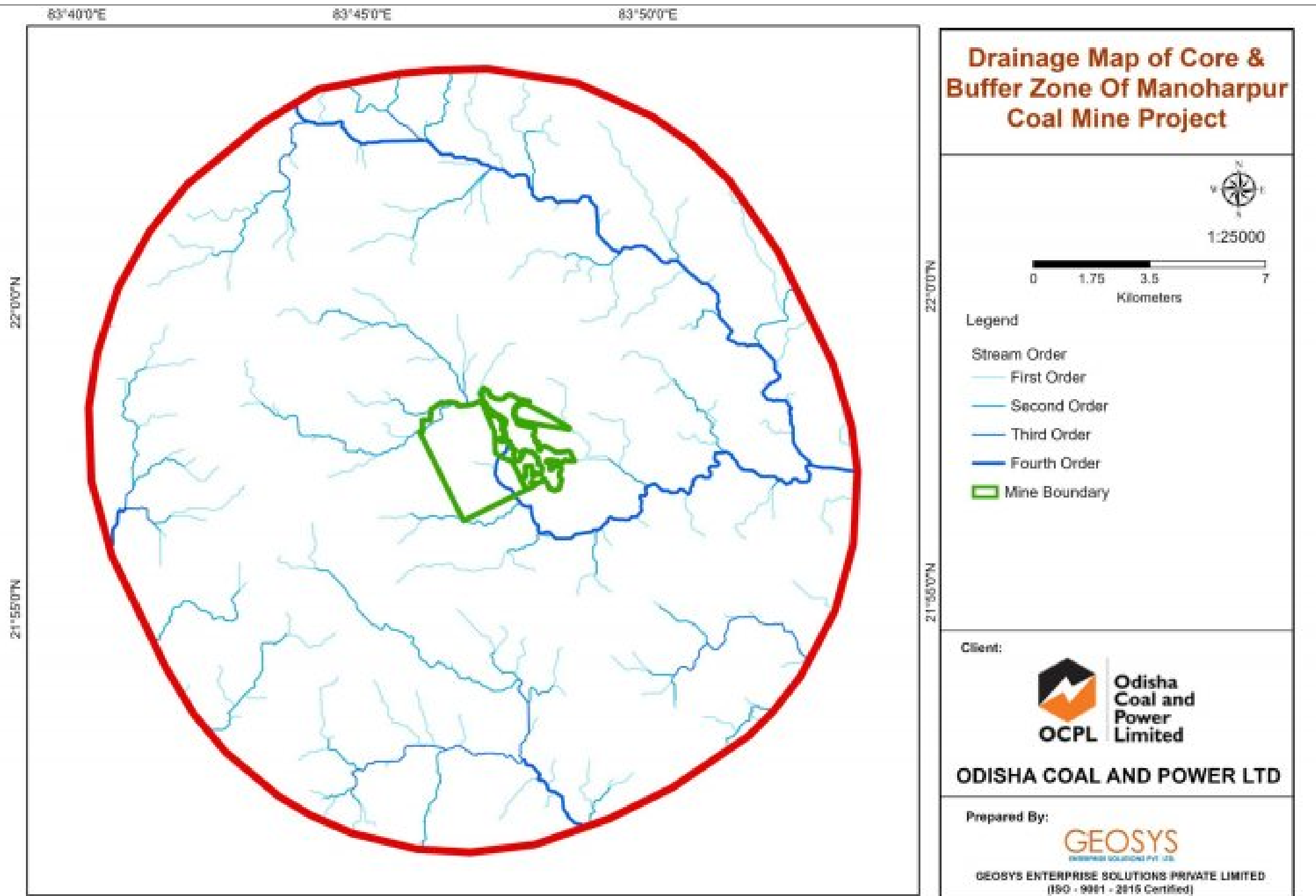
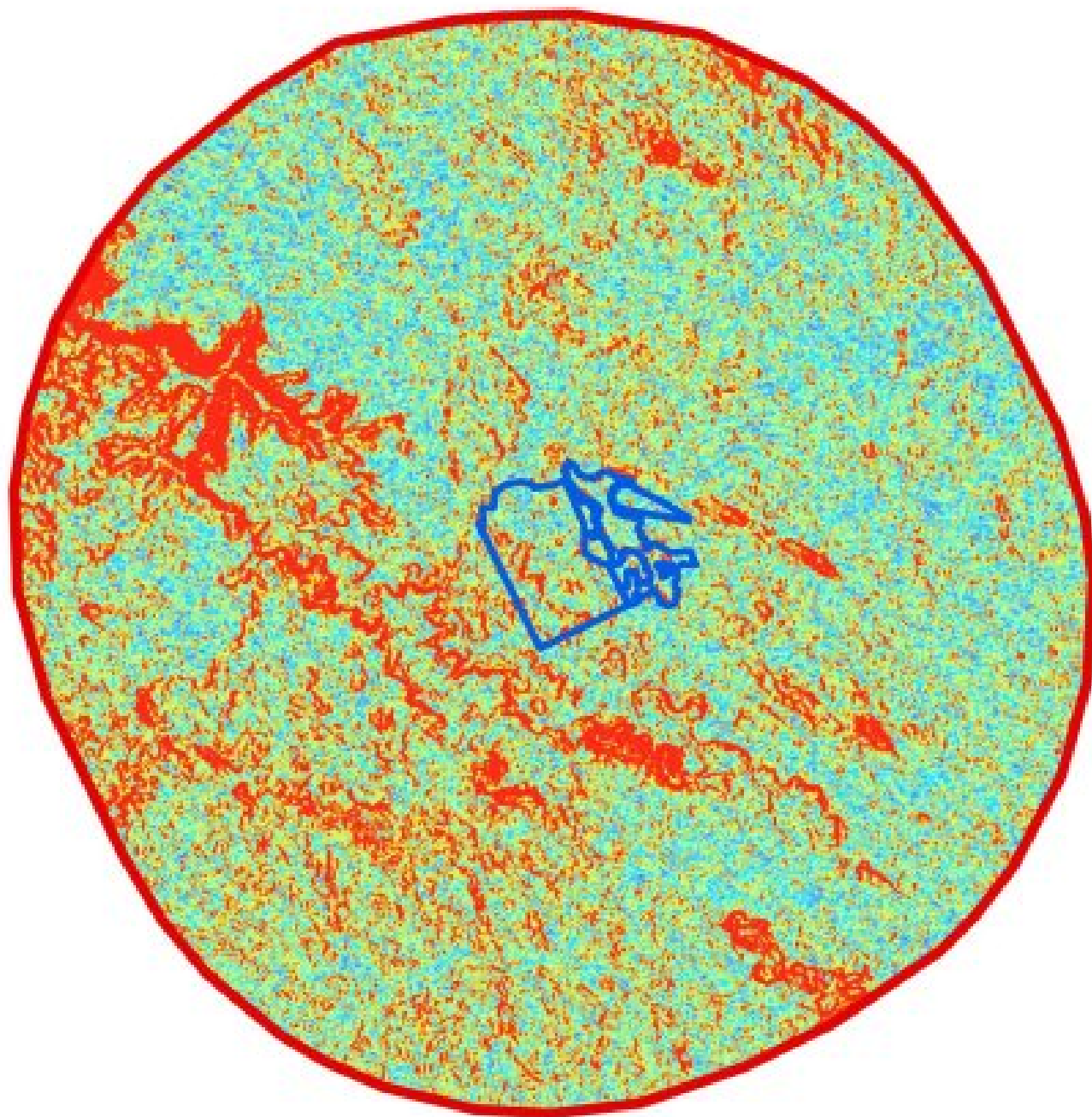


