BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH

NEW DELHI

M.A No. 94 / 2022
IN
ORIGINAL APPLICATION No. 113 OF 2020

IN THE MATTER OF:

RAMESH CHANDRA VERMA .....APPLICANT

VERSUS

STATE OF UTTAR PRADESH & ORS. ...RESPONDENTS

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Northern Coalfields Ltd.
Khadia Project

Through

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RAMESH CHANDRA VERMA .....APPLICANT

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ADDITIONAL REPLY ON BEHALF OF RESPONDENT NO.3
NORTHERN COALFIELDS LTD, KHADIA PROJECT

I, Arvind Kumar Bansal, aged about 57 years, S/o Sh. Rajendra Kumar Bansal, R/o C-7, Sector -2, Jayant, Dist- Singrauli, Madhya Pradesh, Presently at do hereby solemnly affirm and declare as under: -

1. That I am working as General Manager (Civil), Northern Coalfields Limited, Project-Khadia, as such in my official capacity, I am well conversant with the facts and circumstances of the Present Case and also Competent to swear this Present Affidavit.

2. That this Hon'ble Tribunal vide its order dated 07.01.2025 directed the Respondent No. 3/Northern Coalfields Ltd to file an additional reply placing on record current status with regard to construction of wharf wall and steps taken by it for mitigating emission of dust and to reduce pollution.

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3. This Hon'ble Tribunal vide its order dated 28.08.2018 passed in O.A No. 164/2018 directed the M/s Northern Coalfield Limited to take all possible initiatives for slope stabilization thereby preventing any possibility of accidents of sliding OB causing damage to property and life, the coal mines shall ensure that transportation of coal shall only be either by railway wagons or by the dedicated conveyor system. No transportation of coal shall be permitted by road to any of the industries in the Singrauli area, as recommended earlier also.

4. That in order to comply with the directions of this Hon'ble Tribunal the concept of construction of 'wharfwall' was developed which is more or less an infrastructure facility created for railway wagon loading to transport coal through rail. The Khadia Project of Northern Coalfield Ltd is equipped with Coal Handling Plants of 04 & 06 MTPA capacity for dispatch of coal to UPRVUNL through Merry Go-Round arrangement (a derivative of rail transport). For the purpose of reduction in road transportation of coal, to minimize the pollution associated with road dispatch and to decrease in traffic density, a letter of award was issued for 'Construction of Wharfwall & allied works' to M/s Baghel Infrastructure Pvt. Ltd vide letter dated 26.09.2020.

5. That Due to delay in resolution of the problem, contractual agency M/s Baghel Infrastructure Pvt. Ltd repeatedly requested for foreclosure of the work on the ground of hindrance and overhead expenses, thereafter, the East Central Railway agreed on 31.12.2021 for executing the balance work left by the M/s Baghel Infrastructure Pvt. Ltd and the NCL has to foreclose the contract of work of construction of wharf wall and allied works awarded to M/s Baghel Infrastructure Pvt. Ltd.

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6. That the Oversight Committee in its meeting dated 18.10.2021 (held virtually) considered the issue involved in the case and the order dated 14.10.2021. The oversight committee reviewed the implementation of the Hon'ble NGT's order dated 23.08.2021 and considered the compliance report dated 18.10.2021. The Committee observed that the NCL Khadia Project has followed the directions of the Hon'ble NGT.

7. That the Sr. Divisional Engineer, East Central Railway accepted the proposal for carrying out balance work of wharf-wall on 31.12.2021 as other works such as "Escape line for Engine with extension of bridge and Construction of Control room for weigh bridge and barrier at level crossing for making operationalization of Wharf-wall at Khadia Project" were already under their scope of work. The total cost of project was Rs. 25,63,60,427/-, therefore, 10% of the project cost would be Rs. 2.5 Crores but not Rs. 5 Crores as held by this Tribunal.

8. That the East Central Railway vide its letter no. CAO-C-SOUTH-HQ-ENGINEERING/ECR-CAO-C-S-ETEN-54-22-23 dated 04.01.2022 has issued letter of acceptance to M/S K.N. International Ltd for earthwork in cutting, filling, compaction, blanketing, turfing, extension of minor bridges and other associated work as per railway specification and standard for the construction of engine escape line and wharfwall siding for the NCL Khadia Project under Dy.CE/C/Renukoot unit under Dhanbad division of East Central Railway.

9. That the NCL management again filed its Progress report/ Compliance status dated 04.03.2022 stating therein that 66% of the construction includes "retaining wall and drain wall along the adjacent overburden

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dump, RCC Box culvert, wharfwall alongside existing railway track, earth filing work, etc.". In the report it was also stated that Mobile sprinkling was done during the above construction and will also be done during further construction and no water was discharged in drain also no waste was generated during the construction period.

10. That the Ministry of Environment gave its clearance on 27.07.2022 for increase in production capacity from 14 MTPA to 15 MTPA for NCL, Khadia project.

11. That as directed in the Video Conferencing held by the Oversight Committee, a summary report has already been submitted by NCL Management vide letter no. KHD/GM/M/Env/UPPCB/22-23/3527 dated 05.08.2022 detailing about the hindrance caused by the local villagers for construction of Wharfwall under misinterpretation of increase in pollution and action taken.

12. That as per the Terms of Reference for 20 MTPA dated 14.02.2022 issued by the Ministry of Environment under heading "Infrastructure & Mine Management" inpit conveyor belt with silo loading should be proposed and installed for transportation of coal till railway siding. No transportation of coal by trucks/dumpers shall be proposed in EIA/EMP". To comply with this directive, construction of Rapid Loading System (RLS) has been planned which will be completed tentatively by March, 2026. This rapid Loading System shall further augment the coal offtake through rail mode. Here, it may also be noted that for installation and commissioning of RLS, even the escape line/tracks and signaling etc, the work of which is being undertaken by ECR railways is also being opposed by the local villagers.

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13.That in the 279th meeting of Northern Coalfields Ltd. held on 24.09.2022 approval for addendum to the project report for Khadia Expansion OCP (10 to 16 Mtpa, Peak-20 Mtpa) was considered. Wherein at point (iii) (a) it was resolved that in context of Eastern Stream, the proposed location of Krishnashila side CHP stream has been relocated to a position situated in the central haul road of Khadia OCP near to the coal face. Receiving pit is situated in the central haul road for further transportation by conveyor belt to proposed ground bunker located at wharfwall for loading of coal in railway wagon by Silo/Surge Bin located on old KBJ line. Capacity of this CHP has been proposed as 4 Mtpa with estimated capital expenditure of Rs. 237.44 Crores.

14.That the oversight committee headed by Justice SVS Rathore furnished its report before this Hon'ble Tribunal considering the submissions of Regional Officer as a truth and erred in holding that the environmental pollution caused by the NCL Khadia Project due to non-construction of the wharf wall is continuing and the health of the people living in the surrounding area continues to be adversely affected. The committee further stated that the attention of your Lordship is drawn towards stoppage of construction work of the wharf wall soon after the case was released by the Hon'ble NGT on 23.08.2021, its non-resumption till date even after repeated directions of the Oversight Committee and non-enforcement of environmental laws by the Regional Officer, Sonebhadra and the UPPCB headquarters against the polluters. The said report was sent through email dated 01.12.2022 without communicating it to the NCL and the same was treated as M.A No. 94/2022.

15.That it is also necessary to point out that the Northern Coalfield Ltd, Khadia Project had to carry out a study on "Scientific study for the air pollution impacts associated with the operationalization of Wharf-wall and pollution control/mitigation measures to minimize pollution load" by Indian Institute of Technology (Banaras Hindu University) as proposed by Regional Officer, UPPCB, Sonebhadra during the meeting held on 04.07.2021 in the chairmanship of SDM Dudhi and in the presence of NCL Management and Villagers to access as to whether the proposed pollution control measures will be suitable for controlling the pollution during operationalization of rail dispatch through Wharf wall. The study was carried out and report was submitted with certain recommendations. A copy of the Report on "Scientific study for the air pollution impacts associated with the operationalization of Wharf-wall and pollution control/mitigation measures to minimize pollution load is annexed herewith and marked as **ANNEXURE R-1**.

16. That the U.P Pollution Control Board instead of pointing out the law and order situation which was within their knowledge has fastened the fault of non-resumption of construction of wharf wall on the Northern Coalfields Ltd despite of the fact that the villagers were causing hindrance even to the works awarded to ECR Railways regarding railway line and signaling etc which will be necessary for Operationalization of Rapid Loading System as well. If the appropriate measures to maintain law and order situation is not carried out by the State in such situation the installation of Rapid Loading System and other related works may also get affected.

17. That so, far the Over Burden dump is concerned, the Khadia Project has taken due preventive measures to mitigate dust pollution from the OB dump near the village by stopping the dumping activity towards the village side, plantation on over dump area and formation of retaining wall and rain at the toe of the OB dump. The report of the oversight committee

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dated 18.10.2021 also acknowledges that Khadia project has planted 50,000 sapling on OB dump in Finanical Year 2021-2022.

18.That the NCL vide its letter dated 16th March, 2023 sought intervention of the District Magistrate, Sonebhadra thereby pointing out that the East Central Railway tried to resume the work on 27.02.2023 but it was again disturbed by local villagers and the work could not be resumed. The NCL again vide its letter dated 06.05.2023 while pointing out the continued law and order problem created by local villagers of Nautola during construction of wharfwall and rail connectivity executed by the East Central Railway, requested the District Magistrate, Sonebhadra to manage the law and order situation so that the construction of wharfwall could resume at the earliest.

19.That this Hon'ble Tribunal vide its order dated 13.02.2023 has recorded that " *1. Grievance in this application is against developing of a 'wharf wall' (platform for storing coal and **flyash**) and 'Overburden dump' (stack of mined coal, **mixed with fly ash**) by Northern Coalfield Limited, Kharia Project, Shakti Nagar, Sonebhadra, U.P., near railway residential area. On account of such activity, dust is generated, affecting the air quality and the health of the inhabitants. The activity falls in 'Red' category, having serious environmental impact.*

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9. Accordingly, we hold the PP liable to pay compensation of Rs. 5 Cores which is 10% of the project cost for past violations, apart from liability to the remedy the situation within two months. The amount of compensation

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be deposited with the State PCB within two weeks which may be utilized for restoration of environment as per District Environment Plan, if necessary, associating the PP, District Magistrate and other stake holders."

The fact remains that 'fly ash' is not generated in the Coal mines rather coal power plant generates electricity by burning coal which creates a hazardous byproduct known as 'fly ash'.

20. That a work order was issued on 10.07.2021 to IIT-BHU for carrying out "Scientific Study of Fly ash utilization/ dumping/ mixing in the OB of the running/ active mines of NCL along with its viability and safety aspect of man and machines." As per report submitted by IIT BHU, Varanasi, disposal of fly ash with overburden is not possible due to geo mining conditions, high stripping ratio, and huge rate of OB removal and instability of dump due to lowering of factor of safety (less than 1) as per details given below from study in present conditions.

21. Therefore, additionally, Work Order for the study titled "Feasibility study in utilizing fly ash in the running Nigahi mine of NCL has been given to CSIR CIMFR, Dhanbad and study is ongoing at Nigahi mine. After considering the effect of monsoon on the created fly ash mixed OB dump at Nigahi Area, the CIMFR is expected to submit its final report by February, 2025.

22. That during open cast mining the overline soil and the fragmented rock is removed and is heaped to form the Over Burden dump which is to be kept in a proper manner and as per the environmental norms. Over Burden (OB) dumping near the Nawatola village has already been stopped and plantation on OB is a continuing activity, retaining wall and drain has

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been constructed at the toe of the OB dump. The dump stability report prepared in October 2019 by Central Mine Planning and Design Institute Limited (CMPDIL) has been sent to UPPCB vide letter dated 24.01.2023. The Maximum Reduced Level of the east dump is 487m above mean sea level whereas the joint committee in its report has mistakenly considered total height of dump as 487 m. Every year, before onset of the monsoon, measures are taken for control of surface run-off.

23. That it is noteworthy to point out that in order to augment the need of rail transportation of coal, the NCL vide its Letter of Acceptance dated 08.01.2024 has awarded the work of "*Planning, Design, Engineering, Construction, Fabrication, Erection, Supply, Installation, Trial run and commissioning of Coal Handling Plant of 4 MTPA consisting of all Civil, Structural, Electrical and Mechanical Works and all other accessories and facilities complete in all respects on turnkey basis and Operation and Maintenance of plant for 5 years in Khadia OCP of NCL* " to M/s S.K.Samanta & Co. Pvt. Ltd for an amount of Rs. 272 Crores (approx) including GST.

24. That in terms of clause 3 of Letter of Acceptance dated 08.01.2024, the joint inspection was carried out on 11.03.2024 and the site was handed over to M/s S.K.Samanta & Co. (P) Ltd. The date of commencement is to be reckoned from 17.03.2024 and the date of completion of construction of Coal Handling Plant is 16.03.2026. The contractor was requested to take-up the work observing all formalities as per LOA and commence the work only after submission of Performance Security.

25. That being aggrieved by the Order dated 13.02.2023 passed by this Hon'ble Tribunal, the Northern Coalfield Ltd was constrained to

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approach the Hon'ble Supreme Court by preferring Civil Appeal No. 1528/2023 wherein the Hon'ble Supreme Court vide its order dated 17.03.2023 stayed the operation of the order dated 13.02.2023 passed by this Hon'ble Tribunal. The Respondent No.2/ Ramesh Chandra Verma filed his statement of objection before the Hon'ble Supreme Court admitting that he alongwith local villagers were causing obstruction to the construction of wharfwall as the land belongs to East railway and for which they have preferred WRIT-C No. 2243 of 2023 before the Hon'ble High Court of Judicature at Allahabad.

26. That the Hon'ble Supreme Court finally vide order dated 19.04.2024 passed in Civil Appeal No. 1528/2023 allowed the appeal of the Northern Coalfields Ltd by setting aside the order of this Tribunal to the extent of imposition of Rs. 5 Crores as penalty.

27. That the Northern coalfields Ltd vide its letter dated 11.05.2024 furnished necessary details to the East Central Railway regarding deposit work of "Providing escape line for engine with extension of Bridge and construction of control room, in motion weigh bridge and barrier at level crossing for making operationalization of wharfwall at Khadia Project " with a request to complete the work before monsoon, without any change, as agreed by the ECR during estimation, to facilitate coal dispatch from wharfwall in large public interest. A copy of the NCL Letter No. NCL/GM(c)/234 dated 11.05.2024 is annexed herewith and marked as **<u>ANNEXURE R /2.</u>**

28. That the Northern coalfields Ltd vide its letter dated 18.08.2024 awarded the work " Providing one no. of wheel washing facility with complete

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recirculation system at the exit gate of Khadia project with three year AMC after one year warranty". A copy of the NCL Letter No. 2620/kh/C/LOA/394 dated 18.08.2024 is annexed herewith and marked as **ANNEXURE R /3.**

29. That the NCL has given the target of planting 18175 trees in the year 2024-25 which was duly carried out by the Regional Forest Officer, Renukoot. A copy of the Regional Forest Officer, Renukoot letter dated 14.09.2024 is annexed herewith and marked as **ANNEXURE R /4.**

30. That the NCL vide its letter dated 02.01.2025 requested the East Central Railway to provide the expected date of completion of the work in all aspect including level crossing, signaling system, in motion weigh bridge, environmental measures, sprinkler system etc as per the recommendations of IIT BHU. A copy of the NCL Letter NCL/KHD/GM/2025/4624 dated 02.01.2025 is annexed herewith and marked as **ANNEXURE R /5.**

31. That the Northern Coalfields Ltd vide its letter dated 31.01.2025 requested the E.C. Railways to provide the Engineering Scale Plan & Time frame for completion of work. The reply of the same is awaited from the Railway authorities. A copy of the NCL Letter KHD/GM/ESP/2024-2025/4678 dated 31.01.2025 is annexed herewith and marked as **ANNEXURE R /6.**

32. Besides above (i) Engineering Scale Plan for the construction of wharfwall has been approved by Railway Authorities and the construction will be completed within 6 months. (ii) 10 % of the total production capacity is required to be sold to the local consumers through

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e-auction which are to be transported through road mode as local consumers do not have railway network. (iii) The final report on "Evaluation of the effectiveness of measures taken by Khadia Project to control the air and water pollution from the east dump and pollution control/mitigational measures to minimize pollution load" has been submitted by the IIT BHU on 06.02.2025. The measures suggested therein is being implemented by the Northern Coalfields Ltd. A copy of the Report of IIT BHU is annexed herewith and marked as **ANNEXURE R /7.**

33. That MoEEF&CC has sent the notice dated 14.01.2025 to Northern Coal Fields Limited (NCL) pointing out as many as 25 non-compliance, which are mentioned in the notice. In reply to which the NCL vide its letter dated 14.02.2025 furnished detailed submission of clarification/Action Taken Report. A copy of the NCL letter dated 14.02.2025 alongwith enclosures is annexed herewith and marked as **ANNEXURE R /8.**

34. That the Northern Coalfields Ltd is taking appropriate remedial action, in accordance with Statutory provisions for prevention, control and abatement of environmental pollution/degradation and for protection and improvement of environment.

35. That I say that the Annexure R-1 to R- annexed along with the present Affidavit are true copy of its respective original.

36. I say that averments of facts stated herein above are true to my knowledge, no part of it is false and has been derived from the official

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S.R. 1984/2025
Place Waidhan
Date 22/03/2025

records and nothing material has been concealed therein.

Sig. Of Deponent / Execute

DEPONENT

VERIFICATION

I, above named deponent mentioned above do hereby most solemnly affirm and verify that what is stated in the above affidavit is true to my knowledge and I believe the same to be true as per the official records of Northern Coalfield Ltd.

Verified at Singrauli on this 22 day of March, 2025.

DEPONENT

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Ramashankar Shah Advocate
NOTARY
Distt. Court Waidhan, Singrauli (M.P.)

Identified by
Shri Naseemuddin
Adv Waidhan
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काशी हिन्दू विश्वविद्यालय

INDIAN INSTITUTE OF TECHNOLOGY
BANARAS HINDU UNIVERSITY

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Report on

Scientific study of the Air Pollution Impacts associated with operationalisation of Wharfwall and Pollution Control/Mitigational Measures to Minimise the Pollution Load

By

Dr. Tarun Verma

Department of Mining Engineering

Indian Institute of Technology

(Banaras Hindu University), Varanasi 221005

Executive Summary

A mathematical model (Gaussian Dispersion Model) is used to predict the concentration of different air pollutants at the different locations after the operationalisation of wharfwall where measurement has also been done to find out the scenario before the operationalisation of the wharfwall. AERMOD View 8.5 software is used to predict the concentrations of the air pollutants. Based on the scientific study following conclusions and recommendations have been made:

A. Conclusions

As per the study carried out for different locations near and in the vicinity of wharfwall following conclusions can be drawn:

(i) Figure 7 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 49.41, 213.2 and 272.45 respectively in microgram/m^3 without wharfwall at location 1 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 180.25, 210.78 and 220.48 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 1 (in the local village) is very near to the wharfwall construction site (nearly 50 m) so there will be an increase in pollution level of $PM_{2.5}$ at the location 1.

(ii) Figure 8 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 56.1, 500.59 and 737.04 respectively in microgram/m^3 without wharfwall at location 2 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 83.17, 78.33 and 89.56 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 2 (in the local village) is away from the wharfwall construction site (nearly 150 m) so there is a decrease due to easterly wind direction in the overall pollution level at the location 2. Measured concentrations are high in comparison to the predicted concentrations because location 2 is very near to the Shaktinagar road. The transportation of the coal from the mine to the power plants might be causing more air pollution in the road vicinity.

(iii) Figure 9 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 57.69, 437.6 and 581.53 respectively in microgram/m^3 without wharfwall at location 3 whereas predicted concentrations of

PM$_{2.5}$, PM$_{10}$ and TSP are 459, 96.28 and 102.51 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 3 (in the local village) is away from the wharfwall construction site (nearly 250 m) so there is a decrease due to easterly wind direction in the overall pollution level at the location 3. Measured concentrations are high in comparison to the predicted concentrations because location 3 is very near to the Shaktinagar road. The transportation of the coal from the mine to the power plants might be responsible for high air pollution in the road vicinity.

(iv) Figure 10 shows that the average measured concentrations of PM$_{2.5}$, PM$_{10}$ and TSP are 32.83, 164.23 and 239.4 respectively in microgram/m^3 without wharfwall at location 4 whereas predicted concentrations of PM$_{2.5}$, PM$_{10}$ and TSP are 188.11, 230.41 and 243.32 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 4 (in the mine) is very near to the wharfwall construction site (nearly 10 m) so there will be an increase in the overall pollution level at the location 4.

(v) Figure 11 shows that the average measured concentrations of PM$_{2.5}$, PM$_{10}$ and TSP are 36.8, 236.06 and 358.11 respectively in microgram/m^3 without wharfwall at location 5 whereas predicted concentrations of PM$_{2.5}$, PM$_{10}$ and TSP are 188.26, 230.44 and 244.5 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 5 (in the mine) is very near to the wharfwall construction site (nearly 10 m) so there will be an increase in the overall pollution level at the location 5.

(vi) As per the wind-rose diagram shown in the Fig. 1 for one year, the predominant wind direction is South-East. It may be concluded that the pollution level will increase in the North-west direction after the construction of the wharfwall. The local village is on the south-east side of the mine, so the chances of increase in the pollution level due to operationalisation of the wharfwall are minimal as per the predominant wind direction.

(vii) As per the Fig. 2, a dump is located at the north side of the wharfwall whereas the predominant wind direction is North-west. Considering the distance of the toe of the dump from village is about 130-155 m as per the mine plan and predominant wind direction, the chances of recirculation of the air pollutants are minimal towards the village/settlement.

B. Recommendations

The following are the recommendations based on the analysis of data and conclusions:

(i) A curtain wall must be made along the length of wharfwall of 800 m towards the local village. The height of the curtain wall should be at least 5 m so that at the time of wagon loading, the dust can be arrested with in the mining area.

(ii) A fixed water sprinkler system should be developed along the length of the wharfwall so that at the time of loading and unloading of coal, it can suppress the dust quickly.

(iii) Some mobile water sprinkler system should also be made available at the time of loading and unloading as per the need if required.

(iv) Fixed fog canon must also be deployed in the vicinity of the wharfwall to efficiently suppress the dust during the operation of wharfwall. It is the most effective way to reduce the air pollution level in the concerned area.

(v) After implementing all the above-mentioned pollution control measures, the concentration levels of $PM_{2.5}$, PM_{10} and TSP may come down within permissible limits.

The NCL, Kharia Project management entrusted Department of Mining Engineering, IIT (BHU) Varanasi vide its office letter No. NCL/KHD/GM/M/Env/Wharfwall/21-22/3053 dated 31.08.2021 to Scientific study of the Air Pollution Impacts associated with operationalisation of Wharfwall and Pollution Control/Mitigational Measures to Minimise the Pollution Load. The scope of work of this project comprised of the following:

(a) Collection of air samples at wharfwall site and nearby habitation so as to ascertain pre-wharf wall level or air pollution (Samples may also be collected at other sites depending as per methodology of the proposal).

(b) Study of Air impact in terms of increase in Suspended Particular Matter (SPM), Respirable particulate Matter (RPM), PM2.5 level etc. In ambience of nearby habitations due to emission/release of SPM, RPM, PM2.5 etc. due to activities during operationalization of Wharfwall like (1) unloading of coal through tippers / dumpers at wharfwall Platform, (2) Loading of stored coal into railway wagons with the help of pay loaders (3) Dispatch of Coal through railway wagons (4) Movement of vehicles / Heavy Earth Moving Machinery (HEMM) at and around wharfwall platform.

(c) To suggest Air Pollution Control / Mitigating measures to be adopted with an aim to zero negative impact on nearby habitation.

(d) Preparation and submission of report

Scientific study of the Air Pollution Impacts associated with operationalisation of Wharfwall and Pollution Control/Mitigational Measures to Minimise the Pollution Load

1.0 Introduction

The Khadia area is having present production capacity of 14 Million Tonne per Annum (MTPA) as per Environment Clearance and is equipped with coal handling plants of 04 MTPA and 06 MTPA , through which coal is being dispatched through Merry -Go -Round System, a derivative of rail dispatch.

In order to further strengthen its coal dispatch capacity through rail mode, Khadia Area of NCL is constructing a Wharfwall of 04 MTPA . At the Wharfwall, the associated activities are:- (1) Unloading of Coal through tippers/dumpers at Wharfwall platform, (2) Loading of stored coal wagons with the help of payloaders (3) Dispatch of Coal through these railway wagons (4) Movement of Vehicles / Heavy Earth Moving Machineries (HEMM) at and around Wharfwall area.

However, during the course of its construction, the work has been hindered by nearby local villagers citing the apprehension of increased pollution level due to operation of Wharfwall.

Now, in order to address the apprehensions of local villagers regarding increase in pcllution level, Khadia Area needs to conduct a scientific study of assessment of impact of the operations of this wharfwall so that suitable mitigating measures for pollution control can be taken.

In view of the above, The NCL, Kharia Project management entrusted Department of Mining Engineering, IIT (BHU) Varanasi vide its office letter No. NCL/KHD/GM/M/Env/Wharfwall/21-22/3053 dated 31.08.2021 to Scientific study of the Air Pollution Impacts associated with operationalisation of Wharfwall and Pollution Control/Mitigational Measures to Minimise the Pollution Load.

2.0 Scope of Work

The scope of work of this project comprised of the following:

(a) Collection of air samples at wharfwall site and nearby habitation so as to ascertain pre-wharf wall level or air pollution (Samples may also be collected at other sites depending as per methodology of the proposal).

(b) Study of Air impact in terms of increase in Suspended Particular Matter (SPM), Respirable particulate Matter (RPM), PM2.5 level etc. In ambience of nearby habitations due to emission/release of SPM, RPM, PM2.5 etc. due to activities during operationalization of Wharfwall like (1) unloading of coal through tippers / dumpers at wharfwall Platform, (2) Loading of stored coal into railway wagons with the help of pay loaders (3) Dispatch of Coal through railway wagons (4) Movement of vehicles / Heavy Earth Moving Machinery (HEMM) at and around wharfwall platform.

(c) To suggest Air Pollution Control / Mitigating measures to be adopted with an aim to zero negative impact on nearby habitation.

(d) Preparation and submission of report.

3.0 Field Visit

Field visit has been conducted in the month of September 2021 to understand problem. The team of IIT (BHU), Varanasi has interacted with the mine administration and local villagers. The issues raised by the local villagers regarding the increase in the pollution level were heard by the team and it has been ensured by the team that most of the air samples location would be made in their locality to address the issues. The present report is based on the data compiled from these projects. The report was prepared based on the air samples collected and the numerical simulation done on the AERMOD software.

4.0 Data Collection

The figure 1 shows the Wind - rose diagram of the Khadia Project using CAAQMS, Khadia data which shows the predominant wind is blowing from South-East towards the North-West.

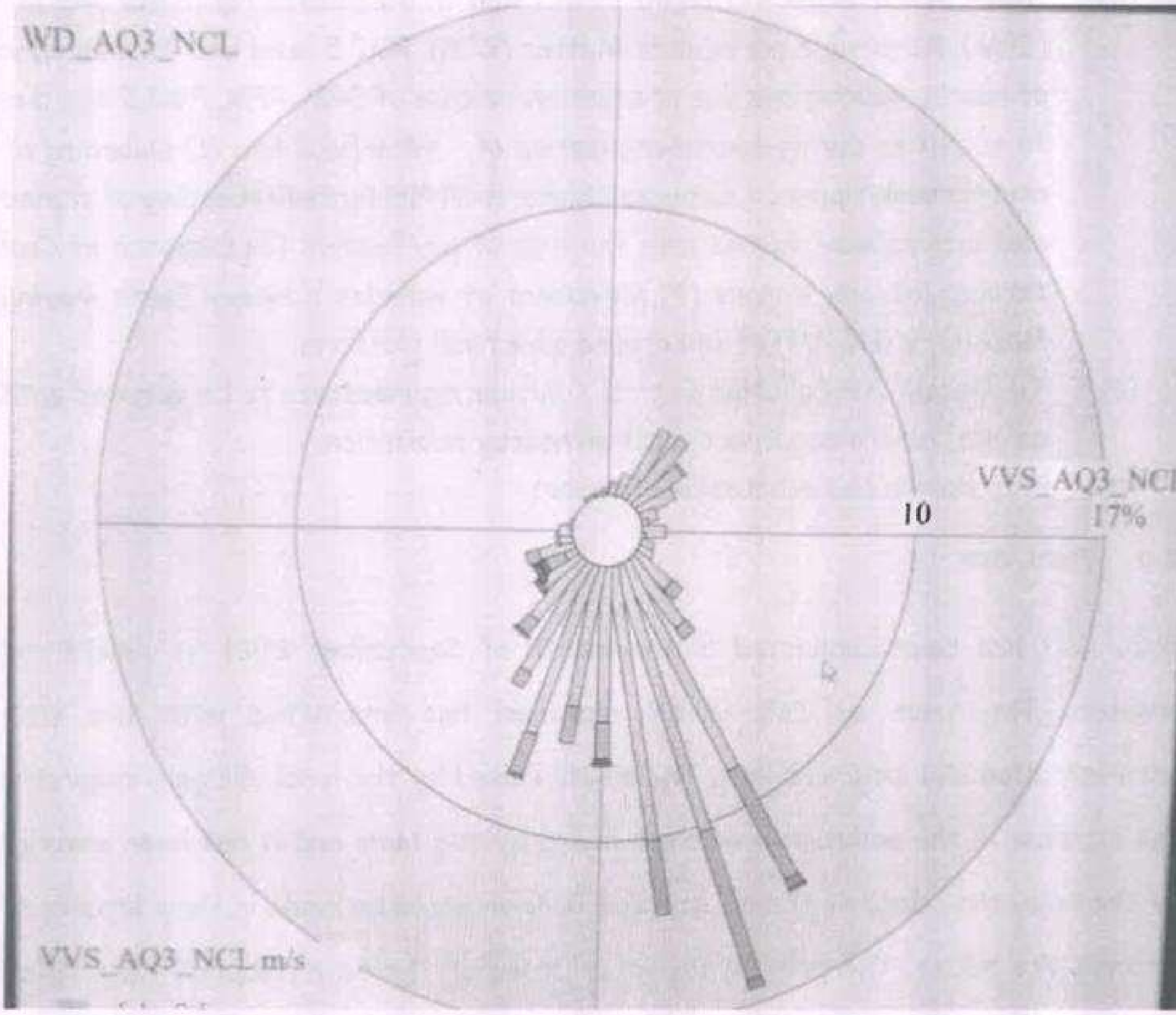

Figure1: Wind-rose diagram of Khadia Project

Based on the wind-rose diagram and in consultation with the mine administration and local villagers, five locations were selected to observe the concentrations of the Total Suspended Particles, PM_{10} and $PM_{2.5}$ using handheld Aerosol Monitor. The location of the air sample locations in Google Earth imagery with the proposed Wharfwall location is shown in figure 2.

Figure 2: Location of the Air samples Collection points, proposed Wharfwall and predominant wind direction of Khadia Project

Location 1, 2 and 3 are in the local village whereas location 4 and 5 are inside the mine, near the wharfwall. Location 1 and 2 are in the vicinity of the local village whereas location 3 is although in the local village but it is also near the main transport road from the coal is dispatched through tippers and other transportation machineries.

Table 1 to 5 show the samples collected using Handheld Aerosol Sampler at these locations:

Table 1: Sampling data of Handheld Aerosol Sampler in μg/m^3 at Location 1 (Lat=24.119457 degree, Long = 82.725756 degree)

S. No.	DATE	Time	PM2.5	PM10	TSP
1	10.09.2021	11:15 AM	38.6	85.9	100.4
2	10.09.2021	04:45 PM	40.3	79.3	95.4
3	11.09.2021	11:05 AM	95	190.9	220.9
4	11.09.2021	04:41 PM	40.3	159.9	199.8
5	12.09.2021	10:59 AM	27.4	243.1	340.1
6	12.09.2021	04:43 PM	38.3	162.2	197.7
7	13.09.2021	11:22 AM	38.7	140.4	179.3
8	13.09.2021	04:40 PM	104.8	744.4	914
9	14.09.2021	10:14 AM	36.5	210.2	278.4
10	14.09.2021	04:15 PM	34.2	115.7	198.5

Table 2: Sampling data of Handheld Aerosol Sampler in μg/m^3 at Location 2 (Lat = 24.118622 degree, Long =82.726412 degree)

S. No.	DATE	Time	PM2.5	PM10	TSP
1	10.09.2021	11: 30 AM	44.5	336.4	736.5
2	10.09.2021	04:40 PM	59.2	682.3	984.1
3	11.09.2021	11:16 AM	90.6	624.1	844.3
4	11.09.2021	05:09 PM	121.6	603.7	728.5
5	12.09.2021	11:05 AM	52.1	636.3	875.7
6	12.09.2021	04:50 PM	22.1	178.2	260.3
7	13.09.2021	11:26 AM	38.4	513.1	733.9
8	13.09.2021	04:55 PM	61.5	744.6	994.7
9	14.09.2021	10:18 AM	38.6	486.5	704.5
10	14.09.2021	04:20 PM	32.4	200.7	507.9

Table 3: Sampling data of Handheld Aerosol Sampler in $\mu g/m^3$ at Location 3 (Lat = 24.118701 degree, Long = 82.728039 degree)

S. No.	DATE	Time	PM2.5	PM10	TSP
1	10.09.2021	11:40 AM	78.6	600.6	829.4
2	10.09.2021	04:30 PM	71.9	541.9	751.6
3	11.09.2021	11:22 AM	89.5	645.9	880.8
4	11.09.2021	05:16 PM	85.9	605.5	757.1
5	12.09.2021	11:11 AM	56.4	643.8	801.6
6	12.09.2021	05:01 PM	38.8	196.2	288.3
7	13.09.2021	11:41 AM	24.3	115.1	157.8
8	13.09.2021	05:01 PM	83.8	776.8	986.6
9	14.09.2021	10:24 AM	23.5	132.4	192.6
10	14.09.2021	04:25 PM	24.2	117.8	169.5

Table 4: Sampling data of Handheld Aerosol Sampler in $\mu g/m^3$ at Location 4 (Lat = 24.1203299 degree, Long = 82.725737 degree)

S. No.	DATE	Time	PM2.5	PM10	TSP
1	10.09.2021	12:37 PM	50.9	292.9	473.8
2	10.09.2021	04:50 PM	36.2	192.5	296.3
3	11.09.2021	10:59 AM	72.1	141.5	164.2
4	11.09.2021	04:34 PM	37.7	167.1	217.6
5	12.09.2021	10:54 AM	17	172.7	245.4
6	12.09.2021	04:36 PM	19.1	121.8	180.6
7	13.09.2021	11:14 AM	18.1	87.8	125.5
8	13.09.2021	04:44 PM	26	162.1	219.2
9	14.09.2021	10:09 AM	30.8	185	267.6
10	14.09.2021	04:43 PM	20.4	118.9	203.8

Table 5: Sampling data of Handheld Aerosol Sampler in µg/m^3 at Location 5 (Lat = 24.1198497 degree, Long = 82.7267486 degree)

S. No.	DATE	Time	PM2.5	PM10	TSP
1	10.09.2021	12:45 PM	51	166.9	236.3
2	10.09.2021	04:55 PM	40.1	318.8	511.9
3	11.09.2021	10:53 AM	77.4	150.8	174.7
4	11.09.2021	04:28 PM	41.4	220.6	313.8
5	12.09.2021	10:50 AM	26	372.7	587.9
6	12.09.2021	04:37 PM	38.1	578.2	891.6
7	13.09.2021	11:40 AM	21.6	145.7	214
8	13.09.2021	04:41 PM	23.8	103.9	124.9
9	14.09.2021	10:05 AM	28.2	185.9	319.6
10	14.09.2021	04:50 PM	20.4	117.1	206.4

5.0 Prediction of the concentrations of TSP, PM_{10} and $PM_{2.5}$ after creating Wharfwall

As per the discussion with mine administration a Wharfwall of length 800 m, width 40 m and 1.3 m height is proposed as mentioned in the figure no. 2. The mine administration has also proposed to create a curtain wall of 5 m height along the railway track to restrict the movement of air pollutants towards the local village.

The dust dispersal prediction/simulation from the Wharfwall requires a certain procedure to be followed. The base map of the mine along with the nearby surrounding area, which can be polluted from the mining activities, is a prime requirement of the simulation. This can be provided in local coordinate system or global coordinate system.

The mining activity involves with the Wharfwall that can contribute directly or indirectly to the problem of air pollution is to be identified. Secondly, information about the potential dust sources is to be provided. This information includes sources strength, source dimension, type of source and source dimension.

In the next step of simulation, one has to provide location of the receptor, where concentration of the air pollutant is to be predicted or calculated. It may be provided in the form of grid or discrete point depending on the requirement. This is required to predict the concentration of an air pollutant at a particular location or contours of concentration in the area provided as base map to be influenced by mining activities.

Surface meteorological data, which are collected from the field or observed from a station cannot be directly used in AERMOD. These are required to be pre-processed in any model. AERMET is a pre-processor which come with the AERMOD and generates the file which can be used in the AERMOD as input for the meteorological data. AERMET processor was used to develop two types of input files for AERMOD.

Surface file (*.SFC): It contains hourly estimates of boundary layer parameters which are derived from the surface meteorological parameters.

Profile file (*.PFL): It contains multiple level observations of wind speed, wind direction, temperature and standard deviation of the fluctuating wind components.

Meteorological parameters are another set of data required for simulation of dust dispersal from an area or mine. There are two type of meteorological data required for simulation: Surface meteorological data and Upper air meteorological data. Opaque cloud cover, dry bulb temperature, wind direction and wind speed are the four important surface meteorological data required for simulation also termed as Primary surface meteorological data. The surface meteorological data, other than primary surface meteorological data are also required for simulation. However, secondary meteorological data can be estimated with the help of primary surface meteorological data. It is always advisable to use measured secondary surface meteorological data for better accuracy. All parameters of upper air meteorological data is required for simulation. These should be collected from a nearby weather station.

Digital elevation model (DEM) of the area is also required for simulation. DEM is a model or set of data contains the terrain contours of the area considered for simulation. This can be provided initially along with the base map or separately by a pre-processor provided in the model. Simulation process predicts dust dispersal with good accuracy, if the elevation of all the discrete points falling in the base map area will be provided as a digital elevation model.

5.1 Equation used for the dust source (Wharfwall) characterisation

The wharfwall is considered as a source of coal handling plant where the dust pollution may come from any of the following activities:

(1) Unloading of coal through tippers / dumpers at wharfwall Platform,

(2) Loading of stored coal into railway wagons with the help of pay loaders

(3) Dispatch of Coal through railway wagons

(4) Movement of vehicles / Heavy Earth Moving Machinery (HEMM) at and around wharfwall platform.

Considering all the above mentioned characteristics of the wharfwall due to its operationalization, the following equation is used to find the emission factor (Chakraborty et al., 2002):

$$E = [\{(100-m)/m\}^{0.4}\{a^2s/\ (100-s)\}^{0.3}\{u/\ (160+3.7u)\}] \text{ ---------------Eq. (1)}$$

Where

m = Moisture content (%)
s = Silt content (%)
u = Wind speed (m/s)
a = Area (km2)
E = Emission rate (g/sec-m^2)

As per the CIMFR reports CIMFR/DHN/TPS/LD/SEP/21-22/16034-A and CIMFR/DHN/TPS/LD/APR/21-22/5489, the average value of 'm' and 's' are considered as 15 and 25 respectively. Whereas as per the surface meteorological data collected from CAAQMS, Khadia, the average value of 'u' is taken as 0.708 m/s. The area 'a' is calculated as 0.032 km^2 as per the dimension of wharfwall.

After putting all the above mentioned values in equation no. 1, the emission factor is derived as 7.94547×10^{-4} g/sec-m^2.

5.2 Meteorological parameters

There are two different kind of meteorological parameters considered to predict the concentration of air pollutants.

5.2.1 Surface meteorological parameters

There are several meteorological parameters which are required as input in AERMOD to provide environmental conditions for the prediction of concentration of air pollutants. The concentrations of air pollutants are predicted for period 01/09/2021 to 14/09/2021. This period is considered because the collection of air samples has been done from 10/09/2021 to 14/09/2021 using hand held aerosol sampler.

The surface meteorological data has been collected from CAAQMS, Khadia for the above mentioned period. The meteorological parameters used for simulation are summaries in Table 6.

Table 6: List of Surface Meteorological Parameters considered for simulation with their unit

Meteorological Parameters	Unit
Opaque Cloud Cover	Tenths
Dry Bulb Temperature	Degree Celsius(°C)
Relative Humidity	Percentage (%)
Station Pressure	Millibars (mb)

Wind Direction	Degree (°)
Wind Speed	Metre per second(m/s)
Ceiling Height	Metre(m)
Hourly Precipitation Amount	Hundredths of inches
Global Horizontal Radiation	Watt-hour per square metre (Wh/m2)

These parameters have been collocated on hourly basis from 01/09/2021 to 14/09/2021. The total data consisted of 336 hours altogether.

5.2.2 Upper air meteorological parameters

Upper air data is necessarily required to calculate the mixing height of the air pollutant. Mixing height is the altitude above the surface where air pollutant will mix with the upper atmosphere with in troposphere. It is calculated using surface and upper air meteorological parameters. These air pollutants disperse very widely in a given region after getting mixed with upper atmosphere. The surface meteorological data were further processed along with the upper air mixing data. Upper air mixing data of the Sonbhadra district are taken from Radiosonde Dataset of Earth System Research Laboratory (ESRL), National Oceanic and Atmospheric Administration (NOAA) from 01/09/2021 to 14/09/2021.

Wind rose diagram generated from AERMET for above mentioned period has been shown in the Figure 3. The diagrams clearly shows that predominant wind direction is near to easterly for this short period where prediction are done for air pollutants due to operationalization of Wharfwall. The total calm period for wind velocity was 3.74 %.

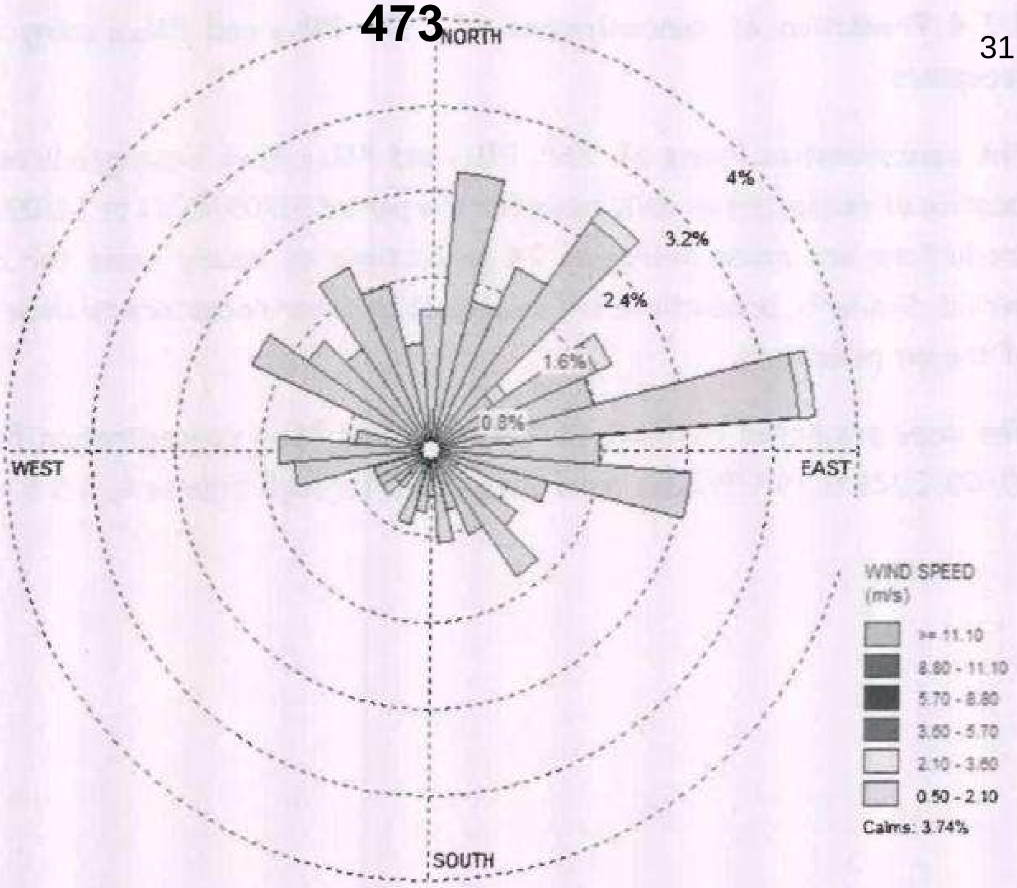

Figure 3: Wind - rose diagram of Khadia for the period 01/09/2021 to 14/09/2021

5.2.3 Development of Digital Elevation Model (DEM)

Digital elevation data or terrain data is another input required in for simulation. An imagery of the mining area has been taken from United States Geological Survey (USGS) for the preparation of DEM. The resolution is limited to 1 m for this imagery. The latitude and longitude have been determined considering the area covered in the study.

The terrain data were uploaded in the model over the base map. AERMAP, which is a pre-processor in the model, was run to develop the digital elevation model of the selected area of the study. Elevation of dust sources and receptors have been calculated based on digital elevation model.

5.2.4 Prediction of concentration of TSP, PM_{10} and $PM_{2.5}$ using AERMOD at receptors

The concentration levels of TSP, PM_{10} and $PM_{2.5}$ have been predicted at all five location of receptors on daily basis for the period 01/09/2021 to 14/09/2021. These predictions are made averaging 24 predictions on hourly basis for daily average period. Similarly, predictions are also made at other receptors to show the contours of the air pollutants.

The daily predicted contours of TSP, PM_{10} and $PM_{2.5}$ concentration for the period 01/09/2021 to 14/09/2021 have been shown through figures 4, 5 & 6 respectively.

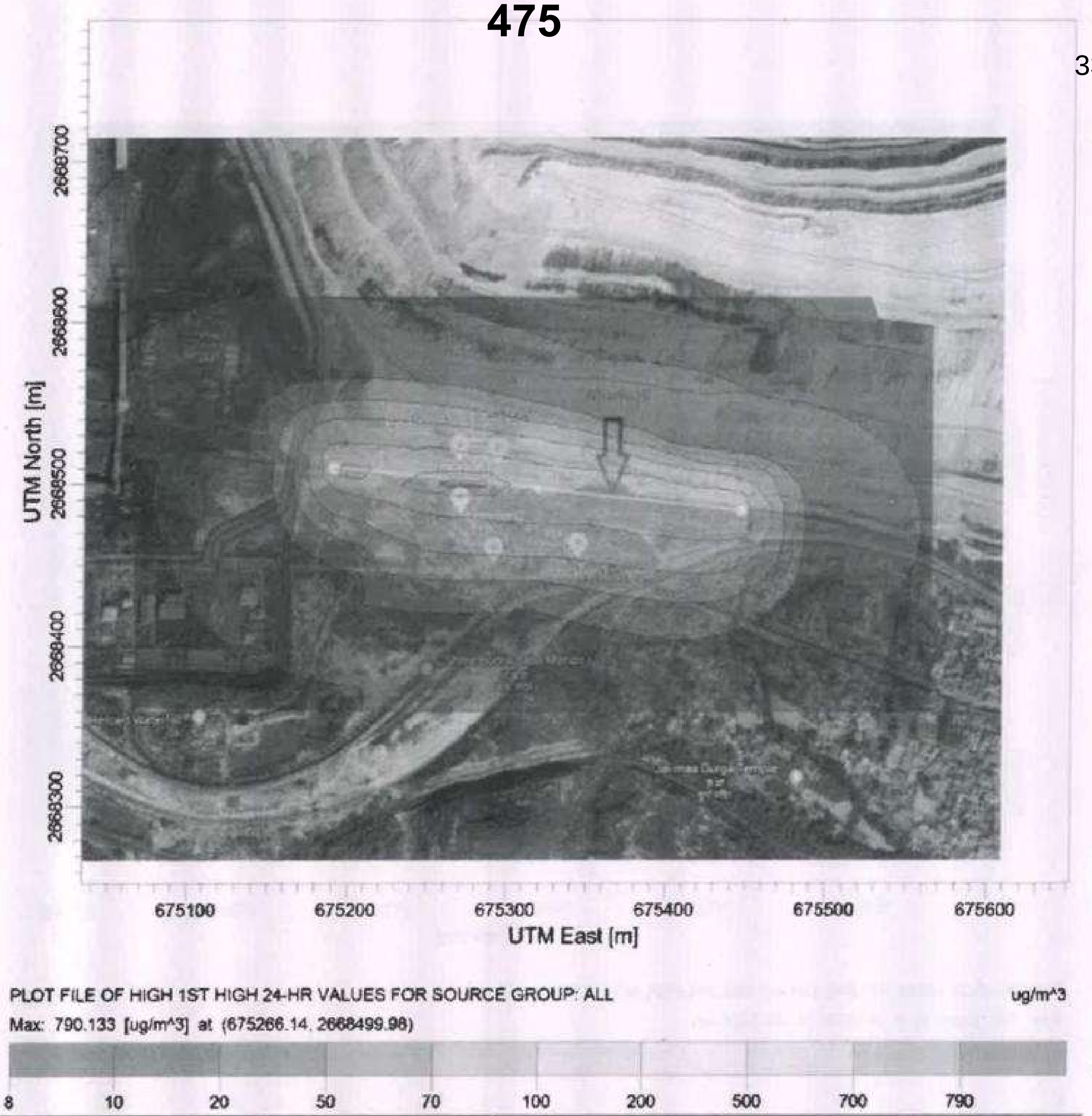

Figure 4: 1st Highest predicted concentration level of TSP for daily averaging time period

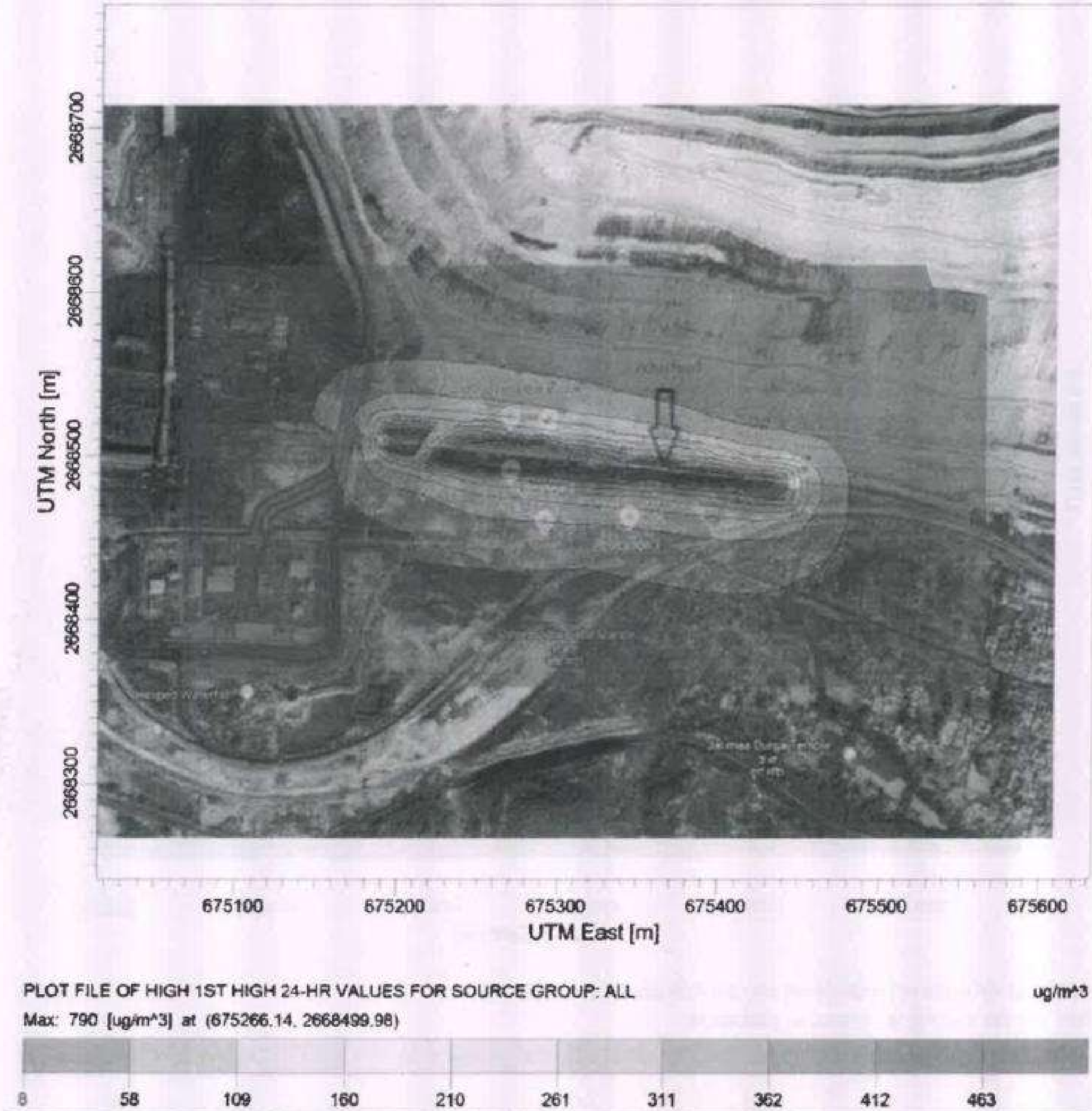

Figure 5: 1st Highest predicted concentration level of PM_{10} for daily averaging time period

Figure 6: 1st Highest predicted concentration level of $PM_{2.5}$ for daily averaging time period

Table 7, 8 and 9 shows the predicted 1st highest concentrations of TSP, PM_{10} and $PM_{2.5}$ after the operationalisation of the wharfwall at the same location where the air samples are collected from 10/04/2021 to 14/04/2021 to compare the measured values and predicted values.

Table 7: Predicted 1st highest concentrations of TSP after the operationalisation of the wharfwall at the receptor locations

Receptor Name	TSP concentration in microgram/m^3
Location 1	220.48
Location 2	89.56
Location 3	102.51
Location 4	243.32
Location 5	244.50

Table 8: Predicted 1st highest concentrations of PM_{10} after the operationalisation of the wharfwall at the receptor locations

Receptor Name	PM_{10} concentration in microgram/m^3
Location 1	210.78
Location 2	78.33
Location 3	96.28
Location 4	230.41
Location 5	230.44

Table 9: Predicted 1st highest concentrations of $PM_{2.5}$ after the operationalisation of the wharfwall at the receptor locations

Receptor Name	$PM_{2.5}$ concentration in microgram/m^3
Location 1	180.25
Location 2	83.17
Location 3	93.49
Location 4	188.11
Location 5	188.26

6.0 Analysis of Data

The Bar chart is plotted for the location 1 using the data measured for different air pollutants as per Table 1 and predicted concentrations of the same mentioned in Table 7, 8 and 9. The average of measured 10 concentrations is considered from Table 1 for the Bar-chart representation as in Fig. 7.

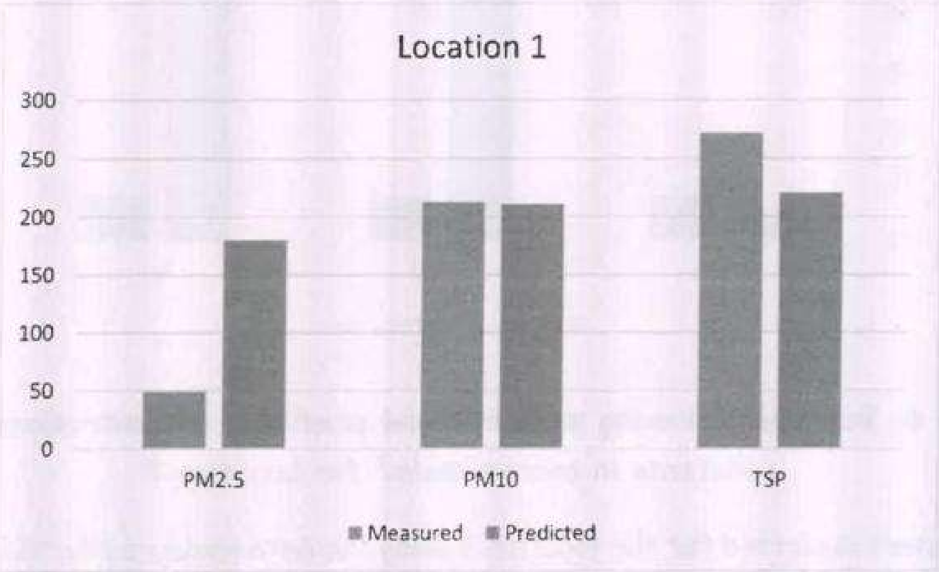

Figure 7: Bar-chart showing measured and predicted concentrations of air pollutants in microgram/m^3 for Location 1

The Bar chart is plotted for the location 2 using the data measured for different air pollutants as per Table 2 and predicted concentrations of the same mentioned in Table 7, 8 and 9. The average of measured 10 concentrations is considered from Table 2 for the Bar-chart representation as in Fig. 8.

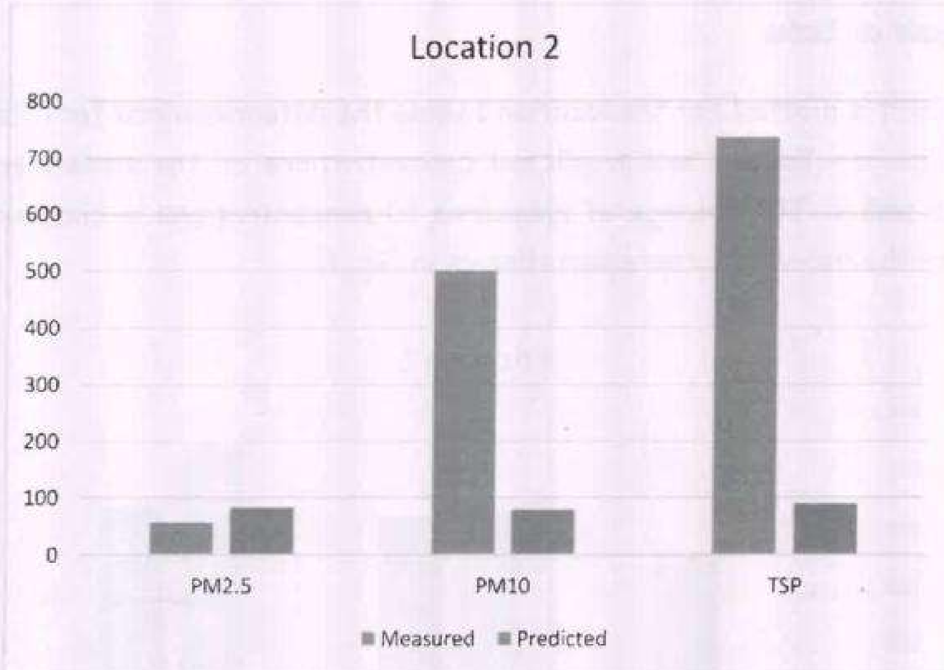

Figure 8: Bar-chart showing measured and predicted concentrations of air pollutants in microgram/m^3 for Location 2

The Bar chart is plotted for the location 3 using the data measured for different air pollutants as per Table 3 and predicted concentrations of the same mentioned in Table 7, 8 and 9. The average of measured 10 concentrations is considered from Table 3 for the Bar-chart representation as in Fig. 9.

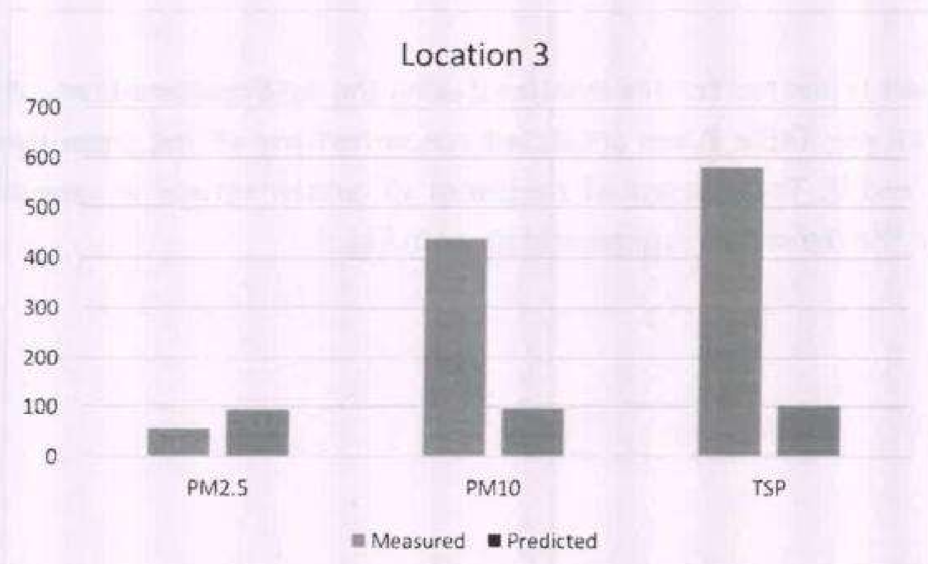

Figure 9: Bar-chart showing measured and predicted concentrations of air pollutants in microgram/m^3 for Location 3

The Bar chart is plotted for the location 4 using the data measured for different air pollutants as per Table 4 and predicted concentrations of the same mentioned in Table 7, 8 and 9. The average of measured 10 concentrations is considered from Table 4 for the Bar-chart representation as in Fig. 10.

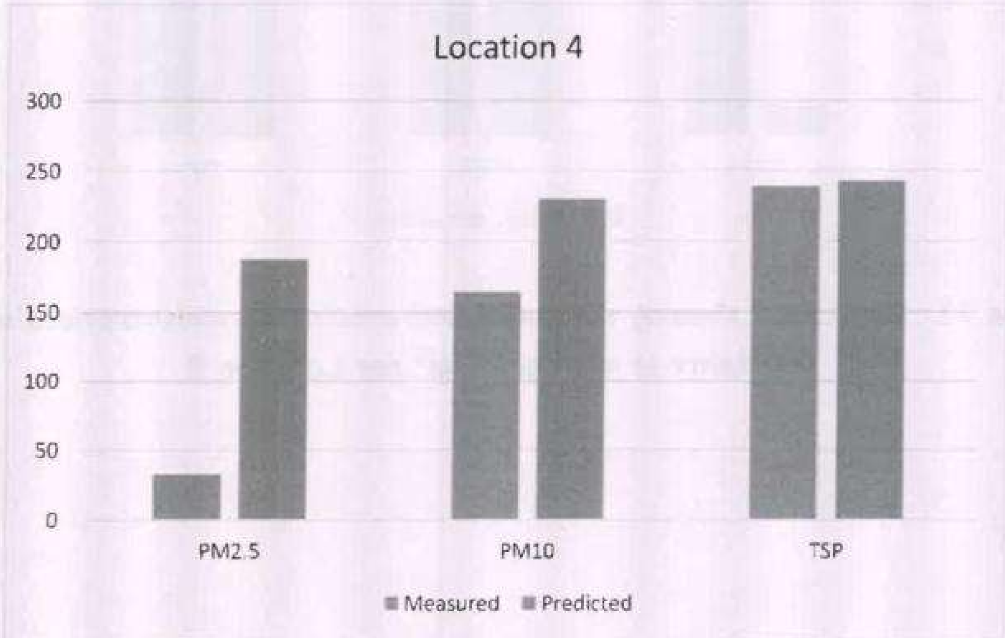

Figure 10: Bar-chart showing measured and predicted concentrations of air pollutants in microgram/m^3 for Location 4

The Bar chart is plotted for the location 5 using the data measured for different air pollutants as per Table 5 and predicted concentrations of the same mentioned in Table 7, 8 and 9. The average of measured 10 concentrations is considered from Table 5 for the Bar-chart representation as in Fig. 11.

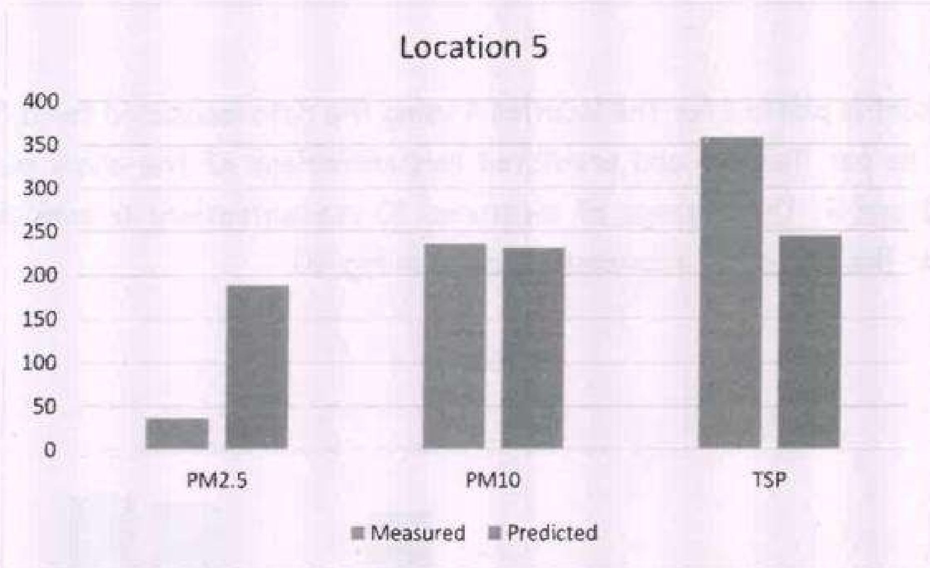

Figure 11: Bar-chart showing measured and predicted concentrations of air pollutants in microgram/m^3 for Location 5

7.0 Conclusions

As per the Bar chart plotted for different locations near and in the vicinity of wharfwall following conclusions can be drawn:

(i) Figure 7 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 49.41, 213.2 and 272.45 respectively in microgram/m^3 without wharfwall at location 1 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 180.25, 210.78 and 220.48 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 1 (in the local village) is very near to the wharfwall construction site (nearly 50 m) so there will be an increase in pollution level of $PM_{2.5}$ at the location 1.

(ii) Figure 8 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 56.1, 500.59 and 737.04 respectively in microgram/m^3 without wharfwall at location 2 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 83.17, 78.33 and 89.56 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 2 (in the local village) is away from the wharfwall construction site (nearly 150 m) so there is a decrease due to easterly wind direction in the overall pollution level at the location 2. Measured concentrations are high in comparison to the predicted concentrations because location 2 is very near to the Shaktinagar road. The transportation of the coal from the mine to the power plants might be causing more air pollution in the road vicinity.

(iii) Figure 9 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 57.69, 437.6 and 581.53 respectively in microgram/m^3 without wharfwall at location 3 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 93.49, 96.28 and 102.51 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 3 (in the local village) is away from the wharfwall construction site (nearly 250 m) so there is a decrease due to easterly wind direction in the overall pollution level at the location 3. Measured concentrations are high in comparison to the predicted concentrations because location 3 is very near to the Shaktinagar road. The transportation of the coal from the mine to the power plants might be responsible for high air pollution in the road vicinity.

(iv) Figure 10 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 32.83, 164.23 and 239.4 respectively in microgram/m^3 without wharfwall at location 4 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 188.11, 230.41 and 243.32 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 4 (in the mine) is very near to the wharfwall construction site (nearly 10 m) so there will be an increase in the overall pollution level at the location 4.

(v) Figure 11 shows that the average measured concentrations of $PM_{2.5}$, PM_{10} and TSP are 36.8, 236.06 and 358.11 respectively in microgram/m^3 without wharfwall at location 5 whereas predicted concentrations of $PM_{2.5}$, PM_{10} and TSP are 188.26, 230.44 and 244.5 respectively in microgram/m^3 after the operationalisation of wharfwall without considering any pollution control measure. The location 5 (in the mine) is very near to the wharfwall construction site (nearly 10 m) so there will be an increase in the overall pollution level at the location 5.

(vi) As per the wind-rose diagram shown in the Fig. 1 for one year, the predominant wind direction is South-East. It may be concluded that the pollution level will increase in the North-west direction after the construction of the wharfwall. The local village is on the south-east side of the mine, so the chances of increase in the pollution level due to operationalisation of the wharfwall are minimal as per the predominant wind direction.

(vii) As per the Fig. 2, a dump is located at the north side of the wharfwall whereas the predominant wind direction is North-west. Considering the distance of the toe of the dump from village is about 130-155 m as per the mine plan and predominant wind direction, the chances of recirculation of the air pollutants are minimal towards the village/settlement.

8.0 Recommendations

The following are the recommendations based on the analysis of data and conclusions:

(i) A curtain wall must be made along the length of wharfwall of 800 m towards the local village. The height of the curtain wall should be at least 5 m so that at the time of wagon loading, the dust can be arrested with in the mining area.

(ii) A fixed water sprinkler system should be developed along the length of the wharfwall so that at the time of loading and unloading of coal, it can suppress the dust quickly.

(iii) Some mobile water sprinkler system should also be made available at the time of loading and unloading as per the need if required.

(iv) Fixed fog canon must also be deployed in the vicinity of the wharfwall to efficiently suppress the dust during the operation of wharfwall. It is the most effective way to reduce the air pollution level in the concerned area.

(v) After implementing all the above-mentioned pollution control measures, the concentration levels of $PM_{2.5}$, PM_{10} and TSP may come down within permissible limits.

Disclaimer

The validity of the modelling work is limited to the data used in this study. In no case, the results of specific sections can be extended to any other similar site that might exist in the mine. Further, the modelling of air pollutants has been done based on the surface meteorological data provided by the mine. If the surface meteorological data provided by the mine contain any deviation from the condition actually prevailing in the field, the validity of the results will seize.

ANNEXURE/R-2

नार्दन कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

सिविल विभाग / CIVIL Department

CIN: U10102MP1985GOI003160
An ISO 9001, ISO 14001 & ISO 45001 Certified Company
पोस्ट-सिंगरौली कोलियरी, जिला- सिंगरौली,म.प., पिन 486889 / Post: Singrauli Colliery, Distt: Singrauli, M.P. PIN-486889
Phone 07805-256290, email: [illegible] website: www.nclcil.in

Letter no. NCL/GM(C)/234

Date: 11.05.2024

To,
Sr. DOM (Planning),
ECR, Dhanbad

Subject: Deposit work of "Providing escape line for engine with extension of Bridge and construction of control room, in motion weigh bridge and barrier at level crossing for making operationalization of wharf wall at Khadia project: reg.

Ref.: Your letter no PL/Khadia NCL/2024 Dtd 15.04.2024

Dear Sir,

This has reference to above letter, copy of which has been marked to undersigned. Genesis of this work is as under:

2. To eliminate/ reduce coal transport by road to reduce pollution and road safety consideration, wharf wall loading was envisaged through the existing rail track of old KBJ.
3. NCL is committed to NGT to construct a wharf wall to check long transport of coal through road and thus reduce environmental pollution.
4. Accordingly, NCL awarded the work of construction of wharf wall to an agency. But due to obstructions by local people in construction the contract was foreclosed and the work was assigned to Railway on deposit work basis.
5. Accordingly, railway submitted an estimate of Rs 25.64 crore (attached) in Nov'2021. The same was agreed by NCL and the amount was deposited with Railway vide cheque number 811025 dtd 04.01.2022 for Rs 51.27 lakh and cheque number 057595 dtd 14.06.2022 for Rs 25.12 crore.
6. The work was awarded by Railway to M/S KN International vide LOA Dtd 04.11.2022. As learnt, the progress of the work till date is 70%.
7. Detail plans & sections duly signed was submitted by ECR to NCL on 01.11.2023 for acceptance. The acceptance of NCL was received by Railways on 09.11.2023 (attached). As per the approved plan, the tracks (two in numbers, one for loading and other to be used as engine escape line) were to be provided on the south side of the proposed wharf wall. Out of these, one line (termed as *Old KBJ*) is an existing track requires relaying, and the engine escape line was to be laid afresh.

11.05.24

.... Contd. Page 2

During a visit of ECR Division officials, it was directed to provide the two lines on the northern side of wharf wall, instead of southern side. It is to reiterate that, southern side tracks laying decided earlier was as per the engineering plan approved by ECR which was also agreed by NCL.

In this regard, it is to apprise that there are apparent operational constraints in implementing the changed layout of track lines as suggested by ECR Divisional Officers. Citing the practical problems, Area General Manager, Khadia Area has submitted a letter number NCL/KHD/GM/24/2408 Dtd 30.03.2024 to Sr. DOM (Planning) expressing the inability to agree with changed layout. Here, it is to point out that there is a mountain of overburden (OB) dump of Khadia OCP of around 200 m high on the northern side of wharf wall. The problem lies in OB dump having its starting point (i.e. toe) near the wharf wall. Along the length of wharf wall, the toe of the dump has a distance ranging from 37.9 m to 0.6 m (enclosed layout may be refereed). On the rear side (i.e. eastern side) of wharf wall, this distance is 4 m to as close as 0.6 m. This translates to the fact that it will require removal of huge OB from the mountain to make way for the two tracks. While suggesting the changed layout. ECR inadvertently missed this aspect of proximity of OB dump and the safety aspect associated with it. It may be noted that rain cuts are a common phenomenon in dumps in monsoon that carry huge silt with it. Possibility of inundation and siltation of tracks cannot be ruled out.

Moreover, being the mining lease hold, OB dump area is governed by the provisions of Mines Act and Regulations for which, Directorate General of Mines Safety (DGMS) is the safety enforcement authority. There are set standards and parameters as far as minimum distance of OB toe from any activity/ infrastructure is concerned. In the present case, the distance being on the lower side will attract restrictive observations from DGMS.

As such, the safety of men, material and machinery takes the centre stage while deciding on laying track on northern side.

It may be noted that the work is being executed by ECR on deposit basis where the cost of the project is being borne by NCL.

If the work is completed on priority, there is possibility of despatching atleast one rake per day from this wharf wall which is in mutual interest of both ECR and NCL. So, loss of one rake per day has financial as well as environmental impact on both NCL & ECR.

In view of the above, it is requested to complete the work before monsoon, without any change, as agreed by ECR during estimation, to facilitate coal despatch from wharf wall in larger public interest (pollution) and mutual benefit of NCL & ECR (financial).

11.05.24

General Manager (Civil)/ HOD
NCL, Singrauli

Copy for kind information:

1. General Manager, ECR, Hajipur.
2. CAO, ECR, Patna.
3. DRM, ECR, Dhanbad

Copy:

1. CMD, NCL.
2. Director Technical (P&P), NCL.

...... Page 2

NORTHERN COALFIELDS LIMITED
OFFICE OF THE GENERAL MANAGER: KHADIA AREA
CIVIL DEPARTMENT
PO: KHADIA PROJECT, DISTT. SONEBHADRA(UP)-231222.

No.-2620/Kh/C/LOA/Providing One no. Wheel Washing/2299/2024/ 394 Dated- 18-08-2024

To,
M/s Shakti Engineering,
Bus Stand, Shaktinagar,
Distt.- Sonebhadra (UP)-231222

Bank A/C No. 20896454342. Indian Bank. Shaktinagar.
PAN No. AUAPS7002E
GST No. 23AUAPS7002E1Z4
Email ID- Shakti.sktn@gmail.com

Sub-LOA for the work "Providing one no. wheel washing facility with complete recirculation system at the exit gate of Khadia Project with three years AMC after one year warranty"

Ref: (i) NIT No.-GM/KHD/C/24-25/ETN-05 Dated: 22.05.2024
(ii) Tender ID No- 2024_NCL_308807_1
(iii)Your offer dated 10.06.2024

Dear Sir.

With reference to the above we are pleased to convey that your offer to undertake the subject work at a total value of **Rs. 11314769.11 (Rs. 9588787.38 + GST @18 % Rs. 1725981.73) (Rupees One Crore Thirteen lakh Fourteen Thousand Seven Hundred & Sixty Nine and paise Eleven)** only has been accepted subject to the following stipulations:

1-All the materials and equipment required for the work will be arranged by you.
2-You are required to submit the Registration/license under Contract Labour (R&A) Act. 1970 within 10 (Ten) days from the date of receipt of this letter of acceptance. if required.
3-The Performance Security (first part of security deposit) shall be **5%** of the contract value amounting to **Rs. 479440.00 (Rupees Four lakh Seventy Nine Thousand Four Hundred Forty)** only. **TheEarnest money amounting to Rs. 172400.00** deposited by you along with the tender through Axis Aggregator Bank **PRN No. 3199881058169** has been taken as part of Performance Security. All ruining account bills shall be paid @ 95% of work value without GST. This 5% deduction towards retention money will be the second part of security deposit.
4-You are required to submit the following **within 21 (twenty one)** days from the date of issue of this letter of acceptance for issuing formal work order and executing agreement for the work.
(i) **Rs. 307040.00 towards balance amount of 5%** Performance Security in acceptable form.
(ii) **Rs. 345963.08** towards amount of Additional Performance Security in acceptable form.
(iii) Copy of Income Tax PAN
(iv) Copy of **UPGST** registration Certificate & Service Accounting Code (SAC) of works/services.
(v) Copy of Memorandum and Article of Association/Power of attorney/partnership deed. if any.
(vi) Copy of CMPF/EPF Registration or Copy of Affidavit for implementation of CMPF Act.
(vii) Authorization form for e-payment duly filled-in.
(viii)PERT/BAR chart showing percentage of periodical progress for completion of work.
(ix) Non-judicial Stamp Paper for Rs. 500/-.of UP State.
(x) Copy of the letter of handing over the site.
(xi) A certificate from practicing Chartered Accountant having a valid Membership Number for complying of Anti-Profiting Clause U/S 171 as well as Office Memorandum F. No. 296/07/2017-CX.9 dated 15.06.2017 issued by Department of Revenue. Ministry of Finance. GOI. if required. If Security Money is deposited in the form of Bank Guarantee. it should be issued through Structural financial Messaging System (SFMS) Platform as per format given in the Tender Document.

(xii)That you have to take necessary insurance for the full contract period for (i)Workmen compensation policy . (ii) Contractors all risk policy in the joint name of **Northern coalfields limited and the contractor.** The policies and certificates for the insurance as per clause no. 13 (xviii) of General Terms &Condition of Tender document shall be delivered by you to the Engineer-in-charge for his approval before commencement of the work .

5- The work shall be completed within **1580 (One Thousand Five Hundred Eighty)** days (i.e **120** days for construction & **1460** days for operation & maintenance. total period 1580 days). The work shall be deemed to have commenced on the expiry of 10 (ten) days from the issue of Letter of Acceptance of Tender or 7(Seven) days after handing over the site of work whichever is later.

6- In case you, without reasonable cause or valid reasons, commits default in commencing the work as per clause no 5 of the LOA, the company shall, without prejudice to any other right or remedy, be at liberty, by giving 15 day's notice in writing to you to commence the work, failing which to **Forfeit the Earnest Money** deposited by you, rescind the Letter of Acceptance of Tender/Work order and debarring to take part in the future re-tender along with other actions as per tender documents.

7. In case you fail to submit the performance security and Additional performance security, if any within 21 days

a) Then the award of the work shall be cancelled with forfeiture of earnest money.

b) Debar from participating in future tenders for a minimum period of 12 months as per NIT.

8- The work should be executed as per General Terms & Conditions, Additional Terms & Conditions, Special Terms & Conditions, CPWD Specification/BIS Standards/description of the items of the accepted Tender documents and instructions of EIC.

9- You shall not pay less than the minimum Wages Act or such other legislation or award of minimum wages fixed by the respective State Govt. Or Central Govt. as may be in force.

10-You should ensure implementation of CMPF and Miscellaneous Provision Act 1948 or Employees Provident Fund and Miscellaneous Provisions Act. 1952 as the case may be and allied scheme framed there under in respect of workers deployed by you and will have to recover statutory dues and deposit the same along with employer's contribution (Contractor's share) to the respective CMPF/EPF Office and to submit statutory returns under intimation to Principal Employer.

11-All Texas (Except GST), local, municipal, provincial or central etc. and cess, royalties etc as payable shall be to the contractor's account and shall be deemed to have been included in the tendered rate for the work to be executed.

12- Regarding GST, the following may please be noted:

a- GST will be reimbursed on production of uploaded invoice/documentary evidence. Amount of statutory levies like CGST, SGST or IGST will be released when the same will appear in GSTR-2A of NCL in the common portal of GST and after submission of documentary evidence of deposition of GST taxes and filing of GST returns.

b-You will have to pass in input tax credit by way of enclosing original tax input invoice with bill.

c- All invoice submitted by you will have to be in the form of GST invoice giving all details as required under the law. You will raise invoice strictly adhering to provisions of Section 31under CGST Act 2017 along with Rule 46 & 47 of CGST Rule, 2017. You will indicate the rate as well as amount of CGST. SGST or IGST in invoice. You will upload the details of invoice on GST portal as per provisions of GST Act. Invoice issued by you should bear GST Registration Number of NCL(23AABCN4884HEM1ZE (MP) & 09AABCN4884H1Z4 (UP) to enable NCL to claim input tax credit.

d-You will file all the Returns and details as applicable under GST laws & rules with due dates.

e-You will give an undertaking on invoice or as separate Annexure along with the invoice that the Invoice/applicable GST returns has been/will be uploaded on GST Portal within due time as prescribed in CGST Act and CGST. SGST or IGST has been deposited as per the provision of GST Act and rules thereof.

f- If there is any delay of payment against the invoice due to your fault and if any reversal of input tax arises, the same will be recovered from you along with interest and penalty if any, as paid by NCL/Khadia Project due to reversal.

g-In case the GST rating of vendor on the GST Portal/Government's official website is negative/black listed at any stage even after award of work, NCL has right to cancel the letter of award.. NCL shall not be obliged or liable to pay or reimburse GST to such vendor and shall also be entitled to deduct/recover such GST along with all penalties/interest, if any incurred by NCL.

h-You will issue credit note as per provisions of Rule 53 of CGST Rule, 2017 on quality deduction or liquidated damages, if any arises.

i- If you default in uploading the invoice/applicable GST returns or default in deposit of applicable GST taxes, NCL reserves the right to upload such defaulter on NCL website and may also debar you from participating in future tenders for a minimum period of one year.

13.

Sl No	Estimated cost put to tender incl GST	Quotes % by L-1 bidder w.r.t estimated cost put to tender	Accepted/awarded amount incl GST
1	Rs. 13791771.22	-17.96%	Rs. 11314769.11

14. As per Clause no. 8.4 of NIT, only material conforming to approved samples shall only be brought to site, as such, you immediately contact Project Engineer (C) & Incharge of the work for the approval of samples of materials to be used in the work.
15. The Project Engineer(C)/Khadia shall be Incharge of the work (ICW hence forth) and Second Level Check Officer. Please contact the ICW/Project Engineer(C) for receiving work details, scope of work, drawings, sites & instructions regarding commencement of work.
16. **SO(C)/Khadia will be Engineer-In-Charge of the work (EIC).** The ICW shall be authorized representative of EIC for the work.
17. The ICW/authorized representative of EIC is to ensure the list of approved materials to be used in the work is conveyed to the contractor in writing alongwith a copy to Quality Control Cell, HQ before commencement of work as per Clause 8.4 of NIT.

18-You are hereby requested to contact Manager(P)/Nodal Officer Biometric Attendance/Khadia and to observe following system regarding Attendance & payments of contract workers and bill payments for the work:-

(i) All the contract workers engaged for the subject work shall be covered with Biometric Attendance system for payment of wages, which is under control of Nodal Officer (Biometric Attendance) of Personnel Department.

(ii) You are requested to issue photo I-card to contract workers engaged for the work, containing details like Name, AADHAR No., LOA No. and photograph and ensure their registration in the Biometric Attendance system under close supervision of Nodal Officer (Biometric Attendance)/Khadia.

(iii) Accordingly, Nodal Officer (Biometric Attendance)/Khadia will provide copy of the I-card alongwith Biometric Registration details of individual contract workers to the civil Engg. Department.

(iv)You shall ensure submission of **Monthly Attendence Sheet** of daily attendance of contract workers to the respective **Site In-Charge** of the work, which will be sent to the Nodal Officer (Bio-metric Attendance)/Khadia after due certification.

(v) Nodal Officer (Biometric Attendance)/Khadia will issue LPC (Labour payment certificate) on monthly basis to you, as per monthly attendance sheet sent from civil department. No RA bill or final bill shall be sent to the personnel department for any certification on the bills.

(vi)You are to follow the above system without any lapses/fail, otherwise, all the onus will lie on you in case of otherwise, and you will be responsible solely as such for any losses &/or delays in payment for the work executed & accepted by the department.

19- All the clauses of safety code on the tender document, as laid down in additional safety measures to be taken by the contractor, are to be strictly followed.

20- Please contact **Project Engineer(Civil)/Khadia** for commencement of the work.

Encl -BOQ

Yours faithfully,

18/08/2024

Staff Officer (C)
Khadia Area.

Copy to:
1) GM/Khadia Area.
2) GM(C)/NCL/Singrauli.
3) PO/KHD

4) AFM/Khadia: - Ref to: Capital Budget No.-KHD/CB/24-25/Environment/172/01 dtd. 12.08.2024 for Rs. 7083772.91 against Capital Budget BE 2024-25 Point NO. 15.1. & Revenue Budget vide FD No.-FC/AFM/KHD/2024-25/ENVIRONMENTAL EXP/92/34 for Rs. 286946.78 and Dated 11.08.2024 & Noted for 2025-26 Rs.1147787.14, 2026-27 Rs.1147787.14, 2027-28 Rs.1147787.14, 2028-29 Rs 860840.35 however fund will be certified in the respective years of expenditure subject to availability & provisio of budget.
5) SO (P), Khadia Area- with a request to observe minimum wages etc. as per laid down guidelines.
6) Area Safety Oficer/Khadia Area- To observe safety norms.
7) ALC(C)/LEO(C), Allahabad, 189/A-4, Alopibagh, PO-Daraganj, Prayagraj(UP)
8) Project Engineer (Civil)/Khadia Project, SLC Officer
9) Dy. Manager(Civil)/Mines, Khadia Project, FLC Officer. (First Level Check Officer)
10) Sri B. K. Shukla, EA(C), Khadia , MEL. Engineer and Site In-Charge(SIC)

कार्यालय क्षेत्रीय वन अधिकारी खड़िया प्रोजेक्ट,रेनुकूट वन प्रभाग,(सोनभद्र)
पत्रांक– 17 /रेनुकूट/29(वृक्षारोपण) दिनांक,रेनुकूट, सितम्बर, 14, 2024

ANNEXURE R-4

50

सेवा में,

महाप्रबन्धक
एन.सी.एल. खड़िया प्रोजेक्ट ।

विषय:– वृक्षारोपण वर्ष 2024–25 (वर्षाकाल 2024) में रोपित किये गये पौधों का प्रजातिवार विवरण के सम्बन्ध में ।

महोदय,

उपरोक्त विषयक के क्रम में सादर अवगत कराना है कि एन.सी.एल. खड़िया प्रोजेक्ट द्वारा वृक्षारोपण वर्ष–2024–25 (वर्षाकाल 2024) में 18175 पौधों के रोपण हेतु लक्ष्य आवंटित किया गया था उक्त आवंटित लक्ष्य के अनुरूप प्रजातिवार पौधों का रोपण निम्न विवरण के अनुसार किया गया है–

वृक्षारोपण वर्ष–2024–25 (वर्षाकाल 2024) में रोपित पौधों का प्रजातिवार विवरण:–

क्र0सं0	प्रजाति	रोपित पौध संख्या
1	शीशम	1500
2	बोगनवेलिया	500
3	चिलबिल	700
4	कनेर	200
5	कंजी	2000
6	एकेसिया ऑरीकुला	500
7	बरा	800
8	कैसियास्यामिया	500
9	कचनार	100
10	आंवला	600
11	कैसियाफिस्टुला	500
12	ग्लोरीसिडिया	500
13	बेल	100
14	[illegible]	2200
15	जंगल जलेबी	100
16	सुबबूल	200
17	अमरूद	100
18	जामुन	200
19	आम	150
20	महुआ	300
21	अनार	100
22	इमलिया	1500
23	अशोक	100
24	नीम	2200
25	[illegible]	200
26	पीपल	300
27	बकायन	1500
28	अन्य प्रजाति	525
	योग–	18175

अतः महोदय की सेवा में सूचनार्थ एवं आवश्यक कार्यवाही हेतु रिपोर्ट प्रेषित है।

भवदीय

(धीरेन्द्र कुमार मिश्र)
क्षेत्रीय वन अधिकारी,
खड़िया प्रोजेक्ट रेंज,
रेनुकूट वन प्रभाग,रेनुकूट

नार्दर्न कोलफील्ड्स लिमिटेड
Northern Coalfields Limited
(मिनीरत्न कंपनी))A Miniratna Company)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी ((A subsidiary of Coal India Limited)
Office of the General Manager, Khadia Project

CIN- U10102MP1985GOI003160
ISO 9001, ISO 14001, ISO 27001 & ISO 45001 Certified Company
थाना - शक्तिनगर, जिला सोनभद्र (उ.प्र.), पिन 231222 / Thana-Shaktinagar, Distt. Sonebhadra (U.P.), Pin- 231222
Phone: 05446- 232274, Email: gmkhd.ncl@coalindia.in, Website: www.nclcil.in

Ref. no.: NCL/KHD/GM/W/2025/4624 Date: 02/01/2025

To,
The Dy. CEN(C)/Con
East Central Railway,
Renukut.
Email ID: dyceconrnq@gmail.com

Subject: Regarding status of Deposit work of "Providing Escape line for engine with extension of bridge and construction of control room, In-motion Weigh Bridge and barrier at level crossing for making operationalization of Wharfwall at Khadia Project".

Ref.: Mail from our office dated 16.05.2024

Dear Sir,

The subject matter of construction of Wharfwall is currently in Hon'ble NGT. The next hearing of this case is going to be held on 07.01.2025. One of the participants in Joint Committee formed by Hon'ble NGT is Uttar Pradesh Pollution Control Board (UPPCB), and they have demanded the current status of construction of Wharfwall and tentative time required for the completion of the said work along with any shortfalls.

You are requested to please provide expected date of completion of the work in all respect including level crossing, signalling system, in-motion weigh bridge, environmental measures, sprinkler system etc. as per the recommendations of IIT, BHU.

Yours faithfully,
2/1/25
Area General Manager
Khadia Area, NCL.

Copy to:-
1. Staff Officer (Civil), Khadia Area
2. Staff Officer (Mining), Khadia Area

1698065 Sprinkler
5169609.

नार्दर्न कोलफील्ड्स लिमिटेड
Northern Coalfields Limited
(मिनीरत्न कंपनी) (A Miniratna Company)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी ((A subsidiary of Coal India Limited)
Office of General Manager
Khadia Area, NCL
CIN- U10102MP1985GOI003160
ISO 9001, ISO 14001, ISO 27001 & ISO 45001 Certified Company
पोस्ट-सिगंरौली कोलियरी, जिला- सिगंरौली (म.प्र.) पिन 486889 / Post- Singrauli Colliery, Distt- Singrauli (M.P.), PIN-486889
Phone: 05446- 232274, (FAX) 05446- 232274, email: cgm.khd@gmail.com website: www.nclcil.in

Ref: KHD/GM/ESP/2024-25/4678 **Date:** 31.01.2025

To,
The Dy. Chief Engineer/Con.
E.C. Railways
Renukut
Distt. - Sonebhadra
Email id- dyceconrnq@gmail.com

Sub: Submission of Engineering Scale Plan & Time frame for completion of Work.
Ref: Deposit work of "Providing Escape line for engine with extension of bridge and construction of control room, In-motion WeighBridge for making operationalization of Wharfwall at Khadia Project".

Dear Sir,

It has been bought to my attention that the ESP has been approved by the competent authority. Kindly arrange to send a copy to the undersigned's office for filing an affidavit before the Honorable Supreme Court regarding the commitment of work.

Additionally, the progress of the CHP-RLS project is delayed due to the pending ESP. Therefore, you are requested to provide the tentative timeline for completion along with an estimate of the remaining work.

Thanking you

31.01.2025
Area General Manager
Khadia Area

Copy to:

- TS to DT(P&P), NCL, Singrauli
- Sr. DEN/Co-ordination/DHN, ECR, Dhanbad
- GM(C)/HOD/NCL, Singrauli

cc: SO(C), KHD

Technical Report of a Scientific Study on

"Evaluation of the Effectiveness of Measures Taken By Khadia Project to Control the Air and Water Pollution from the East Dump and Pollution Control/Mitigational Measures to Minimize Pollution Load"

ANNEXURE R-7

Prof. Aarif Jamal

Prof. Rajesh Rai

Dr. Amrendra Kumar

Department of Mining Engineering

Indian Institute of Technology (BHU), Varanasi

Final Report

On

"EVALUATION OF THE EFFECTIVENESS OF MEASURES TAKEN BY KHADIA PROJECT TO CONTROL THE AIR AND WATER POLLUTION FROM THE EAST DUMP AND POLLUTION CONTROL/MITIGATIONAL MEASURES TO MINIMIZE POLLUTION LOAD"

Submitted To
NORTHERN COALFIELDS LIMITED
KHADIA AREA
SHAKTINAGAR, SINGRAULI-231222
UTTAR PRADESH

by

06.2.2025

Prof. Aarif Jamal

Principal Investigator
Professor

Co-investigators

6/02/2024

Prof. Rajesh Rai
Professor

06/02/25

Dr. Amarendra Kumar
Associate Professor

DEPARTMENT OF MINING ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY
BANARAS HINDU UNIVERSITY,
VARANASI-221005, INDIA

Title of Consultancy Project

Evaluation of the Effectiveness of Measures Taken by Khadia Project to Control Air and Water Pollution from East Dump and Pollution Control/Mitigation Measures to Minimize Pollution Load

(i)	Name of the Principal Investigator:	**Prof. Aarif Jamal** Professor and Former Head, Department of Mining Engineering, Indian Institute of Technology (BHU), Varanasi-221005
(ii)	Name of Co-investigators:	**Prof. Rajesh Rai** Professor, Department of Mining Engineering, Indian Institute of Technology (BHU), Varanasi-221005 **Dr. Amrendra Kumar** Associate Professor, Department of Mining Engineering, Indian Institute of Technology (BHU), Varanasi-221005

Acknowledgement

We express our sincere gratitude to the Staff Officer (Mining), Khadia OCP, for entrusting the Department of Mining Engineering, IIT (BHU), Varanasi with the consultancy project titled "*Evaluation of the Effectiveness of Measures Taken by Khadia Project to Control Air and Water Pollution from East Dump and Pollution Control/Mitigation Measures to Minimize Pollution Load*".

We would like to extend our appreciation to Mr. Kamran Mehdi and Dr. Vikas Pandey, who served as Project Technical Officers, for their crucial efforts in preparing this report.

We also acknowledge the valuable contributions of the research personnel involved in the project, including Pawan Kumar Patel, Praveen Kumar, Dinesh Kumar Rai, and Pervez Akhtar, who worked as Project Assistants, and Rishi Raj and Anand Kumar, who contributed as Project Helpers. Their dedication to fieldwork, data collection, and analysis was instrumental in completing the study.

We are especially grateful to the Khadia OCP for their continuous support, including facilitating field visits, providing necessary documents, and assisting with logistics. Their provision of accommodation and transportation for fieldwork significantly contributed to the smooth execution of this study.

We sincerely appreciate all individuals and organizations involved in making this project a success.

06.2.2025

Prof. Aarif Jamal

Preface

Environmental sustainability in opencast mining operations remains a critical challenge, especially in regions where mining activities are conducted in close proximity to human settlements. Recognizing the concerns associated with overburden dumping at the Khadia Project, Northern Coal Limited (NCL), the Hon'ble National Green Tribunal (NGT), in the case of Mukesh Singh v. State of Uttar Pradesh (O.A. No. 580/2022), mandated an investigation into the environmental impact of the East overburden dump site near Nawatola Basti, Sonbhadra, Uttar Pradesh. The findings of the Joint Committee emphasized that relocating the dump material was not feasible and instead recommended a third-party study to assess the effectiveness of the existing pollution control measures and propose further improvements.

In response to this recommendation, the Staff Officer (Mining), Khadia OCP, commissioned a consultancy project to the Department of Mining Engineering, IIT (BHU), Varanasi to evaluate the air and water pollution control measures at the East dump and suggest mitigation strategies to minimize its environmental impact.

Over a four-month period, the study involved extensive monitoring of both air and water quality. Air quality assessments indicated that the daily particulate matter concentrations ($PM_{2.5}$ and PM_{10}) exceeded permissible limits. The air was characterized as moderately polluted, and heavy metal analyses revealed that the finer particulate matter contained higher levels of toxic metals—primarily Fe and Cr, followed by Ni, Zn, Mn, Pb, Cu, Cd, and As. Meteorological observations noted predominantly calm wind conditions, which tended to allow pollutants to remain concentrated near their sources. In parallel, water quality investigations showed that both surface and groundwater samples met the prescribed physicochemical and heavy metal standards, with overall water quality being rated as good.

This report is organized into eight chapters that comprehensively cover the project. The initial chapters introduce the study area and outline the work order and methodology used for air and water quality assessments. Subsequent sections detail the existing pollution control measures at the Khadia Project and the impact of the East dump on environmental quality. The latter part of the report evaluates their effectiveness of the control measures and is followed by a summary, conclusions, and recommendations for enhancing pollution control measures.

06.2.2025

Prof. Aarif Jamal

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Chapter 1: Introduction

1.1 Background:

The Khadia Opencast Project (OCP) is one of the operational mines in the Moher sub-basin of the Singrauli Coalfield (SCF). Socio-economically, the SCF region is known as Urjanchal, meaning the 'Land of Energy'. Since the discovery of coal in Singrauli in 1840, the region's development has predominantly centred on the exploitation of this mineral resource (Singh, 2020). Mining of coal at present is confined in the north-eastern part of the Singrauli coalfield. The Singrauli region hosts more than 10% of the total installed thermal capacity of the country. The existing Khadia OCM has a coal production rate of 14 MTPA. In 2022, the Ministry of Environment, Forest and Climate Change (MoEF&CC) granted environmental clearance to increase the production capacity to 15 MTPA. The EC was revalidated by MoEF&CC on 7/02/2024. It is estimated that the total extractable reserve is 296.85 Mt and as of 2022 around 152.31 Mt has been mined.

1.2 Location and Accessibility:

The Khadia OCP is covered under Toposheet no. 63-L/12, between Latitude 24°06'50.68" to 24°08'59.22" N and Longitude 82°41'20.91" to 82°44'27.55 E. It is partly located in the Sonbhadra District of Uttar Pradesh and partly in the Singrauli District of Madhya Pradesh. **Figure 1** shows the location map of the Khadia OCP. The total mine lease area of the Khadia Project is 1640 ha. The nearest major city is Singrauli. It is connected by a metalled road to NCL headquarters in Singrauli, as well as to the Shaktinagar-Varanasi Highway and the Rewa Highway. The nearest railway station is Shaktinagar on the Eastern Railway line and the nearest airport is the Lal Bahadur Shastri Airport, Babatpur. The northern boundary of the project is bordered by MP Forest Land, the western side by the Dudhichua Project, and the eastern side by the Krishnashila Project. On the southern side, there are National Thermal Power Corporation's Shaktinagar and Vindhyanagar superthermal power stations.

1.3 Topography:

The topography of the region has been altered significantly since the commencement of mining in 1984. Presently, the Khadia block emerges prominently as a plateau rising above the southern plains. This plateau is characterized by a steep escarpment on its southern face, ascending from a base elevation of 290 m to a summit of 425 m. The plateau's surface is generally gently undulating, except for a single hill in its northeast corner, which reaches an altitude of 489 m. The overall elevation of the plateau ranges between 420 and 440 m.

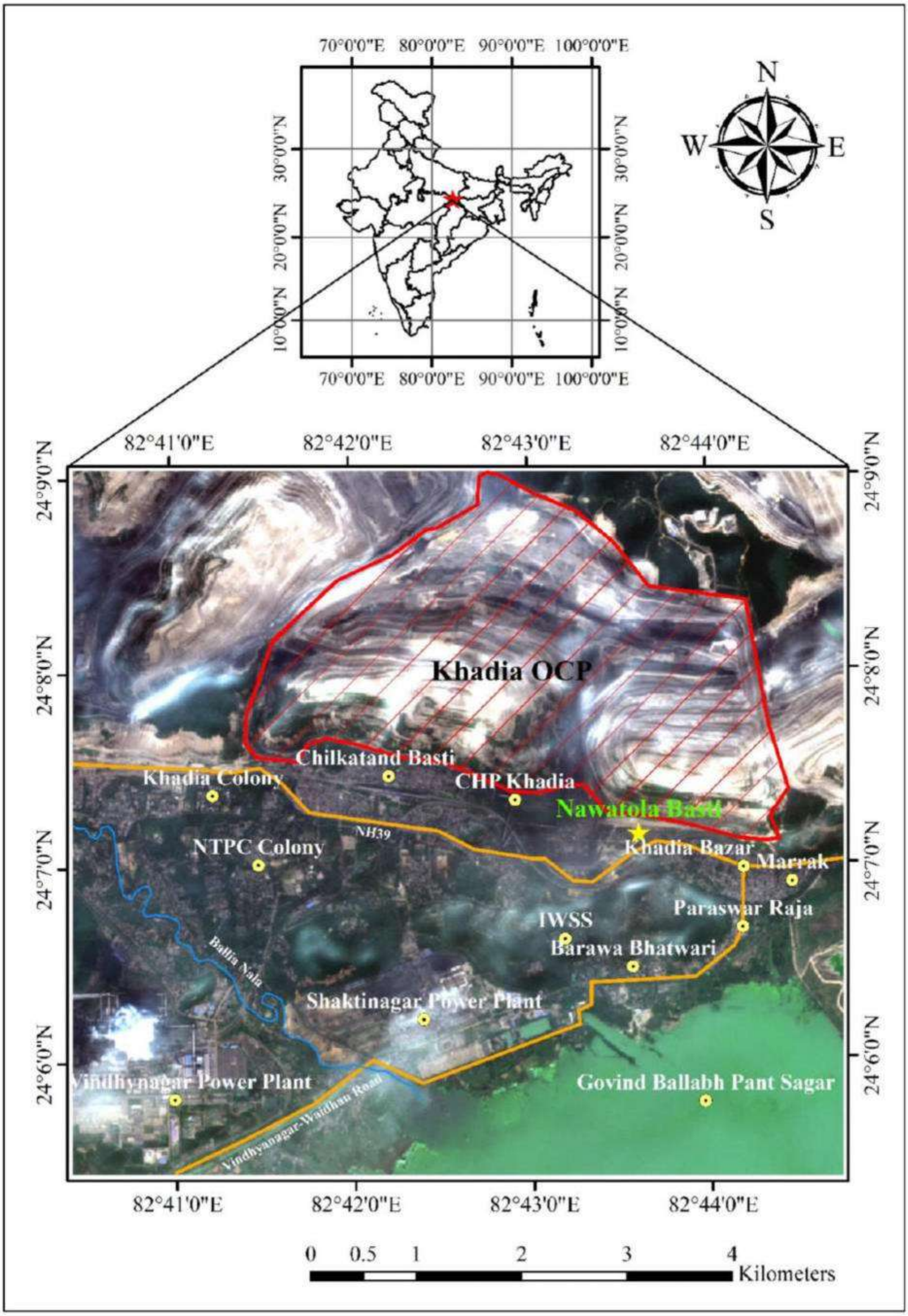


Figure 1: Location Map showing the Khadia OCP and Nawatola Basti based on Sentinel-2 Level-2A imagery acquired on 25 October 2024 from Copernicus Browser

1.4 Climate:

The general climate of the Singrauli region is semi-arid. Winter begins in late November and lasts until early March, followed by summer from March to mid-June, with May being the hottest month. The southwest monsoon sets in by mid-June and continues until the end of September. The post-monsoon season, marked by retreating monsoon conditions, occurs during October and November. The region receives an average annual rainfall of 1132.7 mm, with about 89% occurring between June and September, with July being the wettest month (338.2 mm). The remaining 11% of rainfall occurs from October to May. Humidity is lowest in April, at around 35%, while the southwest monsoon brings peak humidity levels, reaching 85% in August due to heavy rains. In October, humidity decreases with rising temperatures and the retreat of the monsoon. The region's daily mean annual relative humidity is 66%. The predominant wind direction is from the North-East quadrant. The daily annual mean wind velocity of the region is 3.6 km/hr.

1.5 Land Use:

The total leasehold area of the project is 1640 ha which includes 844 ha of forest land, 347 ha of government land and 449 ha of tenancy land. A pie chart shown in **Figure 2** illustrates the distribution of land use in percentages within the mine's leasehold area.

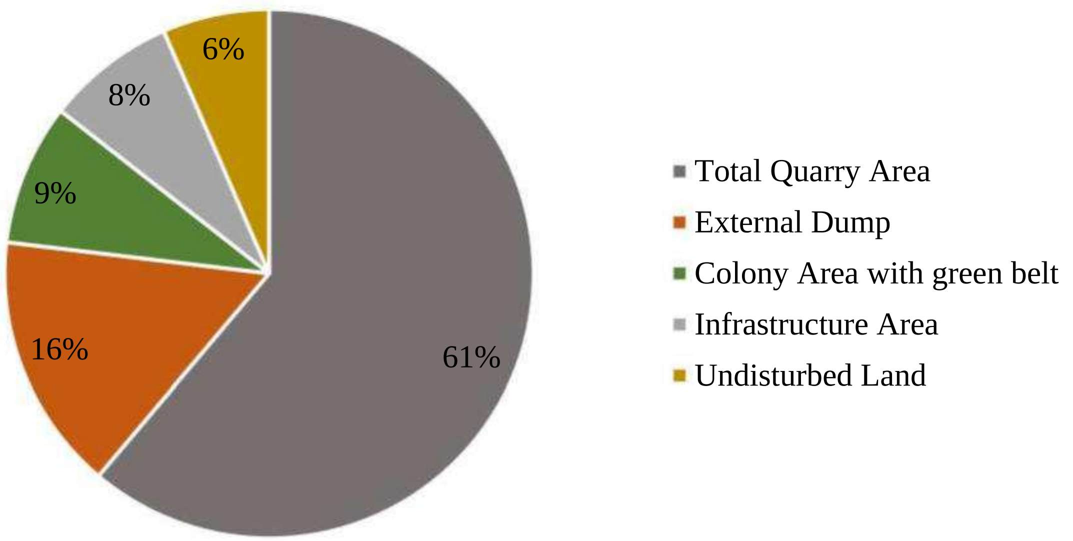


Figure 2: Land Use in the Mine's Leasehold Area

1.6 Drainage:

The drainage system of the Khadia OCM is governed by the Senduri and Hadwaria Nallahs, located in the morphologically distinct southern section of the Moher Basin. These nallahs serve as tributaries to the Ballia Nallah, which eventually discharges into the Govind Ballabh Pant (GBP) Reservoir. Chatka Nala and Tippa Jharia Nala are natural drainage features found on the northern dip side of the project.

The catchment area of the mine is divided into three sections: East Section S1, West Section S2 and West Section S3 covering a total area of 6.39 km^2. To manage water inflow, the mine relies on a combination of sump storage and pumping. Presently, the total existing sump capacity across all three sections is insufficient. A total sump capacity of 9,14,500 m^3 has been proposed to address the shortfall. Additionally, the drainage plan includes standby pumps to ensure operational flexibility.

1.7 Geology:

1.7.1 Regional Geology:

The Singrauli Coalfield, the northernmost part of the Central Indian Coalfields, consists of two distinct techno-sedimentary domains: the Main Basin in the western part, covering an area of 1890 km^2, and the Moher Sub-basin in the northeastern part, spanning 312 km^2. These basins are separated by a NW-SE trending high basement. Among the two, the Moher Sub-basin is the most promising region, and currently, coal mining activities are concentrated in this area. Khadia OCP is situated in the southeastern part of the Moher sub-basin. The general stratigraphic sequence of Singrauli Coalfield (as per GSI, 1977) is shown in **Table 1**.

Table 1: General Stratigraphic Succession of the Singrauli Coalfield

Age	Group	Formation	Lithology	Thickness (m)
Cretaceous		Intrusive	Dolerite dykes and sills	Not estimated
Upper Triassic	Upper Gondwana	Mahadeva	Coarse-grained, ferruginous sandstone with bands of shale, clay and conglomerate.	Not estimated
Lower Triassic	Lower Gondwana	Panchet	White, greenish-white and pink micaceous, medium to coarse-grained sandstone with red beds, greenish-brown silty shales and conglomerates.	Not estimated

Upper Permian		Raniganj	Fine-grained sandstone and shales with coal seams including 134 m Jhingurdah seam.	215-403
Middle Permian		Barren Measures	Very coarse-grained to ferruginous sandstone, green clay and shales	125-300
Lower Permian		Baraker	Medium to coarse-grained sandstones, shale, clay and coal seams.	325-600
Upper Carboniferous		Talchir	Tillites, sandstone, siltstones, needle shales	75-130
--------------------Unconformity-----------------------				
Precambrian	Phyllites, quartzites, schists and gneisses			

1.7.2 Geology of the Khadia Mine:

The Khadia coal mine features multiple coal seams with varying thicknesses and depths. The Purewa Top seam, with a thickness of 7–10.35 m, lies at a depth of 35.35–76.20 m, followed by a parting of 30.34–43.70 m. Below this, the Purewa Bottom seam, 7.10–13.39 m thick, occurs at a depth of 74–139.50 m, separated from the Turra seam by a parting of 52.40–64.28 m. The Turra seam, 18.41–22.93 m thick, lies at a depth of 13.40–209.27 m. The seam gradient ranges between 2° and 4°, with an average stripping ratio of 4.61 m^3/t. The strike exhibits a gradual transition from an NW-SE orientation to an NE-SW direction, curving in the eastern part of Khadia and shifting to an N-S trend in the Bina and Kakri blocks. The area is devoid of any faults; however, two prominent sets of vertical joints (NE-SW and NW-SE) and one less prominent set of joints (E-W) have been observed. Mining operations are conducted at working depths of 158–280 m (EMP-Khadia, CMPDI, 2023). Other seams viz., Kota and Khadia have not been extensively explored due to their thin, discontinuous, and inter-banded nature. These seams belong to the Baraker Formation of the Gondwana Supergroup. The average grade of coal is G-8 (4900-5200 KCal/Kg).

The total overburden as per the project report is 1255.72 Mm^3. By 2023, about 660.05 Mm^3 of overburden had been removed. The East dump, operational since 2002, covers 100.84 ha of external dumping area and 105.6 ha for internal dumping. By 2022, 109.88 Mm^3 of overburden had been deposited in the external section, while 100.36 Mm^3 had been placed in the internal section. The average monthly dumping rate at the East dump is around 2 Mm^3. The height of each dump deck is restricted to 30 meters with individual slopes maintained at 37°. The overall slope of the East dump is approximately 22°. The maximum RL of the East dump is 501.5 m from the MSL which shall be finalized at RL of 530m from MSL as per approved project report.