Fig 10 : Drainage Map Of The Core & Buffer Zone

83°40'0"E 83°45'0"E 83°50'0"E

22°0'0"N

21°55'0"N



Slope Model Of Core & Buffer Zone Of Manoharpur Coal Mine Project



Legend

-  Mine Boundary
-  10 Kms Buffer Boundary

Client:



ODISHA COAL AND POWER LTD

Prepared By:



GEOSYS ENTERPRISE SOLUTIONS PRIVATE LIMITED
(ISO - 9001 - 2015 Certified)

Fig 11 : Slope of Core & Buffer Zone

Boundary Coordinates

The geographic coordinates of the boundary have been collected with Trimble Catalyst. The Coordinates of the Mine Boundary GCPs are shown below.

Buffer Area					
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
1	21.90015	83.68929	26	21.88523	83.86598
2	21.93073	83.67411	27	21.87866	83.8587
3	21.95126	83.66852	28	21.86499	83.8362
4	21.97124	83.66809	29	21.85694	83.81776
5	21.98618	83.67092	30	21.85021	83.7959
6	22.00363	83.67728	31	21.84843	83.77713
7	22.01888	83.68676	32	21.84954	83.76162
8	22.03155	83.69806	33	21.8542	83.74273
9	22.04755	83.71985	34	21.85932	83.7307
10	22.05668	83.73663	35	21.86458	83.72155
11	22.05809	83.7454	36	21.87683	83.70632
12	22.06057	83.76079	37	21.88736	83.69719
13	22.06124	83.77084	26	21.88523	83.86598
14	22.0614	83.78615	27	21.87866	83.8587
15	22.0571	83.81228	28	21.86499	83.8362
16	22.04777	83.8338	29	21.85694	83.81776
17	22.03967	83.84561	30	21.85021	83.7959
18	22.02985	83.85611	31	21.84843	83.77713
19	22.01019	83.87002	32	21.84954	83.76162
20	21.97951	83.88535	33	21.8542	83.74273
21	21.96233	83.89049	34	21.85932	83.7307
22	21.95003	83.89188	35	21.86458	83.72155
23	21.93038	83.89034	36	21.87683	83.70632
24	21.91227	83.8846	37	21.88736	83.69719
25	21.89458	83.87414			

Core Area Part-1								
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
1	21.95697	83.78643	26	21.97065	83.7755	51	21.96261	83.78632
2	21.95697	83.78643	27	21.97005	83.77568	52	21.96261	83.78632
3	21.95573	83.7882	28	21.96984	83.77617	53	21.95697	83.78643
4	21.95573	83.7882	29	21.96984	83.77617			
5	21.9546	83.7912	30	21.97017	83.77989			
6	21.94674	83.7952	31	21.97121	83.78255			
7	21.94674	83.7952	32	21.97053	83.78081			
8	21.94674	83.7952	33	21.97121	83.78255			
9	21.94674	83.7952	34	21.97121	83.78255			
10	21.93868	83.77676	35	21.97121	83.78255			
11	21.93868	83.77676	36	21.97121	83.78255			
12	21.93868	83.77676	37	21.96261	83.78632			
13	21.93868	83.77676	38	21.96261	83.78632			
14	21.93868	83.77676	39	21.96261	83.78632			
15	21.93868	83.77676	40	21.96261	83.78632			
16	21.96302	83.76445	41	21.96261	83.78632			
17	21.96302	83.76445	42	21.96261	83.78632			
18	21.96302	83.76445	43	21.96261	83.78632			
19	21.96302	83.76445	44	21.96261	83.78632			
20	21.96306	83.76535	45	21.96261	83.78632			
21	21.96618	83.76533	46	21.96261	83.78632			
22	21.96616	83.76758	47	21.96261	83.78632			
23	21.96915	83.76799	48	21.96261	83.78632			
24	21.97051	83.77029	49	21.96261	83.78632			
25	21.97101	83.77342	50	21.96261	83.78632			

Core Area Part-2					
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
1	21.96338	83.78841	34	21.96095	83.78649
2	21.96331	83.78842	35	21.96112	83.78635
3	21.96322	83.78848	36	21.96112	83.78635
4	21.9626	83.78886	37	21.96112	83.78635
5	21.96182	83.78922	38	21.96112	83.78635
6	21.96168	83.78926	39	21.96261	83.78632
7	21.9615	83.78928	40	21.96261	83.78632
8	21.96136	83.78927	41	21.96261	83.78632
9	21.96128	83.78924	42	21.96708	83.78436
10	21.9612	83.78917	43	21.96708	83.78436
11	21.96118	83.78907	44	21.96708	83.78436
12	21.96118	83.78894	45	21.96709	83.78508
13	21.9611	83.78863	46	21.96713	83.78549
14	21.96112	83.78838	47	21.96699	83.78614
15	21.96085	83.78844	48	21.96716	83.78626
16	21.96091	83.78815	49	21.96705	83.78677
17	21.96075	83.78809	50	21.96701	83.78733
18	21.96062	83.78811	51	21.96668	83.78763
19	21.96058	83.78823	52	21.966	83.78783
20	21.96057	83.78834	53	21.96599	83.7883
21	21.96036	83.78852	54	21.96597	83.78888
22	21.96013	83.78861	55	21.9658	83.7888
23	21.95997	83.78833	56	21.96551	83.7888
24	21.96017	83.78818	57	21.96528	83.78876
25	21.96046	83.78811	58	21.96498	83.78878
26	21.96051	83.78797	59	21.96488	83.78852
27	21.96042	83.78797	60	21.96479	83.78857
28	21.96054	83.78745	61	21.96458	83.78857
29	21.96033	83.78745	62	21.96454	83.78875
30	21.96083	83.78713	63	21.96423	83.7887
31	21.96073	83.78687	64	21.96365	83.78844
32	21.96075	83.78668			
33	21.96086	83.78654			

Core Area Part-3								
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
1	21.95036	83.79336	42	21.95076	83.79967	81	21.9543	83.79906
2	21.95039	83.79343	43	21.95092	83.7997	82	21.95444	83.79891
3	21.95028	83.79352	44	21.95101	83.79972	83	21.9545	83.79887
4	21.95031	83.794	45	21.95108	83.79971	84	21.95459	83.7988
5	21.95022	83.79413	46	21.95112	83.7997	85	21.95461	83.79878
6	21.95016	83.79424	47	21.95122	83.79974	86	21.95464	83.79879
7	21.95014	83.79427	48	21.95134	83.79979	87	21.95467	83.7988
8	21.95016	83.79435	49	21.95137	83.7998	88	21.95469	83.79883
9	21.95011	83.79436	50	21.95158	83.79989	89	21.9547	83.79886
10	21.9501	83.7944	51	21.95167	83.79995	90	21.9547	83.79889
11	21.95007	83.79454	52	21.95171	83.8	91	21.95471	83.79891
12	21.95001	83.79456	53	21.95187	83.80001	92	21.95471	83.79891
13	21.95006	83.79468	54	21.95196	83.8	93	21.95472	83.79892
14	21.9501	83.7947	55	21.9521	83.79999	94	21.95473	83.79892
15	21.95023	83.79477	56	21.9522	83.8	95	21.95483	83.79891
16	21.95028	83.79472	57	21.95238	83.80005	96	21.95492	83.79889
17	21.95037	83.79476	58	21.95243	83.80007	97	21.95498	83.79887
18	21.95026	83.79516	59	21.95252	83.80006	98	21.95508	83.79883
19	21.95039	83.79515	60	21.95261	83.80004	99	21.95549	83.79882
20	21.95052	83.79511	61	21.95277	83.79997	100	21.95549	83.79882
21	21.95062	83.79504	62	21.95282	83.79995	101	21.9555	83.79881
22	21.95067	83.79496	63	21.95285	83.79994	102	21.9555	83.79881
23	21.95089	83.79512	64	21.953	83.79984	103	21.9555	83.79881
24	21.9532	83.79511	65	21.95301	83.79982	104	21.95551	83.7988
25	21.95322	83.79706	66	21.95321	83.79967	105	21.95551	83.7988
26	21.95055	83.79705	67	21.95342	83.79949	106	21.95551	83.79879
27	21.95057	83.7972	68	21.95341	83.79942	107	21.95551	83.79879
28	21.95058	83.79729	69	21.95343	83.79939	108	21.95551	83.79874
29	21.95058	83.7974	70	21.95347	83.79931	109	21.95548	83.79867
30	21.95054	83.79762	71	21.95348	83.79927	110	21.95551	83.79857
31	21.95055	83.7978	72	21.9535	83.7992	111	21.95549	83.79848
32	21.95097	83.79784	73	21.95354	83.79911	112	21.95549	83.79843
33	21.9512	83.79778	74	21.9536	83.79902	113	21.95555	83.79839
34	21.95133	83.79798	75	21.95366	83.79898	114	21.95561	83.79835
35	21.95124	83.79813	76	21.95371	83.79897	115	21.95568	83.79831
36	21.95109	83.79856	77	21.95374	83.79896	116	21.95574	83.79828
37	21.95094	83.79916	78	21.95378	83.79897	117	21.95577	83.79826
38	21.95093	83.79923	79	21.95404	83.79907	118	21.95584	83.79822
39	21.95094	83.79956	80	21.95427	83.79907	119	21.95588	83.79818
40	21.95075	83.79961	42	21.95076	83.79967	120	21.95593	83.7982

Core Area Part-3								
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
121	21.95601	83.79822	161	21.95752	83.79506	221	21.95758	83.79236
122	21.95609	83.79824	162	21.9575	83.79501	222	21.95758	83.79236
123	21.9561	83.79824	163	21.95746	83.79496	223	21.95762	83.79234
124	21.95611	83.79823	164	21.95742	83.79496	224	21.95772	83.79219
125	21.95618	83.79814	165	21.95739	83.79489	225	21.95773	83.79204
126	21.95624	83.79809	166	21.95737	83.79483	226	21.958	83.79167
127	21.95629	83.79801	167	21.95737	83.79481	227	21.958	83.79159
128	21.95633	83.79796	168	21.95737	83.79472	228	21.95799	83.79148
129	21.95635	83.79791	169	21.95738	83.79455	229	21.95796	83.79118
130	21.9564	83.79782	170	21.95738	83.79451	230	21.95811	83.79121
131	21.95642	83.79777	171	21.9574	83.79448	231	21.95817	83.79123
132	21.95646	83.79768	172	21.95738	83.79443	232	21.9582	83.79127
133	21.95651	83.79754	173	21.95707	83.79387	233	21.95826	83.79135
134	21.95656	83.79745	174	21.95704	83.79385	234	21.95831	83.79141
135	21.95661	83.79738	175	21.95699	83.79386	235	21.95838	83.79141
136	21.95668	83.79734	176	21.95692	83.79387	236	21.95844	83.7914
137	21.95676	83.7973	177	21.95681	83.79386	237	21.95852	83.79135
138	21.95688	83.79727	178	21.95677	83.7939	238	21.95858	83.79138
139	21.95704	83.79722	179	21.95674	83.79393	239	21.9586	83.79142
140	21.95708	83.79709	180	21.95667	83.79394	240	21.95871	83.79142
141	21.95709	83.797	181	21.95661	83.79394	241	21.95872	83.7913
142	21.95709	83.79693	182	21.95658	83.79394	242	21.95881	83.79128
143	21.95709	83.7968	183	21.95654	83.79397	243	21.9588	83.79083
144	21.95709	83.79671	184	21.9565	83.79401	244	21.95907	83.79077
145	21.95709	83.79664	185	21.95649	83.79407	245	21.95934	83.79077
146	21.95707	83.79654	186	21.95647	83.79411	246	21.9598	83.79082
147	21.95707	83.79645	187	21.95646	83.7943	247	21.95982	83.79057
148	21.95707	83.79643	188	21.95646	83.79434	248	21.95999	83.79049
149	21.9571	83.79629	189	21.95647	83.79447	249	21.95999	83.79036
150	21.95719	83.79609	190	21.95636	83.79454	250	21.96013	83.79031
151	21.95723	83.796	191	21.95619	83.79447	251	21.96008	83.79023
152	21.95724	83.79592	192	21.95576	83.7943	252	21.96012	83.7899
153	21.95727	83.79571	193	21.9556	83.79424	253	21.95998	83.78985
154	21.95729	83.79563	194	21.95558	83.79379	254	21.96001	83.78966
155	21.95735	83.79554	195	21.95491	83.79364	255	21.96012	83.78974
156	21.95741	83.79543	196	21.95481	83.79357	256	21.96051	83.78972
157	21.95747	83.79528	197	21.95476	83.79343	257	21.96106	83.78973
158	21.95751	83.7952	198	21.95475	83.79328	258	21.96182	83.78959
159	21.95753	83.79515	199	21.95475	83.79315	259	21.96249	83.78957
160	21.95753	83.79512	200	21.95475	83.79309	260	21.96322	83.78895