1.8 Environmental Challenges of Opencast Coal Mining:

The environmental impact of opencast coal mining is shaped by various factors, with the scale and severity of these impacts being influenced by local site conditions. The environmental effects during the operation of an opencast mine typically involve visual disruption to the landscape, air pollution, surface runoff, flooding, noise pollution, vibrations from blasting, water contamination, and coal transportation impacts. Many of these issues are more influenced by factors such as the surrounding rock geology, mining methods, climate, hydrology, reclamation techniques, and the presence or absence of regulations and their enforcement, rather than the petrography or geochemistry of the coal or the disturbed strata (Suarez-Ruiz & Crelling, 2008). A study conducted in 2020 observed significant land-use/land-cover changes in the Singrauli region between 2000 to 2016, with a fourfold rise in overburden, threefold in dumping yards, 2.5 times in urban areas, and a twofold increase in mining areas (Bhardwaj et al., 2020). In the same region, between 1976 to 2015, it was observed that the total area of dense forest decreased by 2.34 times, while the open forest area decreased by 1.79 times (Ahmad and Goparaju, 2017).

In cognizance of the repercussions of OCMs and the allegations raised regarding the dumping of overburden by the Khadia Project of the Northern Coal Limited (NCL), the honourable National Green Tribunal in *Mukesh Singh v. State Of Uttar Pradesh*; O. A. No. 580/2022 constituted a Joint Committee in 2022 to investigate and provide recommendations. The case pertains to Nawatola Basti (shown in **Figure 1**), located in Khadia, Dudhi Tehsil, Sonbhadra, Uttar Pradesh. According to the district administration, about 134 houses are located within 100 meters of the East dump site. This Basti has an aerial extent of 584.85 ha with a population of 1,190 as per the Census of India, 2011.

The committee observed that relocating the vast volume of material at the East dump site was not feasible. However, it emphasized the need for alternative solutions to safeguard the local population and mitigate environmental harm. Among its recommendations, the committee proposed conducting a third-party study through a reputable organization to assess the effectiveness of existing pollution control measures and suggest improvements for enhanced environmental management. Consequently, a consultancy project was awarded to the Department of Mining Engineering, IIT BHU by the Staff Officer (Mining), Khadia OCP to evaluate the effectiveness of pollution control measures at the East dump and provide recommendations for improvement.

Chapter 2: Work Order Assigned

The work order focuses on addressing environmental concerns associated with the East dump of the Khadia Project. The assigned tasks include:

1. *Collection of air and water samples at appropriate locations.*
2. *Evaluation of the effectiveness of measures taken by the Khadia project to control the air and water pollution from the east dump.*
3. *To suggest augmentation of Air & Water Pollution Control / Mitigating measures to be adopted with an aim to zero negative impact on nearby habitation.*
4. *Preparation and Submission of report*

The objectives outlined in the work order for addressing environmental concerns related to the East dump of the Khadia Project represent a crucial step toward sustainable mining practices. The project establishes a robust scientific basis for evaluating the current state of pollution levels and understanding the extent of their impact on the surrounding environment. The evaluation of existing pollution control measures identifies potential gaps or inefficiencies in the current systems. Further, the directive to suggest improvements to air and water pollution mitigation strategies emphasizes compliance with regulatory standards and a commitment to minimizing adverse effects on nearby communities.

Chapter 3: Background and Methodology

The following methodology has been designed to align with the project's objectives, providing a thorough evaluation of current pollution control measures. It also aims to recommend improvements to air and water pollution controls, with the ultimate goal of minimizing negative impacts on nearby communities. Given that the case pertains to Nawatola Basti, much attention was directed toward this area. This focused approach allows for a granular understanding of the specific challenges faced by the people in Nawatola Basti.

3.1 Air Pollution Study

Opencast mining poses a substantial threat to air quality compared to underground mining due to its extensive surface operations. The primary emissions associated with coal mining include particulate matter (PM), sulphur dioxide (SO_2), oxides of nitrogen (NO_X), and heavy metals (Jamal et al., 1992; Pandey et al., 2014). The main sources of air pollution in coal mining regions stem from activities such as drilling, blasting, overburden loading and unloading, coal handling and transportation, haul roads, stockpiles, exposed overburden dumps, coal handling plants, open pit faces, coal yards, and ore yards (Dhar et al., 1991). The generation of fugitive dust mainly occurs due to two physical processes: the pulverization and abrasion of surface materials through mechanical forces applied by equipment such as wheels and blades, and the entrainment of dust particles by turbulent air currents, particularly from wind erosion of exposed surfaces (USEPA, 2006).

These pollution sources are broadly categorized into two types: point sources and nonpoint (or fugitive) sources. Point sources refer to stationary facilities emitting pollutants from specific, identifiable locations. In contrast, nonpoint sources release pollutants over a broad area, resulting in diffuse emissions that are more challenging to manage due to their dispersed nature and lack of containment. The pollutants released by these sources degrade air quality, adversely affecting the health of local communities and surrounding ecosystems (Chaudhary & Gajghate, 2000; Nanda & Tiwary, 2001). Health studies in these regions report high incidences of Upper Respiratory Infection (URIs), gastric, dermatitis and eye cases. Children and the elderly are particularly vulnerable, as their respiratory systems are either still developing or already weakened. Moreover, air pollution from opencast mining also impacts the local flora and fauna. Dust deposition on plant leaves inhibits photosynthesis and stunts growth, while heavy metals in the air and soil can bioaccumulate in the food chain, threatening wildlife. Furthermore, pollutants such as NO_X and SO_2 contribute to acid rain, which alters soil pH and damages aquatic ecosystems.

3.1.1 Air Sampling

One of the primary objectives of this study was to evaluate the impact of the East Dump on ambient air quality. The study focuses on assessing air quality parameters, including SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, and trace elements (As, Cr, Cu, Hg, Mn, Ni, Pb, Zn) bound to particulate matter. To ensure accurate and representative data collection, a network of air quality monitoring stations was strategically established. The locations of the selected air quality monitoring stations used for data collection are presented in **Table 2**.

Table 2: Details of Air Quality Monitoring Sites in and around Khadia OCP

S.No.	Code	Station Location	Latitude	Longitude
1	NB P1	House	24.119630	82.725617
2	NB P2	House	24.118986	82.728631
3	NB P3	House	24.118820	82.727236
4	NB P4	House	24.119069	82.726533
5	NB P5	House	24.119167	82.726111
6	NB P6	House	24.119472	82.723375
7	WW P1	Proposed Wharf Wall Site	24.120045	82.725632
8	WW P2	Proposed Wharf Wall Site	24.120063	82.725607
9	KC P1	Khadia Guest House	24.122112	82.688355

Sampling at the selected monitoring stations was conducted from October 2024 to January 2025 as per the standards laid in CPCB, 2011. The observed values are compared to the 24-hour National Ambient Air Quality Standards (NAAQS), 2009. Additionally, PM concentrations in-and-around the study area were monitored using a handheld Aerosol Monitor. Sampling at Khadia Colony was done to provide insights into the regional air pollution context, beyond the East dump.

Figure 3 shows an overview of various air monitoring sites. Meteorological observations viz., temperature, relative humidity, wind direction and wind speed were made simultaneously along with air quality sampling. Detailed information about the instruments used for air monitoring is provided in **Table 3**.

For heavy metal analysis, the filter paper collected for $PM_{2.5}$ & PM_{10} was sent for Inductively coupled plasma-optical emission spectroscopy (ICP-OES) at Birbal Sahni Institute of Paleosciences (BSIP), Lucknow.

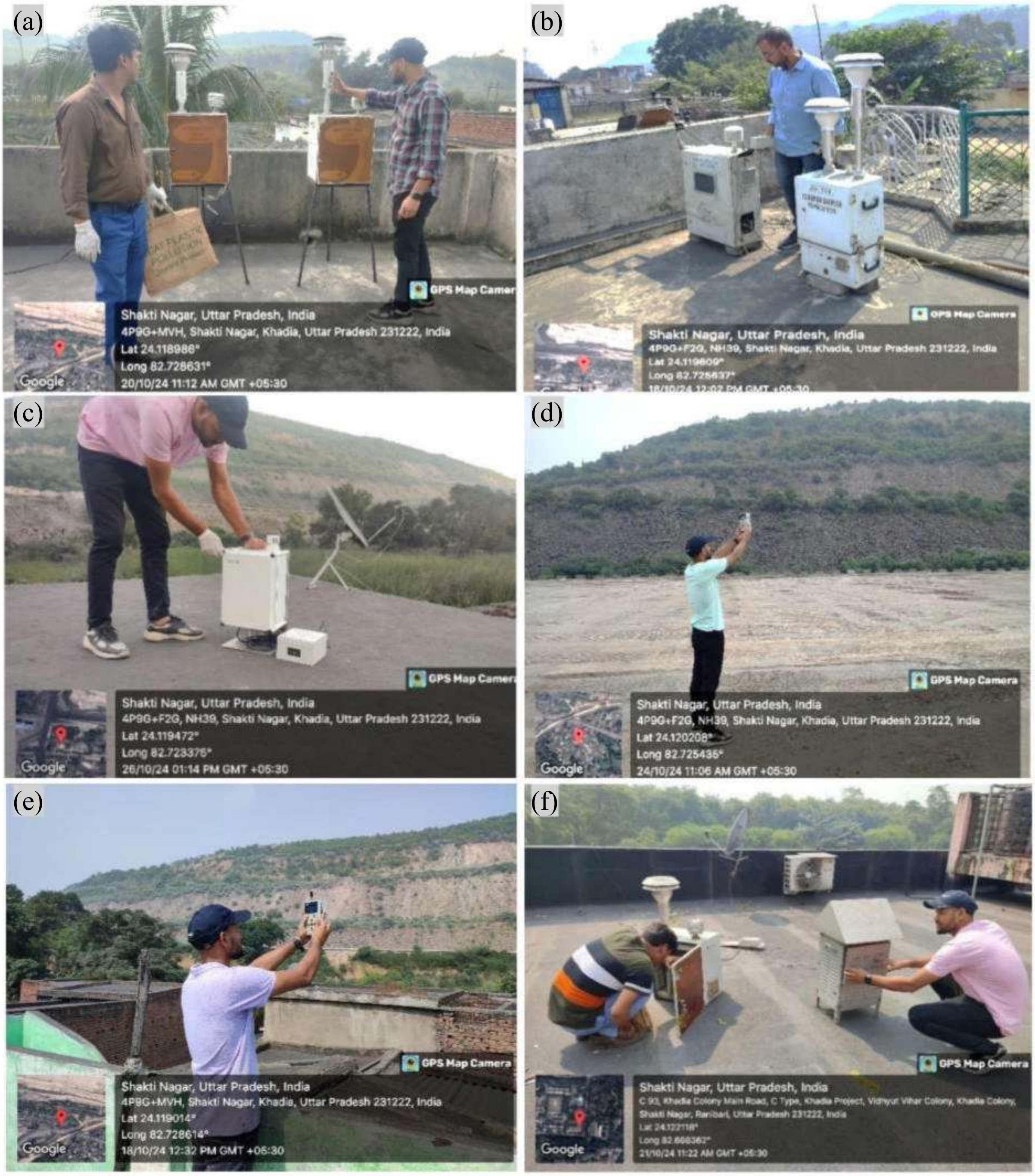


Figure 3: Overview of Various Air Monitoring Sites. (a-c) Instruments installed on the roof of houses in Nawatola Basti. (d) Handheld Aerosol Monitoring on the Wharf Wall in front of the East Dump. (e) Handheld Aerosol Monitoring on the roof of a house in Nawatola Basti. (f) Instruments being installed on the roof of the Khadia Guest House.

3.1.2 Monitoring of TSP in ambient air:

The TSP concentration was measured using a high-volume sampler operating at a flow rate of 1 m^3/min. Glass fibre filter paper (EPM 2000), measuring 8 x 10 inches, was used for sampling.

Table 3: Air Quality Monitoring Instruments used in the Study

S.No.	Instrument Used	Pollutant Measured	Quantity	Method of Analysis	Detection Limit	Figure
1	Respirable Dual Sampler (APM 460 NL)	$PM_{2.5}$ & PM_{10}	1	Gravimetric method (CPCB 2012)	10 µg/m^3 to 1000 µg/m^3	
2	Ambient Fine Dust Sampler (IPM – FDS)		4	Gravimetric method (CPCB 2012)	5 µg/m^3 to 1000 µg/m^3	
3	High Volume Sampler (APM 43-411)	SPM	1	Gravimetric method (CPCB 2012)	10 µg/m^3 to 1000 µg/m^3	
4	Handheld Aerosol Monitor (AEROCET 531S)	PM_{10}, $PM_{2.5}$ & SPM	1	Optical Light Scattering Method	< 1000 µg/m^3	
5	Portable Laser Aerosol Spectrometer (AQ Guard Smart 1100)	$PM_{2.5}$ & PM_{10}	1	Optical Light Scattering Method	< 10^6 µg/m^3	
		SO_2, NO_2 & CO		Electro-chemical Method	100 to 750 µg/m^3, 40 to 340 µg/m^3, 5000 to 20000 µg/m^3	
6	Ambient Air Quality Monitoring System	$PM_{2.5}$ & PM_{10}	1	Optical Light Scattering Method	< 500 µg/m^3, < 1000 µg/m^3	
		SO_2, NO_2 & CO		Electro-chemical Method	< 20 ppm, < 200 ppm, < 1000 ppm	

Before sampling, the filters were equilibrated in silica gel desiccators for 24 hours and weighed using a pre-calibrated microbalance. To account for potential contamination during transport and analysis, a field blank was generated for each sample collected during the study. Subsequently, TSP concentrations were calculated using the following formula (CPCB, 2012):

$$W_{TSP}(\mu g) = (w_f - w_i)g \times 10^6 \mu g$$

Here, W_{TSP} = total mass of the total suspended particulate matter collected (µg), w_f = Final mass of the conditioned EPM2000 filter after sample collection (mg), w_i = Initial mass of the conditioned filter before sample collection (mg), 10^3 = unit conversion factor for mg to µg. After the calculation of the total mass of TSP, the calculation of the total volume of air sampled is as follows:

$$V_{TSP} = Q_{avg} \times t \times 10^{-3} m^3$$

Here, V_{SPM} = Total volume of air sampled for TSP sampling, Q_{avg} = Average flow rate over the entire duration of the sampling period (1 min^{-1}), t = duration of the sampling period (min.), 10^3 = unit conversion for litres (L) into m^3. The concentration of SPM in the air is:

$$TSP = {}^{W_{TSP}}/_{V_{TSP}}$$

Here, TSP = mass concentration of SPM (µg/m^3), W_{TSP} = Total mass of the TSP collected (µg), V_{TSP} = Total volume of air sampled for TSP sampling. These particulates usually range from approximately l-100 µm.

3.1.3 Monitoring of $PM_{2.5}$ and PM_{10} in ambient air:

The monitoring of $PM_{2.5}$ & PM_{10} was performed using a Respirable Dust Sampler operating at a flow rate of 1 m^3/hr. Polytetrafluoroethylene (PTFE) membrane filters with diameters of 47 mm and 46.2 mm were used for collecting PM_{10} and $PM_{2.5}$, respectively. The filter papers were weighed using a MYA 5.3Y microbalance, which has a resolution of 10^{-6} g.

The air sampler includes an omnidirectional air inlet designed to maintain circular symmetry, ensuring uniform air entry regardless of wind direction, while preventing the ingress of rain, insects, and large particles. The inlet system leads directly to an impactor stage, which removes particles larger than 10 µm. For $PM_{2.5}$, an additional impactor operates based on the specific tube length, maintaining the system's flow rate at 1 m^3/hr (equivalent to 16.7 LPM).

To minimize sampling errors caused by the tendency of smaller particles to bounce off the impaction surface, a 37 mm diameter GF/A paper coated with silicone oil was employed. Subsequently, SPM concentrations were calculated using the following formula (CPCB, 2012):

$$W_{2\cdot5/10(ug)} = (w_f - w_i)g \times 10^6 \mu g$$

Here, $W_{2\cdot5/10}$ = total mass of $PM_{2.5/10}$ collected (µg), w_f = Final mass of the conditioned filter after sample collection (mg), w_i = Initial mass of the conditioned filter before sample collection (mg), 10^3 = unit conversion factor for mg to µg.

After the calculation of the total mass of $PM_{2.5/10}$, the calculation of the total volume of air sampled is as follows:

$$V_{2\cdot5/10} = Q_{avg} \times t \times 10^{-3} m^3$$

Here, $V_{2\cdot5/10}$ = Total volume of air sampled for $PM_{2.5/10}$ sampling, Q_{avg} = Average flow rate over the entire duration of the sampling period (LPM), t = duration of the sampling period (min.), 10^3 = unit conversion for L into m^3.

The concentration of $PM_{2.5/10}$ in the air is –

$$PM_{2.5/10} = {W_{2.5/10}}/{V_{2.5/10}}$$

Here, $PM_{2.5/10}$ = Mass concentration of $PM_{2.5/10}$ (µg/m^3), $W_{2.5/10}$ = Total mass of the PM $_{2.5/10}$ collected (µg), $V_{2.5/10}$ = Total volume of air sampled for $PM_{2.5/10}$ sampling.

3.1.4 Estimating the National Air Quality Index (NAQI)

The National Air Quality Index (CPCB, 2015) is a comprehensive tool designed to monitor and communicate air quality in India. It provides a simple, user-friendly framework that translates complex air pollution data into an easily understandable format for the general public. It is based on maximum operating function. The maximum value of the sub-index is considered an index value. Sub-indices of pollutants are calculated by the linear interpolation between the breakpoint concentration values of pollutants as tabulated in **Table 4** and calculated by using the following equations.

$$I_p = \frac{(I_{HI} - I_{LO})}{B_{HI} - B_{LO}} (C_P - B_{LO}) + I_{LO}$$

$$NAQI = max\ (I_P)$$

Where, p = n number of pollutants: 1, 2… n, B_{HI} = Breakpoint concentration value more than or equal to the given concentration value, B_{LO} = Breakpoint concentration value smaller than or equal to the given concentration value, I_{HI} = AQI value corresponding to B_{HI}, I_{LO} = AQI value corresponding to B_{LO}.

AQI categories along with their corresponding health impacts on humans are shown in **Table 5**. It provides a detailed understanding about the implications of each AQI category on the public health.

Table 4: NAQI Categories and Corresponding Breakpoint Concentration of Pollutants

AQI Category	Good	Satisfactory	Moderately Polluted	Poor	Very poor	Severe
AQI Value	0 – 50	51 – 100	101 – 200	201 – 300	301 – 400	401 – 500
PM_{10}	0 – 50	51 – 100	101 – 250	251 – 350	351 – 430	430+
$PM_{2.5}$	0 – 30	31 – 60	61 – 90	91 – 120	121 – 250	250+
NO_2	0 – 40	41 – 80	81 – 180	181 – 280	281 – 400	400+
SO_2	0 – 40	41 – 80	81 – 380	381 – 800	801 – 1600	1600+
CO *	0 – 1	1.1 – 2	2.1 – 10	10 – 17	18 – 34	34+
O_3	0 – 50	51 – 100	101 – 168	169 – 208	209 – 748	748+ **

* All pollutant concentrations are in $\mu g/m^3$ except CO in mg/m^3.
24 h average value for PM_{10}, $PM_{2.5}$, SO_2, NO_2, and 8 h average value for CO and O_3.
** Hourly values instead of 8h average

Table 5: AQI Categories and Associated Health Impacts

AQI Category	Associated Health Impacts
Good	Minimal Impact
Satisfactory	May cause minor breathing discomfort to sensitive people
Moderately Polluted	May cause breathing discomfort to people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very Poor	May cause respiratory illness in people on prolonged exposure. The effect may be more pronounced in people with lung and heart diseases
Severe	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

3.2 Water Pollution Study

Opencast and underground coal mining, along with associated auxiliary activities, significantly influence hydrology and water quality (Zeng et al., 2018). The extent of these impacts on the local water regime depends on factors such as mine structure, groundwater recharge rates, and the aquifer properties of surrounding formations. These effects vary over time and across different mining stages.

Mining activities can contaminate surface waters, reduce aquifer potential, lower water levels near the mine, and disrupt groundwater flow. Contamination of groundwater often results from mine water infiltration, which is facilitated by leaching, increased permeability due to aquifer excavation, and fractures caused by blasting activities (Younger et al., 2002). Pollutants can penetrate groundwater to depths of up to 50 meters, as noted by Negrel et al. (2007). Contaminated mine water can travel over 10 km from its source, affecting soils and water bodies in adjacent areas (Naicker et al., 2003).

Overburden and other mining waste frequently contain toxic elements that may accumulate in water bodies, posing long-term risks to groundwater. The permeability of the overburdened topsoil influences its ability to allow the movement of leachate contaminants into the regional groundwater (Alao et al., 2023). Low resistivity in the overburden suggests the presence of sandy or loose soils that are more permeable and allow easier infiltration.

During the rainy season, runoff from mine-adjacent areas often carries a high load of suspended solids into nearby surface waters. This influx of suspended solids can disrupt the natural flow of rivers and streams, harm aquatic habitats, and reduce water quality, posing challenges for downstream water use. Blasting activities further exacerbate hydrogeological disturbances near the mine face, creating wider fractures and joints. These disturbances increase secondary porosity and establish highly permeable zones around the mine, compounding the risks to both groundwater flow and quality.

3.2.1 Sample Collection

Thirteen sampling locations were identified based on a preliminary field survey to assess the overall impact of the East Dump on surface and groundwater resources (see **Table 6**). Out of the total, 7 samples were collected from surface water sources, including siltation ponds and drain outlets from the East Dump.

The remaining 6 samples were obtained from groundwater sources, such as hand pumps and wells. Water from these sources is used by the community for both domestic and agricultural purposes. **Figure 4** provides an overview of various water sampling sites that were chosen in this study.

Table 6: Details of Water Quality Monitoring around Khadia OCP

S.No.	Sample Code	Sampling Location	Latitude	Longitude
1	SW 1	Nala beneath Wharf Wall	24.119574	82.728426
2	SW 2	Settling Pond	24.118990	82.735195
3	SW 3	Settling Pond	24.119032	82.736082
4	SW 4	Settling Pond	24.119674	82.727133
5	SW 5	Settling Pond	24.118738	82.738984
6	SW 6	Settling Pond	24.118316	82.739229
7	SW 7	Settling Pond	24.117376	82.739464
8	GW 1	Handpump	24.118967	82.728674
9	GW 2	Handpump	24.119685	82.725551
10	GW 3	Handpump	24.119069	82.726533
11	GW 4	Well	24.119245	82.726812
12	GW 5	Well	24.119163	82.723128
13	GW 6	Well	24.119385	82.725516

3.2.2 Sample Preparation for Heavy Metal and Ion Analysis

Sample collection, preservation, and analysis were conducted following standard methods outlined by the American Public Health Association (APHA, 2005). From each location, two sets of samples were collected in 1000 ml narrow-mouth, prewashed polyethylene bottles. Before fieldwork, these bottles were thoroughly cleaned in the laboratory using dilute hydrochloric acid, followed by rinsing twice with double-distilled water. At each sampling site, the bottles were rinsed again with the water to be sampled before collection. Once filled, the bottles were immediately sealed and labelled with a sample code and the name of the sampling site to ensure proper identification for future analysis.

All water samples were transported to the laboratory and stored at 4°C to prevent chemical alterations. One set was filtered through a nylon syringe filter and acidified to pH < 2 using HNO_3 for trace metal (As, Cd, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Zn) analysis, while the other set was preserved for ion analysis (Na^+, K^+, Mg^{2+}, Ca^{2+}), following the standard methods outlined by APHA (2005). Representative samples were sent to BSIP, Lucknow for identification of heavy metal and cation analysis.

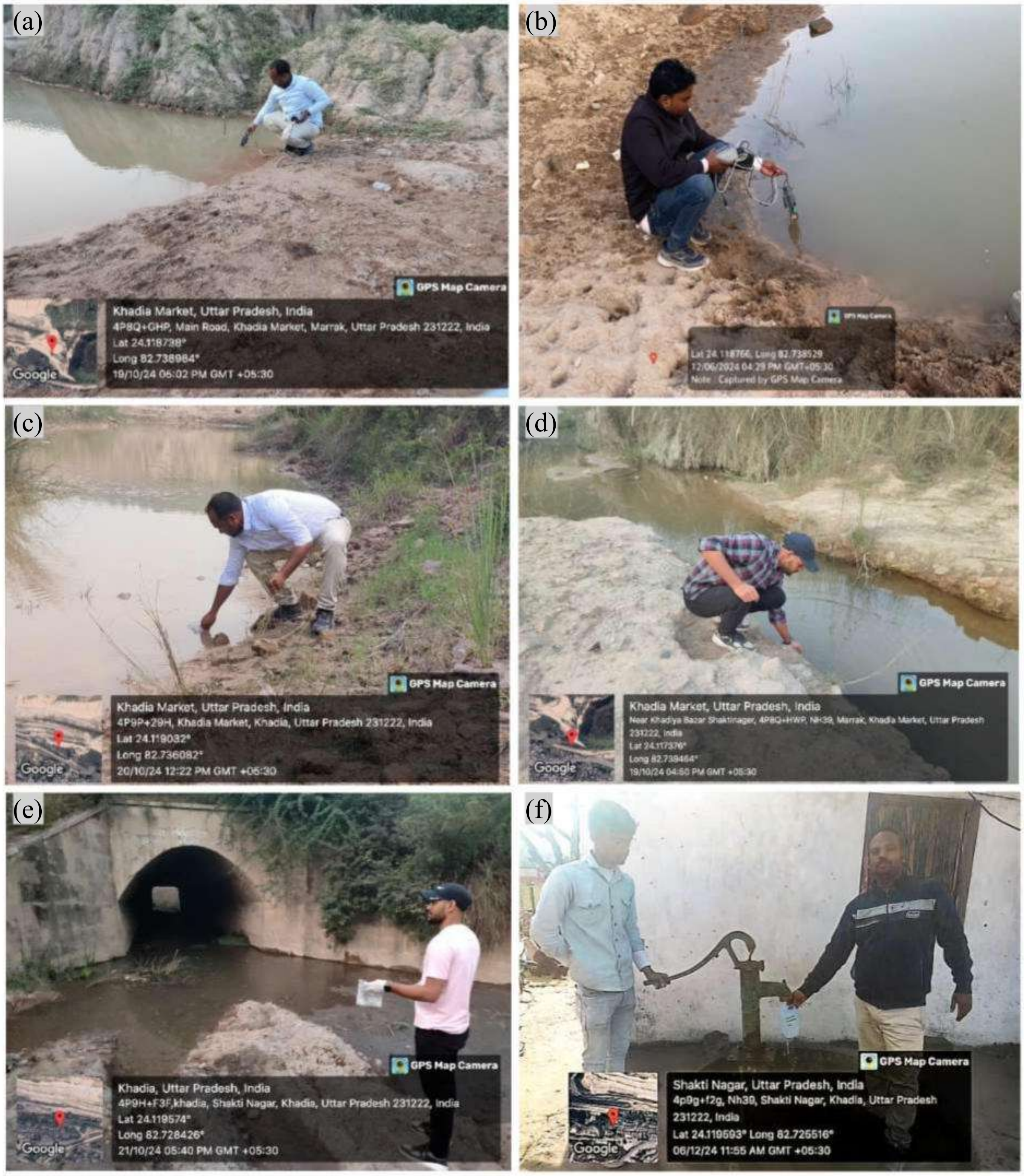


Figure 4: Overview of various Water Sampling Sites. (a-d) Water Sampling and Monitoring at various Siltation Ponds near the East Dump. (e) Sampling of Nala water from the RCC Catch Drain at the East Dump. (f) Sampling of Hand Pump water near the East Dump

3.2.3 Estimating the Water Quality Index

The Water Quality Index (WQI) is calculated using the Canadian Council of Ministers of the Environment Index method. The formulation of the CCME WQI is described in the Canadian Water Quality Index 1.0 –Technical Report (CCME 2001). The WQI provides a convenient means of summarizing complex water quality data and intends to provide a tool for simplifying the reporting of water quality data. The index produces a number between 0 (worst water quality) and 100 (best water quality). These numbers are divided into 5 descriptive categories as shown in **Table 7**.

Table 7: CCME WQI and its respective Values and Description of Water Quality

Category	WQI Value	Description of Water Quality
Excellent	95-100	Protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels
Good	80-94	Protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels
Fair	65-79	Usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Marginal	45-64	Frequently threatened or impaired; conditions often depart from natural or desirable levels.
Poor	0-44	Almost always threatened or impaired; conditions usually depart from natural or desirable levels.

Essentially, the model consists of three measures of variance from selected water quality objectives (Scope, Frequency, and Amplitude). The "Scope (F1)" represents the extent of water quality guideline non-compliance over the period of interest. The "Frequency (F2)" represents the percentage of individual tests that do not meet objectives. The "Amplitude (F3)" represents the amount by which failed tests do not meet their objectives. These three factors combine to produce a value between 0 and 100 that represents the overall water quality.

Factor 1: F1 (Scope) – The Scope assesses the extent of water quality guideline non-compliance over the period of interest, which means the number of parameters whose objective limits are not met. It has been adopted directly from the British Columbia Water Quality Index:

$$F_1 = \frac{(Number\ of\ Failed\ Variables)}{(Total\ number\ of\ Variables)} \times 100$$

Factor 2: F2 (frequency)- The frequency (i.e., how many occasions the tested or observed value was off the acceptable limits) with which the objectives are not met, which represents the percentage of individual tests that do not meet the objectives ("failed tests"):

$$F_2 = \frac{(Number\ of\ failed\ tests)}{(Total\ number\ of\ tests)} \times 100$$

Factor 3: F3 (amplitude)- The amount by which the objectives are not met (amplitude) represents the amount by which the failed test values do not meet their objectives, and is calculated in three steps. The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an "excursion" and is expressed as follows. When the test value must not exceed the objective:

$$Excursion_i = \left(\frac{Failed\ test\ value_i}{Objective_j}\right) - 1$$

For the cases in which the test value must not fall below the objective:

$$Excursion_i = \left(\frac{Objective_j}{Failed\ test\ value_i}\right) - 1$$

The collective amount, by which the individual tests are out of compliance, is calculated by summing the excursions of individual tests from their objectives and then dividing the sum by the total number of tests. This variable, referred to as the normalized sum of excursions (nse) is calculated as:

$$nse = \frac{\sum_{i=1}^{n} excursion_i}{Number\ of\ tests}$$

F3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a value between 0 and 100.

$$F_3 = \left(\frac{nse}{0.01nse + 0.01}\right)$$

The CCME WQI is finally calculated as:

$$CCME\ WQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}\right)$$

3.2.4 Evaluation of the Leaching Properties of the East Dump

In the present study, leaching experiments were conducted to simulate the interaction between water and overburden material as it percolates through the dump and potentially infiltrates groundwater. By conducting laboratory-scale leaching experiments, it is possible to gain insights into the chemical processes occurring within the dump and their potential effects on groundwater and surface water quality. Since replicating the exact composition of rainwater in a laboratory setting is challenging, tap water with known properties was used for consistency. The experimental setup was designed to replicate mine site conditions on a laboratory scale.

Two distinct experimental setups were employed to analyse the leaching behaviour of overburden material from different sections of the dump. These sections were selected from the top, middle, and bottom of the dump to represent variations in material age and composition as shown in **Figure 5.** The top section consisted primarily of freshly dumped material, while the middle and toe sections contained progressively older material.

Figure 5: Collection of samples from the East Overburden Dump for Leachate and Runoff Analysis. (a-b) Collection of Overburden material from the top of the dump (c) Collection of Overburden material from the middle of the dump (d) Collection of Overburden material from the toe of the dump.

The leaching model was fabricated using three acrylic boxes (**Figure 6**). The top box, 19 cm × 19 cm × 19 cm, served as a water reservoir with a perforated base to regulate a controlled dripping rate of 2 L/min. The middle box, measuring 19 cm × 19 cm × 60 cm, held the overburden material and had a perforated base to allow water to percolate through the material.

The bottom box collected the leachate, with dimensions of 19 cm × 19 cm × 19 cm. A sample-to-water volume ratio of 1:5 was adopted in these experiments. This was chosen to avoid the requirement of excessive sample and water volumes, which could be challenging in lab setup.

The study consisted of two experiments to investigate leachate characteristics. In the first experiment, a combined sample was created by adding materials from the bottom, middle, and top of the dump in that order, providing a cumulative representation of the entire dump's leachate. **Figure 6a** shows this setup. In the second experiment, individual samples were collected from the top, middle, and bottom sections to assess section-specific variations in leachate composition, as shown in **Figure 6b**.

Figure 6: Leaching Experiments. (a) Combined Leachate Analysis. (b) Section-specific Leachate Analysis.

The leachate was collected for analysis at 10-minute intervals up to the 160-minute mark. The collected leachate at different time instances was analysed for their physio-chemical properties using a Waterproof Portable Meter. Additionally, the rate of infiltration was also monitored during the process.

Chapter 4: Existing Control Measures Adopted for Air and Water Pollution

4.1 Existing control measures adopted for Air Pollution

To effectively manage air quality, multiple measures have been implemented to control dust emissions and airborne particles. Mobile water sprinklers are deployed on haul roads, while most coal is transported via MGR (rail transport), significantly reducing dust emissions. A dust extraction system is operational in Phase-1 of the Coal Handling Plant (CHP), with fixed sprinklers installed around the coal yard and automatic water sprinklers deployed at the receiving pit of the CHP. Drilling equipment is fitted with dust extractors, and service roads are metaled, with approach roads to the mines blacktopped to minimize dust generation. Vehicles transporting coal are covered with tarpaulin and are not overloaded, while wetting of run-of-mine (ROM) coal is done before crushing in the CHP. The CHP operates within an enclosed system to contain emissions.

Routine maintenance and periodic overhauling of heavy earth-moving machinery (HEMM) is done to ensure efficient operations. Water Bound Macadam (WBM) haul roads are constructed to prevent fugitive dust emissions. Additional dust control measures include the deployment of fog cannons, both mobile and fixed, with a fixed fog cannon deployed specifically at the coal yard. Truck-mounted mist spray machines and road sweepers are utilized to maintain road cleanliness and minimize dust. Two surface miners have been deployed to reduce dust emission during drilling and blasting activities. A wheel washing facility is under development and will be commissioned by February 2025. A Rapid Loading System of 04 MTPA is under construction to increase the rail transportation of coal and which will further improve the air quality of the area

Vegetative covers have been established on non-active overburden dumps, with approximately 39.81 hectares planted as of 2022-23. The plantation data for the Khadia OCP includes trees such as *Acacia auriculiformis*, Shisham (*Dalbergia sissoo*), Neem (*Azadirachta indica*), Mango (*Magnifera* indica), Ber (*Zizyphus mauritiana*), Bamboo, Guava etc.

A Continuous Ambient Air Quality Monitoring Station has been established (Lat: 24.122295, Long: 82.684508) to monitor particulate matter levels in ambient air, with real-time data fed to the CPCB. Air quality is continuously monitored at four stations in the core and buffer zones, tracking pollutants such as SPM, RPM, SO_2, NO_X, and heavy metals, with monitoring handled by CMPDI. An overview of the adopted measures for air pollution is shown in **Figure 7**.

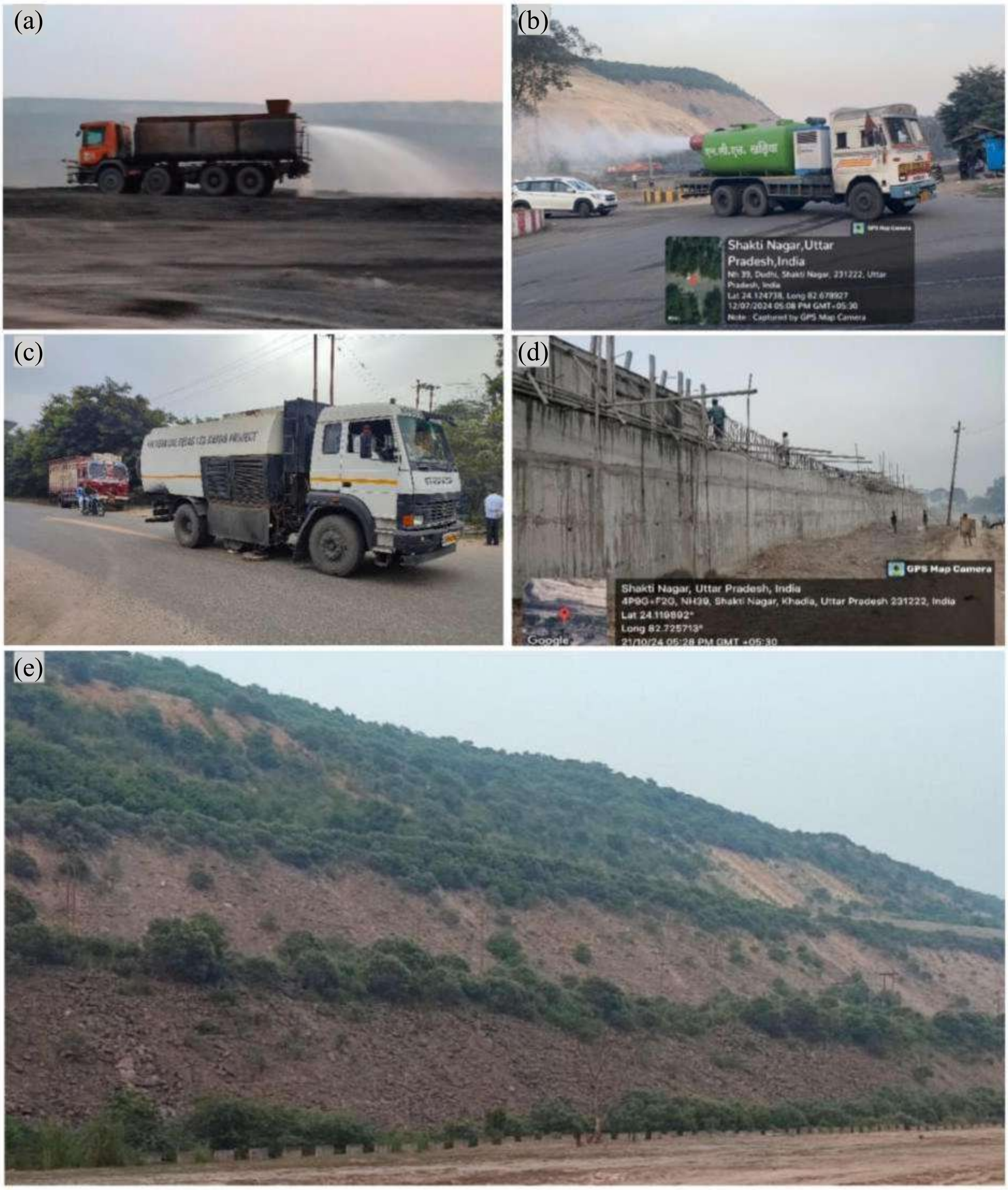


Figure 7: An Overview of different control measures adopted for Air Pollution. (a) Mobile water sprinkling being done on a haul road near the East Dump. (b) Mobile Fog Canon in action on NH 39. (c) Truck-mounted Road Sweeper on NH 39 (d) A Curtain wall in-construction near a proposed Warf Wall to arrest dust. (e) Vegetation planted on the East Overburden Dump facing Nawatola Basti.

4.2 Existing control measures adopted for Water Pollution

In terms of water pollution control, a 4.15 km retaining wall, 3.32 km of catch drains, and 7.8 km of garland drains have been constructed to manage surface runoff effectively. The collected water is treated at a 38.4 MLD Effluent Treatment Plant and reused for watering the mine area, roads, and greenbelt development.

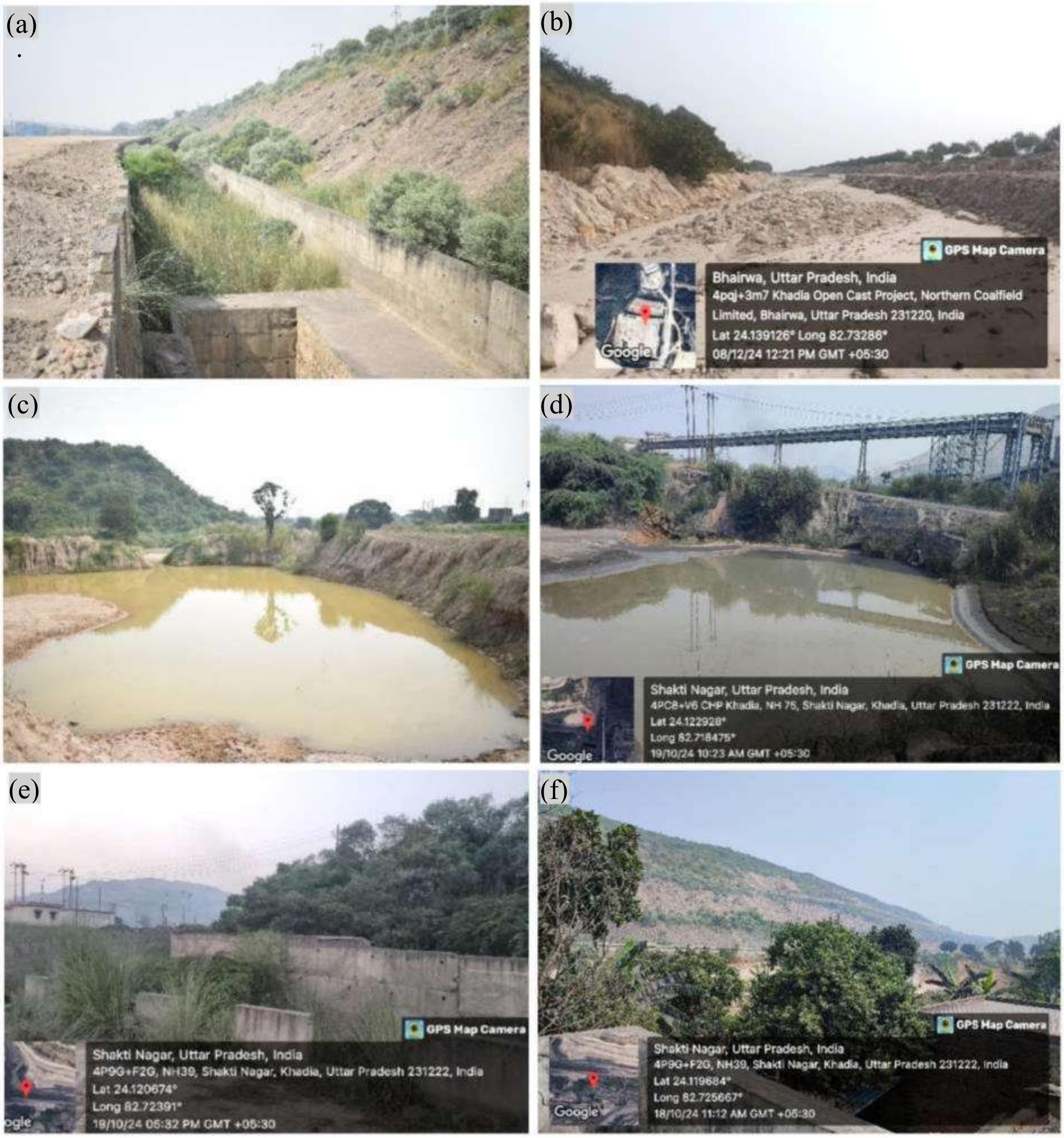


Figure 8: An Overview of different control measures adopted for Water Pollution. (a) RCC Catch Drain along the East Dump. (b) Garland Drain along a dump deck at the East Dump. (c-d) Setling pond near the East Dump. (e) Retaining Wall at the toe of the East Dump. (f) Vegetation along the slope of the East Dump as seen from Nawatola Basti.

Domestic wastewater is treated in a 1.5 MLD Sewage Treatment Plant (STP) and repurposed for horticultural use. Both mine and rainwater are collected in a sump and a large pond for groundwater recharge. Treated sump water is primarily used for mining activities such as dust suppression after allowing silt to settle. Silt-settling ponds have also been constructed to retain sediments and prevent contamination of runoff from dumps, stockyards, and railway sidings. A summary of the adopted water pollution control measures can be found in **Figure 8**.

Chapter 5: Impact of the East Dump on Air and Water Quality of Nawatola Basti

5.1 Air Pollution Study

5.1.1 Meteorological Parameters of the Study Area

The Ambient Air Quality Monitoring System was installed on the rooftop of a house located at coordinates (24.119630, 82.725617) in Nawatola Basti. The site was unobstructed, allowing unrestricted airflow from all directions. Daily measurements were recorded from October 19, 2024, to December 23, 2024, and averaged over a 24-hour UTC period. Monthly meteorological parameter observations are presented in **Tables 8-10**.

Table 8: Meteorological Parameters Observed in October, 2024

Date	Temperature (°C)	Humidity (%)	Wind Direction (deg.)	Wind Speed (m/s)
19-10-2024	29.80	60.80	62.16	0.00
20-10-2024	29.35	62.54	62.02	0.01
21-10-2024	28.87	61.32	63.68	0.00
22-10-2024	29.05	52.59	121.68	0.13
23-10-2024	28.58	55.12	156.72	0.33
24-10-2024	28.20	62.15	157.34	0.74
25-10-2024	26.88	71.15	196.09	0.74
26-10-2024	24.56	81.27	262.71	1.19
29-10-2024	34.43	58.39	40.09	0.14
30-10-2024	33.22	57.58	67.10	0.26
31-10-2024	32.58	48.47	70.14	0.42
Max	34.43	81.27	262.71	1.19
Min	24.56	48.47	40.09	0.00
Mean	29.59	61.03	114.52	0.36
Std. Dvn.	2.86	8.94	-	0.38

Table 9: Meteorological Parameters Observed in November, 2024

Date	Temperature (°C)	Humidity (%)	Wind Direction (deg.)	Wind Speed (m/s)
01-11-2024	31.61	48.98	94.42	0.51
02-11-2024	29.30	43.49	102.21	0.57
12-11-2024	24.84	59.04	50.17	0.00
13-11-2024	27.84	51.16	52.36	0.27
14-11-2024	27.23	44.30	91.14	0.40
15-11-2024	24.77	45.57	62.14	0.24
16-11-2024	25.08	43.84	76.46	0.30
17-11-2024	25.85	42.88	85.98	0.37
18-11-2024	23.89	45.44	76.90	0.14
19-11-2024	23.86	48.58	69.90	0.30

20-11-2024	24.51	48.10	102.89	0.51
21-11-2024	24.25	45.31	77.56	0.36
22-11-2024	22.27	47.91	106.24	0.41
23-11-2024	23.39	47.24	99.61	0.42
24-11-2024	23.25	53.84	69.41	0.19
25-11-2024	23.63	53.38	52.12	0.18
26-11-2024	23.98	44.54	103.93	0.50
27-11-2024	22.85	41.95	91.50	0.44
28-11-2024	22.36	45.41	61.35	0.33
29-11-2024	20.65	53.08	51.60	0.10
30-11-2024	20.88	52.52	70.69	0.13
Max	31.61	59.04	106.24	0.57
Min	20.65	41.95	50.17	0.00
Mean	24.59	47.93	78.50	0.32
Std. Dvn.	2.64	4.45	-	0.15

Table 10: Meteorological Parameters Observed in December, 2024

Date Time	Temperature (°C)	Humidity (%)	Wind Direction (deg.)	Wind Speed (m/s)
01-12-2024	23.31	49.03	55.06	0.09
02-12-2024	23.28	50.14	55.12	0.23
03-12-2024	24.19	47.16	66.20	0.26
04-12-2024	24.41	43.16	61.74	0.29
05-12-2024	24.79	40.52	80.53	0.25
06-12-2024	22.95	38.85	137.33	0.58
07-12-2024	24.61	34.96	85.95	0.14
08-12-2024	23.73	42.60	55.33	0.18
09-12-2024	24.96	41.61	121.12	0.21
10-12-2024	23.77	33.73	154.18	0.19
11-12-2024	20.30	42.36	85.17	0.17
12-12-2024	21.10	35.11	111.42	0.27
13-12-2024	19.59	34.62	118.06	0.30
14-12-2024	19.36	32.64	163.95	0.25
15-12-2024	20.03	33.79	110.47	0.27
16-12-2024	19.61	42.80	49.53	0.02
17-12-2024	19.98	45.34	75.98	0.06
18-12-2024	20.96	48.21	69.97	0.07
19-12-2024	20.80	52.83	66.76	0.11
20-12-2024	23.25	50.86	96.09	0.42
21-12-2024	23.64	47.53	134.74	0.60
22-12-2024	23.02	45.05	90.43	0.59
23-12-2024	24.74	46.43	59.19	0.86
24-12-2024	24.10	49.99	50.83	0.33

25-12-2024	24.96	48.70	68.43	0.25
26-12-2024	24.75	49.73	65.02	0.22
27-12-2024	26.90	45.97	60.26	0.55
28-12-2024	22.22	69.27	83.86	0.66
29-12-2024	23.32	67.06	147.12	0.68
30-12-2024	20.37	58.44	225.68	2.17
31-12-2024	19.67	56.19	188.4	1.31
Max	26.90	53.50	163.95	0.60
Min	19.36	32.64	49.53	0.00
Mean	22.25	42.89	91.74	0.24
Std. Dvn.	2.11	9.03	-	0.43

From Tables 7-9, it can be observed that the temperatures range from a high of 34.43°C in late October to a low of 19.36°C in mid-December, reflecting a gradual cooling trend as the months progress. Humidity levels fluctuate significantly, with values as high as 81.27% in October and as low as 32.64% in December, indicating varying moisture levels in the atmosphere. Wind direction shifts widely, with recorded values spanning from 40.09° to 262.71°, suggesting dynamic wind patterns. Wind speeds are generally low, peaking at 1.19 m/s in October and dropping to nearly zero on several occasions, highlighting calm conditions. Overall, the data reveals a transition from warmer, more humid conditions in October to cooler, drier conditions in December, with generally light winds throughout the period.

In order to illustrate wind speed and direction data observed over the study area between October to December, Lakes Environmental Software was used to generate wind rose plots as shown in **Figure 9-11**. The wind rose plot for the October month in **Figure 9** indicates that the prevailing winds primarily blow from the west-northwest (WNW) direction, with a maximum frequency of 3.5%. The plot notes a significant calm wind (below 0.5m/s) percentage of 74.03%, indicating a lack of notable wind movement during much of the observation period. The average wind speed during October was 0.27 m/s, highlighting overall low wind speeds. While relevant to pollution dispersion, weak winds are excluded from wind rose plots as their random and inconsistent directions contribute little to the understanding of prevailing dispersion patterns. In the month of November, see **Figure 10**, the prevailing wind direction started to blow from the southeast (SE) and south-southeast (SSE) directions. A small fraction (2.1%) also blows from the southwest (SW) direction. There is a high percentage of calm conditions, 68.18%, though slightly fewer compared to October (74.03%). The prevailing wind direction shifts in December, now blowing from east (E) and east-northeast (ENE), with a

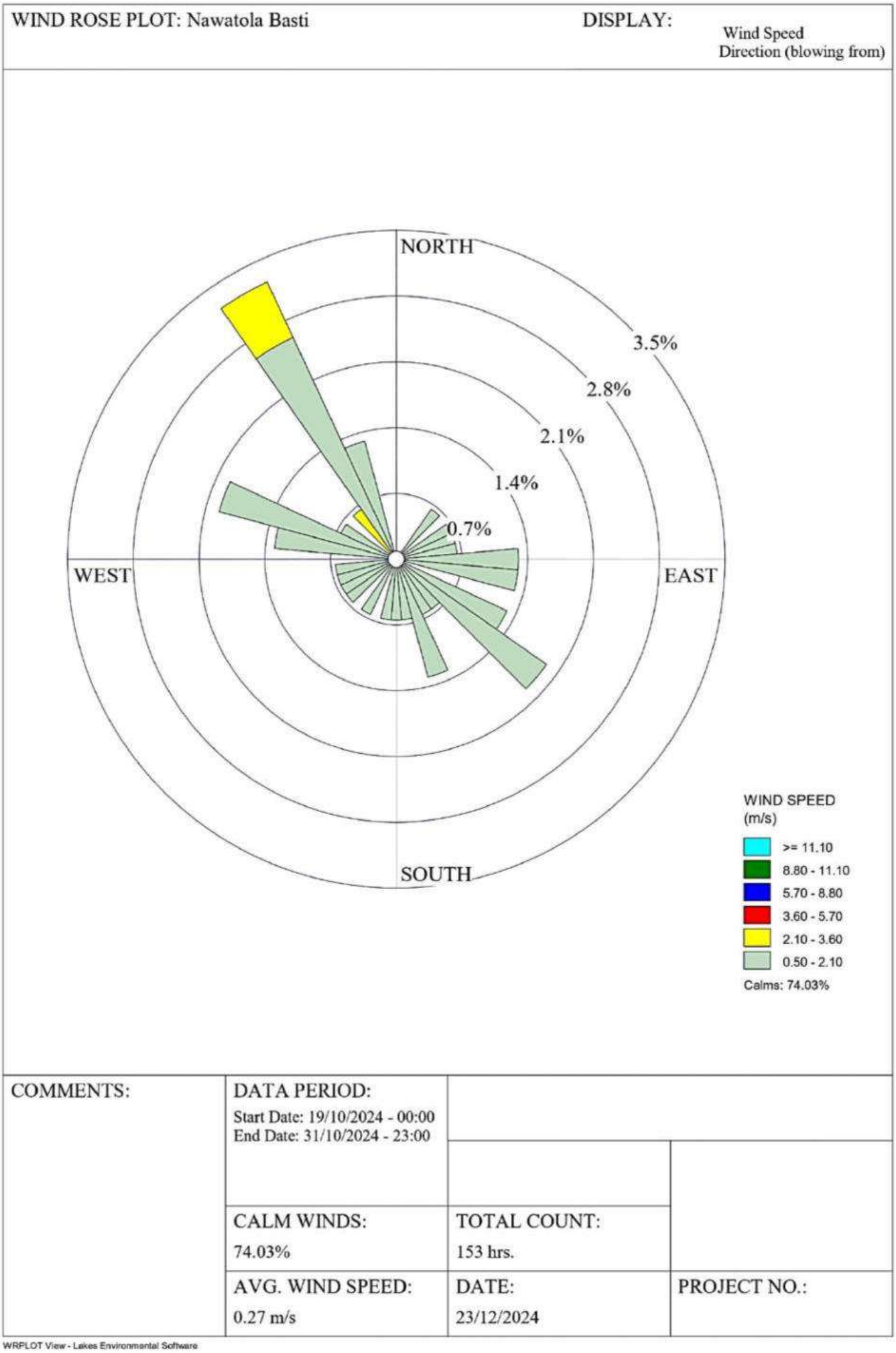
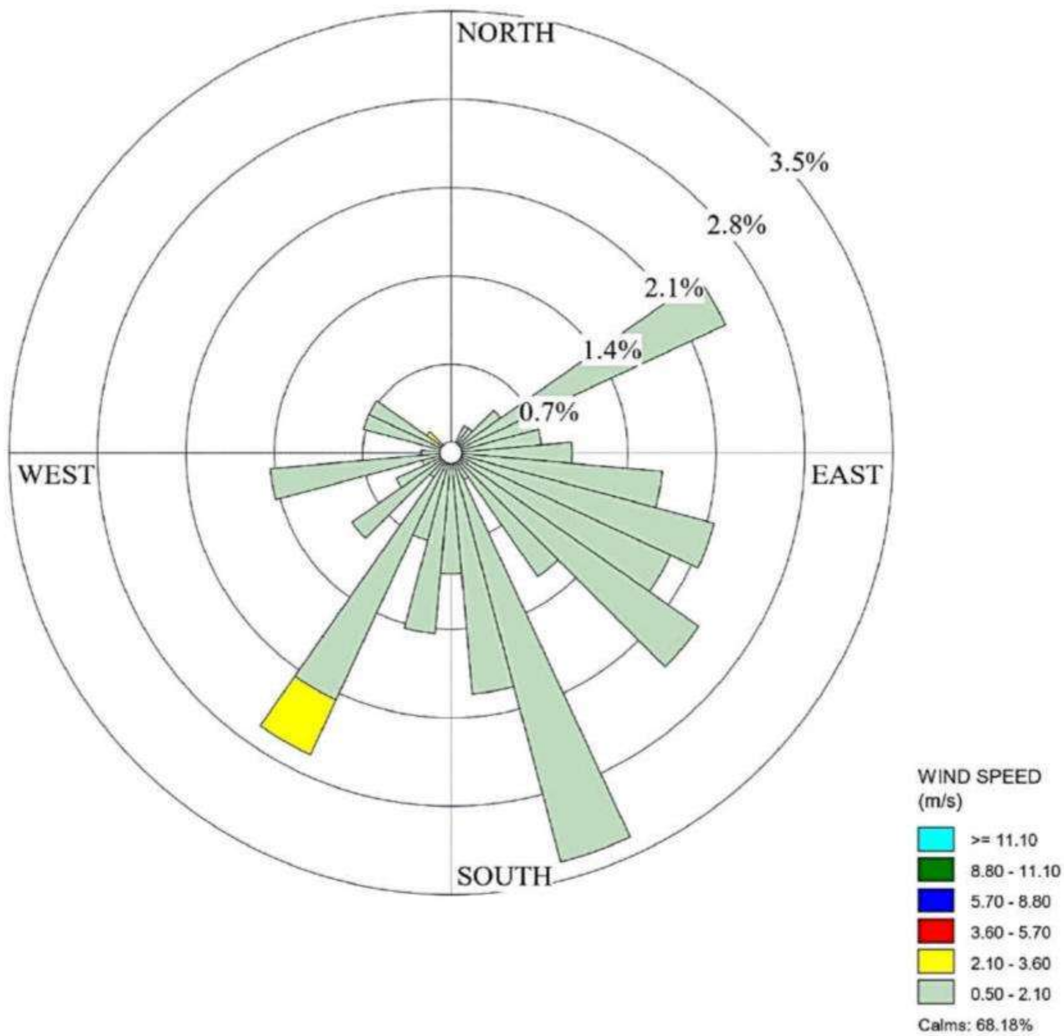


Figure 9: Wind Rose Plot of the Study Area during October, 2024

WIND ROSE PLOT: Nawatola Basti	DISPLAY: Wind Speed Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 01/11/2024 - 00:00 End Date: 30/11/2024 - 23:00		
	CALM WINDS: 68.18%	TOTAL COUNT: 417 hrs.	
	AVG. WIND SPEED: 0.31 m/s	DATE: 23/12/2024	PROJECT NO.:

Figure 10: Wind Rose Plot of the Study Area during November, 2024

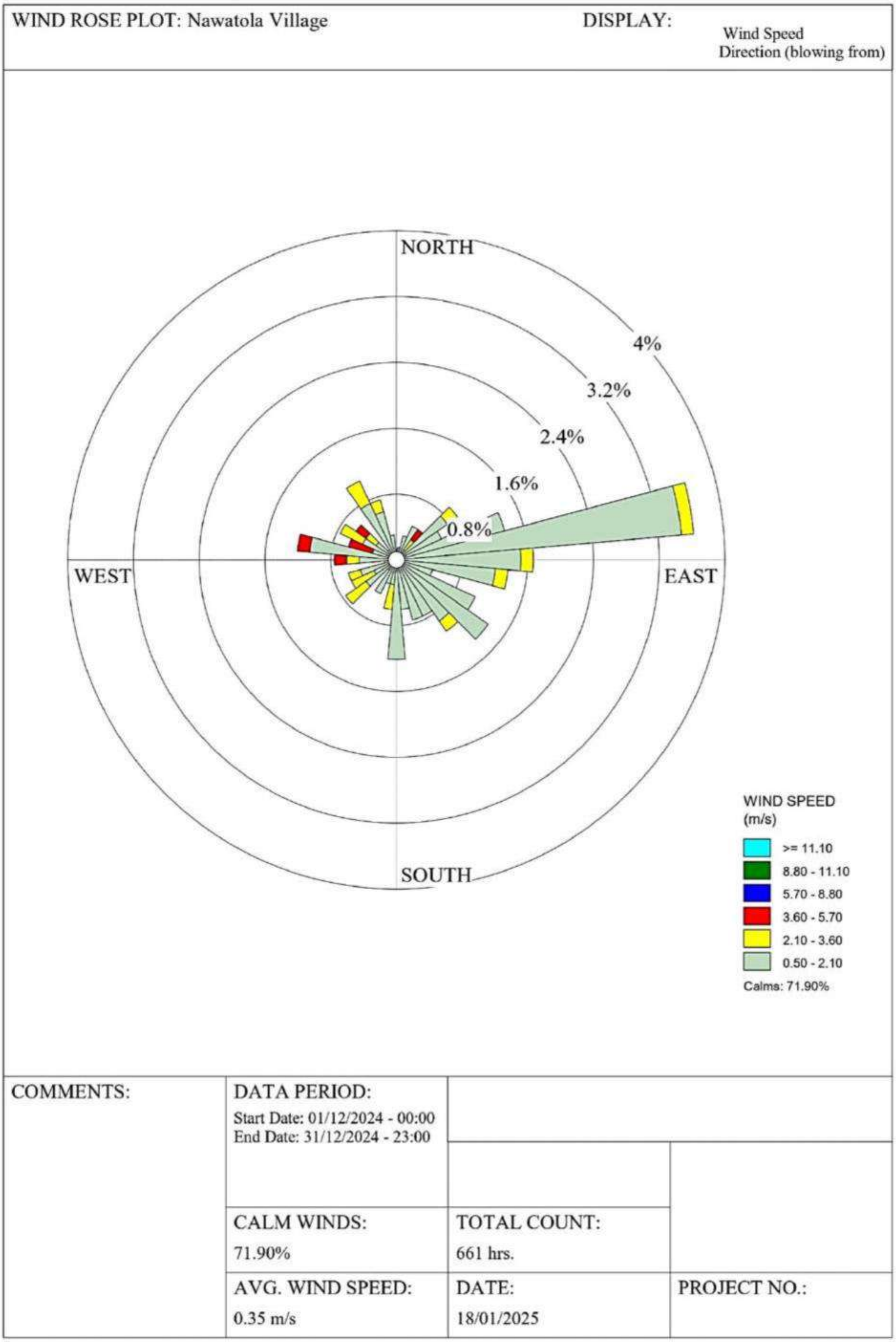
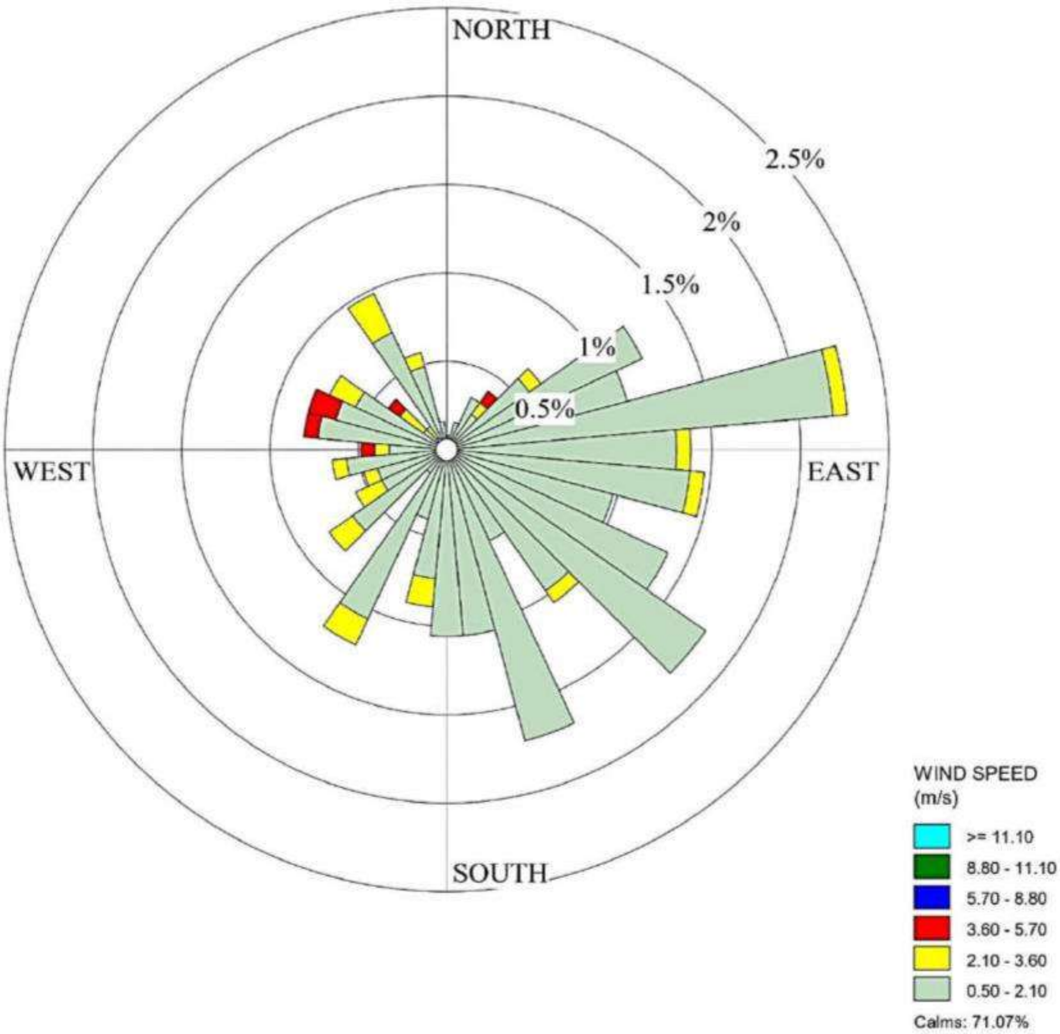


Figure 11: Wind Rose Plot of the Study Area during December, 2024

WIND ROSE PLOT: Nawatola Basti

DISPLAY: Wind Speed Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 19/10/2024 - 00:00 End Date: 31/12/2024 - 23:00		
	CALM WINDS: 71.07%	TOTAL COUNT: 1233 hrs.	
	AVG. WIND SPEED: 0.33 m/s	DATE: 18/01/2025	PROJECT NO.:

Figure 12: Combined Wind Rose Plot of the Study Area from October to December 2024

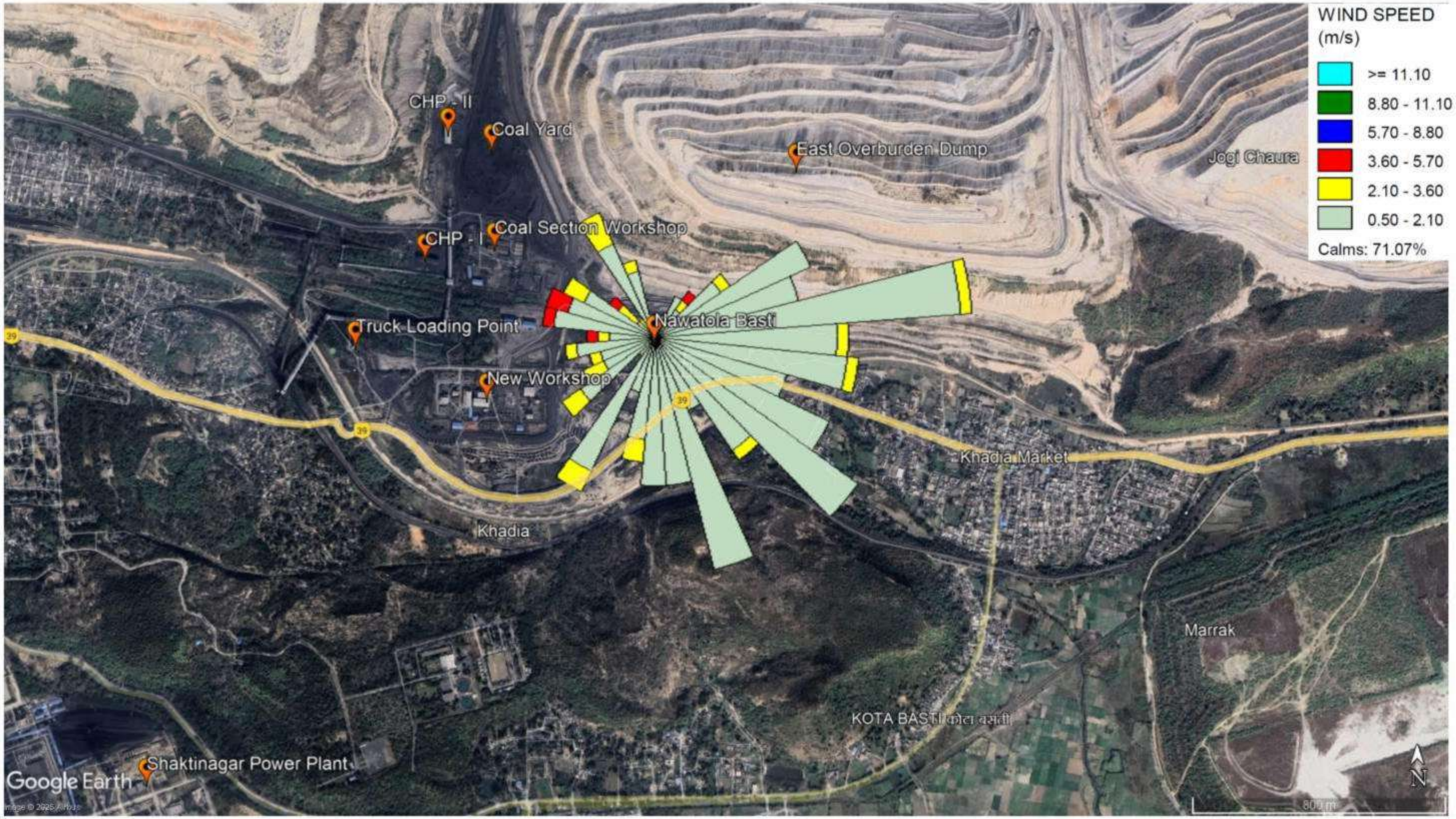


Figure 13: Wind Rose Plot from October to December 2024 on Google Earth Image

maximum frequency of 3%, as shown in **Figure 11**. The percentage of calm winds increased to 71.9%. **Figure 12** represents the wind rose plot from October to December 2024. The calm conditions accounted for 71.07% of the total wind data.

This indicates a predominantly stagnant atmospheric condition which implies that the pollutants released into the atmosphere are likely to remain concentrated near their sources for extended periods. The dominant wind directions are from the East (E), East-Northeast (ENE) and Southeast (SE). Most wind speeds fall within the range of 0.5–2.10 m/s, with a small fraction between 2.10–3.60 m/s. The average wind speed over this period is 0.33 m/s, further emphasizing low wind activity.

To better visualize the prevalent wind dispersion pattern in the geographical context of the study area, the combined wind rose plot (October – December) was exported on the Google Earth Image as shown in **Figure 13**.

5.1.2 Pollutant Concentrations in and around Nawatola Basti

The results for $PM_{2.5}$ and PM_{10} concentrations at NB P1 are presented in **Table 11**, while the corresponding data for NB P2 is detailed in **Table 12**. At NB P1, $PM_{2.5}$ concentrations ranged from 30.61 to 138.53 µg/m^3, while PM_{10} levels varied from 85.21 to 195.06 µg/m^3. The arithmetic means for $PM_{2.5}$ and PM_{10} at NB P1 were 72.19 µg/m^3 and 125.63 µg/m^3. Similarly, at NB P2, $PM_{2.5}$ levels ranged from 45.32 to 123.17 µg/m^3 and PM_{10} concentrations ranged from 85.28 to 188.48 µg/m^3. The arithmetic means for $PM_{2.5}$ and PM_{10} at NB P2 were 69.06 µg/m^3 and 120.33 µg/m^3.

At NB P1, SO_2 and NO_2, ranged from 58.61 to 84.81 and 55.80 to 77.82 µg/m^3 respectively. The mean concentration of SO_2 and NO_2 (77.77 and 65.12 µg/m^3, respectively) were below the permissible limit. The concentration of CO ranged between 0.24 to 1.37 mg/m^3, with the mean concentration also below the permissible limit.

Table 11: Concentration of Air Pollutants at Nawatola Basti (NB P1)

S.No.	Date	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	SO_2 (µg/m^3)	NO_2 (µg/m^3)	CO (mg/m^3)
1	19-10-2024	115.31	135.31	71.52	74.44	0.90
2	20-10-2024	124.21	112.2	71.52	64.62	1.04
3	21-10-2024	103.24	85.21	76.31	74.44	0.94
4	22-10-2024	72.36	107.61	71.52	64.62	1.08
5	23-10-2024	67.36	110.8	71.52	64.62	0.83
6	24-10-2024	84.35	123.9	76.31	74.44	0.81

7	25-10-2024	79.16	132.32	76.31	64.62	0.83
8	26-10-2024	78.33	127.64	84.81	64.62	0.82
9	27-10-2024	77.45	126.28	77.68	66.34	0.83
10	28-10-2024	80.93	152.55	75.08	73.34	0.79
11	29-10-2024	77.45	126.28	77.72	74.44	0.89
12	30-10-2024	78.34	127.64	77.72	74.44	0.72
13	31-10-2024	82.7	132.32	83.92	74.44	0.24
14	01-11-2024	79.33	134.45	77.72	74.44	0.55
15	02-11-2024	75.96	136.55	71.52	74.44	1.04
16	03-11-2024	74.97	136.1	79.89	74.18	1.18
17	04-11-2024	67.45	128.21	70.74	74.64	1.09
18	05-11-2024	74.9	186.41	71.58	75.09	0.80
19	06-11-2024	67.45	128.21	72.43	75.55	1.13
20	07-11-2024	65.35	105.76	73.28	76	1.37
21	08-11-2024	45.25	110.32	74.13	76.45	1.37
22	09-11-2024	40.49	106.64	74.98	76.91	1.37
23	10-11-2024	45.25	110.32	75.83	77.36	1.37
24	11-11-2024	56.77	125.56	76.67	77.82	1.25
25	12-11-2024	53.54	151.12	76.31	64.62	0.84
26	13-11-2024	69.73	153.01	71.52	74.44	0.83
27	14-11-2024	99.88	154.9	76.31	64.62	1.10
28	15-11-2024	86.93	127.45	84.81	64.62	0.85
29	16-11-2024	85.93	128.23	76.31	64.62	0.78
30	17-11-2024	73.97	101.24	76.31	64.62	0.89
31	18-11-2024	94.02	88.48	76.31	64.62	0.94
32	19-11-2024	40.1	146.95	84.81	64.62	1.19
33	20-11-2024	41.41	100.09	84.81	64.62	1.19
34	21-11-2024	82.71	153.23	84.81	64.62	1.19
35	22-11-2024	71.36	126.62	84.81	64.62	1.19
36	23-11-2024	38.09	122.07	84.81	64.62	1.19
37	24-11-2024	96.17	132.53	84.81	64.62	1.19
38	25-11-2024	38.09	195.06	76.31	64.62	1.19
39	26-11-2024	33.61	132.53	76.31	64.62	1.19
40	27-11-2024	75.12	138.27	84.81	64.62	1.19
41	28-11-2024	74.35	137.63	84.81	64.62	1.12
42	29-11-2024	74.72	135.84	58.61	55.8	0.82
43	30-11-2024	74.35	134.67	84.81	55.8	0.78
44	01-12-2024	41.54	125.34	84.81	64.62	0.88
45	02-12-2024	33.07	180.68	76.31	64.62	0.68
46	03-12-2024	69.47	85.43	76.31	64.62	0.46
47	04-12-2024	55.86	105.18	76.31	64.62	0.46
48	05-12-2024	101.9	117.09	76.31	64.62	0.46
49	06-12-2024	31.58	118.91	84.81	64.62	0.46
50	07-12-2024	88.95	147.74	76.31	64.62	0.46
51	08-12-2024	93.92	137.21	84.81	64.62	0.46
52	09-12-2024	88.95	147.74	84.81	64.62	0.46
53	10-12-2024	78.86	166.1	84.81	64.62	0.46
54	11-12-2024	83.74	135.27	84.81	64.62	0.46

55	12-12-2024	78.86	133.27	84.81	55.8	0.46
56	13-12-2024	91.11	98.05	84.81	55.8	0.66
57	14-12-2024	80.29	106.02	84.81	55.8	0.90
58	15-12-2024	138.53	100.78	84.81	55.8	0.87
59	16-12-2024	133.27	134.79	84.81	55.8	0.62
60	17-12-2024	136.23	120.12	76.31	55.8	0.50
61	18-12-2024	75.39	116.69	84.81	55.8	0.50
62	19-12-2024	37.7	136.39	76.31	64.62	0.50
63	20-12-2024	43.55	135.78	76.31	64.62	0.50
64	21-12-2024	78.35	127.55	84.81	64.62	0.50
65	22-12-2024	72.53	120.27	84.81	64.62	0.50
66	23-12-2024	85.05	115.34	76.31	64.62	0.50
67	24-12-2024	94.62	108.05	76.31	64.62	0.63
68	25-12-2024	94.19	115.76	76.31	64.62	0.87
69	26-12-2024	32.1	114.88	76.31	64.62	0.95
70	27-12-2024	30.61	125.94	71.52	64.62	0.87
71	28-12-2024	43.64	124.05	84.81	55.8	0.86
72	29-12-2024	42.64	111.1	84.81	64.62	0.86
73	30-12-2024	81.28	108.2	58.61	55.8	0.86
74	31-12-2024	92.54	108.57	58.61	55.8	0.90
75	01-01-2025	59.8	123.93	74.7	58.51	0.93
76	02-01-2025	56.9	126.47	74.53	58.32	0.89
77	03-01-2025	52.52	113.47	74.35	58.12	0.86
78	04-01-2025	73.97	114.37	74.18	57.92	0.86
79	05-01-2025	46.09	114.03	74	57.72	0.86
80	06-01-2025	72.06	113.5	73.83	57.53	0.86
81	07-01-2025	46.79	105.37	73.65	57.33	0.86
82	08-01-2025	62.83	93.37	73.48	57.13	0.86
Prescribed Standard (NAAQS, 2009)		**0-60**	**0-100**	**0-80**	**0-80**	**0-2**
Minimum Observation		30.61	85.21	58.61	55.80	0.24
Maximum Observation		138.53	195.06	84.81	77.82	1.37
98th Percentile		134.39	182.86	84.81	77.08	1.37
Mean		72.19	125.63	77.77	65.12	0.85
Median		74.81	126.11	76.31	64.62	0.86
Std. Deviation		24.23	20.42	6.17	6.49	0.27

Table 12: Concentration of Air Pollutants at Nawatola Basti (NB P2)

S.No.	Date	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)
1	20-10-2024	74.10	160.23
2	21-10-2024	70.32	167.37
3	22-10-2024	48.45	188.48
4	23-10-2024	59.37	156.21
5	24-10-2024	53.78	139.73
6	25-10-2024	63.61	123.96
7	26-10-2024	54.43	128.39

8	27-10-2024	67.45	107.20
9	28-10-2024	66.88	100.76
10	29-10-2024	68.45	114.99
11	30-10-2024	67.72	104.77
12	31-10-2024	70.28	103.62
13	01-11-2024	72.84	102.50
14	02-11-2024	45.40	102.63
15	03-11-2024	72.84	102.50
16	04-11-2024	72.80	102.19
17	05-11-2024	45.32	146.78
18	06-11-2024	72.80	139.49
19	07-11-2024	54.64	165.63
20	08-11-2024	46.68	160.54
21	09-11-2024	53.10	158.16
22	10-11-2024	46.68	138.51
23	11-11-2024	92.24	145.85
24	12-11-2024	113.27	143.79
25	13-11-2024	120.67	144.61
26	14-11-2024	96.69	145.42
27	15-11-2024	63.35	124.53
28	16-11-2024	55.43	132.98
29	17-11-2024	47.79	130.94
30	18-11-2024	65.49	114.52
31	19-11-2024	74.24	127.41
32	20-11-2024	87.14	134.92
33	21-11-2024	71.29	120.49
34	22-11-2024	55.02	107.29
35	23-11-2024	48.14	107.41
36	24-11-2024	92.50	109.66
37	25-11-2024	123.17	155.69
38	26-11-2024	118.77	149.65
39	27-11-2024	72.53	119.71
40	28-11-2024	69.54	112.36
41	29-11-2024	65.00	109.42
42	30-11-2024	67.96	105.35
43	01-12-2024	45.52	102.79
44	02-12-2024	57.3	123.57
45	03-12-2024	56.39	111.26
46	04-12-2024	55.47	85.21
47	05-12-2024	67.97	102.11
48	06-12-2024	66.61	122.07
49	07-12-2024	64.78	147.3
50	08-12-2024	49.09	147.22
51	09-12-2024	54.21	165.39
52	10-12-2024	66.09	158.94
53	11-12-2024	51.70	124.25
54	12-12-2024	66.09	115.93
55	13-12-2024	64.96	89.73

56	14-12-2024	64.15	88.68
57	15-12-2024	90.45	88.00
58	16-12-2024	102.38	96.62
59	17-12-2024	81.58	94.54
60	18-12-2024	68.14	96.25
61	19-12-2024	63.73	120.76
62	20-12-2024	58.66	118.88
63	21-12-2024	64.39	110.40
64	22-12-2024	61.53	105.38
65	23-12-2024	93.05	93.02
66	24-12-2024	88.97	121.36
67	25-12-2024	86.12	104.69
68	26-12-2024	53.06	108.72
69	27-12-2024	46.43	111.52
70	28-12-2024	55.47	108.72
71	29-12-2024	64.52	111.52
72	30-12-2024	99.04	110.29
73	31-12-2024	110.24	111.68
74	01-01-2025	97.39	99.70
75	02-01-2025	75.72	94.21
76	03-01-2025	66.25	96.78
77	04-01-2025	59.31	99.54
78	05-01-2025	54.62	98.95
79	06-01-2025	58.74	105.67
80	07-01-2025	54.62	108.71
81	08-01-2025	60.29	107.00
82	09-01-2025	69.37	103.19
Prescribed Standard (NAAQS, 2009)		**0-60**	**0-100**
Minimum Observation		45.32	85.21
Maximum Observation		123.17	188.48
98th Percentile		119.49	166.29
Mean		69.06	120.33
Median		65.79	111.60
Std. Deviation		18.46	22.80

In order to observe the instantaneous concentrations of particulate matter ($PM_{2.5}$ & PM_{10}) in and around Nawatola Basti, a handheld aerosol monitor with a sampling period of 1 minute was used. The collected data has been presented in **Table 13**, providing a summary of the observed particulate matter concentrations across different times and locations. It is important to note that these values represent instantaneous measurements, which tend to be higher than longer-term averaged concentrations due to their capture of short-term fluctuations.

The data reveals notable variations in $PM_{2.5}$ & PM_{10} concentrations across different times and locations in Nawatola Basti. However, higher concentrations are generally observed during the late afternoon and evening hours (see **Figure 14f-h**). During field visits, it was observed that many households in Nawatola Basti use coal for cooking (see **Figure 14f-h**). They typically burn the coal in the late evening to prepare it for cooking dinner later in the night. Burning coal earlier allows it to stabilize, reducing smoke and ensuring a consistent heat source for cooking. However, burning coal also produces particulate matter and other harmful gaseous pollutants.

Table 13: Instantaneous Concentrations of $PM_{2.5}$ & PM_{10} in and around Nawatola Basti

S.No.	Latitude	Longitude	Date	Time	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)
1	24.119063	82.728555	18-10-2024	10:47 AM	108	245.8
2	24.119046	82.728553	18-10-2024	12:25 PM	145.4	671.6
3	24.119032	82.728545	18-10-2024	12:27 PM	118.7	610.7
4	24.119031	82.728545	18-10-2024	12:34 PM	107.7	455.2
5	24.119014	82.728614	18-10-2024	12:39 PM	104.4	439.3
6	24.122243	82.688352	18-10-2024	04:59 PM	162.9	903.67
7	24.122243	82.688352	18-10-2024	05:30 PM	348.8	987.97
8	24.118491	82.726891	24-10-2024	10:56 AM	91.7	458.2
9	24.118847	82.727214	24-10-2024	05:53 PM	126	633
10	24.118847	82.727214	24-10-2024	05:55 PM	111.7	313.3
11	24.118463	82.727230	24-10-2024	06:04 PM	154.9	559.4
12	24.119075	82.726527	25-10-2024	11:57 AM	51.9	234.6
13	24.119075	82.726527	25-10-2024	12:00 PM	53.5	262.4
14	24.119075	82.726527	25-10-2024	12:11 PM	54	306.7
15	24.119238	82.725910	26-10-2024	11:11 AM	55.4	275.4
16	24.119228	82.725517	26-10-2024	11:15 AM	51.1	161.9
17	24.119069	82.728547	26-10-2024	11:30 AM	60.2	315.8
18	24.119501	82.723365	26-10-2024	12:16 PM	59.6	279.9
19	24.119501	82.723365	26-10-2024	01:31 PM	215.3	480.5
20	24.119075	82.726527	06-12-2024	10:31 AM	117	512.5
21	24.119075	82.726527	06-12-2024	10:32 AM	112.6	561.2
22	24.119075	82.726527	06-12-2024	10:34 AM	116.1	573.1
23	24.119075	82.726527	06-12-2024	10:36 AM	113.5	490.8
24	24.119075	82.726527	06-12-2024	10:40 AM	109.7	458.2
25	24.119075	82.726527	06-12-2024	10:43 AM	102.6	419.4
26	24.119075	82.726527	06-12-2024	10:46 AM	99.3	409.5
27	24.119075	82.726527	06-12-2024	10:47 AM	96.5	403
28	24.119075	82.726527	06-12-2024	10:49 AM	60.5	261.3
29	24.119075	82.726527	06-12-2024	10:51 AM	63.5	344.1
30	24.119075	82.726527	06-12-2024	04:10 PM	64.1	217.5
31	24.119075	82.726527	06-12-2024	04:12 PM	60.3	528.4
32	24.119075	82.726527	06-12-2024	04:15 PM	55.9	558.9
33	24.119075	82.726527	06-12-2024	04:16 PM	70	1025.6
34	24.119075	82.726527	06-12-2024	04:20 PM	54.6	444
35	24.119075	82.726527	06-12-2024	04:25 PM	79.3	567.2
36	24.119075	82.726527	07-12-2024	11:41 AM	107.5	434.5

37	24.119075	82.726527	07-12-2024	11:44 AM	124.6	550.8
38	24.119075	82.726527	07-12-2024	11:49 AM	127.9	547.3
39	24.119075	82.726527	07-12-2024	11:51 AM	125.4	355
40	24.119075	82.726527	07-12-2024	11:53 AM	126	359.9
41	24.119075	82.726527	07-12-2024	11:55 AM	122.3	387.7
42	24.119075	82.726527	07-12-2024	11:57 AM	122.2	299.1
43	24.119075	82.726527	07-12-2024	12:01 PM	121.8	353.4
44	24.119075	82.726527	07-12-2024	12:03 PM	120.6	350.2

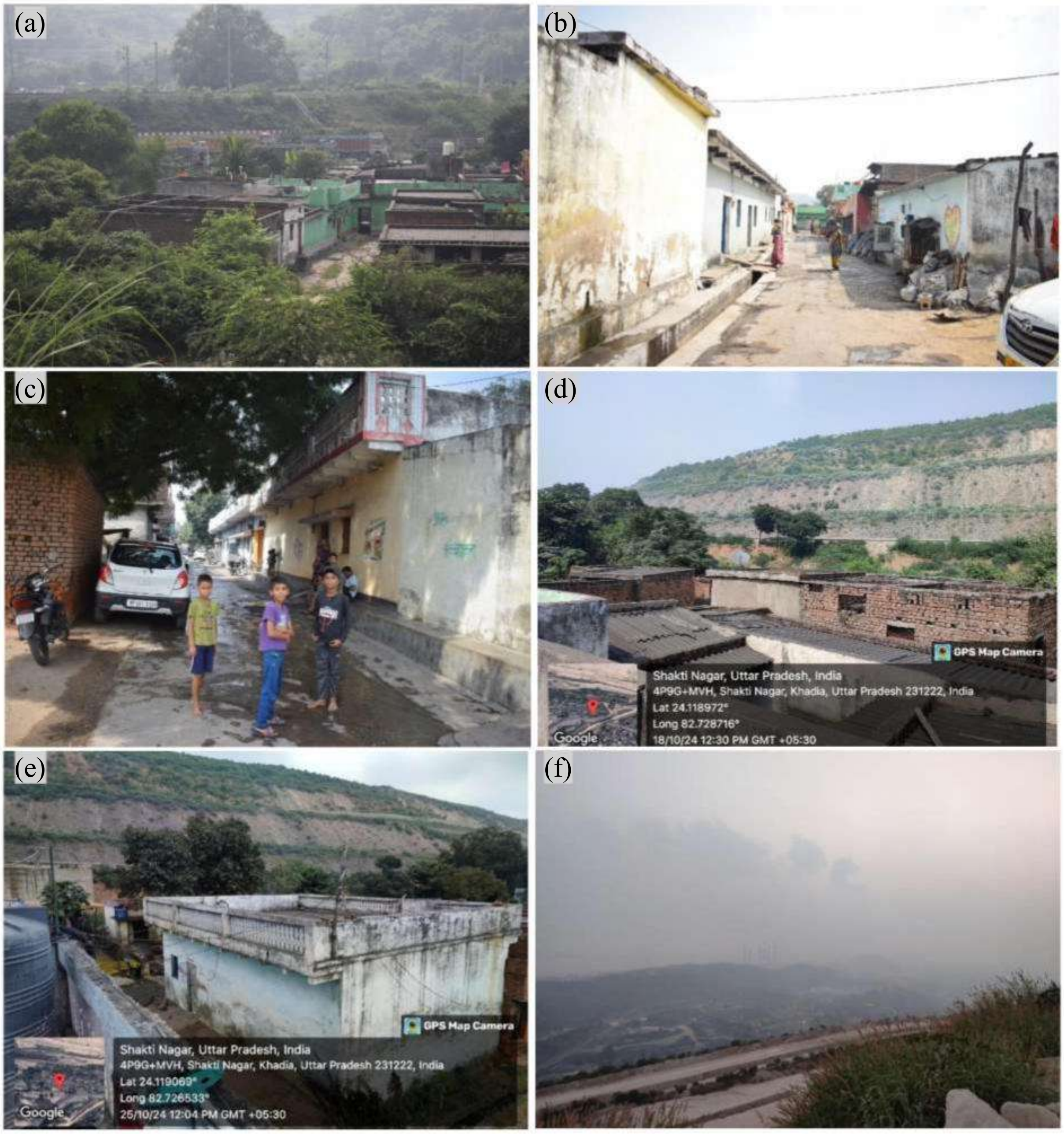


Figure 14: Field Photographs of Nawatola Basti. (a) Nawatola Basti as seen from the Proposed Warf Wall. (b-c) The streets of the Nawatola Basti recently washed to remove dust. (d-e) The East Overburden Dump as seen from the roofs of houses of Nawatola Basti. (f) The view of Shaktinagar from the top of the East Overburden Dump. (f-h) Smoke clouds appearing by the evening hours over Nawatola Basti

5.1.3 Average Concentrations of Pollutants in Winds blowing to Nawatola Basti

The analysis of wind-based average concentrations of air pollutants at Nawatola Basti reveals that the East-Northeast (ENE), East (E), and East-Southeast (ESE) directions dominate wind patterns (see **Table 14**). The high-frequency wind directions are critical in influencing pollutant dispersion and concentration in the area.

Table 14: Wind-Based Average Concentration of Air Pollutants at NB P1

Wind Direction	% Frequency	Avg. $PM_{2.5}$	Avg. PM_{10}	Avg. SO_2	Avg. NO_2	Avg. CO
NE	12.20	71.00	124.74	76.75	64.01	0.89
ENE	30.49	76.79	121.52	77.93	66.55	0.84
E	20.73	67.95	126.05	78.01	66.63	0.79
ESE	21.95	71.30	122.53	78.37	63.94	0.95
SE	3.66	55.61	124.31	81.38	62.52	0.48
SSE	6.10	70.70	123.58	80.45	64.82	0.79
S	1.22	92.54	108.57	58.61	55.80	0.91
SSW	1.22	79.16	132.32	76.31	64.62	0.83
SW	1.22	81.28	108.20	58.61	55.80	0.86
W	1.22	78.33	127.64	84.81	64.62	0.82

Focusing on particulate matter concentrations, the ENE wind direction records 76.79 $\mu g/m^3$ for $PM_{2.5}$ and 121.52 $\mu g/m^3$ for PM_{10}, while the NE shows slightly lower levels of $PM_{2.5}$ at 67.95 $\mu g/m^3$ and a slightly higher PM_{10} concentration of 126.05 $\mu g/m^3$. Although the SSW wind reports the highest $PM_{2.5}$ level at 132.32 µg/m^3, its impact is limited due to its minimal frequency (1.22%). In terms of gaseous pollutants, the SE wind direction shows a slightly higher average concentration of SO_2 at 81.38 µg/m^3. All the other directions have gaseous pollutants under the permissible limit.

5.1.4 Pollutant Concentrations in Khadia Colony

The $PM_{2.5}$ & PM_{10} concentrations at KC P1 varied between 41.31 to 109.01 µg/m^3 and 42.45 to 175 µg/m^3, respectively as can be seen in **Table 15**. The mean concentration observed for $PM_{2.5}$ was 68.69 µg/m^3, while for PM_{10} it was 103.56 µg/m^3. The mean TSP was 371.12 µg/m^3. On comparing the observed averages of $PM_{2.5}$ & PM_{10} between Khadia Colony with that of Nawatola Basti (70.62 µg/m^3 and 122.98 µg/m^3, respectively), it was observed that the pollutant levels at KC P1 were lower than those at Nawatola Basti. This might be because of its farther distance from the core zone of the Khadia project and processing units in particular.

Table 15: Concentration of Air Pollutants at Khadia Colony (KC P1)

S.No.	Date	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	TSP (µg/m^3)
1	19-10-2024	63.23	99.37	301.89
2	20-10-2024	83.91	115.37	386.72
3	21-10-2024	72.34	87.68	427.37
4	22-10-2024	78.23	114.32	528.56
5	23-10-2024	59.37	175.00	480.43
6	24-10-2024	41.31	134.05	355.07
7	26-10-2024	49.82	113.57	309.16
8	28-10-2024	58.32	93.10	263.24
9	05-11-2024	80.49	123.18	245.99
10	07-11-2024	66.88	105.79	250.89
11	09-11-2024	53.27	88.41	255.79
12	10-11-2024	69.69	89.33	262.49
13	12-11-2024	86.10	90.26	269.19
14	13-11-2024	91.77	91.18	289.34
15	14-11-2024	97.45	92.10	309.48
16	19-11-2024	99.39	72.87	342.53
17	27-11-2024	48.57	53.65	485.74
18	02-12-2024	59.32	45.05	555.92
19	03-12-2024	60.01	79.10	498.57
20	04-12-2024	81.23	113.15	441.22
21	18-12-2024	98.34	153.79	384.70
22	23-12-2024	109.01	164.28	375.05
23	24-12-2024	92.46	148.93	375.25
24	25-12-2024	87.24	133.57	375.45
25	27-12-2024	89.55	121.68	373.51

26	30-12-2024	91.86	109.78	371.58
27	31-12-2024	97.75	99.81	396.40
28	01-01-2025	103.63	89.84	421.23
29	03-01-2025	97.98	66.15	407.40
30	06-01-2025	92.32	42.45	393.58
Prescribed Standard (NAAQS, 2009)		60	100	-
Minimum Observation		41.31	42.45	245.99
Maximum Observation		109.01	175.00	555.92
98th Percentile		105.89	168.78	540.04
Mean		78.69	103.56	371.12
Median		82.57	99.59	375.15
Std. Deviation		18.7936	32.41	85.34

5.1.5 Heavy Metal Concentrations in Air at Nawatola Basti

The heavy metal analysis of air at NB P1 and NB P2, shown in **Table 16**, revealed a similar trend that was observed in particulate matter concentrations at these points which is NB P1 having a higher total ($PM_{2.5}$ + PM_{10}) concentration of the heavy metals (THM) (13.46 µg/m^3) than that at NB P2 (11.08 µg/m^3). However, the percentage of heavy metal concentrations (% HM) within the $PM_{2.5}$ & PM_{10} fractions are higher in NB P2 than in NB P1. This discrepancy arises because the overall mass of collected particulate matter on the filter paper was relatively lower at NB P2 as compared to NB P1, leading to a higher proportion of heavy metals.

Table 16: Observed Heavy Metal Concentrations in Air at Nawatola Basti

S.No.	Heavy Metal (µg/m^3)	Date: 23-10-2024					
		NB P1			NB P2		
		$PM_{2.5}$	PM_{10}	$PM_{2.5}$ + PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$ + PM_{10}
1	Cr	0.57	0.48	1.05	0.52	0.51	1.03
2	Mn	0.07	0.23	0.30	0.09	0.23	0.32
3	Fe	2.51	8.41	10.92	2.05	6.28	8.33
4	Ni	0.29	0.23	0.52	0.29	0.25	0.54
5	Cu	0.03	0.05	0.08	0.04	0.04	0.08
6	Zn	0.18	0.13	0.31	0.38	0.14	0.52
7	As	0.004	0.006	0.01	0.005	0.007	0.01
8	Cd	0.002	0.02	0.02	0.002	0.02	0.02
9	Pb	0.05	0.19	0.24	0.04	0.19	0.23
THM		3.71	9.75	13.46	3.42	7.67	11.08
$W_{2.5/10}$ (µg)		1929	6158	8087	226	2827	3053
% HM		0.20	0.16	0.17	1.51	0.27	0.37

Upon observing % HM in $PM_{2.5}$ & PM_{10} at both the monitoring locations, one can observe that higher % HM is in $PM_{2.5}$ than in PM_{10}. This implies that despite PM_{10} contributing a larger mass fraction of total particulate matter, the more toxic and hazardous heavy metals are concentrated in the finer fraction i.e., $PM_{2.5}$. The trend of occurrence of heavy metals in ambient air at NV P1 and NV P2 is as follows: Fe > Cr > Ni > Zn > Mn > Pb > Cu > Cd > As. Among the analyzed metals, iron and chromium are the most abundant heavy metals at both monitoring locations.

The CPCB (NAAQS, 2009) has established standards for Pb, Ni, and As but not for other heavy metals. Among these, only Pb has a 24-hour time-weighted average standard of 1 $\mu g/m^3$, which suggests that the concentration of Pb is below the permissible limit.

5.2 Water Quality Scenario of the Study Area

5.2.1 Physio-chemical parameter analysis of Water Samples

To gain a understanding of water quality in the study area, parameters such as pH, electrical conductivity, total dissolved solids, dissolved oxygen, and temperature were measured in the field using a EUTECH Instrument Portable Water Meter. The properties of the surface waters and groundwater sources are mentioned in **Table 17** and **Table 18**. These observations are compared to the Bureau of Indian Standards (BIS), IS 2296:1992 - Tolerance Limit for Inland Surface Waters, Class – C for surface waters and IS 10500:2012 for groundwater.

Table 17: Physio-chemical Properties and Heavy Metal Analysis of Surface Waters observed near the East Dump

S.No.	Parameter	Sample Code							IS 2296:1992
		SW1	SW2	SW3	SW4	SW5	SW6	SW7	
1	pH	7.28	7.51	7.09	6.78	6.89	6.18	7.01	6.5 to 8.5
2	Temp. (°C)	28.3	29.4	29.92	29.5	29.3	29.7	29.9	NS
3	Cond. (µS)	1.28	267.2	316.5	303	542.5	629.2	684.8	NS
4	TDS (ppm)	762	283.2	208.3	224	271.3	314.6	342.3	≤ 1500
5	DO (mg/l)	6.29	6.18	6.01	6.47	6.06	6.15	6.12	≥ 4
6	TSS (mg/l)	80	60	50	120	80	85	105	NS
7	Na (PPM)	58.02	1.7	3.04	29.53	6.46	8.33	82.85	NS
8	Mg (PPM)	34.37	1.76	1.37	3.4	6.86	6.11	21.68	NS
9	K (PPM)	8.6	3.22	6.35	1.33	2.17	2.31	10.69	NS
10	Ca (PPM)	15.13	2.22	2.12	3.05	5.2	4.96	8.22	NS
11	Cr (PPM)	BQL	BQL	0.01	0.02	0.02	0.01	BQL	≤ 0.05
12	Mn (PPM)	BQL	BQL	0.01	BQL	BQL	BQL	BQL	≤ 0.5

13	Fe (PPM)	0.02	0.04	0.09	0.1	0.08	0.07	0.07	≤ 0.5
14	Ni (PPM)	BQL	BQL	0.01	0.01	BQL	BQL	BQL	NS
15	Cu (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 1.5
16	Zn (PPM)	0.34	0.21	0.52	0.24	0.2	0.26	0.19	≤ 15
17	As (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 0.2
18	Cd (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 0.01
19	Pb (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 0.1

NS = Not Specified; BQL = Below Quantifiable Limit

Table 18: Physio-chemical Properties and Heavy Metal Analysis of Groundwater Sources observed in Nawatola Basti near the East Dump

S.No.	Parameter	Sample Code						IS 10500:2012	
		GW1	GW2	GW3	GW4	GW5	GW6	AL	PL
1	pH	7.08	6.85	6.67	6.92	6.78	7.02	6.5 to 8.5	NR
2	Temp. (°C)	27.2	29.2	28.7	27.6	26.3	26.9	NS	NS
3	Cond. (µS)	758	676	692	630	711.5	658	NS	NS
4	TDS (ppm)	618.4	576.6	563	623	695	742	500	2000
5	DO (mg/l)	6.09	5.99	5.82	5.70	5.85	5.78	NS	NS
6	TSS (mg/l)	18	25	34	25	32	28	NS	NS
7	Na (PPM)	149.5	86.62	92.54	102.44	101.33	98.7	NS	NS
8	Mg (PPM)	26.01	15.44	18.45	29.48	28.91	23.46	30	100
9	K (PPM)	2.85	0.88	1.45	0.5	0.39	0.96	NS	NS
10	Ca (PPM)	18.33	9.99	11.24	12.39	11.33	13.25	75	200
11	Cr (PPM)	BQL	0.03	0.01	BQL	BQL	0.04	0.05	NR
12	Mn (PPM)	0.06	0.06	0.08	0.01	BQL	0.09	0.1	0.3
13	Fe (PPM)	BQL	0.17	0.22	BQL	BQL	0.27	0.3	NR
14	Ni (PPM)	BQL	0.02	BQL	BQL	BQL	BQL	0.02	NS
15	Cu (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.05	1.5
16	Zn (PPM)	0.37	0.2	0.57	0.44	0.25	0.62	5	15
17	As (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.01	0.05
18	Cd (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.003	NR
19	Pb (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.01	NR

NS = Not Specified; NR = No Relaxation

5.2.2 XRF Analysis of Overburden Samples

The chemical composition of samples from the top, middle and toe were determined by a Handheld XRF analyser (Bruker) and is tabulated in **Table 19**. The sample from the top section at the East dump is characterized by higher alumina (Al_2O_3) content and relatively low iron (Fe) concentrations, indicating the dominance of clayey materials with minimal weathering compared to the lower dumps. In contrast, the sample from the middle section shows an increased presence of iron and calcium, suggesting the accumulation of iron-rich materials, possibly due to the weathering of overlying layers and leaching processes. The toe section, on the other hand, exhibits higher concentrations of silica (SiO_2) and potassium oxide (K_2O), pointing to the concentration of lighter silicate minerals that have been transported and deposited downstream. These variations in chemical content across the sections reflect differences in weathering, leaching, and transport processes within the overburden material.

Table 19: XRF Analysis of East Dump Samples

Element/Oxide	Percentage of Elements and Oxides from the East Dump		
	Top Section	Middle Section	Toe Section
MgO	<LOD	<LOD	<LOD
Al_2O_3	20.68	14.78	15.96
SiO_2	44.67	49.53	55.59
P	<LOD	<LOD	<LOD
S	0.05	<LOD	<LOD
K_2O	1.46	0.79	1.67
Ca	0.05	0.38	0.08
Ti	0.36	0.53	0.47
Cr	0.01	0.02	0.01
Mn	0.01	0.03	0.03
Fe	0.32	2.21	1.51
Co	<LOD	<LOD	<LOD
Ni	0.00	0.01	0.00
Cu	0.00	0.00	0.00
Zn	0.00	0.00	0.00
Ga	0.00	0.00	0.00
As	<LOD	<LOD	0.00
Rb	0.01	0.00	0.01
Sr	0.01	0.00	0.00
Y	0.00	0.00	0.00
Zr	0.02	0.05	0.04
Nb	0.00	0.00	0.00
Pd	<LOD	<LOD	<LOD
Cd	<LOD	<LOD	<LOD
Ba	0.05	0.03	0.05
La	0.01	<LOD	<LOD
Ta	<LOD	<LOD	<LOD
Pb	0.00	0.00	0.00
Th	<LOD	0.00	0.00
U	0.00	<LOD	<LOD

LOD = Limit of Detection

5.2.3 Analysis of Leachate Experiments

Before conducting leachate experiments, the textural analysis of the overburden samples was done based on gravimetric and sedimentation techniques. It was found that while the percentages of gravel and sand was more or less constant across the samples from the top, middle and toe of the East dump, the percentages of silt and clay progressively increased from top to toe, possibly by surface runoff.

Experiment 1: Combined Sample Analysis

To prepare this setup, a sample-to-water volume ratio of 1:5 was adopted. The combined thickness of the top, middle and toe samples was 4 cm. Hence, the volume of the sample was 1444 cm^3. By the ratio, the amount of water was deduced to be 7.22 litres. The experimental observations are tabulated in **Table 20**.

The leaching experiment conducted on the combined overburden material from the East dump provided valuable insights into the behaviour of various parameters over time. The pH of the leachate increased gradually over time, starting from 7.31 and reaching 8.11 the next day, indicating the neutral to slightly alkaline nature of the leachate.

Table 20: Leachate Analysis from Combined Sample

Parameters	Tap Water	Time of Observation (minutes)					
		10	20	40	80	160	Final*
pH	7.10	7.31	7.64	7.77	8.04	8.22	8.11
Temperature (°C)	25.3	24.6	26.2	26.4	26.1	26.4	27.6
Conductivity (µS)	1045	5223	3345	2004	1394	1147	1084
TDS (ppm)	521	2028	1658	1038	697	573.2	541.1
NaCl (ppm)	514.2	2005	1552	1021	700.2	537.8	536.5
Resistivity (Ω)	968.5	587	608	699.3	775.5	872.4	923.5
D.O (mg/l)	5.71	8.48	7.82	7.81	5.94	5.8	5.74
Water leached (ml)	-	250	450	750	1300	2350	1500

Final*: Cumulative leachate after 24 hours from the start of the experiment

In conductivity, a sharp increase was observed initially (1045 µS in tap water to 5223 µS at 10 minutes), followed by a steady decline, reaching 1084 µS the next day. This trend suggests the rapid leaching of soluble ions initially, which decreased over time as the material became depleted of easily dissolvable salts. Similarly to conductivity, Total Dissolved Solids (TDS) rose significantly at the start (521 ppm to 2028 ppm at 10 minutes) and then declined steadily to 541.1 ppm the next day. This trend confirms the release of soluble solids during the initial stages of leaching.

The concentration of NaCl increased sharply from 514.2 ppm to 2005 ppm at 10 minutes and gradually reduced to 536.5 ppm the next day. This indicates that sodium chloride was a major contributor to the soluble salts in the overburden material. Resistivity increased over time, starting at 587 Ω and reaching 923.5 Ω the next day. This inverse relationship with conductivity highlights the diminishing presence of ions in the leachate as leaching progressed. The Dissolved Oxygen (DO) levels initially increased to 8.48 mg/L at 10 minutes, then decreased steadily, dropping to 5.74 mg/L the next day. This may reflect oxygen consumption due to chemical reactions within the overburden material. The cumulative water leached increased over time, from 250 ml at 10 minutes to 2350 ml at 160 minutes, with an additional 1500 ml the next day.

Experiment 2: Section-specific Leachate Analysis

In this experiment, 4 cm of overburden material from each section i.e., top, middle and toe were placed in three separate middle boxes. The same sample-to-water volume ratio of 1:5 was adopted. Hence, the volume of samples in each box was 1444 cm^3. By the ratio, the amount of water to be used in the experiment was deduced to be 7.22 litres. The experimental observations are tabulated in **Table 21**.

The leaching experiment conducted on the overburden sample from the top reveal significant insights into the behaviour of various parameters over time. Initially, the pH decreased from 7.27 (neutral) to 6.24 (acidic) within the first 10 minutes, indicating the dissolution of acidic compounds. Subsequently, the pH gradually increased to 7.95 (slightly alkaline) by the next day, suggesting the buffering action of minerals and the dilution of acidic compounds as water percolated through the material. Conductivity and TDS followed a similar trend, peaking at 5554 µS and 2781 ppm, respectively, within 10 minutes, highlighting the rapid dissolution of salts and minerals during the initial phase. These values then steadily declined to 1015 µS and 511.9 ppm by the next day, reflecting the exhaustion of easily soluble ions over time. The DO levels decreased, likely due to oxygen consumption during the oxidation of minerals. NaCl concentrations were notably high at the start, peaking at 3151 ppm at 10 minutes and then stabilizing at lower levels, indicating the dominance of soluble salts in early leaching. Resistivity, inversely related to conductivity, was lowest at 132.6 Ω at 10 minutes but increased as the ion concentration decreased.

The leaching experiment on the dump material from the middle section revealed that the pH value rose from 7.81 to 8.15 at 160 minutes, indicating alkaline mineral dissolution, and was

Table 21: Leachate Analysis of Section-Specific Sample

Parameters	**Initial (Tap water)**	**Leachate from the top section**						**Leachate from the middle section**						**Leachate from the toe section**				
		Time of Observation (minutes)																
		10	**20**	**40**	**80**	**160**	**Final***	**10**	**20**	**40**	**80**	**160**	**Final***	**10**	**20**	**40**	**80**	**Final***
pH	7.27	6.24	6.96	7.76	7.80	7.82	7.95	7.81	8.03	8.15	8.20	8.15	8.01	7.42	7.53	7.58	7.68	7.54
Temp. (°C)	24.6	23.9	24.1	24.3	24.1	22.6	24.8	23.3	23.1	22.8	22.4	22.6	23.7	21.5	22.1	22.1	22.2	22.4
Conductivity (µS)	990.8	5554	2008	1091	1076	1054	1015	6096	3946	2234	1055	1024	985.8	1670	1125	1069	1049	968.5
TDS (ppm)	495.1	2781	1005	544.3	538.1	527	511.9	3052	1972	1117	526	512	501.9	832.4	562.3	535	525	518.5
NaCl (ppm)	488.2	3151	1952	538.6	535.2	520.5	522.5	3519	2080	1158	521.4	520.5	492.5	852.2	557	529.1	519	512.3
Resistivity (Ω)	918	132.6	498	918.6	933	948.8	953.5	123.2	253.3	447.6	501.2	974.6	996.2	601.5	889.1	934.3	951.7	945
Dissolved Oxygen (mg/l)	7.79	6.58	6.22	6.97	6.88	6.70	6.08	7.99	7.96	7.93	7.82	7.17	6.57	5.77	5.32	5.69	5.76	5.82
Water leached (ml)	-	230	500	1300	1900	2500	250	140	290	480	800	1300	3470	450	850	1800	3300	650

Final*: Cumulative leachate after 24 hours from the start of the experiment stabilized at 8.01 by the next day. Conductivity peaked at 6096 µS in 10 minutes, reflecting rapid salt dissolution, then dropped to 985.8 µS by the next day. Similarly, TDS and NaCl peaked at 3052 ppm and 3519 ppm, respectively, before stabilizing. Resistivity was lowest at 123.2 Ω at 10 minutes and increased to 996.2 Ω as ion concentrations reduced. Dissolved oxygen initially peaked at 7.99 mg/L at 10 minutes but dropped to 6.57 mg/L by the next day, likely due to oxidation reaction.

In the dump sample from the toe section, the leaching analysis revealed that the pH value rose from 7.42 to 7.68 at 80 minutes before stabilizing at 7.54 by the next day, indicating mild alkalinity due to leaching materials. Conductivity peaked at 1670 µS after 10 minutes, reflecting the rapid dissolution of soluble ions, then gradually decreased to 968.5 µS by the next day. Correspondingly, the Total Dissolved Solids (TDS) and NaCl concentrations showed an initial rise to 832.4 ppm and 852.2 ppm, respectively, at 10 minutes, before declining to 518.5 ppm and 512.3 ppm by the next day. Resistivity, inversely proportional to conductivity, showed the lowest value of 601.5 Ω at 10 minutes but increased to 945 Ω as the ion concentrations reduced. Dissolved Oxygen (DO) levels dropped initially from 5.77 mg/L to 5.82 mg/L by the next day, indicating reactive oxygen consumption.

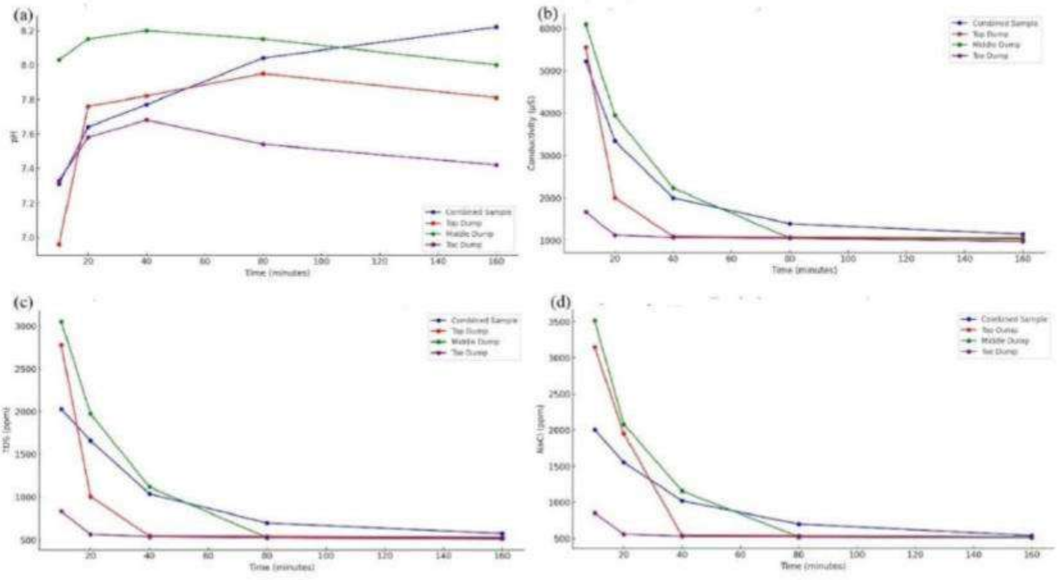


Figure 15: Graphical representation of the Temporal Variation of Physicochemical Properties of Leachates from the Combined and Section-specific samples from East Dump. (a) Variation of Ph with time. (b) Variation of conductivity with time. (c) Variation of TDS with time. (d) Variation of NaCl with time.

The observed data of the leaching experiments are illustrated in **Figure 15**. The pH is lower initially, reflecting the acidic nature of fresh leachate as shown in **Figure 15a**. Over time, pH stabilizes toward neutrality or slight alkalinity, suggesting buffering reactions. The parameters (conductivity, TDS, and NaCl) are high initially, indicating a rapid release of soluble materials due to water interacting with the dump material as shown in **Figure 15b-d**.

Over time, Conductivity, TDS, and NaCl decline steadily, indicating a depletion of easily soluble ions. The middle dump consistently shows the highest conductivity, TDS, and NaCl values, likely due to higher salt content. The toe dump shows the lowest values, possibly due to dilution or less reactive material. Long-term stabilization suggests reduced environmental impact after the initial phase.

Chapter 6: Evaluation of the Effectiveness of Control Measures to Control Air and Water Pollution from the East Dump

6.1 Evaluation of Air Pollution Control Measures

The air pollution study of the Nawatola Basti revealed that, in general, the $PM_{2.5}$ concentrations are 1.1 times higher than the permissible standard of 60 µg/m^3, while PM_{10} concentrations are 1.22 times higher than the standard of 100 µg/m^3. From field visits and monitoring of instantaneous concentrations of particulate matter (see **Table 13**), it was observed that higher concentrations are generally prevalent during the late afternoon and evening hours, likely due to coal burning for cooking activities.

Table 22: Summary of Air Quality Parameter ($PM_{2.5}$)

<table>
<tr><th colspan="2" rowspan="2">Category</th><th colspan="6">(%) $PM_{2.5}$ Values</th></tr>
<tr><th colspan="2">At NB P1</th><th colspan="2">At NB P2</th><th colspan="2">At KC P1</th></tr>
<tr><td colspan="2">Below 60</td><td colspan="2">30.49</td><td colspan="2">35.37</td><td colspan="2">36.67</td></tr>
<tr><td>60-100</td><td rowspan="2">Above 60</td><td>60.98</td><td rowspan="2">69.51</td><td>57.32</td><td rowspan="2">64.63</td><td>63.33</td><td rowspan="2">63.33</td></tr>
<tr><td>Above 100</td><td>8.54</td><td>7.32</td><td>0.00</td></tr>
</table>

Table 23: Summary of Air Quality Parameter (PM_{10})

<table>
<tr><th colspan="2" rowspan="2">Category</th><th colspan="6">(%) PM_{10} Values</th></tr>
<tr><th colspan="2">At NB P1</th><th colspan="2">At NB P2</th><th colspan="2">At KC P1</th></tr>
<tr><td colspan="2">Below 100</td><td colspan="2">6.10</td><td colspan="2">15.85</td><td colspan="2">53.33</td></tr>
<tr><td>100-150</td><td rowspan="2">Above 100</td><td>82.93</td><td rowspan="2">93.90</td><td>71.95</td><td rowspan="2">84.15</td><td>36.67</td><td rowspan="2">46.67</td></tr>
<tr><td>Above 150</td><td>10.98</td><td>12.20</td><td>10.00</td></tr>
</table>

The percentage distribution, shown in **Table 22** and **23**, reveal that at NB P1, 30.49% of $PM_{2.5}$ values are below 60 µg/m^3, 6.98% lie in the range of 60-100 µg/m^3, and 8.54% fall above 100 µg/m^3. For PM_{10}, 6.10% of the values are below 100 µg/m^3, 82.93% in the range of 100-150 µg/m^3, and 10.98% above 150 µg/m^3. At NB P2, 35.37% of the $PM_{2.5}$ values are below 60 µg/m^3, 57.32% between 60-100 µg/m^3, and 7.32% above 100 µg/m^3. For PM_{10}, 15.85% of the values are below 100 µg/m^3, 71.95% fall within the range of 100-200 µg/m^3 and 12.20% values are above 150 µg/m^3 respectively. KC P1 being much farther from the core zone and much vegetated has 36.67% $PM_{2.5}$ values below 60 and 53.33% PM_{10} values below 100.

The NAQI of the study area is calculated based on the maximum value of the sub-index which is calculated for each pollutant by the linear interpolation between the breakpoint concentration values of pollutants. The calculated sub-indices are mentioned in **Table 24**.

Since, $PM_{2.5}$ has the maximum sub-index, 133.84 is considered as the NAQI for Nawatola Basti. This value comes in the "Moderately Polluted" category.

Table 24: Sub-Indices of Air Pollutants at Nawatola Basti for Calculating NAQI

Air Pollutant	I_p
$PM_{2.5}$	133.84
PM_{10}	115.60
SO_2	97.20
NO_2	81.30
CO	29

It is important to note here that these observations only express the prevalent air quality of the region which is subject to a host of sources of all types in all directions. However, in order to solely observe the contribution of the East overburden dump in degrading the air quality of the Nawatola Basti, the wind-based average concentrations of air pollutants, shown in **Table 14**, and the Wind Rose Plot of the entire monitoring period illustrated on a Satellite Image, shown in **Figure 12**, should be taken into account.

The only winds that blow, in a high-frequency, over or close to the East dump towards Nawatola Basti, are the NE winds (12.20%). The dump with a maximum elevation of ~ 200m from the ground appears to guard most of the winds coming from North. The NE winds should bring pollutants from the dump but also from the adjoining coal mines. The average concentration of $PM_{2.5}$ & PM_{10} in the NE winds are 71 µg/m^3 and 124.74 µg/m^3 respectively. Regarding gaseous pollutants, all concentrations are below their respective permissible limits.

To calculate the pollution load of $PM_{2.5}$ & PM_{10} from the East dump generated via wind erosion, the following formula is used:

$$Pollution\ Load\ (kg/hr) = Emission\ Factor\ (kg/ha/hr)\ \times Area\ (ha)$$

The emission factor of $PM_{2.5}$ & PM_{10} from the wind erosion from overburden dump as mentioned in the EMP sourced from the United States Environmental Protection Agency (USEPA) is 0.008 and 0.09 kg/ha/hr respectively. The total area of the East Dump, as of 2022, is 206.44 hectares. This figure is derived by combining the internal and external dumping areas, as mentioned in the case report of Mukesh Singh v. State of Uttar Pradesh (O.A. No. 580/2022). By substituting these values into the above formula, the calculated pollution load is 1.65 kg/hr for $PM_{2.5}$ and 18.58 kg/hr for PM_{10}. It is important to note that this is a simplified estimate assuming constant erosion under the conditions embedded in the emission factor as it does not account for wind speed variability, soil moisture, surface roughness etc.

Efforts have been undertaken for the biological reclamation of the East Dump, covering all individual slopes of the dump decks. These areas have been developed despite challenges posed by the erosion of fertile substrates during periods of heavy precipitation. To counteract this, stabilization measures and soil enrichment techniques have been employed to enhance plant survival and growth. Plantations in this area is relatively recent, and its full development is expected to take approximately 2 to 3 years.

The evaluation of the air pollution control measures indicates that while efforts have been made to mitigate the impact of the East overburden dump, challenges remain in effectively addressing particulate matter levels in Nawatola Basti. These findings suggest the need for more comprehensive and adaptive strategies.

6.2 Evaluation of Water Pollution Control Measures

In order to evaluate the effectiveness of water pollution control measures, the physicochemical characterization and heavy metal analysis of surface- and groundwater sources near the East dump was observed. For surface water (see **Table 17**), it was observed that the pH levels across the locations range from 6.18 to 7.51, indicating slightly acidic to neutral conditions, all within the permissible range of 6.5 to 8.5. Conductivity values range significantly, from 1.28 µS (SW1) to 684.8 µS (SW7), reflecting varying levels of ionic content in the water. The TDS concentrations, which indicate dissolved solids in the water, remain below the permissible limit of 1500 ppm, ranging from 208.3 ppm (SW3) to 762 ppm (SW1). Dissolved oxygen (DO), a critical parameter for aquatic life, varies from 6.01 mg/L (SW3) to 6.47 mg/L (SW4), meeting the minimum requirement of 4 mg/L.

For groundwater sources (see **Table 18**), the pH values across the groundwater sources range from 6.67 (GW3) to 7.08 (GW1), falling within the acceptable range of 6.5 to 8.5, indicating neutral to slightly acidic conditions. Total dissolved solids (TDS) concentrations range from 563 ppm (GW3) to 742 ppm (GW6), remaining below the permissible limit of 2000 ppm but exceeding the acceptable limit of 500 ppm, suggesting moderate mineral content.

Concentrations of heavy metals such as chromium (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd), and lead (Pb) in both surface- and groundwater sources are either below the permissible limit or below quantifiable limits, indicating minimal heavy metal pollution.

The Water Quality Index (WQI) results for surface water samples SW1 to SW7 and groundwater samples GW1 to GW6 were calculated using the Canadian Council of Ministers of the Environment (CCME) Method as shown in **Table 25**.

Table 25: WQI of Surface water and Groundwater Sources near the East Dump.

Sample	F1	F2	F3	WQI
SW1	10	5.26	36.41	83.99
SW2	10	5.26	35.28	88.61
SW3	10	5.26	33.44	81.62
SW4	10	5.26	38.18	87.01
SW5	10	5.26	33.99	80.32
SW6	20	10.53	22.68	83.85
SW7	10	5.26	34.64	80.42
GW1	9	5.26	19.15	87.39
GW2	9	5.26	13.28	90.22
GW3	9	5.26	11.19	91.14
GW4	9	5.26	19.74	87.09
GW5	9	5.26	28.06	82.70
GW6	9	5.26	32.61	80.22

All surface water samples fall within the "Good" category, with WQI values ranging from 80.32 (SW5) to 88.61 (SW2). Groundwater samples also fall within the "Good" category, with WQI values ranging from 82.70 (GW5) to 91.14 (GW3). The good category implies that the water quality is protected with only a minor degree of threat or impairment.

In addition to estimating the physicochemical characteristics, field visits were made along the foot of the East dump and around the siltation ponds. It was observed that the RCC Catch Drain and Retaining Wall has been constructed along the toe of the dump. However, a small portion towards the east side of the dump is damaged and may be repaired. This has resulted in water spilling over surrounding areas, causing gully erosion and the formation of several unplanned ponds. The embankments of the siltation ponds were vegetated and stabilized.

Chapter 7: Summary and Conclusion

7.1 Summary

This study provides a comprehensive assessment of the effectiveness of measures taken by Khadia Project to control the air and water pollution from the East dump and pollution control/mitigative measures to minimize pollution load. It focuses on air and water pollution in the surrounding settlements, with particular emphasis on Nawatola Basti.

Air pollution control measures include mobile water sprinklers on haul roads, fog cannons, and a dust extraction system in the CHP. Coal is primarily transported via rail to reduce dust emissions, while vehicles carrying coal are covered with tarpaulins. Fixed sprinklers and automatic water sprinklers are installed at the coal yard and CHP receiving pit. Roads are metaled or blacktopped to minimize dust, and drilling equipment is fitted with dust extractors. A Rapid Loading System of 4 MTPA is under construction to increase coal transport via rail and would further improve air quality. A wheel washing facility is also under development and will be commissioned by February 2025. A Continuous Ambient Air Quality Monitoring Station track pollutants like SPM, SO_2, and NO_2, with real-time data sent to CPCB. Vegetative covers have been established on the dump, with approximately 39.81 ha planted as of 2022-23.

Water pollution control measures include a retaining wall, catch drains, and garland drains to manage surface runoff. Water is treated in a 38.4 MLD Effluent Treatment Plant and reused for dust suppression, road watering, and greenbelt development. Domestic wastewater is processed in a 1.5 MLD Sewage Treatment Plant for horticulture. Silt-settling ponds prevent runoff contamination, and mine/rainwater is collected for groundwater recharge and mining activities. Besides this, retaining wall and drains have been provided to avoid siltation.

To evaluate the effectiveness of air pollution mitigation measures from the east dump, continuous monitoring was conducted at multiple locations. Monitoring stations were installed over the rooftops of houses to measure pollutant concentrations ($PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and heavy metals) alongside meteorological parameters.

The air pollution study revealed that the mean $PM_{2.5}$ and PM_{10} concentrations observed in Nawatola Basti were 70.62 $\mu g/m^3$ and 122.98 $\mu g/m^3$ respectively.

Upon comparing the average concentrations of $PM_{2.5}$ and PM_{10} across the monitoring locations, it was observed that NB P1 and NB P2, located near the core zone of an opencast coal mine, have higher $PM_{2.5}$ and PM_{10} concentrations than KC P1, which is farther and has more vegetation. NB P1 records the highest pollution levels ($PM_{2.5}$: 72.19 $\mu g/m^3$, PM_{10}: 125.63

$\mu g/m^3$), followed by NB P2 ($PM_{2.5}$: 69.06 $\mu g/m^3$, PM_{10}: 120.33 $\mu g/m^3$), while KC P1 has lower values ($PM_{2.5}$: 68.69 $\mu g/m^3$, PM_{10}: 103.56 $\mu g/m^3$).

The heavy metal analysis at NB P1 and NB P2 follows the trend observed in particulate matter concentrations, with NB P1 having a higher total i.e., $PM_{2.5}$- and PM_{10}- bounded heavy metal concentration (THM: 13.46 $\mu g/m^3$) than NB P2 (11.08 $\mu g/m^3$). However, the percentage of heavy metals (% HM) within $PM_{2.5}$ and PM_{10} is higher at NB P2 due to its lower overall particulate matter mass. Notably, heavy metals are more concentrated in $PM_{2.5}$, indicating that the finer fraction carries more toxic and hazardous metals. The predominant metals at both sites are Fe and Cr, followed by Ni, Zn, Mn, Pb, Cu, Cd, and As. Among monitored metals, only Pb has a 24-hour time-weighted average standard and it remains below the permissible limit.

In order to solely observe the contribution of the East overburden dump in degrading the air quality of the Nawatola Basti, the average concentration of pollutants coming from the winds blowing in a high-frequency, over or close to the dump towards the settlement were observed. The only winds that met these criterions were the NE winds with a percentage frequency of 12.20%. The average concentration of $PM_{2.5}$ & PM_{10} in the NE winds are 71 $\mu g/m^3$ and 144.74 $\mu g/m^3$ respectively. The gaseous pollutants were below their respective permissible limits. Here, it is important to note that this should be seen with the full geographical context of the area. The NE winds coming from the dump are also blowing over other adjoining coal mines. The possibility of the pollution due to other sources like household coal burning, vehicular movement and thermal power plants in vicinity etc., cannot be ruled out.

The NAQI calculation placed the air quality of Nawatola Basti in the "moderately polluted" category. Upon observing wind speed of the region between October to December, 2024, it was observed that calm conditions i.e., wind speed less than 0.5m/s accounted for 71.07% of the total wind data. This indicates a predominantly stagnant atmospheric condition which implies that the pollutants released into the atmosphere are likely to remain concentrated near their sources for extended periods.

For assessing the impact of east dump in terms of quality of water received by the Nawatola Basti, water samples from various locations were collected and analyzed. The study also evaluated the effectiveness of measures taken by the Khadia mine administration to control surface runoff and erosion from the dump.

The physicochemical characteristics and heavy metal concentrations were found to be below the permissible standards. The TDS concentrations for all groundwater samples were below the permissible limit of 2000 ppm but exceeded the acceptable limit of 500 ppm, indicating that the groundwater contains a moderate amount of dissolved minerals. As per the WQI, surface waters near the East dump fall within the “Good” category implying that the water quality is usually protected but occasionally threatened or impaired. The WQI for groundwater sources also lies in the “Good” category.

Field inspections were made along the toe of the East dump to observe the preventive measures taken to minimize erosion and downstream damages from the surface runoff from the East dump. There it was observed that the RCC Catch Drain and Retaining Wall has been constructed along the toe of the East dump. However, a small portion towards the east side of the dump is damaged and may be repaired. This has resulted in water spilling over surrounding areas, causing gully erosion and the formation of several unplanned ponds. The embankments of the siltation ponds were vegetated and stabilized.

Further, recommendations have been proposed to enhance pollution control measures and further reduce the environmental impact of the East dump.

7.2 Conclusion

The key findings of this study regarding the evaluation of the effectiveness of control measures to control air and water pollution from East dump are summarized as follows:

1. Khadia Opencast Project has taken several steps on overburden dump such as grassing, plantation on finalised overburden dump Area through UP Forest Department, Mobile Water Sprinkling on Haul Road, compaction of the overburden dump through HEMMs etc. in order to control pollution due to East Dump.
2. The NAQI of the region places the air quality of Nawatola Basti in the “moderately polluted” category. The role of pollution sources such as Household Coal Burning, near vicinity to highway and thereby vehicular movement, operational thermal power plants in the vicinity, other than Khadia OCP, cannot be ruled out.
3. Heavy metal analysis revealed that heavy metals are more concentrated in $PM_{2.5}$ than in PM_{10}, indicating that the finer fraction carries more toxic metals. The dominant metals are Fe and Cr, followed by Ni, Zn, Mn, Pb, Cu, Cd, and As.

4. To isolate the East overburden dump's impact on the air quality of the Nawatola Basti, pollutant concentrations were analyzed of high-frequency winds blowing over/near the dump towards the settlement. NE winds, meeting these criterions, showed average concentration of $PM_{2.5}$ & PM_{10} as 71 $\mu g/m^3$ and 144.74 $\mu g/m^3$ respectively.

   Here, it is important to note that this should be seen with the full geographical context of the area. The NE winds coming from the dump are also blowing over other adjoining mines.
5. Wind speed analysis during the study duration showed predominantly calm conditions (<0.5m/s). This stagnant atmospheric condition suggests that pollutants released are likely to remain concentrated near their sources for extended periods.
6. The ongoing works such as Wheel Washing Facility and Construction of Rapid Loading System (04 MTPA) will further improve the air quality of the area.
7. In water pollution study, it was found that the water samples were compliant with permissible standards for physicochemical characteristics and heavy metal concentrations.
8. The water quality of surface waters and groundwaters is placed in the "good" category according to WQI. The good category implies that the water quality is protected with only a minor degree of threat or impairment.
9. The RCC Catch drain and retaining wall have been constructed along the toe of the East dump. However, at the eastern side of the dump, it was observed that a small portion was damaged and requires restoration.

Chapter 8: Recommendations

An environmental protection plan involves designing and implementing a series of preventive and suppressive measures aimed at addressing specific pollutants. These measures are guided by considerations such as the cost of controlling pollution, the societal damage caused by the pollutant, and the feasibility of mitigation strategies. As stricter measures are implemented, the cost of pollution control often rises due to the need for advanced technologies and operational adjustments. Conversely, insufficient control results in significant damages, including adverse health impacts, ecosystem degradation, and economic losses. The key challenge is to identify an equilibrium where the combined costs of control measures and societal damages are minimized. This balance ensures that resources are allocated efficiently, achieving meaningful reductions in harm without imposing excessive financial strain.

8.1 Suggestive control measures for Air pollution

Planting vegetation is one of the most effective and sustainable methods to mitigate air pollution, as plants act as natural air filters by trapping dust particles and absorbing harmful gases. However, the steep slopes of dump decks, often inclined at angles up to 37°, present challenges for vegetation establishment. Fertile substrates applied to these slopes are prone to being washed away by water erosion during precipitation, leaving significant bare areas that contribute to air pollution.

Hydroseeding offers a practical and efficient solution to this problem. By using a mixture of grass seeds, trees, and shrubs combined with mineral fertilizers and nutrient-rich substrates (mulch), hydroseeding accelerates vegetation growth on steep slopes. This approach helps stabilize the substrate, reduces bare areas susceptible to wind erosion, and promotes long-term ecological restoration.

Antonik et al. (2022) recommend including seeds from four plant groups in the hydraulic mixture for slope reclamation: herbaceous grasses, herbaceous legumes, deciduous trees, and shrubs. These plants collectively create a green cover and contribute to the development of humus, enhancing soil fertility and stability. Additionally, Skousen and Clinger (1993) highlighted the benefits of incorporating sewage sludge into the hydroseeding mixture. The sludge is rich in essential nutrients such as phosphorus, nitrogen, and potassium, which further support plant growth. A common challenge in biologically reclaiming dump slopes is plant mortality due to drought, especially during hot months. To address this, the same machinery used for hydroseeding can be repurposed for irrigation and maintenance, ensuring adequate care for vegetation and improving the success rate of reclamation efforts.

Strategic tree planting in concentric patterns around pollution sources and perpendicular to prevailing winds enhances their capacity to trap airborne dust and harmful gases. Incorporating a mix of open and dense planting patterns, along with trees of varying heights, will create a layered canopy that optimizes pollution control by targeting different levels of airborne particles (Ghose and Majee, 2001).

In addition to vegetative measures, controlling dust during transportation and unloading of overburden material is equally important. Enforcing strict speed limits for haul trucks can significantly reduce dust uplift from unpaved roads. Furthermore, regular maintenance of haul trucks is crucial to ensure they are in good condition to minimize exhaust emissions.

8.2 Suggestive control measures for Water pollution

During the field visit, it was observed that a small section of the RCC drain towards the eastern side of the dump was damaged. To mitigate this, the catch drain should be repaired to fully connect with the siltation pond, ensuring proper water flow and minimizing the risk of flooding and erosion during heavy rainfall. Additionally, the catch drain was found to be obstructed by eroded material from the East dump. These obstructions can lead to water retention and spillage. Regular inspections of the drain, particularly before the monsoon season, should be conducted to clear any blockages and address damages.

Retaining walls are critical for stabilizing overburden dumps and controlling runoff. It is recommended to ensure proper maintenance of the retaining wall along the toe of the East dump to provide additional structural support and reduce sediment movement.

नॉर्दर्न कोलफील्ड्स लिमिटेड
खड़िया परियोजना
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

एन सी एल
NCL
Office of General Manager

Northern Coalfields Limited
Khadia Project
(A Miniratna Company)
(A subsidiary of Coal India Limited)

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थाना- शक्तिनगर, जनपद-सोनभद्र (उ. प्र.), पिन - 231222/ Thana-Shaktinagar, Dist. Sonebhadra (U.P.) Pin- 231222
Phone: 05446- 232274, (FAX) 05446- 232274 Email: cgm.khd@gmail.com, website : www.nclcil.in

Ref: NCL/KHD/GM/Min/Env/ EC compliance/2024-25/4711 Date:- 14/02/2025

To,
Shri Pankaj Verma,
Scientist 'F'
Compliance & Monitoring Division-IA Division
Ministry of Environment, Forest & Climate Change
Indira Paryawaran Bhawan,
Jor Bhag Road, New Delhi – 110003

Subject:- Submission of Clarifications / Action Taken Report against the Non-conformities observed with respect to the Project "Expansion of Khadia Opencast coal mining project for increase in production capacity from 14 MTPA to 15 MTPA (increase of 10% w.r.t. 10 MTPA) in land area of 1640 Ha by M/s Northern Coalfields Ltd. Located in the village Khadia, Tehsil Dudhi, District Sonebhadra (Uttar Pradesh) & village Dudhichua, Tehsil- Singrauli, District- Singrauli (Madhya Pradesh)
Ref.:- (i) Your good office's letter dated 14.01.2025 with F. No. IA-L-11011/51/2024-IA-I.

Respected Sir,

Khadia Opencast Project of M/s Northern Coalfields Limited (EC capacity 15 MTPA for coal production) is in receipt of your good office's letter dated 14.01.2025 with F. No. IA-L-11011/51/2024-IA-I.

In pursuance with the letter, please find enclosed herewith the clarification/ Clarifications / Action Taken Report against the Non-conformities observed with respect to the Project "Expansion of Khadia Opencast coal mining project for increase in production capacity from 14 MTPA to 15 MTPA (increase of 10% w.r.t. 10 MTPA) in land area of 1640 Ha by M/s Northern Coalfields Ltd. Located in the village Khadia, Tehsil Dudhi, District Sonebhadra (Uttar Pradesh) & village Dudhichua, Tehsil- Singrauli, District- Singrauli (Madhya Pradesh).

Yours faithfully,

14-02-2025
General Manager
Khadia Area, NCL

Copy to:-

1. Deputy Director General of Forests (C), Ministry of Environment, Forest and Climate Change, Integrated Regional Office, Kendriya Bhawan, 5th Floor, Sector "H", Aliganj, Lucknow – 226020.

2. The Member Secretary, Uttar Pradesh Pollution Control Board, Building. No. TC-12V Vibhuti Khand, Gomti Nagar Lucknow-226010.
3. The Member Secretary, Central Pollution Control Board, Parivesh Bhawan, East Arjun Nagar, Delhi-110032.
4. General Manager (Environment & Forest), NCL Singrauli.

Northern Coalfields Limited
Khadia Area

<u>Clarifications / Action Taken Report against the Non-conformities observed with respect to the Project "Expansion of Khadia Opencast coal mining project for increase in production capacity from 14 MTPA to 15 MTPA (increase of 10% w.r.t. 10 MTPA) in land area of 1640 Ha by M/s Northern Coalfields Ltd. Located in the village Khadia, Tehsil Dudhi, District Sonebhadra (Uttar Pradesh) & village Dudhichua, Tehsil- Singrauli, District- Singrauli (Madhya Pradesh)</u>

<table>
<tr><th>Sl. No.</th><th>Observation</th><th>Compliance</th></tr>
<tr><td>1</td><td>Garland drain has not been provided as per the EC condition. (Specific Condition-xi of EC dated 23.03.2016)</td><td>Proper drainage system has been provided by Khadia OCP. Currently about 14.9 KM of the garland drain exists at Khadia OCP. Same has also been mentioned in the monitoring report submitted by Regional Office, MoEF&CC, Lucknow against the EC condition. All the permanent drains are cemented (Shown as Pic - 1).

However, some of the drains remain temporary in nature and are built as the active mine dump shifts in the course of mining.

Besides this, restoration work i.e. cementing of about 400 m retaining wall and drain is in process and will be completed by June 2025. For the purpose, a tender has already been floated and copy of the relevant page of Notice Inviting Tender issued is enclosed herewith as Annexure-A.</td></tr>
<tr><td>2</td><td>Dust mask has not been provided to the workers. (Specific Condition-xvi, xvii, xviii, General Condition-ix of EC dated 23.03.2016, Standard Condition h (iii) of EC dated 07.02.2024)</td><td>Dust Mask are regularly being provided to the workers. Details of the dust mask provided in current Financial year is as below.

<table>
<tr><th>Sl. No.</th><th>Month</th><th>Dust Mask issued to workers</th></tr>
<tr><td>1</td><td>April 2024</td><td>940</td></tr>
<tr><td>2</td><td>May 2024</td><td>917</td></tr>
<tr><td>3</td><td>June 2024</td><td>836</td></tr>
<tr><td>4</td><td>July 2024</td><td>812</td></tr>
<tr><td>5</td><td>August 2024</td><td>748</td></tr>
<tr><td>6</td><td>Sept 2024</td><td>720</td></tr>
</table>
</td></tr>
</table>

		<table><tr><td>7</td><td>October 2024</td><td>920</td></tr><tr><td>8</td><td>November 2024</td><td>870</td></tr><tr><td>9</td><td>December 2024</td><td>817</td></tr><tr><td>10</td><td>January 2025</td><td>895</td></tr></table> Copy of the issuance register is enclosed as Annexure -B. Personnel wear dust masks are shown in pic 2.
3	Green belt has not been developed as per the EC condition. (Specific Condition-xx of EC dated 23.03.2016, Additional Specific condition-iii, iv of EC dated 27.07.2022, (Standard Condition g (ii) of EC dated 07.02.2024)	**Green Belt at Overburden Dump:-** On overburden dump, plantation is regularly being carried out through UP Forest Department. Till date, plantation has been completed on 216.16 Ha of overburden dumps. In the FY 2025-26, plantation on about 08 Ha overburden dump is to be carried out, out of which 05 Ha shall be done through ICFRE, Dehradun and 03 Ha shall be done through Renukoot Forest Division, UP Forest Department. The work awarded to ICFRE, Dehradun is for ecological restoration of the area. (Copy of the work order issued to ICFRE and request for MoU to UPFD are enclosed as Annexure C &D). **Green Belt at outside mine area:-** Green belt outside the project premises is being done by M/s Northern Coalfields Limited. It is to mention that in FY 2024-25, plantation has been carried out in Renukoot Forest Department on 100 Ha The executive agencies like Renukoot Forest Department and Singaruli Forest Division are specialised agencies for carrying out plantation works and species of plants are selected by them based on the local area and geography of the area. In FY 2025-26, area of 100 Ha in UP and 270 Ha in MP shall be carried out through UP Forest Department and MPRVVN, Singrauli respectively and efforts shall be made for plantation of native species with broad leaves and long life plants. **Green Belt along road side:-** As stated in the monitoring report, plantation is required along the coal transportation road and

		approach road, it is to state that an MoU has been finalised with UP Forest Department for planation besides newly constructed CC road and mine boundary, wherever planation is required. The plantation will be carried out in FY 2025-26 monsoon. Copy of the MoU Signed is enclosed herewith as Annexure-E. Pictures of various plantation sites are enclosed as pic 3 to 7. Further, it is pertinent to state here that as per approved mining plan of 15 MTPA, out of total 1640 Ha lease hold area, planation will be done in around 1378 Ha at the time of mine closure. Cost of this plantation shall be borne by NCL. Plantation is continuously being done as per availability of finalised overburden dump and will be continued.
4	Greenbelt has not been developed on the OB dump. (Specific Condition-xxii of EC dated 23.03.2016, (Standard Condition f (v)) of EC dated 07.02.2024)	On overburden dump, plantation is regularly being carried out through UP Forest Department. UP Forest department is a specialized agency for the purpose of plantation and species of plants are selected by them based on the local area and geography of the area. Till date, plantation has been completed on 216.16 Ha of overburden dumps. In the FY 2025-26, plantation on about 08 Ha overburden dump is to be carried out, out of which 05 Ha shall be done through ICFRE, Dehradun and 03 Ha shall be done through Renukoot Forest Division, UP Forest Department. The work awarded to ICFRE, Dehradun is for ecological restoration of the area. Pictures of various plantation sites on OB dump are enclosed as pic 3 to 6. As pointed out in the report against condition no. f (v)) of EC dated 07.02.2024, it shall be ensured that only native species shall be planted as suggested. Further, it is pertinent to state here that as per approved mining plan of 15 MTPA, out of total 1640 Ha lease hold area, planation will be done in around 1378 Ha at the time of mine closure.

		Cost of this plantation shall be borne by NCL. Plantation is continuously being done as per availability of finalised overburden dump and will be continued.
5	Pucca road has not been constructed to control dust emissions within the lease area. Three tier planation all along the major road has not been developed. Management of OB dump is not up to the mark. (Specific Condition-xxii, xxiv, xxviii, xxx, xxxi, xxxiii of EC dated 23.03.2016, Specific condition-xxiv, Standard Condition f (iii) of EC dated 07.02.2024)	Pucca roads have been developed at all the permanent roads. Khadia OCP has constructed Cement Concrete Road of 6.61 KM Length within the mine premises in order to reduce the dust generation during transportation of coal with date of completion as 31.10.2023. Further, 1.5 KM CC road has also been built for movement of light vehicle. Photograph of the recently built CC road is enclosed herewith as Pic 8. For the purpose of three tier plantation along CC road, it is to state that an MoU has been finalised with UP Forest Department for planation besides newly constructed CC road and mine boundary, wherever planation is required. The plantation will be carried out in FY 2025-26 monsoon. With regard to management of OB dump, it is to state that Overburden dumps are being maintained scientifically with proper technical and biological reclamation. For the purpose of stability of the OB dump, a scientific study conducted by M/s CMPDIL, Ranchi is enclosed herewith as Annexure-F.
6	Adequate steps to stop the dust emission from the CHP has not been undertaken. (Specific Condition-xxvi of EC dated 23.03.2016)	As pointed out in the monitoring report for CHP of 04 MTPA, a cyclone arrangement is in place for the purpose of dust extraction. The CHP is equipped with automatic sprinkler system at receiving pits and closed conveying system along with nozzles at transfer points. Further, loading into the wagons is being done through silo, which is an eco-friendly technology and is also suggested in the guidelines issued by Central Pollution Control Board (CPCB) in the name of "Inventorization of Railway Sidings and Guidelines for their Environment Management" and published on March 2015. Photographs of the Pollution control arrangement of CHP of 04 MTPA is enclosed herewith as Pic 9 to 12.

		Further efforts shall be taken for maintaining the same.
7	Third party monitoring of the project has not been conducted through the NABL accredited laboratory. (General Condition-iii, iv of EC dated 23.03.2016)	Environment Laboratory, CMPDIL, Ranchi is NABL accredited (certificate no.TC-7470 issue date 16/12/2022). The environment monitoring samples collected at CMPDI, RI-6, Singrauli are sent to CMPDIL, Ranchi laboratory for analysis. The upgradation of CMPDIL, RI-6, Singrauli lab and its NABL accreditation is under process.
8	PPEs have not been provided to the workers. (General Condition-x of EC dated 23.03.2016)	Distribution of PPEs to the workers is a regular activity. Photographs of the personnel wearing PPEs are enclosed herewith as pic 13 – 14. Further, the copy of the issuance register showing distribution of the PPEs is enclosed herewith as Annexure – G.
9	PP has not advertise the EC as per the EC condition. (General Condition-xiii of EC dated 23.03.2016)	The EC of 14 MTPA, was granted on 23.03.2016. However, the EC was uploaded by MoEF&CC on 30.03.2016 and NCL management came to know about its grant only on 30.03.2016. Same can be proved from the enclosed letter issued by GM (Environment), NCL Singrauli (Enclosed as Annexure-H). Accordingly EC was advertised within 07 working days i.e. on 06 and 07 April 2016. The details of the publication of advertisement of EC are as below. Newspaper — Date of publication Dainik Jagran, Rewa — 06.04.2016 Rashtriy Jagran, Varanasi — 07.04.2016 Amar Ujala, Varanasi- — 07.04.2016 Dainik Bhaskar, Satna- — 07.04.2016
10	Cleaner fuel has not been used in the dumpers/trucks. (Additional Specific condition-ii of EC dated 27.07.2022, Specific condition-xxviii of EC dated 07.02.2024)	Khadia Project is equipped with three nos. of draglines, which are not only electricity driven but also reduces truck movement (which would otherwise be required for transportation of overburden). Besides draglines, 06 nos. of shovel and 07 nos. of drills are also electrical driven. Besides, maximum of coal is being transported through Coal Handling Plants of 04 MTY and 06

		MTY and are electricity driven, which also reduces truck movement (which would otherwise be required for transportation of coal within mine premises). An RLS of 04 MTPA is under construction. For the purpose of cleaner fuel, a study for the use of ***'XtraGreen Diesel'*** is under process at Khadia OCP in collaboration with IOCL. Xtragreen is an optimized combination having higher Cetane Number for providing improved performance by increasing the efficiency & reducing the emission of vehicle. Copy of the letter showing trial run to be conducted by M/s Indian Oil Corporation Limited (IOCL) to explore the possibility of using XtraGreen HSD in Khadia mine to verify the emission efficiency and fuel economy benefits is enclosed as Annexure-I. Specific condition-xxviii of EC dated 07.02.2024 states that, "PP shall explore at least 20% of the overall fleet of dumpers / trucks / other vehicles as electrical or CNG/NLG based transporation of coal / OB etc.". Khadia Opencast Project has applied for amendment of the said condition to MoEF&CC, New Delhi vide EC amendment proposal no. IA/UP/CMIN/509697/2024. The reasons for amendment sought are as below. • As per the approved mining plan, this project is already equipped with adequate no. of HEMMs and there was no additional provision for procurement of HEMM. • For the purpose of exploring the possibility to deploy CNG/LNG/ electrical dumpers /trucks/other vehicles in NCL, a letter seeking availability of such vehicles have been submitted on 06.08.2024 to all major Manufacturers and response of them are still awaited. (Copy of the letters issued are enclosed herewith as Annexure-J).
11	Installed CEQMS has not been connected to the SPCB and CPCB server. (Additional Specific condition-vii of EC dated 27.07.2022)	CEQMS has been installed and has been connected with CPCB and MPPCB server. Copy of the mail received from CPCB for confirming that the CEQMS has been integrated with RTDMS

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		portal of CPCB is enclosed herewith as Annexure – K. Further, Connection has also been provided with MPPCB website. Copy of the screenshot is enclosed herewith as Annexure-L.
12	Adequate measure for the management of hazardous waste, such as oil containers, ETP sludge, etc. has not been taken, further, ETP sludge is being dumped with OB without consulting with the UPPCB/CPCB. (Additional Specific condition-x of EC dated 27.07.2022, (Standard Condition a (vi)) of EC dated 07.02.2024)	The spilled oil as observed during the monitoring was due to recent lifting of burnt oil to auctioned party. The same has been cleaned using lime as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. Current Picture of the site visited at the time of visit of MoEF&CC official is enclosed herewith as pic 15 & 16. With regard to ETP sludge, it is hereby stated that as per Schedule-I of the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, 'The inclusion of wastes contained in this Schedule does not preclude the use of Schedule II to demonstrate that the waste is not hazardous" (Copy enclosed as Annexure-M) i.e. Use of Schedule-II can be made to demonstrate that the waste is not hazardous. Accordingly, a testing has been conducted for the probable heavy metals which may be found in the Coal Industry ETP sludge and all the metals were found below the limit provided in Schedule II of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. Copy of the sample report is enclosed herewith as Annexure – N. Further, after receipt of the letter dated 14.01.2025 from MoEF&CC, New Delhi, a mail has also been sent to premier institutes viz. IIT(ISM), Dhanbad, IIT-BHU Varanasi and IITR, Lucknow for enquiry about testing of ETP Sludge as per Schedule-II of the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. However, no reply has been received from any of the organisation. Copy of the Mails sent are enclosed herewith as Annexure-O.
13	Expenditure incurred under CER has not been provided. (Additional Specific	As per EC dated 07.02.2024, details of the expenditure, required to be performed as

<table>
<tr>
<td></td>
<td>condition-xii of EC dated 27.07.2022, Standard Condition i (iii) of EC dated 07.02.2024)</td>
<td>Corporate Environment Responsibility, are as below.
<table>
<tr><th>Sl. No.</th><th>Nature of Activity to be performed as per EC dated 07.02.2024 in FY 2024-25</th><th>Details of activity performed</th><th>Expenditure incurred in 2024-25 till Jan 2025</th></tr>
<tr><td>1</td><td>Sanitation (Cleaning of Public Road)</td><td>Deployment of sweeping machines the purpose of cleaning of public road.</td><td>56,34,429</td></tr>
<tr><td>2</td><td>Roads (Control of road dust due to public transport)</td><td>Deployment of truck mounted fog cannons on public roads.</td><td>57,70,699</td></tr>
<tr><td>3</td><td>Plantation in community Area</td><td>Plant distribution has been done</td><td>1,98,600/-</td></tr>
</table>
Photographs of the Operation of Road Sweeping Machine and Truck Mounted fog cannons are enclosed herewith as Pic 17 & 18.</td>
</tr>
<tr>
<td>14</td>
<td>Construction of the Rapid Loading System has not yet completed. (Specific condition-i of EC dated 07.02.2024)</td>
<td>Work order for construction of CHP/ RLS of 04 MTPA capacity has been issued to M/s S . K. Samanta & Co. Pvt. Ltd. On 08.01.2024 (Copy enclosed as Annexure- P). Further, site handover letter has been issued to M/s S. K. Samanta & Co. Pvt. Ltd. On 15.03.2024, with date of start of work as 17.03.2024 (Copy enclosed as Q). Currently the work is in progress and will be completed by Feb 2026.

Further, an application has been submitted vide proposal no. IA/UP/CMIN/509697/2024 for amendment of EC conditions for extension of timeline of completion of Rapid Loading System</td>
</tr>
</table>

		(04 MTPA) by February 2026 instead of December 2024 as stipulated in EC conditions.
15	Sal nursery has not been set up by PP. (Specific condition-iv of EC dated 07.02.2024)	In compliance of EC Condition of Khadia OCP, NCL has invited offers for establishment of Sal Nursery from various premier institutes viz. Forest Research Institute (FRI), Dehradun, Renukoot Forest Division, Singaruli Forest Division, Madhya Pradesh Rajya Van Vikash Nigam and Chhatisgarh Rajya Van Vikas Nigam Limited vide letter dtd. 31.10.2023 and 17.01.2024 (Copy attached as Annexure-R). The telephonic discussions were made to pursue for submission of proposal for development of Sal Nursery at Khadia project, NCL. Renukoot Forest Division has submitted the proposal for development of Sal Nursery at Khadia project, NCL. The response from other premier institutes/organizations except DFO Renukoot is still awaited. The proposal submitted by DFO Renukoot for development of Sal Nursery at Khadia project is under scrutiny. The Sal Nursery development work at Khadia project will be taken-up during FY 2025-26.
16	NOC for expanded capacity has been made to the Central Ground Water Authority. (Specific condition-v of EC dated 07.02.2024)	Application for NOC with expanded capacity has been made on 19.03.2024 and application verification has been completed on 22.03.2024. The application is currently at the stage of Application Processing and pending with approval officer since 12.02.2025. (The online screenshot of the application is enclosed herewith as Annexure-S)
17	Wheel washing system and procurement of electric vehicles has not been undertaken by the PP. (Specific condition-vi of EC dated 07.02.2024)	An LoA for wheel washing facility has been issued on 18.08.2024 (Copy enclosed as Annexure-T). The work is in progress and will be completed in February 2025. With regard to deployment of Electrical Vehicle, a tender has been floated on GeM portal vide GeM ID No. GEM/2025/B/5827091 dated 16.01.2025. The copy of the bid documents is

		enclosed herewith as Annexure – U. The vehicles will be deployed by July 2025.
18	Compliance of the Standard Operating Procedure (SoP) issued by CPCB regarding the dumping of mine voids with fly ash has not been provided. (Specific condition-xv of EC dated 07.02.2024)	Khadia OCP has sought amendment of EC condition for exemption of this condition vide EC amendment proposal no. IA/UP/CMIN/509697/2024. The reason given for amendment are as below. A study has been conducted by IIT-BHU Varanasi for "Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of Khadia Opencast Project along with its viability and safety aspect of man and machinery" As per the study done by IIT-BHU, Varanasi dumping of fly ash in active mine of Khadia OCP, following conclusions were made: • Mixing of fly ash with overburden will reduce the permeability of overall dump material, leading to increase in the pore water pressure and in-turn reduce the factor of safety of dump • As per the simulation carried out, it was found that final dump slope will fall under unsafe category (FoS< 1.5) as per DGMS guidelines in case of saturation level beyond 25%. • Fly-ash will make the dump floor slippery when contact with water and reduce the movement of dumper and other HEMM, and hence its not suggestible to use fly ash for HEMM roads within the mine. • Highest conc. of toxic trace metal (Mg, Mn and Ni) ranging upto 41.70 mg/l, 5.39 mg/l and 0.45 mg/l respectively found in the fly ash material, which will increase the conc. of toxic trace material in the surrounding area when this fly ash is mixed with OB or dumped in the mine pit. Based on the above facts, IIT BHU has concluded that it is technically not feasible to dump the fly ash in Mine dump due to geo mining conditions, instability of dump during rainy season in present condition, high stripping ratio and leaching effects.

<table>
<tr><td></td><td></td><td>Copy of the report of IIT-BHU is enclosed herewith as Annexure- V.</td></tr>
<tr><td>19</td><td>Solar parks have not been developed. (Specific condition-xvi of EC dated 07.02.2024)</td><td>Specific Condition no. -XVI of the EC dated 07.02.2024 states that, "The Project Proponent shall include development of solar parks, picnic spot and sports compound in its Mine Closure report. Further if possible, maximum possible area of quarry shall be brought upto original ground level and handover the land to Project affected families."

In this regard, it is to state that Khadia OCP is envisaging expansion of Khadia OCP from 15 MTPA to 20 MTPA and provision of solar park has been made in Mining Plan and Mine Closure Plan) of 20 MTPA. Mining Plan and Mine Closure Plan) of 20 MTPA has been approved by NCL Board. (Relevant pages of Mining Plan is enclosed herewith as Annexure-X)</td></tr>
<tr><td>20</td><td>Data on the plantation of fruit-bearing trees has not been provided. (Specific condition-xviii of EC dated 07.02.2024)</td><td>In compliance of specific condition no. xviii of the EC dated 07.02.2024, the details of fruit bearing plants planted within Khadia OCP after grant of EC is as below.

<table><tr><th>Sl. No.</th><th>Name of Species</th><th>No. of Plants</th></tr><tr><td>1.</td><td>Amla</td><td>600</td></tr><tr><td>2</td><td>Bel</td><td>100</td></tr><tr><td>3</td><td>Amrud</td><td>100</td></tr><tr><td>4</td><td>Jamun</td><td>200</td></tr><tr><td>5</td><td>Aam</td><td>150</td></tr><tr><td>6</td><td>Mahua</td><td>300</td></tr><tr><td>7</td><td>Anar</td><td>100</td></tr></table>
Copy of the report submitted by Range Officer, Renukoot Forest Division, UP Forest Department is enclosed herewith as Annexure – Y for reference.

Besides this, total 4500 fruit bearing plant saplings have been distributed among employees of Khadia OCP and nearby population (Copy of the supply order is enclosed herewith as Annexure-Z). Details of the plants distributed are as below.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>
<table>
<tr><th>Sl. No.</th><th>Name of Plants</th><th>Nos. of plants distributed</th></tr>
<tr><td>1</td><td>Mango</td><td>1200</td></tr>
<tr><td>2</td><td>Papita</td><td>600</td></tr>
<tr><td>3</td><td>Lemon(Kagji)</td><td>300</td></tr>
<tr><td>4</td><td>Kathal</td><td>300</td></tr>
<tr><td>5</td><td>Jamun</td><td>300</td></tr>
<tr><td>6</td><td>Anar</td><td>400</td></tr>
<tr><td>7</td><td>Banana</td><td>400</td></tr>
<tr><td>8</td><td>Amla(Grafted)</td><td>300</td></tr>
<tr><td>9</td><td>Lichi</td><td>200</td></tr>
<tr><td>10</td><td>Guava(Allahabadi)</td><td>300</td></tr>
<tr><td>11</td><td>Bel</td><td>200</td></tr>
</table>
</td></tr>
<tr><td>21</td><td>Construction of the digital library has not yet completed. (Specific condition-xxi of EC dated 07.02.2024)</td><td>Digital lab/library has been set up in DAV Khadia which is equipped with 02 Virtual Reality Device with all the science practical materials to give digital learning to students. It is pertinent to mention that DAV Khadia is the resource schools which shall cater to the needs of the local students to enhance learning on science.

Further, mail from Principle, DAV Khadia is enclosed herewith as Annexure- AA. stating that "The School shall provide all support towards catering to needs of academic excellence in nearby area students."</td></tr>
<tr><td>22</td><td>Solar-mediated light systems on the roads has not been provided. (Specific condition-xxv of EC dated 07.02.2024)</td><td>For the purpose of installation of solar light system, an NOC has been applied to District Administration for the purpose of carrying out the work of solar mediated lights through UPNEDA (Uttar Pradesh New and Renewable Energy Development Agency). Copy of the application made for NOC enclosed as Annexure-AB.

Financial assistance shall be provided to UPNEDA for the purpose of installation of Solar lights after obtaining NOC and necessary approval. Financial assistance shall be provided within 120 days.</td></tr>
<tr><td>23</td><td>Bio-toilets in the study villages have not been provided. (Specific condition-xxvi of EC dated 07.02.2024)</td><td>For the purpose of establishment of bio-toilets, proposal is under progress and need assessment meeting with the local community (Gram Pradhan) is held for understanding the proper site selection so as to cater the mass at large. The activity shall be completed by 120 days.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>Further, it is pertinent to mention here that Khadia Opencast Project has constructed 05 nos. of 'Sulabh Sauchalaya' as below.
<table><tr><th>SL. No.</th><th>Location</th><th>Nos.</th></tr><tr><td>1</td><td>Shaktinagar Bus stand</td><td>01 No.</td></tr><tr><td>2</td><td>Ambedkar Nagar Village</td><td>01 No.</td></tr><tr><td>3</td><td>Nimiatand Village</td><td>01 No.</td></tr><tr><td>4</td><td>Khadia Village</td><td>02 nos.</td></tr></table></td></tr>
<tr><td>24</td><td>Feasibility study for the utilization of fly ash with this mine has not been conducted. (Specific condition-xxix of EC dated 07.02.2024)</td><td>A study has been conducted by IIT-BHU Varanasi for "Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of Khadia Opencast Project along with its viability and safety aspect of man and machinery"
Copy enclosed as Annexure – V.</td></tr>
<tr><td>25</td><td>Suitable action on the use of fly ash as an external dump in the mine as per the study has not been taken. (Standard Condition f (iv) of EC dated 07.02.2024)</td><td>Khadia OCP has sought amendment of EC condition for exemption of this condition vide EC amendment proposal no. IA/UP/CMIN/509697/2024.

The reason given for amendment are as below.
A study has been conducted by IIT-BHU Varanasi for "Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of Khadia Opencast Project along with its viability and safety aspect of man and machinery"

As per the study done by IIT-BHU, Varanasi dumping of fly ash in active mine of Khadia OCP, following conclusions were made:
Mixing of fly ash with overburden will reduce the permeability of overall dump material, leading to increase in the pore water pressure and in-turn reduce the factor of safety of dump
As per the simulation carried out, it was found that final dump slope will fall under unsafe category (FoS< 1.5) as per DGMS guidelines in case of saturation level beyond 25%.
Fly-ash will make the dump floor slippery when contact with water and reduce the movement of dumper and other HEMM,</td></tr>
</table>

		and hence its not suggestible to use fly ash for HEMM roads within the mine. • Highest conc. of toxic trace metal (Mg, Mn and Ni) ranging upto 41.70 mg/l, 5.39 mg/l and 0.45 mg/l respectively found in the fly ash material, which will increase the conc. of toxic trace material in the surrounding area when this fly ash is mixed with OB or dumped in the mine pit. Based on the above facts, IIT BHU has concluded that it is technically not feasible to dump the fly ash in Mine dump due to geo mining conditions, instability of dump during rainy season in present condition, high stripping ratio and leaching effects. Copy of the report of IIT-BHU is enclosed herewith as Annexure-V.

14/02/25
Nodal Officer (Environment)
Khadia Area

14/02/25
Staff Officer (Mining)
Khadia Area

14/2/25
Project Officer
Khadia Project

14-02-2025
General Manager
Khadia Area

Pictures in support of the clarifications / ATR submitted.

Pic 1:-
Drain Besides OB dump

Pic 2:-
Personnel wearing Dust Mask

Pic-3
Plantation on overburden dumps

Pic-4
Plantation on overburden dumps

Pic 5
Recent Plantation on overburden dumps

Pic 6
Plantation on overburden dumps

 Pic 7 Miyawaki Plantation done in Plain area	 Pic 8 Cement Concreting of the permanent roads.
 Pic 9 Water Sprinkling at the CHP of 04 MTPA at the time of unloading	 Pic 10 Cyclone attached with Crusher of CHP pf 04 MTPA

Pic 11

Closed conveying system with loading in rail wagons through silo

Pic 12

Sprinkling at the time of unloading of coal into railway wagons

Pic 13

Personnel Wearing PPEs

Pic 14

Personnel Wearing PPEs

Pic 15

spilled oil during lifting has been cleaned.

Pic 16

Cleaning of the spilled oil during lifting with all burnt oil under shed.

	
Pic 17 Deployment of Road Sweeping Machine on public road	Pic 18 Deployment of truck mounted fog cannon on public road

Annexure-A

NORTHERN COALFIELDS LIMITED

(A Miniratna Company & Subsidiary of Coal India Limited)

OFFICE OF THE GENERAL MANAGER (KHADIA PROJECT)

Civil Engineering Department
P.O. Shaktinagar, DISTT. Sonebhadra (U.P.) 231222
Phone No.05446-232274
E-mail: socivilkhdncl@gmail.com
WEB SITE: www.coalindiatenders.nic.in

NIT संख्या.: GM/KHD/C/24-25/ETN-28 दिनांक: **03.02.2025**

Notice Inviting Tender

1. Tenders are invited on-line under two part system on the website **https://coalindiatenders.nic.in** from the eligible bidders having Digital Signature Certificate (DSC) issued from any agency authorized by Controller of Certifying Authority (CCA), Govt. of India and which can be traced up to the chain of trust to the Root Certificate of CCA, for the following work:

Description of work	Location	Estimated Cost ofWork (Including GST) (In Rs.)	Earnest Money (In Rs.)	Period of Completion (In Days)
Restoration , Repair & Maintenance of Retaining wall with drain along road from OB Time Office to Barrier No 1 at Khadia Project.	Khadia Project NCL	40192251.99	502500/-	120

(i). For Site visit of location of work, the prospective bidder(s) may contact

Tender inviting authority	Contact Person(s)/Tender Dealing Officer(s)	
Sri A K Bansal, SO (C) Contact No 9479713410	Sri SM Wasif, PE (C) Contact no. 9406963432	Sri Rohit Jain , Dy Mgr (C) Contact no. 9406965028

2. Time Schedule of Tender:

Sl. No	Particulars	Date	Time
a.	Tender e-Publication date	03.02.2025	06:55 PM
b.	Document download start date	03.02.2025	06:55 PM
c.	Document download end date	19.02.2025	11:00 AM
d.	Bid Submission start date	**04.02.2025**	11:00 AM
e.	Bid submission end date	**19.02.2025**	11:00 AM
f.	Start date for seeking Clarification on-line	04.02.2025	11:00 AM
g.	Last date for seeking Clarification on-line	12.02.2025	11:00 AM
h.	Technical Bid (Cover I) opening date	20.02.2025	11:00 AM
i.	Price Bid (Cover II) opening date	To be opened after finalisation of Part-1 TCR	

Note: The auto extension of submission of bid shall be applicable as per details mentioned in clause No.14 of NIT.

Date	Received From	Quantity	Up to issue	Issue To	Quantity	Balance
			01.01.2023			140 Nos
			01.01.23 to 31.01.2023	Employees	58	82 Nos
			01.02.23 to 28.02.23	"	45	37 Nos
03.03.23	Q. Project	800	←	—	—	837 Nos
			01.03.23 to 31.03.23	"	128	709 Nos
			01.04.23 to 30.04.23	"	105	604 Nos
			01.05.23 to 31.05.23	"	128	476 Nos
			01.06.23 to 30.06.23	"	56	426 Nos
			01.07.23 to 31.07.23	"	58	368 Nos
			01.08.23 to 31.08.23	"	72	296 Nos
			01.09.23 to 30.09.23	"	86	210 Nos
			01.10.23 to 31.10.23	"	60	150 Nos
			01.11.23 to 30.11.23	"	75	75 Nos
			01.12.23 to 31.12.23	"	70	05 Nos
			01.01.2024 to 31.01.24	"	03 -	02 Nos
22.02.24	R/S	10020	—	—	—	10022 Nos
			01.02.24 to 29.02.24	"	963	9059 Nos
			01.03.24 to 31.03.24	APR23 to March24=2735	1059	8000 Nos
13.04.24	R/S	5000	←	(2675)	—	13000 Nos
			01.04.24 to 30.04.24		940	12060 Nos
			01.05.24 to 31.05.24		917	11143
			01.06.24 to 30.06.24		836	10307
			01.07.24 to 31.07.24		812	9495
			01.08.24 to 31.08.24		748	8747
			01.09.24 to 30.09.24		720	8027
			01.10.24 to 31.10.24		920	7107
			01.11.24 to 30.11.24		870	6237
			01.12.24 to 31.12.24		817	5420
			01.01.2025 to 31.01.2025		895	4525

Annexure-C

कोलइण्डियालिमिटेड
(भारतसरकारकाउपक्रम)
COAL INDIA LIMITED
(A Govt. of India Enterprise)
कोलभवन "COAL BHAWAN"
PREMISES NO: 04, MAR, PLOT NO: AF-III
ACTION AREA-IA, NEW TOWN, RAJHARHAT
KOLKATA-700 156 (WB)

महारत्नकंपनी
A Maharatna Company

ENVIRONMENT DIVISION
पर्यावरण विभाग
E-MAIL: cgmenv.cil@coalindia.in
TEL: 033-2324 6638
FAX:033-23244232
WEBSITE:www.coalindia.in
CIN:L23109WB1973GOI028844

(An ISO 9001:2015, ISO 50001:2018 & ISO 14001:2015 Certified Company)

Ref: CIL/ENV/WO/f145M 11451 .

दिनांक 14 June 2024

To
Centre of Excellence, Sustainable Land Management
Indian Council of Forestry Research and Education, Dehradun

Kind Attention: Shri Sanjeev Kumar, Scientist-E, CoE-SLM, ICFRE

Sub: Work Order for "Standardization of Package and Practices for Eco-rehabilitation of Degraded Coal Mines Falling under Different Agro-climatic Zones of India through Forestry Interventions".

Ref: Proposal from Centre of Excellence on Sustainable Land Management (CoE-SLM), Indian Council of Forestry Research and Education (ICFRE), Dehradun regarding eco-restoration of degraded mined out areas in Coal India Limited and its Subsidiaries received vide email dated 14.03.2024 (Enclosed Annexure 1)

Sir,

Competent Authority agreed to your offer for carrying out the assignment for "Standardization of Package and Practices for Eco-rehabilitation of Degraded Coal Mines Falling under Different Agro-climatic Zones of India through Forestry Interventions" with total project cost of Rs 24,44,08,680 (inclusive of 18% GST)
Year wise project cost break up is as below-

Sl. No.	Head	1 St Year	2 nd Year	3 rd Year	4 th Year	5 th Year	Total
A	Project Expenses	3,88,31,000	4,99,08,000	5,27,51,000	3,31,68,000	2,64,68,000	20,11,26,000
B	Intellectual fee	12,00,000	12,00,000	12,00,000	12,00,000	12,00,000	60,00,000
C	GST (18%)	72,05,580	91,99,440	97,11,180	61,86,240	49,80,240	3,72,82,680
	Total	**4,72,36,580**	**6,03,07,440**	**6,36,62,180**	**4,05,54,240**	**3,26,48,240**	**24,44,08,680**

Scope of Work:

1. Study the extent of degradation in the proposed sites (three sites in each agro-climatic zone)
2. Developing techno-scientific improvisations in top-soil management to facilitate conservation and utilization of the top soils for biological rehabilitation of mined over areas and overburden dumps.
3. Developing agro-climatic zone specific models for eco-rehabilitation of the mined over areas in different representative locations of Coal India Limited.
4. Support capacity building of the concerned personnel of Environment Management Units of subsidiaries of Coal India Ltd. in eco-restoration techniques by way of association with the project activities.
5. Developing RS-GIS based land degradation and eco-rehabilitation monitoring model.

6. Other relevant points related to the proposed study.

Study Area: 39 sites in 13 agro-climatic zones falling under 8 states under which coal mines of CIL are lying (As per enclosed Annexure-2). (5 Ha area to be restored per site). As per availability of land modification in area/ site if required shall be made.

List of 39 sites in CIL will be communicated after acceptance of work order from ICFRE.

Duration of Project —5 Years

Deliverables & Timeline:

1. Annual submission of Interim reports and utilization certificate of funds as proposed.
2. Submission of soft copy of draft reports within 15 days after completion of project.
3. Submission of Soft copy and ten set of hard copies of final report within 15 days of approved draft.
4. Accepting Authority GM (Env) CIL Kolkata.

Payment Terms:

i. 50 % of the total amount of the project cost in advance before the commencement of the project after acceptance of order.

ii. 15% of the total amount of above project cost after completion of activities mentioned up to 2nd year of Work Plan and submission of interim report of work and utilization certificate of previous payments.

iii. 15% of the total amount of above project cost after completion of activities mentioned up to Yd year of Work Plan and submission of interim report of work and utilization certificate.

iv. 20 % of the total amount of above project cost after completion of all the activities and submission of final report at the end of 5th Year.

Acceptance of Work Order:
Letter of acceptance of Work Order should be communicated to CIL within 7 days of receipt of Work Order.

14-06-24

General Manager (Env)
CIL-Kolkata

Copy to:
1. DT(P&P), ECL/BCCL/CCL/MCL/NCL/SECL/WCL
2. ED (Coordination), CIL
3. TS to D(T), CIL
4. GM (NEC)
5. GM (Em), ECL/BCCL/CCL/MCL/NCL/SECL/WCL

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

एन सी एल NCL

वन विभाग / Forest Department
CIN- U10102MP1985GOI003160
An ISO 9001, ISO 14001 & ISO 45001 Certified Company
पोस्ट-सिगंरौली कोलियरी, जिला- सिगंरौली,म.प्र., पिन 486889 / Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

क्रमांक: एनसीएल/मुख्यालय/पर्यावरण/वन/2025/966. दिनांक :-04.01.2025

प्रति,
प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
सोनभद्र उत्तर प्रदेश – 231217.

विषय :- **Plantation& its subsequent maintenance including Gap & Miyawaki Plantation along with Grassing on OB dumps for the Year 2025-26 at NCL.**

महोदय,
NCL projects located in Madhya Pradesh have finalized the following targets of Plantation/Miyawaki/Gap Plantation works to be carried out during the monsoon season of the year 2025-26:-

A. Plantation of OB and Plain Area during FY 2025-26:

Project	Plantation on Overburden Dumps with CPW/CPT		Plantation in Plain Areas & Road side with Fencing/CPT etc.		Total No. of Plants
	Area (Ha.)	No. of Plants @2500 /Ha.	Area (Ha.)	No. of Plants @2500 /Ha.	
Bina	26 (Int.)	65000	0	0	65000
Khadia	3.0 (Ext.)	7500	0	0	7500
Dudhichua	15(Int)	37500	0	0	37500
Krishnashila	05 (Int.)	12500	0	0	12500
Total (UP)	**49**	**122500**	**0**	**0**	**122500**

B. Miyawaki Plantation Target of the year 2025-26:-

Project	Area in Ha.	Total No. of Plants @35000 /Ha.
Bina	1.0	35000
Kakri	0.55	19250
Total (UP)	**1.55**	**54250**

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
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एन सी एल
NCL

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Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

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C. Gap Plantation Target of the year 2025-26:-

Project	Area in Ha.
Khadia	2.82

It is requested to kindly submit detailed proposal in shape of a draft MoU including Terms and Conditions as well as detailed year wise estimates of the aforesaid plantation works in 2025-26 and subsequent maintenance works during next four years period showing clearly all the items of works/expenditures including all the fencing materials for the areas suitable for plantation works. Proper documents related to rates of fencing, seeds etc. material procurements shall require to be attached with the estimates.

Maps for the proposed plantation sites are enclosed for necessary action. While preparing the aforesaid proposal, the following points are to be kept in mind-

1. On overburden dumps, suitable native species (endemic species should be given priority) including fruit bearing species and Sal plantation & bamboo, suitable species of medicinal values like Neem, Karanj etc. are to be planted depending upon local site conditions shall be planted which efficiently bind the loose soils. OB dumps shall be stabilized by making terraces of proper sizes and these terraces are to be further reinforced with pebbles, stones and by planting suitable grass species.

2. Plantation areas are to be secured through proper fencing arrangement like Barbed Wire Fencing (BWF) or Cattle Proof Trench (CPT) or Cattle Proof Wall (CPW) as per the local site requirements.

3. Provisions for providing appropriate safety gears (Helmets, Safety Shoes etc.) for the safety of labours working in plantation areas located inside coal mines should be made in the estimates.

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
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वन विभाग / Forest Department
CIN- U10102MP1985GOI003160
An ISO 9001, ISO 14001 & ISO 45001 Certified Company
पोस्ट-सिगंरौली कोलियरी, जिला- सिगंरौली,म.प्र., पिन 486889 / Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

This may be taken as preliminary call to Renukoot Forest Division, the Govt. of UP for submission of their offer to the NCL. The proposal & estimate, as submitted by you, shall be considered and decided by the NCL. The final work order will be issued only after the competent approval. No financial liability shall accrue to the NCL as result of the present call for offer.

In case, the proposal & estimate of Renukoot Forest Division is accorded approval, Renukoot Forest Division shall be required to execute a MoU for the period from 2025-26 to 2029-30 (plantation works in 2025-26 and maintenance works during next four years from 2026-27 to 2029-30).

You may kindly submit the required draft MoU including estimates as earliest.

Encl.: As above.

भवदीय

महाप्रबंधक (पर्यावरण एवं वन),
एन.सी.एल.-सिंगरौली

प्रतिलिपि :

1. निदेशक (तकनीकी / परियोजना व योजना), एनसीएल.....सूचनार्थ

2. महाप्रबंधक (दुधिचुआ, बीना, खड़िया, ककरी एवम् कृष्णशिला)- उचित कार्यवाही हेतु ।

नॉर्दर्न कोलफील्ड्स लिमिटेड
खड़िया परियोजना
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

एन सी एल
NCL

Northern Coalfields Limited
Khadia Project
(A Miniratna Company)
(A subsidiary of Coal India Limited)

Office of General Manager

Digital India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

CIN- U10102MP1985GOI003160
An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company
थाना- शक्तिनगर, जनपद-सोनभद्र (उ. प्र.), पिन - 231222/ Thana-Shaktinagar, Dist. Sonebhadra (U.P.) Pin- 231222
Phone: 05446- 232274, (FAX) 05446- 232274 Email: cgm.khd@gmail.com, website : www.nclcil.in

KHD/ Mining / Env / Plantation /24-25/4710 Date: 13/02/2025

To,
The Divisional Forest Officer
Renukoot Forest Division
Distt. – Sonebhadra (U. P.)-231217

Sub: - Work order for 3 tier plantation along newly constructed CC Road and mine boundary

Dear Sir,

Enclosed please find herewith the original copy of Memorandum of Understanding (MoU) executed between the Khadia Project NCL and the Renukoot Forest Division for the plantation works to be carried out at Khadia Project besides newly constructed CC Road and mine boundary.

As per the MoU, plantation targets on newly constructed Cement Concrete Road and mine boundary and financial provisions are as follows:

Sl. No.	Area of Plantation	No. of Plants	Total cost of plantation work including maintenance
1	2.8 Ha	1750	6746800/-

It is requested to commence plantation work as per the terms and conditions of enclosed MoU. It is further requested that saplings to be planted should only include native species with plants of broader leaves and long life.

Yours faithfully,

13-02-2025
General Manager
Khadia Area, NCL

Copy to:
(1) The General Manager (Environment & Forest), NCL Singrauli
(2) Staff Officer (Mining), Khadia Area
(3) AFM, Khadia Area

MEMORANDUM OF UNDERSTANDING (MoU) BETWEEN NORTHERN COALFIELDS LIMITED KHADIA PROJECT AND FOREST DEPARTMENT RENUKOOT DIVISION, GOVERNMENT OF UTTAR PRADESH FOR YEARS 2024-25 to 2027-28 FOR C.C. ROAD PLANTATION WORKS (ADVANCE WORKS, PLANTING WORKS AND SUBSEQUENT TWO YEARS MAINTENANCE) IN KHADIA PROJECT NCL

1. (i) The word 'Company' hereinafter shall mean, for the purpose of this Memorandum of Understanding (MoU), the Northern Coalfields Limited (NCL KHADIA PROJECT) (A Project of M/s Northern Coalfields Limited) having its registered office at P.O. Shaktinagar, District Sonebhadra, U.P. represented by General Manager, Khadia Area, NCL or his authorized representative or any other person deputed on his behalf for carrying out all or any of the provisions of this MoU.

   (ii) The word 'Department' hereinafter shall mean, for the purpose of this MOU, the Department of Forest, Government of Uttar Pradesh represented by the Divisional Forest Officer (DFO), Renukoot Forest Division or his authorized representative or any other person deputed on his behalf for carrying out all or any of the provisions of this MoU.

2. The Department shall carry out plantation works on Company's acquired/ leased /purchased/transferred lands of various types viz. tenancy lands, Government revenue lands, forest lands etc., with professional expertise, as per the details of works along with terms and conditions and other provisions of this MOU. On NCL's side, the Environmental Officer of the Khadia project shall be Nodal Officer for carrying out day to day activities as per this MoU, whereas General Managers, Khadia Projects shall be Officers-in-Charge who shall be overall responsible for implementation of the provisions of this MoU.

3. The Department as well as the Company shall always exercise due precautions for ensuring safety of human lives and properties involved in the plantation activities undertaken by the Department. The GM Khadia project and the DFO, Renukoot shall abide by the legally and technically appropriate advices, as tendered by either officials for the safety of human lives and properties involved in the piantation activities. During the entire period of this MoU, the plantation sites shall be "closed sites", which means that any activity other than plantation and forestry related activities shall not be allowed in the plantation site.

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12-02-2025
General Manager
Khadia Area

4. In case of any accident, its causes shall be investigated under the statutory framework of the mine. Based on its findings, the responsibilities of the concerned officials of the Department or/ and the Company shall be fixed by the statutory body. After this, all the consequential liabilities (including compensation etc.), as per the concerned provisions of the Workmen's Compensation Act, 1923 and related laws, shall be borne by the Department or the Company as the case may be.

5. The Department shall carry out all the plantation activities while observing all related laws, rules, regulations and statutory orders applicable to the site and nature of work which has been issued in connection with such site and nature of work by the Government of Uttar Pradesh, the Government of India and NCL.

6. The Company shall furnish to the DFO, Renukoot Forest Division the relevant details of the lands to be covered under the plantation works along with its maps. Various items of plantation works and their rates shown in the enclosed annexures of this MoU have been finalized on the basis of site specific scheme/estimate of the plantation works submitted by the DFO, Renukoot Forest Division. Following works are stipulated:-

   1. Advance soil works – Nursery related works and all site preparation works (to be carried out during 15.02.2025 to 30.06.2025).
   2. Planting works –Planting during monsoon season of 2025 and its subsequent aftercare works including protection and maintenance (to be carried out up-to 31.03.2026)
   3. 1st year maintenance works- Aftercare works including 30% causality replacements and protection works (to be carried out during 01.04.2026 to 31.03.2027)
   4. 2nd year maintenance works– Aftercare works including 20% causality replacements and protection works (to be carried out during 01.04.2027 to 31.03.2028)

7. Six months to twelve months old (polythene) plants shall be used for plantation works by the Department. Mixed Plantation species for planting shall be selected by concerned range forest officer with the consultation of SDO Pipari and DFO Renukoot as per the local site conditions. The selection of species shall also be guided by the opinion of the local villagers with a appropriate blend of fast growing species naturally growing in those areas, fruit bearing trees and trees of commercial value. In no case, however, a particular species shall constitute more than 30% of the total plantation in a particular area.

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12-02-2025
General Manager
Khadia Area

8. The Department and the Company shall comply with the following schedule of Joint Inspections and verifications of the concerned plantation works to be done jointly by the concerned nominated officials of the Department and the NCL:

Schedule of Joint Inspections

S.N.	Joint Inspection	Tentative date of its Completion
1.	1st Joint Inspection – Verification of Advance Works	30th June, 2025
2.	2nd Joint Inspection – Verification of Planting Works	15th October, 2025
3.	3rd Joint Inspection – Verification of 1st year maintenance works	15th October, 2026
4.	4th Joint Inspection – Verification of 2nd year maintenance works	15th October , 2027
5.	5th and final Joint Inspection – Verification of 2nd year maintenance works (full works) including 100% enumeration of planted saplings at the time of handing over of plantation works by the Department to Company	31th March , 2028

10. (i) In the joint inspections and verification of the plantation works in the concerned projects, two officials of the concerned projects, preferably Environmental Officers/ Survey Officers/ Civil Engineers, as nominated by the General Managers Khadia Project shall participate from the NCL side whereas the concerned Range Forest Officer of Renukoot Forest Division as nominated by the DFO, Renukoot shall participate from the Department side. The joint inspection reports shall be signed immediately by the aforesaid officials from both the side who have carried out the joint inspections and later on shall be countersigned by the concerned Chief General Managers / General Managers of the projects. The DFO Renukoot and the CGMs/GMs of the concerned projects shall be responsible for carrying out all the stipulated joint inspections within the stipulated time limit.

(ii) In case of any dispute in the process / result of the joint inspections of the plantation works in the concerned projects, The DFO, Renukoot and the

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12-02-2025
General Manager
Khadia Area

CGMs/GMs of the concerned projects shall within 15 days, after mutual consultation and consent, carry out joint inspections by another team of superior officers different from those officials earlier nominated for joint inspections. The results / findings of this team shall be binding on both the parties.

11. Payment Scheduled and submission of expenditure Bills/details: Fund shall be released (through Cheques or Demand Draft as the case may be) by the Chief General Managers/General Managers of the Khadia project in installments as per the following schedule, subject to submission of physical and financial details of completed works by the Department:-

> **Note-** After the utilization of 80% of the budget released for afforestation activity, utilization certificate will be submitted by DFO for demand of next work. Remaining 20% budget will be utilized and final utilization of 100% budget will be submitted afterwards.

a. 1st Installment- As "Advance Fund" equal to 100% of the total amount estimated for the "Advance Soil Works" component will be released on issue of work order in 2025.

b. 2nd Installment- As "Advance Fund" equal to 80% of the total amount estimated for 'Planting Works' component as per approved scheme will be released by 15th July, 2025 on receipt of 1st joint inspection/verification report of "Advance works" subject to submission of physical and financial details of "Advance work".

c. 3rd Installment- An amount equal to 20% of the total amount estimated for 'Planting Works' component will be released by 15th October, 2025 on receipt of 2nd Joint inspection report subject to submission of physical and financial details of 'Planting Works' and on adjustment of previous advances paid to the Department.

d. 4th Installment- An amount equal to 80% of the total amount estimated for '1st year maintenance works' shall be released by 15th April, 2026 on adjustment of previous installments paid to the Department.

e. 5th Installment- An amount equal to 20% of the total amount estimated for '1st year maintenance works' shall be released by 1st November, 2026 after submission of 3rd Joint inspection report and on adjustment of previous installments paid to the Department.

f. 6th Installment- An amount equal to 80% of the total amount estimated

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12-02-2025
General Manager
Khadia Area

for '2nd year maintenance works' shall be released by 15th April, 2027 on adjustment of previous installments paid to the Department.

g. 07th Installment- An amount equal to 20% of the total amount estimated for '2nd year maintenance works' shall be released by 15th of April, 2028 after submission of 4th and 5th joint inspection report (including results of 100 % enumeration on the basis of which the minimum survival percentage shall have to be ensured) and on final adjustment of all the previous advances/ installments paid to the Department. **Proforma for submission of Physical and financial details for release of subsequent installments:**

Year of Plantation	Nos. of Plants planted		No. of Installment as per Clause 11 of the MoU	Advance Amount paid by the Project as Installment (In Rs.)	Amount spent against paid installment (In Rs.)	Balance Amount to be adjusted from the next installment (In Rs.)
	Location	Nos.				
1	2	3	4	5	6	7
	OBD					
	Plain					

12. Adjustments, if any, from installments released shall be made from the subsequent installments before their release to the Department.

13. The Department will ensure 80% survival of plants during the final joint inspection before handing over of the plantation works to the Company and which shall signify 100% success of plantation works.

"If survival of plants falls below 80% at the time of handing over of plants after Two years of completion of plantation, proportionate deduction of amount paid during Two years for the plants less than 80% shall be recovered except in incidences of natural calamities."

14. The Department shall pay wages not less than the minimum wages fixed by the Govt. of U.P. to the laborers engaged in plantation works. It will be the sole responsibility of the Department to ensure due compliance of existing labour related laws and obtain labour license, permission etc. whatsoever are applicable / required. The company shall in no way be held responsible for the above.

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12-02-2025
General Manager
Khadia Area

15. In case of revision of labour rates (applicable for the Forest Department by the Govt. of UP) an appropriate escalation in costs of the concerned work items shall be allowed and payable (within 30 days) as per the following formula:

$$\Delta R = 0.85 \times P / 100 \times R \times (L_1 - L_0) / L_0$$

Where,

ΔR	=	Increase in the cost of Work Item
P	=	Percentage of labour component of the work = 80 % agreed
R	=	Original Cost of work
L_1	=	Revised labour Rate of work
L_0	=	Original labour Rate of work (base rate Rs. 230.00/mandays)

16. In case either the Department or the Company fails, at any stage of implementation of the MoU, to abide by the schedules of inspections and payments, as envisaged in Clause - 9 and Clause - 11 of this MoU respectively, the first defaulter shall be responsible for all the ensuring the consequences and further action in such cases will be dealt as per the provisions of Clause no.-**17**.

17. In case of any dispute, confusion or difference between the parties hereto, the concerned Chief Conservator of Forests, Mirzapur Forest Circle and the Head of the Forest section of the NCL Hqtrs. shall confer together and arrive at a mutually agreeable solution, which shall henceforth be binding upon both the parties.

18. No claims whatsoever shall lie against the Company for any loss or damage suffered by the Department due to any act of God viz. Natural Calamity, Excessive Rains, Floods, Land Slides, Mine fire etc. in the Project area or due to any eventuality of War, Civil unrest, Strike, Lockout, etc. beyond the control of the Company. However, the Department shall not be responsible for any damage to the plantation works due to the act of God, viz. Natural Calamity, Excessive Rains, Floods, Land slides, Mine fire etc. in the Project area or due to any eventuality of War, Civil unrest, Strike, Lockout, etc. Natural Calamity, War, Civil commotion, Strikes, Lockout, etc. beyond the control of the Department subject to the condition that due precautions have been taken by the Department. In the eventuality of any damage to the plantation works due to any of the above factors, the DFO, Renukoot shall immediately intimate the CGM/GM of the concerned project and a joint assessment of the damages will be carried out within 72 hours and if necessary, photography / videography of the concerned sites / damages shall be carried out.

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12-02-2025
General Manager
Khadia Area

19. Any modification, alteration, addition or deletion in terms and conditions of MoU shall be done as and when required during the course of MoU mutually agreed by the Director, Technical (Project & Planning), NCL and the Chief Conservator of Forests, Mirzapur Forest Circle.

This Memorandum of Understanding is executed between the Department and the Company on the 12/02/2025 Day of the Month of February in the Year 2025 and will be effective from the date of its execution and shall be valid up-to 31.03.2028 unless any modification or alteration takes place as per the terms and conditions of this MoU.

Name:
Designation: प्रभागीय वनाधिकारी
Authorized रेनुकूट वन प्रभाग
Representative of the रेनुकूट-सोनभद्र (उ०प्र०)
Department

Name:
12-02-2025
Designation: General Manager
Authorized Representative Khadia Area
of
the Company

एन०सी०एल० खड़िया परियोजना द्वारा निर्मित सी०सी० रोड एवं माईन बाउण्ड्री के पास मिश्रित साल प्लान्टेशन हेतु माडल व्यय अनुमान पत्र.

क्षेत्रफल– 2.8 हे०

प्रभाग का नाम :– रेनुकूट वन प्रभाग | गड्ढों की संख्या–1750 | सुरक्षा फेंसिंग–11759 मी०

प्रथम चरण (अग्रिम मृदा कार्य)

क्र०सं०	कार्य का विवरण	अनुसूची दर क्रम सं०	इकाई	मात्रा	दर प्रति इकाई	धनराशि
1	2	3	4	5	6	7
1	क्षेत्र का सर्वेक्षण एवं सीमांकन	3.1	हे०	2.8	61.79	173.01
2	क्षेत्र की सफाई	3.2	हे०	2.8	1981.89	5549.29
3	आर०सी०सी० पोल का क्रय एवं आपूर्ति	स्थानीय दर	सं०	3919	505	1979095.00
4	मेटल जाली का क्रय एवं आपूर्ति	स्थानीय दर	र०मी०	11759	250	2939750.00
5	रेखांकन	3.3				
	(क)– गड्ढे (3.00x3.00 मी०)		प्रति गड्ढा	1750	0.56	980.00
7	अग्रिम मृदा कार्य	4				
	(क)– गड्ढा का खुदान (0.45X0.45X0.45 मी०	4.2	प्रति गड्ढा	1750	11.90	20825.00
	माउण्ट निर्माण (0.90x1.80x0.45)	13.3		1750	55.10	96425.00
8	कर्मचारियों को दवाई, पानी की सुविधा	11	प्रति हे०	2.8	197.16	552.05
11	फोटोग्राफी व ड्रोन वीडियोग्राफी एवं एल्बम संधारण	स्थानीय दर				4000.00
12	अन्य व्यय (प्रशासनिक व्यय, औजारों का क्रय व मरम्मत, स्टेशनरी आदि पर व्यय)	–	हे०	2.8		1932.00
					योग–	5049281.35
					या–	5049300.00

प्रभारी क्षेत्रीय वन अधिकारी
खड़िया प्रोजेक्ट,
रेनुकूट वन प्रभाग, रेनुकूट

उप प्रभागीय वनाधिकारी
पिपरी, उप वन प्रभाग, रेनु

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग, रेनुकूट
सोनभद्र, उत्तर प्रदेश

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
रेनुकूट–सोनभद्र (उ०प्र०)

12-02-2025
General Manager
Khadia Area

द्वितीय चरण (वृक्षारोपण कार्य)

क्र0सं0	कार्य का विवरण	अनुसूची दर कम स0	इकाई	मात्रा	दर प्रति इकाई	धनराशि
1	2	3	4	5	6	7
1	गड्ढा का भरान कार्य	5.1	प्रति गड्ढा	1750	1.37	2397.50
2	पौधा क्रय (3 प्रतिशत अतिरिक्त पौधा)	स्थानीय दर	प्रति पौधा	1803	80.00	144240.00
3	पौधों की स्थानीय ढुलान रोपण सहित					
	(क) छोटी थैली (3 प्रतिशत अतिरिक्त पौधा)	7.3 a	प्रति पौधा	1803	3.34	6022.02
4	गड्ढों में पौधा रोपण के समय वर्मी कम्पोस्ट (500 ग्राम) प्रति पौधा मिलवाई सहित	7.5 a	प्रति पौधा	1750	5.05	8837.50
5	थाला बनाना 1.2 मी व्यास	7.8	प्रति पौधा	1750	3.03	5302.50
6	निराई-गुड़ाई (2 बार) शीतकालीन सहित					
	क- गड्ढा पौधा 1750X2=3500	8.1 a	प्रति पौधा	3500	1.03	3605.00
7	पौधों की सिंचाई औसतन माह मे 6 बार 9X6X1750=94500	13.6	प्रति पौधा	94500.0	2.40	226800.0
8	25 ग्राम यूरिया एक बार अगस्त दूसरी बार शीतकालीन वर्षा के बाद (यूरिया का मूल्य सहित)	8.3	प्रति पौधा	1750	0.70	1225.00
9	आर0सी0सी0 खम्भो का स्थानीय ढुलान एवं प्रति गड्ढों तक फैलाना आदि कार्य	9.2 b	सं0	3919	7.56	29627.64
10	आर0सी0सी0 खम्भो की गड़ाई गड्ढा खुदान सहित 45 गहराईX30X30 सेमी माप का गड्ढा	स्थानीय दर	सं0	3919	13.10	51338.90
11	मेटल जाली की खिंचाई एवं खम्भो पर बंधाई	स्थानीय दर	र0मी0	11759	20.00	235180.00
13	वृक्षारोपण बोर्ड की बनवाई	10.5	प्रति बोर्ड	2	5323.18	10646.36
14	वृक्षारोपण सुरक्षा हेतु श्रमिक पर व्यय जून से मार्च (2 प्रहरी)	10.4	दिन	520	230.00	119600.00
16	क्षेत्र की सफाई	3.2	है0	2.8	1981.89	5549.29
17	अन्य व्यय (प्रशासनिक व्यय,, औजारों का क्रय व मरम्मत, स्टेशनरी आदि पर व्यय)	—:	है0	2.8	[illegible]	12800.00
					योग–	863171.71
					या–	863100.00

नोट–रोपित पौधों की सिंचाई हेतु पानी टैंकर द्वारा एन0सी0एल0 खड़िया परियोजना के द्वारा वृक्षारोपण के पास उपलब्ध कराया जायेगा।

प्रभारी क्षेत्रीय वन अधिकारी
खड़िया प्रोजेक्ट
रेनुकूट वन प्रभाग, रेनुकूट

उप प्रभागीय वनाधिकारी
पिपरी, उप वन प्रभाग, रेनुकूट

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग, रेनुकूट
सोनभद्र, उत्तर प्रदेश

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
रेनुकूट-सोनभद्र (उ0प्र0)

12-02-2025
General Manager
Khadia Area

तृतीय चरण (प्रथम अनुरक्षण)

क0सं0	कार्य का विवरण	अनुसूची दर कम सं0	इकाई	मात्रा	दर प्रति इकाई	धनराशि
1	2	3	4	5	6	7
1	पौधो की निराई-गुड़ाई (दो बार)1750X2=3500	8.1 a	प्रति पौधा	3500	1.03	3605.00
2	पौधो की सिंचाई औसतन माह में 5 बार 12X5X1750=105000	13.6	प्रति पौधा	105000.0	2.40	252000.00
3	वृक्षारोपण सुरक्षा हेतु श्रमिक पर व्यय अप्रैल से मार्च (2 प्रहरी)	10.4	दिन	555.0	230.00	127650.00
5	क्षेत्र की सफाई	3.2	हे0	2.8	1981.89	5549.29
6	अन्य व्यय (प्रशासनिक व्यय, औजारों का क्रय व मरम्मत, स्टेशनरी आदि पर व्यय)	—	हे0	2.8	एकमु0	1600.00
					योग–	390404.29
					या–	390400.00

नोट–रोपित पौधों की सिंचाई हेतु पानी टैंकर द्वारा एन0सी0एल0 खड़िया परियोजना के द्वारा वृक्षारोपण के पास उपलब्ध कराया जायेगा।

प्रभारी क्षेत्रीय वन अधिकारी
खड़िया प्रोजेक्ट
रेनुकूट वन प्रभाग, रेनुकूट

उप प्रभागीय वनाधिकारी
पिपरी उप वन प्रभाग, रेनुकूट

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग, रेनुकूट
सोनभद्र, उत्तर प्रदेश

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
रेनुकूट-सोनभद्र (उ0प्र0)

12.02.2025
General Manager
Khadia Area

चतुर्थ चरण (द्वितीय अनुरक्षण)

क० सं०	कार्य का विवरण	अनुसूची दर कम सं0	इकाई	मात्रा	दर प्रति इकाई	धनराशि
1	2	3	4	5	6	7
1	गड्ढो पौध की निराई–गुड़ाई तथा स्पेसिंग कार्य दो बार(1750X2=3500)	8.1 a	प्रति पौध	3500	1.03	3605.00
2	पौधों की सिंचाई औसतन माह में 5 बार 12x5x1750=105000	13.6	प्रति पौध	105000.0	2.40	252000.00
4	सुरक्षा श्रमिक का पारिश्रमिक अप्रैल से मार्च तक (2 प्रहरी)	10.4	दिन	555	230.00	127650.00
5	श्रमिकों हेतु पेयजल एवं प्राथमिक चिकित्सा पर व्यय	11	प्रति हे0	5	197.16	985.80
7	झाड़ी की सफाई	3.2	हे0	2.8	1981.89	5549.29
8	फेंसिंग मरम्मत कार्य					50000.00
10	प्रजातिवार उचाईवार गोलाईवार पौधों की गणना		प्र0हे0	2.8	924.58	2588.82
11	अन्य व्यय (प्रशासनिक व्यय, औजारों का क्रय व मरम्मत, स्टेशनरी आदि पर व्यय)	—	हे0	2.8	607.50	1700.00
					योग	444078.91
					या–	444000.00

नोट–रोपित पौधों की सिंचाई हेतु पानी टैंकर द्वारा एन0सी0एल0 खड़िया परियोजना के द्वारा वृक्षारोपण के पास उपलब्ध कराया जायेगा।

प्रभारी क्षेत्रीय वन अधिकारी
खड़िया प्रोजेक्ट
रेनुकूट वन प्रभाग, रेनुकूट

उप प्रभागीय वनाधिकारी
पिपरी, उप वन प्रभाग, रेनुकूट

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग, रेनुकूट
सोनभद्र, उत्तर प्रदेश

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
रेनुकूट–सोनभद्र (उ0प्र0)

12-05-2025
General Manager
Khadia Area

प्रोजेक्ट की कुल लागत

प्रभाग का नाम– रेनुकूट वन प्रभाग, रेनुकूट सोनभद्र

खड़िया प्रोजेक्ट **क्षेत्रफल–2.8** हे0

कार्य **मद**	भौतिक (हे0 में)	धनराशि (रुपये में)
प्रथम चरण (अग्रिम मृदा कार्य)	2.8	5049300.00
द्वितीय **चरण** (वृक्षारोपण कार्य)	2.8	863100.00
तृतीय **चरण** (प्रथम अनुरक्षण कार्य)	2.8	390400.00
चतुर्थ **चरण** (द्वितीय अनुरक्षण कार्य)	2.8	444000.00
2.8 हे0 क्षेत्र हेतु **कुल आवश्यक** धनराशि योग–		**6746800.00**

प्रभारी क्षेत्रीय वन अधिकारी
खड़िया प्रोजेक्ट
रेनुकूट वन प्रभाग, रेनुकूट

उप प्रभागीय वनाधिकारी
पिपरी उप वन प्रभाग, रेनुकूट

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग, रेनुकूट
सोनभद्र, उत्तर प्रदेश

प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
रेनुकूट–सोनभद्र (उ0प्र0)

12-02-2025
General Manager
Khadia Area

सीएमपीडीआई
cmpdi
A Mini Ratna Company

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The information given in this report is not to be communicated either directly or indirectly to the press or any person not holding an official position in the CIL/Government

(वैज्ञानिक अध्ययन)
SCIENTIFIC STUDY

(UNDER REGULATION 106 OF CMR- 2017)

FOR

(खड़िया विस्तार खुली खनन परियोजना)
KHADIA EXPANSION OCP
(NORTHERN COALFIELDS LIMITED)

SEPTEMBER 2023

ओपनकास्ट विभाग,

सीएमपीडीआई-मुख्यालय

Contents

PREFACE

GM (CP) NCL, Singrauli, vide Letter No: NCL/CP/CMPDI/23/5155 Dated 21.03.2023, confirmed that the assignment for Scientific Study under Regulation 106(2) of CMR 2017 be taken up for Khadia OCP of Northern Coalfields Limited (NCL) by CMPDI HQ under annual action programme of CMPDIL for FY 2023-24 for NCL. The Job no allotted for the assignment is 024622273.

The information given in this report is confidential and is for internal use by the Sponsor and cannot be published in full or part, neither be quoted either directly or indirectly to the press or any other person not holding any official position in Coal India Limited/Government.

1 INTRODUCTION

1.1 BACKGROUND

The Singrauli Coalfield comprises of two separate sedimentary domains, covering an area of about 2375 sq. km. It consists of Main Basin in the western part covering an area of 2075 sq. Km. and the eastern part covering an area of 300 sq. Km. known as Moher Sub-Basin.

The Feasibility Study of Singrauli Coalfield prepared by CMPDI in collaboration with the Soviet Experts in 1974, identified Khadia OCP for a rated capacity of 10 Mtpa. The Project Report for 10 Mtpa capacity was prepared by CMPDI in November, 1982, but Considering the constraint in demand and linkage Govt. of India sanctioned the Project Report for 4 Mtpa capacity on 18.09.1985.

The Detailed Project Report/RCE (4 Mtpa) was prepared jointly by CMPDI and Soviet Experts and was sanctioned by the Govt. of India on 27.09.1991 for a capital investment of `588.75 Crores. Coal production was started from the year 1991-92. The Completion Report for 4Mtpa stage was sanctioned by NCL Board on 29.01.1998

The Scheme for development of Eastern Section as envisaged in the sanctioned PR and also to maintain coal production from Central Section was prepared in April, 2002, and the scheme was sanctioned by the NCL Board in June, 2002.

The scheme for production of additional 4.50 Mt of coal (1.50 Mt in 2006-07,1.50 Mt in 2007-08 and 1.50 Mt in 2008-09) for three years over and above the sanctioned target production was approved in 2005 under Emergency Coal Production Plan (ECPP).

The scheme for development of Western Section was prepared by CMPDI for proper deployment of draglines and for production of additional 1.00 Mt of coal to meet the higher demand and this scheme was approved by the NCL Board in December, 2006.

Subsequently, another scheme for further development of Western Section and to sustain coal production for three years i.e. from 2009-10 to 2011-12 was prepared by CMPDI and approved by the NCL Board on 20.03.2009

PR for Khadia OCP (4 Mtpa to 10 Mtpa), incremental 6 Mtpa coal production was sanctioned by CIL Board on 28th June, 2011 with option of Coal winning by Departmental Shovel-Dumper and Partial OB removal by outsourcing and Dragline departmental.

The RCE for Khadia OCP (4Mtpa to 10Mtpa)) has been prepared mainly due to change in No. of Dragline and associated Drill as well as its impact on electrical P&M and also dropout of some activities as per requirement of the project with respect to additional provision in the sanctioned PR (6Mtpa incremental)

The RCE of Khadia OCP (4 Mtpa to 10 Mtpa) has been sanctioned by CIL Board for additional capital on 11.02.2020.

The Completion Report for Khadia OCP (4Mtpa to 10Mtpa) has been sanctioned by CIL Board on 11.02.2020.

Khadia project is presently a 14MTPA project and being expanded to 16MTPA project as per approved PR No:- NCL/Board/7C/265/1554 date 25.06.21

GM (CP) NCL, Singrauli , vide Letter No: NCL/cp/c,pdil/23/5155 Dated 21.03.2023, confirmed that the assignment for Scientific Study under Regulation 106(2) of CMR 2017 be taken up for Khadia OCP of Northern Coalfields Limited (NCL) by CMPDI HQ under annual action programme of CMPDIL for FY 2023-24 for NCL. The Job no allotted for the assignment is 024622273

A field visit by a team from CMPDI HQ, Ranchi was undertaken for site reconnaissance and sample collection on 11.04.2023. Inputs related to the Scientific Study were requested from Khadia OCP, NCL, which were received from Project on 03-05-2023 and overburden samples from the Khadia project was received at Geotechnical lab, CMPDI on 30-04-2023.

The Scientific Study has been undertaken based on inputs taken from the mine, base documents from CMPDI, RI-VI and Lab test results for material properties.

1.2 SCOPE OF STUDY

The Scope of Services for the Scientific Study is largely in line with the requirement of regulation 106 (2) of CMR 2017 and is broadly outlined below;

a. Review of existing mining operations viz method of mining, sequence of extraction, dumping strategy as practiced by the mine management as per the existing mine layout vis-a vis the “Approved PR” for Khadia OCP and suggest for any modifications if necessary.
b. Overview of the geological setting of the project in respect of lithology, disposition of seams and geological structure (dip/strike/faults/intrusions etc.)
c. Stability analysis of mine slopes (highwall/working benches and OB dump) considering the current profiles/geo-mining conditions.
d. Analysis on Design of Ultimate Pit slope, OB dumps; external or internal in accordance approved Project report /Mining Plan.
e. Review and Suggest slope monitoring techniques.

1.3 FIELD VISIT

A team from CMPDI HQ, Ranchi visited the mine and held discussions with the officials of Khadia OCP , collected sample from the mine and data from mine management on 11-04-2023 to 12-04-2023.

Field investigation has been done to assess the current status mine workings and dumps. The overburden/waste rock contains various materials such as clay, sand, fine grained sandstone, medium grained sandstone, coarse grained sandstone carbonaceous shale, sandy shale, shale, etc. Figure 1.1 below shows the Khadia OCP taken from online coal block information system (OCBIS).

Figure: 1.1 Khadia OCP as taken from online coal block information system (OCBIS).

Figure: 1.2 A team of CMPDI and Khadia Project during site visit to Khaida OCP

1.4 BASE DOCUMENT

The base documents referred for input data in this study are;

1. Geological Report for Khadia block Vol I (October 1980)
2. Hydrogeological inputs for GW application
3. Project Report for Khadia Expansion Ocp (16 Mtpa)
4. OB samples collected from field visit on 11.04.2023
5. Working Plan and section as on 1-04-2023 in AutoCAD format provided by project authorities during field visit and some drawings were sent through email
6. Geotechnical Lab Test Results

Based on the study and review of the above documentation, a Scientific Study of Khadia OCP has been prepared and presented in this document

2 PROJECT SITE INFORMATION

2.1 LOCATION

The Khadia Expansion OCP (16 Mtpa) includes Khadia Geological Block, part of Ruhela Geological Block and small part of Marrak Geological Block is located in the South-eastern part of Moher Sub-basin of Singrauli Coalfield under command area of Northern Coalfields Limited. The proposed Khadia Expansion OCP is situated partly in District of Sonebhadra (UP) and partly in the District of Singrauli (MP) as shown vide Plate No.MIN-I. The proposed Khadia Expansion OCP is located on the east of Dudhichua OCP and on the west of Krishnashila OCP. The area is covered under Topo-sheet No. 63L/12 and L/16 of the Survey of India on 1:50000 scale and special sheet Nos. 9 & 11 (RF 1:10000). The State Boundary between Madhya Pradesh (Singrauli district) and Uttar Pradesh (Sonebhadra district) passes through the proposed Khadia Expansion OCP.

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Geographic co-ordinates are latitude 24º06'50.48" N to 24º09'16.70" N and longitude 82º41'20.91" E to 82º44'27.55" E and is covered in the Survey of India Toposheet 63-L/12 (R.F. 1:50,000) and Special sheet Nos. 9 & 11 (R.F. 1:10,000).

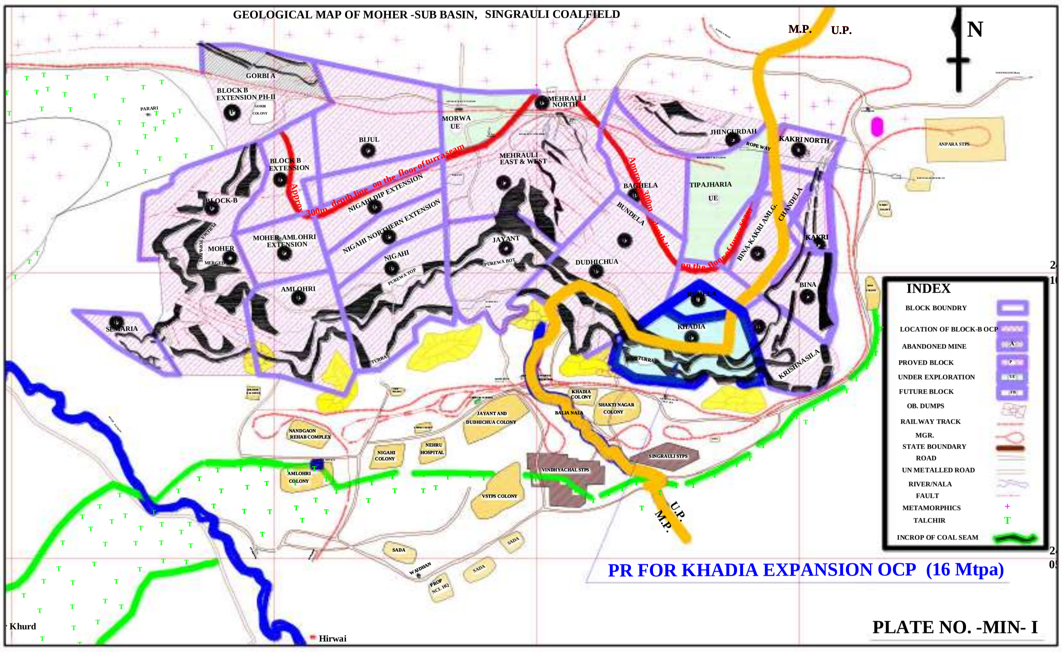


Figure 2.1 Location map with contiguous blocks

2.2 COMMUNICATION AND ACCESSIBILITY

Khadia Expansion OCP is well connected by all-weather roads. The nearest railway station Shaktinagar is at a distance of about 2 km and Singrauli railway station on Katni-Chopan Branch Line of East Central Railway is at a distance of about 12 km from the project. The project is connected with all weathered metalled road to Shaktinagar and Renukut. The project is also approachable from the NCL (HQ) at Singrauli by a fair-weather road. The nearest town Waidhan, the Singrauli district HQ (MP) is located about 12 km to the south, Renukut (UP) is about 45 Km in the east and Varanasi (UP) is about 200 km in the north. The road connecting Renukut to Waidhan passes through the southern part near by the project colony. The nearest air-strip is at Myorpur, located at a distance of about 80 Km from Singrauli, NCL (HQ).

2.3 PHYSIOGRAPHY AND DRAINAGE

2.3.1 Physiography

The Khadia Expansion OCP lies between Krishnashila OCP on the east and Dudhichua OCP on the west. The Khadia Block stands out as a hilly plateau above the plains on its south. The plateau is pronounced by steep escarpment facing south rising from an elevation of 290 m at the base to 425m at the top of the plateau. The area on the top of the plateau is gently undulating except one hill in the north-east corner have an altitude of 490 m. The general elevation of the plateau varies from 425 to 440 m. The drainage of the area is controlled by many small seasonal nallas with southerly flow. All these seasonal nallas discharge into the Balia Nalla in the south which ultimately drains into the GBP Sagar in south.

2.3.2 Climate and Rainfall Data

The climate of the area is tropical with severe summer. The temperature in summer goes as high as 48^0C in May-June and the average minimum summer temperature is 21^0C. In winter the temperature varies from 4^0C to 21^oC (November-February). The average annual rainfall is about 1200 mm out of which about 95% of the precipitation is during rainy season from June to September.

2.3.3 Topography with Drainage Pattern of Area

The area is undulating and hilly terrain. The elevation of the plateau varies from 425m to 490m above MSL (Mean Sea Level). It stands out as a hilly plateau with elevations as high as 490m. The mining block area maintains an undulating rugged topography (RL varying from 290 m to 490 m) sloping towards south and west. The base of the plateau extends with elevation around 290m above MSL. Numerous seasonal nalas flowing from north to south and south to north drain through this area and meet the master drain the Rihand dam (Govind Ballabh Pant Sagar) which is located south of this area. The local drainage is mainly radial in nature. Tippa Jharia Nala, Motwani Nala, Balia Nala, drains this area. Tippa Jharia nala drains the Khadia (Expansion) OCP area in north and Ballia nalla drains this OCP in south and meet the Gobind Ballabh Panth Sagar

3 EXPLORATION AND GEOLOGY

The Singrauli coalfield (Latitude 23^{0}46'37" N & 24^{0}13'17" N and Longitude 81^{0}45'24" E & 82^{0}47'50" E) covering an area of 2375 sq. km is centrally located in the map of India. It constitutes the northern most part of the Son-Mahanadi master Gondwana basin. Singrauli Coalfield is divided in two parts on the basis of geological setup, namely (i) Moher sub-basin (300 sq. km, eastern part) and (ii) Main basin (2075 sq.km, western part), separated by a basement high almost parallel to the Kachan River. The Khadia block is located in the south eastern portion of Moher Sub-basin and has been named after Khadia village situated in the south of the block.

3.1 EXPLORATION ACTIVITY AND PRESENT STATUS

Geological Report on Khadia Block was published in October,1980 by CMPDI, Regional Institute-III, Darbhanga House, Ranchi, Jharkhand (prev. Bihar) on the basis of:

a) Report on the Geology and Coal Reserves of the north-eastern part of the Singrauli coalfield lying in parts of Sidhi District, MP and Mirzapur district, UP, 1964 (field session 1961-62) by GSI.
b) A note on the Exploration for coal carried out till 20th March, 1964, in UP area of Singrauli Coalfield, August,1964 by IBM.
c) A note on the Exploration for coal carried out in Karwari block UP/ MP area of Singrauli Coalfield, during 1963-64 by IBM
d) Report on the Geology and Coal Reserves of Dudhichua sector, Exploration carried out during 1970-72

3.2 GEOLOGY

PR for Khadia Expansion OCP consists Khadia Geological Coal Block, part of Ruhela Geological Coal Block and a small part of Marrak Geological Coal Block. The entire block consist rocks of Barakar formations are exposed in this block along with recent soil/alluvium cover at places. Barakar Formation consists mainly sandstone, coal and occurrence clay horizons. The generalized sequence as established by GSI and updated by IBM, NCDC and CMPDI.is given in table 3.1.

Table-3.1: The general geological sequence of North Eastern Part of Singrauli Coalfield

Group	Formation	Lithology	Thickness (m)
Damuda Group Lower Gondwana	Recent	Soil/ Alluvium Sandstone, Carbonaceous shale &fireclay	150
	Raniganj Formation	Coal, shaly coal & Cabonaceous shales (Jhingurdah Top seam)	131 to 135
		Medium grained sandstone and shale	39 to 58
		Coal, shaly coal & Cabonaceous shales (Jhingurdah Bottom seam)	10 to 15
		Sandstone, carbonaceous shale with coaly stringes	60
	Barren Measures	Medium to coarse grained sandstone with greenish shale Bands changing into red & green clay near outcrop	125
		Carbonaceous shale, sand-stone & thin coal bands Coal, shaly coal and carbonaceous shale (Panipahari Seam)	45 to 70 1to 2
		Fine to coarse grained sandstone	110 to 125
		Coal & shale	10 to 0
		Sandstone and shale Carbonaceous shale, shaly coal and coal (Purewa Top Seam)	30 to 40 8to 12 8 to 12
	Barakar Formation	Fine to coarse grained sandstone	0 to 60
		Coal Carbonaceous shale & shaly coal (Purewa Bottom Seam)	10 to 14
		Fine to coarse grained sandstone	45 to 75
		Coal, carbonaceous shale & shaly coal (Turra Seam)	14 to 23
		Fine to coarse grained sandstone	45 to 90
		Coal & shaly coal (kota Seam)	1 to 3
		Fine to coarse grained sandstone	150 to 230
	Talchir Formation	Khaki green shale & sandstone	230 -250

3.2.1 Geological Structure

Dip and Strike:- The strike is NW-SE in the west which swings to ENE- WSW in the eastern part of the area. The strike is E-W in the central part of the area. The dip generally varies from 2° to 3° (1 in 28 to 1 in 19)).

Faults/Joints: - The areas devoid of any fault. However, two sets of prominent vertical joints (NE-SW and NW-SE) and one set less prominent (E-W) joints have been observed in the area.

3.2.2 Mine Boundary Delineation

The mine boundaries of Khadia OCP Expansion have been delineated and fixed as follows:

Southern Boundary: The Southern boundary (rise side) has been fixed in the incrop zone of Turra seam.

Eastern Boundary: The Eastern boundary of Khadia OCP Expansion shares its boundary on the floor of Turra seam with Krishnashila OCP.

Western Boundary: Khadia OCP Expansion shares its western boundary on the floor of Turra seam with Dudhichua OCP.