Core Area Part-3								
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
261	21.96445	83.78953	301	21.97396	83.78289	381	21.96204	83.79772
262	21.96505	83.78968	302	21.97462	83.78326	382	21.96186	83.79772
263	21.96515	83.78977	303	21.9746	83.7835	383	21.96175	83.7976
264	21.96539	83.78979	304	21.97444	83.78357	384	21.9617	83.79757
265	21.9657	83.78977	305	21.97424	83.78382	385	21.96168	83.79754
266	21.96665	83.78857	306	21.97417	83.78428	386	21.96165	83.79753
267	21.9671	83.78777	307	21.97369	83.78485	387	21.96164	83.79751
268	21.96732	83.78712	308	21.97308	83.78492	388	21.96161	83.7975
269	21.96783	83.78636	309	21.9723	83.78553	389	21.96158	83.79748
270	21.96832	83.78577	310	21.9723	83.78553	390	21.96153	83.79748
271	21.96844	83.78541	311	21.9723	83.78553	391	21.96149	83.7975
272	21.96958	83.78444	312	21.9723	83.78553	392	21.96141	83.79756
273	21.97043	83.784	313	21.9723	83.78553	393	21.96135	83.79767
274	21.97143	83.78297	314	21.9723	83.78553	394	21.96132	83.7977
275	21.97166	83.78281	315	21.9723	83.78553	395	21.96128	83.79772
276	21.97231	83.78304	316	21.9723	83.78553	396	21.9612	83.79778
277	21.97244	83.78297	317	21.97218	83.78579	397	21.96108	83.79787
278	21.97243	83.78279	318	21.97218	83.78579	398	21.96098	83.79796
279	21.97281	83.78249	319	21.97203	83.78611	399	21.96096	83.79798
280	21.97304	83.78229	320	21.97182	83.78663	400	21.96084	83.79806
281	21.97316	83.78246	321	21.97182	83.78663	401	21.96082	83.79808
282	21.97305	83.78268	322	21.97182	83.78663	402	21.9608	83.7981
283	21.97326	83.78271	323	21.97182	83.78663	403	21.96077	83.79814
284	21.97326	83.78291	324	21.97182	83.78663	404	21.96071	83.7982
285	21.97326	83.78291	325	21.97182	83.78663	405	21.9607	83.7982
286	21.97326	83.78291	326	21.97172	83.78674	406	21.96061	83.79815
287	21.97336	83.78296	327	21.97169	83.78682	407	21.96053	83.79808
288	21.97336	83.78296	328	21.97163	83.78701	408	21.96049	83.79804
289	21.97336	83.78296	329	21.97161	83.78742	409	21.96045	83.79803
290	21.97336	83.78296	330	21.97161	83.78751	410	21.96037	83.79799
291	21.97336	83.78296	331	21.97158	83.78762	411	21.96033	83.79803
292	21.97345	83.78306	332	21.97147	83.78823	412	21.96029	83.79818
293	21.97371	83.78311	333	21.97152	83.7884	413	21.96015	83.79826
294	21.97387	83.78324	334	21.97157	83.78869	414	21.96002	83.79819
295	21.9739	83.78339	335	21.97166	83.78913	415	21.95993	83.79815
296	21.97403	83.78348	336	21.97166	83.78916	416	21.95984	83.79806
297	21.9741	83.78336	337	21.97165	83.7892	417	21.95982	83.79805
298	21.97413	83.78328	338	21.9724	83.78986	418	21.95981	83.79805
299	21.97414	83.78317	339	21.9724	83.78986	419	21.9598	83.79806
300	21.97389	83.783	340	21.9724	83.78986	420	21.95979	83.79807

Core Area Part-3								
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
421	21.95967	83.79845	461	21.95446	83.80889	501	21.95382	83.80212
422	21.95949	83.79911	462	21.95427	83.8088	502	21.95379	83.8022
423	21.95913	83.799	463	21.95436	83.8083	503	21.95375	83.80225
424	21.95867	83.79891	464	21.95431	83.8083	504	21.9537	83.80239
425	21.95865	83.79914	465	21.9544	83.80735	505	21.95367	83.80244
426	21.95833	83.79938	466	21.95439	83.80692	506	21.95361	83.80246
427	21.95751	83.79913	467	21.9547	83.80689	507	21.95333	83.80244
428	21.95745	83.79939	468	21.9547	83.80686	508	21.95301	83.80241
429	21.95745	83.79962	469	21.95458	83.80675	509	21.95291	83.80228
430	21.95767	83.79971	470	21.95443	83.80669	510	21.95288	83.80228
431	21.95807	83.79982	471	21.95438	83.80637	511	21.95266	83.80229
432	21.95822	83.79996	472	21.95436	83.80621	512	21.95258	83.8023
433	21.95829	83.80012	473	21.9543	83.80621	513	21.95242	83.80231
434	21.95831	83.80018	474	21.95421	83.8061	514	21.95228	83.8023
435	21.95834	83.80026	475	21.95414	83.80615	515	21.95213	83.80228
436	21.95839	83.80038	476	21.95384	83.80577	516	21.9521	83.80231
437	21.95844	83.80047	477	21.95369	83.80553	517	21.95211	83.80234
438	21.95849	83.80054	478	21.9539	83.80443	518	21.95207	83.80242
439	21.95852	83.8006	479	21.95412	83.80452	519	21.9521	83.80246
440	21.95855	83.80068	480	21.95443	83.80455	520	21.95216	83.80247
441	21.95855	83.80075	481	21.95443	83.80455	521	21.95228	83.80271
442	21.95855	83.80084	482	21.95424	83.80398	522	21.95225	83.80276
443	21.95854	83.80093	483	21.95436	83.80394	523	21.95226	83.80278
444	21.95837	83.80135	484	21.95455	83.80383	524	21.95226	83.80299
445	21.95807	83.80198	485	21.95459	83.80367	525	21.9522	83.80306
446	21.95778	83.80253	486	21.95443	83.80361	526	21.9522	83.80309
447	21.95741	83.80328	487	21.95457	83.80325	527	21.95223	83.80312
448	21.95716	83.80365	488	21.95468	83.80289	528	21.95228	83.80312
449	21.95689	83.80402	489	21.95468	83.80289	529	21.95237	83.80314
450	21.95683	83.80422	490	21.9547	83.80245	530	21.9526	83.80324
451	21.95682	83.80539	491	21.95467	83.80199	531	21.95292	83.80338
452	21.95701	83.80741	492	21.95465	83.80167	532	21.95302	83.80343
453	21.95701	83.80788	493	21.9546	83.80146	533	21.95302	83.80348
454	21.95698	83.808	494	21.95434	83.8013	534	21.95301	83.80354
455	21.95674	83.80831	495	21.95413	83.80134	535	21.95297	83.80363
456	21.95663	83.80839	496	21.95403	83.80157	536	21.95292	83.80375
457	21.95624	83.80856	497	21.95391	83.80186	537	21.9529	83.80382
458	21.95588	83.80872	498	21.9539	83.8019	538	21.95289	83.80421
459	21.95552	83.80888	499	21.95389	83.80195	539	21.95342	83.8044
460	21.95433	83.80953	500	21.95387	83.80204	540	21.95354	83.80439