Northern Boundary: The Northern boundary (dip side) of the Khadia OCP Expansion has been fixed considering the alignment of dragline cuts in the dip side of Khadia Geological Block.

3.2.3 Description of Seams

There is no exposure of coal within the block. The outcrops of clay occurring along with the incrops of coal seams are residual product of spontaneous combustion of the coal seams. Due to the occurrence of this clay, the incrop of coal is rather at depth depending on the depth of penetration of spontaneous combustion.

Five coal seams occur in the block viz. (i) Kota, (ii) Turra, (iii) Purewa Bottom, (iv) Purewa Top and (v) Khadia seam in ascending order. Purewa Bottom and Purewa Top Seams are fairly thick and are potential for exploitation. Other seams viz. Kota and Khadia have not been explored in detail because of its thinness, impersistent and inter-banded nature. The geological sequence of Khadia Expansion OCP is given in table3. 2.

Table 3. 2: Geological sequence of Khadia Exp. OCP

Lithology	Thickness (m)	Normal thickness
Soil and Sub-soil	0 to 8.15	0 to 1.00
Sandstone & shale	Upto74.65	
Khadia seam	0.25-1.25	0.50-0.60
Sandstone & shale	20.66-26.67	23-26
Purewa Top Seam	4.85-10.35	8-10
Sandstone & shale	30.34-43.70	32-40
Purewa Bottom seam	7.10-13.39	9-12.5
Sandstone & shale	50.78-64.28	54-61
Turra Seam	18.20-23.37	19.5-21.5
Sandstone & shale	50.73-79.69	62-70
Kota seam	0.40-2.13	1-2

Turra Seam

Turra Seam is the thickest of all the seams containing comparatively better quality coal. The immediate roof of the Turra seam is generally represented by inter banded horizons of shale, sandy shale and sandstone and carbonaceous shale. The roof of Turra seam within the incrop region is represented by clay. The immediate floor of Tura Seam is generally either shale or alternate Bands of shale and sandstone. Parting in the Turra seam overlies Kota Seam after a parting of 69m to 79.69m. The full thickness of Turra Seam including all dirt Bands varies from 18.20m to 23.37m. The dirt bands in Turra seam are represented by carb, Shale, carb, sandy shale, and sandstone varying in thickness from 0.05m to more than 2 meters.

Purewa Bottom seam

The Purewa Bottom Seam has been encountered in 54 boreholes. Out of these boreholes, full seam has been encountered in 52 boreholes and part thickness in 2 boreholes. The Purewa Bottom Seam overlies Turra Seam with a parting of 50.78 to 64.28m. The lithology of parting is mostly medium to coarse grained sandstone. The full thickness of Purewa Bottom Seam including all dirt bands varies from 7.10mto 13.39m. The full seam occurs within a depth range of 71.60m to 179.30m. Based on the available borehole data the thickness of Purewa Bottom Seam within incrop zone varies from 4.81m to 8.80m and occurs within a depth range from 76.00 m to 76.04m.

Roof and floor characteristics:

The immediate roof of the Purewa Bottom Seam is largely represented by medium to coarse grained sandstone. In incrop zone, the immediate roof is always represented by clay.

The immediate floor of Purewa Bottom Seam is represented either by alternate bands of shale and sandstone or fine grained sandstone.

Purewa Top Seam

General: The Purewa Top Seam is thinner than Turra and Purewa Bottom Seam and its incrop occurs generally on the plateau just above the escarpment. The outcrop of the seam is always burt and is represented by clay/clayey soil.

Parting: The Purewa Top Seam overlies Purewa Bottom Seam after a parting of 30.34m to 43.70m. The Lithology of parting between Purewa Bottom and Purewa Top Seams are medium to coarse grained sandstone.

Thickness: The full thickness of Purewa Top Seam including all din bands varies from 4.85mto 10.35m. In the incrop region the seam was encountered at a depth range of 35.35m to 57.85m Purewa Top Seam is fairly uniform in its thickness.

Roof and Floor Characteristics

The immediate roof of the Purewa Top Searn is exclusively represented by sandstone. Only in incrop zone the roof has been represented by clay.

3.3 PHYSIO-MECHANICAL PROPERTIES

Cores from five boreholes CMSK- 4,10,14,30 and 49 were tested for uniaxial compressive strength and tensile strength, shear strength and density. The detail of test results are given below:

Table No.-3.3 Lithological unit-wise uniaxial compressive strength,Protodyaknov Index and category of rock

Lithological unit	Average % of rock	No. of samples analyzed	Compressive Strength in Kg/cm^2		Protodyaknov strength Index as per USSR norm	Category of rock
					Normal Range	Normal range
			Range	Mean(+SD)	Maximum Range	Maximum range
1. Very coarse grained sandstone	3	19	5.83-231.14	34.58 (49.03)	0.06-0.8 2.3	I - II IV
2 .Coarse grained sandstone	56	455	3.91-389.33	60.31 (40.01)	0.2-1.0 3.9	I – II IV
3. Medium grained sandstone	7	120	3.93-279.90	93.20 (55.55)	0.4-1.5 2.8	I-III IV
4. Fine grained sandstone	3	52	45.20-616.44	121.03 (121.20)	0.5-2.4 6.2	I-III IV
5. Sandy shale	1	20	49.85-242.50	137.93 (46.61)	0-9-1.8 2.4	II-III III
6. Shale	2	34	44.38-433.07	137.15 (98.90)	0.4-2.4 4.3	I-III IV
7. Alternate bands of shale & sand stone	3	73	21 .16-537.06	230.17 (127.23)	1.0-3.6 5.4	II-IV IV
8. Carbonaceous sandy	2	41	15.99-692.91	341.23 (178.41)	1.6-5.2 6.9	III-IV IV
shale	5	128	17.08-740.07	303.66 (147.44)	1.6-4.5 7.4	III-IV IV
9. Carbonaceous shale	15	204	19.06-721.79	270.46 (156.08)	1.1-4.3 7.2	III-IV IV
10. Coal/shalyCoal	3	Nil	Soft rock			

Beside this, an approximate estimation was also done to show the horizon-wise rock and coal seam strength.

Purewa Bottom seam appears to be hardest among the three seams and Purewa Top Seam is the weakest. Similarly, floor rocks of Turra seam are comparatively hard among the other rock horizon.

Tensile Strength: The tensile strength characteristics were determined on 640 specimens of four boreholes in Khadia Block. A compiled range is given in table 4.5 along with other characteristics.

Table No.-3.4 Litho-logical unit wise tensile strengths, shear strength and density of rocks

Sl. No.	Litho-unit description	Compressive Strength Kg/cm^2	Shear Strength Kg/cm^2	Tensile Strength Kg/cm^2	Young's Modulous Kg/cm^2	Density gm/cm^3
1	Very coarse grained sandstone	5.83 - 231.14	7.97 - 7.97	0.79 - 9.50	Not-det.	1.45 - 2.31
2	Coarse grained sandstone	3.91 - 389.33	4.45 - 56.80	1.69 - 32.29		1.34 - 4.44
3	Medium grained sandstone	3.93-279.90	18.28 - 86.17	3.78 - 44.01		1.38 - 2.72
4	Fine grained sandstone	45.20-616.44	27.59 - 144.13	6.56 - 44.48		1.39 - 3.25
5	Sandy shale	49.85-242.50	10.30 - 29.71	5.74 - 14.16		1.58 - 2.76
6	Shale	44.38-433.07	4.89 - 38.78	4.89 - 38.78		1.18 - 2.58
7	Alt. Bands of shale & sandstone	21.16-537.06	8.74 - 49.03	8.74 - 49.03		1.53 - 2.38
8	Carbonaceous sandy shale	15.99-692.91	9.55 - 48.22	9.55 - 48.22		1.31 - 2.42
9	Carbonaceous shale	17.08-740.07	2.80 - 54.47	2.80 - 54.47		1.15 - 2.19
10	Coal / shaly coal	19.06-721.79	4.80 - 61.77	4.80 - 61.77		1.01 - 2.02
11	Soil / clay	Soft rocks.	-	-	-	-

It may be seen from the table that the carbonaceous shale shows the maximum tensile strength followed by carbonaceous sandy shale, alternate bands of shale and sandstone, coal and other stone. This also confirms that the rocks are generally weaker than coal and carbonaceous rocks.

Density of rock and coal

As usual the density of coal is quite less in comparison to rocks and normally varies between 1.12 gm/cm3 to1.44 gm/cm^3 . The density of rocks within the normal range reaches as high as 2.51 gm/cm^3 in fine grained sandstone.

3.4 GEOLOGICAL RESERVES

Coal seams for opencast mining have been defined considering 1 metre and above coal/shaly coal or carbonaceous shale low bands at roof and floor, despite of thicker following or preceding dirt band respectively.

Thickness and quality considered for preparation of isochore and isograde plans are inclusive of combustible, non-combustible and obvious dirt bands of less than 1 metre in thickness. Dirt bands of 1 metre and above in thickness have been added to the overburden.

Block-wise geological reserves projectized in Khadia OCP since inception is given in table below:

Table No.-3.5 Geological block-wise net geological reserves

Block Name	Net Proved Reserve (Mt)
Khadia	287.59
Ruhela	89.81
Marrak	28.77
Grand Total	**406.17**

On the basis of inter-spacing of borehole data, the estimated coal reserves have been placed under proved category.

3.5 HYDROGEOLOGICAL SETTING

Aquifer Description

The permeable formations within the Gondwanas behave as aquifer units. The three persistent thick coal seams, shales developed behave as impermeable beds i.e. aquiclude. Below the soil cover thick Barakar formations have been developed. The formation comprising mainly of alluvium, weathered sandstone and sandstone within shale lying above top most working coal seam- Purewa Top behaves as unconfined aquifer. Whereas, lower formations consisting of compact sandstone with secondary porosity behave as semi-confined to confined aquifer.

In the unconfined aquifer groundwater moves laterally through the inter-granular pore spaces in the sandstone. Whereas in lower aquifers the groundwater movement is restricted mainly through joints and fractures (i.e. secondary porosity) developed. With the presence of intercalated shale and carbonaceous shale beds and reduction in permeability with depth, the lower aquifers are poor in potential. The deeper aquifers are divided into multi aquifer system due to the presence of clay, shale beds and persistent impervious thick Coal seams (i.e. Purewa Top and Purewa Bottom and Turra seam). The deeper aquifers behaves as unconfined aquifers at the outcrop region.

The water table configuration in the unconfined aquifer is conforming to the local topography. A ground water divide is running across the centre of the area from west to east more or less following the high ground of coal mining projects. A flat water table with a gradient of 7.6 $x10^{-3}$, slopping towards south east and east has been observed in the area. The aquifer units present above the working coal seams are the major sources for inflow into present and the proposed mine workings. With the presence of shale and compaction, the seepage from Mine floor may be considered as negligible.

Recharge and Discharge zone

The emergence of water table contour in higher altitude area and their sloping towards the low lying areas (*i.e.* GBP Sagar) indicate that the high altitude area (north and northeast of the project) is acting as recharge zone for unconfined aquifer and low lying areas (GBP Sagar) located in the east and south of Khadia project act as a discharge zone. The core area of project also acts as discharge area for underlying semi-confined aquifer by losing its water through fractures, faults, etc.

Ground Water Level Monitoring : Sampling Location and rationale

For ground water level monitoring of Khadia OCP, a network of 63 nos. existing dug wells has been identified by CMPDI. NCL has also established, 6 Nos Piezometers (3 Nos Shallow and 3 Nos Deep Piezometer) in the core zone of the project.

The seasonal water level of the established hydrographic monitoring stations and Piezometers has been carried out four times a year in pre-monsoon, monsoon, post-monsoon and winter seasons. The water levels are measured through measuring tape below ground level from the marking point for dug wells. For piezometers, electronic water level sounder is used to measure water level from marked measuring point.

The monitoring reveals that from the period Nov'16 to Aug'20, the water levels during Pre-Monsoon varies from 1.18 m.bgl (2017) to 14.20 m.bgl (2019), Monsoon varies from 0.13 m.bgl (2017) to 14.40 m.bgl (2017), Post-Monsoon it varies from 0.55 m.bgl (2019) to 15.60 m.bgl (2016) and during Winter it varies from 0.74 m.bgl (2017) to 14.10 m.bgl (2017) in the monitored Dug wells.

A detailed Aquifer Performance Test (APT) was carried out in the Jayant Block by Russian experts for confined aquifer between Purewa Bottom and Turra seam in 1975 (As per the Hydrogeological chapter incorporated in Geological report of Jayant block). The hydraulic conductivity was found to be 0.13 to 0.15 m/day.

Another hydrogeological investigation carried out by CMPDI in the nearby Kakri Project reveal that the hydraulic conductivity and permeability of the aquifer system lying above the working seams are 82 m/d and k=1.0 m/d respectively.

3.5.1 Likely Impact on Ground water

It is generally observed that the trend of water table contours, its gradient and configuration are mainly controlled by topography, drainage pattern, rainfall, geologic controls and induced flow of ground water towards mine excavation.

Mining is associated with groundwater problems, particularly when it is below water table. The impact of mining on groundwater is mainly dependent on parameters of mines and aquifers, groundwater recharge-discharge processes etc. In opencast mining, the unconfined aquifer and the semi-confined aquifers are get affected due to continuous gravity drainage and conventional sump pumping for efficient and safe working.

4 PROJECT STATUS, MINING METHODOLGY AND TECHNOLOGY (AS PER PR)

4.1 STATUS OF EXISTING OPERATIONS

The minefield is being worked in two sections namely East Section and West Section with a central haul road located on the floor of Turra seam. Overburden has been dumped in internal dumps in both the sections.

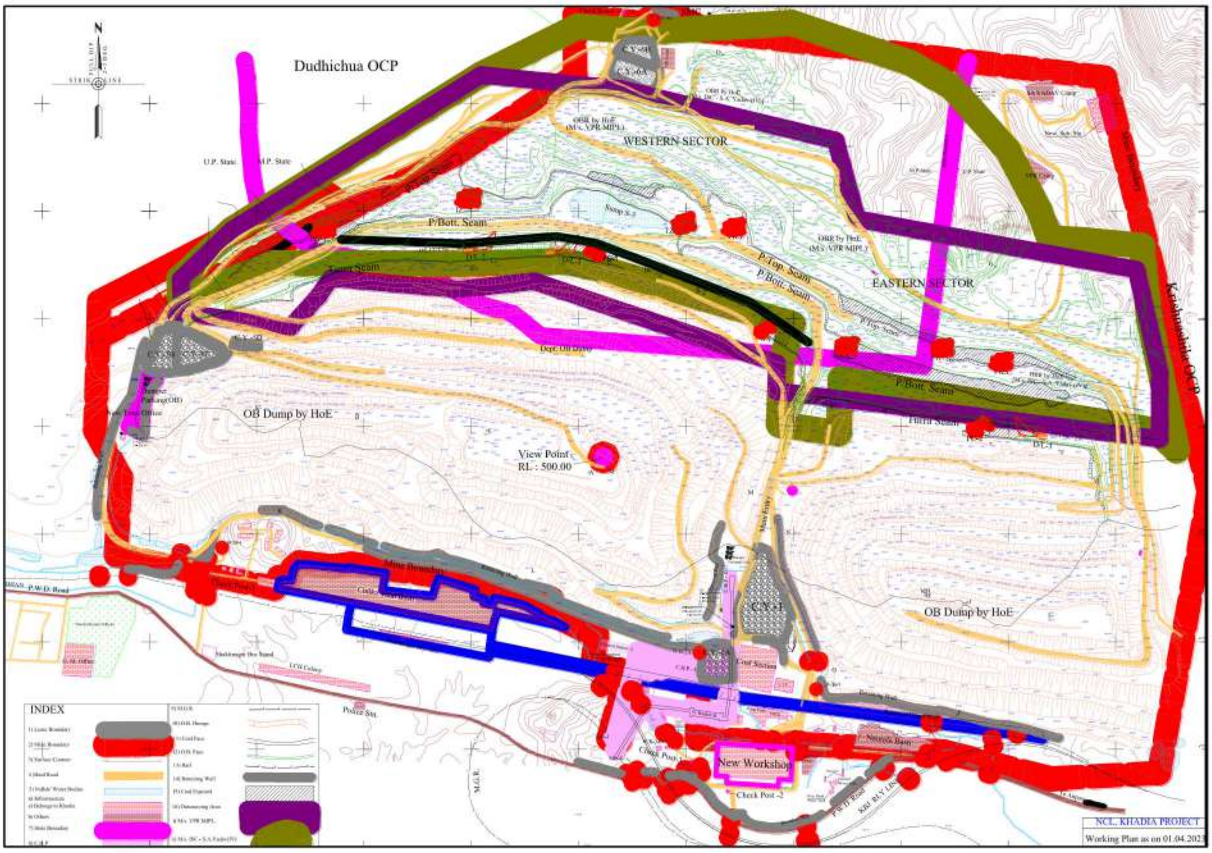


Figure: 4.1 Present working plan of Khadia OCP

Currently, the mine is being worked by Departmental equipment and Hiring of Equipment HoE/Outsourcing.

West Section:

Top OB up to Purewa top seam is handled by HOE. Overburden between Purewa top and Purewa Bottom seam is handled by departmental shovel dumpers. OB above 30-32m of Tura Seam in west section is handled by two Draglines.

East section:

Only 30-32 m of OB above the Tura seam is being handled by dragline , and rest of the part in East section is handled by HoE.

The current workings of the mine are presented in the Working Plan drawing (provided by the mine authorities) showing the benches, dumps, sumps, haul roads, public roads, location of mine infrastructure, underground workings etc.

With due consideration to geo-mining characteristics of the deposit, the mine is proposed to be worked by combined system of mining using dragline and shovel-dumper combination. All the OB of expansion area are dumped in internal dumps in both the sections. Total Turra seam Coal and part of Purewa Bottom seam coal in both sections is proposed to be extracted by shovels and transported to receiving pits/coal stockyards by 100 T Rear Dumpers. Total Purewa Top seam coal and part of Purewa Bottom seam coal in both sections is proposed to be extracted by Surface Miner but it is being extracted by shovels as on date loading and transportation of coal by outsourcing means. The detailed existing equipment is given below sections.

4.1.1 Production Phasing

The Khadia Expansion OCP (16 Mtpa) has been planned to achieve its target production capacity of 16 Mtpa of ROM Coal in the year 2024-25 i.e. 5th year of quarry operation considering 2020-21 as Yr-1. The production programme up to achieving the rated capacity is given below:

Table: 4.1 Production Phasing from Zero date upto target year

Year of Production		Coal Production (Mtpa)	OB Removal (Mm^3)	SR (m^3/t)
Yr-1	2020-21	14.0	57.28	4.09
Yr-2	2021-22	14.0	57.28	4.09
Yr-3	2022-23	14.0	57.28	4.09
Yr-4	2023-24	15.0	59.69	3.89
Yr-5	2024-25	16.0	59.90	3.74

The combined coal production and overburden removal by departmental means and outside agency for last 6 years of Khadia OCP is given below:

Table 4.2 Coal and OB removal in the last 8 years

Year	Coal (Mt)	OB (Mcum)
2016-2017	6.006	24.67
2017-2018	8.8	39.31
2018-2019	11.40	44.56
2019-2020	13.183	39.62
2020-2021	14.00	49.28
2021-2022	14.00	51.68

4.2 BROAD PARAMETERS OF THE MINING PLAN

The PR for Khadia OCP (10 Mtpa) was prepared mainly in Khadia Geological Block and partly in Ruhela Block. The PR for Khadia Expansion OCP (16 Mtpa) has been envisaged with the inclusion of balance reserve of existing Khadia OCP (10 Mtpa) as on 01.04.2020, dip side reserves of part of Ruhela Geological Block and eastern side reserves of small part of Marrak Geological Block of Moher Sub-basin of Singrauli coalfield. The existing mine working plan of Khadia OCP is as given in figure 4.1 above

4.2.1 Mining Method

The method of mining proposed to extract coal and OB in Khadia Expansion OCP will be open cast mining deploying dragline and Shovel-Dumper combination in OB Removal and Shovel-Dumper as well as Surface miner in coal winning. However, there is no surface miner is deployed in the current operations. Combined system of Mining Deploying Draglines and Shovel-Dumpers is being practiced.

4.2.2 Mine Boundaries

The Boundaries of Khadia Expansion OCP (16Mtpa) have been delineated and fixed as follows:

i) Southern Boundary: (Rise side) The southern boundary of Existing Khadia OCP as on 01.04.2020, forms the southern boundary of proposed Khadia Expansion OCP;

ii) Western Boundary: The western boundary has been fixed considering common boundary on the floor of Purewa Bottom seam with eastern boundary of Purewa Bottom Seam of Dudhichua OCP (20 Mtpa) within sanctioned area of Khadia OCP (10

Mtpa) and in the rest of the dip side area western boundary has been fixed considering leaving a barrier of 7.5m with common mine lease hold boundary with adjoining Dudhichua OCP (20 Mtpa) on the surface and accordingly Turra seam floor has been delineated;

iii) Northern Boundary: (Dip side) The northern boundary has been fixed considering leaving a barrier of 7.5m with common mine leasehold boundary with adjoining Bina-Kakri Amalgamation OCP on the surface and accordingly Turra seam floor has been delineated;

iv) Eastern Boundary: The eastern boundary has been fixed considering leaving a distance of 7.5m from common mine leasehold boundary with adjoining Krishnashila OCP on the surface and accordingly Turra seam floor has been delineated;

the existing Khadia OCP boundaries have been extended in the dip side by adding the part of Ruhela Geological Block and a small part of Marrak Geological Block in the eastern side for exploitation of coal in the proposed Khadia Expansion OCP (16 Mtpa). The Final Stage Quarry boundary has been shown below

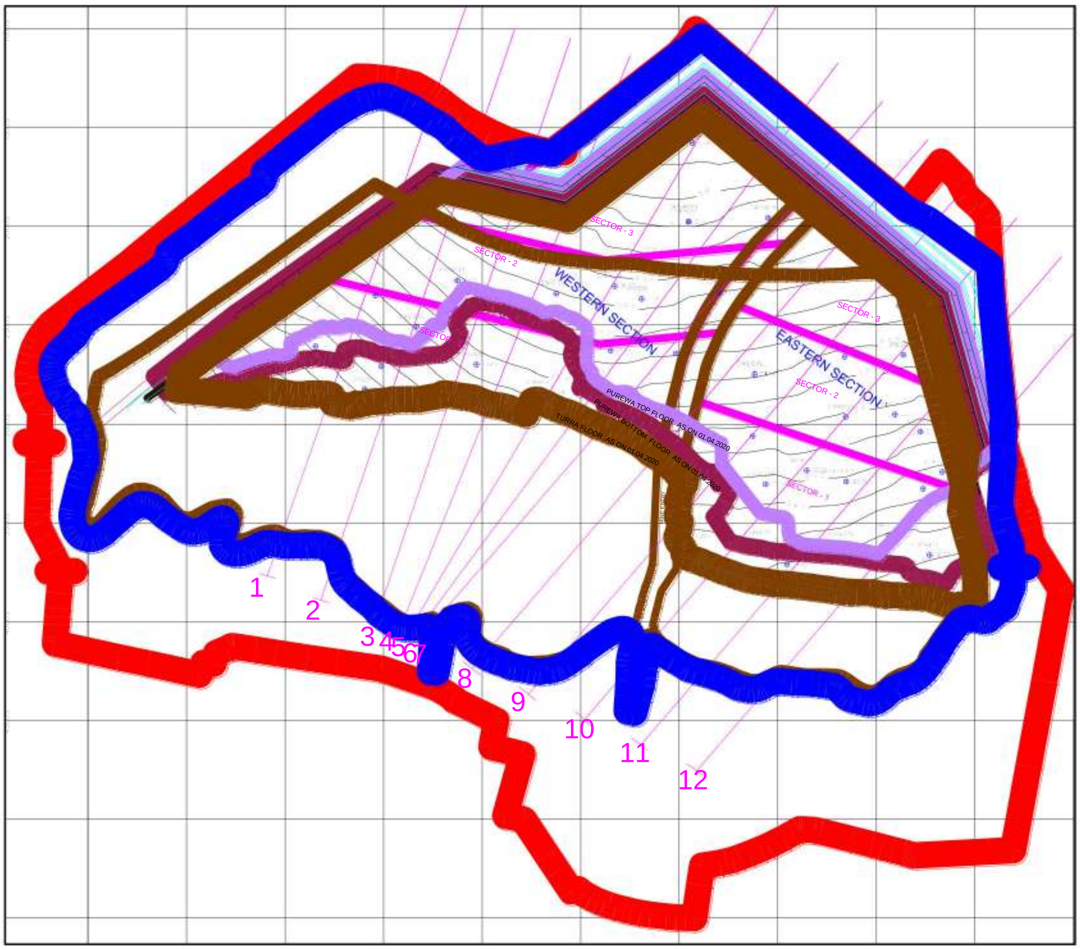


Figure 4.2: Final Stage Plan (As per Mining Plan)

4.2.3 Sequence of Mining

The minefield is being worked in two sections namely East section and West section. It is proposed in PR that PR for Khadia Expansion OCP (16 Mtpa), East and West sections are to be worked simultaneously with the deployment of 2 Nos. of 20m3/83mR Draglines in tandem operation in west section and 1 No.33m3/72mR in East section with central sump located near the central haul road. Both the sections are advancing from rise to dip simultaneously.

The same sequence is continued in the proposed stage also. Presently, the working of West section is leading and East section is lagging.

Considering the flat dip (2o-3o) of the seams, it is proposed to excavate the OB from advanced benches by inclined layers parallel to the seam roof. This system eliminates the need to cut new horizons from the roof of seam and simplifies water drainage from the benches to the central sump

4.2.4 Geo-Mining Parameters

Table 4.3 Quarry Parameters

Quarry Parameters		Eastern Section	Western Section
Maximum Strike length of quarry along Turra Seam Floor	Km	1.49	2.08
Maximum Strike length of quarry along Surface	Km	1.60	2.20
Dip-rise width of the quarry on Turra Seam floor	Km	1.76	1.78
Dip-rise width of the quarry on Surface	Km	2.03	2.10
Maximum depth of the quarry from surface	m	250	275
Final quarry surface area	Sq. Km	3.50	6.45

Table 4.4 Description of Coal Seam proposed to be worked

Coal Seam	Effective Seam Thick-ness Range (m)	Thickness/ Parting Thick-ness (m)
Purewa Top	3.75-10.35	37.55- 117.60
Purewa Bottom	5.60- 13.39	30.34- 43.70
Turra	14.57- 22.56	50.78- 64.28

4.2.5 Mining System & System Parameters

Elements of mining system have been determined in accordance with the parameters of excavation, transport equipment and the parameters of drilling and blasting. The minefield is being worked in two sections namely East Section and West Section with a central haul road located on the floor of Turra seam.

Presently, two Nos. of 20m3/83mR Draglines and one No. of 33m3/72mR Dragline are deployed for excavation of OB bench above Turra Seam in both the sections. 2 Nos. of 20m3/83mR Draglines in tandem operation are deployed for excavation of OB bench above Turra seam in west section and 1 No. of 33m3/72mR Dragline is deployed for excavation of OB bench above Turra Seam in East section. This is in line with the proposed system in the PR.

In the PR it is proposed that, the height of main OB bench over Turra seam are to be sidecast by Dragline in the previous decoaled cut would vary from 30m to 38m at production level of 16 Mtpa. The Dragline cut width adopted is 65m in East section and 70m in the West section. With two-way traffic along the bench, the width of the Shovel-Dumper OB working bench would vary from 55m to 61m and 35m for non-working OB bench.

Persistent in-seam bands of thickness 1m and above present in Turra coal seam is proposed to be mined separately by Shovel-Dumper provided for coal winning.

Table 4.5 System Parameters

SL. No.	Particulars	Unit	Overburden		Coal
			D/L	Shovel	
1	Bench Height	m	40-45	15-18	10-15
2	Working Bench Width	m	70	55-60	45
3	Non-working Bench Width	m	70	35-40	25
4	Bench slope	Deg.	70	70	80
5	Blast Hole Dia.	mm	311	250	160
6	Inclination of Boreholes		Inclined	Vertical	Vertical
7	Powder Factor		0.6	0.3	0.2

The width of cut for coal benches has been adopted as 10-15m. The width of working bench in coal seam has been considered as 35-70m while width of non-working benches has been kept at 25m. The slope of each bench is proposed as 70^o in OB and 80^o in coal. But the overall running slope in working faces are about 18^0-19^o.

The above mining system and system parameters have been proposed in PR for departmental HEMM deployed for coal winning and OB removal

Mining System parameters for outsourcing of OB as proposed in depends upon the size of HEMM deployment

OB Dump Benches

Bench height of OB dumps formed by Shovel-Dumper system will be 30m and slope of individual dump benches will be 37^o (equal to angle of natural repose of OB material). Width of berm between two adjacent benches will be 40m. Overall slope of dump works out to be 28^o

4.2.6 Balancing Diagrams for Dragline Combination

The dragline balancing diagrams for 70m cut width at different bench heights for the working of 2 Nos. of 20m^3/83mR draglines in tandem operation for single bench blasting have been drawn and presented in the PR for Khadia Expansion OCP (16Mtpa) and The dragline balancing diagrams for 65m cut width at different bench heights for the working of 1 No. of 33 m^3/72mR dragline for single bench blasting have been drawn and presented in the PR for Khadia Expansion OCP (16Mtpa).

The coal exposure, dragline load along with the quantity of re-handling for different bench heights are given in Table No.6.4 and 6.5.

Dragline deployment scheme with single bench blasting as envisaged in the PR for Khadia Expansion OCP (16Mtpa) is being presently practiced

The dragline deployment scheme envisages leaving of coal rib in the balancing diagrams as per permission of DGMS. It is suggested to extract the coal rib to the extent possible while coming back after finishing the cut so that there is no chance of accumulation of water against the coal rib causing hydraulic thrust on the dump.as suggested in PR.

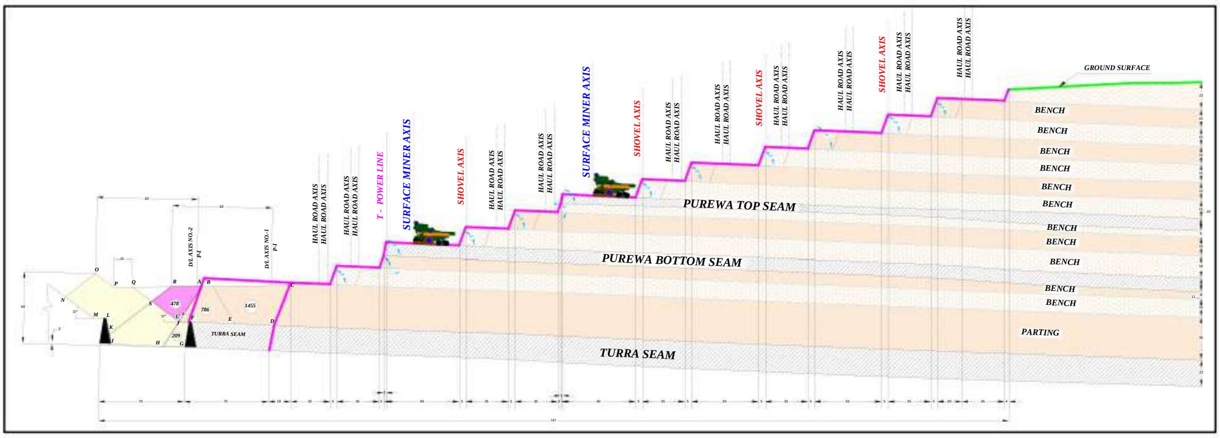


Figure 4.3 Proposed System parameters in west section as per PR

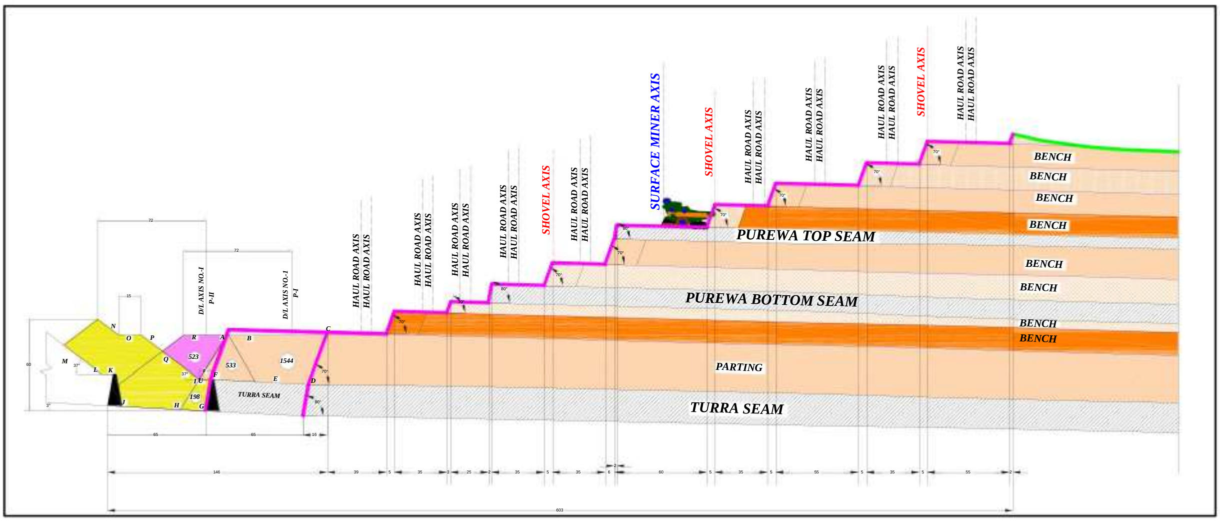


Figure 4.4 Proposed System parameters in East section as per PR

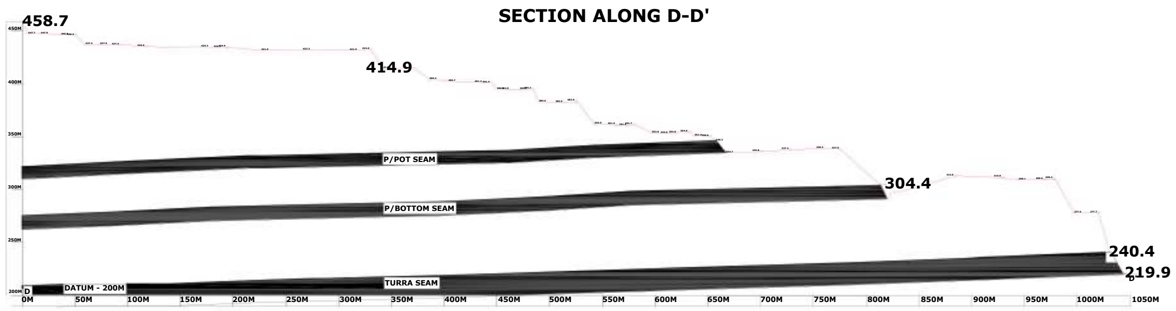


Figure 4.5 Bench parameters along West section –Existing

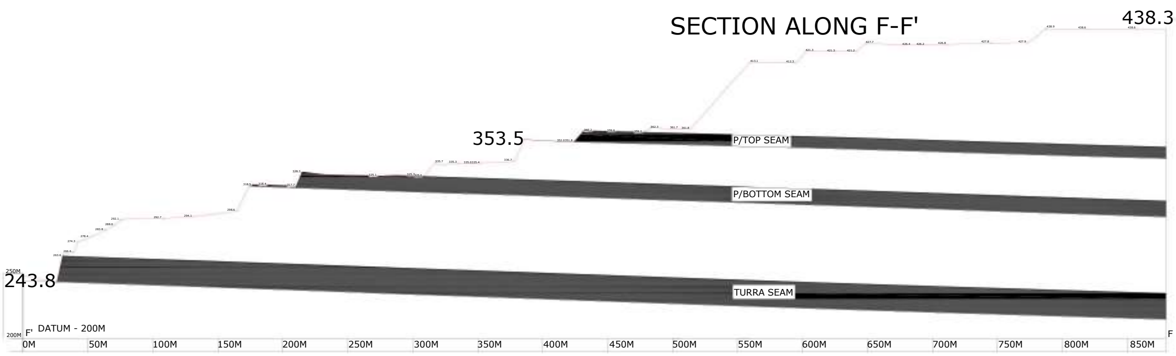


Figure 4.6 Bench parameters along East section –Existing

As per the working plan as on 01-04-2023 provided during the site visit, the existing system parameters are in line with the proposed parameters in some patches/ benches. Bench geometries are deviated with those as proposed in PR. There is no surface miner deployment as proposed in PR

4.2.7 Equipment Provisioning

A combined system of mining with the use of Dragline and Shovel-Dumper combination for OB removal and Shovel-Dumper & Surface Miner combination for coal winning is the most suitable option for the project as Indicated in the PR.

The Two options have been suggested in PR as given below:

Option-I: Departmental (Sanctioned10 Mtpa + Incremental 6Mtpa coal winning by Departmental Surface Miner & Loading and transportation by outsourcing means and incremental OB Removal by Departmental HEMM)

Option-II: Partial OB Outsourcing (Sanctioned10 Mtpa+ Incremental 6Mtpa coal winning by Departmental Surface Miner & Loading and transportation by outsourcing means and incremental OB Removal by Outsourcing). In both the options, coal winning has been proposed departmentally.

For selection of size and population of departmental HEMM, the parameters that should be considered are

- Existing population of HEMM,
- Existing method of mining, ,
- Geo-mining characteristics of the deposit,
- Annual workload,
- Equipment deployment and equipment life.
- General technology-culture, standardization of equipment

Based on the above selection criteria and keeping in view of the Geological and Mining parameters of working quarries of Khadia OCP, the deployment proposed as per PR (in partings, seams, etc.) of the selected equipment is given below.

Table: 4.6: Major HEMM Deployed

Major HEMM Deployed for Coal winning						
HEMM	Cap/ Size	Existing (Upgraded) (10Mtpa)	Option-I		Option-II	
			Incre-mental (6Mtpa)	Inte-grated (16Mtpa)	Incre-mental (6Mtpa)	Inte-grated (16Mtpa)
Surface Miner	4000mm		2	2	2	2
Diesel Hyd. Shovel	10-12m3	4		4		4
Rear Dumper	100 T	28		28		28
RBH Drill	160 mm	6		6		6
Dozer	410 HP	4		4		4

Major HEMM Deployed for OB Removal						
Dragline	20m3/83m R	2		2		2
Dragline	33m3/72m R	1		1		1
Elect. Rope Shovel	20 m3	3	5	8		3
Dumper	190 T	21	33	54		21
RBH Drill	311 mm	3		3		3
RBH Drill	250 mm	5	6	11		5
Dozer	850 HP	7	4	11		7

Against the proposed deployment in the PR the following departmental and outsoursed HEMM are being deployed as on August 2023 at Khadia OCP.

Table 4.7: Existing List of Departmental Major HEMM deployed at Khadia Project as on August 2023

S.No	Equipments	Capacity	Quantity	
1	Dragline	33/72	1	3
2	Dragline	20/90	2	
3	Electric Rope shovel	20 Cum	1	5
4	Electric Rope shovel	10 cum	4	
5	Hyd. Shovel	11.5 cum	2	
6	Pay Loader	10.7 cum & 6.5 cum	2	
7	PC	3.8 cum & 3.5 cum	2	
8	Rear Dumper	190T	7	58
9	Rear Dumper	100 T	50	
10	Rear Dumper	85T/100T	1	
11	Drill	311 mm, 250 mm & 160 mm	13	
12	Dozer	850 HP, 450 HP & 410 HP	7	

Table 4.8: Existing List of equipment (HOE) of M/S S A Yadav (JV) as on August 2023

S.No	equipment	Capacity	Quantity	
1	PC	3.1 Cu.M	16	
2	Tipper	20.2 Cu.M	15	90
3	Tipper	22 Cu.M	51	
4	Tipper	24 Cu.M	15	
5	Tipper	18 Cu.M	9	
7	Dozer	160,200&175 HP	7	
8	Grader	145 HP	4	
9	Loader	160 HP	3	
10	Drill	130 HP & 140 HP	4	

Table 4.9: Existing List of Equipment of equipment (HoE) of M/S VPR-MIPL as on August 2023

<table>
<tr><td>S.No</td><td>Equipments</td><td>Capacity</td><td colspan="2">Quantity</td></tr>
<tr><td>1</td><td>PC</td><td>3.1 Cu.M</td><td colspan="2">20</td></tr>
<tr><td>2</td><td>Tipper</td><td>18.8 Cu.M</td><td>6</td><td rowspan="3">114</td></tr>
<tr><td>3</td><td>Tipper</td><td>20.2 Cu.M</td><td>73</td></tr>
<tr><td>5</td><td>Tipper</td><td>18 Cu.M</td><td>35</td></tr>
<tr><td>7</td><td>Dozer</td><td>200 HP</td><td colspan="2">12</td></tr>
<tr><td>8</td><td>Grader</td><td>145 HP& 200 HP</td><td colspan="2">4</td></tr>
<tr><td>9</td><td>Loader</td><td>180 HP</td><td colspan="2">2</td></tr>
<tr><td>10</td><td>Drill</td><td>130 HP</td><td colspan="2">4</td></tr>
</table>

On the basis of geo-mining characteristics of the deposit, mining system parameters like slope of the quarry batter, bench height, bench width, dump height, final dump slope and slope of the working benches have been decided. Design of mining system has been done considering technical parameters of HEMM and safety guidelines of Directorate General of Mines Safety (DGMS).

However, during mine operations, the safety rules, regulations and various circulars issued by DGMS should be strictly followed and adhered to. The parameters of benches and deployed equipment should be in line with the DGMS guidelines in departmental as well as outsourced patches.

4.2.8 Excavation, Transport & Dumping

OB Excavation

All the OB benches above dragline bench horizon is to be excavated by 20m^3 Elect. Rope Shovel. The OB immediately above Turra Seam roof will be sidecast by using 2 Nos. of 20m^3/83mR Draglines working in horizontal tandem in west section and 1 No. of 33m^3/72mR Dragline in East section.

The height of main bench over Turra seam excavated by draglines varies according to the requirement of coal exposure from Turra Seam. 30-38 m bench height at production level of 16 Mtpa has been proposed for dragline working. The dragline cut width is adopted as 70m in west section and 65 m in East section.

The balance OB above Dragline bench has been proposed to be excavated by 20m3 Elect. Rope Shovels working in conjunction with 190-210T Rear Dumpers.

the upper OB benches are proposed to be worked by 20m3 Elect. Rope shovels working in conjunction with 190-210 T Rear Dumpers and balance OB have been proposed to be outsourced in Option-II of the PR

OB Transportation

For OB transportation, 190-210T rear dumpers are proposed to be deployed , However, for partial OB outsourcing option (Option-II), the lead will vary from year to year and therefore, fresh assessment of lead will have to be done on year to year basis for finalization of rate of OB transportation.

OB Dumping

The main OB bench overlying Turra seam is to be removed by dragline system and proposed to be side cast in the decoaled cut. The OB from upper benches is being handled by Shovel-dumper system and accommodated over the dragline side cast spoil within the pit.

The volume of OB (including in-seam band) to be handled as per PR of Khadia Expansion OCP as on 31.03 2020 is 844.0 Mm3, out of which 156.35 Mm3 OB will be directly sidecast by draglines including throw blast of 13.35 Mm3 in the decoaled cut and balance 687.65 Mm3 is proposed to be removed and dumped by shovel-dumper system in the internal dumps in both the sections.

The mine is being worked since 1981-82 and 487.66 Mm3 of OB has already been dumped in external/internal dumps since inception till 31.03.2020. The final stage dump plan shows that apart from existing dump volume of 487.66 Mm3, further 844.0 Mm3 will be accommodated in the internal dumps in both the sections

Shovel-dumper spoil dumps will be formed in benches of 30m in height. For the formation of dumps and leveling of dumps, 850 HP and 410 HP dozers have been envisaged.

The Tier-wise OB volume of internal dumps is given below:

Table No.4.10 Tire wise OB volume of internal dumps

Sl. No.	Tier (RL)	Volume (Mm^3)
A	**EAST SECTION**	
1	Dragline Dump	66.65
2	Upto 290 & 290-320	69.00
3	320-350	45.12
4	350-380	41.40
5	380-410	34.43
6	410-440	28.90
7	440-470	20.97
8	470-500	12.95
9	500-530	6.90
TOTAL EAST (A)		**326.32**
B	**WEST SECTION**	
1	Dragline Dump	89.70
2	Upto 270 & 270-300	78.78
3	300-330	60.08
4	330-360	57.36
5	360-390	53.26
6	390-420	46.91
7	420-450	44.16
8	450-480	39.98
9	480-510	29.16
10	510-540	18.29
TOTAL WEST (B)		**517.68**
GRAND TOTAL (A+B)		**844.00**

Since inception, 487.66 Mm3 of OB has already been dumped in internal/external OB dumps of the mine. Apart from the above OB, the volume of OB estimated in the PR (16Mtpa) is 844.0 Mm3, which will be accommodated in internal OB dumps in both the sections. The final stage dump plan has been reproduced below.

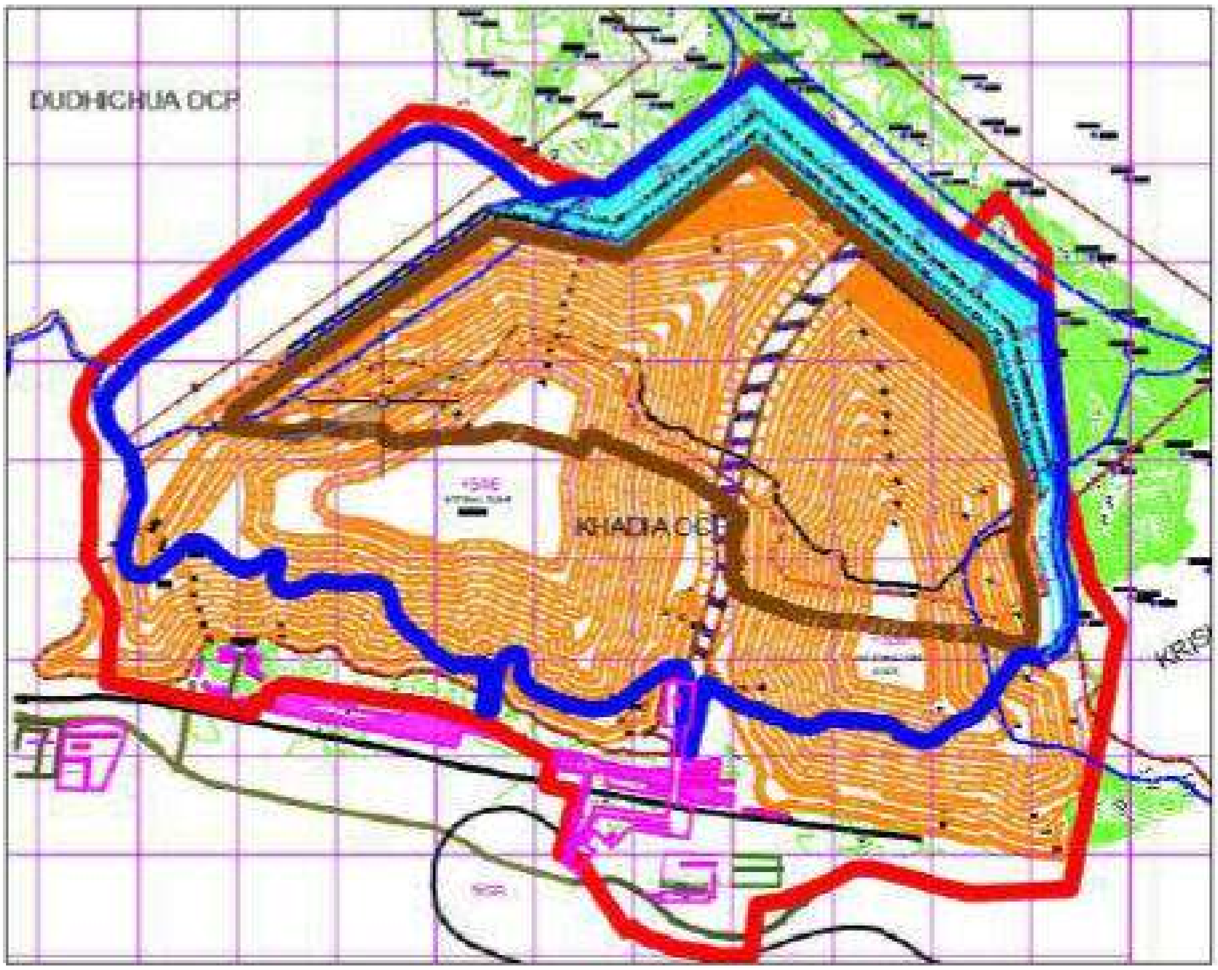


Figure: 4.7: The final stage dump plan

OB Dump Benches

Shovel-dumper spoil dumps are proposed to be formed in benches of 30m and slope of individual dump bench will be 37 (equal to angle of natural repose of OB material). The width of berm between two adjacent benches will be 40m. Overall slope of dump works out to 28. Top soil wherever available is proposed to be stacked separately which will be used up for spreading over the completed OB dumps. The Tier-wise OB volume of internal dumps is given in table 4. There are deviations observed in the current bench geometries in comparison with the those proposed in khadia expansion PR.

4.2.9 Elements of Drilling and Blasting:

The elements of drilling and blasting are decided during actual operation after trial blasting in the field. Controlled blasting is being practiced near project boundary. However, drilling of coal & OB benches is recommended to be done vertically at 90^0.

It is suggested to use slurry explosive in cartridge / site mixed slurry for better result and enhance safety with proper stemming material. Secondary blasting is not suggested in any circumstances.

4.2.10 Sump and Drainage

The planning of de-watering of the mine has been done in such a way that as far as possible the working faces and haul roads remain dry. The layout of the quarry provides suitable gradient along the quarry floor and the benches to facilitate self-drainage of water to the lowest level of the quarry.

Khadia Block stands as hilly plateau above the plains in the south, a steep escarpment faces the southern part of the plateau rising from elevation of 290 m at the base to 425 m at the top of the plateau. The plateau surface is gently undulating. In the north–east corner the area rises to an altitude of 490 m. The general elevation of the plateau varies from 425 to 440 m.

The entire pumped out water will be discharged near the mine entry where from water will be drained to nearby its natural gravity.

Within the quarry, the alignment of dragline cut is so planned that most of the water from the flanks will flow into the central sump due to gravity. From the central sump, the main pumps will pump the water out of the mine.

4.3 SAFETY MANAGEMENT

Safety of men and machine deployed in the mining area should be properly taken care of irrespective of whether the mining activities are performed by departmental or by outsourcing means.

All the statutory provisions laid down in The Mines Act 1952, Coal Mine Regulation 2017 and specific permission from DGMS relating to mining in general and opencast mining in particular have to be adhered to and implemented in order to maintain day to day safety.

4.3.1 Safety aspects for of HEMM / equipment

Special precaution should be taken while deploying workers in the mine. Before employing any person to the mine proper vocation training should be imparted and recommendations of various Safety Conferences should be strictly followed.

4.3.2 Stability of Benches, Quarry Highwalls and Spoil Dumps:

During quarry operations, it is necessary to adopt required mining parameters for the stability of benches, highwalls and spoil dumps. It is also mandatory to examine systematically the fencing of mine workings, landslides and cracks between benches. It is required to maintain well-graded and wide roads on benches keeping the width of working areas sufficient for spreading of blasted rock and movement of the mining and transport equipment.

- During actual mining operation, systematic observations of the condition of benches, high wall slopes and spoil dumps should be carried out and the dimensions be modified if necessary, to suit the local conditions.
- During actual mining operation, systematic observations of the condition of benches, high wall slopes and spoil dumps should be carried out and the dimensions be modified, if necessary to suit the local conditions.
- Provisions laid down in Reg. 106 and 108 of the Coal Mines regulation 2017 shall be strictly adhered to for the safety of quarry and OB/ spoil dumps. Further all related / relevant DGMS Technical Circulars shall also require to be considered during the mine operations. In addition to above, the following precaution should also be taken:
- The individual dump bench should not exceed 30m and overall spoil dump height should not exceed 90m with an overall slope of 28^0 or less. In the event of encountering steep floor gradient, floor blasting should be done and the area properly levelled by dozer before spoil dumping in addition to creating a toe wall to arrest falling boulders/rocks.
- No working or construction should be allowed within the 100m toe of the OB dump.
- Before dumping the OB on the floor of seam if required, at least 10m width all along the strike length should be made horizontal at every 50 meters by floor ripping/blasting.

- Dump should be created in such a way that there is no chance of accumulation of water in and around the top and base of dump as it could adversely affect the shear strength of the base material of dump
- The toe and face of the dump should not be eroded or cut at any point of time to avoid slope failure. A suitable toe wall should be created along the dump periphery.
- Formation of dumping should be done in square or circular or any regular shape as far as possible.
- Proper drainage system should be provided to bring down rain water by construction of inclined drain on dump face and catch drain on all benches.
- During active period of dump, all rain water should be diverted away from mining site as far as possible.
- Sump and pumping capacity should be sufficient to accommodate peak surface run-off and seepage of water.
- Gabion wall and garland drain should be constructed and maintained to trap the surface run-off and sludge coming from dump.
- Plantation and grassing should be done on top and slope of the dump respectively.
- Regular monitoring is required for development of tension crack, gullies, movement of soil mass, stagnation of water and any other unusual occurrence. In case of dump movement, rate of movement of dump should be monitored. Special attention should be given at curve area/turning area of the dump.

4.3.3 Precautions Against Danger of Inundation from Surface Water:

- Adequate protection against any danger of inrush of surface water into the mine or part shall be provided and maintained to the satisfaction of DGMS, whose decision shall be final.
- The entrance into the mine shall be so designed, constructed and maintained that its lowest point (which means the point at which a body of rising water on

surface can enter the mine) shall be not less than 3.0 meters above the highest flood level at that point.

- Every year, during the rains constant watch shall be kept on the flood levels on the surface of the mine and if at any time the levels cross the highest levels earlier recorded, such levels shall be marked by permanent posts along the edges of water and the new highest levels thus observed shall be recorded with the date as the highest flood level on the plans by an actual survey.
- If water dams or reservoirs are built across rivers and water courses on the upstream side of the mine, arrangements shall be made for communication between appropriate authorities for the purpose of ascertaining the quantity and timing of water released from the dams which is likely to endanger safety of the mine and arrangement for similar communication shall be made when water level rises on the upstream side which is likely to endanger the mine.
- The highest flood levels and danger levels at least 1.2 meters below the highest flood level, shall be permanently marked at appropriate places on the surface and whenever water rises towards the danger level at any place, all persons shall be withdrawn from the mine sufficiently in advance and for this purpose adequate arrangements of quick communication to all parts of the mine by effective systems shall be provided and maintained.
- No working shall be made in the mine at any spot lying within a horizontal distance of 15 meters from either bank of a river or nala.
- A competent person shall, once at least in every fourteen days during the rainy season and once at least in every thirty days during other periods of the year, examine every protective measure provided under regulations 149, whether in use or not, for their stability, and a report of every such examination shall be recorded. The protective measures and workings shall also be inspected, once at least in every quarter by the Manager personally.
- A careful assessment is to be made against the danger from surface water before the onset of rainy season. The necessary precautions should be clearly laid down and implemented. A garland drain needs to be provided to drain away the surface rainwater from coming into the mine.

- Inspections for any accumulation of rainwater, obstruction in normal drainage and weakening in the embankment should be made.
- Standing order for withdrawal of working persons in case of apprehended danger. During heavy rain inspection of vulnerable points is essential. In case of any danger persons are to be withdrawn to safer places for Protection of Equipment Deployed at bottom horizons from flooding.
- During the heavy monsoon period, the mining operation in the lower-most bench may have to be stopped. Therefore, it is proposed to drown the lower-most bench, which would work as a sump. The water will be pumped out and discharged into the nearby nala/ river after proper sedimentation.
- For ensuring safety of the equipment while working out bottom horizons with no access to surface profile, the following measures should be taken:
- Drivage of initial trenches if any and coal cutting on bottom benches should be done during the dry period of the year.
- Ramps should be made for quick shifting of equipment from bottom horizons, liable to be flooded during monsoon period, to the top horizons.

4.4 SLOPE MONITORING AS AN INTEGRAL PART OF MINE PLANNING

Monitoring is indispensable way to safeguard loss of mine and machinery from slope failure.

Every slope is subjected to movement. The monitoring methods are generally based on displacement of slope mass. It is crucial to judge the change of displacement or velocity which may be critical. A critical review of the available literature by the many researchers reveals that, a significant component of the slope stability surveillance plan should involve regular inspection of the bench faces and crest areas to promptly detect any signs of potential slope instability.

Ideally, these routine inspections should be carried out by the same individual to ensure consistent observations over time.

The primary objectives of monitoring the waste dump and mine slope are as follows:

- Sustain safe operational conditions.
- Offer insights into the mechanisms causing instability.
- Provide early alerts for emerging instability.

- o Measure displacements and their rates.
- o Establish and uphold a record of facility performance.

The findings from monitoring need to be meticulously documented in either a diary or a computer system. This documentation is essential to maintain a historical record of the stability performance for every stage of pit development. The frequency of monitoring should be adjusted based on factors such as slope stability, time of year, mining rate, and the specific mining activities conducted in the open pit.

During both summer and winter months, the slope monitoring prisms should be surveyed on a monthly basis, assuming visual inspections indicate stable slopes. However, during the rainy season, the frequency should be escalated to weekly surveys. Intensive slope monitoring will only be necessary when mining operations are being carried out in proximity to unstable sections of the open pit slopes. The available methods for slope monitoring are discussed below along with necessary recommendations.

4.4.1 Visual Monitoring

Visual Monitoring is the best practice when done vigilantly. Visual inspection of any cracks, seepage in high wall helps to spot any movement. Development of tension cracks and any change in them can be carefully observed. Visual monitoring also includes demarcating weak strata on the basis of spontaneous combustion, weathered zone or any deformation. A diligent visual survey always helps in taking preventive measures and/or safeguarding man and machinery.

Crack monitoring:

Crack monitoring techniques typically consist of:

- Regular detailed mapping of location, depth, width of cracks, rate of extension and opening;
- Installation of targets on opposite sides of cracks to monitor rates of opening;
- Installation of surface (wireline) extensometers;
- Installation of picket lines or lines of targets that can be monitored using theodolites or precise levels to detect changes in alignment, location or elevation along a given crack or the crest of the slope

4.4.2 Monitoring by Total Station

Geodetic Surveys:

Traditional ground-based geodetic surveys involve measuring the precise positions of slope features using total stations or GPS devices. These surveys provide accurate data on the movement of specific points on the slope over time. Monitoring points are established along the slope, and their positions are periodically measured to detect any significant movement.

Prism Monitoring:

Prism monitoring is a subset of geodetic surveys where reflective prisms are placed at monitoring points on the slope. Total stations are used to measure the distances and angles to these prisms, allowing for accurate determination of their positions. Any displacement of the prisms indicates slope movement.

Monitoring stations or pillars are generally installed at the places susceptible to displacement. It includes rehandled OB dumps, high wall etc. Change in RL of these monitoring stations needs to be continuously monitored for any unwanted movement. A dedicated team of personnel should monitor and record RL of each monitoring stations of the mine.

4.4.3 Monitoring by Slope Stability Radar (SSR)

Slope stability Radars are state of art instrument to detect slope instability and give early warning depending upon the threshold limit. Slope stability radar can remotely scan the pit slope and dump slope as within certain range in vertical and horizontal direction depending upon its specification. A slope stability radar continuously scans the slope wall within its range. SSR are so precise it can detect movement up to millimetres. Slope stability's radar effectiveness is evident from the fact that it captures and stores the scan image of target area and any minute movement can be distinctively marked. Depending upon the critical velocities considering site specific geo mining conditions a threshold limit can be set for slope stability radar to give out early warning in case of undesirable movement. Slope stability radar waves can penetrate through rain, dust and smoke to provide supreme accuracy in monitoring.

4.4.4 Recommendations on Slope Monitoring

- The monitoring program include visual inspection of the pit and dump slopes, with focus on crest, face of slope, toe areas for any evidence of cracks, seepage, erosion, gully formation, deformation etc. It is recommended that the shift supervisor or field engineer visually inspect these areas. Other observations such as cracking, seepage, erosion, deformation should also be recorded properly. It should be ensured that benches have gradient in any direction for proper drainage.
- Continuous slope monitoring is essential to detect any instability in advance to safeguard against impending slope failure. The OB dumps shall be regularly surveyed to produce up to date and accurate dump geometry.
- The monitoring should be done for strata movement on weekly basis. If any crack, deformation, movement in benches is detected, it shall be immediately informed to higher management. If the symptoms are abnormal, it must be referred to DGMS authority and the work will be stopped till further instructions from statutory bodies are obtained. Monitoring system should be implemented as described in the paragraph as described in the paragraph slope monitoring above. In case of any dump movement observed during “Conventional Monitoring or Semi-advanced slope monitoring technique” Mine management should initiate steps for implementation of advance monitoring technique for the prediction of impending failure at critical areas of mine.

5 SLOPE STABILITY -LITERATURE REVIEW AND DATA PREPARATION

5.1 SLOPE STABILITY

Overburden Dumps (Inpit/Internal and Out of pit/External) and Mine Pit Slopes (Working slopes, Final pit slopes) are the essential parts of the opencast mining systems, particularly over different phases of mining life cycle. The slope stability aspects of mine design were generally based on slope – height relationship curves for a given factor of safety under similar geo-mining conditions, which, despite being time tested and at times conservative, ignored, the design needs required in special cases involving complex geology, structure, conditions and varied material properties.

Challenges in land acquisition and various surface constraints and restrictions, generally result in non-availability of land make it difficult to maintain the designed slopes, both on highwall/working slopes and on OB dump. This leads to steeper slopes and higher dumps to accommodate material, affecting the stability and compromising safety. The problem gets compounded as mines get deeper and involve higher stripping ratios.

It has thus now become inevitable to scientifically study/assess the stability of such slopes to attain maximum productivity with adhering to highest standard of safety.

5.2 FACTORS GOVERNING SLOPE STABILITY

There are two main aspects of slope failure and they are natural and manmade disturbances. The seismic activities of the earth crust, rain, tornado and geology come under the naturally occurred disturbance. Blasting, excavation are manmade disturbance for slope instability. Following are the main factors that influence the slope stability.

5.2.1 Properties of Material Forming the Slope

a. Shear strength parameter:

This is the basic parameter that holds the key role to control the stability of the slope. All stability analysis involves knowledge of the shearing strength of the soil but it is most difficult to comprehend it accurately. The shearing resistance of soil comprises basically of the following components:

- The frictional resistance between the individual soil particles at their contact points.
- The cohesion between the surfaces of the soil particles, i.e. the structural resistance to displacements of the soil because of the interlocking of the particles.
- The shear strength in cohesion-less results from inter-granular friction alone, while in other soils, it results from both: internal friction as well as cohesion.
- The fundamental shear strength equation proposed by French engineer Coulomb is S=C + б Tan (Φ).

b. Hydro-geological parameters:

The effect of ground water present within the rock mass surrounding an open pit can be detrimental to the stability of the slope (Hoek and Bray, 1981) Therefore, it is expedient to constantly monitor groundwater levels as well as pore pressure to assist in the assessment of slope stability (Ding, et al. 1998). Piezometers are important for monitoring the effectiveness of mine dewatering programmes (Girard and McHugh, 2000). Measurement or calculation of water pressure is an integral part of site investigation for slope stability studies. Information on water pressures is essential for designing and maintaining safe slopes (Girard, et al. 1998).

For hydrogeology study as part of PR, monitoring of profile of water table in and around active mining areas, through groundwater monitoring points, using dugwells/ Piezometers was carried out. The same are assumed to be representative of hydrostatic condition of the mine bench for the current analysis.

For stability analysis of undisturbed material viz Working faces and High wall Phreatic line were assumed considering the groundwater level/ piezometric data as provided by the hydro geology dept, CMPDI.

Hydrostatic pressure/ water level condition (above the ground) within the overburden dumps (recent/old) can't be directly measured as OB dumps are not stratified Geological Formation. Study of groundwater monitoring/levels may be not directly required in case of stability of OB dumps as it will not intersect the groundwater table of the surrounding area. However, rate of infiltration of rainwater may be increased due to loose OB dump material.

Ground water level and phreatic surface assumptions, piezometric levels were based on the hydrological data of hydrogeological study of khadia OCP as provided in PR. of Khadia OCP

5.2.2 Geology of Mine Pit

Geology of the mine pit plays a vital role towards determining the stability of working pit. Understanding subsoil condition includes the knowing seam alignment, type of material underneath. In addition to this it is prudent to know various geological disturbances present in the mineable area.

5.2.3 Seismic Forces

(a) Earthquake Effect

Earthquake experience by a structure depends on its own dynamic characteristics and ground motions such that random motion of ground, vibration intensity, magnitude of the earthquake; depth of focus, distance from the epicentre and the strata on which the structure stands.

Seismic forces are considered as per "Indian standard criteria for earth quake resistant design of structures (fifth revision) IS 1893:1984 (reprint 2002) in the following manner: -

Seismic force/coefficient αh is calculated as per the above IS Code by following two methods and higher value is taken for slope stability calculation

a). Seismic Coefficient Method,

$\alpha h = \beta I \alpha 0$

β = Coefficient depending on soil foundation system

I = Factor depending upon importance of structures

$\alpha 0$ = basic horizontal seismic coefficient

b) Response Spectrum method

$\alpha h = \beta I F_0 S_a/g$

F_0 = Seismic zone factor for average acceleration spectra

S_a/g = Average acceleration coefficient for appropriate natural period and damping of structure. Value taken from T- S_a/g graph

T = 2.9 H t (ρ/G)1/2,

T = Natural period of vibration for earth fill structure.

Ht = Height, P = Mass density, G = modulus of rigidity.

Since Khadia OCP, is situated in Zone III expected Ground Acceleration for zone III due to earthquake has been calculated as follows

I. Seismic Coefficient Method,

αh = βI α0

Here

β = 1.0, I = 1.5, α0 = 0.04

Hence, αh = 0.06

II. Response Spectrum method

αh = βI F0 Sa/g

F0 = 0.2

Sa/g = Value taken from graph between natural period of vibration verses average acceleration coefficient

Natural period of vibration T for earth fills structure will be calculated as follow

T = 2.9 H t (ρ/G)1/2 , H t = 80m

P = 18000N/m3

G = 15 MPa x 1000

Hence, T = 0.239 sec.

Now αh = 1*1.5*0.2*0.16 = 0.048

Hence it was found that the value of horizontal acceleration from seismic coefficient method is more than the value obtained from response spectrum method. Hence the same value was considered for incorporating earthquake effect during stability analysis.

(b) Blasting Effect

Blasting plays a devil’s role towards stability of Pit and Dump Slopes in Mines. Generally a blast vibration wave of low frequency has hostile impact on stability (Dowding and Gilbert 1988). Wong and Pang(1992) suggested Pseudo-Static approach to evaluate blasting effect on slopes.

Hoek etal (2002) introduced Disturbance factor due to blasting, “D” applicable to rock slope. The value of D varies from “0” to “1” where “0” signifies minimal effect of blasting where “1” means large scale blast having significant effect to slopes.

The ground motion is directly influence by scaled distance and a square root of the explosive. Microsecond-delayed blasts are used for reduction of PPV of ground vibrations which are connected with the maximum charge weight detonated per delay. Peak particle velocity has been widely accepted as criteria for evaluating effect of blasting. Langefors and Khilstrom has suggested predictor equation to calculate peak particle velocity. DGMS has laid down accepted parameter in terms of PPV as shown in table

Permissible peak particle velocity (PPV) at the foundation level of structures in mining area is in mm/sec:

Table 5.1

TYPE OF STRUCTURES		Dominant excitation frequency (Hz)		
		< 8 Hz	8-25 Hz	> 25 Hz
A	Building/structures not belonging to owner			
	(i) Domestic houses/structures (Kuchha, Brick in cement).	5	10	15
	(ii)Industrial building (RCC) framed structures.	10	20	25
		2	5	10

	(iii) Object of historical importance and domestic structures.			
B	Building belonging to owner with limited span of life (i) Domestic houses/structures (Kuchha, Brick in cement) (ii) Industrial building (RCC) framed structures	 10 15	 15 25	 25 50

5.3 CALCULATION OF FOS

The shear resistance of the sliding slope is assessed by an index called the factor of safety. The factor of safety gives relative static state of the studied slope about its mobilization. This also gives an indication of risk factor of failure at a glance. This is a ratio of the shear resistance to shear force develop at the sliding surface (mobilization force).

Literature found to have categorized that slope is safe with the ratio more than the value of 1.20.

In many literature and different agencies such as National Coal Board, UK, Appolonia Consulting Engineers, mine branch, Canada, GL Fiesenko, Russia, etc has envisaged a factor of safety more than 1.10 in the design of slope stability is safe, if appropriate seismic acceleration is considered and more than 1.20 if seismic acceleration is not considered.

As per DGMS Tech Circular no 3 of Dt 16.01.2020 the suggested factor of safety are as follows

1. FoS greater than or equal to 1.3 for temporary slopes
2. FoS greater than or equal to 1.5 for permanent slopes.

5.4 SOFTWARE USED

The following software tools from Rocscience have been used in this study:

1. SLIDE2 -2D Limit equilibrium software
2. RS2- 2D Finite element software
3. RSData: Strength & Stress Analysis of Rock and Soil Materials

SLIDE2: Limit equilibrium method software

The conventional limit equilibrium method is used in many geotechnical practices to investigate the equilibrium condition and analyse the stability of slope with varying geotechnical data and geometry. The most common methods for limit equilibrium analysis are method of slices. The soil mass above the assumed slip surface is divided into vertical slices for purpose of analysis. Several different methods of slices are available for analysing the circular and non-circular condition.

In the present study limit equilibrium method has been used to compute the factor of safety using bishop method and janbu method

The Slope analysis of Pit Slopes and OB Dump Slopes in Khadia OCP is performed by limit equilibrium method software namely SLIDE2. Slide2 is a 2D limit equilibrium slope stability program for evaluating the safety factor or probability of failure, of circular or non-circular failure surfaces in soil or rock slopes. Slide2 analyse the stability of slip surfaces using vertical slice or non-vertical slice limit equilibrium methods. Slide2 also includes finite element groundwater seepage analysis built right into the program, for both steady state and transient conditions.

Slide2 analyses the stability of slip surfaces using vertical slice or non-vertical slice limit equilibrium methods (e.g. Bishop, Janbu, Spencer, Sarma, etc). Individual slip surfaces can be analysed, or search methods can be applied to locate the critical slip surface for a given slope. Deterministic (safety factor) or probabilistic (probability of failure) analyses can be carried out.

Finite element groundwater (seepage) analysis, for steady-state or transient conditions, is built right into the Slide2 program

SLIDE2 has the Multi-Modal Optimization feature was introduced to help address some of the real-world complexities of analysing a slope. Slope stability analyses generally focus on the search for the single global minimum surface. Yet in reality, a slope will often have multiple critical regions that may fail, instead of a single critical region. This is where MMO comes into play.

RS2- 2D Finite element software

RS2 is a program for 2D finite element analysis of geotechnical structures for civil and mining applications. Applicable for both rock and soil (RS2 = Rock and Soil 2-dimensional analysis program), RS2 is a general purpose finite element analysis program for tunnel and support design, underground excavations, surface excavation, slope stability, embankments, dynamic analysis, foundations, consolidation, groundwater seepage and more. RS2 is used to determine the safety factor of a simple homogeneous slope using the shear strength reduction (SSR) method. SSR analysis is the ability to plot maximum deformation versus SRF. As the SRF is increased, the strength properties are decreased. As the strength decreases the maximum displacement increases. At some point, the slope will fail, deformations will increase rapidly, and the finite-element analysis will not converge. It is this point of non-convergence that defines the critical SRF.

RSData: It is a versatile toolkit for the analysis of rock and soil strength data, and the determination of strength envelopes and other physical parameters. RSData includes RocProp, a database of intact rock properties that runs as a standalone application.

5.5 SAMPLE COLLECTION AND TESTING

It is generally difficult and expensive to sample and test large samples of rock mass. Consequently, empirical methods of determining the friction angle and cohesion of rock masses are available in the literature (Duncan C. Wyllie et all.,). In empirical methods also it is necessary to categorize the rock mass in terms of both the intact rock strength and the characteristics of the fractures/joints.

One of the methods is Strength Determination by Back Analysis of Failures: Probably the most reliable method of determining the strength of a rock mass is to back analyse a failed, or failing, slope. This procedure involves carrying out a stability analysis with the factor of safety set at 1.0 and using available information on the position of the rupture surface, the groundwater conditions at the time of failure, and any external forces such as foundation loads and earthquake motion, if applicable. In many cases it may not be feasible to carry out a back analysis of a slope in geological conditions similar to those in which the new slope is to be excavated. In these circumstances, published results of rock mass shear strength can be used in design. (Duncan C. Wyllie et all)

As an alternative to back analysis to determine the strength of fractured rock masses, an empirical method was developed by Hoek (1983) and Hoek and Brown (1988) in which the shear strength is represented as a curved envelope. This strength criterion was derived from the Griffith crack theory of rock fracture, as well as from observations of the behaviour of rock masses in the laboratory and in the field (Marsal 1973; Jaeger 1970).

The three parameters defining the curved strength envelope of the rock mass are the uniaxial strength of the intact rock, and two dimensionless constants m and s.

Estimation of Rock Mass Properties for Highwall:

RSData developed by Rocscience is used in this study for estimation of rock mass properties, which developed on Hoek-Brown strength criterion based on intact rock strength. RSData is a versatile toolkit for the analysis of rock and soil strength data, and the determination of strength envelopes and other physical parameters. RSData includes RocProp, a database of intact rock properties that runs as a standalone application. the additional Output Parameters that can be generated from RSdata Includes

- Hoek-Brown: rock mass tensile strength, compressive strength, deformation modulus
- Mohr-Coulomb: uniaxial compressive strength, alpha angle
- Power Curve: uniaxial compressive strength, tensile strength

Samples were collected appropriate to ground conditions and transported them to Geotechnical Lab at CMPDI. Laboratory tests were conducted to determine the strength properties of OB materials such as cohesion and angle of internal friction. The purpose of the sample collection and laboratory studies is to predict subsurface conditions, classification and identifying strata and estimating strength properties. Field and Laboratory works were conducted based on Indian Standard specifications and, as per the requirement of project.

Figure 5.1 Pictures showing Sample collection and compositions of Ob material at field

5.5.1 Large Scale Direct shear testing of OB samples.

Different compositions of materials found at various benches of overburden dumps, were collected from the field and packed in approximately 30 bags were transported to CMPDI, HQ, Ranchi.

These samples were tested on an automatically servo-controlled Large Direct shear machine which has a shear and normal load capacity of 2500kn, with a shear box size of 300X300x300MM and 1000X1000X1000 mm. Mohr-Coulomb failure criteria were used to determine the shear parameters cohesion 'c' and friction angle 'ϕ' using equation $\tau = \sigma tan\phi + c$.

Figure 5.2 Pictures showing sample testing on Large Direct Shear Machine, CMPDI

5.6 INPUT PARAMETRS FOR SLOPE STABILITY ANALYSIS

The mixed material found in the interface of top soil and coalmine overburden material is very complex in terms of both material type and its size distribution. The materials properties of these overburden rocks or rock-soil mixture are most likely to change due to repeated exposure to weathering and particle crushing during loading and hauling process. The crushed sandstone material being formed by similar kind of sand grains during sedimentation possesses characteristics somewhat similar to that of sand, while the weak, weathered and crushed materials of shale tends to behave like a clay material formation when subjected to watery condition.

Estimation of the key physico-mechanical properties of coalmine waste dumps was done using the large scale testing of representative sample from OB dumps on Large direct shear machine at field scale stresses, as well as considering laboratory studies (from available literature) on mixed earth rock observed in Indian coalmine waste dumps where the properties of all major constituent materials are taken into consideration.

For high wall/working face material each material profile is defined by referring lithological data of the nearby borehole.

RSData software based with observations during field visit and Physio-mechanical properties of the strata in GR/PR is used for deriving the rock mass properties of different strata depth wise to use as input parameters in stability analysis using SLIDE2.

After correlating the test results from the laboratory test and with lithology data available from borehole along with site specific literature review with judicial judgment g value of shear strength parameters considered are given below.

Large Direct Shear Machine Testing of Over Burden Dump samples from Khadia OC, NCL.

Different compositions of materials found at various benches of overburden dumps, both internal and external dumps were collected from Khadia OCP, NCL during the filed visit. The collected samples which were packed and labelled in approximately 16 bags are transported (by RI-VI) to CMPDI, HQ, Ranchi

These samples were tested on an automatically servo-controlled Large Direct shear machine which has a shear and normal load capacity of 2500kN, with a shear box size of 300X300x300MM and 1000X1000X1000 mm.

Mohr-Coulomb failure criteria were used to determine the shear parameters cohesion 'c' and friction angle 'ϕ' using equation $\tau = \sigma tan\phi + c$.

The summary of Direct shear test results is placed below.

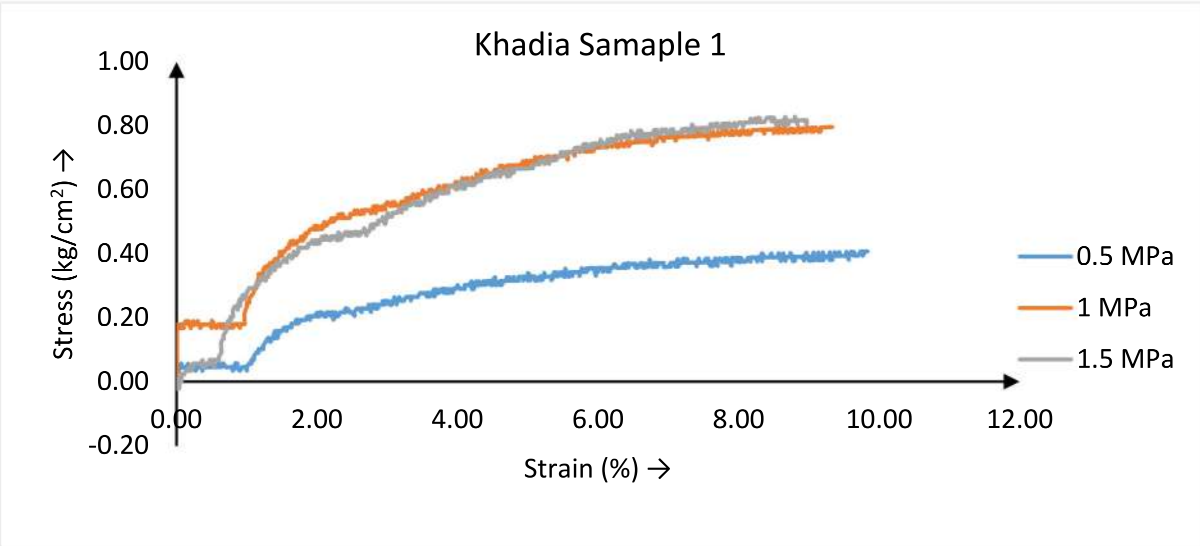
A) Results for Khaida OCP

Table 5.2: Input strength parameters for OB dumps

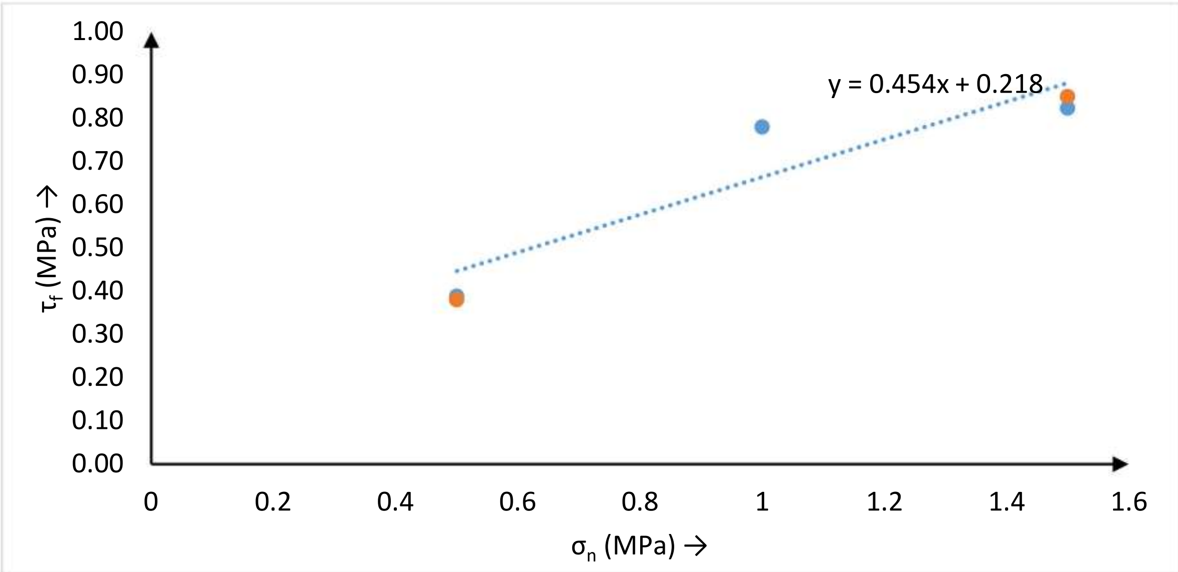
Sample No	Sample Code	Site	C(MPa)	Phi (Degree)
1	KH1	OB DUMP	0.21	24.23
2	KH2	OB DUMP	0.18	28.37
3	KH7	OB DUMP	0.15	29.68
4	KH8	OB DUMP	0.21	23.27

Sample wise Stress-strain plots and Mohr–Coulomb failure envelops are given below

1. Sample KH1



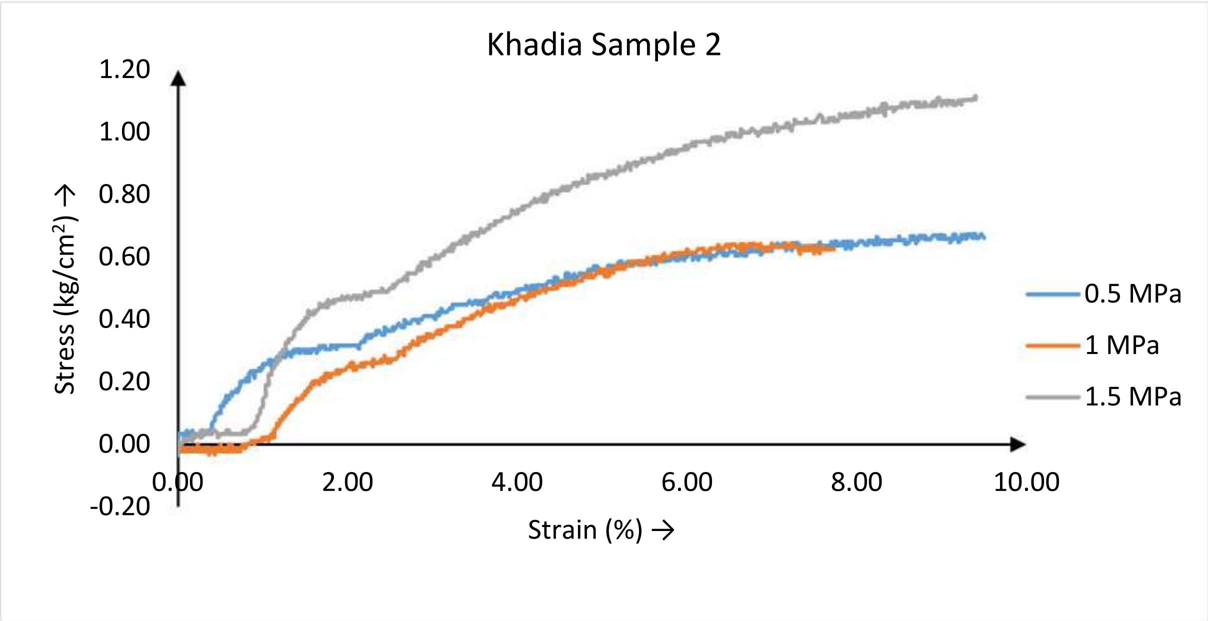
Stress strain Plot of Sample KH1



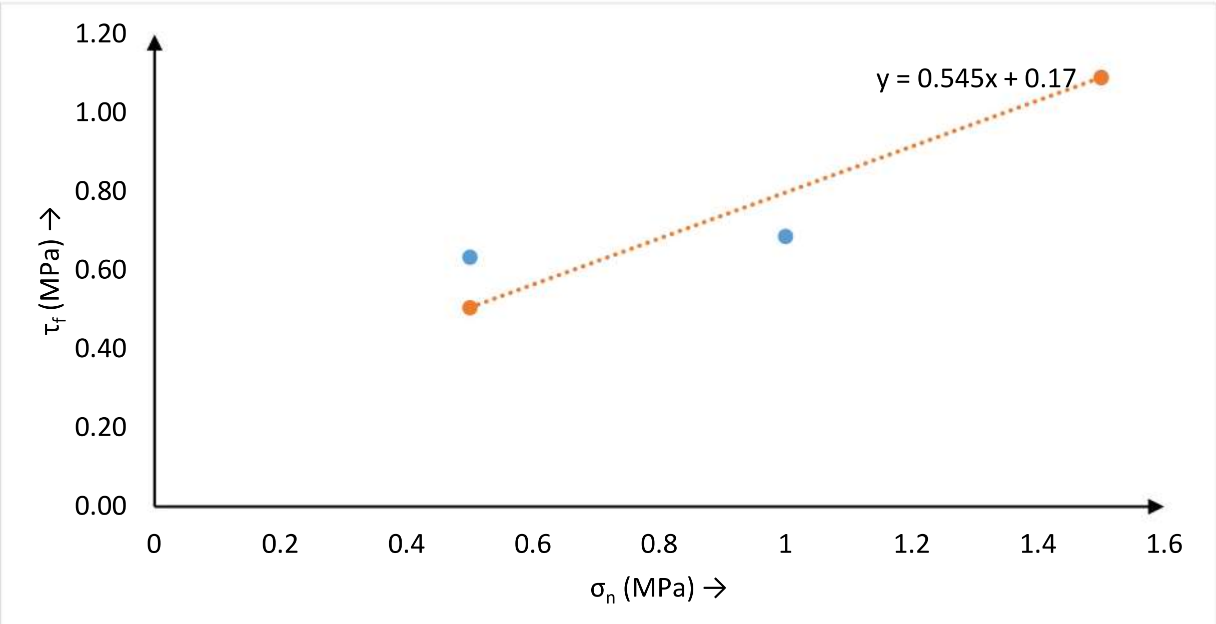
Failure Envelope for Sample KH1

m	0.45	**C (MPa)**	0.21
c	0.21	**φ (°)**	24.23

2. Sample KH2



Stress strain Plot of Sample KH2

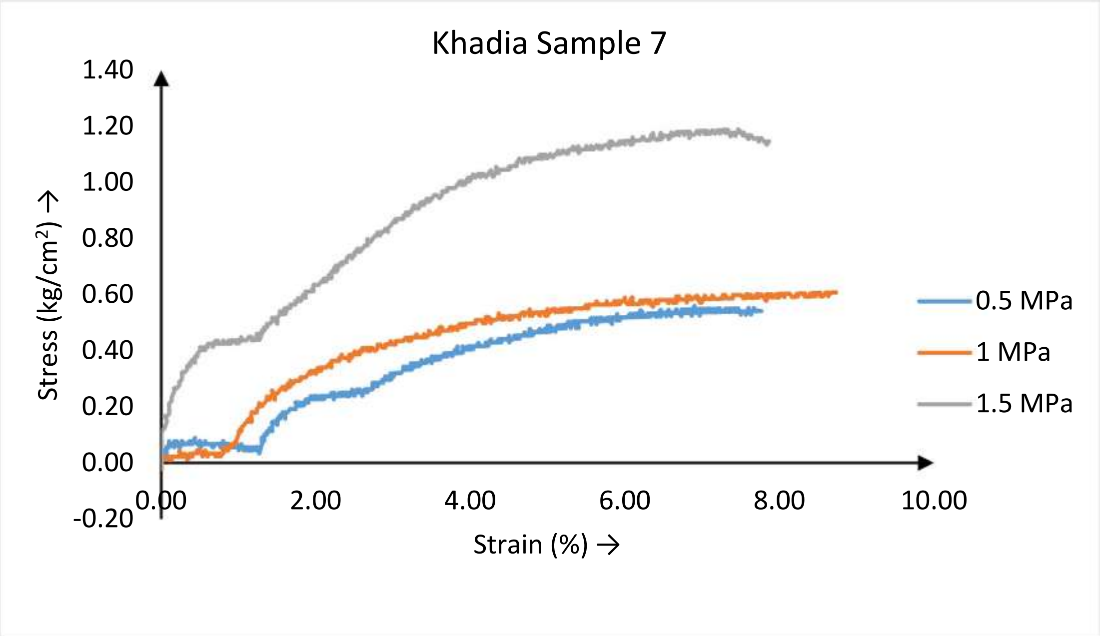


Failure Envelope for Sample KH2

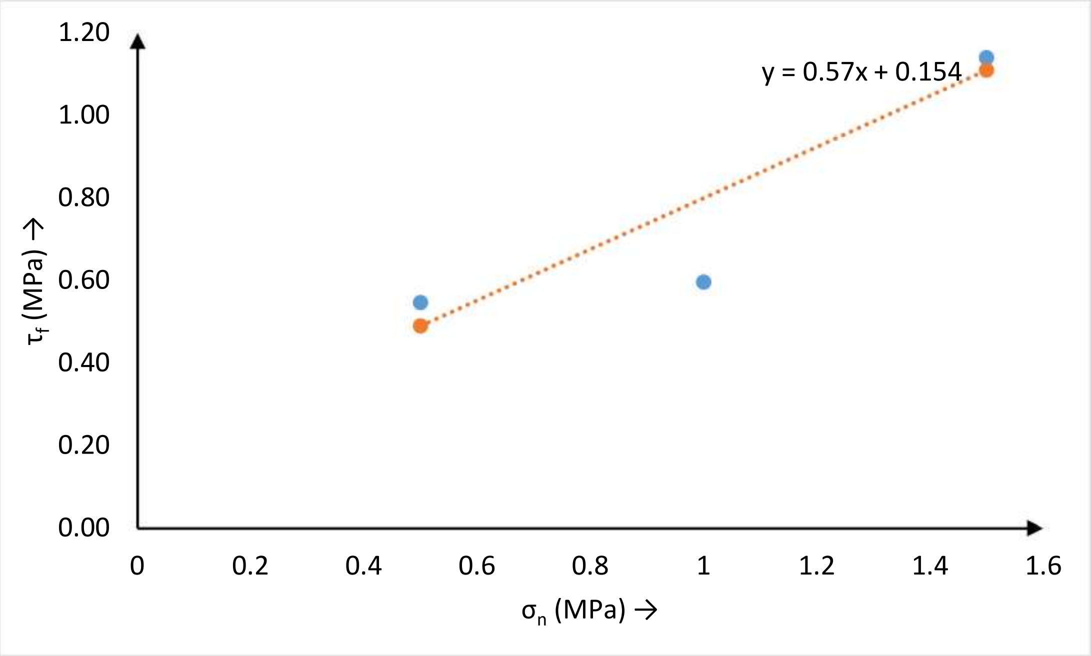
m	0.58	**C (MPa)**	0.18

c	0.17	**φ (°)**	28.37

3. Sample KH7



Stress strain Plot for Sample KH7

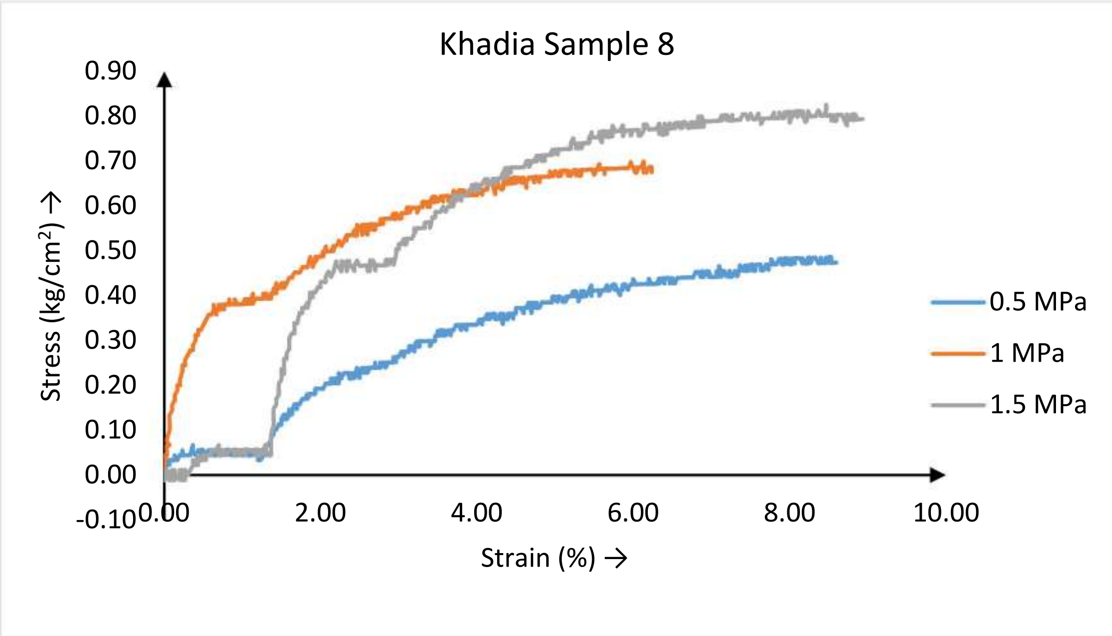


Failure Envelope for Sample KH7

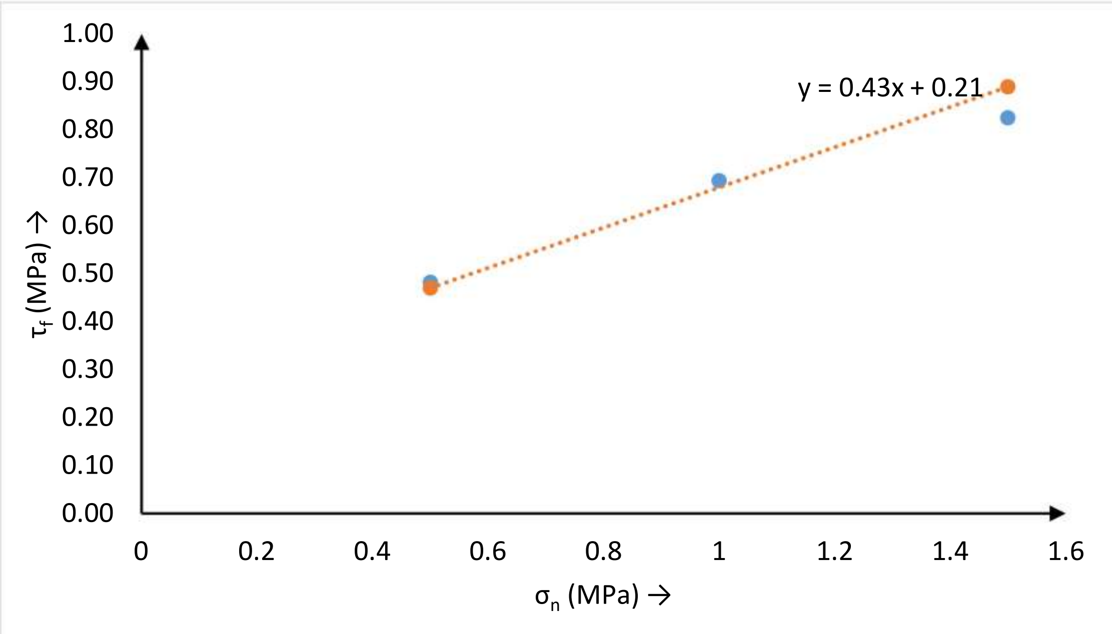
m	0.57	**C (MPa)**	0.15

c	0.15	**φ (°)**	29.68

4. Sample KH8



Stress strain Plot for Sample KH8



Failure Envelope for Sample KH8

For Highwall :

Rock samples from the field were collected and cores revovered from the sample were tested for UCS and density . Using the UCS of intact rock from lab tests and compressive test values avalble in GR for the intact rock Rock mass properties were derived.

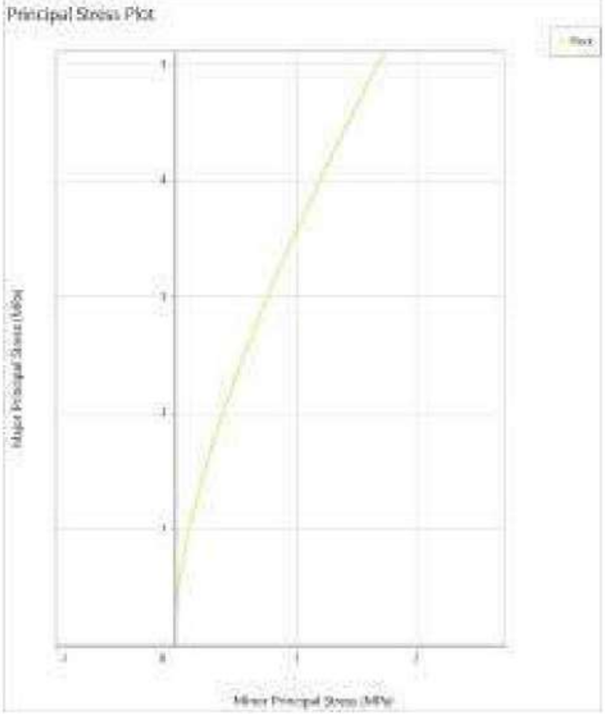
The intact rock may be considered as a continuum or polycrystalline solid among discontinuities comprising an aggregate of minerals or grains. The rock mass is the in situ medium comprising intact rock blocks separated by discontinuities such as joints, bedding planes, folds, sheared zones, and faults.

In general, compared to intact rock, a rock mass has reduced tensile strength (almost zero), and reduced shear strength especially along discontinuity planes. Furthermore, if a rock mass is cut by directional joint sets, the rock mass strength is anisotropic.

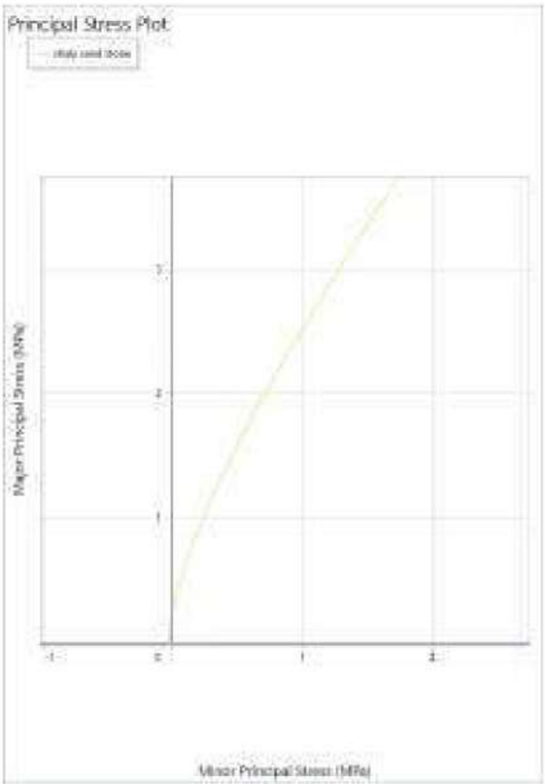
The rockmass strength properties were derived using RocData software by incorporting the lab test data of CMPDI, rock testing rpoperties avialbe in the Khadia GR, previous test data from IIT BHU and BIT Mesra and correlating test data from adjucent mines the input strength parameters are derived using Rocdata software and few plots are reporduced bwlow.

Table 5.3 : Input strength parametrs for highwall

Description	Unit weight (Kn/m^3)	C (kPa)	Phi (Degree)
Coal seam	16	150	17
Sand stone	23	275	30
Shaly sand stone	22	200	26
Base rock	26	350	35



Sand stone	
Hoek Brown Classification	
UCS of intact rock (MPa)	15
GSI	40
mi	17
disturbance factor	1
Intact Modulus (MPa)	20000
Hoek Brown Criterion	
mb	0.445
s	0.000200
a	0.506
Rock Mass Parameters	
tensile strength (MPa)	0.007
uniaxial compressive strength (MPa)	0.203
global strength (MPa)	1.3
modulus of deformation (MPa)	1268.88
Failure Range Envelope	
application	Custom
sig3max (MPa)	1.75
Mohr Coulomb Fit	
cohesion (MPa)	0.279
friction angle (°)	25.788



shaly sand stone	
Hoek Brown Classification	
UCS of intact rock (MPa)	15
GSI	40
mi	8
disturbance factor	1
Intact Modulus (MPa)	20000
Hoek Brown Criterion	
mb	0.187
s	0.000200
a	0.506
Rock Mass Parameters	
tensile strength (MPa)	0.016
uniaxial compressive strength (MPa)	0.203
global strength (MPa)	0.777
modulus of deformation (MPa)	1258.88
Failure Range Envelope	
application	Custom
sig3max (MPa)	1.75
Mohr Coulomb Fit	
cohesion (MPa)	0.195
friction angle (°)	18.164

Figure 5.3 Plots showing RSData Analysis results for Rock mass properties

6 STABILITY ANALYSIS

6.1 SCOPE OF ANALYSIS

There are many areas within the excavation area and the dumps where the mining and dump profiles are in deviation with the designed/desired profiles, the details of which have been deliberated earlier in the report. Stability analysis for the Pit and Dump slopes for the khadia coal mine was performed for the

- Existing Highwall Slopes, where the working benches have been clubbed to form highwall profile, steeper/flatter than the designed/proposed profile.
- Ultimate Pit Slope as per Approved Mining Plan/ PR
- Existing Overburden Dump Slopes
- Final Dump slope as per approved mining plan/ PR
- Proposed High wall and OB dump slope profiles for specified areas

Considerations in the analysis:

Cross sections along various alignments were drawn across the mine workings and dump profiles were superimposed on the seam and topographic dispositions, generated through the digital model in Minex. Existing profiles on such sections were taken from the Working plan of the mine dated 01.04.2023, showing the position of mining operations, in consultation with mine officials. These sections have formed the basis of the profiles used for Slope stability analysis for highwall and dump slopes.

Slope Stability Analysis for the Ultimate Pit slopes and Final Dump profiles are as proposed in the Project Report/Mining Plan.

The factor of safety 1.5 has been considered for long term stability of the dump slope. The angle of repose was considered to be 37^0. The stability analyse were done to determine the safe dump slope configuration.

Locations of the cross sections and models and analysis results of the stability analysis using SLIDE2 and RS2 software are presented below.

Stability Analysis:

As per the working plan as on 01.04.2023, provided by the Khadia project on 16-04-2023 , the following critical sections were marked along high wall and dumps and the drawings of the same were obtained from the project

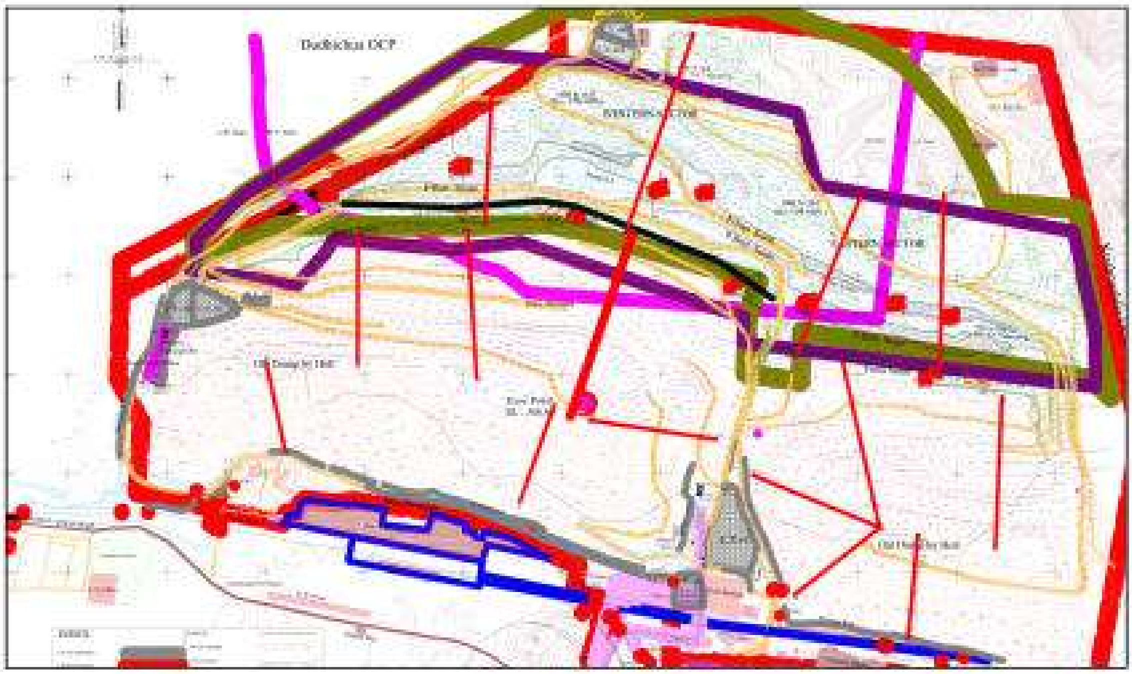


Figure 6.1: showing location of sections considered along existing dump and workings

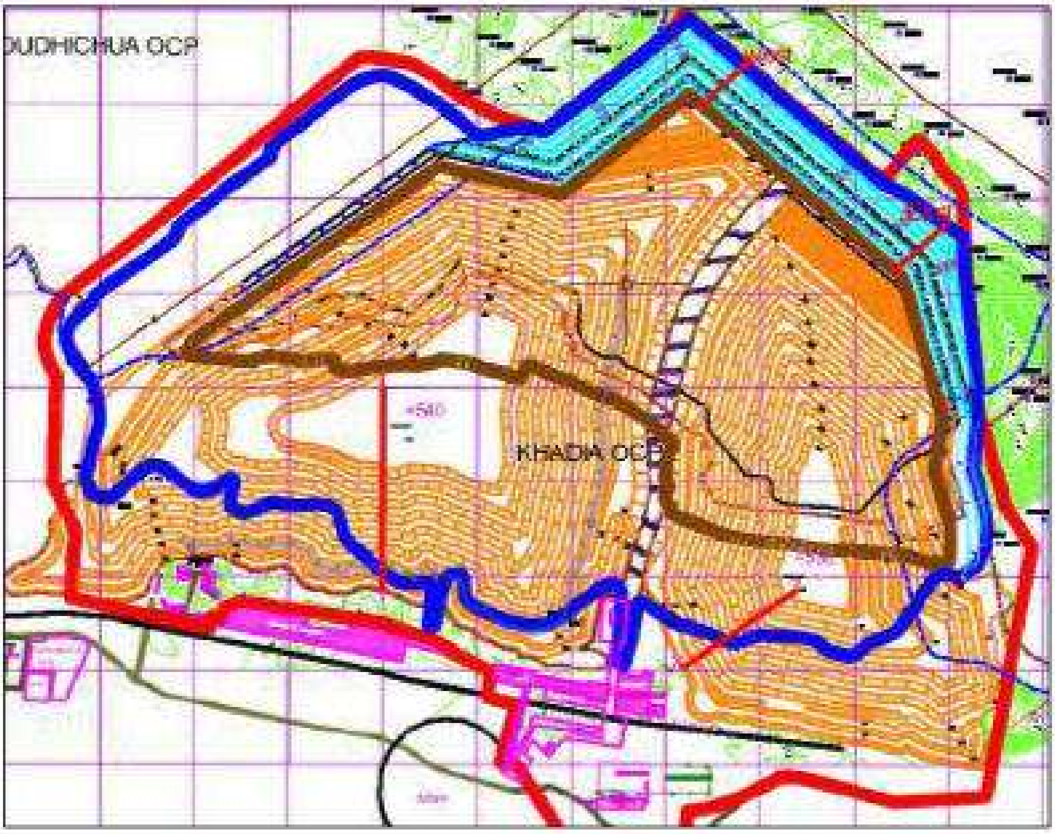


Figure6.2 showing location of sections considered along final stage pit and dump

1. Section A-A’

Section along A-A’ represents overburden dump on western side of the mine near view point. The elevation at toe of the dump is 222 m and top of the dump is 500 m. The average height of the dump along the section from the toe is 278m and overall slope angle is 18^0, the intermediate benches have bench angles ranging from 36^0-40^0.

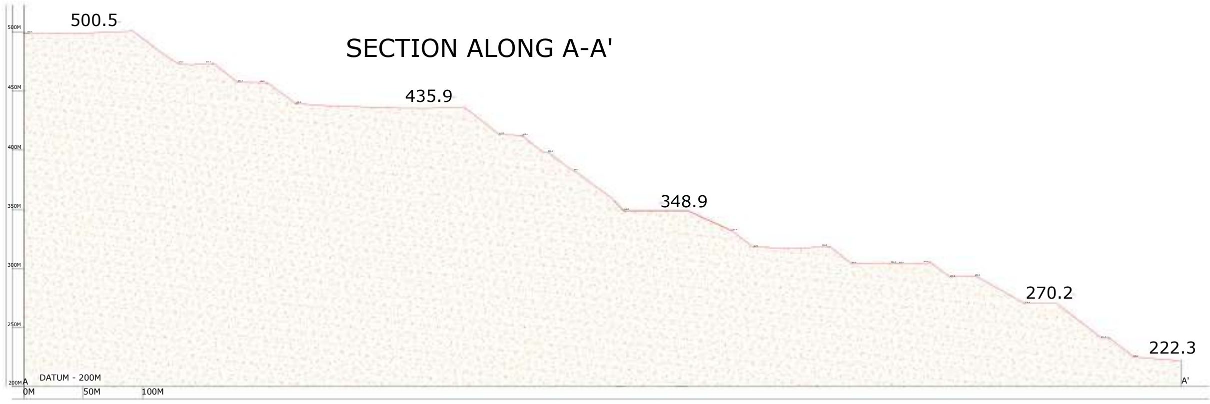


Figure 6.3: A-A’ represents overburden dump on western section

2. Section B-B’

Section along B-B’ represents a section along western most part of the overburden dump. The elevation at toe of the dump is 257 m and top of the dump is 502 m. The average height of the dump along the section from the toe is 245 m and overall slope angle is 21$^{0.}$ the intermediate benches have bench angles ranging from 34^0-40^0.