Core Area Part-4								
GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude	GCP_ID	Longitude	Latitude
1	21.96883	83.79271	26	21.96914	83.79756	51	21.96546	83.79446
2	21.96897	83.7928	27	21.96914	83.79756	52	21.96547	83.79442
3	21.9691	83.7929	28	21.96914	83.79756	53	21.96568	83.79392
4	21.9692	83.79299	29	21.96774	83.80042	54	21.96539	83.79371
5	21.96929	83.79309	30	21.9676	83.80069	55	21.96553	83.79351
6	21.96941	83.79319	31	21.9675	83.8009	56	21.96567	83.79336
7	21.96953	83.79331	32	21.96746	83.801	57	21.96572	83.79331
8	21.96964	83.79344	33	21.96656	83.80279	58	21.966	83.79308
9	21.96974	83.79361	34	21.96548	83.80465	59	21.96617	83.79292
10	21.96988	83.79391	35	21.96548	83.80465	60	21.96624	83.79287
11	21.96995	83.79409	36	21.96548	83.80465	61	21.96636	83.7928
12	21.97004	83.79435	37	21.96334	83.8082	62	21.96639	83.79277
13	21.97008	83.79459	38	21.96291	83.80805	63	21.96655	83.79269
14	21.97011	83.79482	39	21.96326	83.80626	64	21.96678	83.79258
15	21.9701	83.79534	40	21.96392	83.802	65	21.96679	83.79257
16	21.97008	83.7956	41	21.96435	83.79964	66	21.96682	83.79256
17	21.97006	83.79574	42	21.96478	83.79756	67	21.96685	83.79255
18	21.97	83.79596	43	21.9648	83.79746	68	21.96706	83.7925
19	21.96999	83.79603	44	21.96481	83.79738	69	21.9673	83.79246
20	21.96994	83.79613	45	21.96492	83.79679	70	21.96769	83.79241
21	21.96983	83.79636	46	21.96497	83.79655	71	21.96791	83.79238
22	21.96972	83.79654	47	21.96507	83.79595	72	21.96803	83.79238
23	21.96964	83.79667	48	21.96531	83.79495	73	21.96814	83.79239
24	21.96914	83.79756	49	21.96531	83.79495	74	21.96823	83.79242
25	21.96914	83.79756	50	21.96534	83.79481	75	21.96839	83.79249
						76	21.96873	83.79264

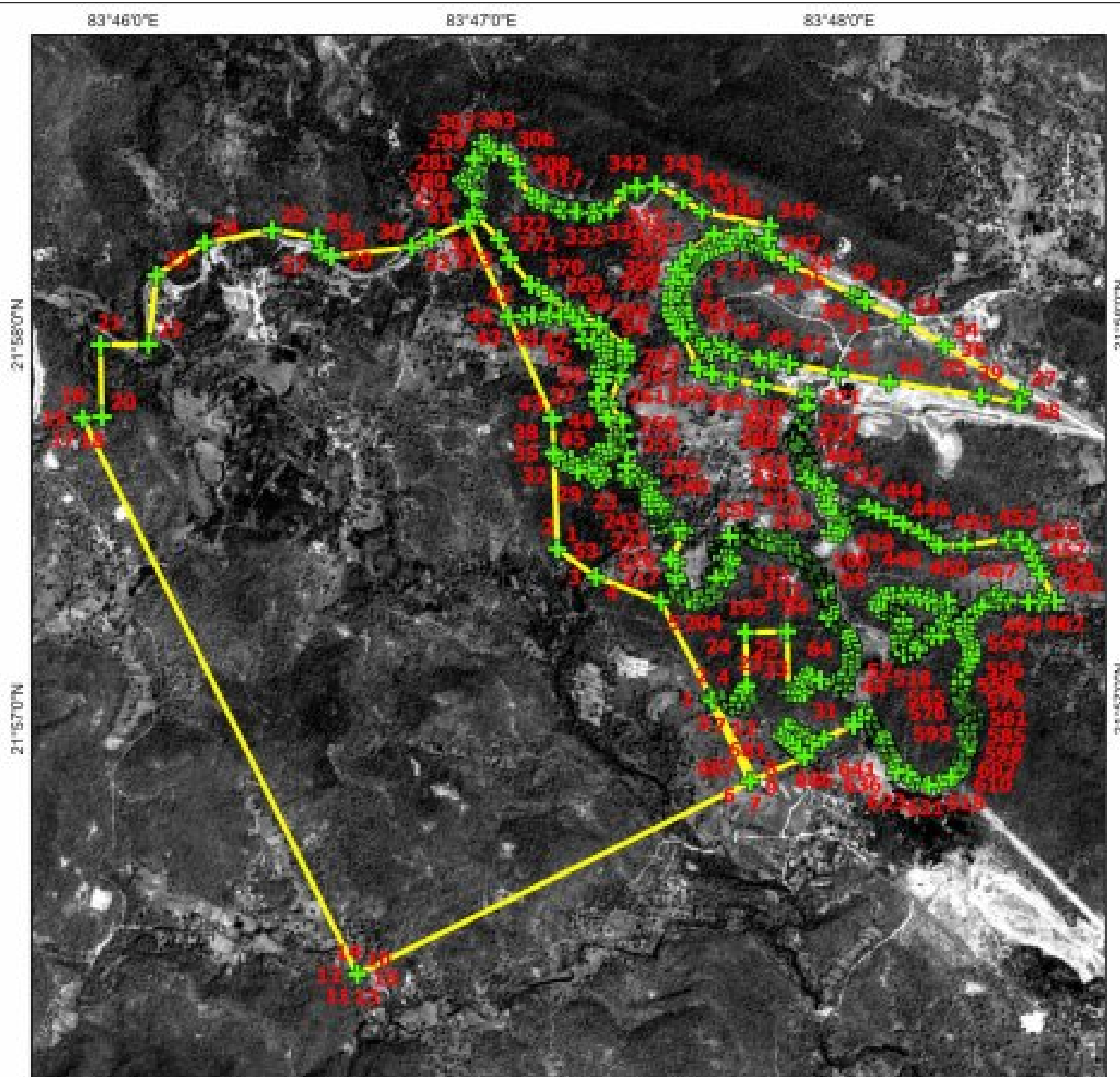
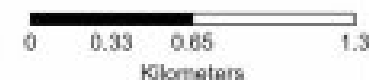