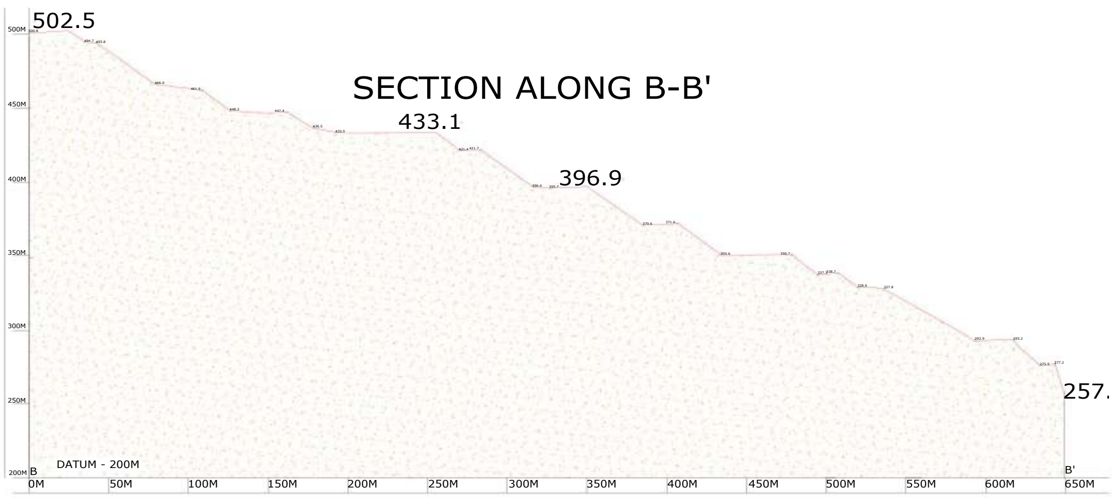


Figure 6.4: B-B’ represents a section along western most part of OB

3. Section E-E’

Section along E-E’ represents a section along middle of the western overburden dump. The elevation at toe of the dump is 239.2 m and top of the dump is 505 m. The average height of the dump along the section from the toe is 265 m and overall slope angle is $22^{0.}$ The intermediate benches have bench angles ranging from 30^0-38^0.

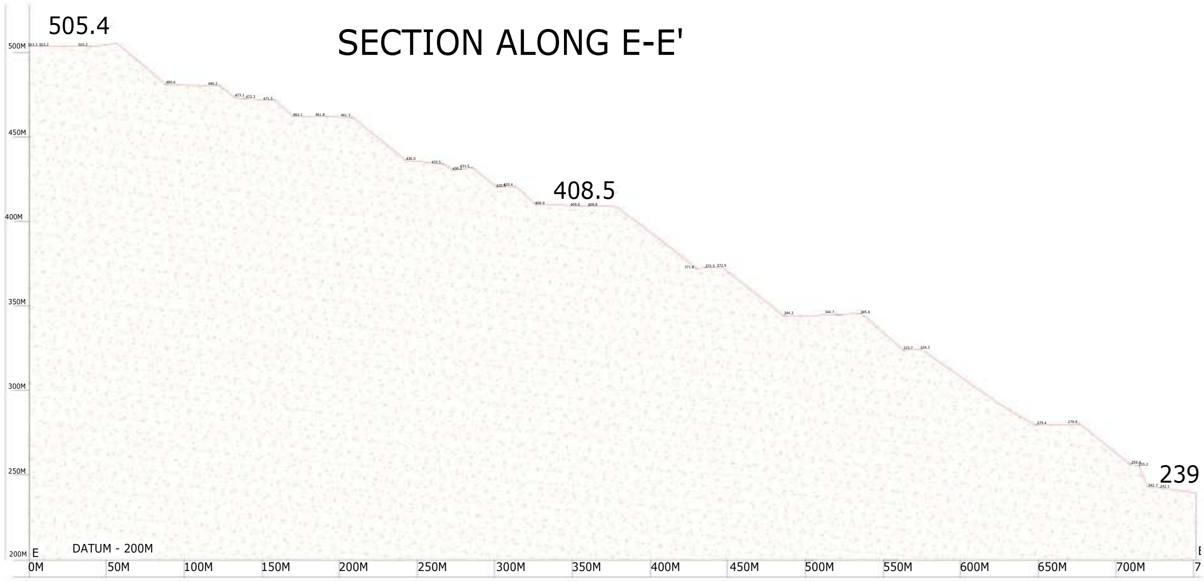


Figure 6.5: E-E’ represents a section along middle of the western overburden dump

4. Section H-H’

Section along H-H’ represents a section along left part of the eastern overburden dump. The elevation at toe of the dump is 247 m and top of the dump is 495 m. The average height of the dump along the section from the toe is 248 m and overall slope angle is $17^{0.}$ The intermediate benches have bench angles ranging from 34^0-40^0. Except the intial bench at toe.

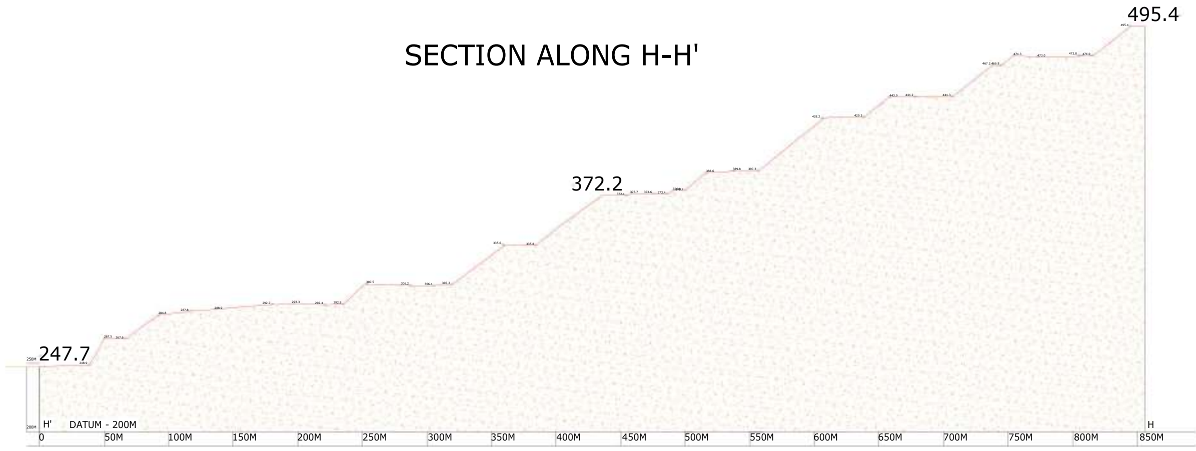


Figure 6.6: H-H' represents a section along left part of the eastern overburden dump

5. Section I-I'

Section along I-I' represents a section along middle of the eastern overburden dump. The elevation at toe of the dump is 257 m and top of the dump is 495 m. The average height of the dump along the section from the toe is 238 m and overall slope angle is $18^{0.}$ The intermediate benches have bench angles ranging from 34^{0}-45^{0}. Except the intial bench at toe

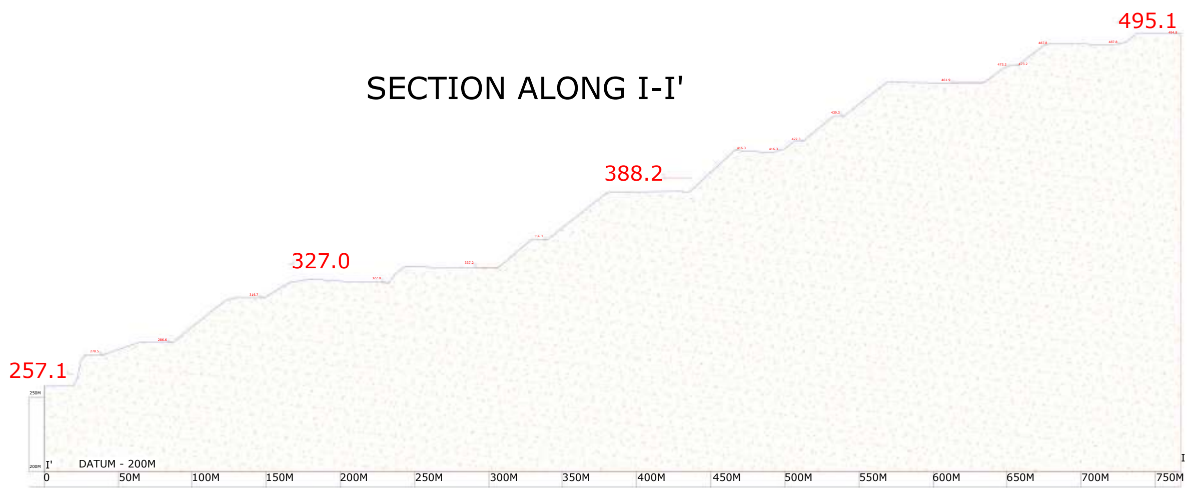


Figure 6.7: I-I' represents a section along middle of the eastern overburden dump

6. Section J-J'

Section along J-J' represents a section along eastern overburden dump. The elevation at toe of the dump is 280 m and top of the dump is 499 m. The average height of the dump along the section from the toe is 220 m and overall slope angle is $23^{0.}$ The intermediate benches have bench angles ranging from 34^0-43^0.

Figure 6.8: J-J' represents a section along eastern overburden dump

7. Section K-K'

Section along K-K' represents a section along western overburden dump. The elevation at toe of the dump is 320 m and top of the dump is 502 m. The average height of the dump along the section from the toe is 192 m and overall slope angle is $24^{0.}$ The intermediate benches have bench angles ranging from 29^0-55^0. But one intermediate bench has a height of 82m placed at angle of 36^0

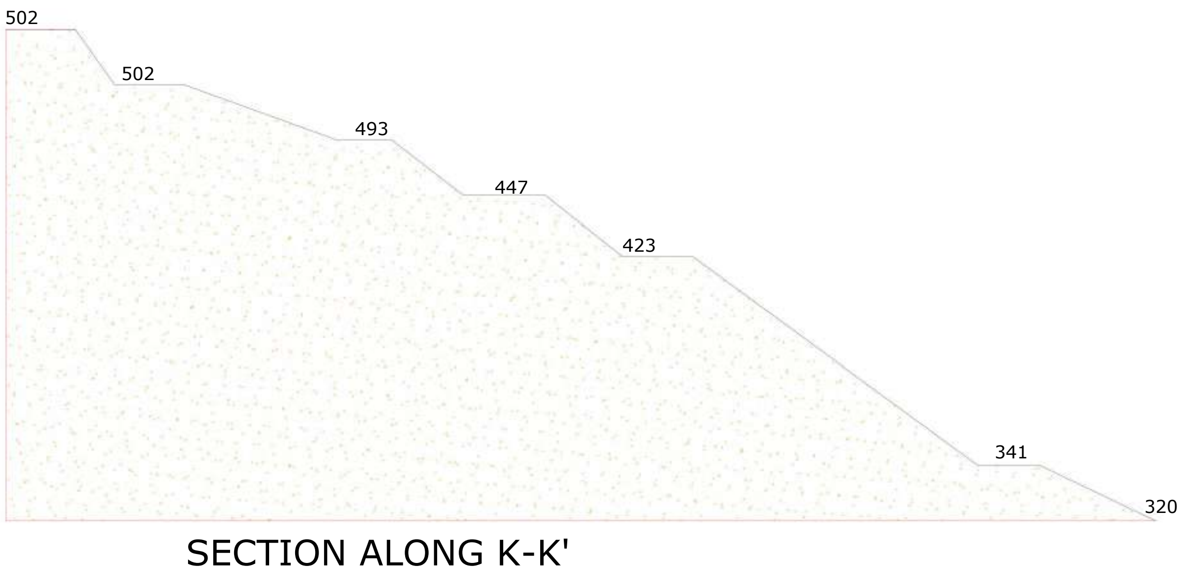


Figure 6.9: K-K' represents a section along western overburden dump

8. Section L-L'

Section along L-L' represents a section along western overburden dump. The elevation at toe of the dump is 304 m and top of the dump is 500 m. The average height of the dump along the section from the toe is 195 m and overall slope angle is $33^{0.}$ The intermediate benches have bench angles ranging from 34^0-$45l^0$. But one intermediate bench has a height of 100m placed at angle of 40^0

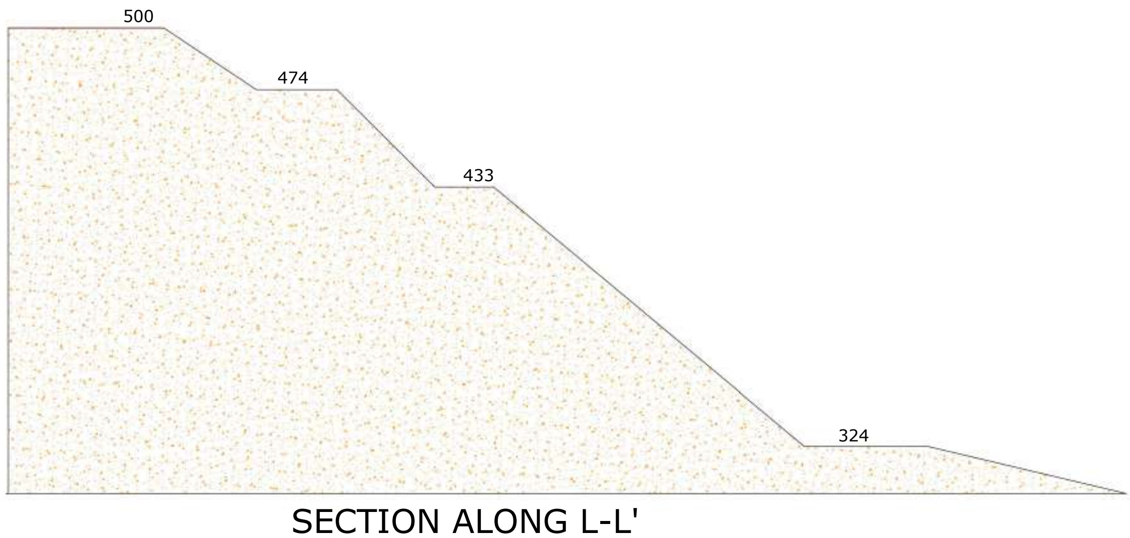


Figure 6.10: L-L' represents a section along western overburden dump

9. Section M-M'

Section along M-M' represents a section along western overburden dump. The elevation at toe of the dump is 275 m and top of the dump is 497 m. The average height of the dump along the section from the toe is 222 m and overall slope angle is $21^{0.}$ The intermediate benches have bench angles ranging from 26^0-46^0.

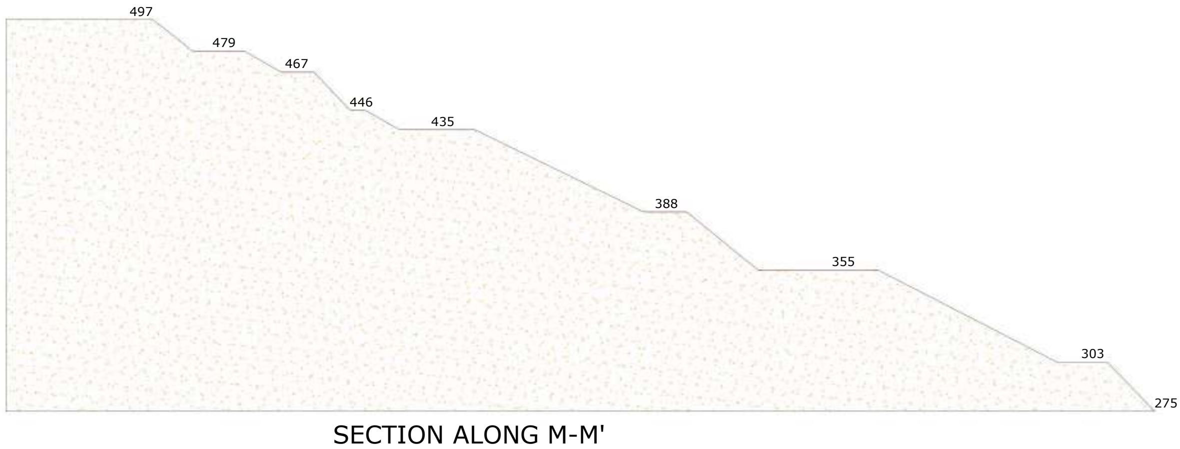


Figure 6.11: M-M' represents a section along western overburden dump

10. Section O-O'

Section along O-O'' represents a section along eastern overburden dump. The elevation at toe of the dump is 293 m and top of the dump is 495 m. The average height of the dump along the section from the toe is 202 m and overall slope angle is $20^{0.}$ The intermediate benches have bench angles ranging from 30^0-33^0

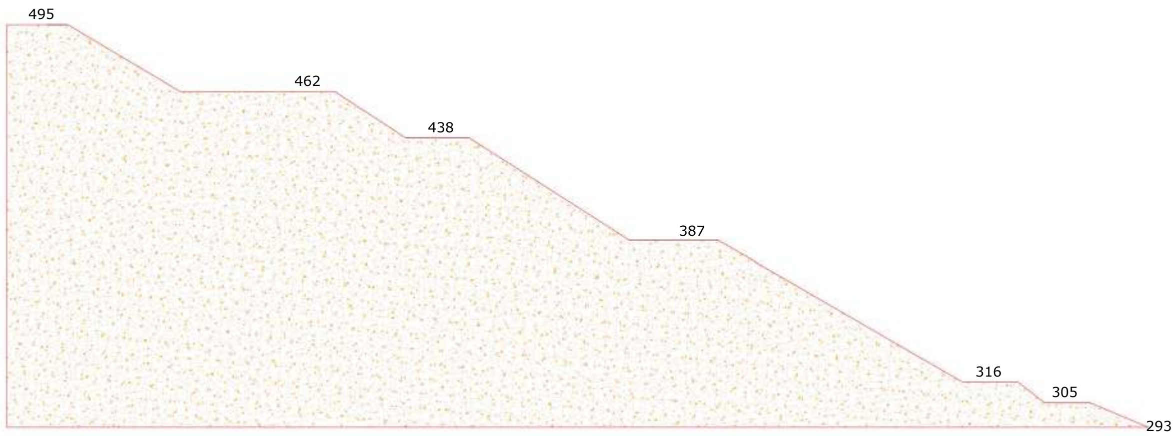


Figure 6.12: O-O'' represents a section along eastern overburden dump

11. Section N-N'

Section along N-N' represents a section along eastern overburden dump. The elevation at toe of the dump is 280 m and top of the dump is 495 m. The average height of the dump along the section from the toe is 215 m and overall slope angle is 19^0. The intermediate benches have bench angles ranging from 34^0-55^0

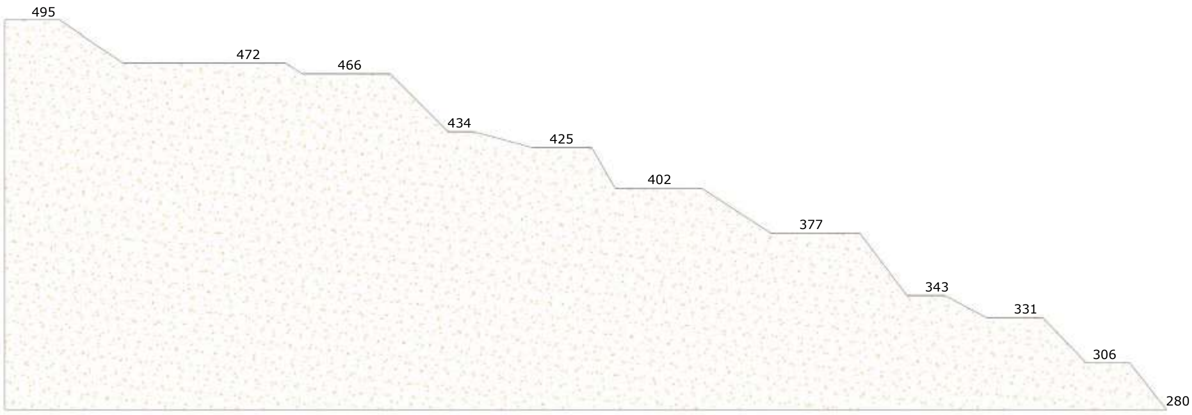


Figure 6.13: O-O'' represents a section along eastern overburden dump

12. Final stage Dump : Section 1-1 Along western dump

The elevation at toe of the dump is 300 m and top of the dump is 540 m. The average height of the dump along the section from the toe is 240 m and overall slope angle is $18^{0.}$ The intermediate benches have bench angle of 37^0 and bench height of 30m.

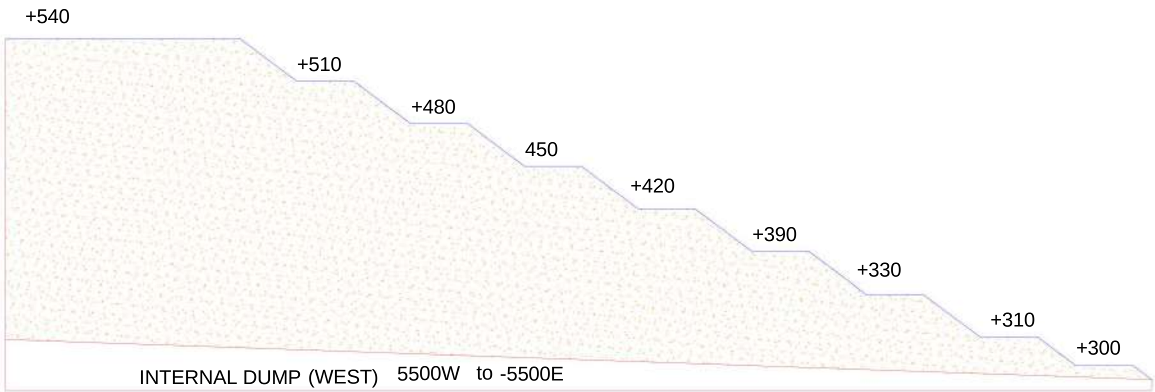


Figure : 6.14: Final stage Dump : Section 1-1 Along western dump

13. Final stage Dump: Section 2-2 Along Eastern dump

The elevation at toe of the dump is 285 m and top of the dump is 530 m. The average height of the dump along the section from the toe is 245 m and overall slope angle is 18^{0}. The intermediate benches have bench angle of 36^{0} and bench height of 30m.

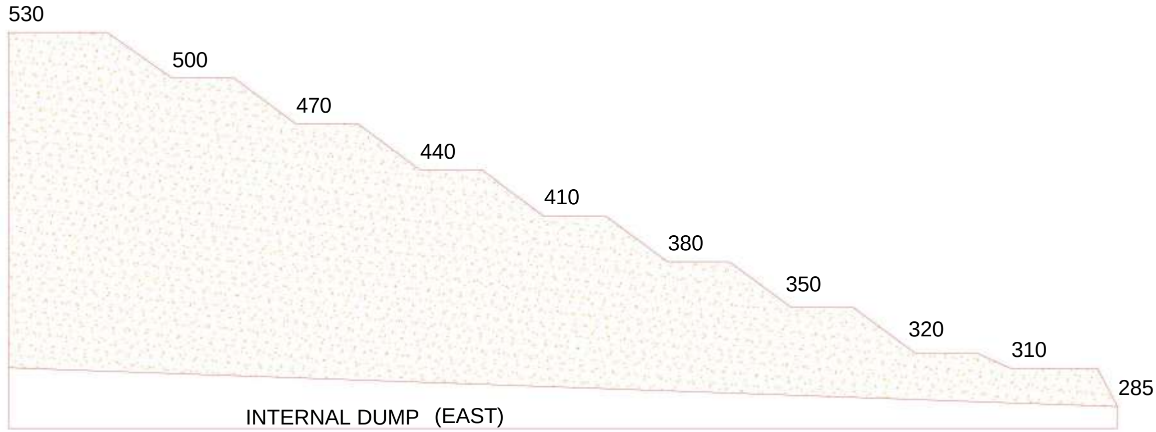


Figure : 6.15: Final stage Dump : Section 1-1 Along Eastern dump

14. Section C-C'

Section along C-C' represents a profile along working benches at western quarry. The elevation at floor is 234 m and at the top is 407 m. The average height of the face along the section from the floor is 195 m and overall slope angle is 25^{0}. The intermediate benches have bench angles ranging from 49^{0}-69^{0}. The part of the profile near the floor is having a height of 45 m with an angle of 80^{0}.

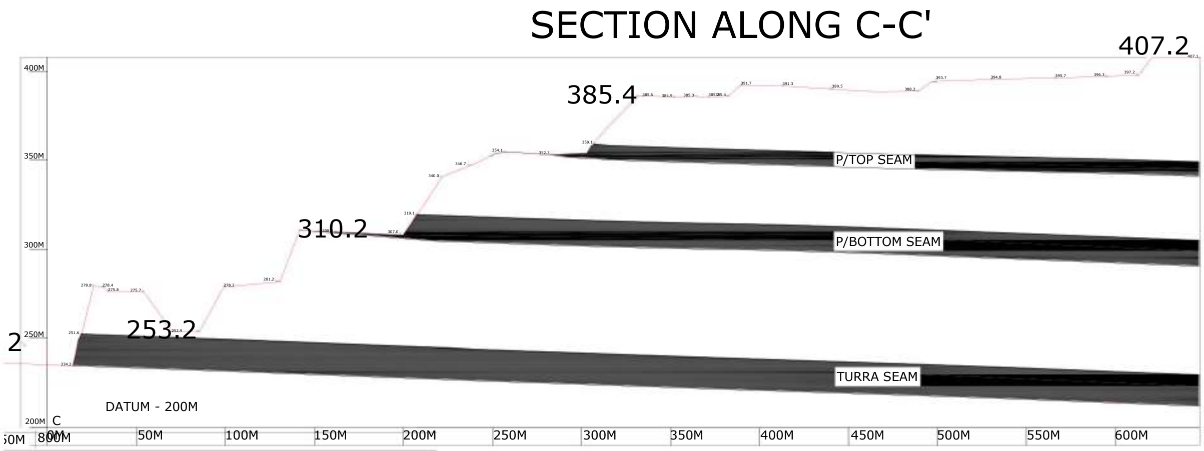


Figure 6.16: C-C' represents a profile along working benches at western quarry

15. Section D-D'

Section along D-D' represents a profile along working benches at western quarry. The elevation at floor is 220 m and at the top is 458 m. The average height of the face along the section from the floor is 250 m and overall slope angle is 16^0. The intermediate benches have bench angles ranging from 54^0-$67^{0.}$ The part of the profile towards the floor is having a height of 90 m with two benches. The with an individual bench angle of 75^0 and overall slope the particular section is 67^0.

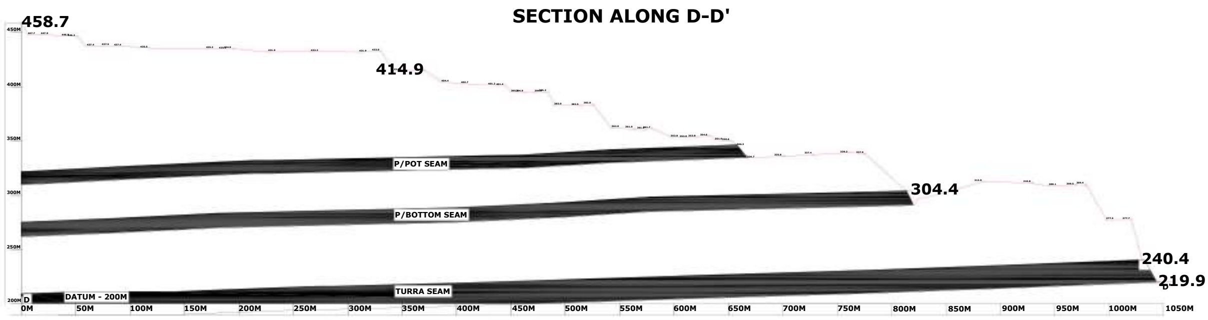


Figure 6.16: D-D' represents a profile along working benches at western quarry

16. Section F-F'

Section along F-F' represents a profile along working benches at eastern quarry. The elevation at floor is 243 m and at the top is 438 m. The average height of the face along the section from the floor is 224 m and overall slope angle is 16^0. The intermediate benches have bench angles ranging from 47^0-$64^{0.}$ The part of the profile towards the floor is having a height of 48 m with two benches. The with an individual maximum bench angle of 77^0 and overall slope the particular section is 44^0.

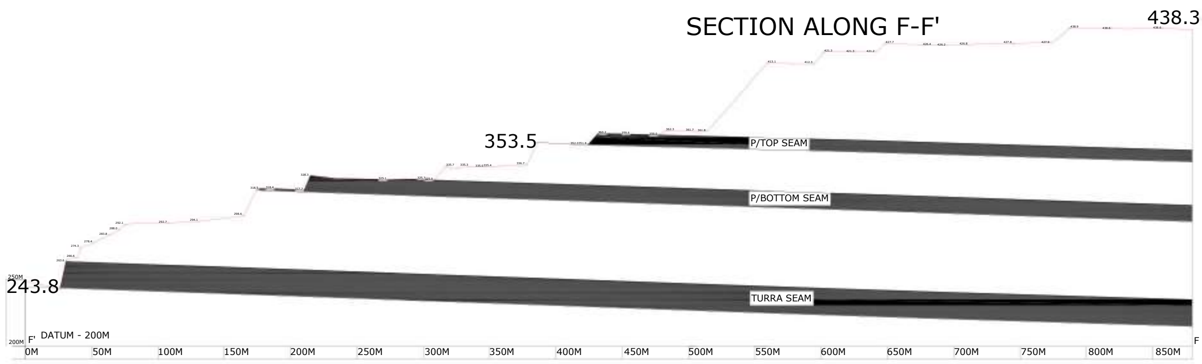


Figure 6.17: F-F' represents a profile along working benches at eastern quarry

17. Section G-G'

Section along G-G' represents a profile along working benches at eastern quarry. The elevation at floor is 270 m and at the top is 474 m. The average height of the face along the section from the floor is 250 m and overall slope angle is 18^0. The intermediate benches have bench angles ranging from 47^0-$65^{0.}$ The part of the profile towards the floor is having a height of 45 with bench angle of 77^0.

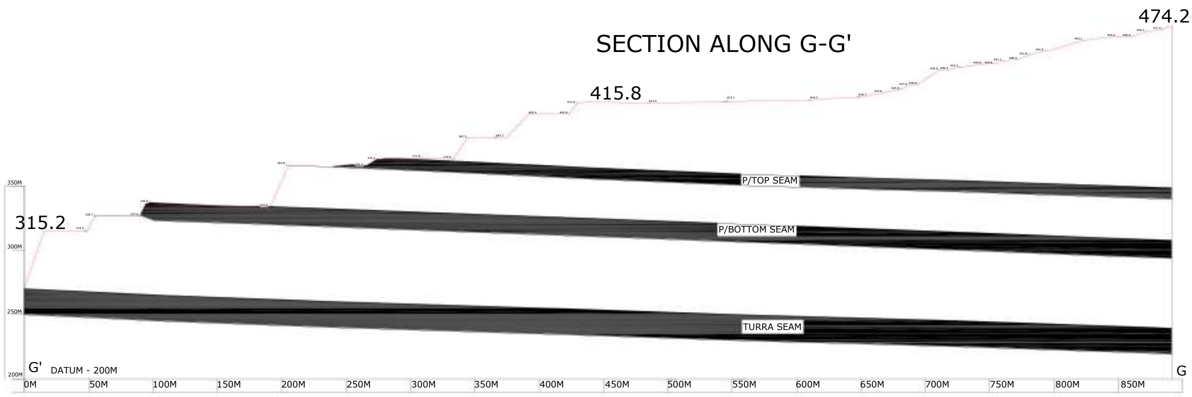


Figure 6.18: G-G' represents a profile along working benches at eastern quarry

18. Final stage pit slope : along Eastern Section

The particular profile indicates a final pit slope considered along the final stage quarry as proposed in approved PR. The toe of the profile is having an RL of 215m and at the top the RL is 480m, there by the average height of the final pit slope along that section is 265m. the overall slope of the profile is 36^0 with individual bench angle of 70^0 in OB.

19. Final stage pit slope: along western Section

The particular profile indicates a final pit slope considered along the final stage quarry as proposed in approved PR. The toe of the profile is having an RL of 175m and at the top the RL is 400m, there by the average height of the final pit slope along that section is 220m. the overall slope of the profile is 36^0 with individual bench angle of 70^0

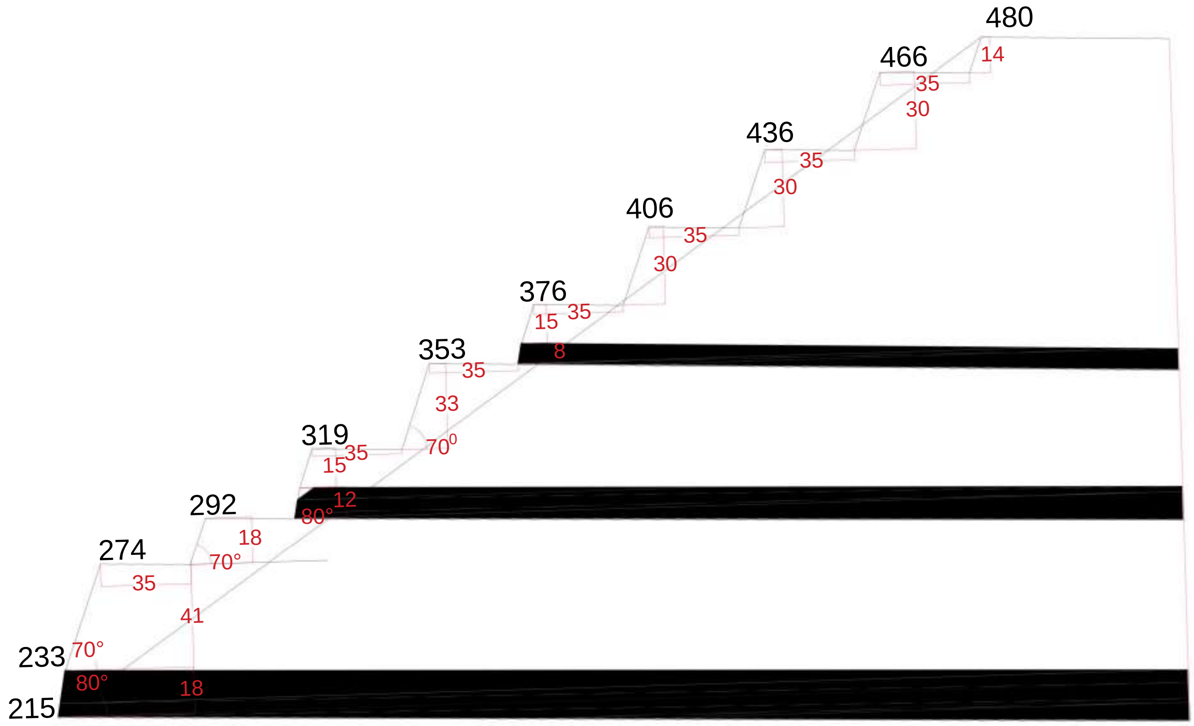


Figure 6.19: Final stage pit slope along eastern section

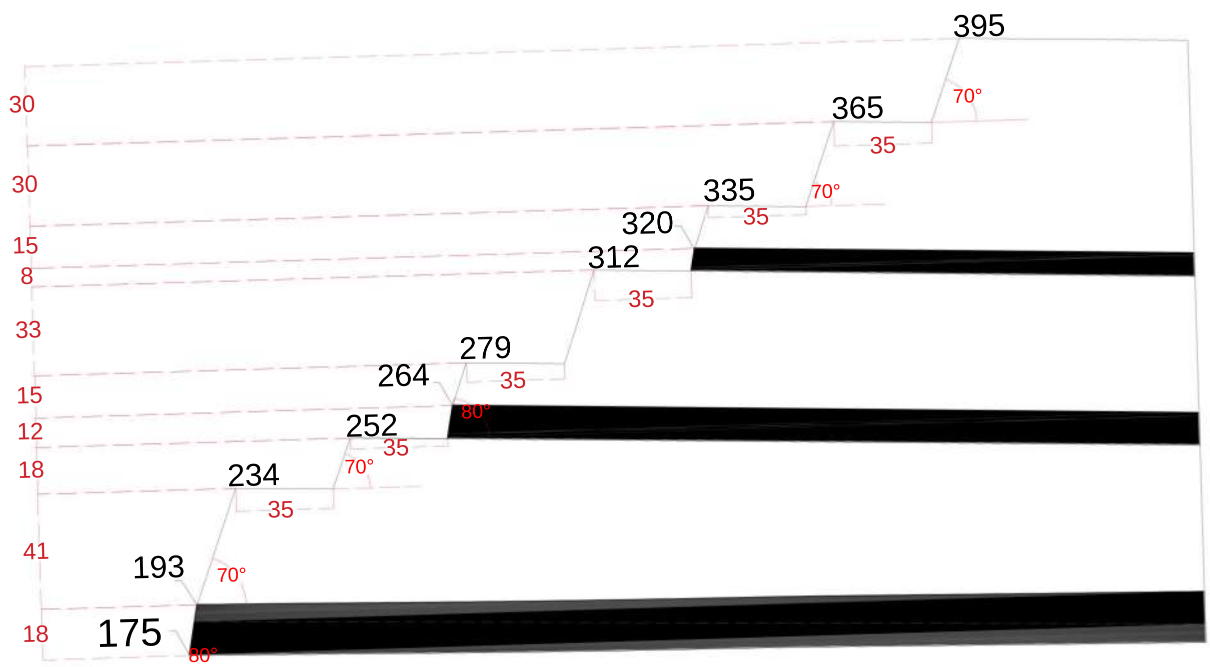


Figure 6.20: Final stage pit slope along western section

6.2 CONCLUSIONS OF STABILITY ANALYSIS

Table 6.1: Summary of analysis results

S.No	Section Description	FoS (Dry condition)	FoS (with Phreatic surface)
Existing Internal OB DUMP –West			
1	Section A-A’	1.37	1.37
2	Section B-B’	1.48	1.41
3	Section E-E’	1.32	1.26
4	Section K-K’	1.25	1.21
5	Section L-L’	1.02	0.95
6	Section M-M’	1.41	1.33
Existing Internal Dump –East			
7	Section H-H’	1.49	1.44
8	Section I-I’	1.45	1.42
9	Section J-J’	1.25	1.21
10	Section O-O’	1.35	1.33
11	Section N-N’	1.40	1.37
Proposed Final Stage Dump			
12	Section 1-1’ along West	1.37	1.32
13	Section 2-2’ along East	1.40	1.38
Existing High Wall –West			
14	Section C-C’- Overall slope	1.54	1.50
16	Section D-D’ Overall slope	1.07	1.06
17	Section D-D’- Analysis for Intermediate Benches	1.6	
Existing High Wall –East			
18	Section F-F’	1.52	1.52
19	Section G-G’	1.73	1.68
Proposed Final stage Pit slope			
20	Along East	1.48	1.37
21	Along West	1.42	1.40

For stability analysis of existing sections viz section of dump, highwall , ultimate pit slope and final stage dump plans sections (as indicated above in figure 6.19 & 6.20) are considered for modelling using SLIDE2 software as these appears to be critical by virtue of geometry of slope profile and consequence of failures.

All these sections are analysed for deterministic global minimum Factor of safety for dry condition and also with elevated phreatic surface condition for simulating rise in water table above ground level during monsoon or due to any hydrological conditions

Out of these sections,

i) Analysis for existing dump Section K-K’ along dump (west) results in a FoS of 1.25 for dry condition and 1.21 with phreatic surface respectively for given conditions.
ii) Along existing dump section L-L’ Analysis along dump (west) results in a FoS of 1.02 for dry condition and 0.95 with phreatic surface respectively for given conditions.
iii) Analysis for existing dump Section J-J’ along dump (East) results in a FoS of 1.25 for dry condition and 1.21 with phreatic surface respectively for given conditions.
iv) Existing highwall section D-D’ along highwall (west) result in FoS of 1.07 and 1.06 dry and phreatic surface conditions respectively

The lesser FoS for profile along Section K-K’, could be due to an 83 m high single bench OB dump. The lesser FoS for profile along Section-L-L’, could be the approx. 100 m high single bench with slope angle of around 40 degrees. Along highwall section D-D’, the lesser FOS may be due to the part of profile towards the floor, which is having a height of 90 m with two benches. The with an individual bench angle of 75^0 and overall slope the particular section is 67^0.The geometry of these sections should be modified to attain better safety.

The remaining existing working sections in highwall and OB yields factor of safety more than 1.30 in all cases, which is required for temporary working slopes. This indicates these existing profiles along these sections appears to be safe for the given site conditions.

Final batter sections along section east and west in PR as shown in figure 6.19 & 6.20 are considered for stability analysis. Analysis for overall stability of sections results in FoS of 1.48 and 1.42 respectively and it is nearly 1.50 which is the stipulated FoS for permeant slopes. Final batter slope along East and west indicates that the slope profile along this is safe for the present given strata properties and slope conditions. However further detailed analysis in later stage of mining may be required to confirm the impact of water and with exact strength properties of depth wise start along final pit slope.

Stability analysis for final stage external dump along section 1-1’ and 2-2’ along west and East dumps as per PR results in the FoS of 1.37 and 1.40 (>1.3 but <1.5) which indicates the proposed external dumping appears safe for the given conditions. The final stage dump section as proposed in PR results in FoS of less than stipulated FoS (i.e 1.5) for permanent slopes. Better Drainage management and not allowing to accumulate water along with proper benching as proposed in PR may result in further stability.

6.2.1 Geometry of the benches recommendations

6.2.2 Ultimate Pit slope

The overall slope angle of ultimate pit should be limited to 36^0- 38^0 as proposed in PR. The Elements of mining system have been determined in accordance with the parameters of excavation and transport equipment and the parameters of drilling and blasting (table 4.5). The main OB bench overlying Turra seam is to be removed by dragline system and proposed to be side cast in the decoaled cut. The OB from upper benches is being handled by Shovel-dumper system and accommodated over the dragline side cast spoil within the pit. The proposed ultimate pit slope section is shown below

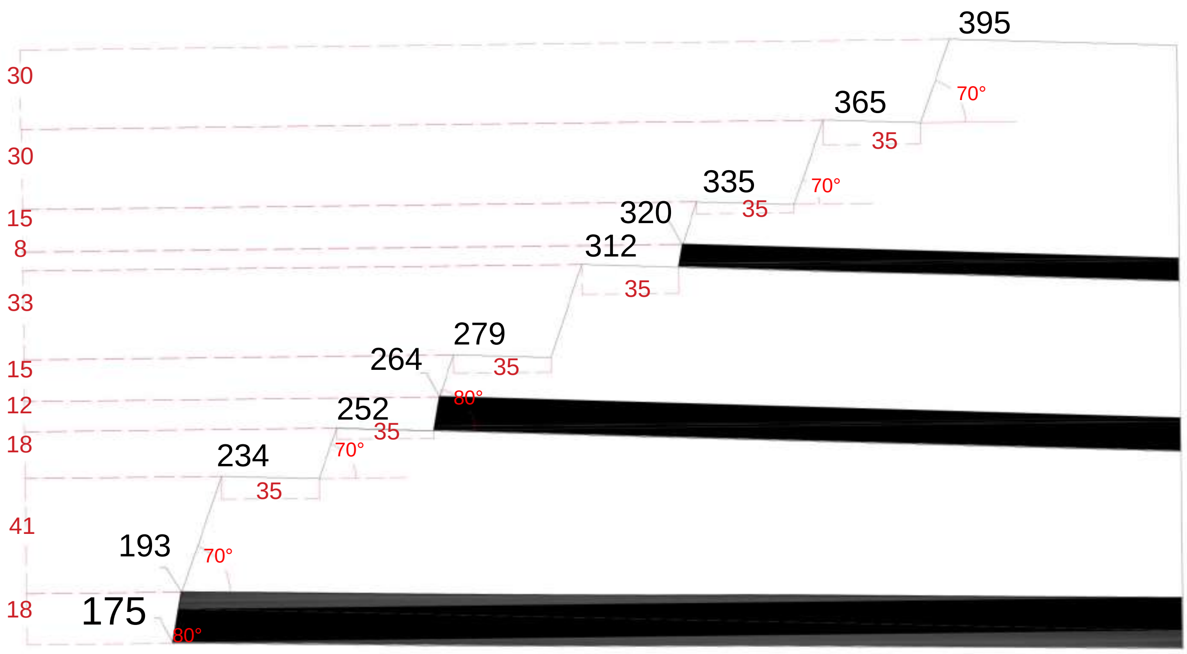


Fig 6.21 Proposed Ultimate pit slope with various elements

6.2.3 Overburden dumps

The geometry for the benches is recommended as per the dump geometry proposed in the PR/Mining plan i.e the Bench height of OB dumps formed by Shovel-Dumper system will be 30m and slope of individual dump benches will be 37^{o} (equal to angle of natural repose of OB material). Width of berm between two adjacent benches will be 40m. Overall slope of dump works out to be 28$^{o.}$

While forming any new dumps or modifying the slope profile of existing dumps attention should be given to the CMR 2017 guidelines, which says any spoil bank exceeding 30 meter in height shall be benched so that no bench exceeds 30 meter in height and the overall slope shall not exceed 1 vertical to 1.5 horizontal.

The below suggested typical profile as per CMR 2017 is to be followed for any new OB dumps that are being planned as well as it is to be adopted where ever it is practically possible along existing sections for any further dumping that may be planned or while modifying any existing dump sections. However, along sections of old and abandoned dumps where active dumping is not going or further dumping is not proposed or planned, the existing dump profile may be continued with imposing restrictions on movement of men and machinery by placing proper fence/signboards

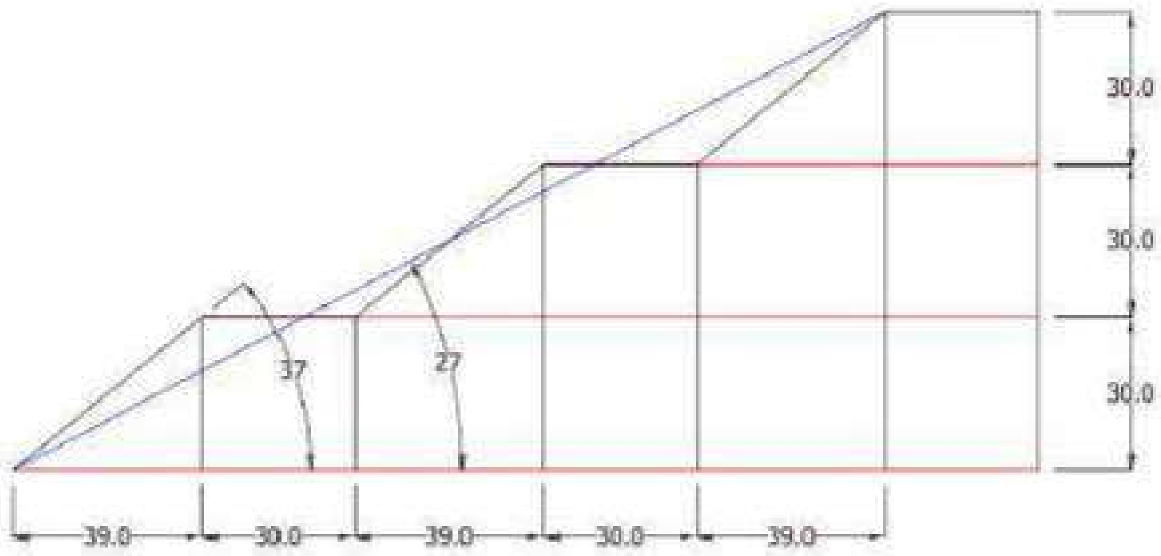


Fig 6.22 proposed typical profile of benches to be incorporated as per CMR 2017

6.3 RECOMMENDATIONS

The mine is being worked by shovel-dumps combination. The stability of the slope primarily depends on the strength properties of the dump material, orientation and geology of the dump foundation, infiltration of the rainfall, and drainage and ground water conditions within the slope.

The bench geometry of mine pit should strictly follow specifications as mentioned in Mining plan. In case of use of any other machinery, the bench geometry will be guided by maximum width of machinery & related DGMS guidelines.

Failures can occur in local level, even if the overall slope of the working pit is found to be safe, if the individual benches are steeper and doesn’t follow the specified criteria. Locally, in many areas of working benches, individual benches are narrow with some localized failures and gulley formations. It is necessary to maintain proper bench geometry having adequate bench width & proper bench height for better stability. Bench geometries stipulated in regulation 106 of CMR 2017 should be adhered wherever it is practically feasible for the existing and future planned slopes and critical slopes.

Presence of water causes negative consequence towards pit stability. Garland drains are to be provided along crest side for smooth passage of water. Benches are to be properly graded to inhibit formation of sludge. Semi horizontal pipes may be inserted for draining out water wherever necessary.

In the formation of external dumps, the slope profile, viz bench height and bench angle should be as indicated in PR/Mining Plan.

In dragline mining, the toe of the dragline dump/coal barrier is generally at a distance equivalent to the cut width of the dragline bench. Permission/exemption, if required may have to be taken as per the requirement of mine.

As the rehandled dumps are comparatively newer and of less height, strict measures should be taken so as to maintain tier system of dumping, where each tier should not exceed a height of 30 meters.

Placement of the materials in the dump in accordance with the planned development and operating plans, including lift height and location.

A dedicated geotechnical cell should be formed at project level which should undertake frequent visual inspection and all the relevant information should be recorded.

RL measurement of monitoring stations should be thoroughly carried out. The monitoring work is to be supervised and verified by a senior survey officer.

Visual inspection of any cracks should be done diligently. Widening of cracks should be measured by crack meters and recorded regularly.

For continuous monitoring of slope movement installation of Slope Stability Radar may be considered. Today almost all SSR are equipped with mechanisation to provide early warning signals about approaching failure.

6.4 LIMITATIONS OF THE STABILITY ANALYSIS

- Soil/OB is a very complex material. In nature, heterogeneous type of soil is found which has different properties at different depth and places.
- Accurate soil/OB properties cannot be derived in laboratory by merely testing few samples, because no theory can exactly simulate the field conditions.

- It is very difficult to take the soil/OB sample from the deep inside the OB dump and measures were taken to collect the representative samples as per IS codes.
- Judicious judgement based on combination of theory and practical experience from the past studies help to arrive at the necessary assumptions for the study.
- In geotechnical engineering field there are many uncertain factors which govern the stability analysis which depends on the assumptions made for the study. As a result, factor of safety determined may vary to some extent from study to study. In the study, all normal failure conditions are checked for determination of FoS with the best possible assumptions and judgment

6.4.1 Disclaimer

This scientific study is based on the data and information available at the time of the study, as well as on certain assumptions and models used in the analysis. The study may not have been able to fully account for the inherent variability and uncertainties associated with geological and mining conditions, as well as for the limitations of the data and the analysis methods used. Therefore, the study results and recommendations should be considered as estimates and subject to some degree of uncertainty. The actual conditions at the coal mine may differ from those assumed in the study, and unexpected events or changes in mining operations may impact the reliability and validity of the study results.

In summary, this study provides a preliminary assessment of the geological and mining conditions at the coal mine and recommends design measures and strategies based on the available information and analysis methods. However, it is subject to the inherent uncertainties and variability associated with geotechnical work and should be considered in conjunction with other available information and professional judgment.

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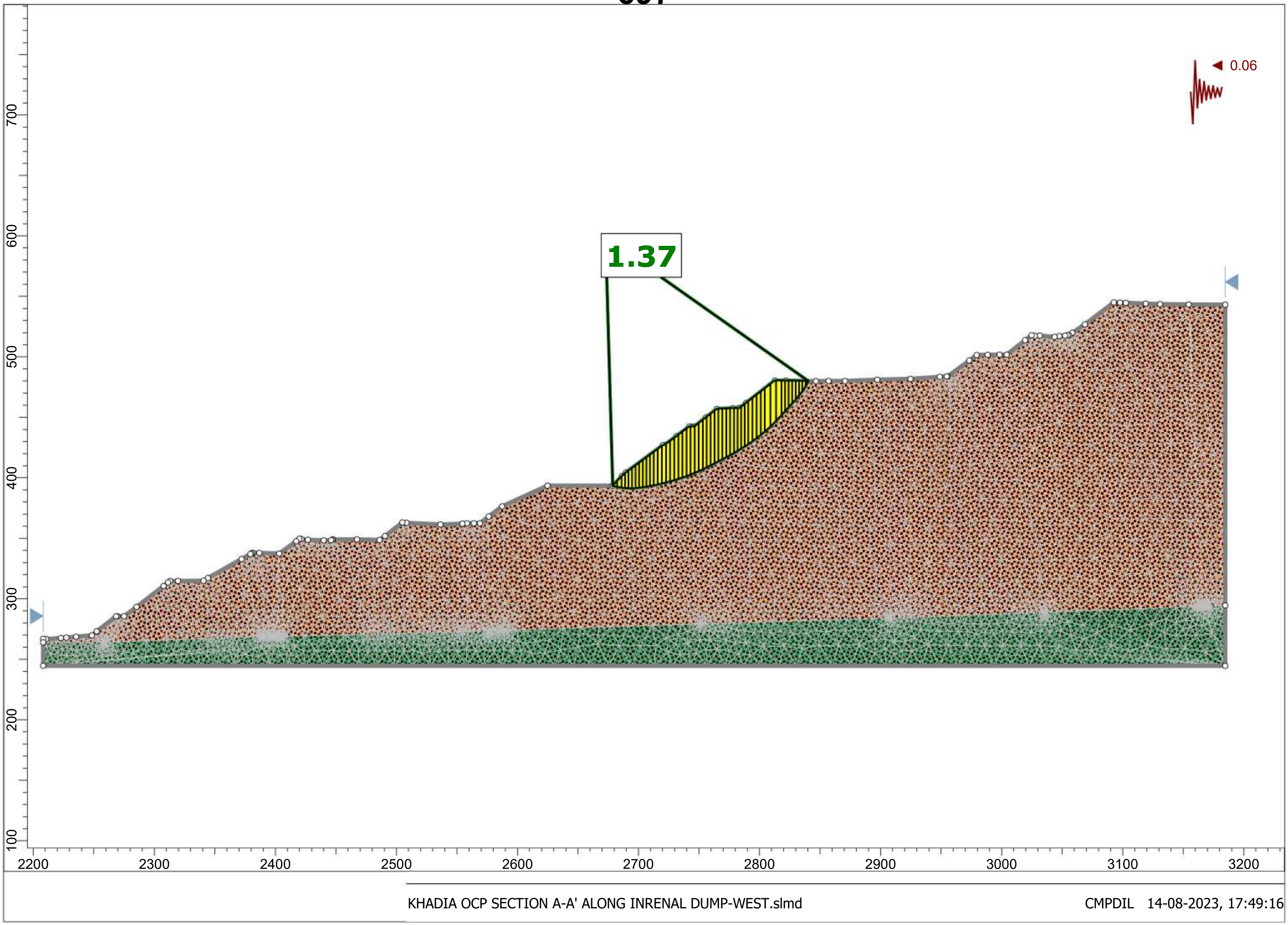
***Slope Analysis Models and Results:** The detailed slope stability models developed by SLIDE2 by LEM usining steady state ground water FEM for existing sections and ultimate pit and dump slopes (As indicated in section 6.2 above) are presented below as Annexure-1*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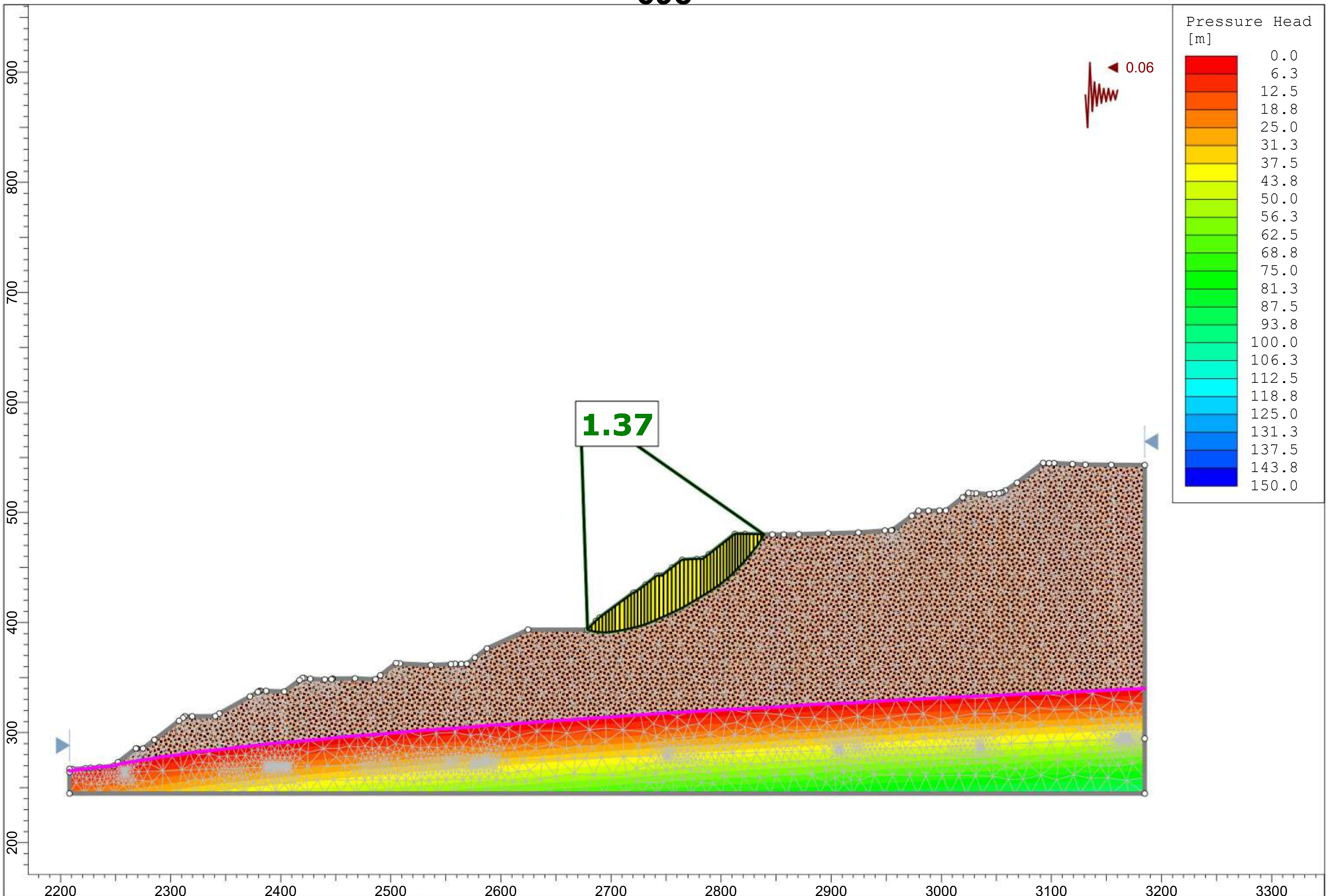

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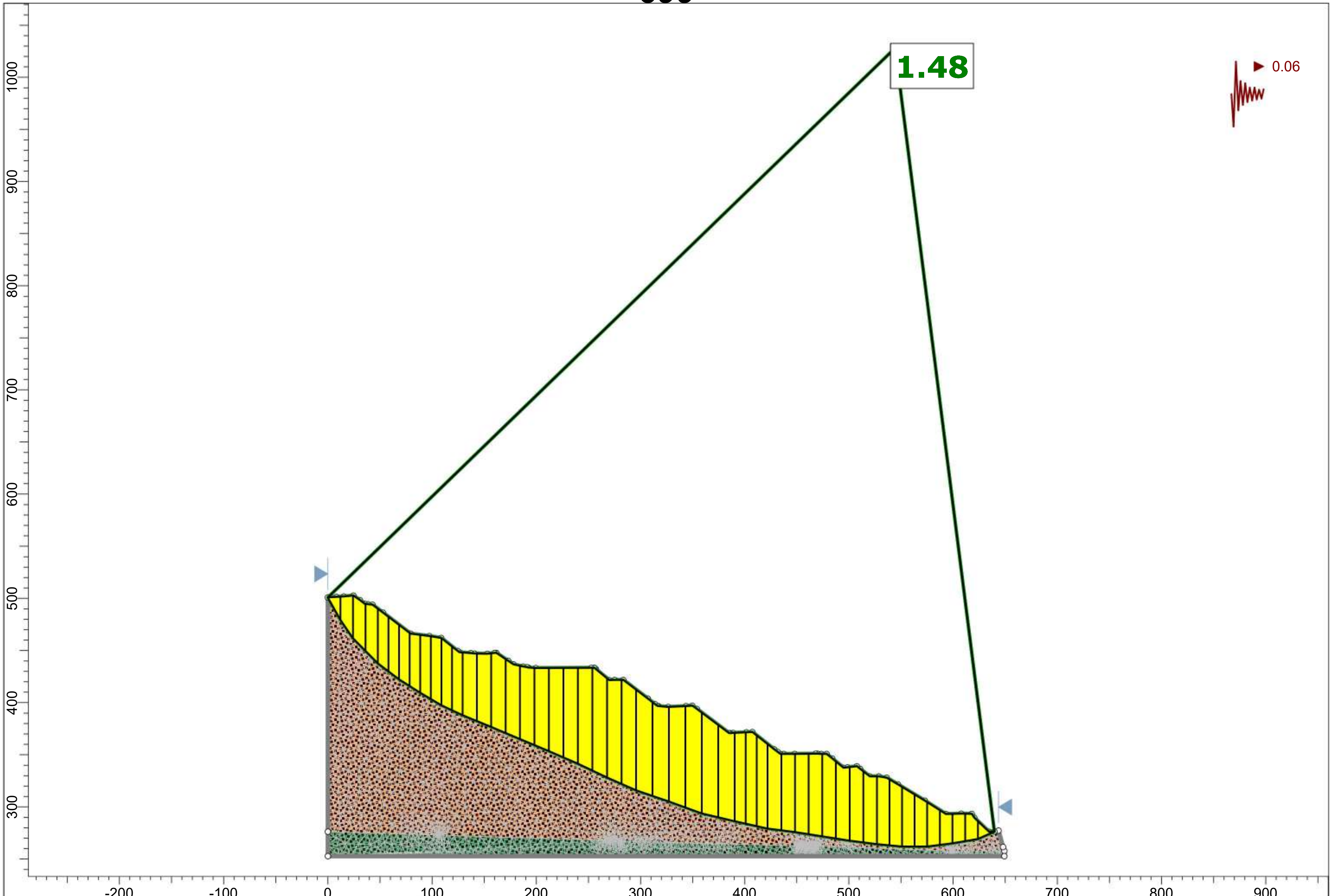

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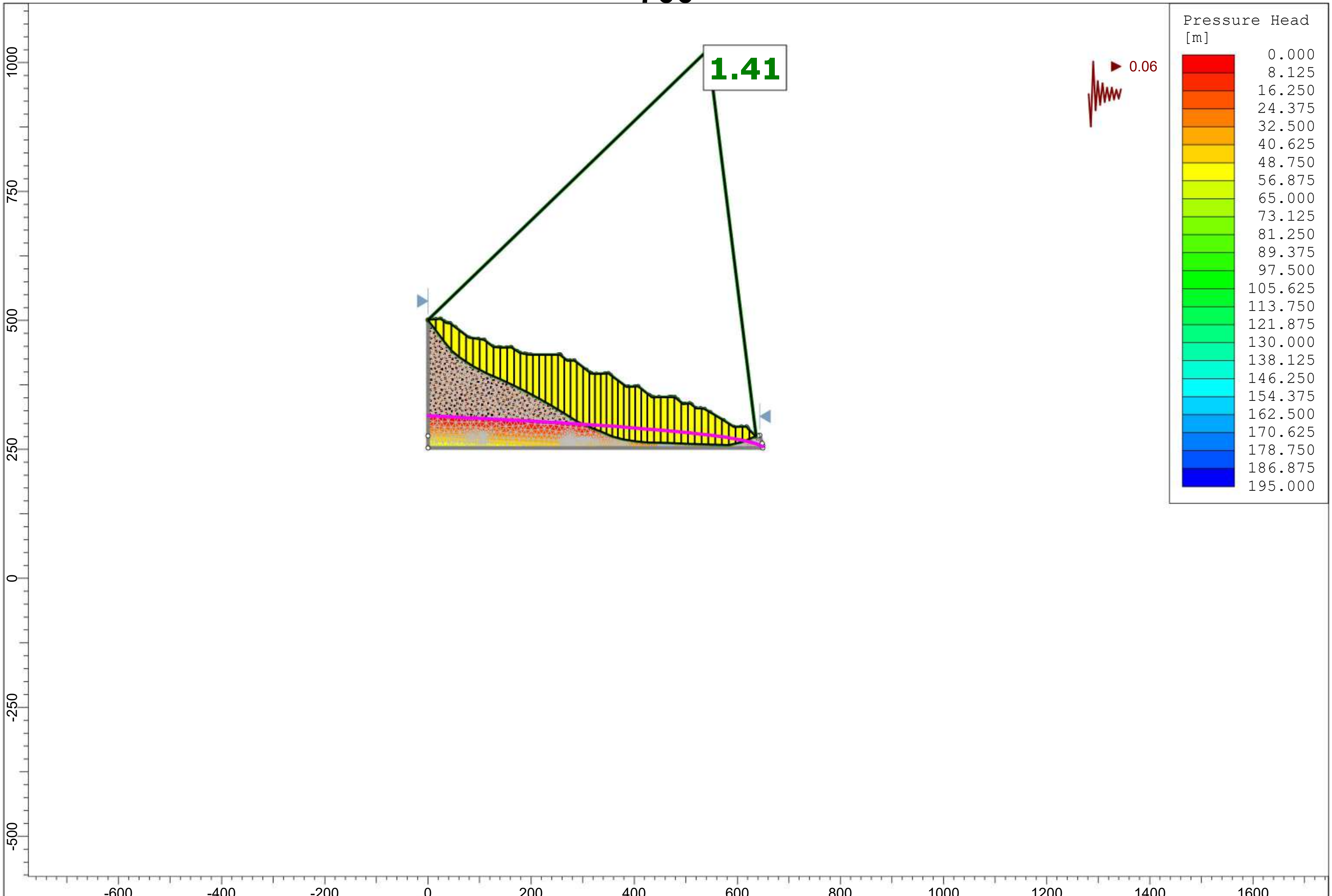

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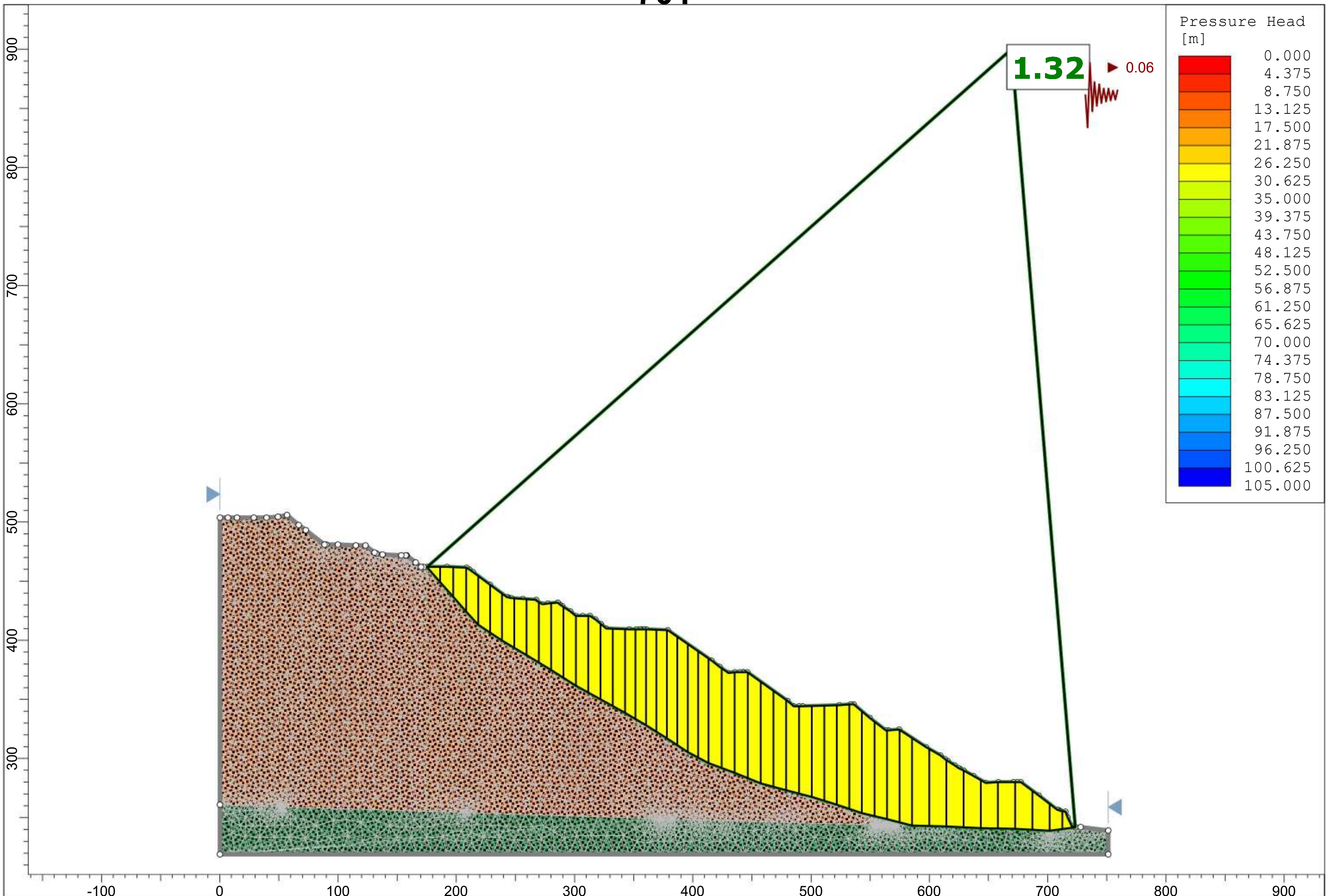

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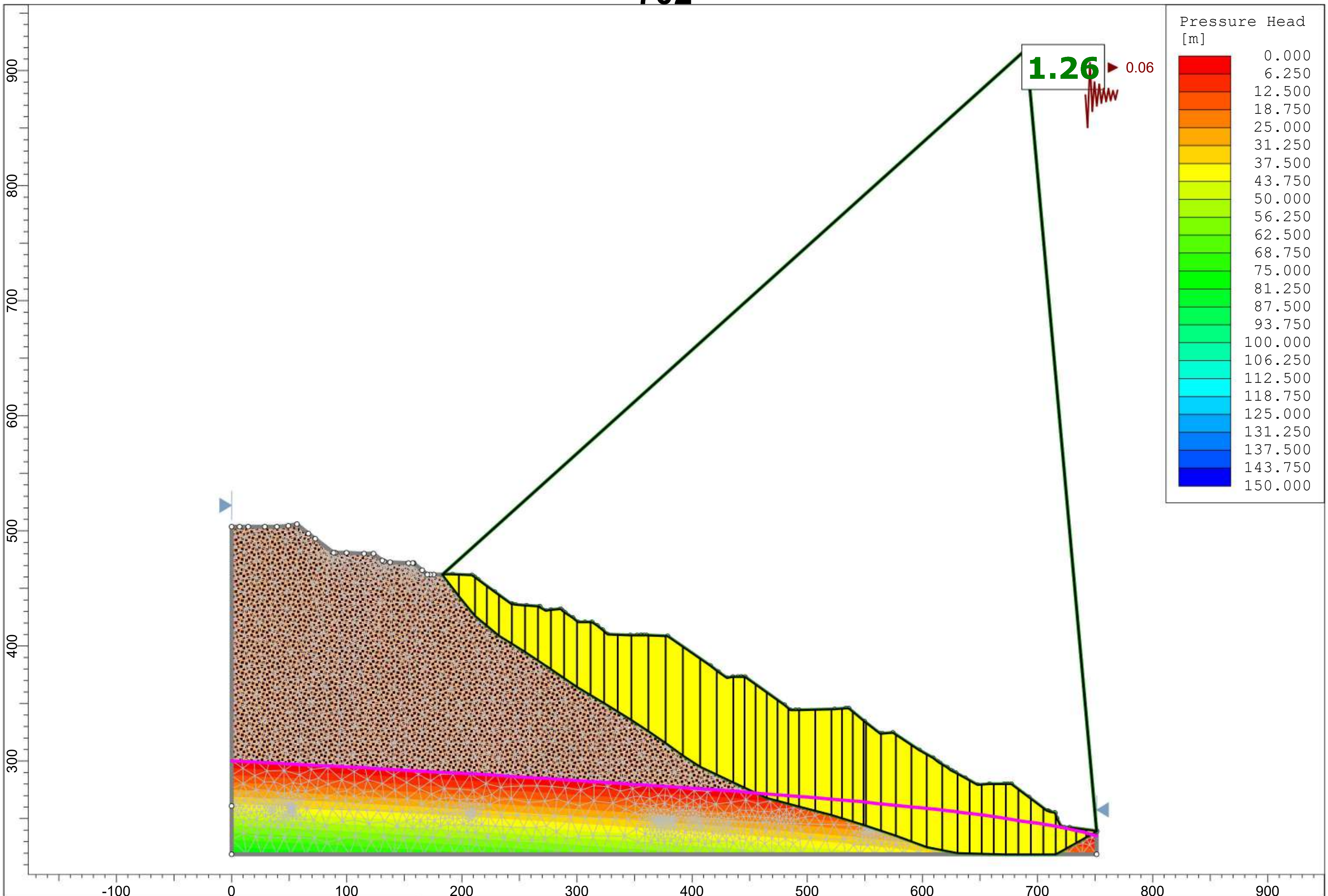

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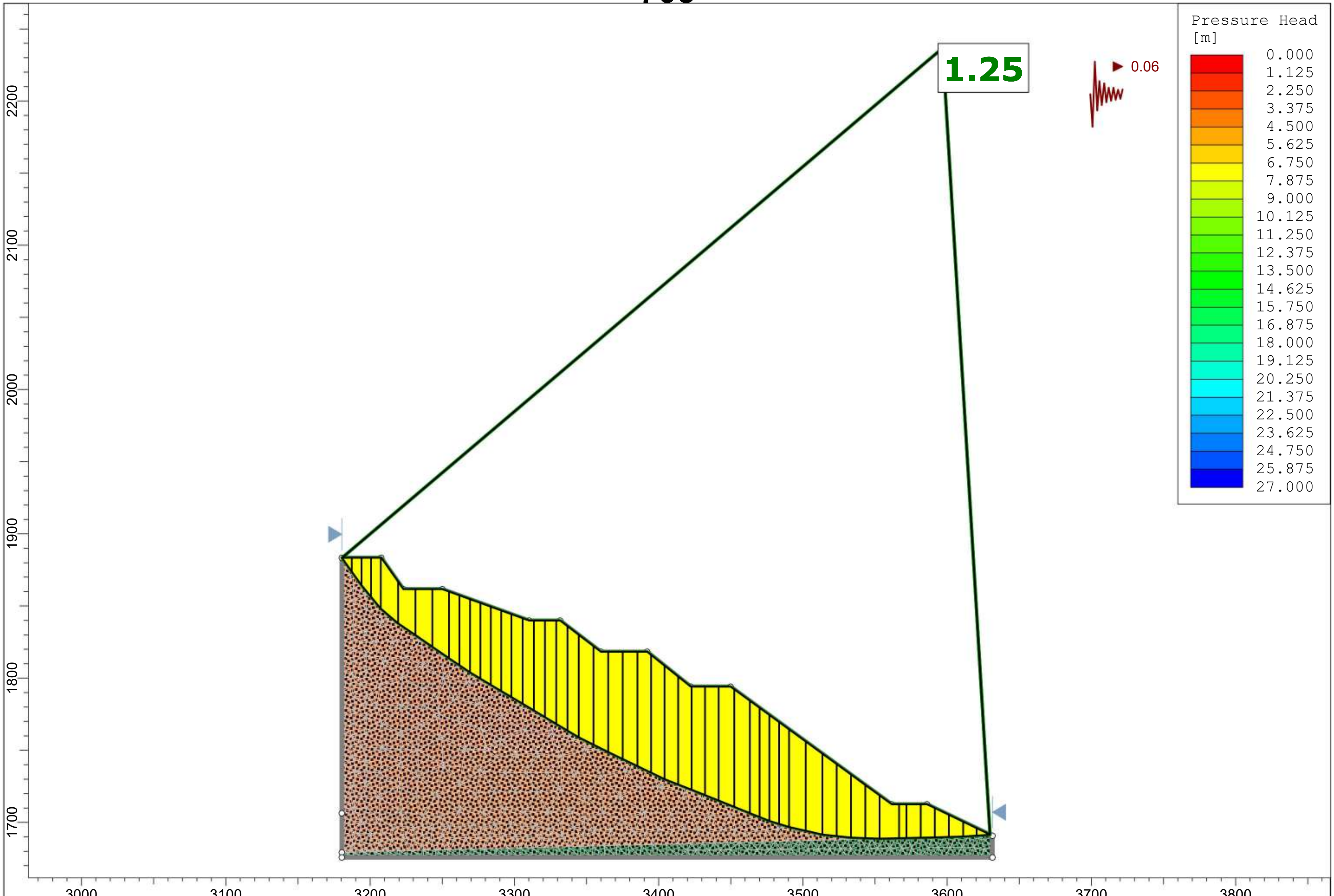

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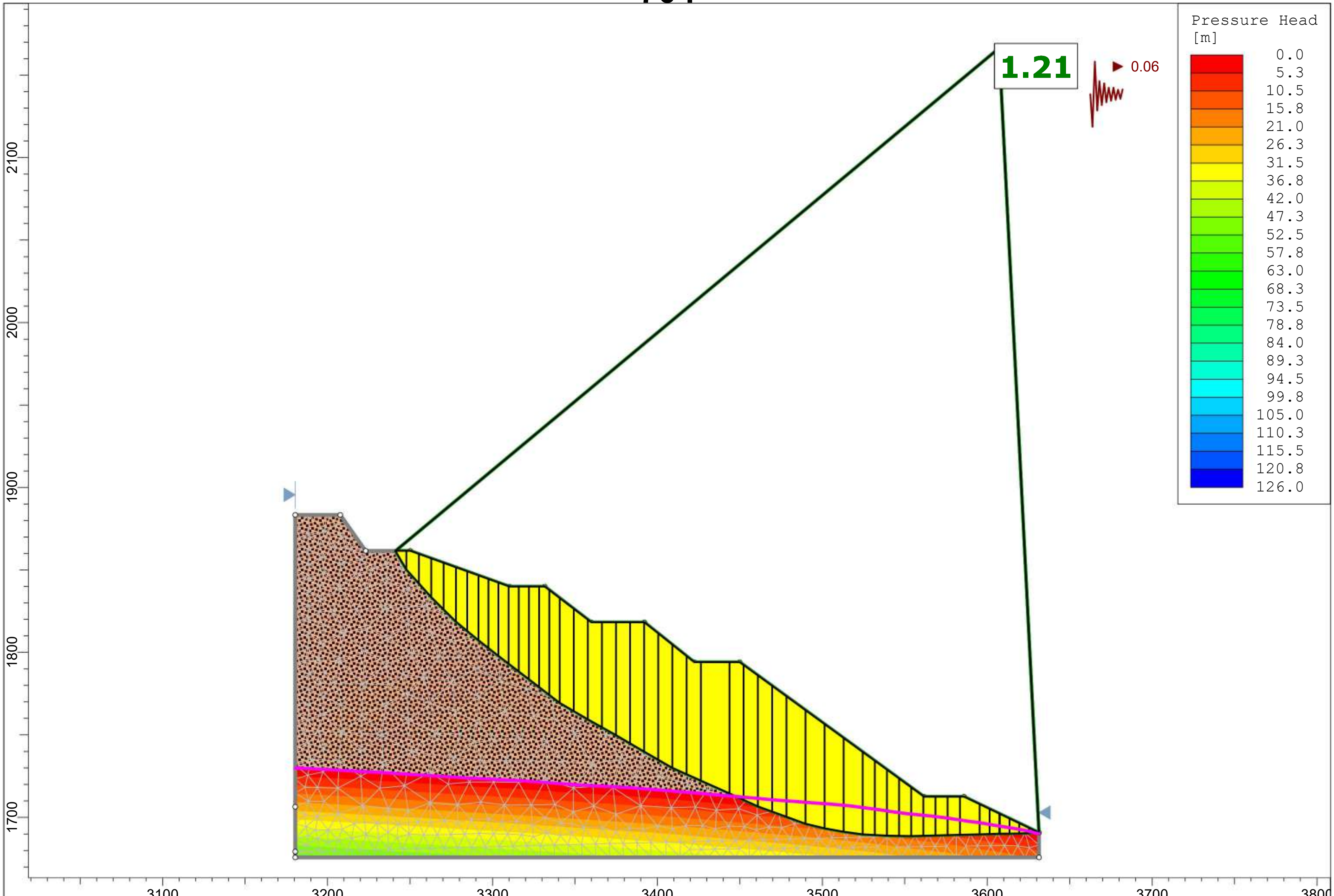

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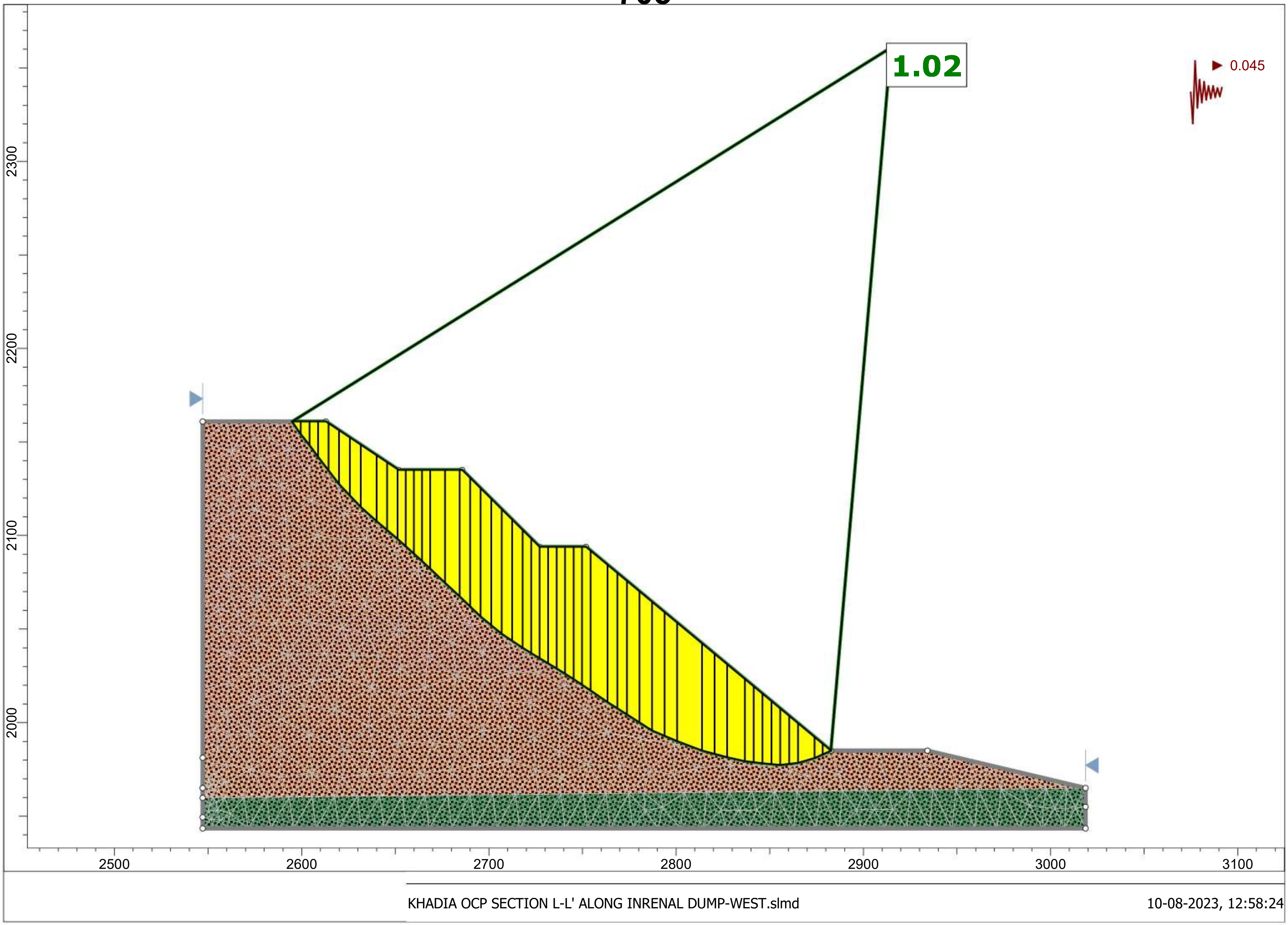
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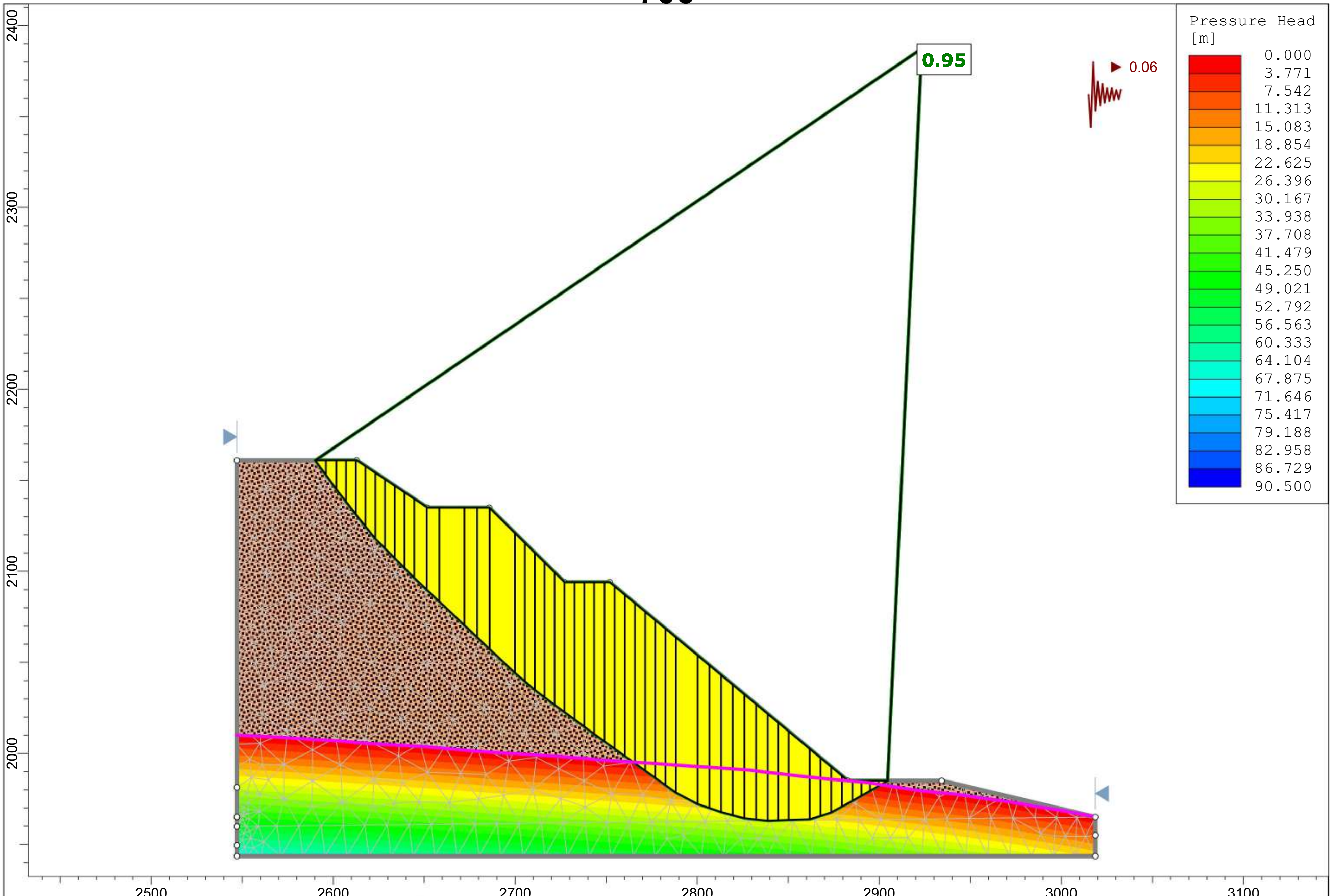

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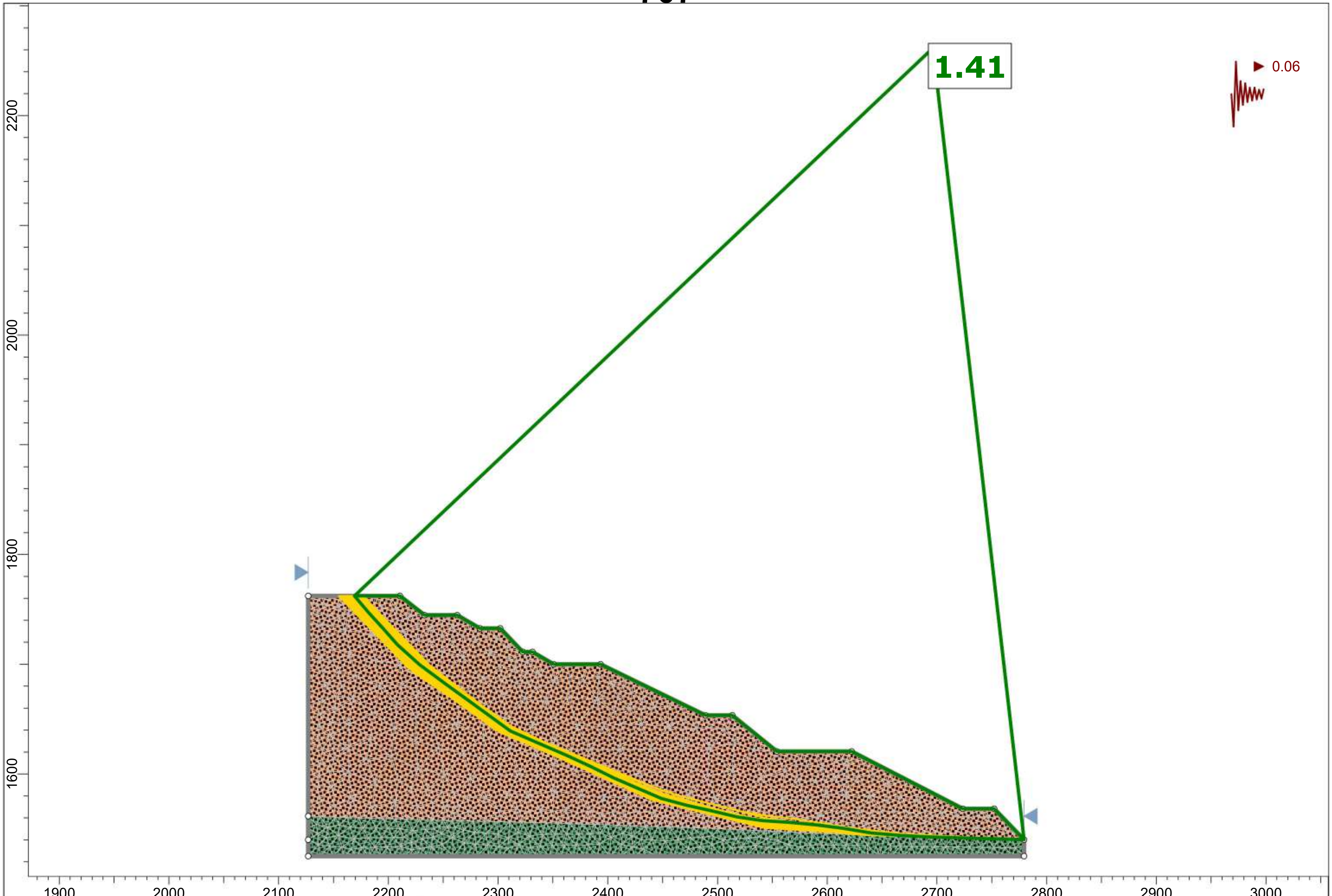

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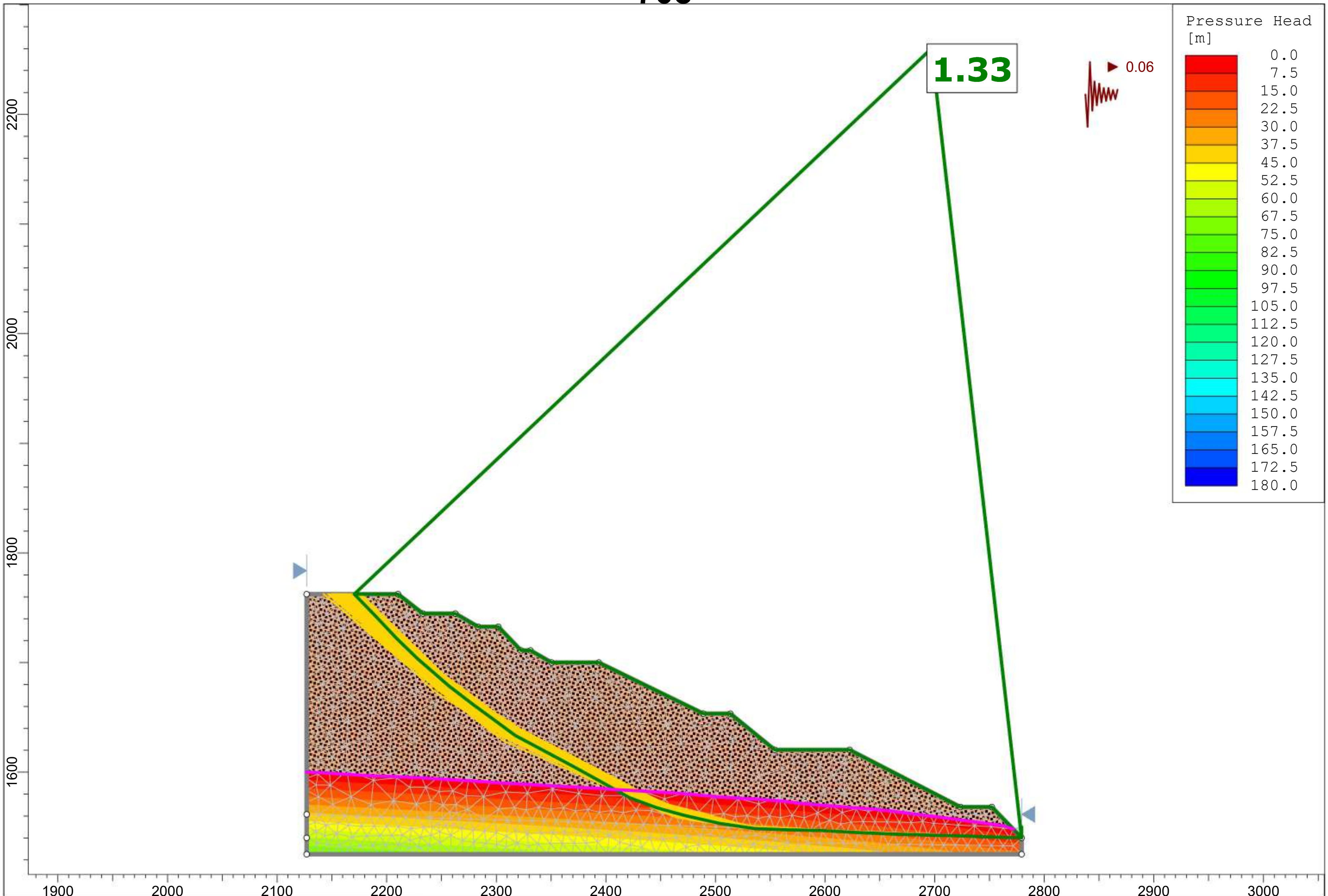

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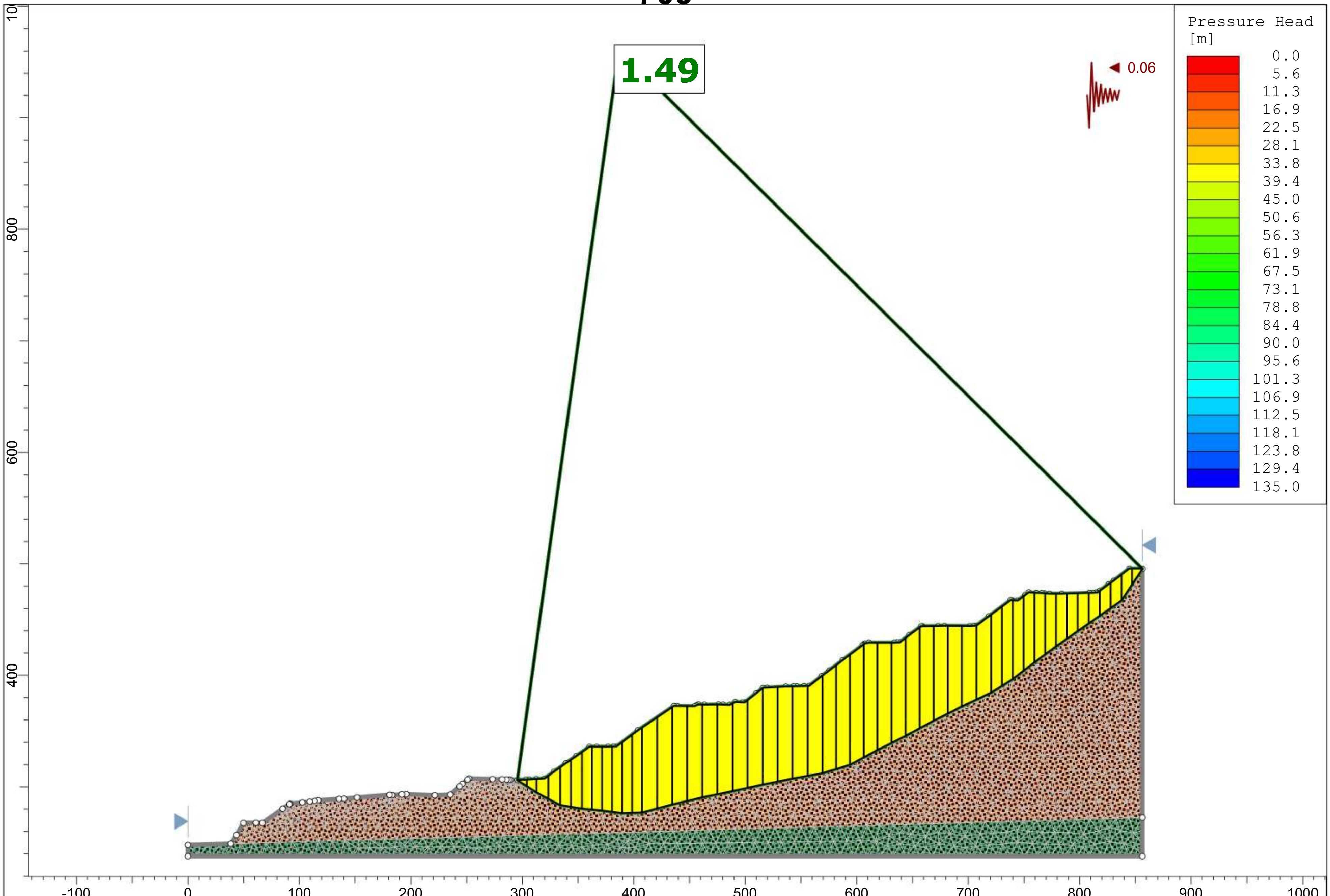

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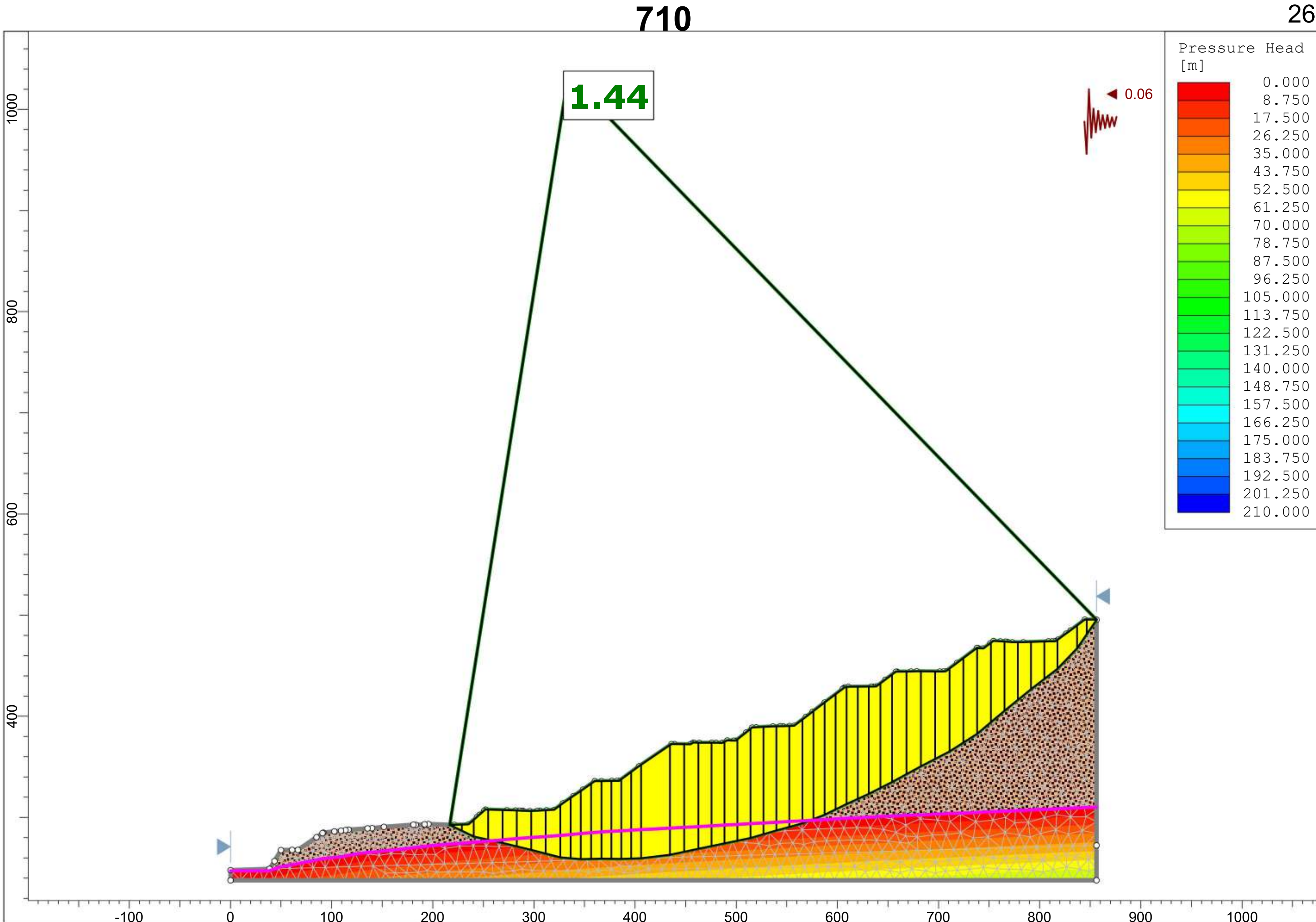

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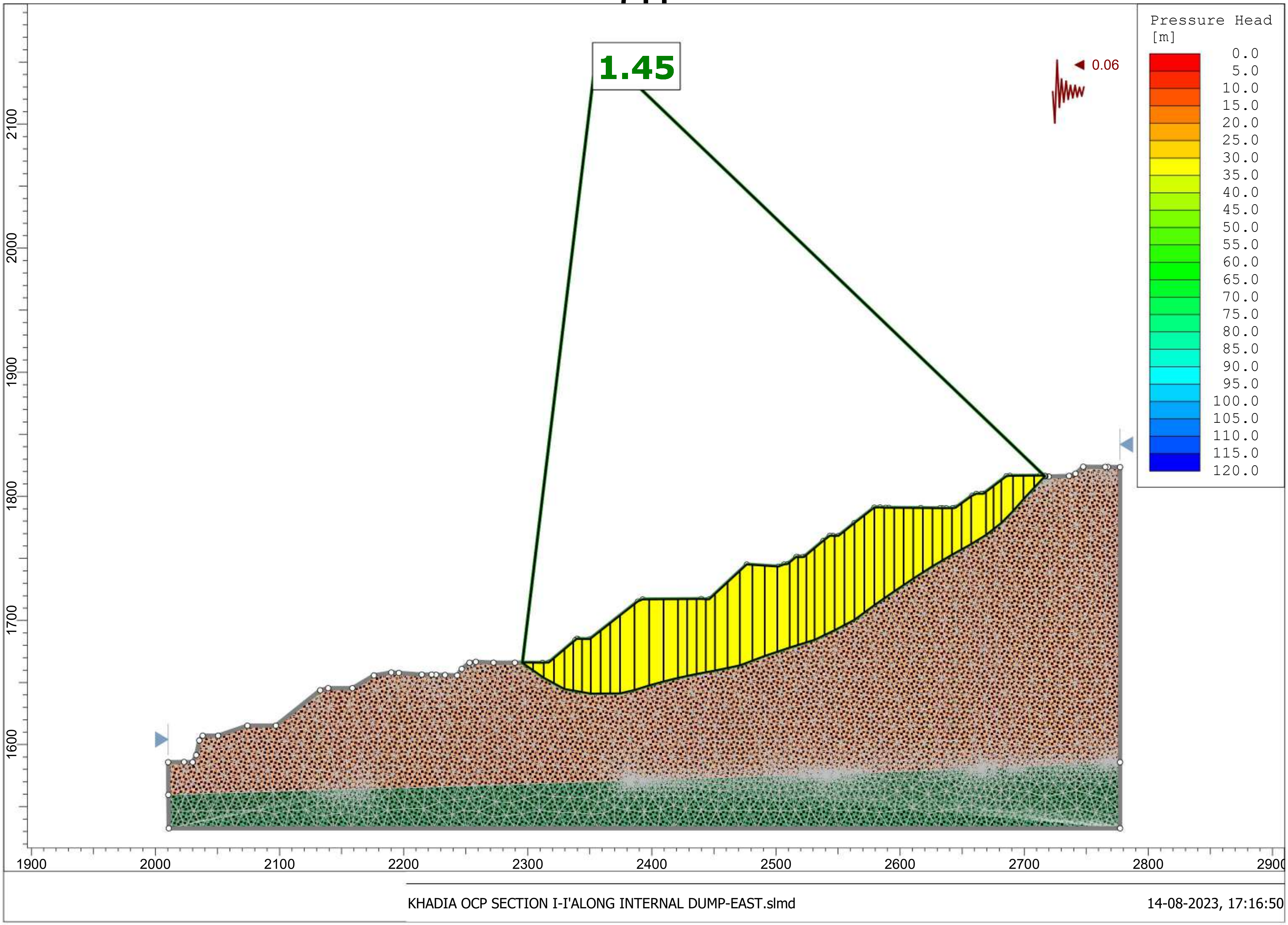
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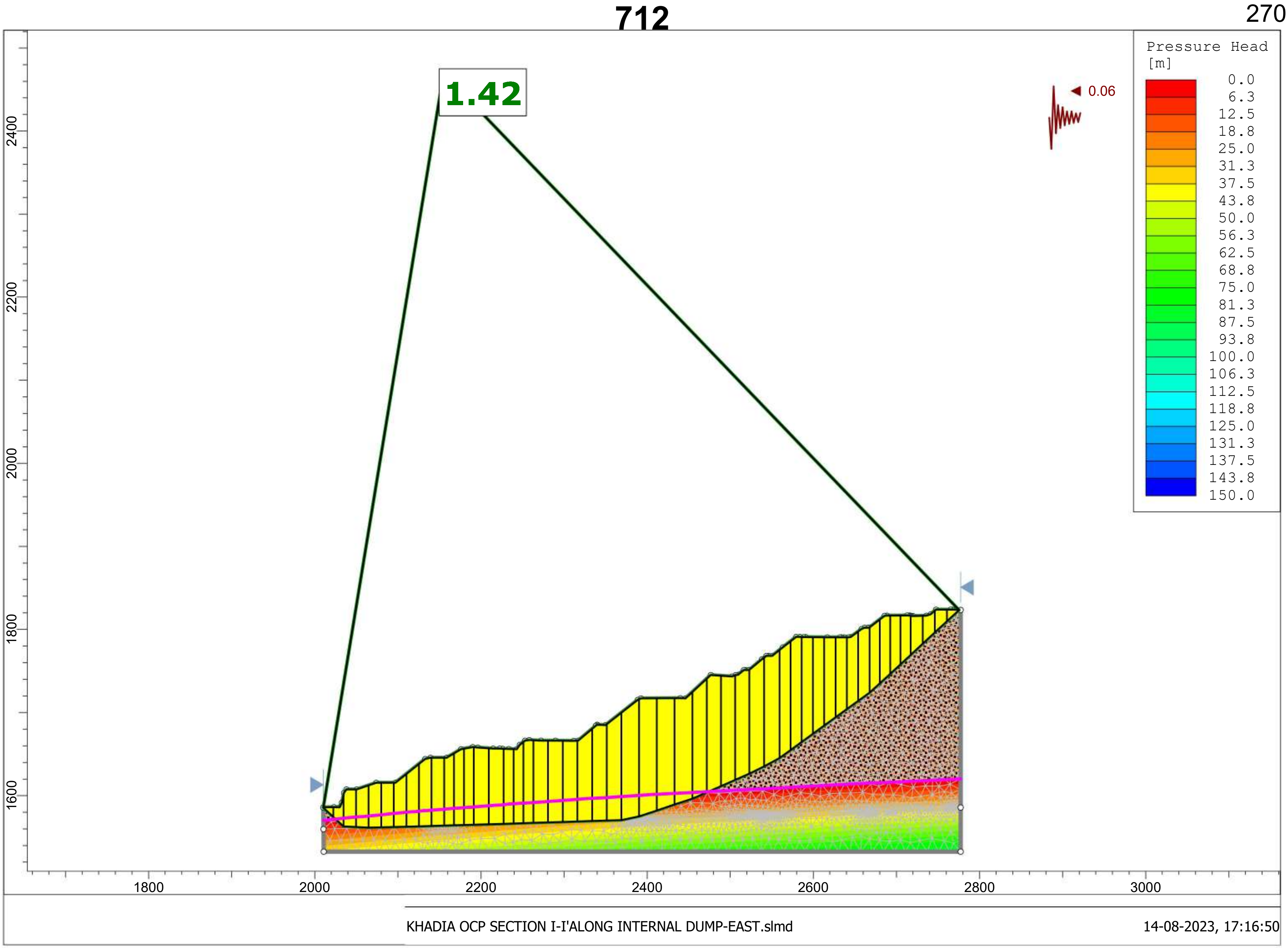
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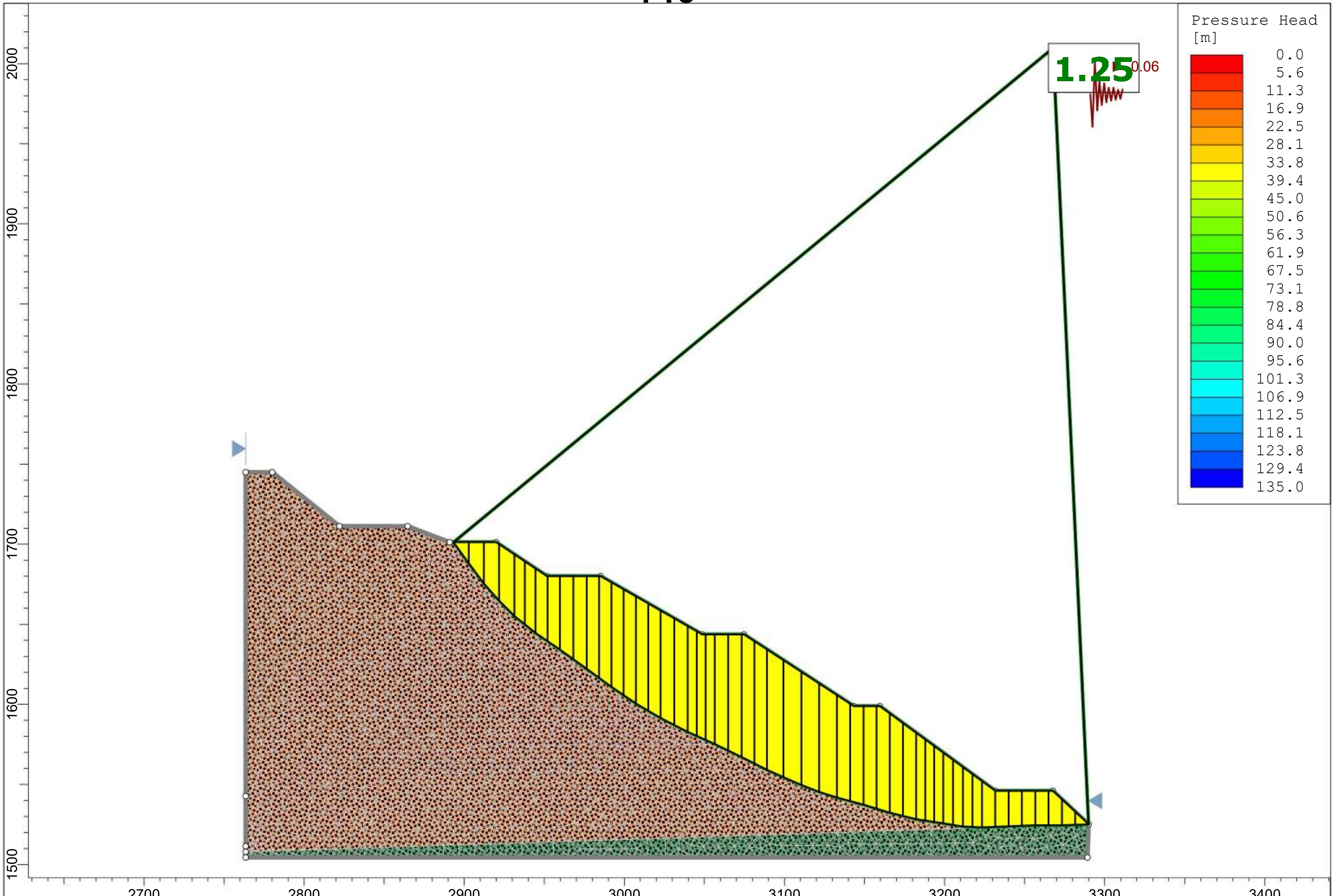