Fig 13 GCPs on Mine Boundary

GCPs on Mine Boundary of Manoharpur Coal Mine Project



1:5000



Legend

- + Ground Control Points
- Mine Boundary

Client:



**Odisha
Coal and
Power
Limited**

ODISHA COAL AND POWER LTD

Prepared By:

GEO SYS
ENTERPRISE SOLUTIONS PVT. LTD.

GEO SYS ENTERPRISE SOLUTIONS PRIVATE LIMITED
(ISO - 9001 - 2015 Certified)

Site Photographs



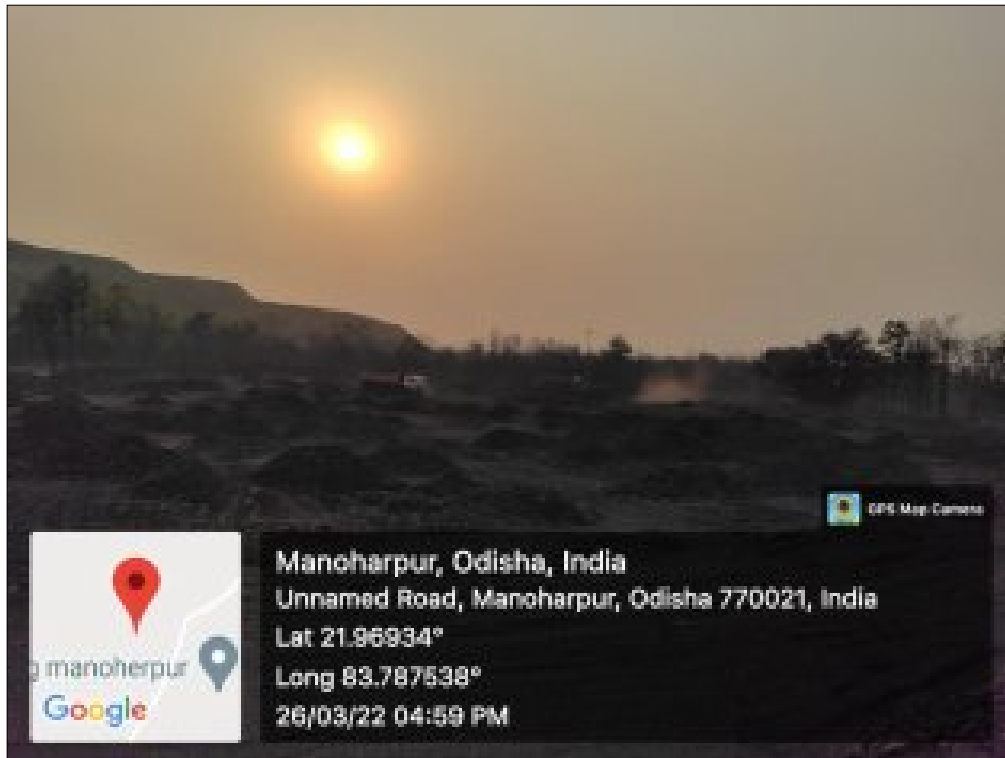
Agriculture area

Lat: 21.963502° Long: 83.770761°



Coal Stock 1

Lat: 21.966961° Long: 83.785354°



Coal Stock 2

Lat: 21.96934° Long: 83.787538°



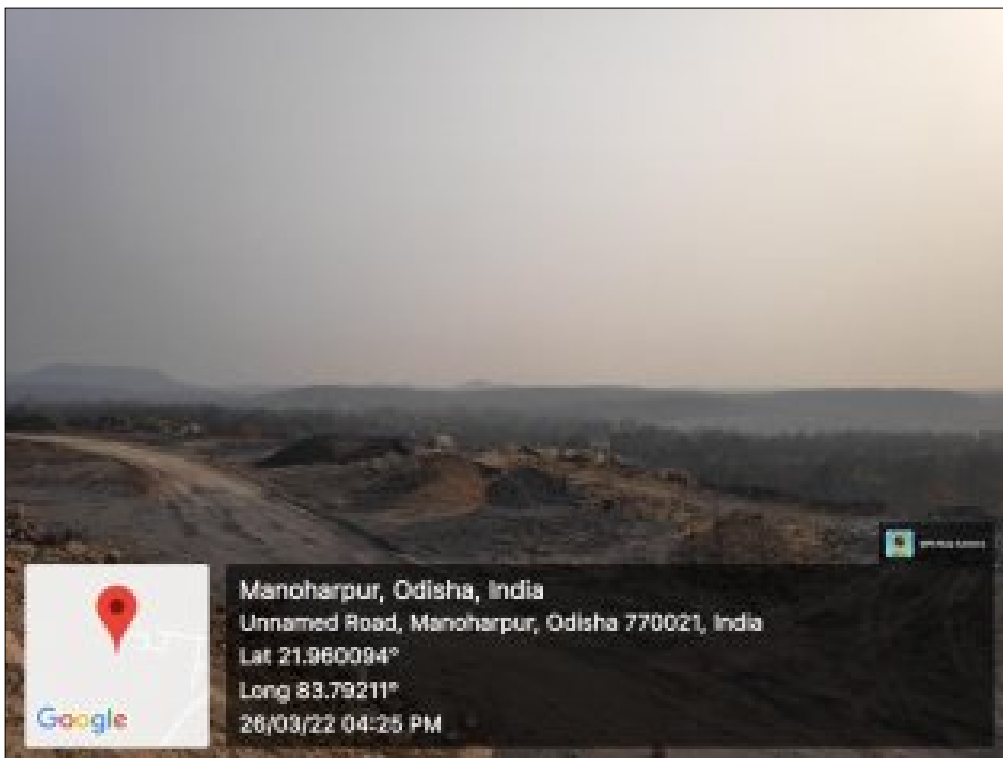
Coal Stock 3

Lat: 21.960193° Long: 83.787537°



External Dump1

Lat: 21.967638° Long: 83.782809°



External Dump2

Lat: 21.960094° Long: 83.79211°



Forest

Lat: 21.956859° Long: 83.778596°



Internal Dump

Lat: 21.969021° Long: 83.773126°



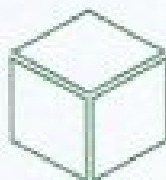
Quarry Area

Lat: 21.968976° Long: 83.773131°



Service Building

Lat: 21.96799° Long: 83.789498°



Ref: Envlab/22/R-0549

ANNEXURE 6

Date: 08.04.2022

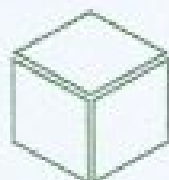
AAQ MONITORING REPORT FOR MARCH-2022(CORE ZONE)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sampling Location : AAQMS-1:Near OB Dump-II
5. Location Co-ordinates : 21° 56' 57.6996" N, 83° 47' 46.1436" E
6. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m ³)
09.03.2022	24 hrs.	246.0	141.0	74.8	24.3	33.8	0.77
22.03.2022	24 hrs.	261.0	152.0	81.5	21.6	31.2	0.65
As per MoEF & CC Standard Notification no. GSR 742 (E) for Coal mine		500	250	--	120	120	--
NAAQ Standard		--	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Geake Method IS 5182 (Part-2) RA 2017	Modified Jacob & Hochheiser Method IS 5182 (Part-4) RA 2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$





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Food Lab
Material Lab
Soil Lab
Mineral Lab
&
Microbiology Lab

Ref: Envlab/22/R-0550

Date: 08.04.2022

AAQ MONITORING REPORT FOR MARCH-2022 (CORE ZONE)

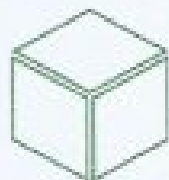
1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sampling Location : AAQMS-2:Near OB Dump-I
5. Location Co-ordinates : 21° 57' 46.71" N, 83° 47' 5.352" E
6. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m^3)
07.03.2022	24 hrs.	253.0	143.0	76.6	20.8	31.2	0.81
21.03.2022	24 hrs.	229.0	128.0	67.3	19.5	27.6	0.74
As per MoEF & CC Standard Notification no. GSR 742 (E) for Coal mine		500	250	—	120	120	—
NAAQ Standard		—	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Geake Method IS 5182 (Part-2) RA 2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA 2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$



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Food Lab
Material Lab
Soil Lab
Mineral Lab
&
Microbiology Lab

Ref:Envlab/22/R-0551

Date:08.04.2022

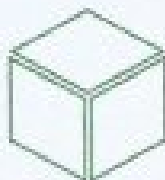
AAQ MONITORING REPORT FOR MARCH-2022 (CORE ZONE)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sampling Location : AAQMS-3: CHP OCPL Office