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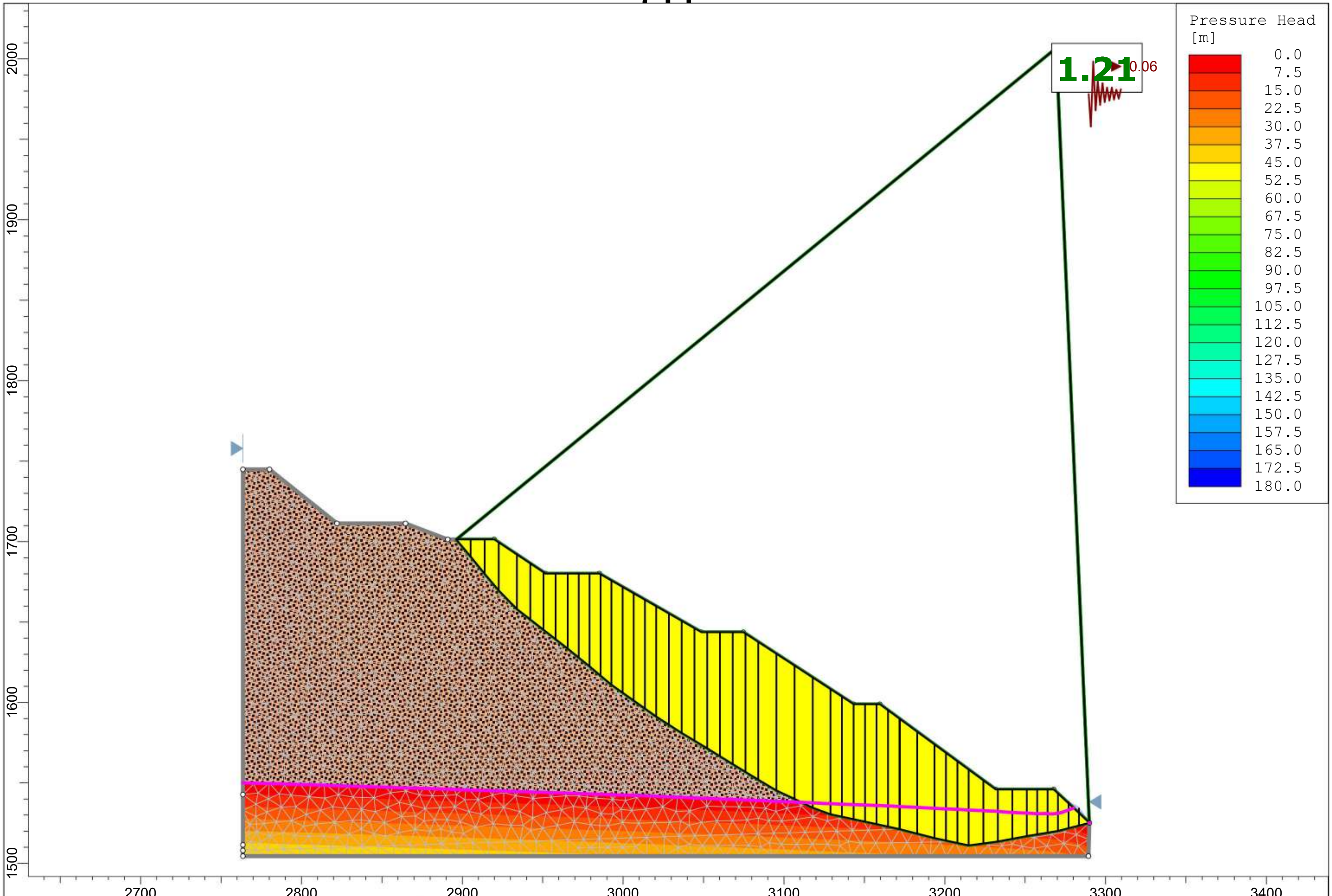

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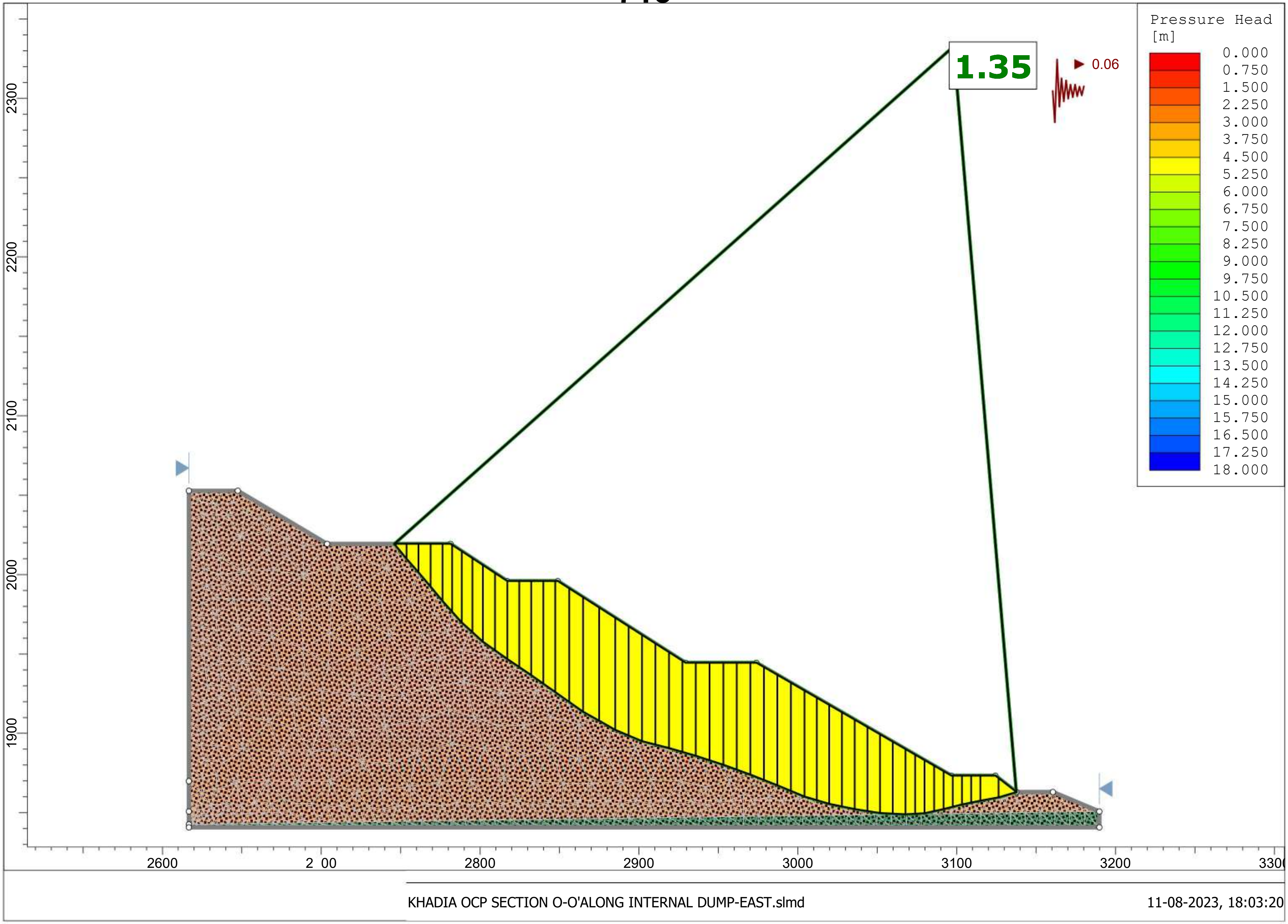
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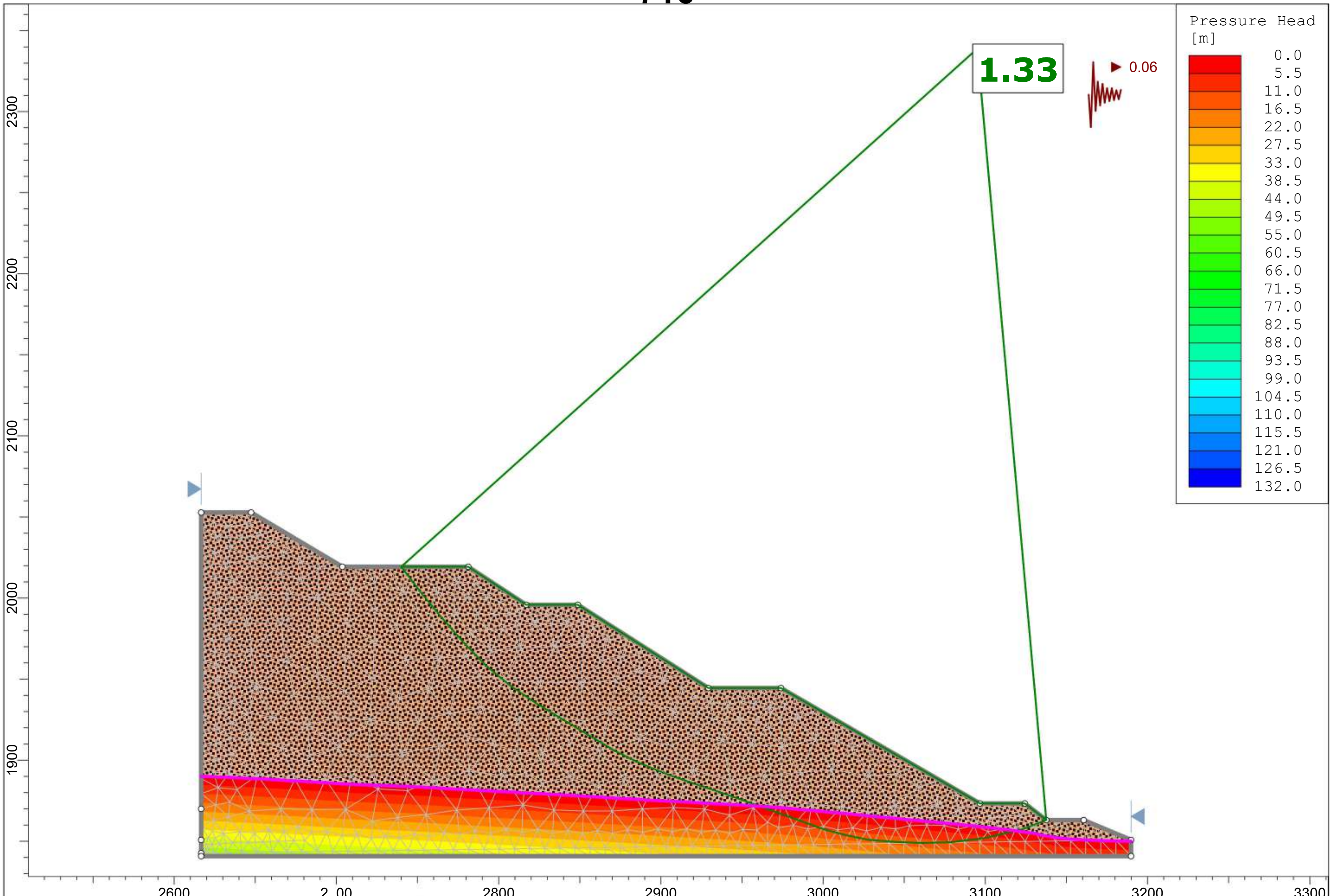

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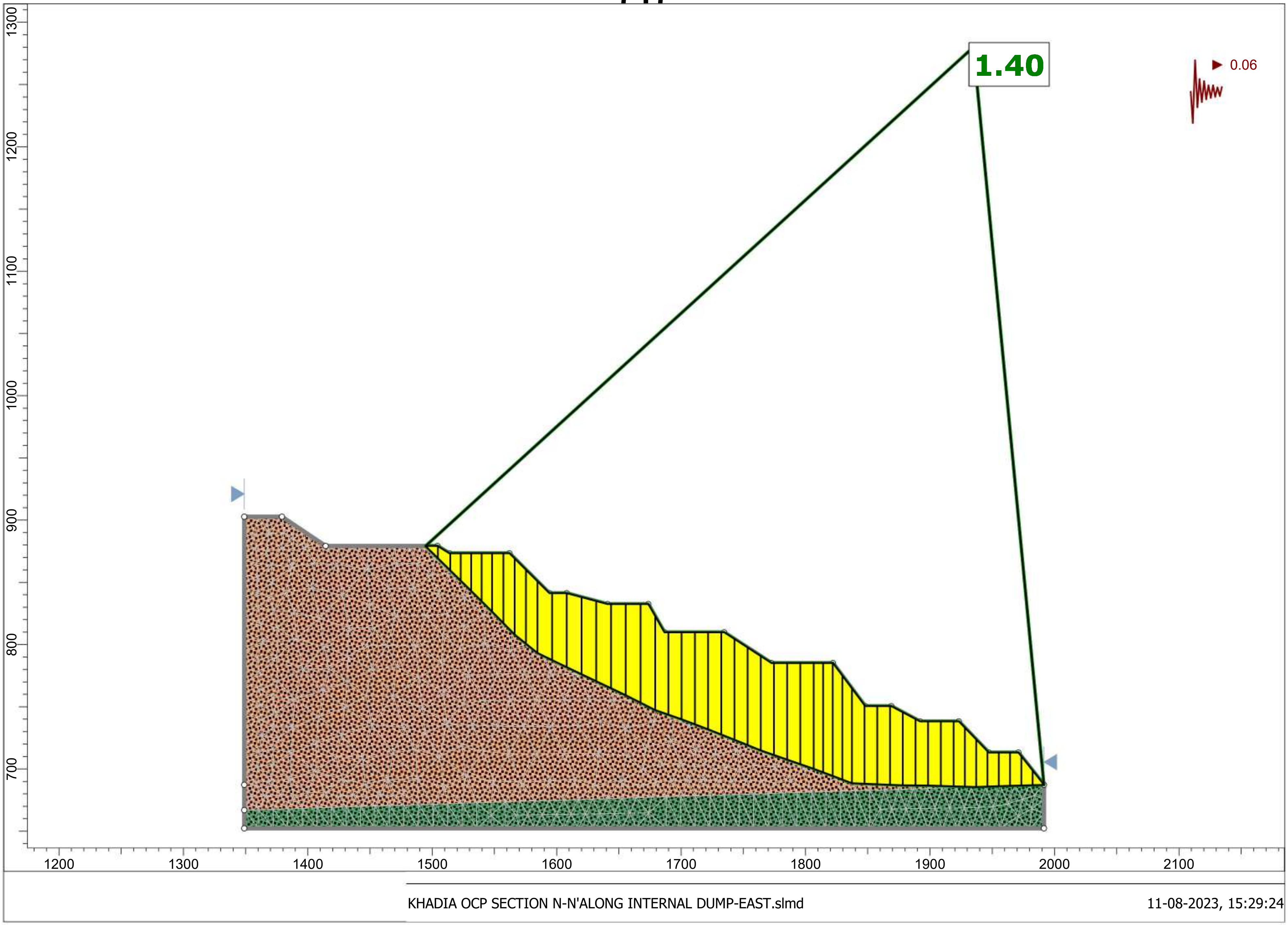
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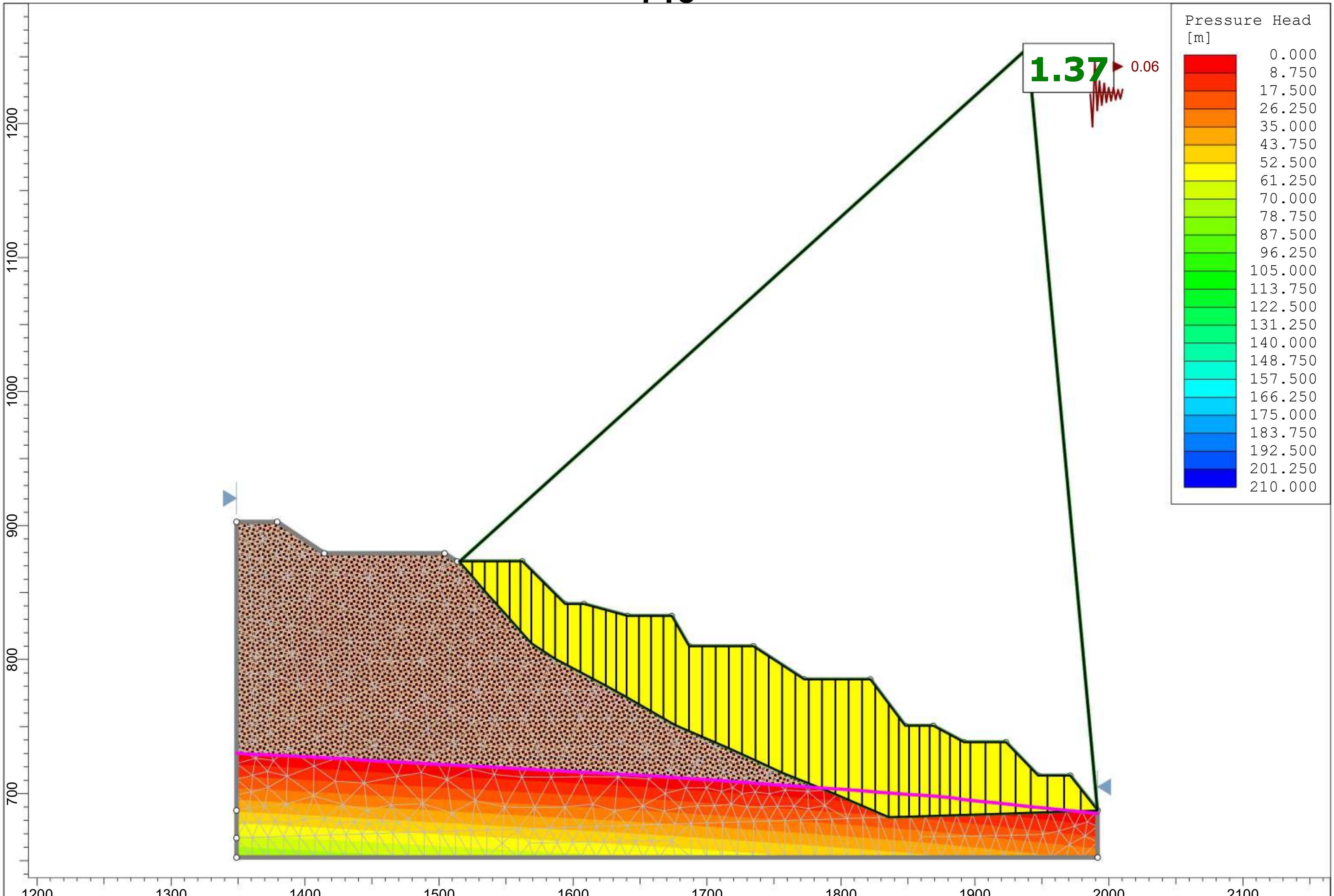

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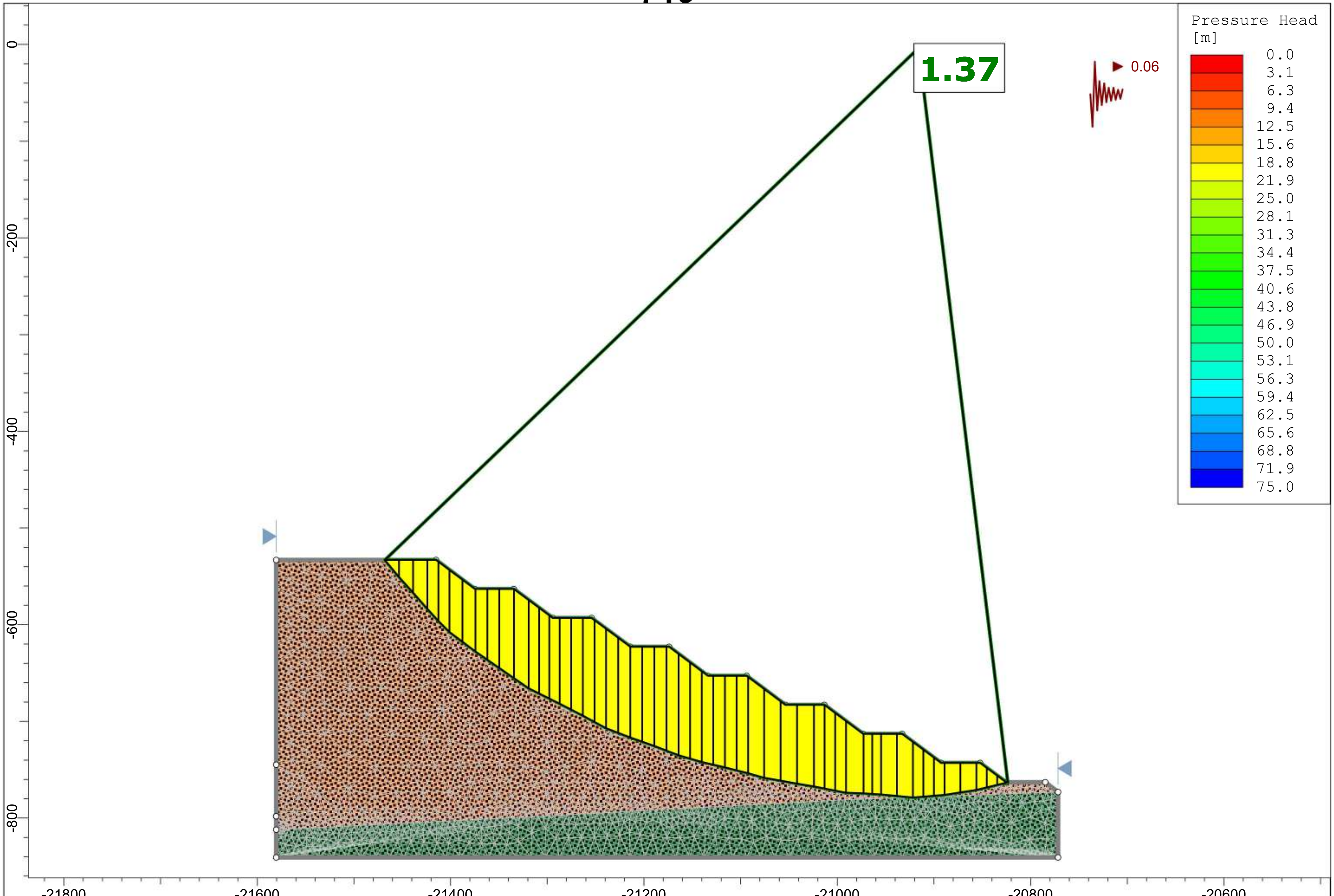

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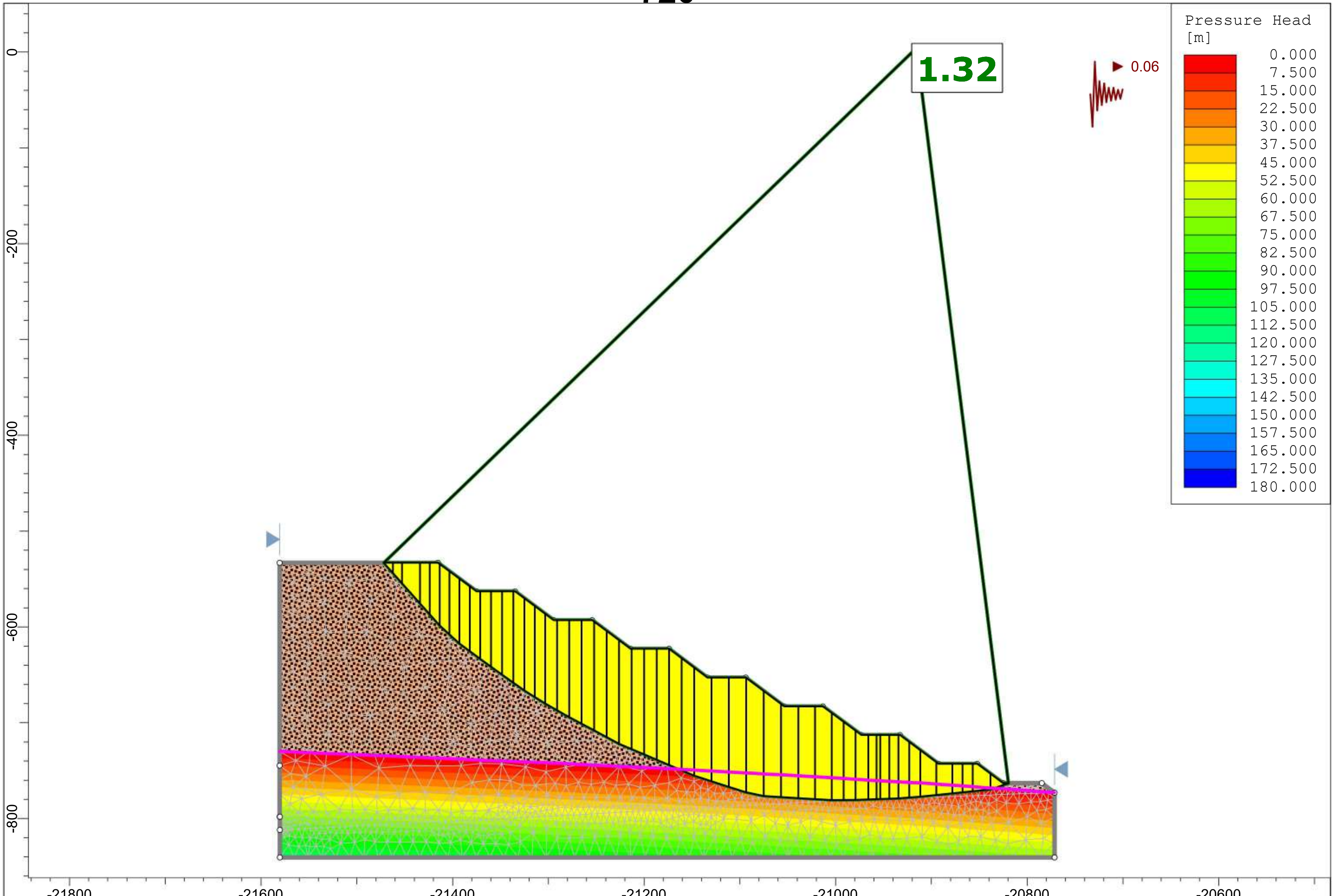

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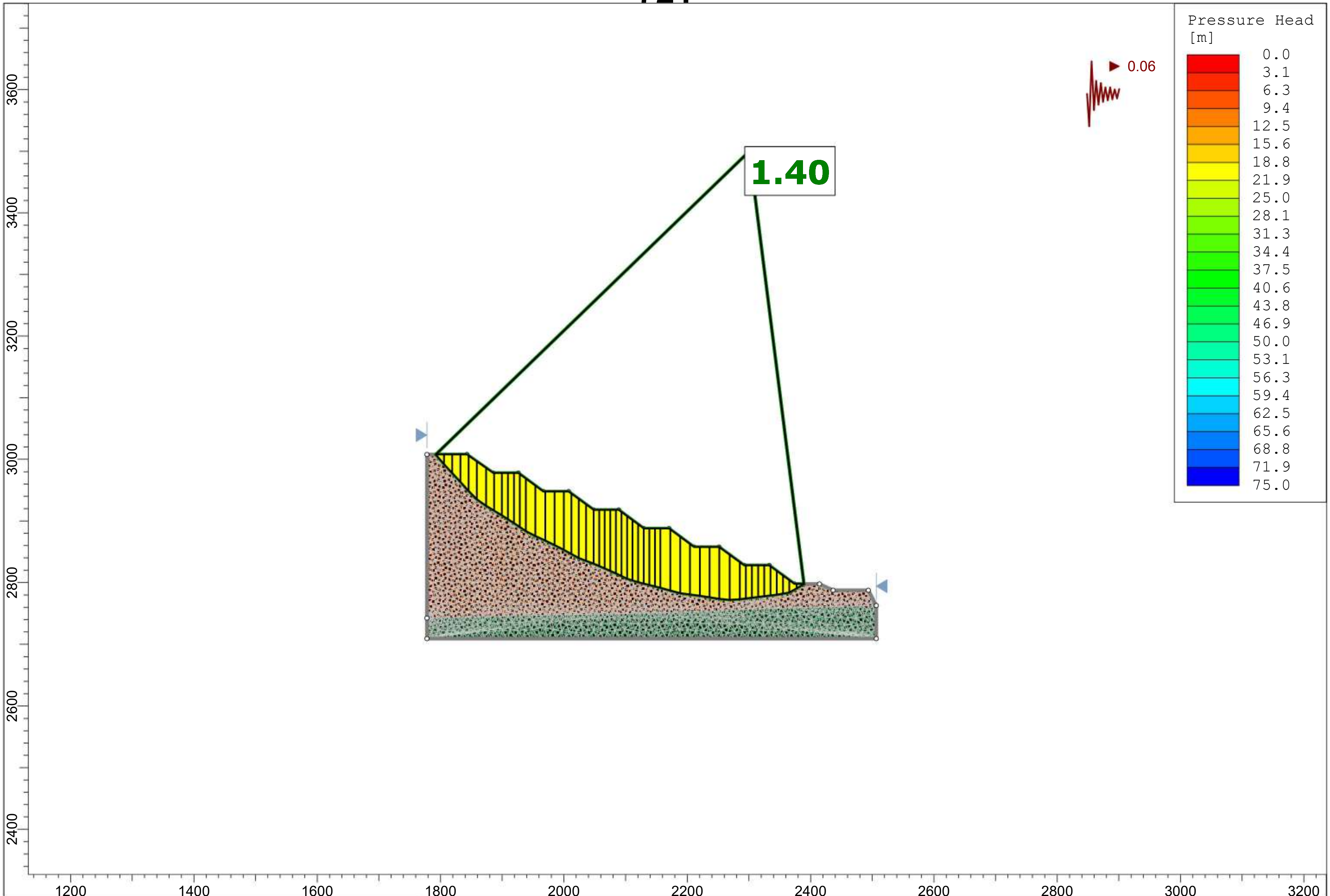

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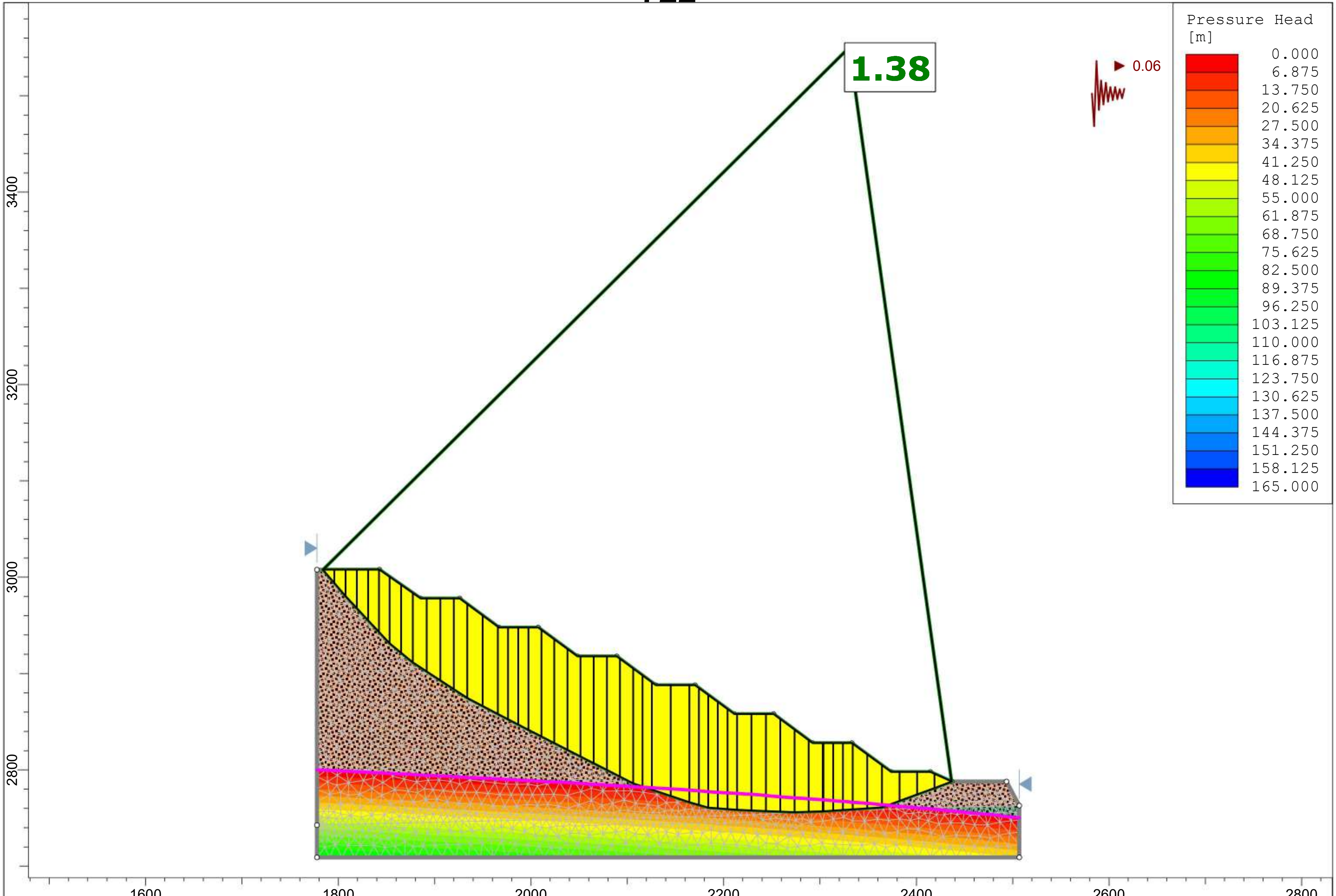

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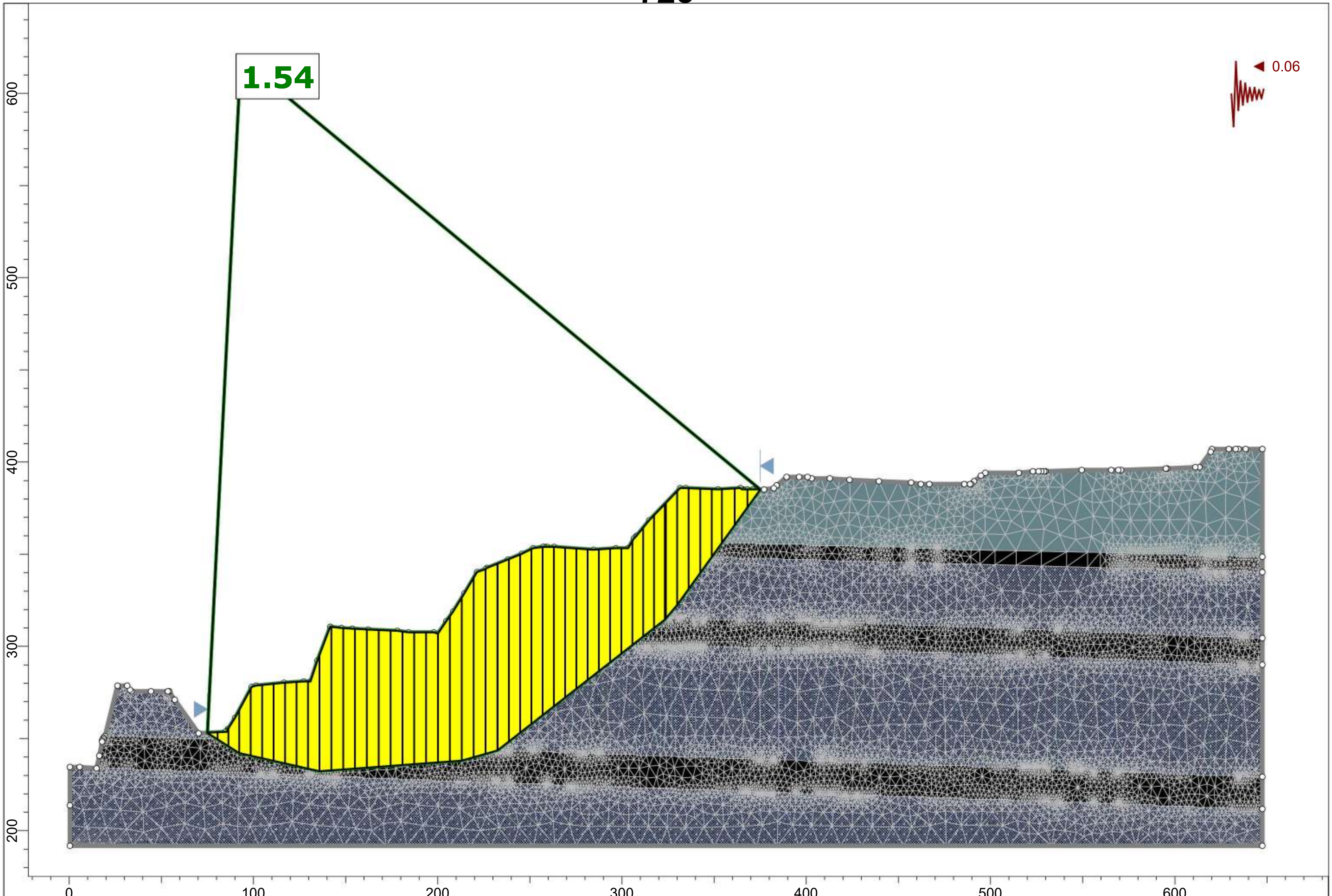

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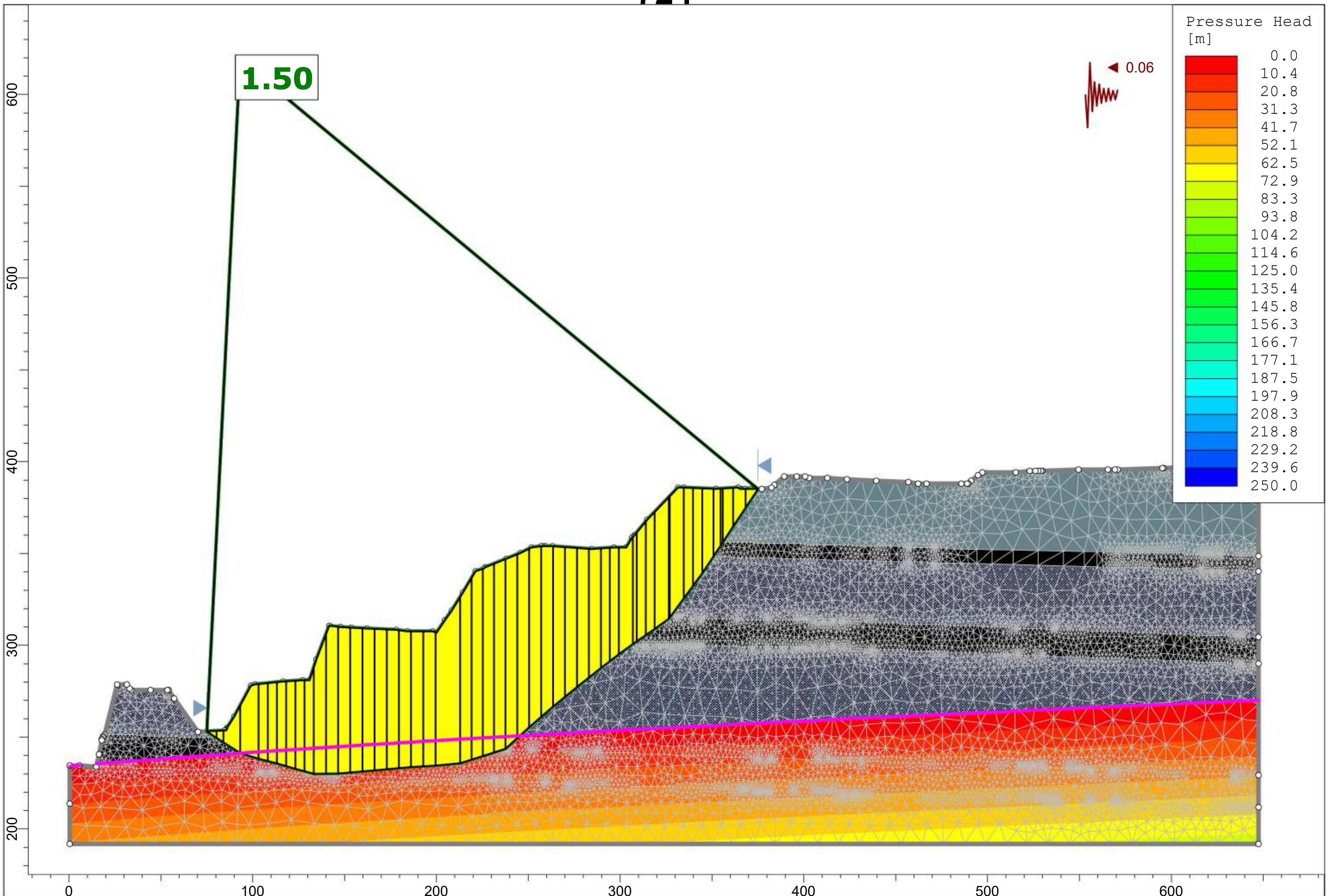

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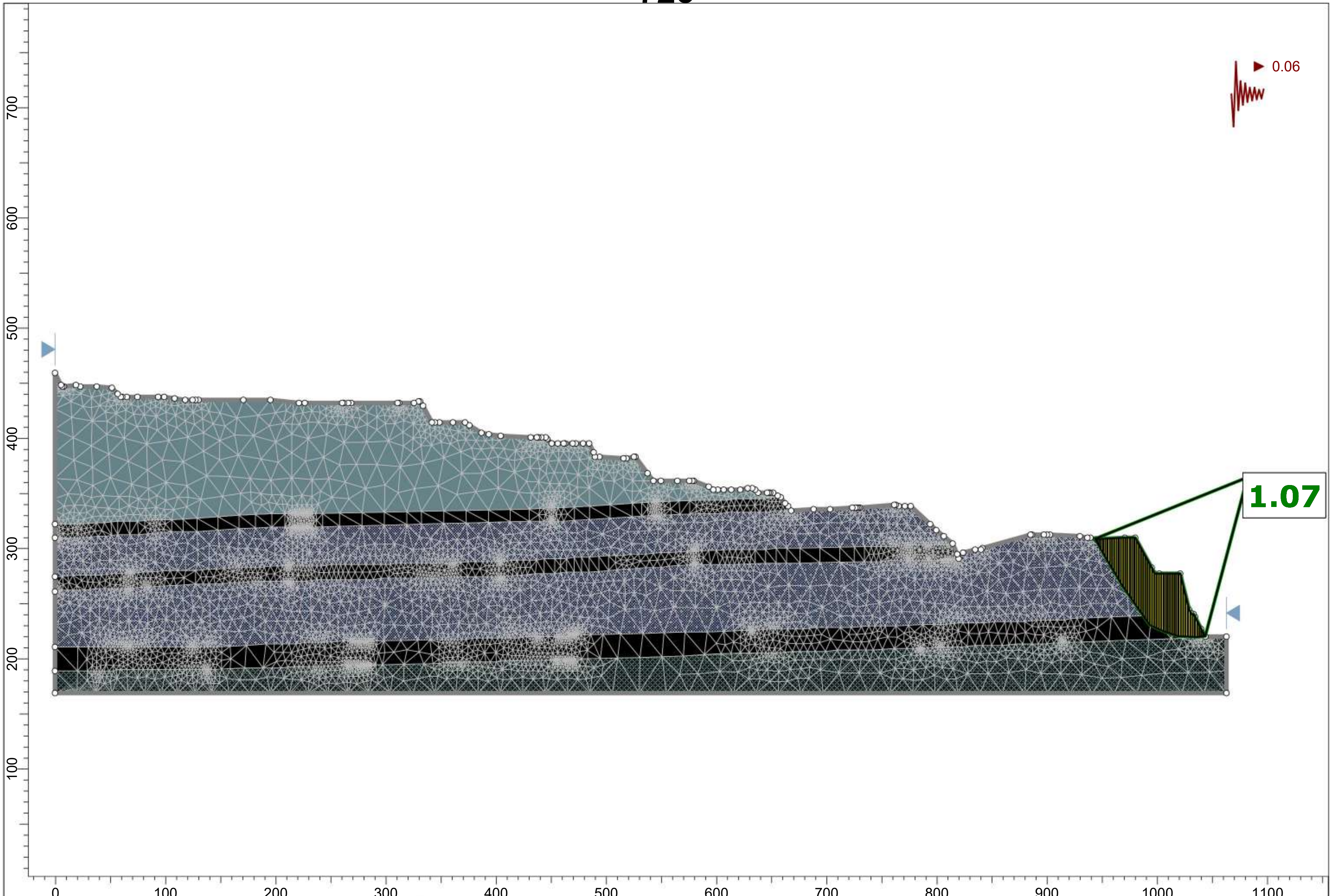
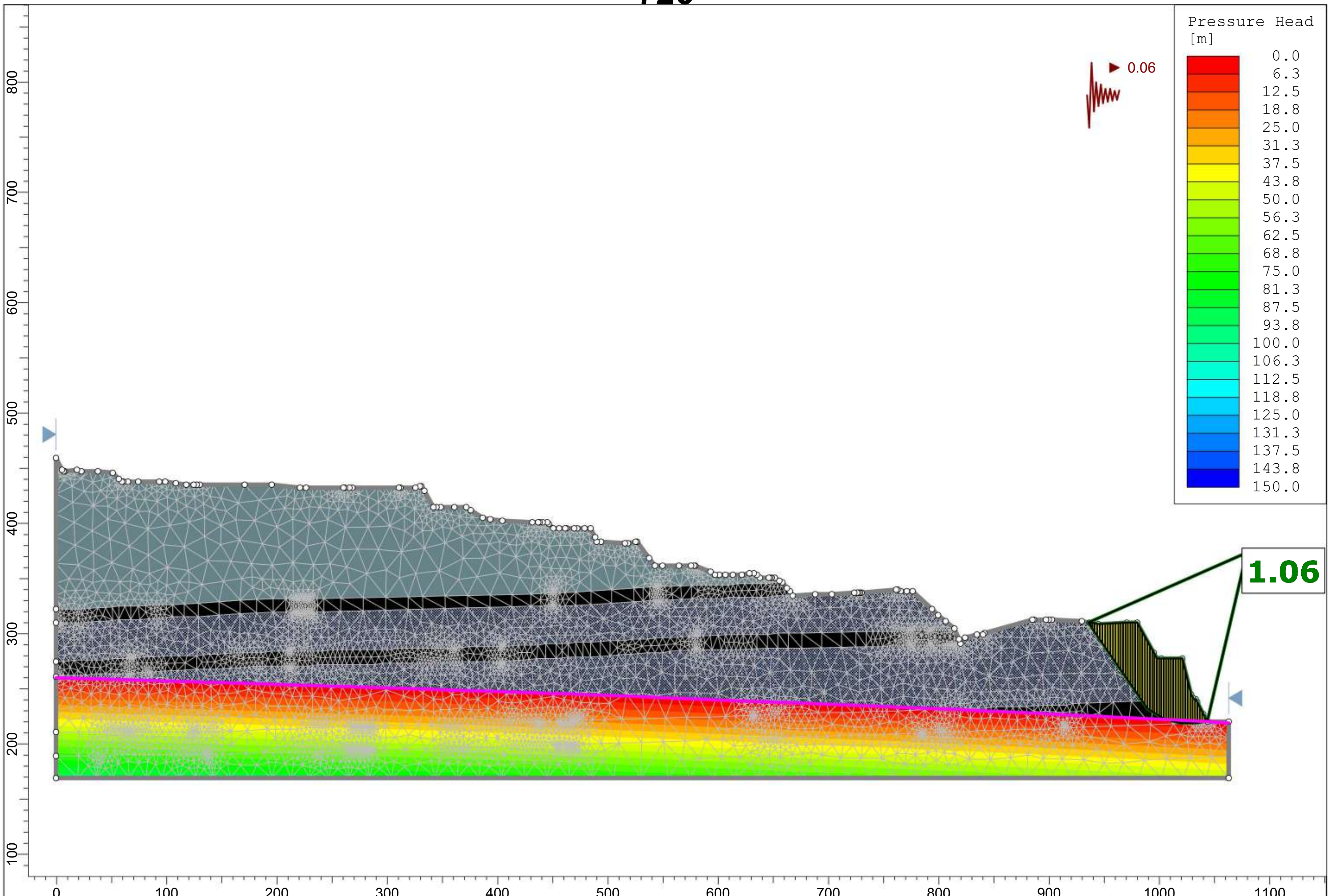


KHADIA OCP SECTION D-D' ALONG HIGHWALL-WEST.slmd

12-07-2023, 17:55:56



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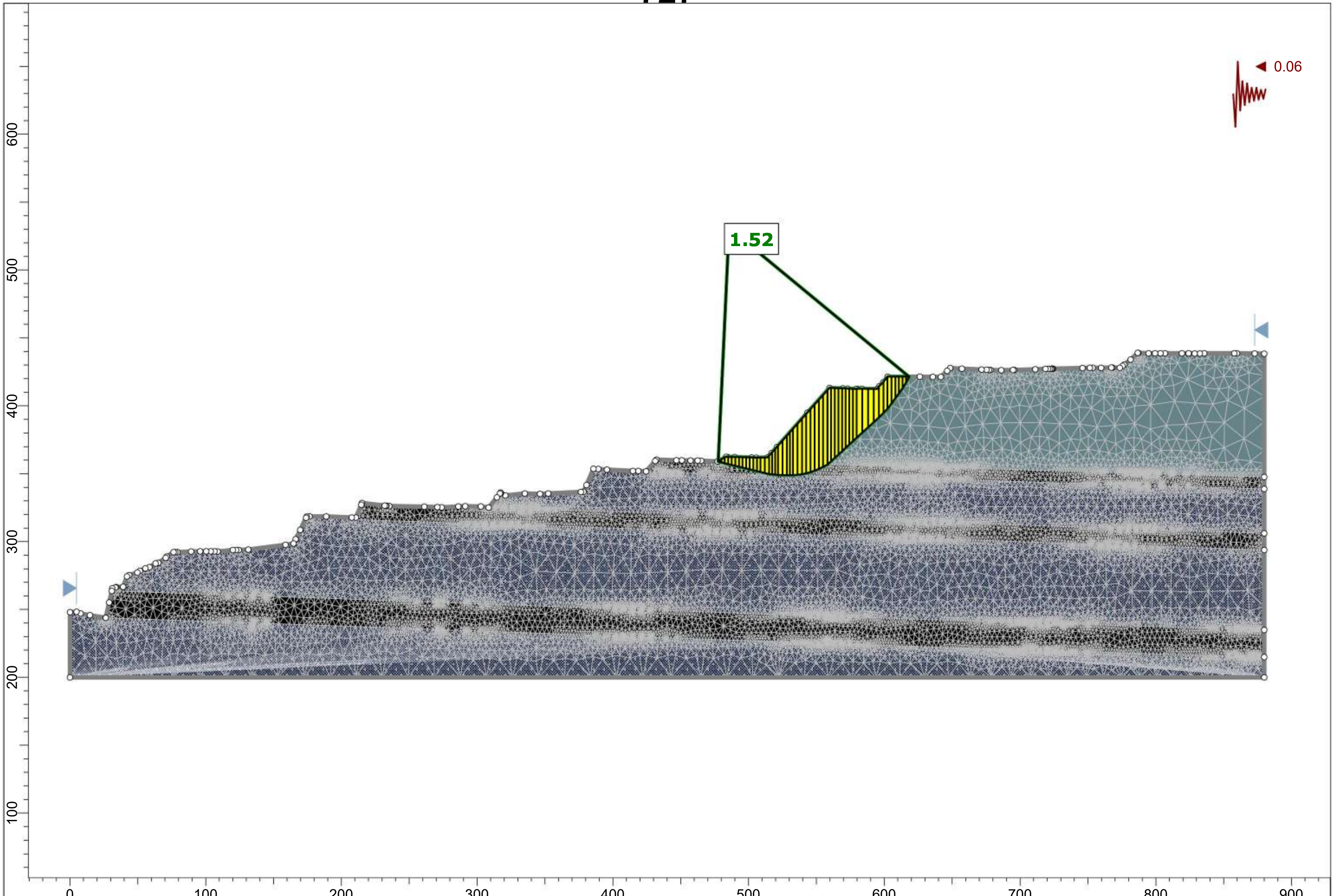
12-07-2023, 17:55:56



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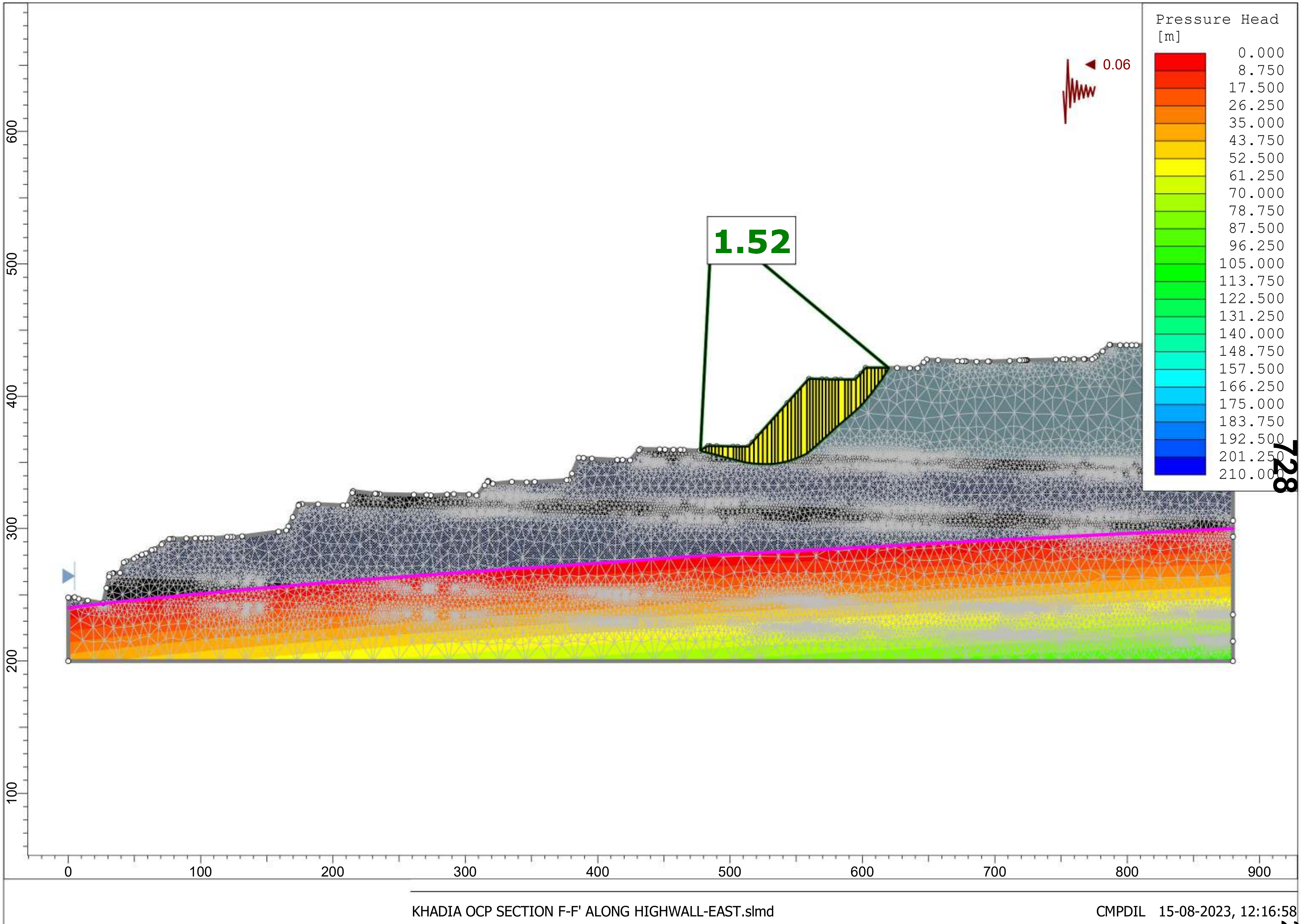
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35.000
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122.500
131.250
140.000
148.750
157.500
166.250
175.000
183.750
192.500
201.250
210.000
0.06
1.52
0
100
200
300
400
500
600
700
800
900
100
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300
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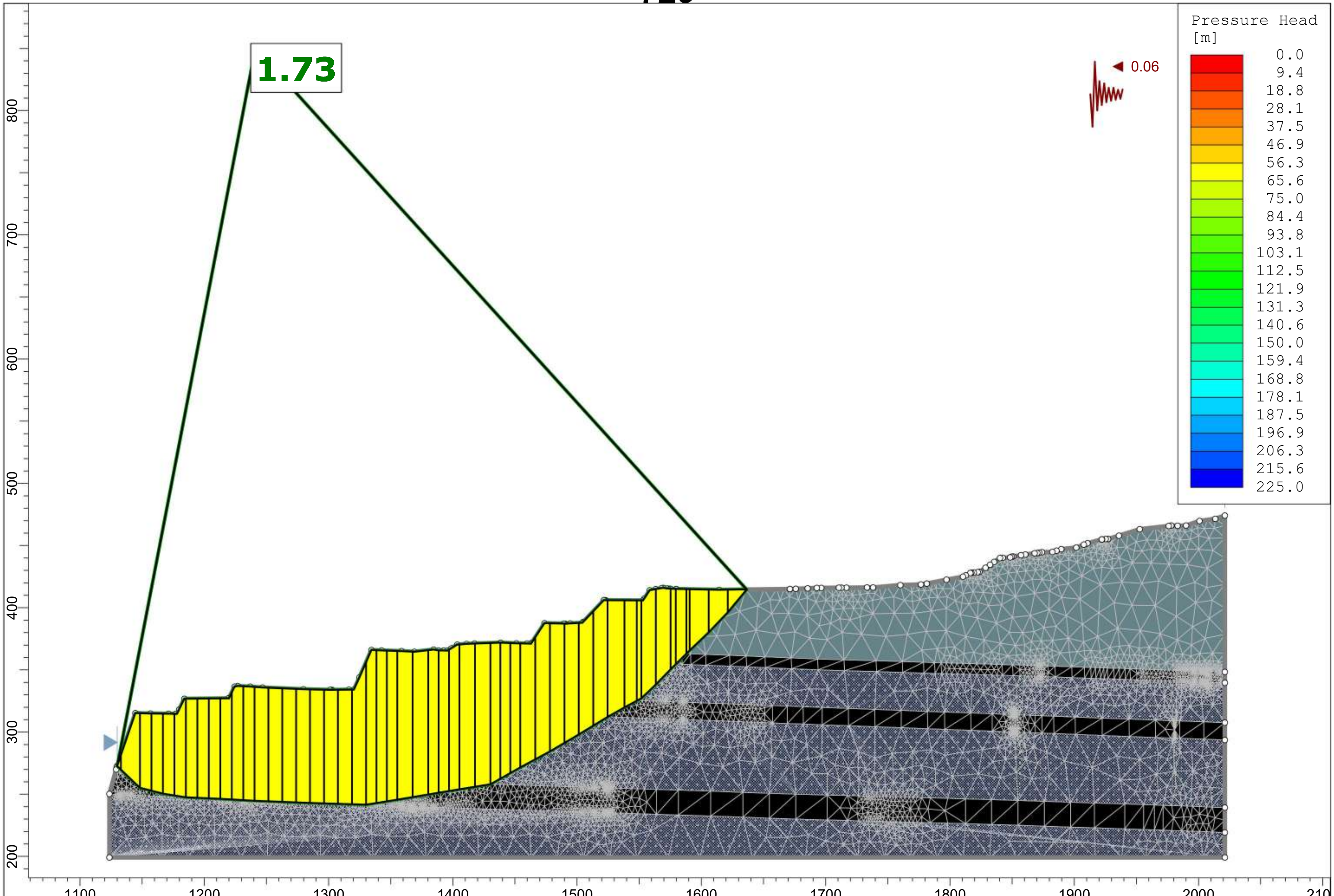
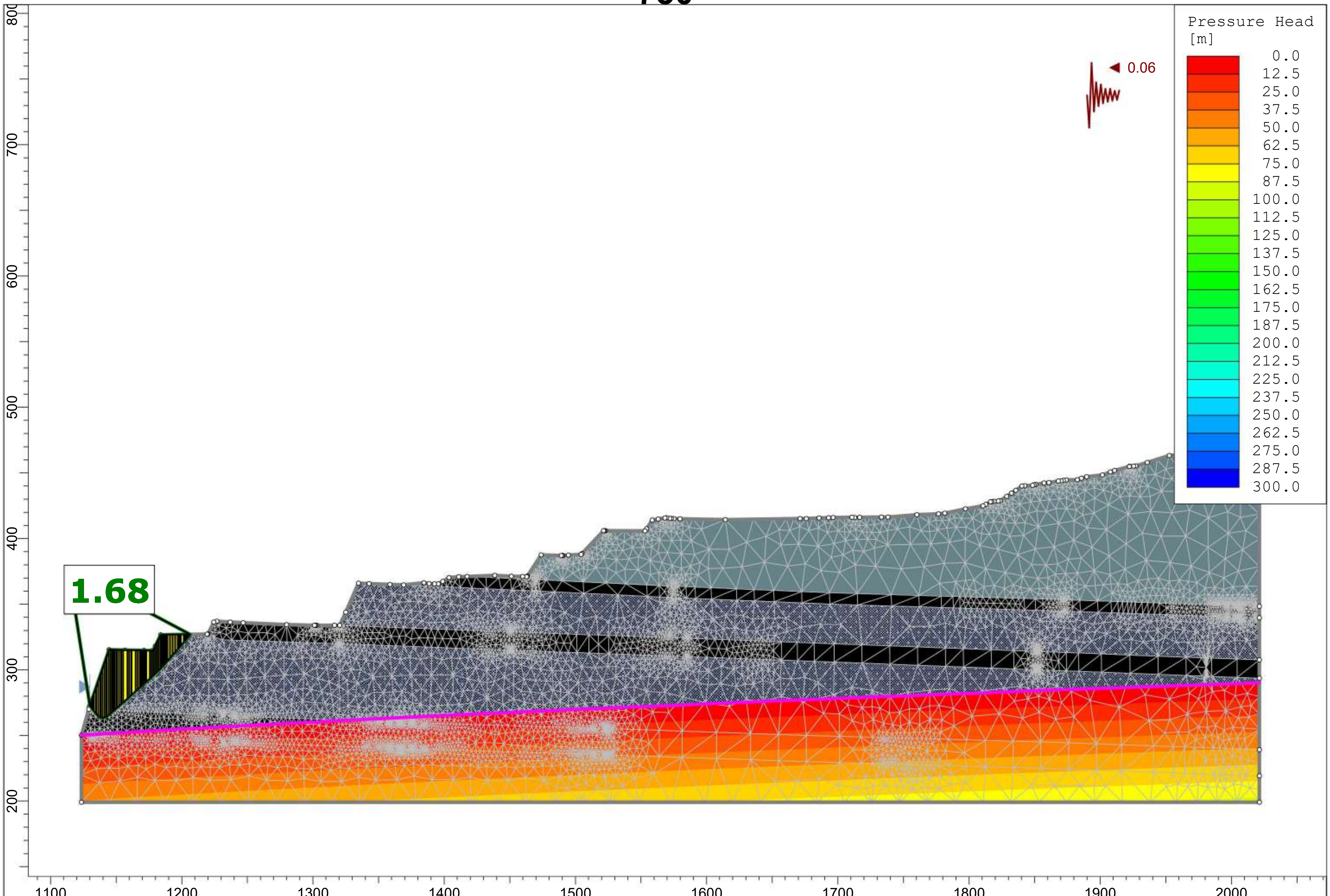
500
600
KHADIA OCP SECTION F-F' ALONG HIGHWALL-EAST.slmd
CMPDIL 15-08-2023, 12:16:58



KHADIA OCP SECTION G-G' ALONG HIGHWALL-EAST.slmd

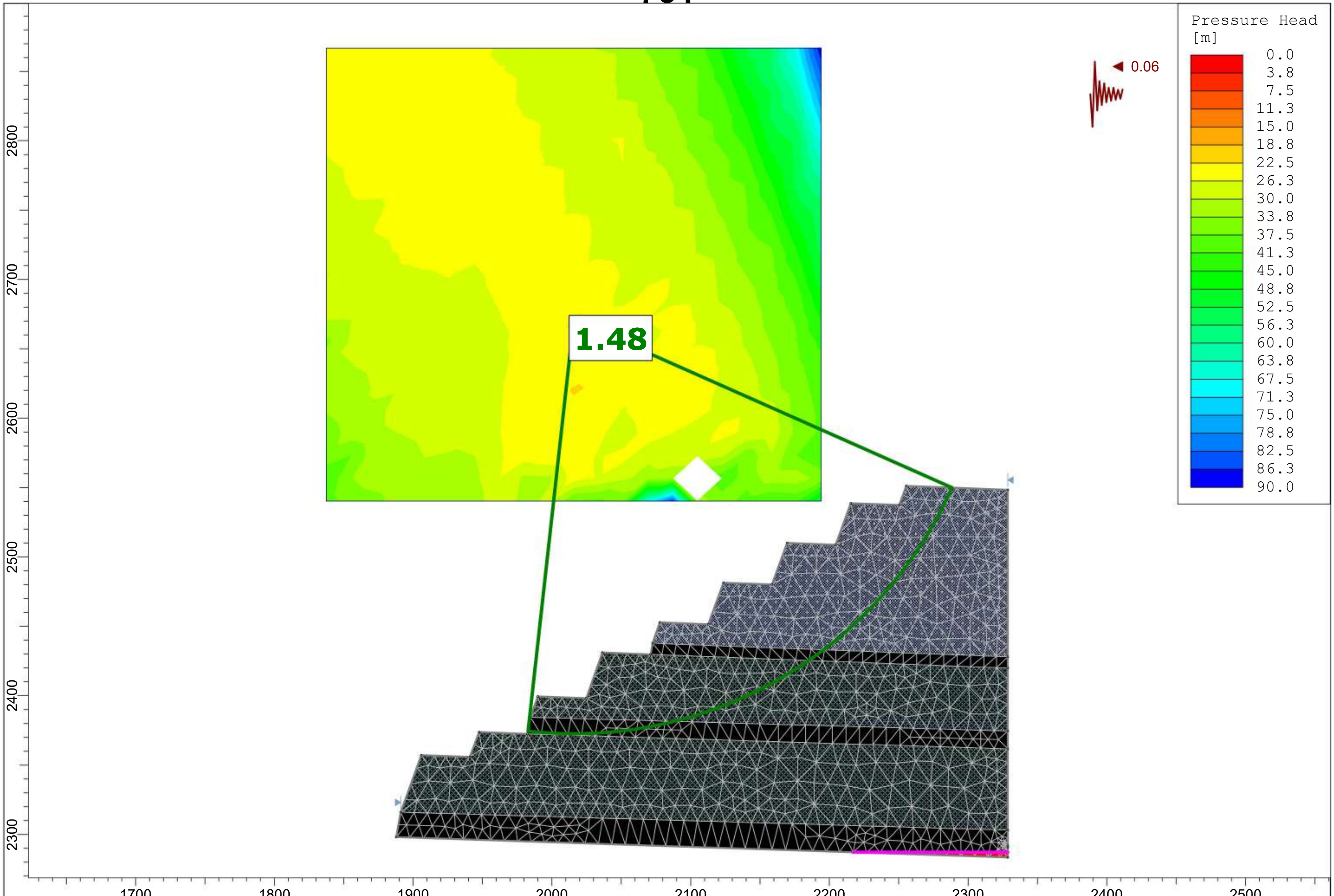
15-08-2023, 12:46:53

730



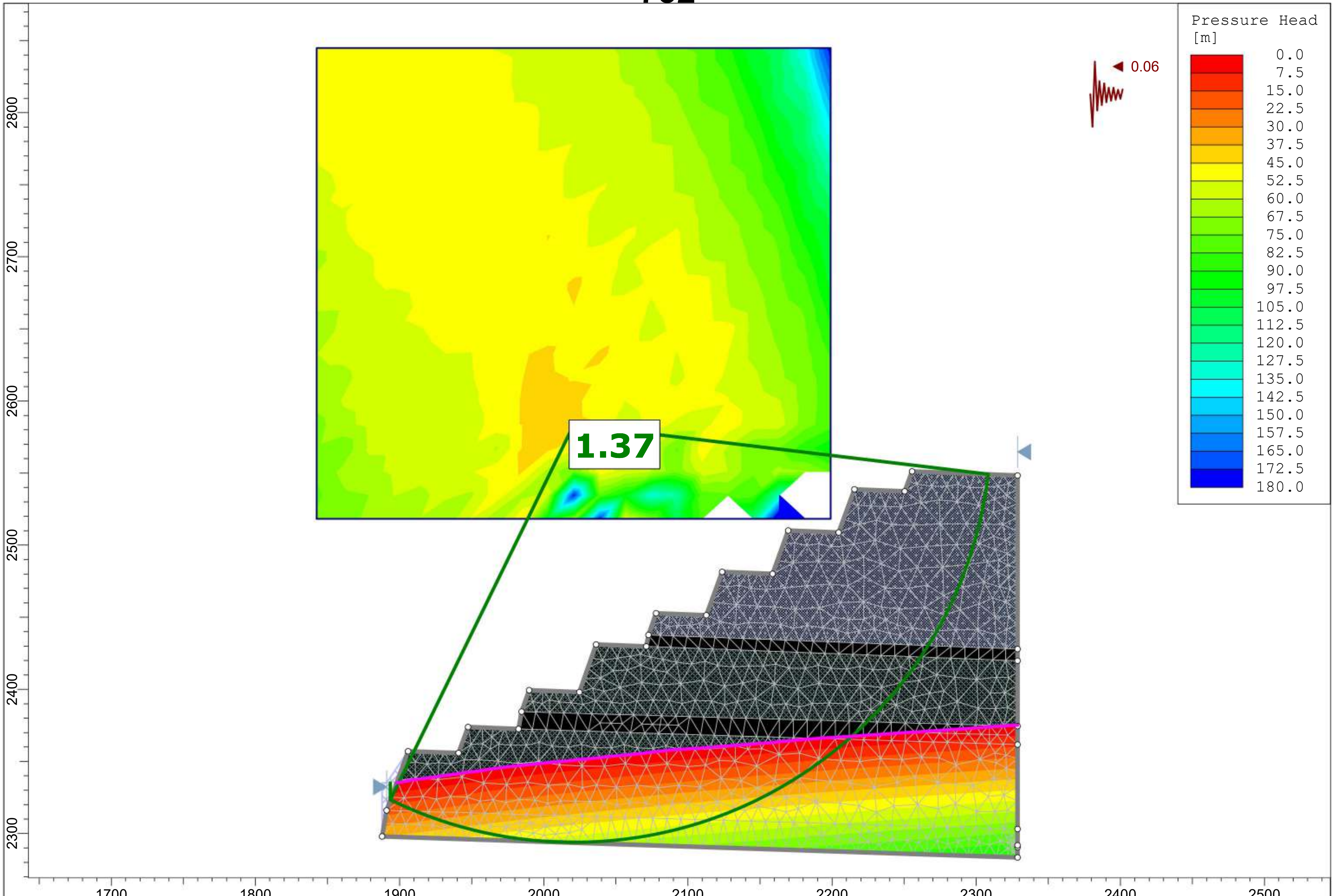
KHADIA OCP SECTION G-G' ALONG HIGHWALL-EAST.slmd

15-08-2023, 12:46:53



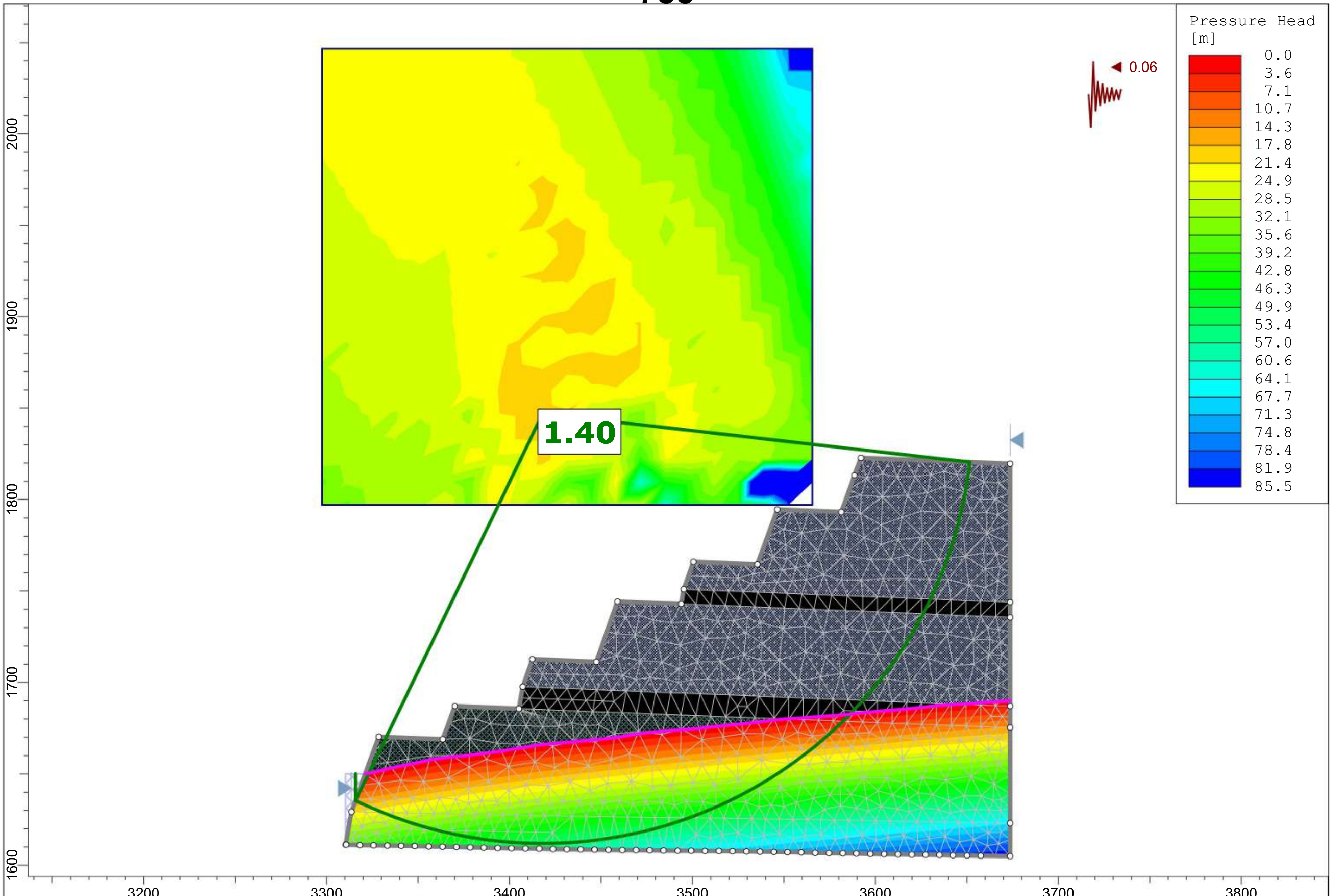
ultimate pit slope east.slmd

28-08-2023, 17:18:42



ultimate pit slope east.slmd

28-08-2023, 17:18:42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10.7
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24.9
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35.6
39.2
42.8
46.3
49.9
53.4
57.0
60.6
64.1
67.7
71.3
74.8
78.4
81.9
85.5
0.06
1.40
2000
1900
1800
1700
1600
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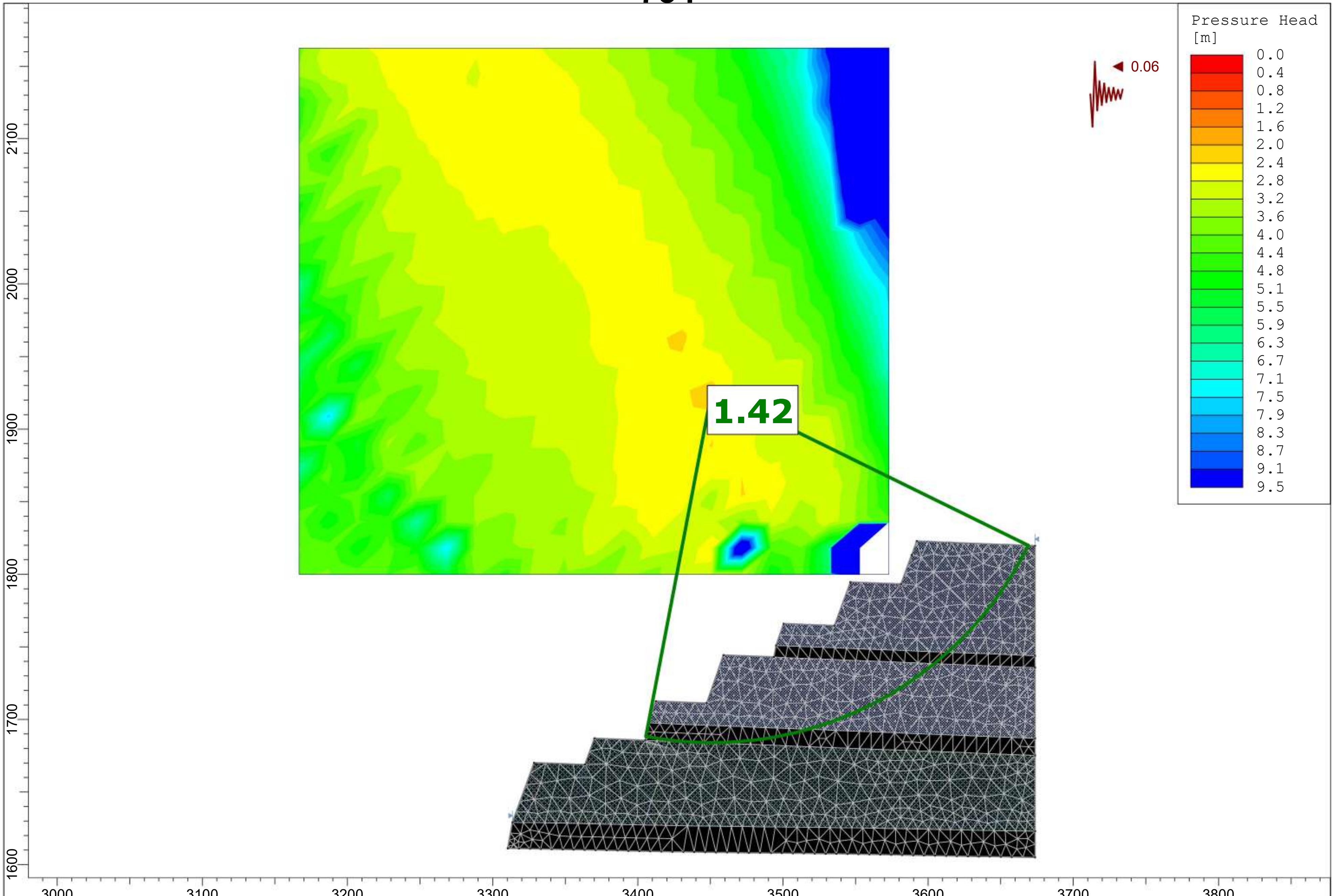
3500
3600
3700
3800



ultimate pit slope west2.slmd

28-08-2023, 18:30:47

Helmet 735

Date	Recived from	Quantity Recived	up to Issued	Issued To	Qty. Issued	Balance
			01.01.2023	—	-	280 N
			01.01.23 to 31.01.23	Emp	56	224 N
			01.02.23 to 31.03.23	"	90	134 Nos
			01.04.023 to 30.04.23	"	07	127 Nos.
			01.05.23 to 31.05.23	"	26	101 Nos
17/06/23	R/S	600	———	—	—	701 Nos
			01.06.23 to 30.06.23	—	24	677 Nos
			01.07.23 to 30.07.23	—	57	620 Nos.
			01.08.23 to 31.08.23	—	22	598 Nos.
28.09.23	R/S	250	———	—	—	848 Nos
			01.09.23 to 30.09.23	—	—	848 Nos.
			01.10.23 to 31.10.23		128	720 Nos
			01.11.23 to 30.11.2023		107	613 Nos
			01.12.23 to 31.12.2023		47	566 Nos.
			01.01.24 to 29.02.2024		68	498 Nos.
			01.03.24 to 31.03.24	571	85	413 Nos
			01.04.24 to 30.04.24		103	310 Nos
			01.05.24 to 31.05.24		78	232 Nos
			01.06.24 to 30.06.24		83	149 Nos
11.07.24	R/S	640		—	-	789 Nos
			01.07.24 to 31.07.24		117	672 Nos
			01.08.24 to 31.08.24		88	584 Nos
			01.09.24 to 30.09.24		67	517 Nos
			01.10.24 to 31.10.24		73	444 Nos
			01.11.24 to 30.11.24		92	352 Nos
			01.12.24 to 31.12.24		123	229 Nos.

Rain Coat

Date	Recieved From	Quantity	Up to issued.	Issued To	Quantity	Bailance
			01.01.2023			239 Nos
			01.01.23 to 31.01.2023	Employe	–	239 Nos
			01.02.23 to 28.02.2023	"	–	239 Nos.
			01.03.23 to 31.03.2023	"	–	239 Nos.
			01.04.23 to 30.04.2023	"	–	239 Nos.
			01.05.23 to 31.05.2023	"	–	239 Nos
			01.06.23 to 30.06.23	"	03	236 Nos
			01.07.23 to 31.07.23	"	46	190 Nos
			01.08.23 to 31.08.23	"	10	180 Nos.
			01.09.23 to 30.09.23	"	–	180 Nos
			01.10.23 to 31.10.23	"	16	164 Nos.
			01.11.23 to 30.11.23	"	00	164 Nos
			01.12.23 to 31.12.23	"	09	155 Nos
			01.01.2024 to 31.01.2024	"	20	135 Nos.
			01.02.2024 to 29.02.24	"	11	124 Nos.
			01.03.24 to 31.03.24	"	02	122 Nos.
			01.04.24 to 30.04.24	"	17	105 Nos
			01.05.24 to 31.05.24		03	102 Nos
			01.06.24 to 30.06.24		35	67 Nos
			01.07.24 to 31.07.24		22	45 Nos
			01.08.24 to 31.08.24		30	15 Nos
			01.09.24 to 30.09.24		03	12 Nos
			01.10.24 to 31.10.24		08	04 Nos
			01.11.24 to 30.11.24		–	04 Nos
			01.12.24 to 31.12.24		–	04 Nos

737

Water Bottle

Date	Recived Fram	Quantity	Up to Issued.	Issued TO	Quantity	Bailance.
			01.01.2023 - 31.01.2023	Employee	~~11~~	11 Nos
			01.01.2023 to 31.01.2023	"	11	00
			01.02.2023 to 28.02.2023	"	—	00
			01.03.23 to 31.03.2023	"	—	00
			01.04.23 to 30.04.23	"	—	00
			01.05.23 to 31.05.23	"	—	00
			01.06.23 to 30.06.23	"	—	00
			01.07.23 to 31.07.23	"	—	00
			01.08.23 to 31.08.2023	"	—	00
			01.09.23 to 30.09.2023	"	—	00
			01.10.23 to 30.11.2023	"	—	00
22.12.24	R/S	900	—	—	—	900 Nos
			01.12.23 to 31.12.2023	"	70	830 Nos
			01.01.2024 to 31.01.2024	"	62	768 Nos
			01.02.2024 to 29.02.2024	"	39	729 Nos.
			01.03.2024 to 31.03.24	" 325	154	575 Nos
			01.04.24 to 30.04.24	"	147	428 Nos
			01.05.24 to 31.05.24		27	401 Nos
			01.06.24 to 30.06.24		79	322 Nos.
			01.07.24 to 31.07.24		38	284 Nos.
			01.08.24 to 31.08.24		74	210 Nos.
			01.09.24 to 30.09.24		43	167 Nos.
			01.10.24 to 31.10.24		58	109 Nos.
			01.11.24 to 30.11.24		22	87 Nos.
			01.12.24 to 31.11.24		25	62 Nos

Dust Mask 738

17 296

Date	Received From	Quantity	Up to issue	Issue To	Quantity	Balance
			01.01.2023			140 Nos
			01.01.23 to 31.01.2023	Employees	58	82 Nos
			01.02.23 to 28.02.23	"	45	37 Nos
03.03.23	Q. Reject	800	←	—	-	837 Nos
		[illegible]	01.03.23 to 31.03.23	"	128	709 Nos
			01.04.23 to 30.04.23	"	105	604 Nos.
			01.05.23 to 31.05.23	"	128	476 Nos
			01.06.23 to 30.06.23	"	56	426 Nos
			01.07.23 to 31.07.23	"	58	368 Nos
			01.08.23 to 31.08.23	"	72	296 Nos
			01.09.23 to 30.09.23	"	86	210 Nos
			01.10.23 to 31.10.23	"	60	150 Nos
			01.11.23 to 30.11.23	"	75	75 Nos
			01.12.23 to 31.12.23	"	70	05 Nos
			01.01.2024 to 31.01.24	"	03 -	02 Nos
22.02.24	R/S	10020	—	—	-	10022 Nos
			01.02.24 to 29.02.24	"	963	9059 Nos
			01.03.24 to 31.03.24	APR23 to March24=2735	1059	8000 Nos
13.04.24	R/S	5000	←	(2675)	-	13000 Nos
			01.04.24 to 30.04.24		940	12060 Nos
			01.05.24 to 31.05.24		917	11143
			01.06.24 to 30.06.24		836	10307
			01.07.24 to 31.07.24		812	9495
			01.08.24 to 31.08.24		748	8747
			01.09.24 to 30.09.24		720	8027
			01.10.24 to 31.10.24		920	7107
			01.11.24 to 30.11.24		870	6237
			01.12.24 to 31.12.24		817	5420
			01.01.2025 to 31.01.2025		895	4525

Gamchha 739

1

Date of recieved	Recieved From	Quantity recived	Date of issued.	Issued To	Quantity Issued.	Bailance
			01.01.2023			897 No
			01.01.23 to 31.01.2023	Employ	245	652 Nos
			01.02.23 to 28.02.23	"	105	547 Nos.
			01.03.23 to 31.03.23	"	110	437 Nos.
			01.04.23 to 30.04.23	"	51	386 Nos
			01.05.23 to 31.05.23	"	88	298 Nos
			01.06.23 to 30.06.23	"	20	278 Nos
			01.07.23 to 31.07.23	"	42	236 Nos
			01.08.23 to 31.08.23	"	20	216 Nos.
			01.09.23 to 30.09.23	"	—	216 Nos.
			01.10.23 to 31.10.23	"	65	151 Nos
			01.11.23 to 30.11.23	"	39	112 Nos
			01.12.23 to 31.12.23	"	70	42 Nos.
			01.01.24 to 31.01.24	"	40	02 Nos.
			01.02.24 to 29.02.24	"	02	Nil
11.03.24	R/S	3200	01.03.24 to 31.03.24	—	—	3200
			01.03.24 to 31.03.24	— 1456	1019	2181
			01.04.24 to 30.04.24	—	481	1700
			01.05.24 to 31.05.24		295	1405
			01.06.24 to 30.06.24		308	1097
			01.07.24 to 31.07.24		376	721
			~~01.08.24 to 31.08.24~~		—	2821
20.08.24	R/S	2100	~~01.08.24~~ to 31.08.24		~~100~~ 532	2289
			01.09.24 to 30.09.24		338	1951
			01.10.24 to 31.10.24		288	1663
2.11.24	RS	1100				2763
			01.11.24 to 30.11.24		209	2554
			01.12.24 to 31.12.24		153	2401

Gumboot 740

Date Recived.	Recieved From	Quantity Recived.	Date of Issued	Issued To	Quantity Issued.	Balance
			01.01.2023			05 Pair
			01.01.23 to 31.01.23	—	—	05 Pair
			01.02.23 to 28.02.23	—	—	05 Pair
			01.03.23 to 31.03.23	—	—	05 Pair
			01.04.23 to 30.04.23	—	01	04 Pair
			01.05.23 to 31.05.23	—	—	04 Pair
			01.06.23 to 30.06.23	—	01	03 Pair
02.06.23	R/S	200 Pair	—	—	—	203 Pair
			01.07.23 to 31.07.23	—	18 No.	185 Pair
			01.08.23 to 31.08.23	—	30	155 Pair
			01.09.23 to 30.09.23	—	—	155 Pair
			01.10.23 to 31.10.23	-	07	148 Pair
			01.11.23 to 30.11.23	—	06	142 Pair
			01.12.23 to 31.12.23	—	—	142 Pair
			01.01.24 to 31.01.24	—	—	142 Pair
			01.02.24 to 29.02.24	—	14	128 Pair
			01.03.24 to 31.03.24	83	06	122 Pair
			01.04.24 to 30.04.24		08	114 Pair
			01.05.24 to 31.05.24		—	114 Pair
			01.06.24 to 30.06.24		12	102 Pair
11.07.24	R/S	695 Pair	01.07.24 to 31.07.24		40	797 Pair 757 Pair
			01.08.24 to 31.08.24		115	642 Pair
			01.09.24 to 30.09.24		68	574 Pair
			01.10.24 to 31.10.24		60	514 Pair
			01.11.24 to 30.11.24		58	456 Pair
			01.12.24 to 31.12.24		25	431 Pair

Flourocent Jaicket

741

Date	Recieved From	Quantity	Up to Issue	Issued TO	Quantity	Bailance
			01.01.2023 -			678 Nos
			01.01.23 to 31.01.23	Employee	10	668 No
			01.02.23 to 28.02.23	"	45	623 Nos
			01.03.23 to 31.03.2023	"	28	595 Nos
			01.04.23 to 30.04.23	"	96	499 Nos
			01.05.23 to 31.05.2023	"	16	483 Nos
17/06/23	R/S	950 No	-	-	-	1433 Nos
			01.06.23 to 30.06.23	Visitors + Employ	148	1285 Nos
			01.07.23 to 31.07.23	"	136	1149 Nos.
			01.08.23 to 31.08.23	New Joing "	196	953 Nos
			01.09.23 to 30.09.23	Warfwall siding starty	125	828 Nos
			01.10.23 to 31.10.23		85	743 Nos
			01.11.23 to 30.11.23		110	633 Nos.
			01.12.23 to 31.12.23		68	565 Nos
			01.01.24 to 31.01.24	New Joing Quarantice	117	448 Nos.
			01.02.24 to 29.02.24	Employee	44	404 Nos.
			01.03.24 to 31.03.24	" (1248)	107	297 Nos
			01.04.24 to 30.04.24	"	55	242 Nos
			01.05.24 to 31.05.24		47	195 Nos
			01.06.24 to 30.06.24		-	195 Nos
			01.07.24 to 31.07.24		38	157 Nos
			01.08.24 to 31.08.24		12	145 Nos
			01.09.24 to 30.09.24		27	118 Nos
			01.10.24 to 31.10.24		63	55 Nos
18.11.24	R/S	100 No	01.11.24 to 30.11.24		35	155 Nos 120 Nos
			01.12.24 to 31.12.24		85	35 Nos

Dust Mask 742.

Date	Recived From	Quantity	Up to issue	Issue To	Quantity	Bailance
			01.01.2023			140 Nos
			01.01.23 to 31.01.2023	Employees	58	82 Nos
			01.02.23 to 28.02.23	"	45	37 Nos.
03.03.23	@ Project	800	———	—	—	837 Nos.
		~~800~~	01.03.23 to 31.03.23	"	128	709 Nos
			01.04.23 to 30.04.23	"	105	604 Nos.
			01.05.23 to 31.05.23	"	128	476 Nos
			01.06.23 to 30.06.23	"	56	426 Nos
			01.07.23 to 31.07.23	"	58	368 Nos
			01.08.23 to 31.08.23	"	72	296 Nos
			01.09.23 to 30.09.23	"	86	210 Nos
			01.10.23 to 31.10.23	"	60	150 Nos
			01.11.23 to 30.11.23	"	75	75 Nos
			01.12.23 to 31.12.23	"	70	05 Nos
			01.01.2024 to 31.01.24	"	03 -	02 Nos
22.02.24	R/S	10020	———	—	—	10022 Nos
			01.02.24 to 29.02.24	"	963	9059 Nos
			01.03.24 to 31.03.24	APR 23 to March 24 = 2735	1059	8000 Nos
13.04.24	R/S	5000	—	(2675)	—	13000 Nos
			01.04.24 to 30.04.24		940	12060 Nos
			01.05.24 to 31.05.24		917	11143
			01.06.24 to 30.06.24		836	10307
			01.07.24 to 31.07.24		812	9495
			01.08.24 to 31.08.24		748	8747
			01.09.24 to 30.09.24		720	8027
			01.10.24 to 31.10.24		920	7107
			01.11.24 to 30.11.24		870	6237
			01.12.24 to 31.12.24		817	5420
			01.01.2025 to 31.01.2025		895	4525

Leather 743 Safety Shoe

Date	Recived Fram	Quantity	Up to Issue	Issue To	Quantity Issue	Bailance
			01.01.2023			493
			01.01.23 to 31.01.2023	Emp.	92	401 Pair
			01.02.23 to 28.02.2023	"	64	337 Pair
			01.03.23 to 31.03.2023	"	96	241 Pair
			01.04.23 to 30.04.2023	"	48	193 Pair
9.05.23	R/store	87	Inplace of Old Shoe.	—	—	280 Pair
			01.05.2023 to 31.05.2023	"	102	178 Pair
			01.06.23 to 30.06.2023	"	39	139 Pair
12.07.23	R/Store	47	01.07.23 to 31.07.2023	"	93	186 Pair 93 Pair
			01.08.23 to 31.08.2023	"	04	89 Pair
			01.09.23 to 30.09.2023	"	—	89 Pair
10.23	R/S	1100	01.10.23 to 31.10.2023	—	—	1189 Pair
			01.10.23 to 31.10.2023 01.11.23 to 30.11.23	"	365 120	824 Pair 704 Pair
			01.12.23 to 31.12.23	"	112	592 Pair
			01.01.24 to 31.01.2024	"	109	483 Pair
			01.02.24 to 29.02.2024	"	89	394 Pair
			01.03.24 to 31.03.2024	"	124	270 Pair
			01.04.24 to 30.04.24		120	150 Pair
			01.05.24 to 31.05.24		50	100 Pair
			01.06.24 to 30.06.24		76	24 Pair
			01.07.24 to 31.07.24		24	0
06.8.24	RS	1300				1300
			01.08.24 to 31.08.24		211	
			01.09.24 to 30.09.24		204	1089
			01.10.24 to 31.10.24		101	988
			01.11.24 to 30.11.24		61	927
			01.12.24 to 31.12.24		171	756 585

नार्दर्न कोलफील्ड्स लिमिटेड
(भारत सरकार का उपक्रम)
सिंगरौली
मध्य प्रदेश

Northern Coalfields limited
(A Mini Ratna Company)
P.O. Singrauli, Dist. Singrauli
MP – 486889

Office of the General Manager (Environment)

Tel: 07805-266565
Fax: 07805-266565

Date: 31.03.2016

Ref.No.: NCL/Env./EC of KHD for 14 MTY/16/

To,
GM, Khadia.

Sub: EC letter for Khadia OCP for 14 MTY.

Dear Sir,

This is to inform you that the final Environment Clearance letter No. J-11015/255/2005.IA.II(M)(Part File) dated 23.03.2016 from MoEF&CC, New Delhi has been obtained for 14 MTY, which is enclosed herewith, the same was uploaded in MoEF&CC website on 30.03.2016.

You are requested to kindly go through the letter and take appropriate actions. However the following actions are required to be taken now on urgent basis.

1. To apply for Consent to Establish, Consent to Operate and HW Authorization for 14 MTY to UPPCB and MPPCB through their Regional Office.
2. Advertise in two local newspapers as per EC letter within 7 days of issue of EC letter. It is to be uploaded in the NCL website also.
3. Arrange to check all the data and conditions given in the EC letter and if any modification is required in the EC letter, immediate action is required to be taken within one month.
4. Ensure the compliance of all Specific Conditions (45 in number), General Conditions (19 in number) and other conditions at the earliest.
5. Six monthly compliance report is to be sent to MoEF Regional Office, Zonal Office of CPCB, SPCBs and uploaded in the NCL website with a copy to this Office.

Yours faithfully,

(B.K.Sharma)
GM (Environment/IMS)

Encl.: As above.

DGM(FI)

file

31/3/16

CC:
1. Dir (T/O) - For kind information.
2. Dir (T/P&P) - For kind information.
3. GM –TS to CMD- For kind information of CMD.
4. RD, RI VI, CMPDI, Jayant.
5. GM (CP).

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनी रत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

745

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

सामग्री प्रबंधन विभाग / Materials Management Department
CIN U10102MP1985GOI003160
An ISO 9001, ISO 14001 & ISO45001 Certified Company
पोस्ट सिंगरौलीकोलियरी, जिला सिंगरौली म.प्र. पिन 486889 /Post Singrauli Colliery, Distt Singrauli, M.P. PIN-486889

Annexure- I

Ref: NCL/SGR/STR/XtraGreen Diesel/24-25/ 114 E **Date: 12 /06/2024**

To,
Genral Manager/HOD (Excv.)
Northern Coalfields Limited

Sub: XtraGreen Diesel trial run at Khadia & Amlori

Ref:

1. **Letter No JDO/IB/NCL dated 24/04/2024 from IOCL**
2. **MOM Dated 6 June 2024 on TFM & Automation**
3. **e-Office File No- NCL/SGR/MMD/STORE/XTRAGREENDIESEL (Computer No 1495034)**

Dear sir,

A trial run to explore the possibility of using XtraGreen HSD in **Khadia** and **Amlori** may be initiated, to verify the emission efficiency and fuel economy benefits claimed by M/s IOCL.

Administrative approval (Note # 11 Computer no 1495034) by the Director (Technical / Operation) has also been attached.

Yours faithfully

12/6/24

GM(MM)Store/HOD

Copy to:

- TS to DT(O), NCL

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एन सी एल
NCL

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उत्खनन विभाग, एनसीएल मुख्यालय / Excavation Department, NCL HQ

CIN- U10102MP1985GOI003160

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Phone & Fax: 07805-256231, email: gmexcv.ncl@coalindia.in website : www.nclcil.in

---

NCL/SGRL/HQ/EXCV-DEPT/H-350 Date: 06.08.2024

To
M/s Komatsu India Private Limited
Plot No. A-1, Sipcot Industrial Park
Growth Centre, Oragadam, Thenneri (Via),
Kanchipuram, Tamilnadu- 631604
Email: lal.asokansumangala@global.komatsu; Manish.Jhamb@larsentoubro.com; prajeeshchandra@Lntecc.com

Sub: Exploring the possibility of CNG/LNG/Electrical battery Driven 100 Ton / 190 Ton Rear Dumpers for transportation of Coal/Overburden at NCL.

Dear Sir,

NCL is exploring the possibility of acquiring CNG/LNG/Electric Battery-Driven 100 Ton / 190 Ton Rear Dumpers for the transportation of coal and overburden at Northern Coalfields Limited (NCL). Adopting more sustainable practices in compliance of environment, NCL is exploring the availability and feasibility of these Dumpers.

Specifically, NCL is interested in understanding whether your company currently manufactures or is planning to manufacture of CNG/LNG/Electrical battery Driven Dumpers for transportation of Coal/Overburden.

In view of above, it is requested to provide the information of CNG/LNG/Electrical battery Driven 100 Ton / 190 Ton Rear Dumpers for transportation of Coal / Overburden being manufaured / proposed to be manufactured at your company.

Regards,

B.Kum

General Manager (Excv)/HOD
महाप्रबंधक विभागाध्यक्ष/(उत्खनन) (एन.सी .एल)

Pradeep

For kind information- D.T. (O), NCL

Copy to: 1. G.M (CP), NCL, G.M. (R&D), NCL, G.M. (Environment), NCL
2. Area G.M- Khadia Project
3. M/s Larsen & Toubro Limited, Mining Machinery, #32, Shivaji Marg, New Delhi-110015

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी

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Phone & Fax: 07805-256231, email: gmexcv.ncl@coalindia.in website : www.nclcil.in

NCL/SGRL/HQ/EXCV-DEPT/H-351 Date: 06.08.2024

To
M/s BEML Limited
23/1, 4th Main Road
Sampangiram Nagar (S.R.Nagar)
Bengaluru, Karnataka-560027
Email: mmd@beml.co.in; mtt@beml.co.in; rm.singrauli@beml.co.in

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महाप्रबंधक विभागाध्यक्ष/(उत्खनन) (एन.सी .एल)
Pradeep

For kind information- D.T.(O), NCL
Copy to;

1. G.M (CP),NCL, G.M. (R&D),NCL, G.M. (Environment),NCL
2. Area G.M- Khadia Project

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Phone & Fax: 07805-256231, email: gmexcv.ncl@coalindia.in website : www.nclcil.in

NCL/SGRL/HQ/EXCV-DEPT/ H-353 Date: 06.08.2024

To
M/s Tata Hitachi Construction Machinery Company Private Limited
Jubilee Building, 45 Museum Road
Bengaluru, Karnataka-560025
Email: Rishi.Raj@tatahitachi.co.in

Sub: Exploring the possibility of CNG/LNG/Electrical battery Driven 100 Ton / 190 Ton Rear Dumpers for transportation of Coal/Overburden at NCL.

Dear Sir,

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General Manager (Excv)/HOD
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Pradeep

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2.Area G.M- Khadia Project

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Phone & Fax: 07805-256231, email: gmexcv.ncl@coalindia.in website : www.nclcil.in

NCL/SGRL/HQ/EXCV-DEPT/H-354 Date: 06.08.2024

To
M/s OJSC "BELAZ"
Management Company of Holding "BELAZ-HOLDING"
Republic of Belarus
Email: export@belaz.minsk.by; import@belaz.minsk.by; jvgokal@vsnl.com

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Regards,

B.K.M

General Manager (Excv)/HOD
महाप्रबंधक विभागाध्यक्ष/(उत्खनन) (एन.सी .एल)
Pradeep

For kind information- D.T. (O), NCL
Copy to: 1. G.M (CP), NCL, G.M. (R&D), NCL, G.M. (Environment), NCL
2.Area G.M- Khadia Project
3.M/s J.V. Gokal & Co. Private Limited, Mumbai

Annexure-K

Gmail

Environment Khadia <environmentkhadia@gmail.com>

Approval Request-New Unit Connectivity-Mining-KHADIA PROJECT NORTHERN COALFIELDS LIMITED-Uttar Pradesh-Reg.

RTDMS Connectivity <rtdmsapproval1.cpcb@gov.in> Fri, Dec 13, 2024 at 5:43 PM
To: environmentkhadia <environmentkhadia@gmail.com>
Cc: Archit Uprit <architurprit.cpcb@nic.in>, B Vinod Babu <itdiv.cpcb@gov.in>, "rajasekar.r" <rajasekar.r@rockwellautomation.com>, connect <connect@enggenv.com>, "cgm.khd" <cgm.khd@gmail.com>, sominingkhdpro <sominingkhdpro@gmail.com>, Sanjeev kumar <gmenv.ncl@coalindia.in>, B Vinod Babu <itdiv.cpcb@nic.in>, arpitnanavati <arpitnanavati@dcmshriram.com>, Anurag Sharma <anurag.cpcb@gov.in>, KRISHAN DEV <kd.cpcb@gov.in>, NEHA SINGH <neha.cpcb@gov.in>

Sir/Ma'am,

PFA provisional connectivity sheet of M/s KHADIA PROJECT NORTHERN COALFIELDS LIMITED, UP. The connectivity is provisional but subjected to Future review of measurement principles used in the device and/or device capability, by any CPCB Division, and any corrective action including direction for replacement of these devices if found unsuitable.

Note: The unit/Station has been integrated with RTDMS Portal, kindly update the industry code in CPCB Registration portal.

Thanks & Regards

IT Division
Central Pollution Control Board
Delhi

---- On Mon, 25 Nov 2024 17:56:22 +0530 **<environmentkhadia@gmail.com>** wrote ---

[Quoted text hidden]

NCL Khadia Project,Shaktinagar | Delay

Reports

Quick Range

1 Day | 3 Days | 7 Days | 30 Days

From Date *

1/14/2025, 1:59 PM

To Date *

1/20/2025, 1:59 PM

Station

ETP_of_Khadia_Project

Frequency

15 Minutes

table View

Fetch

Average Report

Print | Excel | Pdf

Calibration Expected	Calibration Span
Error	Faulty
Invalid	Maintenance
Negative	Out of Range
Raw	Validated
Zero Calibration	Estimates
Corrected	Drift
Failure	Correct
Non-obtained	warning
Anomaly	Out of Field

Time Stamp × BOD (mg/l) × COD (mg/l) × TSS (mg/l) × pH (pH) × +4 ×

Search...

2025-01-14 13:45	14.36	225.57	169.16	6.97	0.36
2025-01-14 14:00	14.31	224.58	168.42	7.03	0.08
2025-01-14 14:15	0.00	0.00	0.00	0.00	0.00
2025-01-14 14:30	14.10	221.32	165.97	7.10	0.23

37.	Hazardous waste treatment processes, e.g. pre-processing, incineration and concentration	37.1 37.2 37.3	Sludge from wet scrubbers Ash from incinerator and flue gas cleaning residue Concentration or evaporation residues
38.	Chemical processing of Ores containing heavy metals such as Chromium, Manganese, Nickel, Cadmium etc.	38.1 38.2	Process residues Spent acid

*** The inclusion of wastes contained in this Schedule does not preclude the use of Schedule II to demonstrate that the waste is not hazardous. In case of dispute, the matter would be referred to the Technical Review Committee constituted by Ministry of Environment, Forest and Climate Change.**

Note: *The high volume low effect wastes such as fly ash, Phosphogypsum, red mud, jarosite, Slags from pyrometallurgical operations, mine tailings and ore beneficiation rejects are excluded from the category of hazardous wastes. Separate guidelines on the management of these wastes shall be issued by Central Pollution Control Board.*

SCHEDULE II

[See rule 3 (1) (17) (ii)]

List of waste constituents with concentration limits

Class A: Based on leachable concentration limits [Toxicity Characteristic Leaching Procedure (TCLP) or Soluble Threshold Limit Concentration (STLC)]

Class	Constituents	Concentration in mg/l
(1)	**(2)**	**(3)**
A1	Arsenic	5.0
A2	Barium	100.0
A3	Cadmium	1.0
A4	Chromium and/or Chromium (III) compounds	5.0
A5	Lead	5.0
A6	Manganese	10.0
A7	Mercury	0.2
A8	Selenium	1.0
A9	Silver	5.0
A10	Ammonia	50*
A11	Cyanide	20*
A12	Nitrate (as nitrate-nitrogen)	1000.0
A13	Sulphide (as H_2S)	5.0
A14	1,1-Dichloroethylene	0.7
A15	1,2-Dichloroethane	0.5
A16	1,4-Dichlorobenzene	7.5
A17	2,4,5-Trichlorophenol	400.0
A18	2,4,6-Trichlorophenol	2.0
A19	2,4-Dinitrotoluene	0.13
A20	Benzene	0.5
A21	Benzo (a) Pyrene	0.001
A22	Bromodicholromethane	6.0
A23	Bromoform	10.0
A24	Carbon tetrachloride	0.5
A25	Chlorobenzene	100.0
A26	Chloroform	6.0
A27	Cresol (ortho+ meta+ para)	200.0
A28	Dibromochloromethane	10.0
A29	Hexachlorobenzene	0.13
A30	Hexachlorobutadiene	0.5
A31	Hexachloroethane	3.0
A32	Methyl ethyl ketone	200.0

A33	Naphthalene	5.0
A34	Nitrobenzene	2.0
A35	Pentachlorophenol	100.0
A36	Pyridine	5.0
A37	Tetrachloroethylene	0.7
A38	Trichloroethylene	0.5
A39	Vinyl chloride	0.2
A40	2,4,5-TP (Silvex)	1.0
A41	2,4-Dichlorophenoxyacetic acid	10.0
A42	Alachlor	2.0
A43	Alpha HCH	0.001
A44	Atrazine	0.2
A45	Beta HCH	0.004
A46	Butachlor	12.5
A47	Chlordane	0.03
A48	Chlorpyriphos	9.0
A49	Delta HCH	0.004
A50	Endosulfan (alpha+ beta+ sulphate)	0.04
A51	Endrin	0.02
A52	Ethion	0.3
A53	Heptachlor (& its Epoxide)	0.008
A54	Isoproturon	0.9
A55	Lindane	0.4
A56	Malathion	19
A57	Methoxychlor	10
A58	Methyl parathion	0.7
A59	Monocrotophos	0.1
A60	Phorate	0.2
A61	Toxaphene	0.5
A62	Antimony	15
A63	Beryllium	0.75
A64	Chromium (VI)	5.0
A65	Cobalt	80.0
A66	Copper	25.0
A67	Molybdenum	350
A68	Nickel	20.0
A69	Thallium	7.0
A70	Vanadium	24.0
A71	Zinc	250
A72	Fluoride	180.0
A73	Aldrin	0.14
A74	Dichlorodiphenyltrichloroethane (DDT), Dichlorodiphenyldichloroethylene (DDE), Dichlorodiphenyldichloroethane (DDD)	0.1
A75	Dieldrin	0.8
A76	Kepone	2.1
A77	Mirex	2.1
A78	Polychlorinated biphenyls	5.0
A79	Dioxin (2,3,7,8-TCDD)	0.001

Class B: Based on Total Threshold Limit Concentration (TTLC)

Class	**Constituent**	**Concentration in mg/kg**
(1)	**(2)**	**(3)**
B1	Asbestos	10000
B2	Total Petroleum Hydrocarbons (TPH) (C5 - C36)	5,000

Note:

(1) The testing method for list of constituents at A1 to A61 in Class-A, shall be based on Toxicity Characteristic Leaching Procedure (TCLP) and for extraction of leachable constituents, USEPA Test Method 1311 shall be used.

(2) The testing method for list of constituents at A62 to A79 in Class- A, shall be based on Soluble Threshold Limit Concentration (STLC) and Waste Extraction Test (WET) Procedure given in Appendix II of section 66261 of Title 22 of California Code regulation (CCR) shall be used.

(3) In case of ammonia (A10), cyanide (A11) and chromium VI (A64), extractions shall be conducted using distilled water in place of the leaching media specified in the TCLP/STLC procedures.

(4) A summary of above specified leaching/extraction procedures is included in manual for characterization and analysis of hazardous waste published by Central Pollution Control Board and in case the method is not covered in the said manual, suitable reference method may be adopted for the measurement.

(5) In case of asbestos, the specified concentration limits apply only if the substances are in a friable, powdered or finely divided state.

(6) The hazardous constituents to be analyzed in the waste shall be relevant to the nature of the industry and the materials used in the process.

Wastes which contain any of the constituents listed below shall be considered as hazardous, provided they exhibit the characteristics listed in Class-C of this Schedule :

1.	Acid Amides
2.	Acid anhydrides
3.	Amines
4.	Anthracene
5.	Aromatic compounds other than those listed in Class A
6.	Bromates, (hypo-bromites)
7.	Chlorates (hypo-chlorites)
8.	Carbonyls
9.	Ferro-silicate and alloys
10.	Halogen- containing compounds which produce acidic vapours on contact with humid air or water e.g. silicon tetrachloride, aluminum chloride, titanium tetrachloride
11.	Halogen- silanes
12.	Halogenated Aliphatic Compounds
13.	Hydrazine (s)
14.	Hydrides
15.	Inorganic Acids
16.	Inorganic Peroxides
17.	Inorganic Tin Compounds
18.	Iodates
19.	(Iso- and thio-) Cyanates
20.	Manganese-silicate
21.	Mercaptans
22.	Metal Carbonyls
23.	Metal hydrogen sulphates
24.	Nitrides
25.	Nitriles
26.	Organic azo and azooxy Compounds
27.	Organic Peroxides
28.	Organic Oxygen Compounds
29.	Organic Sulphur Compounds
30.	Organo- Tin Compounds
31.	Organo nitro- and nitroso compounds

32.	Oxides and hydroxides except those of hydrogen, carbon, silicon, iron, aluminum, titanium, manganese, magnesium, calcium
33.	Phenanthrene
34.	Phenolic Compounds
35.	Phosphate compounds except phosphates of aluminum, calcium and iron
36.	Salts of pre-acids
37.	Total Sulphur
38.	Tungsten Compounds
39.	Tellurium and tellurium compounds
40.	White and Red Phosphorus
41.	2-Acetylaminofluorene
42.	4-Aminodiphenyl
43.	Benzidine and its salts
44.	Bis (Chloromethyl) ether
45.	Methyl chloromethyl ether
46.	1,2-Dibromo-3-chloropropane
47.	3,3'-Dichlorobenzidine and its salts
48.	4-Dimethylaminoazobenzene
49.	4-Nitrobiphenyl
50.	Beta-Propiolactone

CLASS C : Based on hazardous Characteristics

Apart from the concentration limit given above, the substances or wastes shall be classified as hazardous waste if it exhibits any of the following characteristics due to the presence of any hazardous constituents:

Class C1: Flammable- A waste exhibits the characteristic of flammability or ignitability if a representative sample of the waste has any of the following properties, namely:-

(i) flammable liquids, or mixture of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc; but not including substances or wastes otherwise classified on account of their dangerous characteristics), which give off a flammable vapour at temperature less than 60°C. This flash point shall be measured as per ASTM D 93-79 closed-cup test method or as determined by an equivalent test method published by Central Pollution Control Board;

(ii) it is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns vigorously and persistently creating a hazard;

(iii) it is an ignitable compressed gas;

(iv) It is an oxidizer and for the purposes of characterisation is a substance such as a chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter.

Class C2: Corrosive- A waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties, namely:-

(i) it is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5;

(ii) it is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm per year at a test temperature of 55 °C;

(iii) it is not aqueous and, when mixed with an equivalent weight of water, produces a solution having a pH less than or equal to 2 or greater than or equal to 12.5;

(iv) it is not a liquid and, when mixed with an equivalent weight of water, produces a liquid that corrodes steel (SAE1020) at a rate greater than 6.35 mm per year at a test temperature of 55 °C.

Note:

For the purpose of determining the corrosivity, the Bureau of Indian Standard 9040 C method for pH determination, NACE TM 01 69 : Laboratory Corrosion Testing of Metals and EPA 1110A method for corrosivity towards steel (SAE1020) to establish the corrosivity characteristics shall be adopted.

Class C3: Reactive or explosive- A waste exhibits the characteristic of reactivity if a representative sample of the waste it has any of the following properties, namely:-

(i) it is normally unstable and readily undergoes violent change without detonating;

(ii) it reacts violently with water or forms potentially explosive mixtures with water;

(iii) when mixed with water, it generates toxic gases, vapours or fumes in a quantity sufficient to present a danger to human health or the environment;

(iv) it is a cyanide or sulphide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapours or fumes in a quantity sufficient to present a danger to human health or the environmental;

(v) it is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement;

(vi) it is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure;

(vii) it is a forbidden explosive.

Class C4: Toxic- A waste exhibits the characteristic of toxicity, if, :-

(i) the concentration of the waste constituents listed in Class A and B (of this schedule) are equal to or more than the permissible limits prescribed therein;

(ii) it has an acute oral LD50 less than 2,500 milligrams per kilogram;

(iii) it has an acute dermal LD50 less than 4,300 milligrams per kilogram;

(iv) it has an acute inhalation LC50 less than 10,000 parts per million as a gas or vapour;

(v) it has acute aquatic toxicity with 50% mortality within 96 hours for zebra fish (*Brachidanio rerio*) at a concentration of 500 milligrams per litre in dilution water and test conditions as specified in BIS test method 6582 – 2001.

(vi) it has been shown through experience or by any standard reference test- method to pose a hazard to human health or environment because of its carcinogenicity, mutagenecity, endocrine disruptivity, acute toxicity, chronic toxicity, bio-accumulative properties or persistence in the environment.

Class C5: Substances or Wastes liable to spontaneous combustion - Substances or Wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.

Class C6: Substances or Wastes which, in contact with water emit flammable gases- Substances or Wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

Class C7: Oxidizing - Substances or Wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.

Class C8: Organic Peroxides - Organic substances or Wastes which contain the bivalent O−O structure, which may undergo exothermic self-accelerating decomposition.

Class C9: Poisons (acute) - Substances or Wastes liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact.

Class C10: Infectious ~~substances~~ - Substances or Wastes containing viable micro-organisms or their toxins which are known or suspected to cause disease in animals or humans.

Class C11: Liberation of toxic gases in contact with air or water - Substances or Wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.

Class C12: Eco-toxic- Substances or Wastes which if released, present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation or toxic effects upon biotic systems or both.

Class C13: Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

Annexure-N

757

भारतीय प्रौद्योगिकी संस्थान
INDIAN INSTITUTE OF TECHNOLOGY
(काशी हिन्दू विश्वविद्यालय)
(BANARAS HINDU UNIVERSITY)
रासायनिक अभियांत्रिकी एवं प्रौद्योगिकी विभाग
DEPARTMENT OF CHEMICAL ENGINEERING & TECHNOLOGY
(उच्चानुशीलन केन्द्र एवं डी एस टी प्रायोजित 'फिस्ट' विभाग)
(CENTRE OF ADVANCED STUDY & DST DEPARTMENT UNDER FIST)
(वाराणसी - २२१००५) Varanasi - 221005

Ref.No.ChE/2017-18/245

Date: November ~~23~~ 30, 2017

To,
Mr. A.N. Pandey
General Manager
Khadia Project
Northern Coal Field Ltd.
P.O – Saktinagar
Dist – Sonbhadra – 231 222

Dear Sir,

In reference to your letter No. KHS/Min/Sampling/17/381 dated 02.05.2017, the test report of your sample submitted and collected by you are as under:

Test Report

EPT Sludge Sample KHSL1	Pb (ppm)	Hg (ppm)	As (ppm)	Cd (ppm)	Ni (ppm)	Co (ppm)
1.	0.0006	00	4.312	0.014	00	.0291

Forwarded

(A.S.K. Sinha)
Lab-Incharge
Hydrogen Energy Lab
प्राचार्य/Professor
रासायनिक अभियांत्रिकी एवं प्रौद्योगिकी विभाग
Deptt. of Chemical Engg. & Tech.
भारतीय प्रौद्योगिकी संस्थान
Indian Institute of Technology
काशी हिन्दू विश्वविद्यालय
Banaras Hindu University
वाराणसी/Varanasi-221005

(P.K. Mishra)
Head of the Department
विभागाध्यक्ष/Head
रासायनिक अभियांत्रिकी प्रौद्योगिकी विभाग
Department of Chemical Engg. & Tech.
भारतीय प्रौद्योगिकी संस्थान/Indian Institute of Technology
काशी हिन्दू विश्वविद्यालय/Banaras Hindu University
वाराणसी/Varanasi-221005

AM(Env)

31/3/18

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Fax (फैक्स): 091-0542-2368092, Email : head.che@itbhu.ac.in
☎ 0542-2368092, 6702029, 6702024

Gmail

Environment Khadia <environmentkhadia@gmail.com>

Testing of ETP Sludge

Environment Khadia <environmentkhadia@gmail.com> Mon, Jan 27, 2025 at 7:16 PM
To: director@iitism.ac.in
Cc: staff officer mining khadia project <sominingkhdpro@gmail.com>, Cgm Khadia <cgm.khd@gmail.com>

Dear Sir,

Khadia Opencast Project is an opencast coal mine of M/s Northern Coalfields Limited. During its operation, Khadia OCP treats its effluent generated from coal mine in an Effluent Treatment Plant and in this process, ETP sludge is generated.

As per schedule -I of the Hazardous & Other Waste (Management & Transboundary Movement) Rules, 2016, the use of Schedule II can be done to demonstrate that the waste is not hazardous.

Khadia Project wishes to ascertain the hazardous nature of ETP sludge being generated as per Schedule- II of the Hazardous & Other Waste (Management & Transboundary Movement) Rules, 2016. (Copy enclosed).

It is requested to kindly furnish the quotation / estimated amount and necessary details for above work.

With regards
Nodal Officer (Environment)
Khadia Area, NCL

Schedule-II_Hz Waste.pdf
85K

Gmail Environment Khadia <environmentkhadia@gmail.com>

Testing of ETP Sludge

Environment Khadia <environmentkhadia@gmail.com> Mon, Jan 27, 2025 at 7:13 PM
To: director@iitbhu.ac.in
Cc: staff officer mining khadia project <sominingkhdpro@gmail.com>, Cgm Khadia <cgm.khd@gmail.com>

Dear Sir,

Khadia Opencast Project is an opencast coal mine of M/s Northern Coalfields Limited. During its operation, Khadia OCP treats its effluent generated from coal mine in an Effluent Treatment Plant and in this process, ETP sludge is generated.

As per schedule -I of the Hazardous & Other Waste (Management & Transboundary Movement) Rules, 2016, the use of Schedule II can be done to demonstrate that the waste is not hazardous.

Khadia Project wishes to ascertain the hazardous nature of ETP sludge being generated as per Schedule- II of the Hazardous & Other Waste (Management & Transboundary Movement) Rules, 2016. (Copy enclosed).

It is requested to kindly furnish the quotation / estimated amount and necessary details for above work.

With regards
Nodal Officer (Environment)
Khadia Area, NCL

Schedule-II_Hz Waste.pdf
85K

Gmail

Environment Khadia <environmentkhadia@gmail.com>

Testing of ETP Sludge

Environment Khadia <environmentkhadia@gmail.com> Mon, Jan 27, 2025 at 7:11 PM
To: "rpbd@iitrindia.org" <rpbd@iitrindia.org>
Cc: staff officer mining khadia project <sominingkhdpro@gmail.com>, Cgm Khadia <cgm.khd@gmail.com>, "Hemendra B. Shinde" <gmenv.ncl@coalindia.in>

Dear Sir,

Khadia Opencast Project is an opencast coal mine of M/s Northern Coalfields Limited. During its operation, Khadia OCP treats its effluent generated from coal mine in an Effluent Treatment Plant and in this process, ETP sludge is generated.

As per schedule -I of the Hazardous & Other Waste (Management & Transboundary Movement) Rules, 2016, the use of Schedule II can be done to demonstrate that the waste is not hazardous.

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It is requested to kindly furnish the quotation / estimated amount and necessary details for above work.

With regards
Nodal Officer (Environment)
Khadia Area, NCL

Schedule-II_Hz Waste.pdf
85K

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

संविदा प्रबंधन प्रकोष्ठ /Contract Management Cell

CIN- U10102MP1985GOI003160
An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company
पोस्ट- सिंगरौली कोलियरी, जिला- सिंगरौली, म.प्र. पिन 486889/ Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266671, (FAX) 266640 email: gmcmc.ncl@coalindia.in website : www.nclcil.in

Ref.No.: NCL/SGR/CMC/KHADIA CHP/ LOA/2024/ 02 Date: 08.01.2024

To,
M/s. S. K. Samanta & Co. Pvt. Ltd.,
2/5, Sarat Bose Road
Kolkata - 700020.
E-mail id: kol@sksl.in

Sub: Letter of Acceptance (LoA) / Work order for the work of: "Planning, Design, Engineering, Construction, Fabrication, Erection, Supply, Installation, Testing, Trial Run and Commissioning of Coal Handling Plant of 4 MTPA consisting of all Civil, Structural, Electrical and Mechanical Works and all other accessories and facilities required to make it complete in all respects on turnkey basis and Operation and Maintenance of plant for five years in Khadia OCP of NCL."

Ref: 1. NIT No.: GM (CMC)/NCL/NIT/KHD CHP/105 Date: 31.05.2023
2. Tender Id: 2023_NCL_280513_1
3. Your submitted bid with Bid ID: 956949 along with confirmatory documents on www.coalindiatenders.nic.in including Price Justification.

Dear Sir,

With reference to above, this is to communicate the approval of the Competent Authority for award of the subject work to M/s S K Samanta & Co Pvt Ltd for an amount of Rs. 272,69,80,000/- (Rupees Two Hundred Seventy Two Crore Sixty Nine Lakh Eighty Thousand only including GST@18%)

[Capital Cost: Rs. 251,34,00,000/- including GST, Revenue Cost (O&M): Rs. 21,35,80,000/- including GST], subject to the following terms and conditions:

1. PERFORMANCE SECURITY DEPOSIT (PSD) / SECURITY DEPOSIT

You have to deposit a sum of Rs. 11,55,50,000/- (Rupees Eleven Crores Fifty Five Lakh Fifty Thousand only) only as 5% of the Contract Price, within 21 days of issuance of LOA, as per Clause No. 3 'Contract Performance Guarantee/ Security Deposit' of General Terms & Conditions of Contract of the NIT.

Work shall commence only after submission of Performance Security. In case the successful bidder fails to submit the Performance Security within the stipulated time then the award of work shall be cancelled and bidder will be banned for two years from being eligible to submit bids in CIL and its subsidiaries. In addition to the above penal measures, the bidder will not be allowed to participate in the retendering process.

All running on Account bills shall be paid at 95% (ninety five percent) of the executed work value. This 5% (Five percent) deduction towards Retention Money will be the second part of Security Deposit.

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(A Miniratna Company)
(A subsidiary of Coal India Limited)

Contract Management Cell

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Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266671, (FAX) 266640 email: gmcmc.ncl@coalindia.in website : www.nclcil.in

2. **Goods & Service Tax :**

The payment of the Goods & Service Tax shall be governed as per the Terms and Conditions of the NIT / Tender document.

3. **Contract Period:**

The contract period for this work shall be 2555 days from the date of commencement which shall be within 30 (Thirty) days of issue of letter of acceptance and submission of Performance Security or from 7th day of handing over of the site for the first activity as per PERT network chart, whichever is later.

- **Work shall commence only after submission of Performance Security.**

2555 days shall comprise of:
(i) 730 days for Construction including Trial Run, PGT & Commissioning of the Plant
(ii) 1825 days (05 years) for Operation & Maintenance of Plant during Defect Liability Period.

The date of uploading of this Letter of Acceptance / Work order on e-Procurement Portal (www.coalindiatenders.nic.in) shall be treated as the date of receipt of this LOA / Work order by you.

4. **Price Variation (Escalation/De-escalation) :**

(a) That the contract price shall remain firm without any price variation due to escalation for the portions of survey, geo-engineering investigations, design and engineering and supply of equipments, plant and machineries as envisaged in the scope of work and the price agreed thereon as per the contract except the statutory increase/decrease in taxes and duties such as GST, GST (Compensation to State) Cess etc.

If the contract is to be extended beyond the stipulated period for completion of the work due to fault on the part of the contractor escalation on prices should not be allowed further if not provided otherwise in the accepted contract.

(b) That for the portions of Civil and Structural Works and Erection and commissioning Works of the Plant and machineries, the Price Variation due to Escalation shall be in compliance with Cl.No.2 of Additional Terms & Conditions of Contract (Price Variation Clause).

(c) That the base date for working out Escalation/De-escalation is 14.07.2023 i.e. the last date of submission of bid.

(d) That the ceiling on price variation due to escalation covered under clauses mentionec hereinbefore on the contract, limited to 10% of that portion of Contract Price for which price variation is applicable.

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

एन सी एल
NCL

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

संविदा प्रबंधन प्रकोष्ठ /Contract Management Cell

CIN- U10102MP1985GOI003160
An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company
पोस्ट- सिंगरौली कोलियरी, जिला- सिंगरौली, म.प्र., पिन 486889/ Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266671, (FAX) 266640 email: gmcmc.ncl@coalindia.in website : www.nclcil.in

5. **EMPLOYMENT OF LABOUR:**

   The provisions / guideliens as incorportated in the NIT and Bid Document with regard to "Employment of Labours" and the wages & others to be paid shall be followed.

6. **INSURANCE:** That you have to take necessary insurance policies required for this work, in compliance with the provisions of NIT and Bid Document, in the joint name of Northern Coalfields Limited (NCL) and the Contractor, M/s. S. K. Samanta & Co. Pvt. Ltd.

7. **SAFETY:** That you will be responsible for any damage resulting from your operations. You will also be responsible for protection of all persons including members of public and employees of the NCL and the employees of other contractors and sub-contractors and all public and private property including structures, buildings, other plants and equipment and utilities either above or below the ground. You will ensure provision of necessary safety arrangement/equipment such as barriers, sign-boards, warning lights and alarms, etc. to provide adequate protection to persons and property. You will be responsible to give reasonable notice to the Engineer-in-Charge and the owners of public or private property and utilities well in advance, when such property and utilities are likely to get damaged or injured during the performance of your works and shall make all necessary arrangements with such owners, related to removal and/or replacement or protection of such property and utilities.

8. That the matters rélating to any dispute or differences arising out of this work order and subsequent contract agreement entered, based on this tender and work order shall be subject to the jurisdiction of District Court, Waidhan (Singrauli) Madhya Pradesh only.

9. That you have to submit a detailed PERT network within the time frame agreed as per NIT consisting of adequate number of activities covering all key phases of the works such as design, procurement, manufacturing, shipment, field erection activities etc. within fifteen (15) days after the date of acceptance of tender in compliance with Clause No.6 of General Terms & Conditions of Contract.

10. That the Engineer-in-Charge (EIC) for this work will be **Area General Manager, Khadia project**, NCL certifying payment due to the contractor, valuing variations to the contract, awarding extension of time and valuing compensation events. Engineer-in-charge/Designated Officer-in-charge may further appoint his representatives i.e. another person / Project Manager or any other competent person and notify to the contractor who is directly responsible for supervising the work being executed at the site, on his behalf under the Delegation of Powers of the company. However, overall responsibility, as far as the contract is concerned will be that of the Engineer-in-charge/Designated Officer-in-charge.

11. No sub-letting of the work as a whole by the contractor is permissible. Prior permission is required to be taken from the principal employer for engagement of sub- contractors in part work/piece rated work.

12. That the Paying Authority for this work will be the **Area Finance Manager, Khadia NCL.**

13. Schedule of Quantity / BOQ for this work is enclosed.

Northern Coalfields Limited
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Contract Management Cell

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Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266671, (FAX) 266640 email: gmcmc.ncl@coalindia.in website : www.nclcil.in

14. That you have to submit the following documents within 30 days of issue of this LOA/Work Order (*except Performance Security which is to be submitted within 21 days*) for execution of Agreement:

    i. PSD amounting to Rs. 11,55,50,000/- (Rupees Eleven Crores Fifty Five Lakhs Fifty Thousand only) as per Cl. No.1 of LOA i.e. within 21 days.
    ii. Non Judicial Stamp Paper of Rs. 500.00
    iii. Site handover and takeover certificate, jointly signed by Engineer-in-Charge and the Contractor.
    iv. Labour License as per Contract Labour (Regulation & Abolition) Act, 1970.
    v. Insurance Policy certificates (Worker's Compensation Policy & All Risk Policy) duly pledged in the name of NCL.
    vi. CMPF / EPF Registration certificate.
    vii. Valid H.T. Electrical Contractor's license
    viii. Detail Time and Progress Chart, jointly signed by Engineer-in-Charge and the Contractor.
    ix. List of Technical & Supervisory Personnel to be deployed for execution of the work.
    x. Integrity Pact on Non Judicial Stamp Paper of Rs. 500.00
    xi. Copy of PAN card
    xii. Copy of GST Registration Certificate
    xiii. Copy of Certificate of Incorporation, Memorandum and Article of Association alongwith Power of Attorney for person signing the contract agreement.
    xiv. E-payment Mandate form as per NIT
    xv. Any other document, if required, as per NIT / Tender document.

15. All other terms and conditions as detailed in the NIT and Bid Document and subsequent clarifications made thereof with regard to bidder's queries and uploaded on e-Procurement portal shall be followed and form an integral part of the contract agreement.

Enclosure: Schedule of Quantities / BOQ.

For further instructions, please contact **Area General Manager, Khadia NCL**.

Yours faithfully

08/01/24

General Manager (CMC)

Copy for kind information to:

1. CMD, NCL
2. Director (Technical)/Operations
3. Director (Technical)/P&P, NCL
4. Director (Finance), NCL
5. CVO, NCL

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

Contract Management Cell

CIN- U10102MP1985GOI003160
An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company

Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266671, (FAX) 266640 email: gmcmc.ncl@coalindia.in website : www.nclcil.in

Distribution:

1. GM, Khadia project
2. HOD, Board Secretariat.
3. GM (E&M) / HOD, NCL
4. GM, CP NCL
5. GM, Civil, NCL
6. GM (P&IR) NCL
7. GM (E&M), NCL
8. HOD (M&S) NCL
9. GM(Finance), I/C(C&B), Internal Audit, NCL
10. AFM, Khadia

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

766

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

Office of the General Manager
Khadia Area

Annexure-Q

CIN- U10102MP1985GOI003160
An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company
Post- SHAKTINAGAR Distt- SONEBHADRA U.P. PIN-231222
Phone: 05446- 232274, (FAX) 232274 email: cgm.khd@gmail.com website : www.nclcil.in

No. NCL/KHD/GM/24/4194

Dated: 15.03.2024

To,

M/s S.K. Samanta & Co.(P)Ltd.
Suite 4A.2/5, Sarat Bose Road
Kolkata -700020
E-mail id:kol@sksl.in

Sub: Regarding Handing over of site for the work of Planning. Design, Engineering, Construction, Fabrication, Erection, Supply, Installation, Testing, Trial run and Commissioning of Coal handling Plant of 4MTPA consisting of all Civil, Structural, Electrical & Mechanical works and all other accessories and facilities required to make it compete in all respect on Turnkey basis and Operation & Maintenance of plant for five years in Khadia OCP of NCL.

Ref: i) NIT No: GM(CMC)/NCL/NIT/KHD CHP/105 dated 31.05.2023
ii) LOA No. NCL/SGR/CMC/KHADIA CHP/LOA/2024/02 dated. 08.01.2024
iii) Letter No. NCL/KHD/GM/NewCHP/4181 dated 06.03.2024
iv) Letter No. NCL/SGR/CMC/23-24/79 dated 06.03.2024

Dear Sir,

Consequent to Joint inspection by the representatives of NCL, Khadia and M/s S.K.Samanta &Co.Pvt.Ltd on dt.11.03.24, the site has been handed over as per LOA Clause no.3. The date of commencement of the work shall be reckoned from 17.03.2024 and accordingly date of completion of construction shall be 16.03.2026.

You are requested to take-up the work observing all formalities as per LOA and commence the work only after submission of Performance Security.

Yours faithfully.

15/03/2024

Area General Manager
Khadia Area

15/3

Copy for kind information to:
1. TS to DT (P&P),NCL HQ

Copy to :

1) GM(E&M),NCL HQ
2) GM(CMC),NCL HQ
3) GM(C)/HOD, NCL HQ
4) SO(Mining), Khadia Area
5) Project Officer, Khadia
6) S.O.(Civil) , Khadia Area
7) S.O.(E&M) , Khadia Area
8) A.F.M, Khadia Area
9) S.O.(P) , Khadia Area

For needful action
for administration of Contract.

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

एन सी एल
NCL

वन विभाग / Forest Department
CIN- U10102MP1985GOI003160
An ISO 9001, ISO 14001 & ISO 45001 Certified Company
पोस्ट-सिगंरौली कोलियरी, जिला- सिगंरौली,म.प्र., पिन 486889 / Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

क्रमांक: एनसीएल/मुख्यालय/पर्यावरण/वन/2023/ 666 दिनांक :-31.10.2023

प्रति,
Director,
Forest Research Institute,
Chakarata Rd, New Forest,
P.O, Indian Military Academy,
Dehradun, Uttarakhand 248006,

विषय : **Submission of offer/quotation/Estimate for Development of SAL Nursery at different Projects of NCL.**

महोदय,

In the Environment Clearance conditions of different projects of NCL, MoEF&CC has included the condition for establishing Sal Nursery for increasing the availability of saplings for Sal plantation in the vicinity of mining areas in NCL. The Location/Projects and area of Nursery as under:

SL. No.	Name of the projects/Location of Nursery	Area of Nursery in Ha.
1.	Jhingurda Area	5.0 Ha.
2.	Bina Area	10.0 Ha.
3.	Nigahi, Area	5.0 Ha.
4.	Khadia, Area	10.0 ha.

In view of the above you are requested to submit the offer/quotation/Estimate for Development of SAL Nursery at above locations/Projects/area of NCL.

भवदीय
31.10.23
महाप्रबंधक/ विभागाध्यक्ष (पर्यावरण एवं वन), I/C
एन.सी.एल.-सिंगरौली

प्रतिलिपि :
1. निदेशक (तकनीकी /परियोजना व योजना), एन सी एल.....सूचनार्थ

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

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Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

क्रमांक: एनसीएल/मुख्यालय/पर्यावरण/वन/2023/ 667 दिनांक :-31.10.2023

प्रति,
Divisional Forest Officer (DFO)
District- Singrauli, Waidhan
MP-486886.

विषय : **Submission of offer/quotation/Estimate for Development of SAL Nursery at different Projects of NCL.**

महोदय,

In the Environment Clearance conditions of different projects of NCL, MoEF&CC has included the condition for establishing Sal Nursery for increasing the availability of saplings for Sal plantation in the vicinity of mining areas in NCL. The Location/Projects and area of Nursery as under:

SL. No.	Name of the projects/Location of Nursery	Area of Nursery in Ha.
1.	Jhingurda Area	5.0 Ha.
2.	Bina Area	10.0 Ha.
3.	Nigahi, Area	5.0 Ha.
4.	Khadia, Area	10.0 ha.

In view of the above you are requested to submit the offer/quotation/Estimate for Development of SAL Nursery at above locations/Projects/area of NCL.

भवदीय
31.10.23
महाप्रबंधक/ विभागाध्यक्ष (पर्यावरण एवं वन),
एन.सी.एल.-सिंगरौली

प्रतिलिपि :
1. निदेशक (तकनीकी /परियोजना व योजना), एन सी एल.....सूचनार्थ

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Azadi Ka Amrit Mahotsav G20

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

एन सी एल NCL

वन विभाग / Forest Department
CIN- U10102MP1985GOI003160
An ISO 9001, ISO 14001 & ISO 45001 Certified Company
पोस्ट-सिगंरौली कोलियरी, जिला- सिगंरौली,म.प्र., पिन 486889 / Post- Singrauli Colliery, Distt- Singrauli, M.P. PIN-486889
Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

क्रमांक: एनसीएल/मुख्यालय/पर्यावरण/वन/2023/ 668 दिनांक :-31.10.2023

प्रति,
प्रभागीय वनाधिकारी
रेनुकूट वन प्रभाग
सोनभद्र उत्तर प्रदेश - 231217

विषय : **Submission of offer/quotation/Estimate for Development of SAL Nursery at different Projects of NCL.**

महोदय,

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भवदीय
ई. शिन्दे 31.10.23
महाप्रबंधक/ विभागाध्यक्ष (पर्यावरण एवं वन), IIC
एन.सी.एल.-सिंगरौली

प्रतिलिपि :
1. निदेशक (तकनीकी /परियोजना व योजना), एन सी एल.....सूचनार्थ

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Azadi Ka Amrit Mahotsav

G20

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एन सी एल NCL

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Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

क्रमांक: एनसीएल/मुख्यालय/पर्यावरण/वन/2023/ 669 दिनांक :-31.10.2023

प्रति,
सम्भागीय प्रबंधक
रीवा- सीधी परियोजना मण्डल
सीधी मध्यप्रदेश -486661.

विषय : **Submission of offer/quotation/Estimate for Development of SAL Nursery at different Projects of NCL.**

महोदय,

In the Environment Clearance conditions of different projects of NCL, MoEF&CC has included the condition for establishing Sal Nursery for increasing the availability of saplings for Sal plantation in the vicinity of mining areas in NCL. The Location/Projects and area of Nursery as under:

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भवदीय
31.10.23
महाप्रबंधक/ विभागाध्यक्ष (पर्यावरण एवं वन), I/C
एन.सी.एल.-सिंगरौली

प्रतिलिपि :
1. निदेशक (तकनीकी /परियोजना व योजना), एन सी एल.....सूचनार्थ

O.C

नॉर्दर्न कोलफील्ड्स लिमिटेड
(मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

Northern Coalfields Limited
(A Miniratna Company)
(A subsidiary of Coal India Limited)

एन सी एल
NCL

वन विभाग / Forest Department
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Phone: 07805- 266615, (FAX) 266652, email: gmforest.ncl@coalindia.in website : www.nclcil.in

क्रमांक: एनसीएल/मुख्यालय/पर्यावरण/वन/2023/670 दिनांक :-31.10.2023

प्रति,
Managing Director,
Chhattisgarh Rajya Van Vikas Nigam Limited
Industrial Plantation Division (Korba)
Office Campus, Block – A, Sector- 24,
Nava Raipur, Atal Nagar, Raipur (C.G)- 492002
Email: vanvikasnigam@yahoo.com, cgrvvnl@gmail.com

विषय : Submission of offer/quotation/Estimate for Development of SAL Nursery at different Projects of NCL.

महोदय,

In the Environment Clearance conditions of different projects of NCL, MoEF&CC has included the condition for establishing Sal Nursery for increasing the availability of saplings for Sal plantation in the vicinity of mining areas in NCL. The Location/Projects and area of Nursery as under:

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भवदीय
ह०/- शिन्दे 31.10.23
महाप्रबंधक/ विभागाध्यक्ष (पर्यावरण एवं वन),
एन.सी.एल.-सिंगरौली

प्रतिलिपि :
1. निदेशक (तकनीकी /परियोजना व योजना), एन सी एल.....सूचनार्थ

772

Annexure-S

330

Government of India
Ministry of Jal Shakti
Department of Water Resources, River Development and Ganga Rejuvenation
Central Ground Water Authority (CGWA)

सत्यमेव जयते

Application for Issue of NOC to Abstract Ground Water (NOCAP)

Welcome : khadiaproject
Previous Login Date Time: 12/02/2025 13:05:55 PM , **IP Address:** 1.7.142.58

Logout

Applicant Home | Apply | Feedback | Change Password | Update PAN | Profile | Grievance | Submitted Application Payment | User Request | Application Pass Book | Upload IAR | Upload Attachment | Payment for Associate

Information

Guidelines
Steps for Filling Online Application

Documents Required

Documents Required for Online Application
- Industrial
- Infrastructure
- Mining

Track Status

Application Status
- Online

Location

Area Type
Segment-B Area Type
Regional office Location
CGWA Headquarters
Know Your Environmental Compensation(EC)
Know Your Penalty
Ground Water Abstraction/Restoration Charges

Reports

Applied for NOC - Online
NOC Issued-Online

Contact Us

Contact

Application Status

Application No :	21-4/1269/MP/MIN/2022
Receive Date :	12/02/2025
Name of Mining :	KHADIA OPENCAST PROJECT
Application Processing Fee :	Rs. 5000.00/- (Rupees Five Thousand Only) (**Submitted:** Yes)
Ground Water Abstraction/Restoration Charge :	Charge:

S.No.	Amount	Arear Amount	Total	Ref No	Date	Status	View
1	2626175.00	0.00	2626175.00	1903240021880	19/03/2024	Success	View

☐ **Environment Compensation**

SN	Date From	Date To	Daily Quantum (m3/day)(KLD)	Annual Quantum (m3/Year)(KLY)	Area Type Category	Reason Name	Rate	Amount	Remark
No Record Exists.									

Current Stage :	Application Processing Stage
Current Status :	In Process
Address :	Central Ground Water Authority 18/11,Jamnagar House, Man Singh Road NEW DELHI DELHI

Current Status

Application Verification

Receive Date	From User Name	To User Name	Forwarded User Name	Action Date	Action Internal Status	Action Comment	Copy of Application Received On
19/03/2024		**(Evaluation Officer)** Central Ground Water Authority	**(Evaluation Officer)** Central Ground Water Authority	22/03/2024	Approved	Approved and forwarded for processing	

Application Processing

Receive Date	From User Name	To User Name	Forwarded User Name	Action Date	Action Internal Status	Action Comment	Ground Water Recom Per Day	Ground Water Recom Annual

22/03/2024	**(Evaluation Officer)** Central Ground Water Authority	**(Evaluation Officer)** Central Ground Water Authority	**(Approval Officer)** Central Ground Water Authority	12/02/2025	Forward	Forwarded to AO (HQ)	2878.00	1050470.00
12/02/2025	**(Evaluation Officer)** Central Ground Water Authority	**(Approval Officer)** Central Ground Water Authority			In Process		2878.00	1050470.00

NOC Processing

Receive Date	From User Name	To User Name	Forwarded User Name	Action Date	Action Internal Status	Action Comment
No Record for this Stage.						

NOC Disbursement

Receive Date	From User Name	To User Name	Forwarded User Name	Action Date	Action Internal Status	Action Comment
No Record for this Stage.						

Go Back

NORTHERN COALFIELDS LIMITED
OFFICE OF THE GENERAL MANAGER: KHADIA AREA
CIVIL DEPARTMENT
PO: KHADIA PROJECT, DISTT. SONEBHADRA(UP)-231222.

No.-2620/Kh/C/LOA/Providing One no. Wheel Washing/2299/2024/ 394 Dated- 18-08-2024

To,
M/s Shakti Engineering,
Bus Stand, Shaktinagar,
Distt.- Sonebhadra (UP)-231222

Bank A/C No. 20896454342, Indian Bank, Shaktinagar.
PAN No. AUAPS7002E
GST No. 23AUAPS7002E1Z4
Email ID- Shakti.sktn@gmail.com

Sub-LOA for the work "Providing one no. wheel washing facility with complete recirculation system at the exit gate of Khadia Project with three years AMC after one year warranty"

Ref: (i) NIT No.-GM/KHD/C/24-25/ETN-05 Dated: 22.05.2024
(ii) Tender ID No- 2024_NCL_308807_1
(iii)Your offer dated 10.06.2024

Dear Sir,

With reference to the above we are pleased to convey that your offer to undertake the subject work at a total value of **Rs. 11314769.11 (Rs. 9588787.38 + GST @18 % Rs. 1725981.73) (Rupees One Crore Thirteen lakh Fourteen Thousand Seven Hundred & Sixty Nine and paise Eleven)** only has been accepted subject to the following stipulations:

1-All the materials and equipment required for the work will be arranged by you.
2-You are required to submit the Registration/license under Contract Labour (R&A) Act, 1970 within 10 (Ten) days from the date of receipt of this letter of acceptance, if required.
3-The Performance Security (first part of security deposit) shall be **5%** of the contract value amounting to **Rs. 479440.00 (Rupees Four lakh Seventy Nine Thousand Four Hundred Forty)** only. **TheEarnest money amounting to Rs. 172400.00** deposited by you along with the tender through Axis Aggregator Bank **PRN No. 3199881058169** has been taken as part of Performance Security. All ruining account bills shall be paid @ 95% of work value without GST. This 5% deduction towards retention money will be the second part of security deposit.
4-You are required to submit the following **within 21 (twenty one)** days from the date of issue of this letter of acceptance for issuing formal work order and executing agreement for the work.
(i) **Rs. 307040.00 towards balance amount of 5%** Performance Security in acceptable form.
(ii) **Rs. 345963.08** towards amount of Additional Performance Security in acceptable form.
. (iii) Copy of Income Tax PAN
(iv) Copy of **UPGST** registration Certificate & Service Accounting Code (SAC) of works/services.
(v) Copy of Memorandum and Article of Association/Power of attorney/partnership deed, if any.
(vi) Copy of CMPF/EPF Registration or Copy of Affidavit for implementation of CMPF Act.
(vii) Authorization form for e-payment duly filled-in.
(viii)PERT/BAR chart showing percentage of periodical progress for completion of work.
(ix) Non-judicial Stamp Paper for Rs. 500/-.of UP State.
(x) Copy of the letter of handing over the site.
(xi) A certificate from practicing Chartered Accountant having a valid Membership Number for complying of Anti-Profiting Clause U/S 171 as well as Office Memorandum F. No. 296/07/2017-CX.9 dated 15.06.2017 issued by Department of Revenue, Ministry of Finance, GOI, if required. If Security Money is deposited in the form of Bank Guarantee, it should be issued through Structural financial Messaging System (SFMS) Platform as per format given in the Tender Document.

(xii)That you have to take necessary insurance for the full contract period for (i)Workmen compensation policy , (ii) Contractors all risk policy in the joint name of **Northern coalfields limited and the contractor.** The policies and certificates for the insurance as per clause no. 13 (xviii) of General Terms &Condition of Tender document shall be delivered by you to the Engineer-in-charge for his approval before commencement of the work .

5- The work shall be completed within **1580 (One Thousand Five Hundred Eighty**) days (i.e **120** days for construction & **1460** days for operation & maintenance, total period 1580 days). The work shall be deemed to have commenced on the expiry of 10 (ten) days from the issue of Letter of Acceptance of Tender or 7(Seven) days after handing over the site of work whichever is later.

6- In case you, without reasonable cause or valid reasons, commits default in commencing the work as per clause no 5 of the LOA, the company shall, without prejudice to any other right or remedy, be at liberty, by giving 15 day's notice in writing to you to commence the work, failing which to **Forfeit the Earnest Money** deposited by you, rescind the Letter of Acceptance of Tender/Work order and debarring to take part in the future re-tender along with other actions as per tender documents.

7. In case you fail to submit the performance security and Additional performance security, if any within 21 days
   a) Then the award of the work shall be cancelled with forfeiture of earnest money.
   b) Debar from participating in future tenders for a minimum period of 12 months as per NIT.

8- The work should be executed as per General Terms & Conditions, Additional Terms & Conditions, Special Terms & Conditions, CPWD Specification/BIS Standards/description of the items of the accepted Tender documents and instructions of EIC.

9- You shall not pay less than the minimum Wages Act or such other legislation or award of minimum wages fixed by the respective State Govt. Or Central Govt. as may be in force.

10-You should ensure implementation of CMPF and Miscellaneous Provision Act 1948 or Employees Provident Fund and Miscellaneous Provisions Act, 1952 as the case may be and allied scheme framed there under in respect of workers deployed by you and will have to recover statutory dues and deposit the same along with employer's contribution (Contractor's share) to the respective CMPF/EPF Office and to submit statutory returns under intimation to Principal Employer.

11-All Texas (Except GST), local, municipal, provincial or central etc. and cess, royalties etc as payable shall be to the contractor's account and shall be deemed to have been included in the tendered rate for the work to be executed.

12- Regarding GST, the following may please be noted:

a- GST will be reimbursed on production of uploaded invoice/documentary evidence. Amount of statutory levies like CGST, SGST or IGST will be released when the same will appear in GSTR-2A of NCL in the common portal of GST and after submission of documentary evidence of deposition of GST taxes and filing of GST returns.

b-You will have to pass in input tax credit by way of enclosing original tax input invoice with bill.

c- All invoice submitted by you will have to be in the form of GST invoice giving all details as required under the law. You will raise invoice strictly adhering to provisions of Section 31under CGST Act 2017 along with Rule 46 & 47 of CGST Rule, 2017. You will indicate the rate as well as amount of CGST, SGST or IGST in invoice. You will upload the details of invoice on GST portal as per provisions of GST Act. Invoice issued by you should bear GST Registration Number of NCL(23AABCN4884HEM1ZE (MP) & 09AABCN4884H1Z4 (UP) to enable NCL to claim input tax credit.

d-You will file all the Returns and details as applicable under GST laws & rules with due dates.

e-You will give an undertaking on invoice or as separate Annexure along with the invoice that the Invoice/applicable GST returns has been/will be uploaded on GST Portal within due time as prescribed in CGST Act and CGST, SGST or IGST has been deposited as per the provision of GST Act and rules thereof.

f- If there is any delay of payment against the invoice due to your fault and if any reversal of input tax arises, the same will be recovered from you along with interest and penalty if any, as paid by NCL/Khadia Project due to reversal.

g-In case the GST rating of vendor on the GST Portal/Government's official website is negative/black listed at any stage even after award of work, NCL has right to cancel the letter of award.. NCL shall not be obliged or liable to pay or reimburse GST to such vendor and shall also be entitled to deduct/recover such GST along with all penalties/interest, if any incurred by NCL.

h-You will issue credit note as per provisions of Rule 53 of CGST Rule, 2017 on quality deduction or liquidated damages, if any arises.

i- If you default in uploading the invoice/applicable GST returns or default in deposit of applicable GST taxes, NCL reserves the right to upload such defaulter on NCL website and may also debar you from participating in future tenders for a minimum period of one year.

13.

Sl No	**Estimated cost put to tender incl GST**	**Quotes % by L-1 bidder w.r.t estimated cost put to tender**	**Accepted/awarded amount incl GST**
1	**Rs. 13791771.22**	**-17.96%**	**Rs. 11314769.11**

14. As per Clause no. 8.4 of NIT, only material conforming to approved samples shall only be brought to site, as such, you immediately contact **Project Engineer (C) & Incharge of the work** for the approval of samples of materials to be used in the work.
15. **The Project Engineer(C)/Khadia** shall be **Incharge of the work (ICW hence forth) and Second Level Check Officer**. Please contact the ICW/**Project Engineer(C)** for receiving work details, scope of work, drawings, sites & instructions regarding commencement of work.
16. **SO(C)/Khadia will be Engineer-In-Charge of the work (EIC).** The ICW shall be authorized representative of EIC for the work.
17. The ICW/authorized representative of EIC is to ensure the list of approved materials to be used in the work is conveyed to the contractor in writing alongwith a copy to Quality Control Cell, HQ before commencement of work as per Clause 8.4 of NIT.

18-You are hereby requested to contact **Manager(P)/Nodal Officer Biometric Attendance/Khadia** and to observe following system regarding Attendance & payments of contract workers and bill payments for the work:-

(i) All the contract workers engaged for the subject work shall be covered with Biometric Attendance system for payment of wages, which is under control of Nodal Officer (Biometric Attendance) of Personnel Department.

(ii) You are requested to issue photo I-card to contract workers engaged for the work, containing details like Name, AADHAR No., LOA No. and photograph and ensure their registration in the Biometric Attendance system under close supervision of Nodal Officer (Biometric Attendance)/Khadia.

(iii) Accordingly, Nodal Officer (Biometric Attendance)/Khadia will provide copy of the I-card alongwith Biometric Registration details of individual contract workers to the civil Engg. Department.

(iv)You shall ensure submission of **Monthly Attendence Sheet** of daily attendance of contract workers to the respective **Site In-Charge** of the work, which will be sent to the Nodal Officer (Bio-metric Attendance)/Khadia after due certification.

(v) Nodal Officer (Biometric Attendance)/Khadia will issue LPC (Labour payment certificate) on monthly basis to you, as per monthly attendance sheet sent from civil department. No RA bill or final bill shall be sent to the personnel department for any certification on the bills.

(vi)You are to follow the above system without any lapses/fail, otherwise, all the onus will lie on you in case of otherwise, and you will be responsible solely as such for any losses &/or delays in payment for the work executed & accepted by the department.

19- All the clauses of safety code on the tender document, as laid down in additional safety measures to be taken by the contractor, are to be strictly followed.

20- Please contact **Project Engineer(Civil)/Khadia** for commencement of the work.

Encl -BOQ

Yours faithfully,

18/08/2024

Staff Officer (C)
Khadia Area.

Copy to:
1) GM/Khadia Area.
2) GM(C)/NCL/Singrauli.
3) PO/KHD

4) AFM/Khadia: - Ref to: Capital Budget No.-KHD/CB/24-25/Environment/172/01 dtd. 12.08.2024 for Rs. 7083772.91 against Capital Budget BE 2024-25 Point NO. 15.1. & Revenue Budget vide FD No.-FC/AFM/ KHD/2024-25/ENVIRONMENTAL EXP/92/34 for Rs. 286946.78 and Dated 11.08.2024 & Noted for 2025-26 Rs.1147787.14, 2026-27 Rs.1147787.14, 2027-28 Rs.1147787.14, 2028-29 Rs 860840.35 however fund will be certified in the respective years of expenditure subject to availability & provisio of budget.
5) SO (P), Khadia Area- with a request to observe minimum wages etc. as per laid down guidelines.
6) Area Safety Oficer/Khadia Area- To observe safety norms.
7) ALC(C)/LEO(C), Allahabad, 189/A-4, Alopibagh, PO-Daraganj, Prayagraj(UP)
8) Project Engineer (Civil)/Khadia Project, SLC Officer
9) Dy. Manager(Civil)/Mines, Khadia Project, FLC Officer. (First Level Check Officer)
10) Sri B. K. Shukla, EA(C), Khadia , MEL. Engineer and Site In-Charge(SIC)

Bid Number/बोली क्रमांक (बिड संख्या): GEM/2025/B/5827091
Dated/दिनांक : 16-01-2025

Bid Document/ बिड दस्तावेज़

Bid Details/बिड विवरण	
Bid End Date/Time/बिड बंद होने की तारीख/समय	31-01-2025 13:00:00
Bid Opening Date/Time/बिड खुलने की तारीख/समय	31-01-2025 13:30:00
Bid Offer Validity (From End Date)/बिड पेशकश वैधता (बंद होने की तारीख से)	120 (Days)
Ministry/State Name/मंत्रालय/राज्य का नाम	Ministry Of Coal
Department Name/विभाग का नाम	Coal India Limited
Organisation Name/संगठन का नाम	Northern Coalfields Limited
Office Name/कार्यालय का नाम	Ncl Singrauli Madhya Pradesh
क्रेता ईमेल/Buyer Email	gmem.ncl@coalindia.in
Item Category/मद केटेगरी	Leasing of Electric Vehicles (Long Term) - Wet Lease; Tata Nexon EV or Equivalent as per Bid Document; 2250 KM Per Month and 12 Hours per day; 60 Months Lease; White
Contract Period/अनुबंध अवधि	5 Year(s) 1 Month(s) 18 Day(s)
MSE Exemption for Years of Experience and Turnover/ अनुभव के वर्षों से एमएसई छूट	No
Startup Exemption for Years of Experience and Turnover/ अनुभव के वर्षों से स्टार्टअप छूट	No
Document required from seller/विक्रेता से मांगे गए दस्तावेज़	Experience Criteria,Certificate (Requested in ATC),Additional Doc 1 (Requested in ATC),Additional Doc 2 (Requested in ATC),Additional Doc 3 (Requested in ATC),Additional Doc 4 (Requested in ATC) *In case any bidder is seeking exemption from Experience / Turnover Criteria, the supporting documents to prove his eligibility for exemption must be uploaded for evaluation by the buyer
Do you want to show documents uploaded by bidders to all bidders participated in bid?/	No
Bid to RA enabled/बिड से रिवर्स नीलामी सक्रिय किया	No
Type of Bid/बिड का प्रकार	Two Packet Bid
Time allowed for Technical Clarifications during technical evaluation/तकनीकी मूल्यांकन के दौरान तकनीकी स्पष्टीकरण हेतु अनुमत समय	7 Days

Bid Details/बिड विवरण	
Estimated Bid Value/अनुमानित बिड मूल्य	98112263
Evaluation Method/मूल्यांकन पद्धति	Total value wise evaluation
Financial Document Indicating Price Breakup Required/मूल्य दर्शाने वाला वित्तीय दस्तावेज ब्रेकअप आवश्यक है	Yes
Arbitration Clause	No
Mediation Clause	No

EMD Detail/ईएमडी विवरण

Advisory Bank/एडवाईजरी बैंक	ICICI
EMD Amount/ईएमडी राशि	245300

ePBG Detail/ईपीबीजी विवरण

Required/आवश्यकता	No

(a). EMD EXEMPTION: The bidder seeking EMD exemption, must submit the valid supporting document for the relevant category as per GeM GTC with the bid. Under MSE category, only manufacturers for goods and Service Providers for Services are eligible for exemption from EMD. Traders are excluded from the purview of this Policy./जेम की शर्तों के अनुसार ईएमडी छूट के इच्छुक बिडर को संबंधित केटेगरी के लिए बिड के साथ वैध समर्थित दस्तावेज़ प्रस्तुत करने है। एमएसई केटेगरी के अंतर्गत केवल वस्तुओं के लिए विनिर्माता तथा सेवाओं के लिए सेवा प्रदाता ईएमडी से छूट के पात्र हैं। व्यापारियों को इस नीति के दायरे से बाहर रखा गया है।

(b). EMD & Performance security should be in favour of Beneficiary, wherever it is applicable./ईएमडी और संपादन जमानत राशि, जहां यह लागू होती है, लाभार्थी के पक्ष में होनी चाहिए।

Beneficiary/लाभार्थी :
Northern Coalfields Limited
NCL Singrauli Madhya Pradesh, COAL INDIA LIMITED, Northern Coalfields Limited, Ministry of Coal (Northern Coalfields Limited)

MII Compliance/एमआईआई अनुपालन

MII Compliance/एमआईआई अनुपालन	Yes

MSE Purchase Preference/एमएसई खरीद वरीयता

MSE Purchase Preference/एमएसई खरीद वरीयता	Yes

1. Purchase preference to Micro and Small Enterprises (MSEs): Purchase preference will be given to MSEs as defined in Public Procurement Policy for Micro and Small Enterprises (MSEs) Order, 2012 dated 23.03.2012 issued by Ministry of Micro, Small and Medium Enterprises and its subsequent Orders/Notifications issued by concerned

Ministry. If the bidder wants to avail the Purchase preference for services, the bidder must be the Service provider of the offered Service. Relevant documentary evidence in this regard shall be uploaded along with the bid in respect of the offered service. If L-1 is not an MSE and MSE Service Provider (s) has/have quoted price within L-1+ 15% of margin of purchase preference /price band as defined in the relevant policy, then 100% order quantity will be awarded to such MSE bidder subject to acceptance of L1 bid price. The buyers are advised to refer to the OM_No.1_4_2021_PPD_dated_18.05.2023 for compliance of Concurrent application of Public Procurement Policy for Micro and Small Enterprises Order, 2012 and Public Procurement (Preference to Make in India) Order, 2017. Benefits of MSE will be allowed only if the credentials of the service provider are validated on-line in GeM profile as well as validated and approved by the Buyer after evaluation of submitted documents.
2. Estimated Bid Value indicated above is being declared solely for the purpose of guidance on EMD amount and for determining the Eligibility Criteria related to Turn Over, Past Performance and Project / Past Experience etc. This has no relevance or bearing on the price to be quoted by the bidders and is also not going to have any impact on bid participation. Also this is not going to be used as a criteria in determining reasonableness of quoted prices which would be determined by the buyer based on its own assessment of reasonableness and based on competitive prices received in Bid / RA process.

Excel Upload Required/एक्सेल में अपलोड किए जाने की आवश्यकता :

BID SUBMISSION CONFIRMATION (BSC) SHEET - 1737012504.xlsx

Additional Qualification/Data Required/अतिरिक्त योग्यता /आवश्यक डेटा

Buyer may upload Scope of Work for the bid:1737012512.pdf

Additional Condition pertaining to Past Experience/Service specific Turnover - 1 (Also specify the documents to be uploaded by Service Provider in Compliance of this condition):1737012528.pdf

Leasing Of Electric Vehicles (Long Term) - Wet Lease; Tata Nexon EV Or Equivalent As Per Bid Document; 2250 KM Per Month And 12 Hours Per Day; 60 Months Lease; White (30)

Technical Specifications/तकनीकी विशिष्टियाँ

Specification	Values
Core	
Type of Lease	Wet Lease
Type of Vehicle	Tata Nexon EV or Equivalent as per Bid Document
Packages	2250 KM Per Month and 12 Hours per day
Lease Period	60 Months Lease
Color of the Vehicle	White
District	NA
Zipcode	NA
Addon(s)/एडऑन	

Additional Specification Documents/अतिरिक्त विशिष्ट दस्तावेज़

Consignees/Reporting Officer/परेषिती/रिपोर्टिंग अधिकारी

S.No./क्र. सं.	Consignee Reporting/Officer/ परेषिती/रिपोर्टिंग अधिकारी	Address/पता	Number of Vehicles	Additional Requirement/अतिरिक्त आवश्यकता
1	Aman Lavania	486890,CENTRAL STORES, JAYANT COLLIERY, PO - JAYANT	1	• Number of Lease Months wthin Contract Period : 60
2	Shiveshwar Prasad	486887,REGIONAL STORES, NCL, AMLOHRI PROJECT, PO - AMLOHRI	1	• Number of Lease Months wthin Contract Period : 60
3	Rohan Kumar Lahangir	231224,O/O GENERAL MANAGER, E&M DEPARTMENT, KAKRI PROJECT, KAKRI, DISTT - SONEBHADRA (U.P. - 231224)	4	• Number of Lease Months wthin Contract Period : 60
4	Amit Pratap Singh	231222,GM OFFICCE, E&M DEPARTMENT, KHADIA PROJECT, DISTT - SONBHADRA (U.P.) 231222	3	• Number of Lease Months wthin Contract Period : 60
5	Shailendra Kumar	486890,O/O GM CWS JAYANT, E&M DEPARTMENT, CWS JAYANT, SINGRAULI, M.P. 486890	8	• Number of Lease Months wthin Contract Period : 60
6	RAMESH KUMAR MISHRA	486892,E&M DEPARTMENT, BLOCK-B PROJECT, NCL PO - GORBI/ BLOCK-B	5	• Number of Lease Months wthin Contract Period : 60
7	Jitendra Kumar Prajapati	231220,OFFICE OF STAFF OFFICER (E&M), GM'S OFFICE, KRISHNASHILA PROJECT, BINA	5	• Number of Lease Months wthin Contract Period : 60
8	Bhupendra Singh	486890,REGIONAL STORES, JAYANT PROJECT, NCL, PO - JAYANT, DISTT - SINGRAULI M.P.	3	• Number of Lease Months wthin Contract Period : 60

Buyer Added Bid Specific Terms and Conditions/क्रेता द्वारा जोड़ी गई बिड की विशेष शर्तें

1. **Buyer Added Bid Specific ATC**

Buyer Added text based ATC clauses

Bidders are advised to go through Buyer Uploaded ATC for Eligibility Criteria, Evaluation Process, Terms and Condition of Contract, Location-wise deployment, Applicable Performance Security and Additional Performance Security, Arbitration Clauses etc.

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2. **Buyer Added Bid Specific ATC**

   Buyer uploaded ATC document Click here to view the file.

Disclaimer/अस्वीकरण

The additional terms and conditions have been incorporated by the Buyer after approval of the Competent Authority in Buyer Organization, whereby Buyer organization is solely responsible for the impact of these clauses on the bidding process, its outcome, and consequences thereof including any eccentricity / restriction arising in the bidding process due to these ATCs and due to modification of technical specifications and / or terms and conditions governing the bid. If any clause(s) is / are incorporated by the Buyer regarding following, the bid and resultant contracts shall be treated as null and void and such bids may be cancelled by GeM at any stage of bidding process without any notice:-

1. Definition of Class I and Class II suppliers in the bid not in line with the extant Order / Office Memorandum issued by DPIIT in this regard.
2. Seeking EMD submission from bidder(s), including via Additional Terms & Conditions, in contravention to exemption provided to such sellers under GeM GTC.
3. Publishing Custom / BOQ bids for items for which regular GeM categories are available without any Category item bunched with it.
4. Creating BoQ bid for single item.
5. Mentioning specific Brand or Make or Model or Manufacturer or Dealer name.
6. Mandating submission of documents in physical form as a pre-requisite to qualify bidders.
7. Floating / creation of work contracts as Custom Bids in Services.
8. Seeking sample with bid or approval of samples during bid evaluation process. (However, in bids for attached categories, trials are allowed as per approved procurement policy of the buyer nodal Ministries)
9. Mandating foreign / international certifications even in case of existence of Indian Standards without specifying equivalent Indian Certification / standards.
10. Seeking experience from specific organization / department / institute only or from foreign / export experience.
11. Creating bid for items from irrelevant categories.
12. Incorporating any clause against the MSME policy and Preference to Make in India Policy.
13. Reference of conditions published on any external site or reference to external documents/clauses.
14. Asking for any Tender fee / Bid Participation fee / Auction fee in case of Bids / Forward Auction, as the case may be.
15. Any ATC clause in contravention with GeM GTC Clause 4 (xiii)(h) will be invalid. In case of multiple L1 bidders against a service bid, the buyer shall place the Contract by selection of a bidder amongst the L-1 bidders through a Random Algorithm executed by GeM system.

Further, if any seller has any objection/grievance against these additional clauses or otherwise on any aspect of this bid, they can raise their representation against the same by using the Representation window provided in the bid details field in Seller dashboard after logging in as a seller within 4 days of bid publication on GeM. Buyer is duty bound to reply to all such representations and would not be allowed to open bids if he fails to reply to such representations.

All GeM Sellers / Service Providers are mandated to ensure compliance with all the applicable laws / acts / rules including but not limited to all Labour Laws such as The Minimum Wages Act, 1948, The Payment of Wages Act, 1936, The Payment of Bonus Act, 1965, The Equal Remuneration Act, 1976, The Payment of Gratuity Act, 1972 etc. Any non-compliance will be treated as breach of contract

and Buyer may take suitable actions as per GeM Contract.

This Bid is governed by the General Terms and Conditions/सामान्य नियम और शर्तें, conditons stipulated in Bid and Service Level Agreement specific to this Service as provided in the Marketplace. However in case if any condition specified in General Terms and Conditions/सामान्य नियम और शर्तें is contradicted by the conditions stipulated in Service Level Agreement, then it will over ride the conditions in the General Terms and Conditions.

In terms of GeM GTC clause 26 regarding Restrictions on procurement from a bidder of a country which shares a land border with India, any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Competent Authority. While participating in bid, Bidder has to undertake compliance of this and any false declaration and non-compliance of this would be a ground for immediate termination of the contract and further legal action in accordance with the laws./जेम की सामान्य शर्तों के खंड 26 के संदर्भ में भारत के साथ भूमि सीमा साझा करने वाले देश के बिडर से खरीद पर प्रतिबंध के संबंध में भारत के साथ भूमि सीमा साझा करने वाले देश का कोई भी बिडर इस निविदा में बिड देने के लिए तभी पात्र होगा जब वह बिड देने वाला सक्षम प्राधिकारी के पास पंजीकृत हो।बिड में भाग लेते समय बिडर को इसका अनुपालन करना होगा और कोई भी गलत घोषणा किए जाने व इसका अनुपालन न करने पर अनुबंध को तत्काल समाप्त करने और कानून के अनुसार आगे की कानूनी कार्रवाई का आधार होगा।

---Thank You/धन्यवाद---

Final Report

On

Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of NCL along with its viability and safety aspect of man and machinery

For

Khadia Opencast Project

Feb 2022

Submitted By

DEPARTMENT OF MINING ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY

(BANARAS HINDU UNIVERSITY)

VARANASI 221 005

UP (INDIA)

Project report prepared by a Team of faculty members of Indian Institute of Technology (BHU)

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- ***This report is prepared for internal use of Northern Coalfields Ltd and will be utilized for the concerned legal requirement.***
- ***Indian Institute of Technology (Banaras Hindu University), Varanasi reserves the right to publish the result of research for the benefit of Society.***

DEPARTMENT OF MINING ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY
(BANARAS HINDU UNIVERSITY)
VARANASI 221 005
UP (INDIA)

Contents

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1.0 Introduction

1.1 Project Brief

Northern Coalfields Limited (NCL)., a subsidiary company of Coal India Limited (CIL) is operating Opencast Mines in Singrauli coalfield. The Singrauli Coalfield is divided into two basins namely Main basin and Moher sub-basin. Moher sub-basin having an area of 312 Sq.KM. Out of which 80 Sq.KM on Eastern side lies in Sonebhadra Distt. of U.P. and rest in Singrauli Distt. of M.P. The Main basin is located west of Waidhan. The Moher sub basin is the centre of mining activities. The southern half of the Moher basin is preserved while the northern half was up thrown by a metamorphic fault and is eroded, hence called Moher Sub basin.

The PR for Khadia OCP (4Mtpa to 10Mtpa) was prepared by RI-VI, CMPDI with coal winning by Department Shovel-Dumper and Partial OB removal by outsourcing (Dragline departmental) on 28.06.2011. The existing Environmental Clearance of Khadia OCP is 14 MTPA. To meet the growing demand of coal, it has been proposed to increase the production capacity of Khadia OCP from 14Mtpa to 20Mtpa, incremental 6Mtpa. To augment the production for an optimum life of the project, it is necessary to encompass the additional coal reserves from the dip side blocks, namely, remaining part of Khadia block, small part of Ruhela Geological Coal Block and a small part of Marrak Geological Coal Block.

1.2 Scope of the work

Fly Ash is the fine particulate matter outcome of coal-burning, mainly primarily from the coal-based electricity generation plants. Fly ash is considered a harmful product for the environment and it is becoming a concern for everyone. Fly ash disposal in an unscientific way affects the local ecosystems due to the heavy metal pollution through erosion and leachate generation. Fly ash contaminates surface and groundwater, soils and vegetation by mobilization of its hazardous metals.

Ministry of Environment and Forest has notified to reduce the impact of fly ash on the environment and to lower the requirement of land for its disposal. MOEF also compelled 100% utilization of fly ash. Therefore, many mining companies plan to get back the fly ash generated from the neighboring coal-fired thermal power plants, namely NTPC, Anapara, Renusagar, etc. These companies are facing tremendous space constraints. The enormous quantities of fly ash occupy vast tract of land area, and adversely affects the environment due to its storage and disposal problem.

As per Fly Ash Notification dated 3rd November, 2009, issued by MoEF&CC, Government of India, it is mandated to use fly ash in different sectors with the objective of its gainful utilization. This Notification states that:

i. No person or agency shall within 50 kms (by road) from coal or lignite based thermal power plants, undertake or approve stowing of mines without using at least 25% of fly ash on weight to weight basis, of the total stowing material used and this shall be done under the guidance of the Director General of Mines Safety (DGMS), and
ii. No person or agency shall within 50 kms (by road) from coal or lignite based thermal power plants, undertake or approve without using at least 25% of fly ash on volume to volume basis of the total material used for external dump of overburden and the same percentage in upper benches of back filling of opencast mines and this shall be done under the guidance of the Director General of Mines Safety (DGMS).

Therefore, scientific assessment of fly ash from selected locations is required to be carried out and analyzed for any possibility of its disposal in the mine by mixing with overburden materials in appropriate proportions considering the environmental, safety and other statutory conditions. Based on the above discussion the following objectives have been taken for the present project study

1. Geotechnical Study of Overburden dump form mine
2. Geotechnical study of Fly ash sample collected from power plants
3. Geotechnical investigation of mix overburden and fly ash
4. Fly ash characterization study
5. Leaching study
6. Slope stability of mix overburden and fly ash
7. Traffic study for fly ash dumping (Route and Mode of Fly ash Transportation).

1.3 Work order and term of reference

The NCL Board in their 265thmeeting vide reference no. NCL/SGRL/R&D/2021/90, dated 10.07.2021, has approved the subject proposal –"Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of NCL along with its viability and safety aspect of man and machinery". The Department of Mining Engineering, Indian Institute of Technology (Banaras Hindu University) was assigned the job vide work order No.NCL/SGRL/R&D/2021/90, dated 10.07.2021.

2.0 Study Area

2.1 Project site

Khadia OCP is an existing working mine under sanctioned Khadia OCP (10 Mtpa). The project has Environmental Clearance for production capacity of 14.0 Mtpa within the leasehold boundary of sanctioned Project Report of 10 Mtpa. The existing Khadia OCP (10Mtpa) is working in Khadia Geological Coal Block, which is located in the South-eastern part of Moher Sub-Basin of Singrauli Coalfield and lies partly in Sonebhadra district of Uttar Pradesh and partly in Singrauli district of Madhya Pradesh.

The proposed PR of Khadia Expansion OCP (16 Mtpa; Peak Capacity 20 MTPA). incremental 6 Mtpa has been envisaged with inclusion of remaining part of Khadia Geological Coal Block, part of Ruhela Geological Coal Block and a small part of Marrak Geological coal Block. Khadia Geological Block having an area of 7.72 sq.km. and Geological reserve of 287.59 Mt is located in the South-eastern part of Moher Sub-basin of Singrauli Coalfield. Ruhela Geological Block having an area of 4.82 Sq.km and Geological reserve of 228.43 Mt lies in the dip side of Khadia Geological Block. Marrak Geological Block having an area of 5.37 Sq.km and Geological reserve of 162.82 Mt lies in the Eastern side of Khadia Geological Block.

Krishnashila OCP (4Mtpa) lies on its east and Dudhichua OCP (20Mtpa) in the west. The terrain of the opencast minefield represents the hily plateau with varying RLs of about 290m 490m above MSL. The drainage of the area is controlled by many seasonal nallas with southerly flow in a major portion of the minefield which discharges into Balia Nalla and which ultimately drains into the GBP Sagar in south. There are three coal seams namely Turra (14.57-22.56m), Purewa Bottom (5.60-13.39m) and Purewa Top (3.75-10.35m) which are envisaged to be mined within the quarry boundary.

Figure 1: Location MAP of Khadia OCP

2.2 Location, topography and drainage

The area is undulating and hilly terrain. The elevation of the plateau varies from 425m to 490m above MSL (Mean Sea Level). It stands out as a hilly plateau with elevations as high as 490m. The mining block area maintains an undulating rugged topography (RL varying from 290 m to 490 m) sloping towards south and west. The base of the plateau extends with elevation around 290m above MSL.

Khadia OCP is situated partly in district of Sonebhadra (UP) and partly in the district of Singrauli (MP), within Singrauli Coalfield. The Khadia block lies between Latitude 24°7'26" & 24°8'47" and Longitude 82°41'40" & 82°44'47" and is covered in the Survey of India Toposheet 63-L/12 (R.F. 1:50,000) and Special sheet Nos. 9 & 11 (R.F. 1:10,000). Khadia block is adjacent to Dudhichua OCP in the west and Krishnashila OCP in the east.

Climate

The climate of the area is dry to moist, tropical with well-defined summer from April to June, rainy season from July to September and winter from November to February. The temperature varies from a maximum of 48^{0}C to a minimum of 8^{0}C. The area receives an average annual rainfall of 1200.00 mm (Based on rainfall data from 2006 onwards). The daily highest rainfall has been recorded as 264.40 mm on 18.07.71

Drainage

The Khadia block stands out as a plateau above the plains on its south. The plateau is pronounced by steep escarpment facing south rising from an elevation of 290 m at the base to 425 m at the top of the plateau. The area on the top of -the plateau is gently undulating except one hill in the north-east corner have an altitude of 489 m. The general elevation of the plateau varies from 420-440 m.

The drainage is controlled by a few seasonal nallas with southerly flow. All these seasonal nallas meet the Balia Nalla in the south which is semi- perennial and join the GBP Sagar on the south.

Numerous seasonal nalas flowing from north to south and south to north drain through this area and meet the master drain the Rihand dam (Govind Ballabh Pant Sagar) which is located south of this area. The local drainage is mainly radial in nature. Tippa Jharia nala drains the Khadia (Expansion) OCP area in north and Ballia nalla drains this OCP in south and meet the Gobind Ballabh Panth Sagar.

Accessibility and Communication

Khadia OCP is well connected by all weather roads. The nearest railway station Shaktinagar is at a distance of about 2 km. Another railway station 'Singrauli' on Katni-Chopan Branch Line of East -Central Railway is at a distance of about 12 km from the project. The nearest town Waidhan, the Singrauli district HQ is located about 12 km to the south, Renukut (UP) is 50 Km in the east and Varanasi (UP) is about 225 km in the north. Renukut-Waidhan all weather road passes through the southern part of the block without blocking any coal reserves.

2.3 Geological features

The Singrauli coalfield (Latitude $23^{0}46'37''$ N & $24^{0}13'17''$ N and Longitude $81^{0}45'24''$ E & $82^{0}47'50''$ E) covering an area of 2375sq. Km is centrally located in the map of India. It constitutes the northern most part of the Son-Mahanadi master Gondwana basin. Singrauli Coalfield is divided in two parts on the basis of geological setup, namely (i) Moher sub-basin (300sq km, eastern part) and (ii) Main basin (2075 sq. Km western part), separated by a basement high almost parallel to the Kachan River. The Khadia block is located in the south eastern portion of Moher Sub-basin and has been named after Khadia village situated in the south of the block.

Geology of the Block

PR for Khadia Expansion OCP consists Khadia Geological Coal Block, part of Ruhela Geological Coal Block and a small part of Marrak Geological Coal Block.

The entire block consist rocks of Barakar formations are exposed in this block along with recent soil/alluvium cover at places. Barakar Formation consists mainly sandstone, coal and occurrence clay horizons. The generalised sequence as established by GSI and updated by IBM, NCDC and CMPDI is as follows:

Table 1: The general geological sequence of North Eastern Part of Singrauli Coalfield

Group	Formation	Lithology	Thickness (m)
Damuda Group Lower Gondwana	Recent	Soil/ Alluvium Sandstone, Carbonaceous shale &fireclay	150
	Raniganj Formation	Coal, shaly coal & Cabonaceous shales (Jhingurdah Top seam)	131 to 135
		Medium grained sandstone and shale	39 to 58
		Coal, shaly coal & Cabonaceous shales (Jhingurdah Bottom seam)	10 to 15
		Sandstone, carbonaceous shale with coaly stringes	60
	Barren Measures	Medium to coarse grained sandstone with greenish shale Bands changing into red & green clay near outcrop	125
		Carbonaceous shale, sand-stone & thin coal bands Coal, shaly coal and carbonaceous shale (Panipahari Seam)	45 to 70 1to 2

		Fine to coarse grained sandstone	110 to 125
		Coal & shale	10 to 0
		Sandstone and shale Carbonaceous shale, shaly coal and coal (Purewa Top Seam)	30 to 40 8to 12 8 to 12
	Barakar Formation	Fine to coarse grained sandstone	0 to 60
		Coal Carbonaceous shale & shaly coal (Purewa Bottom Seam)	10 to 14
		Fine to coarse grained sandstone	45 to 75
		Coal, carbonaceous shale & shaly coal (Turra Seam)	14 to 23
		Fine to coarse grained sandstone	45 to 90
		Coal & shaly coal (kota Seam)	1 to 3
		Fine to coarse grained sandstone	150 to 230
	Talchir Formation	Khaki green shale & sandstone	230 -250

Description Of Seams

There is no exposure of coal within the block. The outcrops of clay occurring along with the incrops of coal seams are residual product of spontaneous combustion of the coal seams. Due to the occurrence of this clay, the incrop of coal is rather at depth depending on the depth of penetration of spontaneous combustion.

Five coal seams occur in the block viz. (i) Kota, (ii) Turra, (iii) Purewa Bottom, (iv) Purewa Top and (v) Khadia seam in ascending order. Purewa Bottom and Purewa Top Seams are fairly thick and are potential for exploitation. Other seams viz. Kota and Khadia have not been explored in detail because of its thinness, impersistent and inter-banded nature.

Table 2: Geological sequence of Khadia Exp. OCP

Lithology	Thickness (m)	Normal thickness
Soil and Sub-soil	0 to 8.15	0 to 1.00
Sandstone & shale	Upto74.65	
Khadia seam	0.25-1.25	0.50-0.60
Sandstone & shale	20.66-26.67	23-26
Purewa Top Seam	4.85-10.35	8-10
Sandstone & shale	30.34-43.70	32-40
Purewa Bottom seam	7.10-13.39	9-12.5
Sandstone & shale	50.78-64.28	54-61
Turra Seam	18.20-23.37	19.5-21.5

Sandstone & shale	50.73-79.69	62-70
Kota seam	0.40-2.13	1-2

DIP AND STRIKE: The strike is NW-SE in the west which swing to ENE-WSW in the eastern part of the area. The strikes is E-W in the central part of the area. The dip generally varies from 2^0 to 3^0 (1 in 28 to 1 in 19) towards north.

Faults/Joints

The areas devoid of any fault. However, two sets of prominent vertical joints (NE-SW and NW-SE) and one set less prominent (E-W) joints have been observed in the area.

Turra Seam

Turra Seam is the thickest of all the seams containing comparatively better quality coal. The immediate roof of the Turra seam is generally represented by inter banded horizons of shale, sandy shale and sandstone and carbonaceous shale. The roof of Turra seam within the incrop region is represented by clay. The immediate floor of Tura Seam is generally either shale or alternate Bands of shale and sandstone. Parting in the Turra seam overlies Kota Seam after a parting of 69m to 79.69m. The full thickness of Turra Seam including all dirt Bands varies from 18.20m to 23.37m. The dirt bands in Turra seam are represented by carb, Shale, carb, sandy shale, and sandstone varying in thickness from 0.05m to more than 2 meters.

Purewa Bottom seam

The Purewa Bottom Seam has been encountered in 54 boreholes. Out of these boreholes, full seam has been encountered in 52 boreholes and part thickness in 2 boreholes. The Purewa Bottom Seam overlies Turra Seam with a parting of 50.78 to 64.28m. The lithology of parting is mostly medium to coarse grained sandstone. The full thickness of Purewa Bottom Seam including all dirt bands varies from 7.10mto 13.39m. The full seam occurs within a depth range of 71.60m to 179.30m. Based on the available borehole data the thickness of Purewa Bottom Seam within incrop zone varies from 4.81m to 8.80m and occurs within a depth range from 76.00 m to 76.04m.

Roof and floor characteristics:

The immediate roof of the Purewa Bottom Seam is largely represented by medium to coarse grained sandstone. In incrop zone, the immediate roof is always represented by clay.

The immediate floor of Purewa Bottom Seam is represented either by alternate bands of shale and sandstone or fine grained sandstone.

Purewa Top Seam

General: The Purewa Top Seam is thinner than Turra and Purewa Bottom Seam and its incrop occurs generally on the plateau just above the escarpment. The outcrop of the seam is always burt and is represented by clay/clayey soil.

Parting: The Purewa Top Seam overlies Purewa Bottom Seam after a parting of 30.34m to 43.70m. The Lithology of parting between Purewa Bottom and Purewa Top Seams are medium to coarse grained sandstone.

Thickness: The full thickness of Purewa Top Seam including all din bands varies from 4.85mto 10.35m. In the incrop region the seam was encountered at a depth range of 35.35m to 57.85m Purewa Top Seam is fairly uniform in its thickness.

Roof and Floor Characteristics

The immediate roof of the Purewa Top Searn is exclusively represented by sandstone. Only in incrop zone the roof has been represented by clay.

2.4 Geo mining Characteristics

Considering the existing working of Dudhichua east section and Khadia west section and also the gap between the working front of both the mines, it is not possible to follow the working limit as per sanctioned Western boundary of Khadia OCP (10 Mipa) as it involves major rehandling of OB Dump from eastern section of Dudhichua OCP and about 200 m strike length is being left by Khadia West section from the sanctioned boundary of Dudhichua OCP on the floor of Turra seam. So, common boundary on the floor of Purewa Bottom Seam has been envisaged for proposed Khadia Expansion OCP (16Mtpa). As Dudhichua OCP (20Mtpa) is a leading mine, there will not be any restriction for the working of Dudhichua OCP.

The working limit of proposed Khadia OCP will be restricted upto the working limit of Purewa Bottom and Purewa Top seam of eastern section of Sanctioned Dudhichua OCP and about 200m strike length of Turra seam will be left as barrier between East section of Dudhichua OCP and west section of Khadia OCP. The position of faces in east section of Dudhichua OCP vis-à-vis west section of Khadia OCP have been so planned as to maintain a sufficient lag for maintaining the transport horizon from advance benches to the spoil dumps.

Table 3: Geological and Mining Characteristics

SL.NO	PARTICULARS	UNIT	VALUE	
1	Thickness of coal Seam (Full seam thickness zone)			
	Seam		Stratigraphic Thickness (m)	Effective Thickness (m)

	a) Purewa Top Seam	m	4.85-10.35 (8.28)	3.75-10.35 (7.20)
	b) Purewa Bottom Seam	m	7.10-13.39 (11.40)	5.60-13.39 (10.84)
	c) Turra Seam	m	18.20-23.37 (20.76)	14.57-22.56 (18.74)
2	Thickness of OB and Partings			
	a) OB above Purewa Top seam	m	37.55-117.60	
	b) Parting between Purewa Bottom & Purewa Top Seams		30.40-43.70	
	c) Parting between Turra & Purewa Bottom Seams	m	50.78-64.28	
3	Seam Gradient	Deg.	2-3	
4	Volume weight of Coal (with dirt band upto 1 m thick)			
	a) Turra Seam	t/m^3	1.58	
	b) Purewa Bottom Seam	t/m^3	1.61	
	c) Purewa Top seam	t/m^3	1.62	
5	Volume Weight of OB	t/m^3	2.35	
6	Volume weight of dirt band	t/m^3	2.00	
7	Excavation Category			
	a) Coal	Cat-III – 90% & Cat-IV – 10%		
	b) Overburden	Cat-III – 90% & Cat-IV – 10%		
8	Total mineable reserves of Khadia Expansion OCP (16 Mtpa) as on 01.04.2020	Mt	233.50	
9	Total volume of OB of Khadia Expansion OCP (16 Mtpa) as on 01.04.2020 (without in-seam band)	Mm^3	830.00	
10	Average Stripping Ratio (without in-seam band)	m^3/t	3.55	
11	Total volume band of Khadia OCP (16 Mtpa) as on 1.04.2020	Mm^3	14.00	
12	Total volume of OB of Khadia Expansion OCP (16 Mtpa) as on 01.04.2020 (with in-seam band)	m^3/t	844.00	
13	Average stripping ratio (with in-seam band)	m^3/t	3.61	

Characteristics of Coal & OB

The average stratigraphic thickness of Turra coal seam, Purewa Bottom coal seam and Purewa Top coal seam are 20.76m, 11.40m and 8.28m respectively. The roof and floor of the seams are composed mainly of coarse grained sandstone, shale and sandy shale.

The bulk of the overburden is represented by sandstones, which forms 80 to 90% and shales forms 6 to 10% of the OB. Soil and clay constitutes 4 to 10% of the OB. Shales present in block are grey shale, sandy shale & carbonaceous shale which are normally associated with the floor and roof strata of the coal seams. Sandstones are generally grey to white, medium to coarse grained and are often gritty.

The coal seams are dipping at angles 2-3 towards the north. The area is devoid of any fault and intrusive. The surface RL ct the opencast minefield varies in the range of 290m to 490m above mean sea level.

Khadia OCP (10Mtpa) has been working since 2010-11 with combined system of mining using Dragline and Shovel-Dumper combination for OB removal. The existing system has been proposed to be continued with up gradation of equipment size for achieving higher production level. Surface Miner has been envisaged for coal winning from total Purewa Top and part of Purewa Bottom Seams and existing shovel-dumper for Turra seam and partially for Purewa Bottom seam coal winning in the proposed PR for Khadia Expansion OCP (16Mtpa)

2.5 Mining and Dumping Strategy

The estimation of mineable coal reserve and volume of OB has been done, based on existing mine working plan as on 01.04.2020.

The total Mineable Reserve as on 01.04.2020 has been estimated as 233.50 Mt and corresponding total OB including inseam band as 844.00Mm³ with an average stripping ratio of 3,61mt (table 4).

Table 4: The section-wise MR, OBR & Average Striping Ratio

Particulars	West section	East section	Total
Mineable Coal Reserves			
Purewa Top Seam	25.03	16.27	41.30
Purewa Bottom Seam	40.04	30.61	70.65
Turra Seam	67.38	54.17	121.55
Total	**132.45**	**101.05**	**233.50**
Volume of OBR (Mm^3) without Band			
Top OB	246.18	108.24	354.42
Parting between Purewa Top and Purewa Bottom Seams	105.93	73.57	179.50
Parting between Purewa Bottom and Turra Seams	168.73	127.35	296.08
Total	**520.84**	**309.16**	**830.00**
Volume of Band (Mm^3)			
Purewa Top Seam	2.90	0.98	3.88
Purewa Bottom Seam	1.18	0.71	1.89
Turra Seam	4.35	3.88	8.23
Total	8.43	5.57	14.00
Total OB including Band	529.27	314.73	844.00
Average Stripping Ratio including in-seam band (m^3/t)	4.00	3.11	3.61

Mine Development Strategy

Khadia OCP (10 Mtpa) is existing working mine. The PR for Khadia Expansion OCP Expansion (16 Mtpa) has been proposed to be worked by extending the existing workings in the dip side of Khadia Block, part of Ruhela Block and a small part of Marrak Block. The existing Khadia

OCP (10 Mtpa) is being worked in two sections viz Eastern and Western sections and proposed Khadia Expansion OCP (16 Mtpa) has also been envisaged to be worked in two sections viz. Eastern and Western Sections.

Dumping

The main OB bench overlying Turra seam is to be removed by dragline system and proposed to be sidecast in the decoaled area of previous cut. The OB from upper benches will be handled by Shovel-dumper system and is proposed to be stacked upto the extent possible over the dragline sidecast spoil within the pit.

The volume of OB (including in-seam band) to be handled as per PR of Khadia Expansion OCP as on 31.03 2020 is 844.0 Mm^3, out of which 156.35 Mm^3 OB will be directly sidecast by draglines including throw blast of 13.35 Mm^2 in the decoaled cut and balance 687.65 Mm^3 is proposed to be removed and dumped by shovel-dumper system in the internal dumps in both the sections. The mine is being worked since 1981-82 and 487.66 Mm? of OB has already been dumped in external/internal dumps since inception till 31.03.2020. The final stage dump plan shows that apart from existing dump volume of 487.65 Mm^3, further 844.0 Mm^3 will be accommodated in the internal dumps in both the sections.

Table 4A: The Tier-wise OB volume of internal dumps is given below:

SL.No.	Tier (RL)	Volume (Mm^3)
A	**EAST SECTION**	
1	Dragline Dump	66.65
2	Upto 290 & 290-320	69.00
3	320-350	45.12
4	350-380	41.40
5	380-410	34.43
6	410-440	28.90
7	440-470	20.97
8	470-500	12.95
9	500-530	6.90
TOTAL EAST (A)		
1	Dragline Dump	89.70
2	Upto 270 & 270-320	78.78
3	300-330	60.08
4	330-360	57.36
5	360-390	53.26
6	390-420	46.91
7	420-450	44.16
8	450-480	39.98

9	480-510	29.16
10	510-540	18.29
Total West (B)		**517.68**
Grand Total (A+B)		**844.00**

Since inception, 487.66 Mm^3 of OB has already been dumped in internal/external OB dumps of the mine. Apart from the above OB, the volume of OB estimated in the PR (16Mtpa) is 844.0 Mm', which will be accommodated in internal OB dumps in both the sections.

OB Dump Benches

Shovel-dumper spoil dumps will be formed in benches of 30m and slope of individual dump bench will be 37 (equal to angle of natural repose of OB material). The width of berm between two adjacent benches will be 40m. Overall slope of dump works out to 28. Top soil wherever available will be stacked separately which will be used up for spreading over the completed OB dumps. The total mineable reserves within the sanctioned mine boundary of Khadia OCP as well as volume of OB and stripping ratio are given table 5

Table 5: Overburden and stripping ratio

Seam	Sanctioned MR (10Mtpa)	Estimated Balance MR as on 01.04.2020 (10 (Mtpa)	Incremental in Expansion area (6 Mtpa)	Total in PR (16 Mtpa) as on 01.04.2020
Purewa Top Seam (Mt)	32.07	26.00	15.3	41.30
Purewa Bottom Seam (MT)	67.95	53.00	1.65	70.65
Turra Seam (Mt)	142.53	10150	20.05	121.55
Total Coal (Mt)	343.55	180.5	53.00	2.33
Volume of OBR (Mm^3) (with band)	1039.67	653.50	190.55	844.00

2.6 Mining Technology

Elements of mining system have been determined in accordance with the parameters of excavation and transport equipment and the parameters of drilling and blasting.

Table 5A: Element of Mining system

SL.No.	Particulars	Unit	Overburden		Coal
			D/L	Shovel	
1	Bench Height	m	40-45	15-18	10-15
2	Working Bench Width	m	70	55-60	45
3	Non-working Bench Width	m	70	35-40	25
4	Bench slope	Deg.	70	70	80
5	Blast Hole Dia.	mm	311	250	160
6	Inclination of Boreholes		Inclined	Vertical	Vertical
7	Powder Factor		0.6	0.3	0.2

The main OB bench overlying Turra seam is to be removed by dragline system and proposed to be side cast in the decoaled cut. The OB from upper benches is being handled by Shovel-dumper system and accommodated over the dragline side cast spoil within the pit. However, a part of OB is being accommodated in external dumps. Total volume of OB to be handled has been estimated as 844 Mm^3 as on 01.04.2020.

2.7 Existing Environmental condition

Ambient air quality

Parameters chosen for assessment of ambient air quality were Suspended. Particulate Matter (SPM), Particulate Matter (PM10), Fine Particulate Matter (PM2.5), Sulphur Dioxide (SO2) and Nitrogen Oxides (NOx). Respirable Dust Samplers (RDS) were used for sampling of SPM, PM10, So2 & NOx and Fine Dust Samplers (PM 2.5 sampler) were used for sampling of PM2.5 at 24 hours interval once in a fortnight.The samples were analysed in Environmental Laboratory of CMPDI.

It has been seen from the analysis results that the 24 hours average concentration of parameters like SPM, PM10, PM2.5, SO2 and NOx are mostly within the permissible limits in ali sampling locations as per MoEF & CC Gazette Notification No. GSR 742 (E) dt 25.09.2000 standards for coal mines and national ambient air quality standard – 2009. Sometimes the concentration of SPM, PM10 & PM2.5 exceeds the limits due to presence of numbers of thermal powers in the vicinity.

Water quality

Water samples were collected as per standard practice. Drinking water samples were collected and analysed for four/five parameters on fortnightly basis. The drinking water sample was collected and analysed for all parameters on quarterly basis. Parameters like pH, Temperature and Dissolved Oxygen were analysed on site while collecting the samples. Thereafter the samples were preserved and analysed at the laboratory of CMPDI. The test results indicate that the major parameters compared with MoEF & CC Gazette Notification No. GSR 742 (E) dt 25.09.2000 standards for coal mines (For 4/5 parameters of drinking and effluent water) IS. 10500/2012 (All parameters of Drinking water) are within permissible limits.

Noise level quality

Noise level measurement is n form of 'LEQ' were taken using integrated Averaging sound level meter (CR: 812 C) during day and night time. Noise levels were measured for about one hour time in day and night time. Noise levels were measured in Decibels, ‘A’ weighted average, i.e. dB (A). During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF & CC Gazette Notification No. GSR 742 (E) dt 25.09.2000 standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000, for residential Area.

2.8 Impact of fly Ash on Environment and dumping

The combustion of pulverized coal at high temperatures and pressures in power stations produces different types of ash. The ash fraction is carried upwards with the flue gases and captured before reaching the atmosphere by highly efficient electro-static precipitators. It is composed mainly of extremely fine, glassy spheres and looks similar to cement. Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron.

Fly ash is left behind when coal is burnt. Coal-fired power plants are the biggest sources of fly ash mainly contain quartz, mullite and the iron oxides hematite, magnetite. I also contain toxic chemicals such as arsenic, barium, cadmium, nickel and lead, among others. These are known to cause cancer, lung and heart ailments and neurological damage, and contribute to premature mortality.

Irregular accumulation and inappropriate disposal of fly ash will lead to its disposal over vast areas of land, with resultant degradation of the soil and danger to both human health and the environment. Fly ash particles, small enough to escape emission control devices, are easily suspended in air and have become a major source of air pollution. Repeated exposure to fly ash can cause irritation of the eyes, skin, nose, throat and respiratory tract, and can even result in arsenic poisoning. Fly ash can even reach the sub-soil and ultimately cause siltation, clog natural drainage systems and contaminate the ground water with heavy metals. (Yao et.al, 2015).

Coal contains significant amount of various trace metals, and after combustion these metal concentrations in fly ash are higher than that of in parent coal. Sometime, under favouring conditions, a considerable amount of these trace elements can easily be leached out from the surface of fly ash particles by the interaction with water in ponds or landfills (Bhattacharyya et al., 2009). It has been reported that the metal contaminants like V, Cr, Ni, Cd and Pb are potential hazards to the environment even at low levels (Patra et al., 2012).

The effect of fly ash on soils and microorganisms in the soils are influenced by the pH of the ash and trace metal concentrations in the ash. Microbial communities in contaminated soil have shown reductions in respiration and nitrification. These contaminated soils can be detrimental or beneficial to plant development. Most detrimental effects were observed when boron phytotoxicity was observed. Plants absorb elements elevated by the fly ash from the soil. Arsenic, molybdenum, and selenium were the only elements found at potentially toxic levels for grazing animals.

2.9 Fly ash Dumping in Mine Voids

As per the approved mining plan Khadia OC expansion, the available voids, at end of mining of Khadia OC quarry could be utilized by the backfilling of overburden. In addition, a part of the overburden will have to be accommodate in internal dumps. As the external dump is already reached to it maximum height (as reported by mine official). In such, there will not be any possibility of accommodating fly ash dump into External dump. Therefore, the only option is left is to accommodate the overburden material into internal dump or at end of mine void.

3.0 Sample Collection and laboratory testing

3.1 Introduction

The important geotechnical properties of overburden dump materials are grain size distribution, specific gravity, optimum moisture content, Atterbergs limits, Cohesive properties, shear strength, etc. These properties play important role in slope stability and characteristic of fly ash material. Properties have been determined for overburden, fly ash and of overburden and fly mixture of various proportions. These has been determined to know the suitability of OB and fly ash as aback filling material in the Khadia opencast project.

3.2 Collection and Preparation of Samples

The overburden sample has been collected from different places of Khadia OCP dump. Ten to fifteen kg of overburden samples have been collected in the bags. Care has been taken to collect enough samples to represent the various conditions of strata in the mines. Total 6-8 bags have been taken from mines. The fly ash is taken from power plants in bags. The mouth of each bag was sealed immediately after collection and the same was again inserted in another poly bag to prevent atmospheric influences. The bags were transported with almost care from the plant to the laboratory/filed and kept in a secure and controlled environment. The sample of OB and fly ash are brought in the Laboratory of Department of Mining IIT (BHU) in tightly packed condition (to avoid contamination or moistening). Representative samples were then prepared by coning and quartering in the laboratory for the analysis. The location of collection point in the Khadia opencast project is shown in figure 2.

Figure 2 : Sampling location and collection of samples

3.3 Geotechnical Properties of soil and fly ash

3.3.1 Specific Gravity and bulk density

The specific gravity of soil is the ratio of the mass of a given volume of the material at a stated temperature. The specific gravity of soil is used in relating the weight of soil to its volume. It is obtained using a specific gravity bottle (50ml) for fine grain soils or pycnometer (1000ml) for coarse grain soil. The following formula obtains specific Gravity of Soil (Gs):

$$G_S = \frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)}$$

Where, W_1 (gm) is the weight of sp. gr. Bottle, W_2(gm) is the weight of sp. gr. bottle + soil, W_3(gm) is the weight of sp. gr. bottle + soil + water and W_4(gm) is the weight of sp. gr. bottle + water. The complete test procedure is given in IS: 2720 part 3: Sec 1:1980.

Bulk density is an indicator of soil compaction. It is calculated as the dry weight of soil divided by its volume. This volume includes the volume of soil particles and the volume of pores among soil particles. Bulk density is typically expressed in g/cm^3. Bulk density is measured using proctor compaction mold. The Bulk Density(γ_{Bulk}) is obtained using the following formula:

$$\gamma_{Bulk} = \frac{W_2 - W_1}{V_m}$$

Where, W_2(gm) is the Weight of mold + compacted soil, W_1 (gm) is the weight of empty mould and V_m (cc) is the volume of the mold. The complete test procedure is given in IS-2720-PART-7-1980.

Table 6 and 7 show the specific gravity and bulk density of various samples taken from mine and power plant. The average specific gravity and bulk density of overburden ash samples was found to be 2.66 and 1.86 t/m^3, respectively. The specific gravity of Fly Ash sample was 2.29 for UPRVUNL, Anpara and 2.10 for Hindalco, Renusagar. The average bulk density of the fly ash samples was found to be 1.25 t/m^{3}and 1.29 t/m^{3}for and Hindalco Renusagar and UPRVUNL Anpara respectively.

Table 6: Specific gravity and bulk density Khadia OCP

Sample No	Specific gravity	Bulk density t/m^3
Sample 1	2.50	1.85
Sample 2	2.71	1.86
Sample 3	2.56	1.84
Sample 4	2.86	1.89
Average	2.66	1.86

Table 7: Specific gravity and bulk density of fly ash Samples

Sample No	Specific gravity	Bulk density t/m^3
Hindalco Renusagar		
Sample 1	2.11	1.19
Sample 2	2.09	1.21
Average	2.10	1.25
UPRVUNL Anpara		
Sample 1	2.24	1.28
Sample 2	2.34	1.31
Average	2.29	1.29

3.3.2 Grain Size Distribution

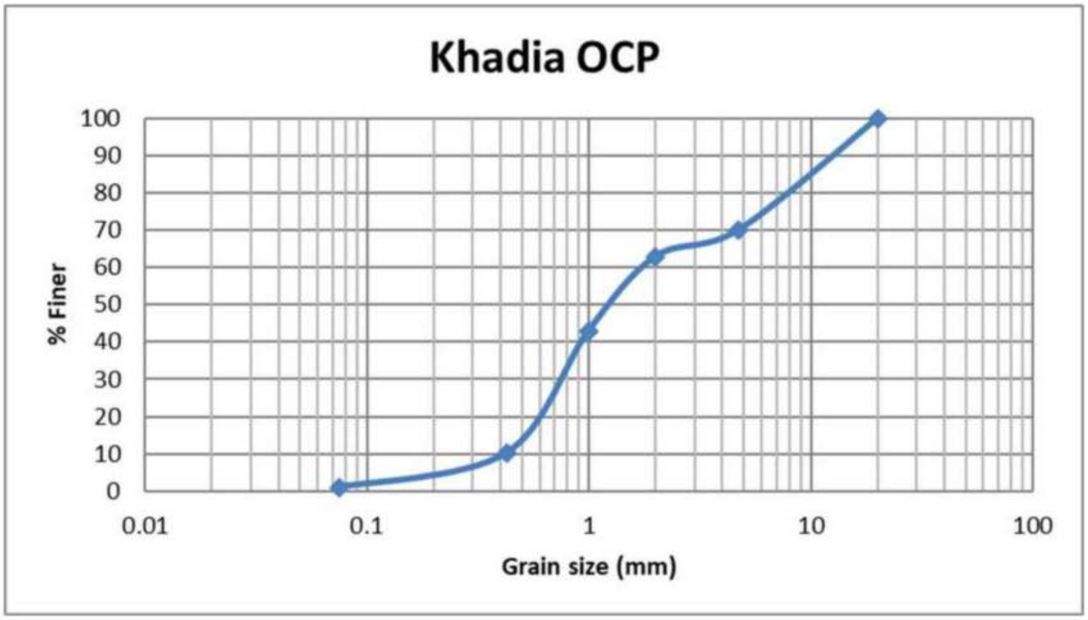
Soil gradation is the distribution of particle sizes expressed as a percent of the total dry weight. It is determined by passing the material through a series of sieves stacked with progressively smaller openings from top to bottom and weighing the material retained on each sieve. Sieve analysis is performed according to IS 2720: Part 4: 1985.

The results of testing will reflect the condition and characteristics of the aggregate from which the sample is obtained. Therefore, it is important to obtain a disturbed representative sample of the source being tested the distribution of different grain sizes affects the engineering properties of soil. The sieves of different standard IS size (4.75mm, 2.00mm, 1.00mm, 425µm, 75µm) are used for analysis. Samples were placed in the top sieve (4.75mm) and it was covered. A receiver, known as pan, which has no opening, was placed at the bottom of the smallest sized sieve. The set of sieves was kept on a mechanical shaker and the machine was started. Mechanical shaking was done for 15-20 minutes. The mass of the samples retained on each sieve and on the pan was weighed and percentages of different sizes were calculated.

Hydrometer analysis is a measurement method used to determine soil particle size in a sample. Hydrometer analysis is specifically for soil particle sizes that are less than approximately 0.75 mm in diameter. The hydrometer is placed in a container filled with a water and soil mixture and measurements are taken over time to perform the test.

Figure 3 shows the size distribution of two samples from Khadia Overburden dump. It indicates that the presence of fine material in overburden sample is very less. Moreover, this has been done neglecting large boulders and fragmentation. If we considered, then the percentage of fine material in overburden soil is negligible. The percentage of fine material in overburden soil is negligible after considering large boulders. Therefore, the amount of clay is very less that is act and use as binding material of overburden soil.

The figure 4 shows the size distribution of fly ash of two power plants. It indicates that the percentage fine is high compare to overburden soil. This will lead to reduce the permeability of overburden soil when it mixed with overburden soil.



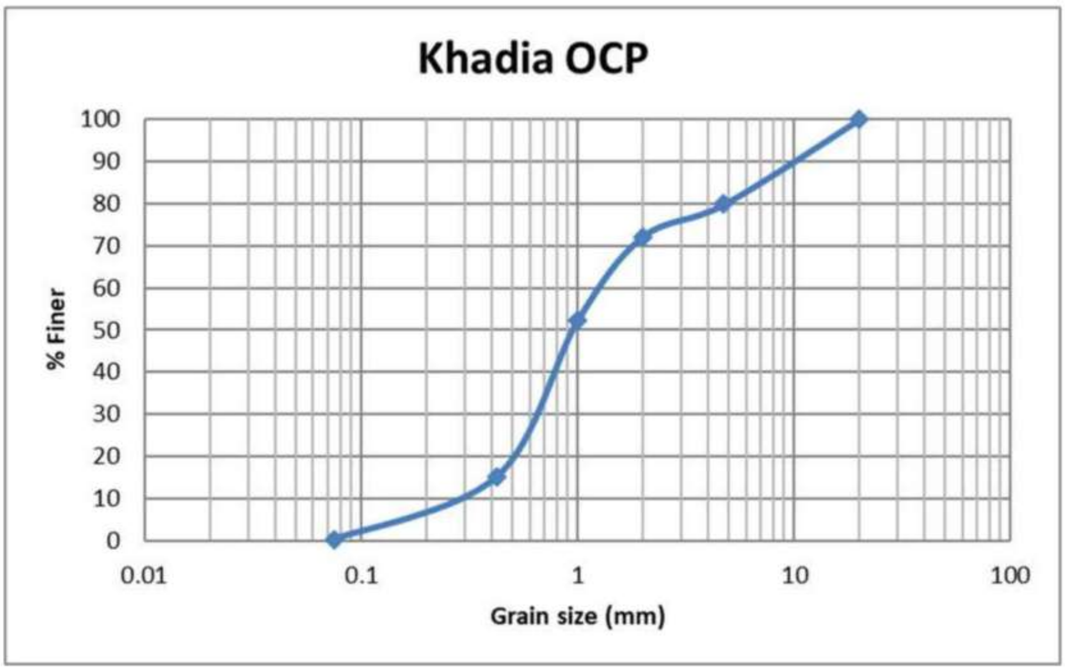
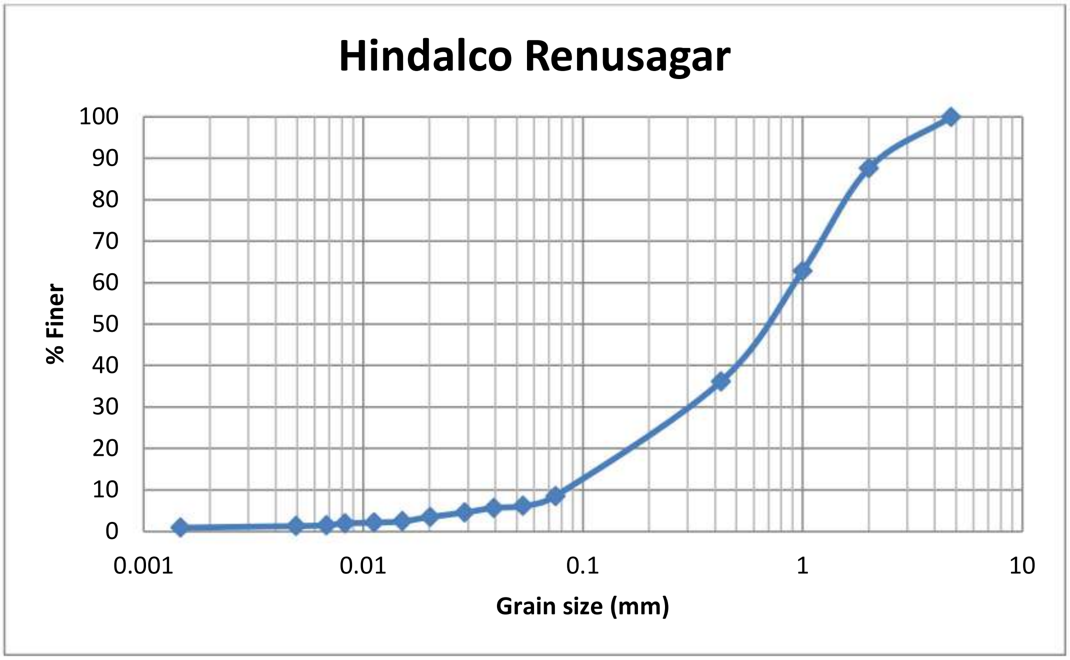


Figure 3 : Size distribution of different samples from Khadia Overburden dump



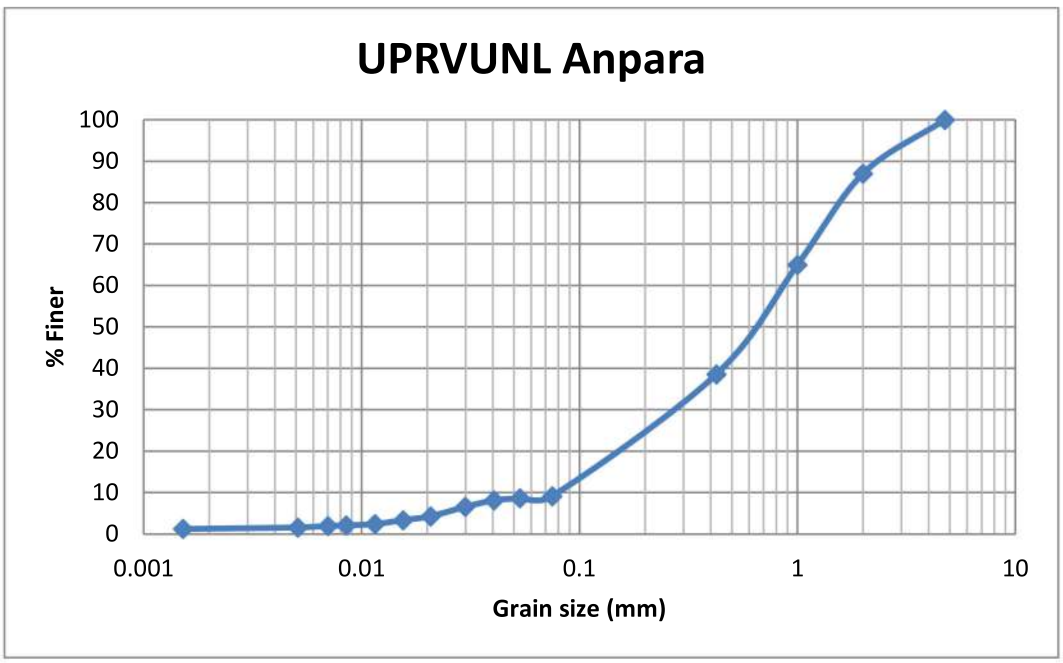


Figure 4: Size distribution of different samples of Fly Ash

The Co-efficient of Uniformity (Cu) and Co-efficient of curvature (Cc) has been calculated. $D_{10}$is define as the effect size of the material, lesser the D_{10} having less permeability of material. A soil is considered to be well graded if the coefficient of curvature Cc is between 1 and 3, with Cu greater than 4 for gravels and 6 for sands.

Table 8 show the Coefficient of curvature and coefficient of uniformity of overburden soil and Fly ash. The percentage of distribution has been determined using graph of $D_{60}D_{30}$and D_{10}. The coefficient of uniformity is greater than 4, and coefficient of curvature is near to 1. Hence, the material is classified as uniformly graded sand with particles of same size. It contains particles of the same sizes which allow more drainage of water. Poorly graded soils are more susceptible to soil liquefaction than well graded soils.

Table 8 : Coefficient of curvature and coefficient of uniformity

	Particles at different size (mm)			Co-efficient of Uniformity (Cu)	Co-efficient of curvature (Cc)
	D_{60}	D_{30}	D_{10}	D_{60} / D_{10}	$D^2_{30} / D_{60} * D_{10}$
Overburden	1.1	0.85	0.45	2.44	1.46
Overburden	1.05	0.75	0.25	4.20	2.14
Fly Ash (R)	0.90	0.30	0.07	11.33	1.22
Fly Ash (A)	0.85	0.20	0.65	9.00	1.36

3.3.3 Atterberg's Limits (Liquid and Plastic Limits)

The water content at which the soil changes from one state to other (i.e., from solid to plastic to liquid) is known as consistency limits or Atterberg's limit. The consistency of a fine-grained soil refers to the physical state in which it exists. A fine-grained soil can exist in four states, namely, liquid, plastic, semi-solid and solid states. Atterberg's limit consists of the determination of liquid limit, and plastic limit of soil or soil like material. It is performed according to (IS: 2720 part 5: Sec 1:1985).

Casagrande cup method has been used to determine the liquid limit. In the Casagrande cup method, the soil paste is placed in the Casagrande cup, and a groove is made at its center (see procedure below). The limit is defined as the moisture content, in percent, required to close a distance of 0.5 inches along the bottom of a groove after 25 blows in a liquid limit device. It is difficult to adjust the moisture content in the soil to meet the required 12.5 mm (0.5 in.) closure of the groove in the soil pat at 25 blows. Hence, at least three tests for the same soil are conducted at varying moisture contents, with the number of blows, N, varying between 15 and 35. The graph between water content (on y-axis) and number of blows (on x-axis) on semi-log graph is plotted for different test under different water content. The curve obtained is called flow curve. The moisture content corresponding to 25 drops (blows) as read from the represents liquid limit.