5. Location Co-ordinates : 21° 58' 4.782" N, 83° 47' 56.0616" E
6. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m^3)
07.03.2022	24 hrs.	278.0	167.0	93.0	29.2	35.3	0.82
21.03.2022	24 hrs.	259.0	146.0	78.0	25.7	36.8	0.88
As per MoEF & CC Standard Notification no. GSR 742 (E) for Coal mine		500	250	—	120	120	—
NAAQ Standard		—	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Geake Method IS 5182 (Part-2) RA 2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA 2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$





Ref: Envlab/22/R-0552

Date:08.04.2022

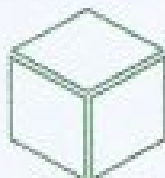
AAQ MONITORING REPORT FOR MARCH-2022 (CORE ZONE)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sampling Location : AAQMS-4:Near Mine Pit Area
5. Location Co-ordinates : 21° 57' 18.97121° N, 83° 46' 47.65163° E
6. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m^3)
09.03.2022	24 hrs.	250.0	140.0	75.3	26.7	33.8	0.77
22.03.2022	24 hrs.	237.0	134.0	72.6	24.4	32.0	0.85
As per MoEF & CC Standard Notification no. GSR 742 (E) for Coal mine		500	250	—	120	120	—
NAAQ Standard		—	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Gaeke Method IS 5182 (Part-2) RA2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$





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Material Lab
Soil Lab
Mineral Lab
&
Microbiology Lab

Ref: Envlab/22/R-0553

Date:08.04.2022

AAQ MONITORING REPORT FOR MARCH-2022 (BUFFER ZONE)

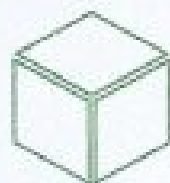
1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
1. Sampling Location : AAQMS-1:Kalamegha Village
4. Location Co-ordinates : 21° 56' 55.5288" N, 83° 50' 33.9036" E
5. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m ³)
10.03.2022	24 hrs.	138.0	82.0	44.7	14.3	25.5	0.39
23.03.2022	24 hrs.	126.0	72.0	39.0	12.8	23.7	0.46
NAAQ Standard		--	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24)2019	Improved West & Gaeke Method IS 5182 (Part-2) RA2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$



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• Infrastructure Engineering
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Ref: Envlab/22/R-0554

Date:08.04.2022

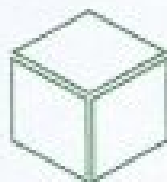
AAQ MONITORING REPORT FOR MARCH-2022 (BUFFER ZONE)

2. Name of Project : Manoharpur Open Cast Coal Mine Project
3. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
4. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
5. Sampling Location : AAQMS-2:Paramanandpur Village
6. Location Co-ordinates : 21° 57' 15.7464" N, 83° 45' 54.8172" E
7. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m^3)
10.03.2022	24 hrs.	129.0	74.0	40.3	13.2	22.8	0.55
23.03.2022	24 hrs.	140.0	85.0	45.6	15.5	24.5	0.48
NAAQ Standard		--	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Gaeke Method IS 5182 (Part-2) RA2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$





Visiontek Consultancy Services Pvt. Ltd.

(Committed For Better Environment)

Certified for : ISO 9001:2015, ISO 14001:2015, ISO 45001:2018 (OH&S), ISO/IEC 17025:2017

Accredited by : NABET-A Grade, MOEF & CC/CPCB & SPCB-A Grade

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Ref: Envlab/22/R-0555

Date: 08.04.2022

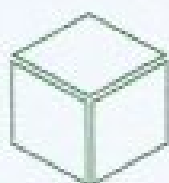
AAQ MONITORING REPORT FOR MARCH-2022 (BUFFER ZONE)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sampling Location : AAQMS-3: Sarbahal Village OCPL Mines Colony
5. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m^3)
11.03.2022	24 hrs.	169.0	93.0	50.4	15.8	29.5	0.53
29.03.2022	24 hrs.	154.0	81.0	42.8	17.3	26.3	0.60
NAAQ Standard		---	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Gaeke Method IS 5182 (Part-2) RA2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$





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Ref:Envlab/22/R-0556

Date:08.04.2022

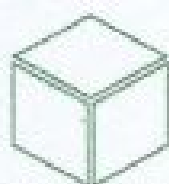
AAQ MONITORING REPORT FOR MARCH-2022 (BUFFER ZONE)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sampling Location : AAQMS-4: Kiripsira Village
5. Location Co-ordinates : 21° 59' 22.6788" N, 83° 46' 47.2368" E
6. Sample collected by : VCSPL representative

Date of Monitoring	Sampling duration	Suspended Particulate Matter, SPM ($\mu\text{g}/\text{m}^3$)	Respirable Particulate Matter, PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO _x ($\mu\text{g}/\text{m}^3$)	CO (mg/m ³)
11.03.2022	24 hrs.	148.0	83.0	43.8	14.6	25.3	0.53
29.03.2022	24 hrs.	130.0	75.0	41.5	16.3	28.4	0.49
NAAQ Standard		—	100.0	60.0	80.0	80.0	4.0 (1hour)
Testing Method		Gravimetric IS 5182: (Part 4) RA 2019	Gravimetric IS 5182: (Part 23) RA 2017	IS 5182 (Part 24) 2019	Improved West & Geake Method IS 5182 (Part-2) RA2017	Modified Jacob & Hochheiser Method IS 5182 (Part-6) RA2017	NDIR Spectroscopy method IS 5182 (Part-10) RA 2019

BDL Values: SO₂ < 4 $\mu\text{g}/\text{m}^3$, NO_x < 9 $\mu\text{g}/\text{m}^3$





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Ref: Envlab/21/R-0080

ANNEXURE 7

Date: 06.01.2022

AAQ MONITORING REPORT (Heavy Metals) FOR DECEMBER-2021 **(Core Zone)**

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sample collected by : VCSPL representative in presence of OCPL representative

Monitoring Location	Date	Hg (mg/m ³)	As (ng/m ³)	Ni (ng/m ³)	Cd (mg/m ³)	Cr (mg/m ³)
AAQMS-1: BGR Office Camp	08.12.2021	BDL	BDL	BDL	BDL	BDL
AAQMS-2: BGR New Workshop Area	06.12.2021	BDL	BDL	BDL	BDL	BDL
AAQMS-3: CHP OCPL Office	06.12.2021	BDL	BDL	BDL	BDL	BDL
AAQMS-4: OCPL Mines Area	08.12.2021	BDL	BDL	BDL	BDL	BDL
CPCB, New Delhi AAQ Standard		--	6	20	--	--
Testing Method		AAS Method IS 5182(Part-22):2004				

BDL Values: Ni < 2.5 ng/m³, As < 1.0 ng/m³, Hg < 0.001 mg/m³, Cd < 0.002 mg/m³, Cr < 0.006 mg/m³





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Ref: Envlab/21/R-0085

Date: 06.01.2022

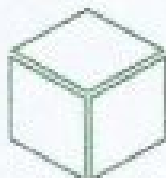
AAQ MONITORING REPORT (Heavy Metals) FOR DECEMBER-2021 (Buffer Zone)

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh
3. Monitoring Instruments : RDS (APM 460 BL), FPS (APM 550)
4. Sample collected by : VCSPL representative in presence of OCPL representative

Monitoring Location	Date	Hg (mg/m ³)	As (ng/m ³)	Ni (ng/m ³)	Cd (mg/m ³)	Cr (mg/m ³)
AAQMS-1: Dulanga Village	11.12.2021	BDL	BDL	BDL	BDL	BDL
AAQMS-2: Kalamegha Village	09.12.2021	BDL	BDL	BDL	BDL	BDL
AAQMS-3: Paramanandpur Village	09.12.2021	BDL	BDL	BDL	BDL	BDL
AAQMS-4: Kiripsira Village	11.12.2021	BDL	BDL	BDL	BDL	BDL
CPCB, New Delhi AAQ Standard		--	6	20	--	--
Testing Method		AAS Method IS 5182(Part -22):2004				

BDL Values: Ni < 2.5 ng/m³, As < 1.0 ng/m³, Hg < 0.001 mg/m³, Cd < 0.002 mg/m³, Cr < 0.006 mg/m³





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Date: 01.04.2021

ANNEXURE 8

NOISE MONITORING REPORT MARCH-2021

1. Name of Project : Manoharpur Open Cast Coal Mine Project
2. Name of Industry : Odisha Coal and Power Limited (OCPL), Sundargarh

Location ID	Date of Recording	Location	Location Co-ordinates	Day time Equivalent	Night time Equivalent
				Noise Level in dB(A) 1eq	
CORE ZONE					
N-1	01.03.2021	BGR Office Camp	21° 58' 57.6996" N, 83° 47' 46.1436" E	59.8	40.6
N-2	01.03.2021	BGR New Workshop Area	21° 58' 3.6588" N 83° 47' 23.5104" E	62.7	44.4
N-3	20.03.2021	CHPL OCPL Office	21° 58' 4.782" N 83° 47' 56.0616" E	71.3	49.7
N-4	20.03.2021	OCPL Mines Area	21° 57' 48.1284" N 83° 46' 55.6068" E	70.6	51.4
BUFFER ZONE					
N-5	24.03.2021	Dulanga Village	21° 56' 46.2372" N 83° 47' 54.9456" E	52.3	36.7
N-6	03.03.2021	Kalamegha Village	21° 56' 55.5288" N 83° 50' 33.9036" E	51.7	35.2
N-7	03.03.2021	Paramanandpur Village	21° 57' 15.7464" N 83° 45' 54.8172" E	48.6	37.8
N-8	24.03.2021	Kiripsira Village	21° 59' 22.6788" N 83° 46' 47.2368" E	50.4	42.6
Standard as per CPCB	Industrial Area			75	70
	Residential Area			55	45