The Plastic limit test is performed by repeatedly rolling an ellipsoidal-sized soil mass on a non-porous surface. Casagrande defined the plastic limit as the water content at which a thread of soil just crumbles when it is carefully rolled out to a diameter of 3 mm (1/8"). If the thread crumbles at diameter smaller than 3 mm, the soil is too wet. If the thread crumbles at a diameter greater than 3 mm, the soil is drier than the plastic limit. The sample can then be remolded and the test repeated. Once the appropriate size rolls are made, their moisture content is assessed using the procedure described previously.

The overburden soil having large boulder to fine soil. The size range is varying from micron to meters. The Atterberg's limit is determined for clay and silt type soil. The finer soil (clay and silt) has been taken out from overburden material through sieve analysis and Atterberg's limit has been determined.

The table 9 and 10 show the Atterberg's Limits of fine soil (Clay) present in overburden soil and fly ash. The significance of Liquid limit in this study is that it indicates at what moisture content the fly-ash and OB mixture will get liquefied. The overburden soil has liquid limit of 24% which means the moisture content of the material should not exceed 24% otherwise the dump or slope may get liquefied. However, the overburden material consists of well graded sand and silt with large gravel and boulders. This will allow drainage through the overburden material. Therefore, Atterberg's Limits is not applicable to the OB material as this is coarse grain size. However due to presence of some clay material in the OB its Liquid limit was found to be 24%.

The Liquid limit of fly ash is 17 and 14 for Hindalco Renusagar and UPRVUNL Anpara fly ash respectively. The liquid limits and plastic limit of overburden considering of boulders also is very less and exhibit only small amount of liquid limit and are generally slightly plastic. However, when it will be mixed with fly ash the amount of fines will may be increased. Therefore, it may generate pre water pressure in water. The pore water pressure will not quickly dissipate in the overburden and fly ash mixed material.

Table 9 : Atterberg's Limits of clay present in overburden soil

Sample No	Liquid Limit	Plastic limit
Sample 1	25.5	12
Sample 2	26.5	15
Sample 3	22	16
Sample 4	21	13
Average	23.75	14

Table 10 : Atterberg's Limits of fly ash

Name of Power Plant	Liquid Limit	Plastic limit
Hindalco Renusagar	17	-NA-
UPRVUNL Anpara	14	-NA-

3.3.4 Procter Compaction Test

The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density (γ_d). Higher the dry density of the material, higher is the stability. Determination of the relationship between the moisture content and density of soils compacted in a mold of a given size with a 2.5 kg rammer dropped from a height of 30 cm. This test is performed according to IS: 2720 part 7: 1980.

$$\gamma_d = \frac{W - W_m}{(1 + w) * V}$$

Where, W (gm)is the weight of the mold and the soil mass, W_m (gm)is the weight of the empty mold, w (%) is the water content of the soil and V (cc) is the volume of the mold.

After obtaining maximum dry density for different water content, the curve (compaction curve) between dry density and moisture content is plotted to determine the maximum dry density and optimum moisture for the soil. The peak point of the compaction curve is the point with the maximum dry density dry density max. Corresponding to the maximum dry density max is a water content known as the optimum water content (also known as the optimum moisture content, OMC).

Figure 5 shows the relation between water content and maximum dry density of overburden material and fly ash respectively. Table 11 shows the MDD and OMC for Khadia overburden samples 11 and 1.98, respectively. Table 12 shows the MDD and OMC for fly ash. The OMC for Hindalco Renusagar and UPRVUNL Anpara are 22 and 21 percentages. Whereas, The MDD are 1.28 and 1.29 for fly ash of Hindalco Renusagar and UPRVUNL Anpara respectively.

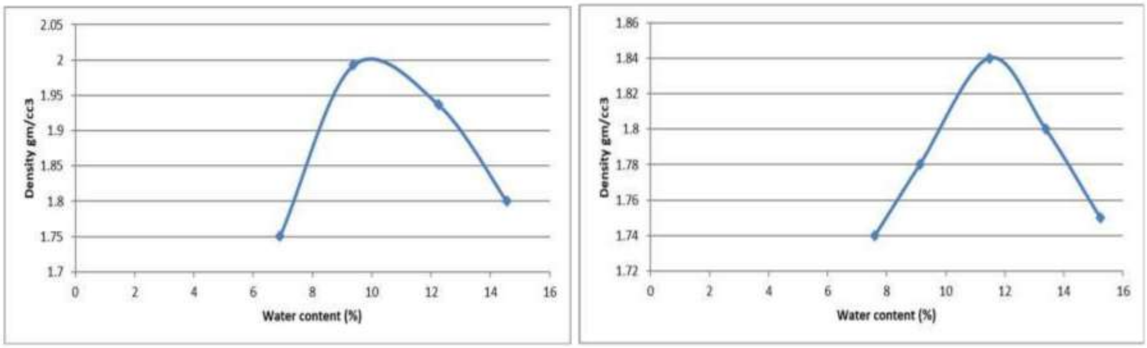


Figure 5 : Compaction curve of overburden material

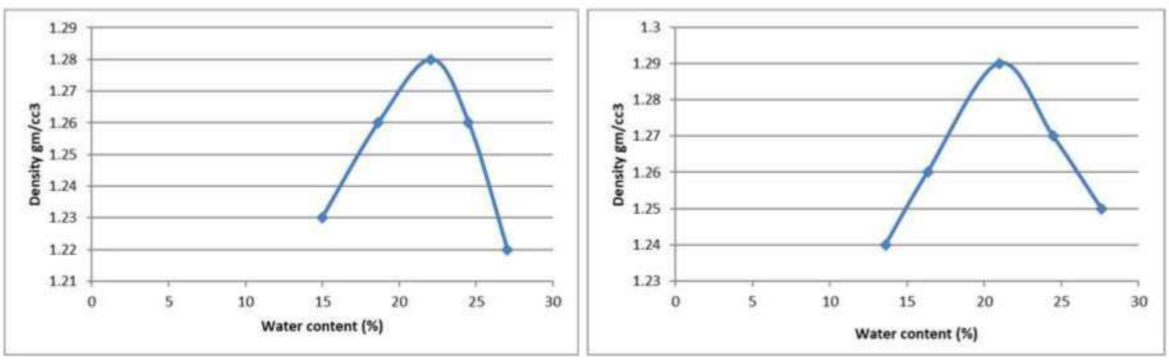


Figure 6 : Compaction curve of Fly ash material (Hindalco Renusagar and UPRVUNL Anpara)

Table 11 : OMC and MDD of Khadia OCP

Sample No	OMC	MDD
Sample 1	10.6	1.81
Sample 2	9.8	1.89
Average	10.2	1.85

Table 12 : OMC and OMD of fly ash sample

Sample No	OMC	MDD
Hindalco Renusagar		
Sample 1	21	1.27
Sample 2	23	1.30
Average	22	1.28
UPRVUNL Anpara		
Sample 1	22	1.32
Sample 2	21	1.26
Average	21	1.29

3.3.5 Permeability

The rate of flow under laminar flow conditions through a unit cross sectional area of porous medium under unit hydraulic gradient is defined as the coefficient of permeability. Permeability is useful in solving problems involving yield of water bearing strata, seepage through earthen dams, stability of earthen dams, and embankments of canal bank affected by seepage, settlement etc. It is very important factor for the structures which are in contact with water. Flow of water in soil takes place through void spaces, which are interconnected.

The falling head method of determining permeability is used for soil with low discharge, whereas the constant head permeability test is used for coarse-grained soils with a reasonable discharge in a given time. The permeability test is performed using Permeameter mould made up of of non-corrodible material having a capacity of 1000 ml, with an internal diameter of 100± 0.1 mm and internal effective height of 127.3± 0.1 mm. The coefficient of permeability (k) is obtained by using the following equations:

$$k = \frac{QL}{Aht}$$

Where, k (m/sec) is the coefficient of permeability, Q (cc) is discharge, L (cm) is the length of specimen, A (cm^2) is the area of specimen, h (cm) is the height of water column and t (sec) is the time for testing. Table 13 shows the permeability of overburden sample and fly ash sample. It shows the permeability of fly ash is low compared to overburden sample.

Table 13 : show the permeability of overburden sample and fly ash sample

Sample No	Permeability (k in m/s)
Khadia overburden	5.18E-05
Fly ash (Hindalco Renusagar)	5.92E-07
Fly ash (UPRVUNL Anpara)	1.60E-07

3.3.6 Shear strength

The two methods have been used to determine the shear strength of overburden, fly ash, and mixed material, i.e. triaxial and direct shear tests. A triaxial shear test is a common method to measure the mechanical properties of many deformable solids, especially soil (e.g., sand, clay) and rock, and other granular materials or powders. Shear box test is a testing method used to determine the shear strength of a soil sample. Since granular soils cannot be retrieved undisturbed, the soil is re-compacted inside a shear box. Shear strength testing is carried out for analyses of short term and long term slope stability.

In soil mechanics, the shear strength is evaluated using the Mohr-Coulomb (M-C) Failure Criterion. The M-C Criterion assumes that the shear strength depends on three factors:

1. The normal effective stress (σ_n)
2. The friction angle of the material (φ)
3. The cohesion of the material (c)

The qualitative correlation of those components is expressed as:

$$t = c + \sigma_n * \tan(\varphi)$$

Table 14 show the cohesion and friction angle of over burden sample and fly ash sample of different power plants. Table 15 shows the shear strength of mixed overburden and fly ash material. It is observed from table 15 that around 20 percentage of fly ash will increase the cohesion of dump material. However, the friction angle is reducing with increase in fly ash in the overburden material.

Table 14 : Shear strength of overburden and fly ash

Sample No	Cohesion kPa	Friction angle Degree
Overburden sample 1	55	32
Overburden sample 2	48	30
Fly ash (Hindalco Renusagar)	18	28
Fly ash (UPRVUNL Anpara)	48	24

Table 15 : Shear strength of mixed material of overburden and fly ash

Sr. No	% Overburden	% Fly Ash	Cohesion (kPa)	Friction angle (degree)
1	100	0	55	31
2	95	5	76	30
3	90	10	98	29
4	80	20	126	28
5	70	30	90	29
6	60	40	82	28

4.0 Characterization of Fly ash

Introduction

The combustion of pulverized coal at high temperatures and pressures in power stations produces different types of ash. The 'fine' ash fraction is carried upwards with the flue gases and captured before reaching the atmosphere by highly efficient electro static precipitators. This material is known as Pulverized Fuel Ash (PFA) or 'fly ash'. It is composed mainly of extremely fine, glassy spheres and looks similar to cement. Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal-fired power plants, whereas bottom ash is removed from the bottom of the furnace.

To investigate the geotechnical properties of fly ash such as grain size, moisture content, water holding capacity, specific gravity, optimum moisture content, settling velocity, density, etc., should be tested for safety and environmental suitability. Other characterizations such as chemical composition, elemental composition, surface morphology, etc. also have been done.

4.1 Chemical / physical properties of Characterization of fly ash

4.1.1 pH

Acidic/basic water is characterized by pH of the sample, and range goes from 0 to 14, with 7 being neutral. pH value of less than 7 indicate acidity, whereas pH value of greater than 7 indicates a base. The pH of water is a very important measurement concerning water quality. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water.

Practically this parameter does not affect stability of the filling material however it may affect the biological reclamation process. The nutrient deficiencies that occur on alkaline soils often cause crop failure, but if a balanced plant nutrition program is implemented, most crops can be successfully grown. In this case high pH will lead to failure in plantation program, if no measures are taken to neutralize it.

About 10g of samples were taken in 250ml conical flask and 100ml of distilled water was added, maintaining the sample to soil ratio of 1:10. The fly ash water suspension was stirred at regular intervals for 30 minutes and then the pH was recorded. The suspension was stirred well just before electrodes were immersed and readings were taken. The instrument was first calibrated with buffer solutions of known pH values. The pH of the fly ash samples was found to be in the range of 6.0 to 7.0.

The pH of the fly ash samples was found to be in the range of 6.4 and 6.3 for UPRVUNL, Anpara TPS and Hindalco, Renusagar TPS respectively. It means the pH of fly ash is Slightly acidic in nature. It can be considered as natural in all practical purpose. This will help in biological reclamation in the backfilled land.

S.No.	**Name of sample**	**pH value**
1.	UPRVUNL, Anpara TPS	6.4
2.	Hindalco, Renusagar TPS	6.3

4.1.2 Electrical Conductivity

The electrical conductivity (EC) of any solution is a fundamental property of a material that measures how strongly it resists electric_current. A low resistivity indicates a material that readily allows electric current which is dependent on the soluble salts present in it. Thus the measurement of electrical conductivity (EC) can be directly related to soluble salts concentration of the soil at any temperature. With an electrical conductivity **between 0.05 and 0.1 S/ m**, fly ash-based geopolymer are considered as semiconductor materials.

Calibration of the instrument has been done with KCl solution at a specified temperature. As in the case of EC, 20g of sample was shaken intermittently with 40ml of distilled water in a 250ml conical flask (keeping the ratio of soil-water as 1:2) for an hour and allowed to stand. The clear extract was then taken and used for the electrical conductivity measurement using the Cyber Scan 200 Conductivity meter. It was found to be in the range of 1.062 to 1.065mS/cm for both fly ash samples. The range electrical conductivity is suitable for seedlings for salt sensitive plants mainly.

Table 16: electrical conductivity of fly ash

S.No.	**Name of sample**	**EC value (mS/cm.)**
1.	UPRVUNL, Anpara TPS	1.062
2.	Hindalco, Renusagar TPS	1.065

The electrical conductivity of the fly ash is around 1.06 ms/cm. It is suitable for seeding and salt sensitive plants, which growth and occurrence is rare. Therefore, it is not advisable to directly mix in the overburden dump materials. The mixing of fly ash may increase the salinity of overburden/soil mixed with fly ash.

4.1.3 Chemical composition of fly ash (XRF)

The chemical composition of the as-received FA ash was determined using X-ray fluorescence spectroscopy (XRF), which is a non-destructive analytical technique that used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent (or secondary). X-ray emitted from a sample when it is excited by a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X-rays ("a fingerprint") that is unique for that specific element.

Fly ash samples were analyzed by the PAN alytical, Netherland Model Axios MAX at the Birbal Sahini Institute of Palaeosciences in Lucknow, Uttar Pradesh, India. It is a nondestructive analysis technique for the major oxides and trace elements present in the sample. Wavelength dispersive (WD XRF) Machine (power: -3KW, 60kV-160mA) is used for detecting the elements. Analysis can be done on pressed powder pellets made from fine powder. The chemical compositions of fly ash are shown in Table 17-18.

According to American Society for Testing and Materials (ASTM) fly ash is classified into two classes (C & F) based on the amount of lime present. Oxides of silicon, aluminum, calcium and iron in fly ash are responsible for pozzolanic activity, which decreases by loss of ignition. According to ASTM classification method, the FA used in this study is Class F types since the summation of SiO_2, Al_2O_3 and Fe_2O_3 is greater than 70%.
The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 10% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementious compounds. Alternatively, the addition of a chemical activator such as sodium silicate (water glass) to a Class F ash can leads to the formation of a geopolymer. The geochemical analysis of fly ash is summarized in tables 17-18. From the tables, its shows that oxides of silica composition are relatively higher in both the sample which is ranging from 47.5- 45.85% however the lowest concentration of oxides of Manganese (MnO) was found in UPRVUNL, Anpara TPS whereas in case of Hindalco, Renusagar TPS the lowest concentration of oxide was sodium dioxide i.e. only (0.64%).

Table 17: Major and trace elements in the fly ash obtained by XRF of UPRVUNL, Anpara TPS Fly ash sample

Sr. No	XRF analysis data of fly ash Composition	Percentage
1	SiO2	47.53%
2	Al2O3	21.10%
3	CaO	5.04%
4	FeO	9.32%
5	MgO	1.36%
6	MnO	0.50%
7	Na^2O	1.19%
8	K_2O	0.67%

Table 18 : Major and trace elements in the fly ash obtained by XRF of Hindalco, Renusagar TPS Fly ash sample

Sr. No	XRF analysis data of fly ash com Composition	Percentage
1	SiO2	45.85%
2	Al2O3	27.33%
3	CaO	7.40%
4	FeO	3.19%
5	MgO	2.90%
6	MnO	1.04%
7	Na^2O	0.64%
8	K_2O	0.71%

4.1.4 Metal composition of Fly ash (ICP-MS)

Inductively coupled plasma-optical emission spectroscopy (ICP-MS) is an analytical technique used for the elemental determination in samples. The samples were analyzed by the Agilent 7700 ICP-MS at the Birbal Sahni Institute of Palaeosciences in Lucknow, Uttar Pradesh, India. The Agilent 7700 ICP-MS produces unparalleled accuracy and precision in high-matrix samples, with the help of redefining cell performance in helium mode with a revolutionary third-generation cell design of the ORS3. Microwave digestion-coupled ICP-MS were used to determine REEs' concentrations in the samples.

For the analysis of metal composition the digestion was carried out by taking 0.25 g of the fly ash sample was weighed into a Teflon cup. 2 cm3 of concentrated HF and 5 cm^3 aqua regia were added. The Teflon cup was put in a digestion vessel (Parr bomb), sealed and heated to 200°C for 2 hours in an oven. The Parr bomb was removed from the oven and allowed to cool down. 25 cm^3 of H_3BO_3 was added to the sample in order to prevent the formation of sparingly soluble in the sample. The digestate was filtered through 0.45 µm membrane filter and made up to 100 cm^3 with ultra-pure water (ELGA Pure lab UHQ). The solution obtained from the total acid digestion experiments was analyzed for major and trace concentration using Varian 710-ES ICP Optical Emission Spectrometry.

The sample was introduced through a high sensitivity glass, single-pass cyclone spray chamber and conical nebulizer using argon gas. It was then passed through axially oriented plasma. The wavelength released by different analytes was detected with a CCD detector and auto integrated using ICP Expert II software. The ICP-OES instrument was calibrated before analysis with three calibration standards and a blank (2% HNO3). The certified standards used in calibrating and checking the accuracy of the instrument was supplied by Industrial Analytical. Potentially toxic metals and elements concentration of fly ash samples are shown in Table 19-20.

From the tables its shown that the Al concentration found highest 160379.04 and 154547.24ppb for UPRVUNL, Anpara TPS and Hindalco, Renusagar TPS respectively, as compare with other metal like Ti, Fe and Ba was 11405.11, 48517.85 and 1073.87ppb in UPRVUNL, Anpara TPS and 11463.53, 44867.04 and 940.00ppb for Renusagar TPS respectively. Other earthly earth metal was found less than 1000ppb, shown in tables.

Table 19: Metal Composition of fly ash ICP-MS of UPRVUNL, Anpara TPS **Fly ash sample**

Sr. No	ICP-OES analysis data of fly ash com Composition	Values in PPB	Sr. No	ICP-OES analysis data of fly ash com Composition	Values in PPB
1.	**Mg**	2908.25	21.	**Cs**	7.38
2.	**Al**	160679.04	22.	**Ba**	1073.87
3.	**Sc**	33.93	23.	**La**	89.74
4.	**Ti**	11405.11	24.	**Ce**	191.17
5.	**V**	206.32	25.	**Pr**	19.39
6.	**Cr**	332.64	26.	**Nd**	71.87
7.	**Mn**	946.79	27.	**Sm**	14.40
8.	**Fe**	48517.85	28.	**Eu**	2.69
9.	**Co**	40.24	29.	**Gd**	12.45
10.	**Ni**	113.13	30.	**Tb**	1.77
11.	**Cu**	101.85	31.	**Dy**	10.31
12.	**Zn**	281.29	32.	**Ho**	1.99
13.	**As**	15.47	33.	**Er**	5.40
14.	**Rb**	68.09	34.	**Tm**	0.74
15.	**Sr**	204.05	35.	**Yb**	4.95
16.	**Y**	52.68	36.	**Lu**	0.70
17.	**Zr**	224.96	37.	**Hf**	5.52
18.	**Nb**	42.72	38.	**Pb**	81.28
19.	**Mo**	8.81	39.	**Th**	28.13
20.	**Cd**	1.20	40	**U**	7.56

Table 20: Metal Composition of fly ash ICP-OES of Hindalco, Renusagar TPS **Fly ash sample**

Sr. No	ICP-OES analysis data of fly ash com Composition	Values in PPB	Sr. No	ICP-OES analysis data of fly ash com Composition	Values in PPB
1.	**Mg**	2858.04	21.	**Cs**	6.59
2.	**Al**	154547.24	22.	**Ba**	940.13
3.	**Sc**	34.11	23.	**La**	117.98
4.	**Ti**	11463.53	24.	**Ce**	220.03
5.	**V**	175.39	25.	**Pr**	22.68
6.	**Cr**	226.01	26.	**Nd**	83.70
7.	**Mn**	821.51	27.	**Sm**	16.32
8.	**Fe**	44867.04	28.	**Eu**	2.99
9.	**Co**	36.25	29.	**Gd**	14.09
10.	**Ni**	105.97	30.	**Tb**	2.00
11.	**Cu**	88.17	31.	**Dy**	11.34
12.	**Zn**	194.11	32.	**Ho**	2.12
13.	**As**	10.96	33.	**Er**	5.71
14.	**Rb**	73.06	34.	**Tm**	0.81
15.	**Sr**	192.09	35.	**Yb**	5.21
16.	**Y**	60.35	36.	**Lu**	0.71
17.	**Zr**	211.64	37.	**Hf**	5.33
18.	**Nb**	43.26	38.	**Pb**	60.66
19.	**Mo**	5.26	39.	**Th**	32.07
20.	**Cd**	0.88	40	**U**	6.96

4.1.5 Mineralogical Composition by SEM and EDS

The **scanning electron microscope** (**SEM**) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample's surface topography, composition and other properties such as electrical conductivity.

The three signals which provide the greatest amount of information in SEM are the secondary electrons, backscattered electrons, and X-rays. A high-resolution image can be obtained because of the small diameter of the primary electron beam. Backscattered electrons are primary beam electrons which are 'reflected' from atoms in the solid. The contrast in the image produced is determined by the atomic number of the elements in the sample. The image will therefore show the distribution of different chemical phases in the sample.

The types of signals produced by an SEM include secondary electrons, back-scattered electrons (BSE), characteristic X-rays, light (cathodoluminescence), specimen current and transmitted electrons. Secondary electron detectors are common in all SEMs, but it is rare that a single machine would have detectors for all possible signals. The signals result from interactions of the electron beam with atoms at or near the surface of the sample. In the most common or standard detection mode, secondary electron imaging or SEI, the SEM can produce very high-resolution images of a sample surface, revealing details about less than 1 to 5 nm in size. Due to the very narrow electron beam, SEM micrographs have a large depth of field yielding a characteristic three-dimensional appearance useful for understanding the surface structure of a sample

Suitable samples include most solids which are stable under vacuum (metals, ceramics, polymers, minerals). Sample must be less than 2 cm in diameter. Sample preparation: non-conducting samples are coated with a thin layer of carbon or gold. Metallographic embedding, polishing, and sectioning is available for samples requiring special preparation. Samples are usually mounted and coated and introduced into the vacuum chamber. Digital images are acquired with an electron microscope image scanner. Images may be printed on a laser printer or transferred to disk or an e-mail account.

SEM/EDS investigations involved two different fly ash samples from UPRVUNL, Anpara TPS and Hindalco, Renusagar TPS Fly ash samples were analyzed by Carl Zeiss EVO-MA15/18 scanning electron microscope (SEM-EDX). SEM-EDX instrument helps in producing the detailed high-resolution images of sample by restoring a focused electron beam across the surface and detecting secondary or backscattered electron signal.

SEM analysis showed that the ash is primarily composed of small glassy particles (some as cenospheres and pleurospheres), and minor coarse unburned carbon particles (the LOI was determined at 2%). Obtained SEM images show that FA is made of spherical particles of less than 10 µm and irregular shaped particles like bubbles (Figure 7-8). In the SEM image of both the fly ash sample, spherical bubbles like structure. The fly ash particles are spherical as can be viewed in the images of SEM. Figure 9- and 10 show the EDS analysis and Spectrum of the UPRVUNL, Anpara TPS. Whereas figure 11 and 12 show the EDS analysis and Spectrum of the Hindalco, Renusagar TPS fly ash. During the combustion process, the heat causes the inorganic mineral to become fluid or volatile or to react with oxygen. During cooling, it may form crystalline solids, spherical amorphous particles or condense as coatings on particles. Volatiles trapped in a particle cause it to have swelled surfaces, varying the shape of the particles and bubbles, which alters its surface. The bubbles formed may be attributed to the release of volatile matter from the internal zones of the particle as the solid particle’s surface is softening and melting. The bubbles can generate large cavities under the surface, which are smooth zones and considered to be less reactive for the subsequent steps of oxidation. There is no significant difference in morphology of the particles collected at various locations, apart from the particle size. Spherically and colourless particles indicate glassy textures or predominance of crystallinity and spherical, rounded light colored particles indicate a glassy surface. Rounded particles indicate a glassy particle, irregular shapes indicate partly crystalline particles, and angular shapes indicate a crystalline nature.

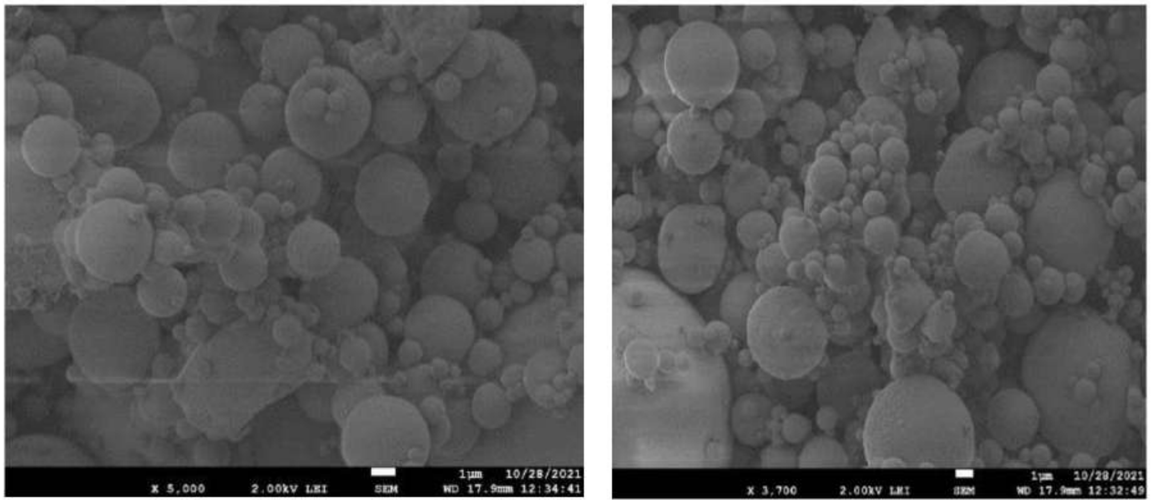


Figure 7 : Surface Morphology image at different magnification of **UPRVUNL, Anpara TPS** Fly ash sample

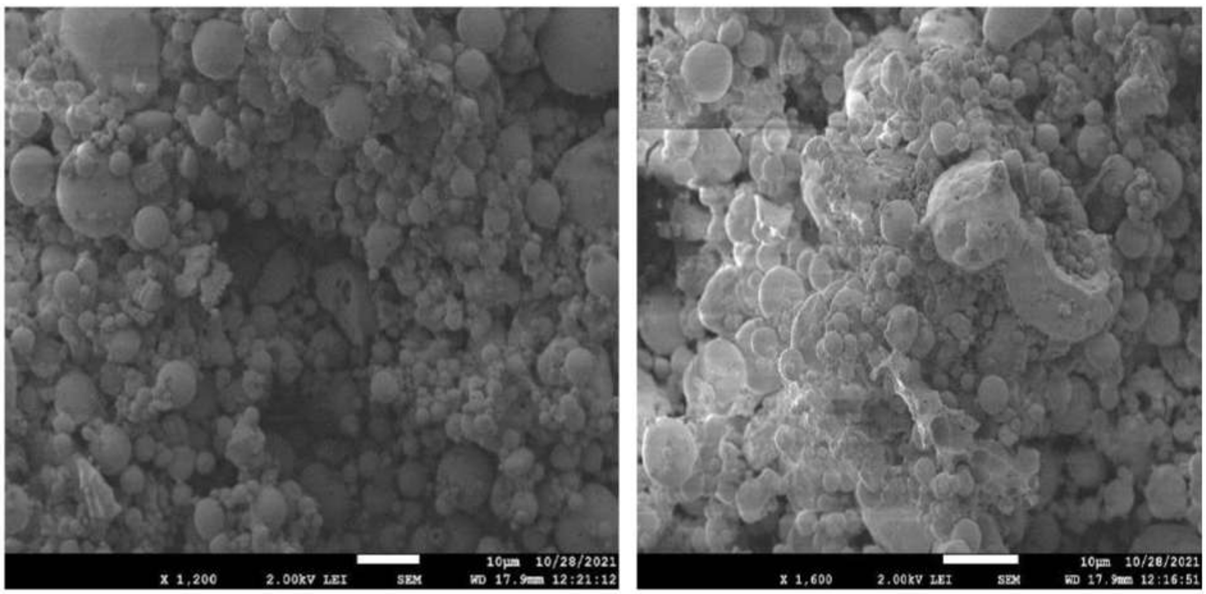


Figure 8 : Surface Morphology image at different magnification of **Hindalco, Renusagar TPS** Fly ash sample

4.1.6 Elemental Composition Analysis

The elemental composition of fly ash by various advanced technique (EDS) has also being studies and the result are shown in table 21 and 22. All the elements were analysed for both the fly ash samples and peaks were obtained for them according to their weight and atomic concentrations. Oxygen, aluminium, silica and carbon were the most abundant elements observed in all the fly ash samples. Oxygen percentage was found to be high (58.75 and 55.73 weight % of Anpara and Renusagar sample respectively).

The presence of Ca was found to be very less (0.12 and0.20%) in all the fly ash samples hence it is expected that the material is very less cohesive in nature. Other major elements were not significant. The morphology and elemental data indicated that the fly ash samples were composed of over 50% amorphous alumino-silicate spheres and a lesser amount of iron-rich spheres. Hence these are very light materials and can become easily air borne. Due to presence of very less amount of Ca will not enhance stability in the slopes.

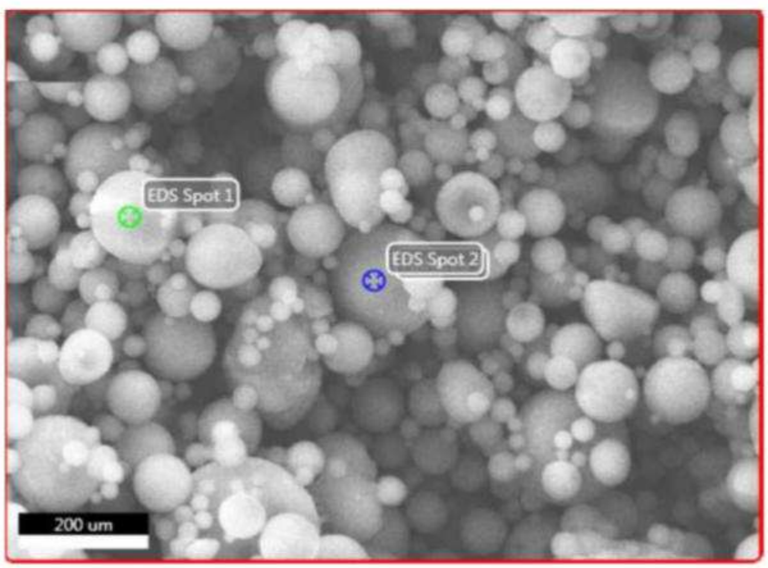


Figure 9 : **EDS analysis of UPRVUNL, Anpara TPS ash**

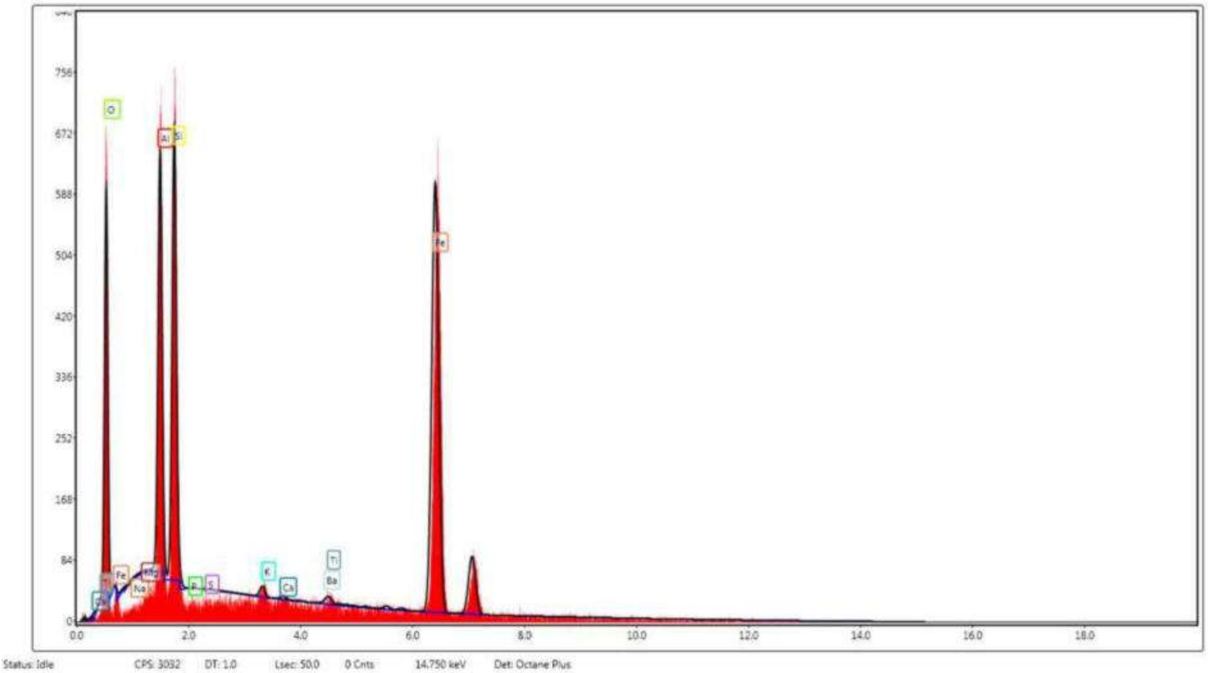


Figure 10 : EDS Spectrum of the UPRVUNL, Anpara TPS fly ash

Table 21 : Elemental analysis of UPRVUNL, Anpara TPS fly ash

Element	Weight %	Atomic %
O K	58.75	71.81
Na K	0.34	0.29
Mg K	0.26	0.21
Al K	18.19	13.18
Si K	18.44	12.84
P K	0.61	0.38
S K	0.06	0.03
K K	0.90	0.45
Ca K	0.12	0.06
Ba L	0.38	0.05
Ti K	0.06	0.02
Fe K	1.89	0.66
Total	**100.00**	**100.00**

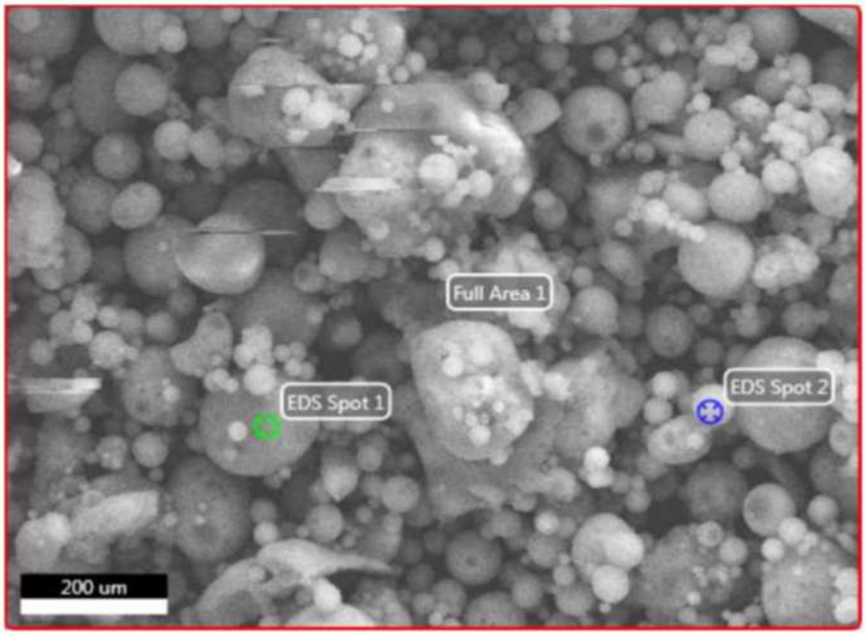


Figure 11 : EDS analysis of Hindalco, Renusagar TPS fly ash

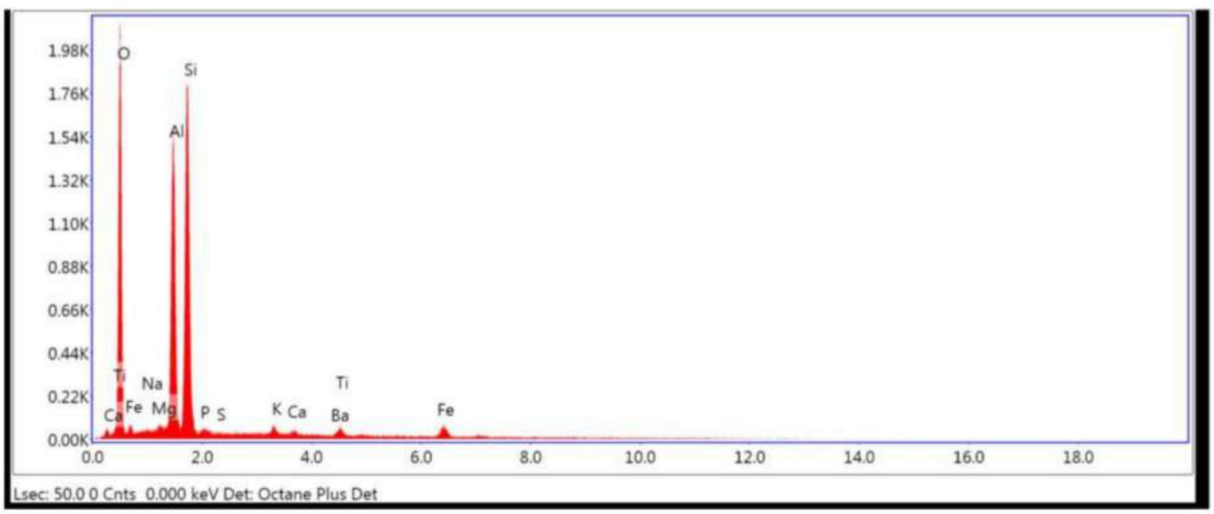


Figure 12 : EDS spectrum of Hindalco, Renusagar TPS ash

Table 22 : Elemental analysis of Hindalco, Renusagar TPS ash

Element	Weight %	Atomic %
O K	55.73	68.51
Na K	0.06	0.05
Mg K	0.31	0.25
Al K	16.89	12.39
Si K	24.70	17.46
P K	0.24	0.15
S K	0.07	0.04
K K	0.66	0.33
Ca K	0.20	0.10
Ba L	0.21	0.03
Ti K	0.13	0.06
Fe K	0.80	0.28
Total	**100.00**	**100.00**

It is observed from the table 21 and 22 that alkali and alkaline earth metals concentration also present in the samples. Highest alkali and alkaline earth metals present in Hindalco Renusagar sample i.e. 1.96% as compare to UPRVUNL Anpara (1.05%). Due to presence of alkali and alkaline metal in fly ash sample it may utilize for the neutralization of acidic mine water. Alkalis (i.e., alkalis (K2O and Na2O), as sodium oxide equivalent) limits are stated to minimize the effect of alkalis reacting with aggregates, containing a reactive form of silica (alkali-silica reaction, or ASR), in the presence of moisture. The reaction under those conditions produces a gel that can absorb water and swell, generating a pressure that causes expansion and cracking. The high potassium content of the biomass, the fly ash quality did not have an adverse impact regarding unwanted alkali levels.

As determined by EDX, the predominant elements in the fly ash samples were calcium, silicon, aluminium, iron, magnesium and sulphur in various compounds. Calcium was observed to primarily be associated with oxygen, sulphur, and silica, or possibly with carbon (calcite).

4.2 Physical Properties of Fly ash

4.2.1 Moisture content

Water content or moisture content is the quantity of water contained in a material. moisture content is used in a wide range of scientific and technical areas, and is expressed as a ratio, which can range from 0 to the value of the materials' porosity at saturation. Fixed amount of finely powdered (212 micron) air-dried fly ash sample is weighed in a tray and then placed inside an electric hot air oven, which was maintained at $105^0 \pm 5$C. The tray with the fly ash sample is allowed to remain in the oven for 24 hours and is then taken out, cooled at room temperature for about 15 minutes and then weighed. The loss in weight is reported as moisture (on % basis). Table 23 shows the moisture content of fly ash. Then calculation is done as per the following formula.

Moisture percentage = Y−Z/Y−X*100

Where X= weight of empty crucible, gram

Y= weight of crucible + fly ash sample before heating, gram

Z= weight of crucible + fly ash sample after heating, gram

Y−X= weight of fly ash sample, gram

Y−Z= weight of moisture

Table 23 : Moisture content of fly ash

Sample name	Weight of empty petry plate (g)	Weight of fly ash (g)	Weight of petry plate and fly ash before heating (gm)	Weight of petry plate and fly ash after heating (gm)	Moisture content (%)
UPRVUNL, Anpara TPS	42.338	10.010	52.346	52.312	0.34
Hindalco, Renusagar TPS	29.444	10.015	39.456	39.425	0.31

4.2.2 Water Holding Capacity

It can be defined soil water holding capacity is the amount of water that a given soil can hold for crop use. Field capacity is the point where the soil water holding capacity has reached its maximum for the entire field. Water holding capacity is important to soil health. Soils that can retain a balanced amount of water are able to nourish crops and keep soil organic matter alive. Healthy soil structure forms into aggregates, lessening the density in the soil to create more pores, where water can filter in and out.

A cylindrical cup having pores of **diameter 1–2 mm** was fitted with filter paper (No. 41). The cup was then filled with **125gm** of fly ash and then poured in water in such a way that the cup remains submerged up to half its height for 24 hrs. After a time of interval **24 hrs** the cup was removed from water and hung for **1hr** so that excess water, adhering to the inner wall of the cup, is drained off in a trough containing water its height. Figure 13 shows the method to determine the settling properties of fly ash. The water holding capacity was determined using the following equation (%):

$$\textbf{Water holding capacity } = \frac{X-Y}{X} * 100$$

Sr. No.	Samples	Initial Weight of fly ash (X)	Final Weight of Fly ash (Y)	Water holding capacity in %age (X-Y/X)100
1.	UPRVUNL, Anpara TPS	125 gram	155.011	24.00
2.	Hindalco, Renusagar TPS	125 gram	156.709	25.36

The retention capacity of fly ash study at laboratory stage, conclude that there is ample water retention capacity in the fly ash. Hence when water availability will increase from 24% or more a swamp like condition will be created where in fly ash would be dumped. Figure 14 and 15 shows fly ash settling characteristic of Hindalco Renusagar and UPRVUNL Anpara. Hence for proper utilization of fly ash as a filling material along with overburden dump, proper blending with OB is required. Hence a separate detailed study is required for mixing of fly ash with OB in case of higher dumped height. The sequential dumping (alternate layer of OB & FA) technique will do in the pit surrounded by wall with no free space.

4.2.3 Settling Properties

Settling rates establish the ease with which solid-liquid separation takes place in slurries during filling activity, and the tests also provide a means of determining the recycled water quality. Take a measuring jar graduated in ml. clean it thoroughly with pure water. Take water into the flask up to certain level (x ml) and then add fly ash (100-x ml) slowly into the jar. Mix the water and fly ash thoroughly with a stirrer for some time. Note down upper and lower meniscus of the mixture. Then note down time for each ml settling of fly ash in water. Repeat the other sample and tabulate the results.

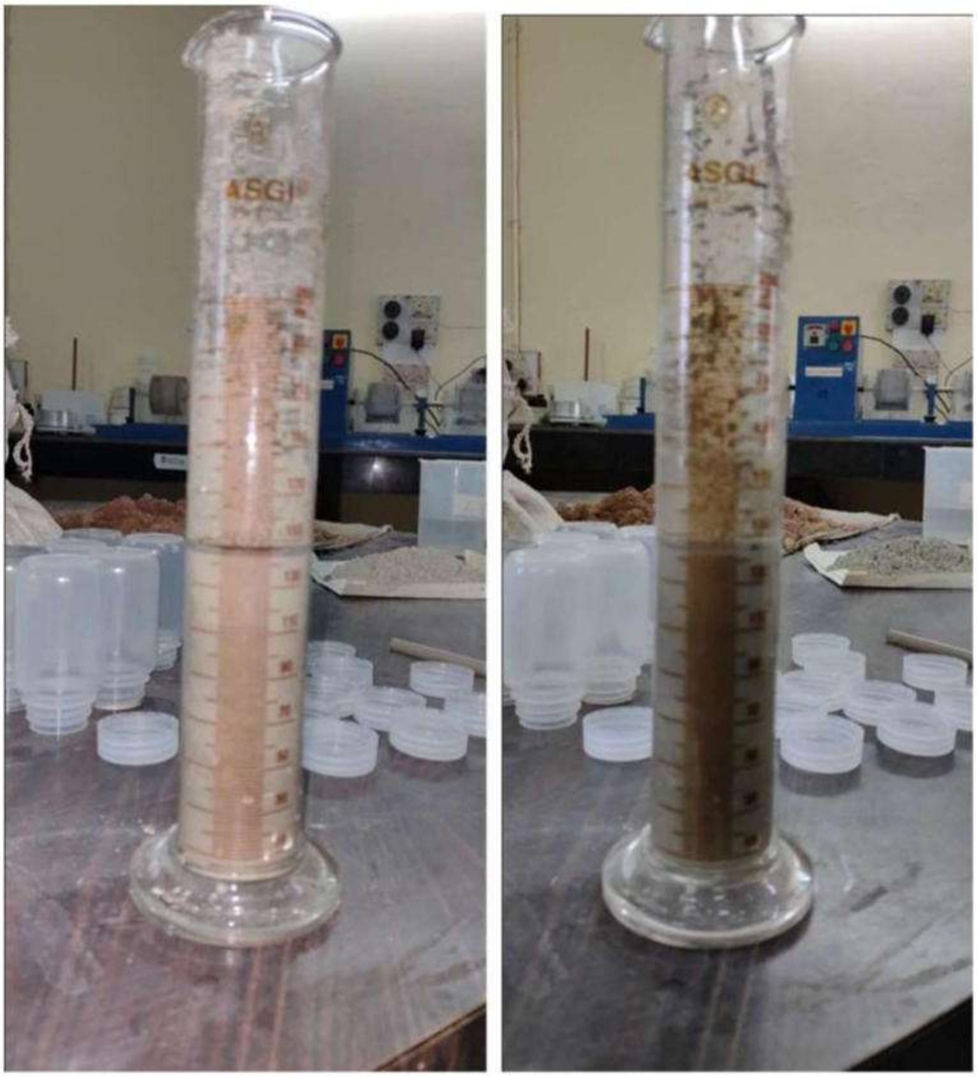
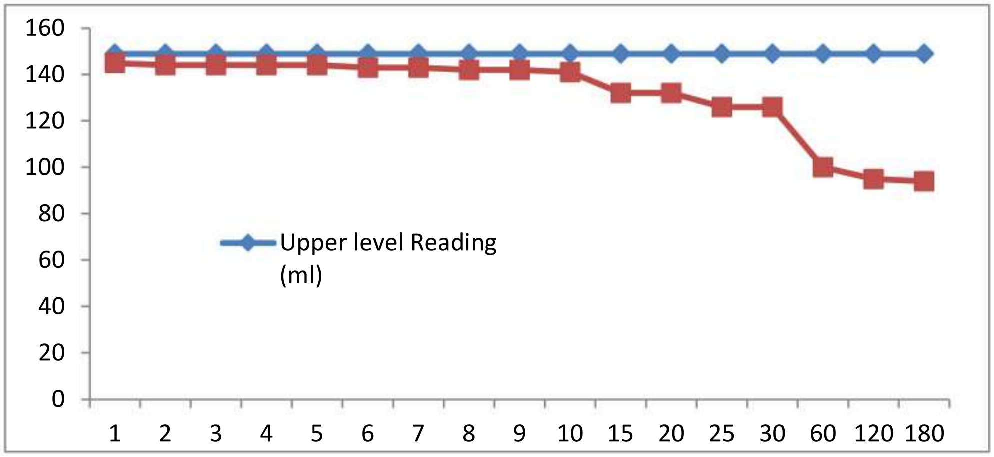


Figure 13 : Settling properties of fly ash



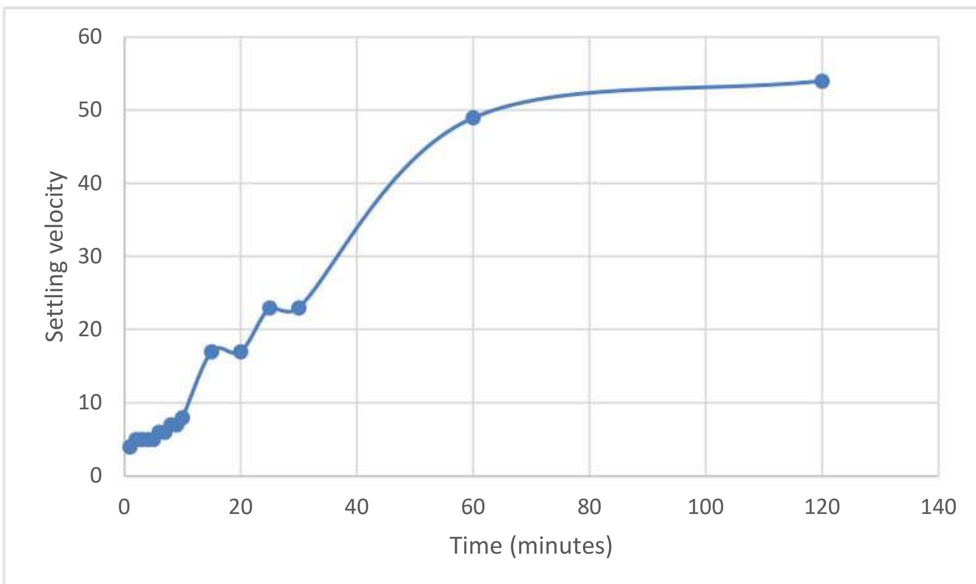
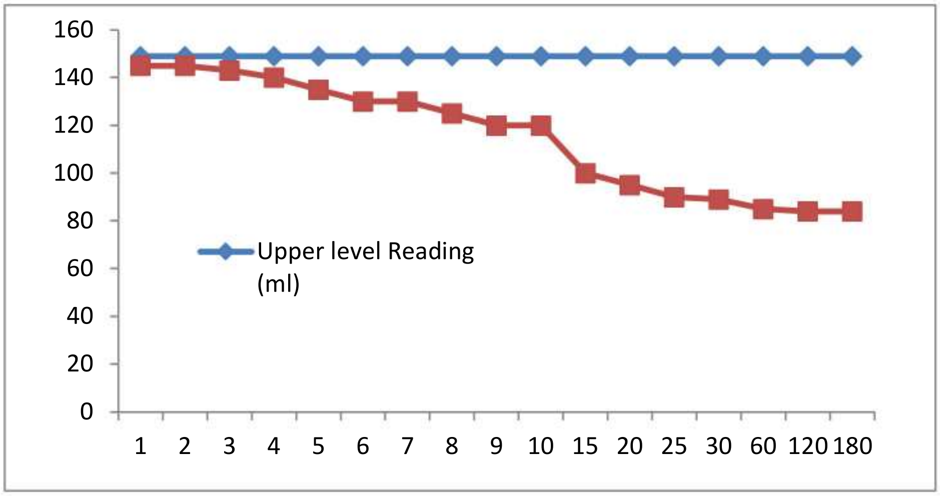


Figure 14 : Fly ash settling characteristic of UPRVUNL, Anpara TPS



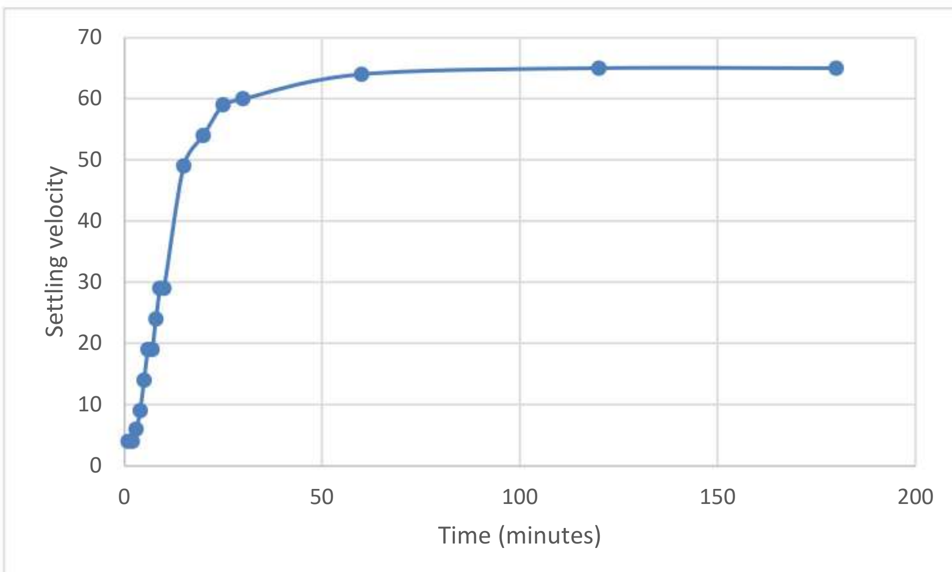


Figure 15 : Fly ash settling characteristic of Hindalco, Renusagar TPS

The fly ash is mostly ranging in fine size. The settling rate study has been conducted in laboratory in order to assess the impact of leachate to the discharge from overburden fly ash mixed filling. It concludes that the fly ash settling is relatively fast and within one hour maximum settling took place. Further, it also reached that maximum fly ash will be accumulated very near to dump area and it will not travel for longer distance. Hence, maximum fly ash impact will be there in nearby land and soil**.**

4.3 Leaching Characteristics of Fly Ash

The ash from thermal power plants if used for the disposal in opencast mines then there is every possible chance of the leachate coming in contact with the ground water. This may occur in two ways either by the recharge of the area by the percolation of the leachate under gravity or lateral movement of the water through the filled mine. Hence there is always risk of contamination of ground water and which may affect human health. The purpose of this study is to assess the potential contamination of trace/heavy metals by leaching experiments (open column percolation test).

Open column percolation test was used for long- term leaching characteristic study. A set up for the test consist of a column of PVC pipe approximately 1.0m height, 10cm diameter, and open at the top end and closed at bottom end. A small hole is made at the centre of the bottom for collection of leachate. The fly ash samples with their optimum moisture contents were placed in the columns. The samples were packed in each tube/column in layers Here mili-Q water was used as the leaching medium. Leachate was collected in conical flasks. The column percolation experiment is the only experiment that predicts the leaching behaviour that could be observed in the field. In the test there are however, chances that material develops preferential pathways for the water in the column experiments due to the formation of cracks, this possibility exist in the field also. Using groundwater/rain as the leaching medium one can even arrive at site-specific results.

Open column percolation test (result)

In fly ash the elemental composition generally increased 2-3 times depending upon the mineral matter content in coal. The details elemental analysis (table 21) of the fly ash indicates that there are 16 Element present in fly ash. The highest concentration of toxic trace metal (Mg and Mn,) are ranging from 41.69, 41.35 and 46.48, 53.90mg/L in Anpara and Renusagar fly ash sample respectively. All other metal concentration is shown in table 24.

After interaction of fly ash with water, there will be migration of metal from dumped depending upon the pH level of water (mine water and rain water).

In acidic range of pH the solubility of metal is more hence the migration of toxic metal in the soil and nearby land will also be enriched. Therefore, the mine suffering with acidic water will allow to used fly ash filling in active mine.

heavy metals and radioactive components that can be released into the soil. The environmental impact of fly ash, either used in an application or sent to a landfill depends to a large extent on the mobility of the polluting components in the ash. Concentration for Cu, Pb, and Cd were below the detection limit in both the fly ash samples whereas the concentration of Ni and As more in leaching sample.

Table 24 : Open column leaching analysis of Fly ash samples by ICP OES

S. No.	**Elements**	UPRVUNL, Anpara TPS	Hindalco, Renusagar TPS
1	B	2007.98	4392.52
2	Mg	41698.00	41356.31
3	Al	46.21	1218.21
4	Ti	0.26	1.84
5	Cr	0.76	0.72
6	Mn	4648.01	5390.69
7	Fe	<0.000	21.55
8	Co	107.79	155.64
9	Ni	75.49	447.04
10	Cu	7.88	7.70
11	Zn	521.97	173.05
12	As	9.40	14.32
13	Mo	386.49	527.24
14	Cd	5.35	8.51
15	Ba	102.62	49.26
16	Pb	0.66	0.67

4.4 Dispersion of Fly ash

The transportation and dumping of fly ash will be further increased the particulate matter concentration in the mining area. The suspended particulate matter more than 10micron will reduce the visibility in the core zone. Hence the accidental cases will be increased by light and heavy vehicle and earth moving machinery.

Not only this, occurrence of incident health issue will also be further increase and need advanced dust separation devices and equipment to bring the dust concentration below permissible limit.

4.5 Toxicity of fly ash

When fly ash is filled directly into voids of active mine, heavy metals are able to enter in environment and human body through leaching and inhalation or dermal contact. As can be seen from Table 25, the maximum heavy metal content in leached was within the permissible limits such as Mg, Cr, Co, Cu, Zn, As etc. Among the above metal in leached sample, only five metals (B, Al, Mn, Ni and Mo) concentration was beyond the permissible limit.

As we know that fly ash contains trace amounts of toxic metals that may have negative effects on human health and on plants. Globally, fly ash is considered to be a toxic waste creating hazards to the environment. Due to the presence of metals, plants growing nearby ash disposal sides can be found to have disparity in plant enzymatic activities. The microbial activity in soil may be decreased due to the deposition of fly ash to soil. Adverse effects can be observed on bird population nest in around dumping side and accumulation of Sr, Cd, As, and Se in their offspring. People can be affected to suffer from cancer and other disorders those living to nearby dumped side.

Plants growing in fly ash amended soil are reported to be rich in elements such as Ba, Mo, and B, As, V, Sr, and Se etc. These elements are required for plant growth and animal nutrition in trace amounts. It is reported that higher levels of these elements can be toxic. Highly phytotoxic elements are dangerous for plant growth and often kill plants. Elements such as Mo and Se are not that toxic to plants but are concentrated in plant tissues that cause toxicities in grazing animals. Fly ash addition at higher rates to soil may accumulate Mo and thus causes molybdenosis in cattle.

It was reported that when plants were grown in fly ash amended soil elevated concentrations of As, Se, Mo, B, Sr, and S are commonly reported in plant tissue. When fly ash was added to soil, concentrations of different metals such as Mn, Zn, Fe, Cr, Cd, and Ca have were found to decrease. The decrease in concentration was observed in plant tissues, due to the alkaline nature of fly ash. The high pH brings about precipitation and strong absorption of elements onto soil and surface of fly ash thus decreasing their availability to the plant

It was also reported that the dumping of fly ash, increases the microbial population, however, the higher doses of fly ash resulted in the deposition of toxic elements such as Arsenic and Boron in soil which had adverse effects on soil microorganisms and enzyme activity.

The chromium accumulates in plants can affects the growth of plants and Lead (Pb) in fly ash is of more serious concern because it is toxic to animals and human beings especially young children.

Arsenic concentration in fly ash generally ranges from 4 to 440mg/kg however, depending on the quality of coal the concentration may reach up to 1000 mg/kg.

When the plants are grown in soil amended with fly ash undesirable and stunted growth occurs due to B toxicity in plants. Boron has a tendency to accumulate in soils. Boron concentration in fly ash varies depending upon the origin and nature of the coal.

Boron contents of > 0.30 mg/g were considered as highly toxic while boron contents of < 0.10 mg/g, and 0.20 mg/g and 0.30 mg/g were considered as slightly toxic, moderately toxic and toxic to plants respectively. As leaching of fly ash occurs there is gradual decrease in concentration of boron.

Although, fly ash is toxic on one hand but on the other hand it contains nutrients and trace elements required for the vegetation to grow. Therefore, study of toxicity of fly ash and its possibilities to explore its utility from environmental perspective are important.

Table 25: Heavy metal concentration (mg/g) in leached sample of different thermal power plant fly ash

S. No.	Elements	Anpara	Renusagar	Permissible limit
1	B	**2.01**	**4.39**	**0.1-0.3**
2	Mg	41.70	41.36	100
3	Al	0.05	1.22	0.03
4	Ti	0.00	0.00	0.1
5	Cr	0.00	0.00	0.05
6	Mn	4.65	5.39	0.3
7	Fe	0.00	0.02	1.00
8	Co	0.11	0.16	1.3
9	Ni	0.08	0.45	0.1
10	Cu	0.01	0.01	0.05
11	Zn	0.52	0.17	5
12	As	0.01	0.01	0.01
13	Mo	0.39	0.53	10PPB
14	Cd	0.01	0.01	0.003
15	Ba	0.10	0.05	2
16	Pb	0.00	0.00	0.01

5.0 Slope Stability Analysis

5.1 General

Computer-based modeling offers the ability to evaluate the slope stability over the short and long term. Computer programs provide an efficient and detailed rapid analysis of a wide variety of slope geometry and loading conditions. Modeling has advantages that design ideas can be tested, different material properties can be evaluated and risk analysis carried out. Analysis has been conducted using and finite element method (FEM). These methods have also been used to assess the failure mechanisms and determine the factor of safety. The numerical method is widely used for slope stability analysis now-a-days. The term numerical analysis and numerical modeling are used here to describe analysis method or numerical solution for a problem. The numerical methods take into account the physical constraints under which the OB dumps are generated and effect of both of dynamic acceleration & static force. The techniques are widely used to perform stability analysis where the condition are complex and possible consequences of failure are significant.

The factor of safety of dump slope have been determined by strength reduction technique. The shear strength reduction technique has two advantages over the conventional approach. The critical failure surface is found automatically and it is not necessary to specify the shape of the failure surface. In general, the failure mode of slopes is more complex than simple circles or segmented surfaces. Further, numerical methods automatically satisfy translational and rotational equilibrium. To perform slope stability analysis with the shear strength reduction technique, simulations are run for a series of increasing trial factor of safety, F^{trial} (Griffiths and Lane, 1999). The actual shear strength properties cohesion (c) and internal friction angle (Φ) are reduced for each trial according to the equations 1 and 2. If the multiple materials are present, the reduction is made simultaneously for all materials. The trial factor of safety is gradually increased until the slope fails. At failure, the safety factor equals the trial safety factor. The factor of safety is defined according to the equation

$$C^{trial} = \frac{1}{F^{trial}} C \qquad \ldots\ldots(1)$$

$$\phi^{trial} = \arctan\left(\frac{1}{F^{trial}} \tan\phi \right) \qquad \ldots\ldots(2)$$

The factor of safety generally used is in the range of 1.2–1.5 for open pit mines (table 22). This factor of safety could either be directly calculated based on limit equilibrium method or indirectly by numerical modeling based on strength reduction technique. The factor of safety must be greater than 1 for stable slope. Due to uncertainties involved in determining the properties of material, leaving some of the parameters in simulation for simplification and presence of some external factors that are not considered for simulation, it is advisable to have factor of safety of slope as 1.5.

Table 26 : Values of minimum safety factors (Duncan and Christopher 2004)

Failure type	**Category**	**factor of Safety**
Shearing	Earthworks	1.3–1.5
	Earth retaining structures, excavations	1.5–2.0
	Foundations	2–3

5.2 Overburden Dump simulation

Field investigation has been done to assess the current status of dragline dump, shovel dumper dump and external dump. The overburden contains various materials such as clay, sand, fine grained sandstone, medium grained sandstone, coarse grained sandstone carbonaceous shale, sandy shale, shale, etc. Figure 16 shows the mine plan of the Khadia OCP. The overburden is removed by dragline and coal is removed by shovel dumper combination. The internal dump is initially formed by dragline operation. Subsequently, dump material with a help of shovel dumper combination is dumped over this internal dump formed by dragline. The stability analysis has been carried out for various height for Internal Dragline dump along with Shovel dumper internal dump. Finite element method has been used for analysis of different geo mining condition. The value 1.5 is taken minimum factor of safety for optimum design of slope for long term stability.

Mine Plan of dump slope as provided by Company has been shown in figure 16. Four different scenarios have been created (with varying height) and simulated. The simulation has been done for height 60m, 90m, 150m and 180m as shown in figure 17. This height has been taken above from dragline dump. The simulation has been done in two stage one is only from dragline dump and other is for shovel dumper dump. The factor of safety is varying for dragline dump is 1.29 to 1.34. The dragline dump is short term stable therefore, during the simulation of shovel dumper dump the dragline dump slope is excluded. Figure 18 shows the shear strain in opencast mine slope with factor of safety. The factor of safety is varying from 1.61 to 1.76 for shovel dumper dump. Table 27 shows the summarized factor of safety for both cases. It has been observed that the factor of safety decreasing with the increase in height of dump. The overall slope angle is decreasing as the height of overburden is increasing, therefore decreasing trend in factor of safety is not significantly. It indicates that shovel dumper slope sections are stable for long term. The factor of safety is more than 1.5 for shovel dumper dump, therefore the dump is stable for long term.

Table 27: factor of safety of overburden dump

Sr. No	Height of dump (m)	Factor of safety for Internal dragline dump	Overall slope angle of shovel dumper dump (degree)	Only overburden
1	60	1.30	26.4	1.76
2	90	1.29	25.7	1.70
3	120	1.32	25.2	1.67
4	180	1.31	24.5	1.61

Figure 16 : Mine Plan shown in working plan of Khadia OCP

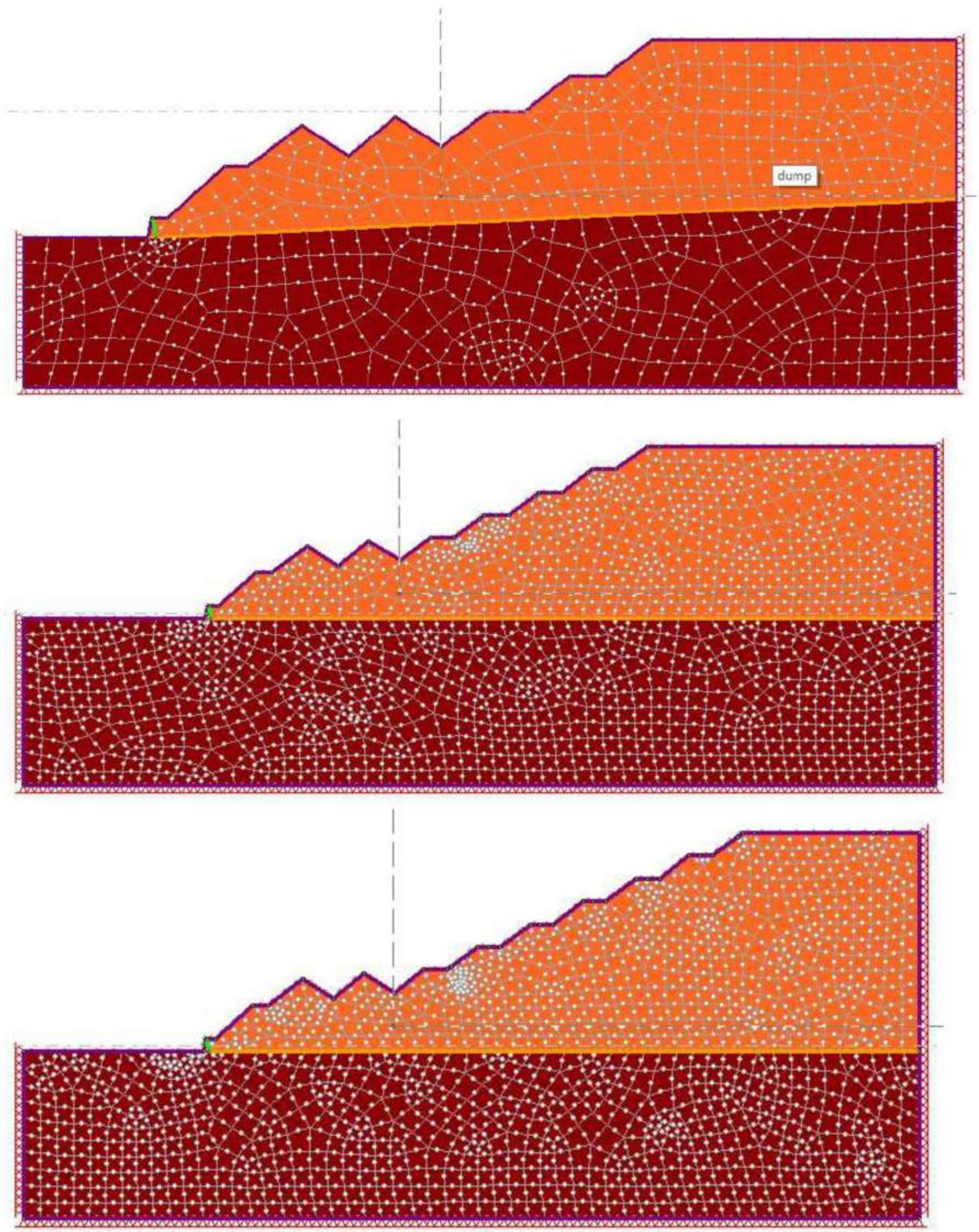


Figure 17 : Discretized view of opencast mine benches at different height

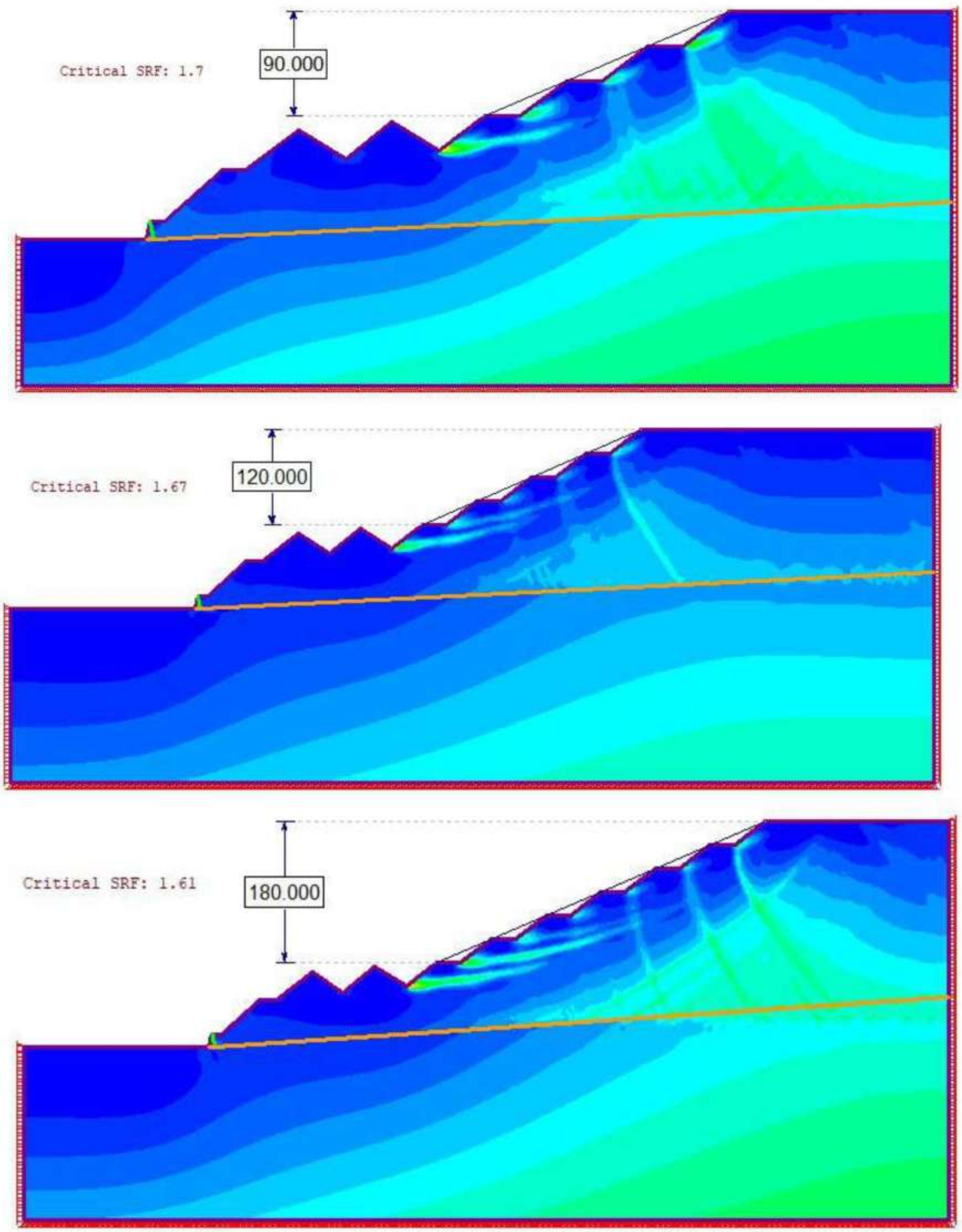


Figure 18 : Shear strain in opencast mine slope with factor of safety

5.3 Fly ash simulation with mixing with OB (% Variation)

The fly ash samples collected from Hindalco Renusagar and UPRVUNL Anpara power plants have been mixed as a single fly ash mixture in equal proportions by weight for preparing the sample for mixing with overburden of Khadia OCP. Table 15 shows the effect of percentage fly ash on shear strength of dump material. It is observed from table 15 that the best suitable option is 20 % of fly ash.

The dump configurations are likely to be stable against large-scale failure only in drained condition. The maximum height of a single bench should be 30m. The minimum exposed bench width after each lift should be 30m.

The fly ash has been mixed with overburden in various options. The following procedure has been used of dumping of fly ash:

1. The Fly Ash may be dumped in alternative layer/stages of height not exceeding 5m in each layer/stage
2. Initially a row of Overburden dump (bund) not less than 15m width shall be dumped of height upto 5m all around the area proposed for ash dump.
3. A number of such areas shall be formed in a layer/stage wherein the fly ash shall be dumped so that one dump of fly ash is separated by otherer with 15m wide overburden dump.
4. Thereafter, Fly Ash will be dumped within the area surrounded by such overburden dumps. In this matter the dumping shall be laid in the section/layer containing both overburden as well as fly ash
5. Immediately above the bottom section/stage., only overburden dumping shall be made to ensure that the Fly Ash is totally covered and protected from the Overburden dump all around.
6. In the same matter the alternative layer /section of the overburden and overburden with fly ash shall be dumped.
7. The percentage of Fly Ash content in the overburden mix shall be determined by scientific study.

The bund around the mixed fly ash and overburden can be design in three ways: Centre line, Upstream and downstream. Figure 19 shows the simulation of Fly ash with different laying options (a) fly ash mixed model (b) downstream (c) downstream and (d) center line. The numerical simulation has been done for all three options. 20% Fly ash have been simulated and factor of safety is calculated. The factor of safety for only dump material and mixed material is tabulated in table 28. Figure 20 shows shear strain in opencast mine slope with factor of safety.

Table 28 shows the factor of safety of dump and mixed fly ash of overburden layering options. The factor of safety of over burden dump material is 1.72 for 90m dump height and 1.61 for 180m dump height. Whereas, the factor of safety of fly ash mixed dump is 1.79 for 60m and 1.68 for 120m dump.

It is observed that the increase in factor of safety for fly ash mixed dump is 0.02 for 90m and 0.01for 180m dump height. The increment in the factor safety is not very high due to some reduction in friction angle of mixed material. Moreover, as the height is increased the effect of fly ash will be negligible in stability.

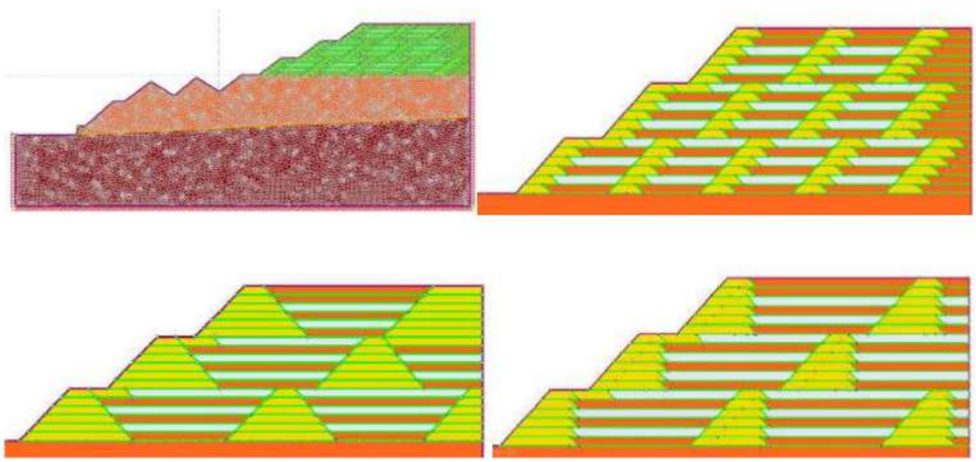


Figure 19 : Simulation of Fly ash with different laying options (a) fly ash mixed model (b) downstream (c) upstream and (d) center line

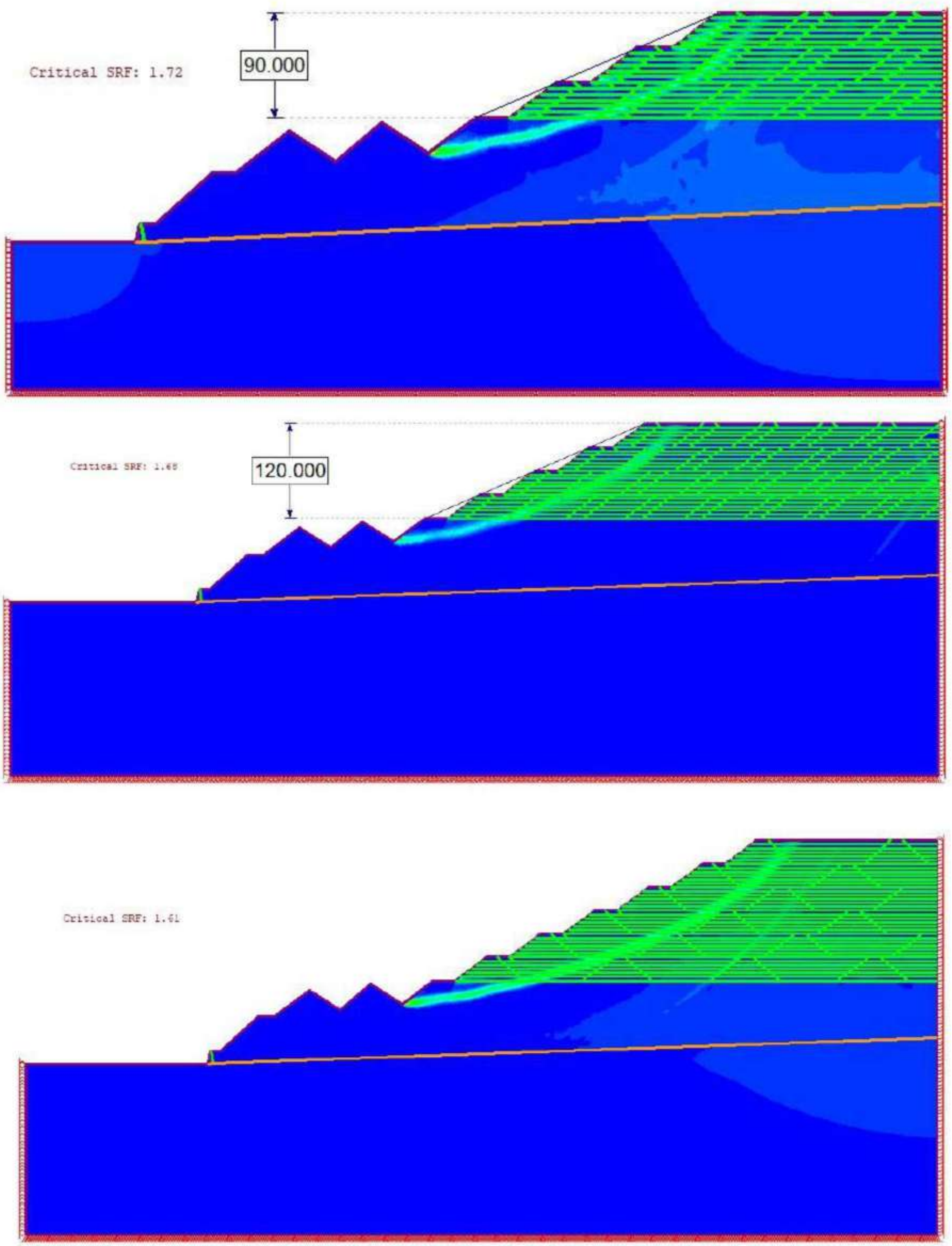


Figure 20 : Shear strain in opencast mine slope with factor of safety

Table 28 : Factor of safety of dump and mixed (Dump and Fly ash)

Sr. No	Height of dump (m)	Only overburden	Overburden with fly ash (20%) + overburden (80) in alternative layers			Average Factor of safety
			Centre line	Downstream	Upstream	
1	60	1.76	1.78	1.79	1.79	1.79
2	90	1.70	1.72	1.71	1.72	1.72
3	120	1.67	1.69	1.68	1.68	1.68
4	180	1.61	1.61	1.61	1.62	1.61

Table 29: Factor of safety at 180m dump height with percentage variation of fly ash with OB

Sr. No	OB %	Fly ash %	Factor of safety
1	100	0	1.61
2	95	5	1.62
3	90	10	1.61
4	80	20	1.63
5	70	30	1.62

5.4 Effect of water on dump stability

A dump of 180m height has been taken to simulate the effect of water on overburden mixed dump. The term ‘mixed OB’ dump has used for a dump of fly ash material and overburden material in varied proportions. The saturation level of dump, fly ash or mixed material has been varied. The fly ash percentage in the mixed dump have been varied to study the impact of water on mixed dump stability. The shear strength of different level of saturation has been taken from literature and laboratory testing.

Table 31 shows the effect of saturation of water on dump stability. It indicates the factor of safety of mixed dump increases at 10 % and at 25% saturation of water. However, the factor of safety reduces drastically. It reduces upto 1.04 which is critical in term of stability

Table 32 shows the effect of saturation of water on dump stability (with 5% fly ash + 95 % OB). It indicates the dump stability increase at 10 % of saturation and at 25% saturation of water. The factor of safety reduces drastically upto 1.04 at higher level of saturation of water which is critical in terms of stability.

Table 33 shows the effect of saturation of water on mixed ump stability (with 10% fly ash + 90 % OB). It indicates the dump stability increase at 10 % of saturation and at 25% saturation of water. The factor of safety reduces drastically upto 1.02 at higher level of saturation of water which is very critical in terms of stability.

Table 34 shows the effect of saturation of water on dump stability (with 20% fly ash + 80 % OB). It indicates the dump stability increase at 10 % of saturation and at 25% saturation of water it is stability. However, at a higher level of saturation of water, the factor of safety reduces drastically and it is below 1.00 which indicates failure of dump slope.

Table 30: Effect of water saturation on dump stability

Sr. No	% of saturation	Cohesion MPa	Friction angle Degree	Factor of safety
1	0	0.055	31	1.61
2	10	0.076	30	1.56
3	25	0.097	28	1.56
4	50	0.070	26	1.37
5	100	0.043	21	1.04

Table 31: Effect of water saturation on mixed material of dump slope (5% Fly ash + 95 OB)

Sr. No	% of saturation	Overburden		Mixed (5% Fly ash + 95 OB)		Factor of safety
		Cohesion MPa	Friction angle Degree	Cohesion MPa	Friction angle Degree	
1	10	0.076	30	0.102	29	1.64
2	25	0.097	28	0.113	28	1.60
3	50	0.070	26	0.036	26	1.36
4	100	0.043	21	0.018	21	1.04

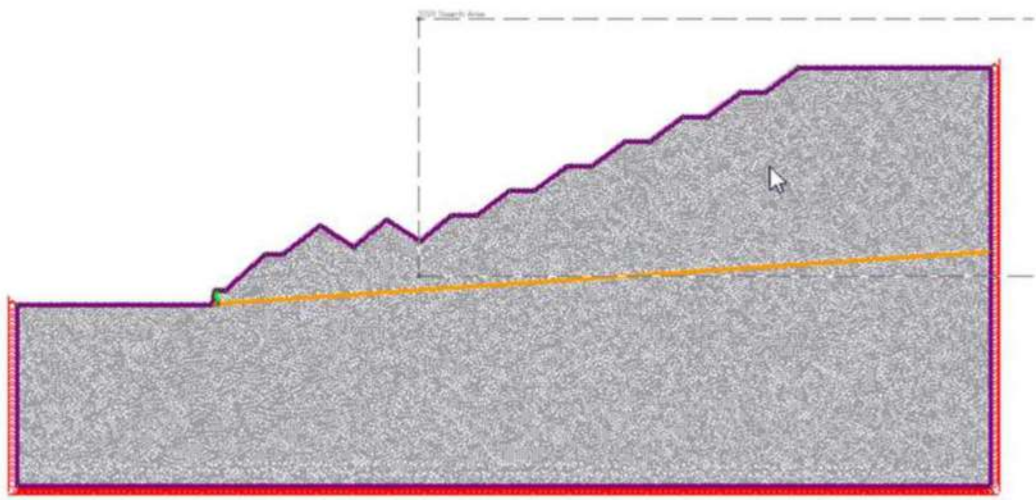
Table 32: Effect of water saturation on mixed material of dump slope (10% Fly ash + 90 OB)

Sr. No	% of saturation	Overburden		Mixed (10% Fly ash + 90 OB)		Factor of safety
		Cohesion MPa	Friction angle Degree	Cohesion MPa	Friction angle Degree	
1	10	0.076	30	0.131	28	1.64
2	25	0.097	28	0.146	29	1.63
3	50	0.070	26	0.046	25	1.36
4	100	0.043	21	0.023	19	1.02

Table 33: Effect of water saturation on mixed material of dump slope (20% Fly ash + 80 OB)

Sr. No	% of saturation	Overburden		Mixed (10% Fly ash + 90 OB)		Factor of safety
		Cohesion MPa	Friction angle Degree	Cohesion MPa	Friction angle Degree	
1	10	0.076	30	0.143	28	1.65
2	25	0.097	28	0.162	26	1.54
3	50	0.070	26	0.047	22	1.31
4	100	0.043	21	0.017	16	0.93

(A)



(B)

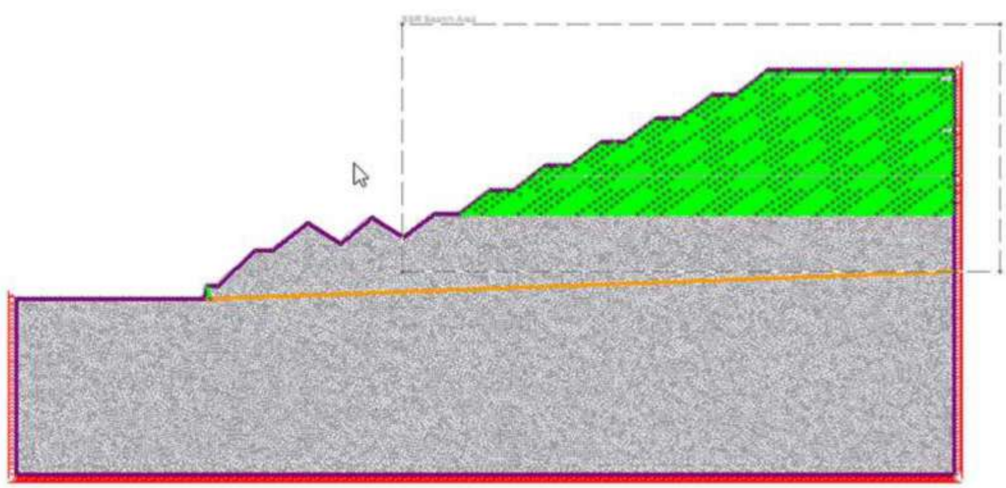
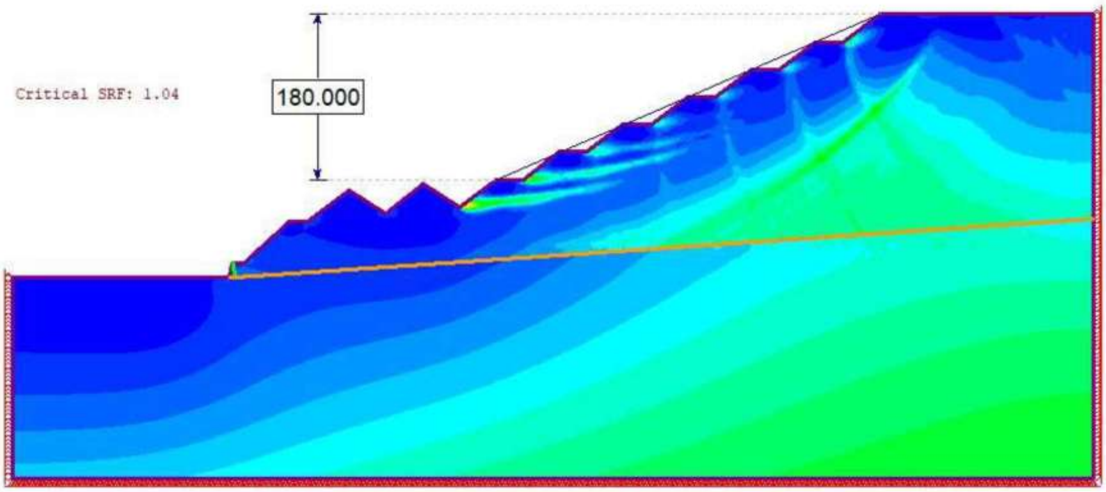


Figure 21 : Discretized model for simulation of water (A) Simulation of only dump (B) Simulation of Fly ash with OB

(A)



(B)

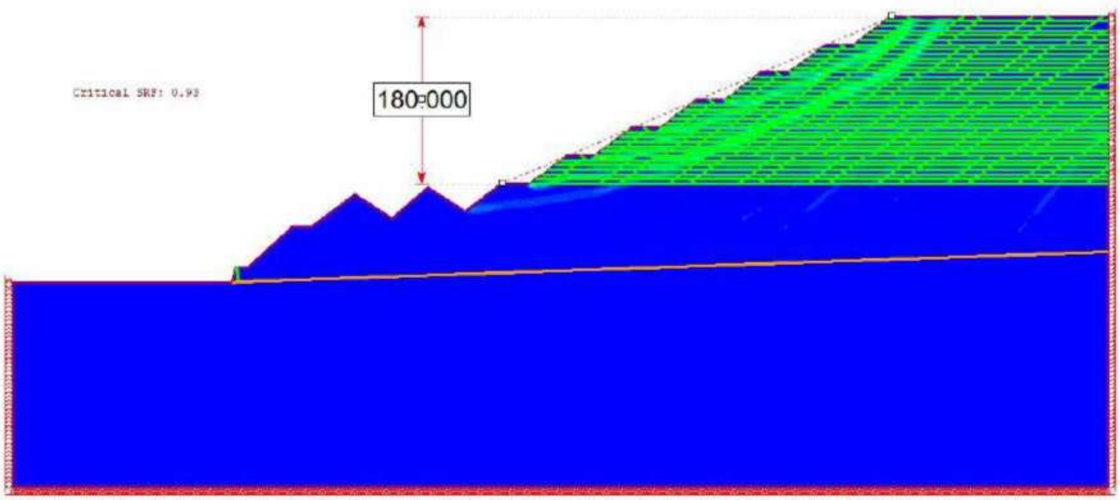


Figure 22 : Shear strain and factor of safety of only dump (A) and Fly ash with OB (B)

6.0 Mode of Transportation of Fly ash

Road Capacity Analysis for Fly Ash Transportation

An intersection is a traffic bottleneck which can be responsible for (1) hazardous materials to stay on the road (in trucks) for a longer time thereby increasing the chance for exposure, or (2) possible traffic conflicts between trucks when the crossing vehicles are significant in number. In order to assess the traffic movements from and to the mines, six major intersections were considered to assess the amount of traffic during the peak hours. Traffic at these intersections has been observed to be higher than at other intersections. Five (1,2,4,5,6) of these are directly on NH-39 with access to mines or power plants. These intersections are three-legged intersections.

Data was collected for 30 minutes peak hour on each of the six approaches (incoming and outgoing) at each intersection to estimate the peak flow rate. Flow rate or traffic volume is the number of vehicles that pass a given point on the road during a designated duration (generally 1 hour) of time. Road capacity is a measure of traffic volume during peak hours. Traffic volume near the capacity implies vehicles would be moving slowly making the fly ash truck to spend more time on the road. This is not desirable. Therefore, the chosen routes for the dump truck to transport fly ash to the mines, should have as less traffic below the capacity as possible.

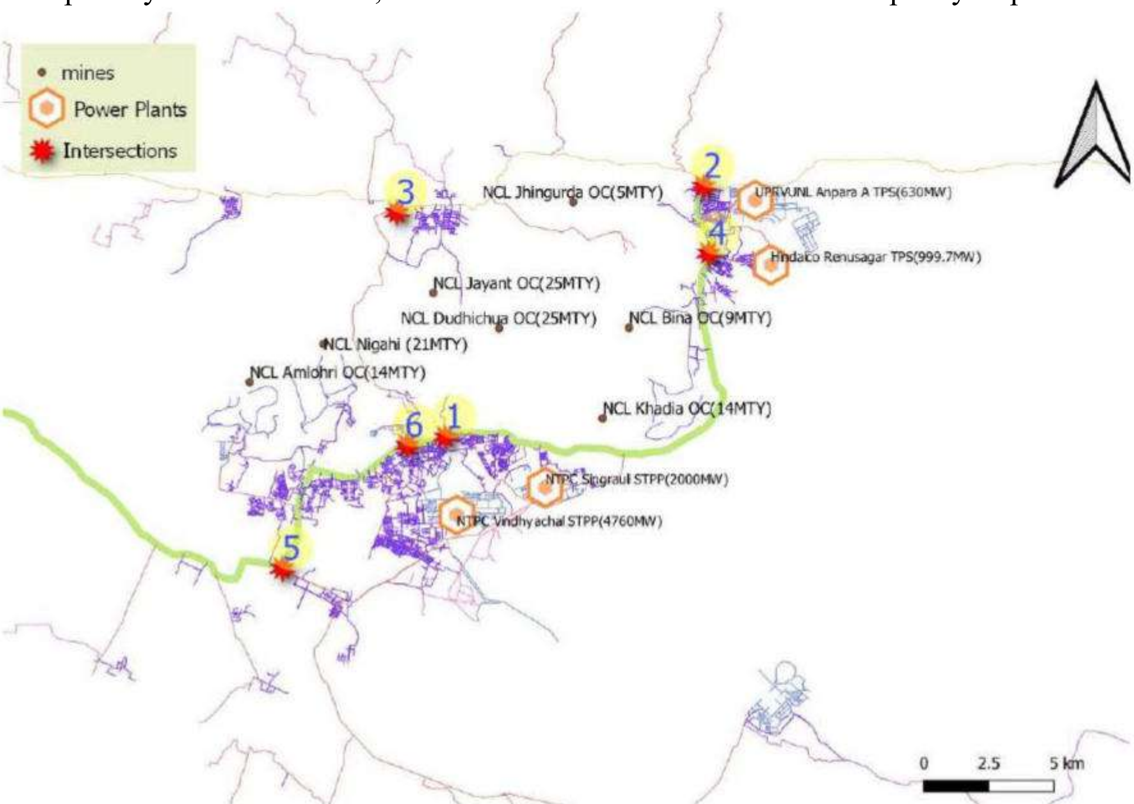
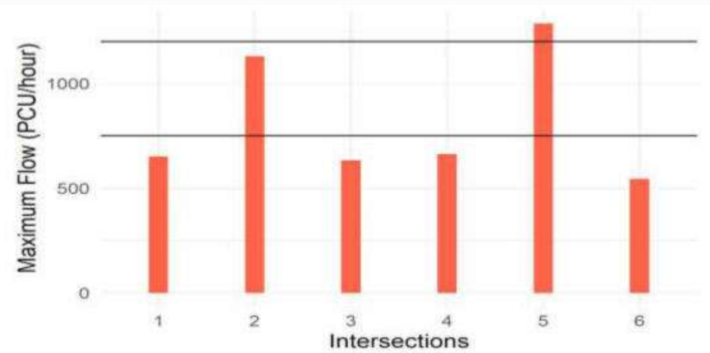


Figure 23: Layout of mine and road for transportation for fly ash

The major vehicle types observed were motorbikes (and scooters), car/jeep, trucks, and bus. Different vehicles contribute to the traffic impedance differently. A factor called Passenger Car

Unit is used in this regard. Passenger Car Unit is a measure of relative interaction between a vehicle and a traffic stream with respect to a standard passenger car under a specified set of roadway and traffic conditions. It is used to convert a heterogeneous traffic stream into an equivalent homogeneous stream to enable expressing flow and density in a common unit. The Indian Highway Capacity Manual (2017) suggests median values of passenger car unit on semi urban road for truck, bus, cars, and motorized two-wheelers as 5, 4.5, 1.0 and 0.5 respectively. Based on these values the peak hour traffic volume was estimated for each intersection approaches. IRC provides tentative capacities of urban roads. Almost all approaches and road sections in the area (including NH-39) are two lanes. According to IRC, the capacity of such a road is 1200 (no parked vehicles) or 750 (with parked vehicles and crossing heavy vehicles). As seen in the figure 24 below, intersections 2 and 5 crosses the 750 PCU per hour mark while traffic at intersection 5 crosses the 1200 mark. This suggest that trucks carrying fly ash may not be routed through intersection 2 ad 5 in case of significant crossing vehicles and parked trucks, or at least not through intersection 5 even with limited stranded vehicles. At least a provision should be made to transport fly ask during pre-identified low volume hours.



Intersection	Peak Flow PCU/Hour
1	651
2	1130
3	633
4	662
5	1287
6	544

Figure 24: Maximum flow and intersection of transportation

Based on traffic study and estimated congestion at major intersections where trucks are likely to enter and exit NH-39, the following table 29 depicts the illustrative routes (called desire lines) that the fly ash trucks can take. These origin-destination desire lines can be used as a guide to plan fly ash transport. The planned route may consider maximum distance travelled on the national highway (NH-39). The planned route should also avoid entering or exiting locations where the traffic is reaching the road capacity.

Table 34: Routes (called desire lines) for fly ash transportation

Mine	Thermal Powerplant	Distance (~km)	Exit from NH-39	Remark
Amlohri	NTPC Vindhyachal	29	6	Avoid Intersection #5
Khadia	Renusagar	6.8	4	
Khadia	NTPC Shaktinagar	14	1	
Jayant	NTPC Shaktinagar	14	4	
Jhingurda	UPRVUNL Anpara	16	4	Avoid Intersection #2
Khadia	UPRVUNL Anpara	17	4	
Nigahi	NTPC Vindhyachal	24	1	
Total Mean Distance		**17.25**		

The following map (figure 23) shows desire lines from (NTPC) power plants to (NCL) mines based on traffic study and minimizing total distance travelled. A further analysis can be done that weighs the amount of fly ash that need to be transported from the power plants.

7.0 Dumping strategy and Mine closure

The estimation of mineable coal reserve and volume of overburden has been obtained from mine officials. The total Mineable Reserve estimated based on existing mine working plan was 233.50 Mt and corresponding total OB was 844.0 Mm³ with average stripping ratio of 3.61m³ as on 31.03.2020. The main OB bench overlying Turra seam is to be removed by dragline system and proposed to be side cast in the decoaled cut. The OB from upper benches is being handled by Shovel-dumper system and accommodated over the dragline side cast spoil within the pit. However, a part of OB is being accommodated in external dumps. Total volume of OB to be handled has been estimated as 844.00 Mm^3, as on 31.03.2020 which completely filled or accommodated in internally.

Table 35 : Seam-wise, Section wise MR, OB, in-seam Band & SR as on 31.03.2020

SI. NO.	**EAST SELECTION**		**WEST SELECTION**	
A	**Tier (RL)**	**Volume (Mm³)**	**Tier (RL)**	**Volume (Mm³)**
1	Dragline Dump	66.65	Dragline Dump	89.70
2	Up to 290 & 290-320	69.00	Up to 270 & 270-300	78.78
3	320-350	45.12	300-330	60.08
4	350-380	41.40	330-360	57.36
5	380-410	34.43	360-390	59.26
6	410-440	28.90	390-420	46.91
7	440-470	20.97	420-450	44.16
8	470-500	12.95	450-480	39.98
9	500-530	6.90	480-510	29.16
			510-540	18.29
TOTAL EAST (A)		**326.32**	**TOTAL WEST (B)**	**517.68**
GRAND TOTAL (A+B) = 844.00				

Since inception, 487.66 Mm³ of OB has already been dumped in internal/external OB dumps of the mine. Apart from the above OB, the volume of OB estimated in the PR (16Mtpa) is 844.0 Mm³, which will be accommodated in internal OB dumps in both the sections.

The volume of OB (including in-seam band) to be handled as per PR of Khadia Expansion OCP as on 31.03 2020 is 844.0 Mm³, out of which 156.35 Mm³ OB will be directly sidecast by draglines including throw blast of 13.35 Mm² in the decoaled cut and balance 687.65 Mm³ is proposed to be removed and dumped by shovel-dumper system in the internal dumps in both the sections. The mine is being worked since 1981-82 and 487.66 Mm^3 of OB has already been dumped in external/internal dumps since inception till 31.03.2020. The final stage dump plan shows that apart from existing dump volume of 487.65 Mm^3, further 844.0 Mm^3 will be accommodated in the internal dumps in both the sections. Figure show the Final mine closure plan of Khadia OCP.

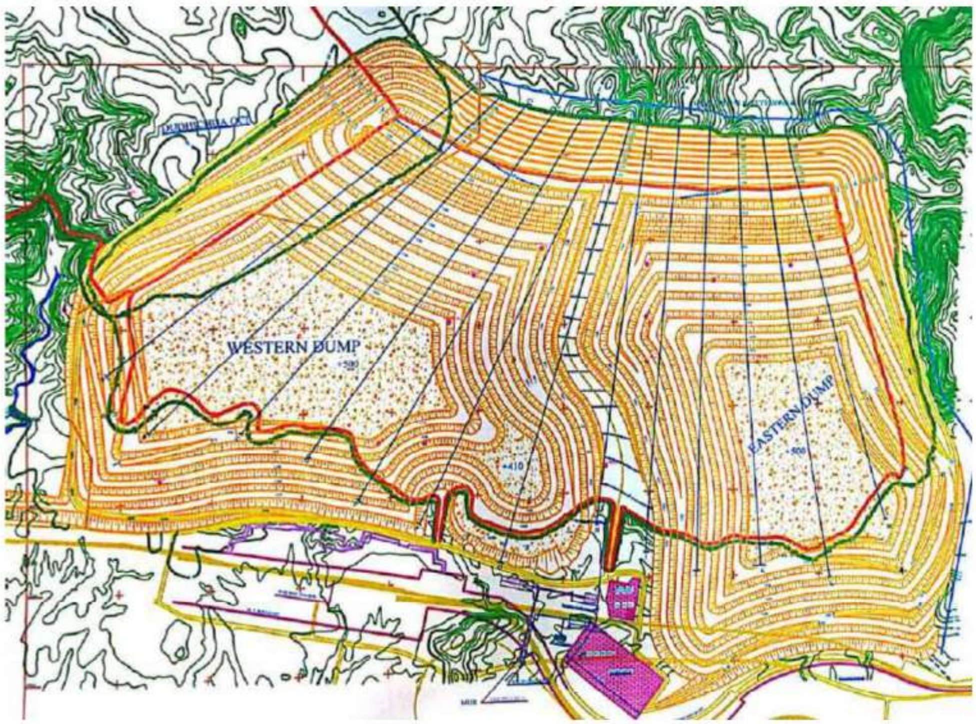


Figure 25 : Final mine closure plan

Solid waste that would be generated in course of coal mining are overburden material consisting of fragments of sandstone of assorted size. The Open cast mining of Khadia involves removal of 487.66 as on 31.03.2020. The OB from upper benches being handled by Shovel-Dumper system is to be stacked up to the extent possible over the dragline cast spoil within the pit.

The over burden will be dumped in internal dumps (in two to three tiers in each year). The height of each tier will be 30 m. The total estimated OB of 844.0Mm³, for expansion will be accommodated in the internal and external dumps. As per mine plan of Khadia OCP, total portion of quarry will be back filled and reclaimed; only an area of 37 Ha would be left out to be void**.** In due course of time, dip side of void will be filled with rain & ground water. This water reservoir may be developed for pisci-culture. At the time of final closure of mine, fencing with RCC post and barbed wire will be erected around the water body.

To maintain proper depth of water amicable for pisci-culture, the void will be back filled with OB dump material to certain height. In the final mine closure plan, design of voids due to mining are to be dealt and the final land use plan will include filling of the voids for land reclamation wherever possible and for hydro reclamation wherever feasible.

The final quarry slope has been so designed and then subsequently developed that after the closure of the mine, there is no likelihood of any slope failure. The final slope of the quarry has been designed with above consideration.

The final quarry slope has been so designed that after the closure of the mine, there is no likelihood of any slope failure. The internal dump will be completely filled by overburden material. We have created a scenario where 8-10 % fly ash is used. The fly ash will be put in layers (i.e. 80% overburden + 20% fly ash) as per stability analysis. The total volume will increase in the internal dump which will subsequently increase the final height of de-cold area. It will results further change the mine closure plan.

It has been proposed in PR that 844.0Mm^3 of OB of Khadia OCP is to be dumped in Internal dump. If fly ash with a mixture (i.e. 80% overburden + 20% fly ash) will be dumped then around 80 Mm^3 would be added to the mine overburden dump. Therefore, there will be land shortage for dumping of 80 Mm^3 of extra OB. Dumping of fly ash will require additional land for dumping and it also require proper planning. The height of external or internal dump could not be increased without taking prior permission from regularity authority.

1. The extra overburden has to be left out i.e. approximately 80-90 Mcum^3 which will lead to requirement of extra space for dumping.
2. If the void is left out and filled with water for pici-culture at end of mines. It is most likely to have contaminated the water as the base and side will have fly ash material. then the water
3. Mine closure plan has to be changed looking above extra material need to be dumped in mining area. This will lead to extra work load to production system;

Therefore, it is not advisable to used fly ash in fill with overburden dump in internal dumps.

8.0 Conclusions and Recommendations

The present Scientific study of fly ash dumping with overburden in the internal dump of Khadia Opencast Project, NCL has been done considering various aspects. The overburden samples have been brought from Khadia Opencast Project and fly ash sample from Hindalco Renusagar and UPRVUNL Anpara. Various geotechnical tests and characterization have been done for overburden, fly ash and various combination of mixed material (overburden and fly ash). Leaching study, dump slope stability, traffic study has been done to know the dumping possibility of fly ash with mixed overburden material in running mines. The conclusions and suggestions of the present study are summarized below.

Dumping of fly ash in external dump

- In opencast mining, handling of overburden (OB) is considered the most important activity requiring very careful and elaborate planning. The purpose is to reduce land requirement for external dumping of overburden and accommodate maximum overburden in internal dumps. There are also restrictions on maximum dump height from above surface level. The external dump is already reached to it maximum height (as reported by mine official). In such, there will not be any possibility of accommodating fly ash dump into External dump.
- The plantation is usually carried out on top of external dump after putting top soil layers. This has already been done for external dump of Khadia OCP. The growth of plant is healthy. If planning is done for putting fly ash on top of external dump, then the plantation has to be removed and top soil layer has to be scraped ad keep aside. However, mixing of fly ash with dump material leads to increase the height beyond the permissible limit and lead to safety issue.
- Therefore, keeping above points it is advisable not to dump the fly ash on external dump in Khadia OCP.

Dumping of fly ash in Internal dump

Various geotechnical tests of overburden and fly ash material has been done to know the suitability of mixing fly ash with overburden material in Internal dump. The conclusions and recommendation have been summarized in the following headings.

Geotechnical properties of dump and fly ash

- The size distribution of dump material and fly ash material indicates that the fly ash is having more fine material than the dump material. It will reduce the permeability of dump material when mixed with overburden material. The permeability of overburden is 1.23E-4 m/sec whereas for fly ash it is around 1.6E-5. Therefore, mixing of fly ash with overburden will reduce the permeability of overall dump material. The lower permeability will have the chances of generating water pressure during rain water.
- The Atterberg's limits indicates that the overburden dump is having very low amount of clay and silt. It contains sand, gravels and boulders. Therefore, the liquid and plastic limit is very high for overburden material considering the large size particles. The liquid and plastic limit of fly ash is low comparing to overburden material. If can be concluded that if dump material is mixed with fly ash the liquid limit and plastic limit will reduce significantly. Therefore, the material can slide on low water contain. Moreover, if fly ash is not mixed properly with the OB, it will slide more rapidly to the bottom of the slope
- The Optimum moisture content (OMC) and Maximum dry Density (MDD) of overburden is 11 % and 1.92 t/m^3 respectively. OMC is in range of 20-32 % and MDD is in range of 1.28-1.29 for fly ash of Hindalco Renusagar and UPRVUNL Anpara respectively. The OMC will increase and MDD will reduce when the overburden material is mixed with fly ash. Therefore, it is not advisable to mix dump material with fly ash.
- The average cohesion and friction angle of dump material are 52 KPa and 31 degree respectively. The friction angle of fly ash is range between 24-28 degree and cohesion is 18-48 KPa. The shear strength has been determined by mixing fly ash with overburden in different proportions. The maximum shear strength is observed at 20 % of fly ash mixed with 80% of dump material. The cohesion has increased from 52 kPA to 126 kPa whereas, the friction angle has reduced from 31 degree to 28 degree. The fly ash of the area does not have much binding capacity; therefore, cohesion will not increase significantly. The fiction angle reduces due to presence of in material in the fly ash.

Fly Ash characterization

- The pH of the fly ash samples are found to be in the range of 6.4 and 6.3 for Hindalco Renusagar and UPRVUNL Anpara respectively. It means the pH of fly ash is slightly acidic in nature. This will help in biological reclamation in the backfilled land
- The electrical conductivity of the fly ash is around 1.06 mS/cm. It is suitable for seedlings and salt sensitive plants. Therefore, it is not advisable to directly mix in the overburden dump material. Some additive should be added to increase the electrical conductivity of the fly ash.
- The major trace elements in the fly ash obtained by XRF are SiO_2 and $Al2O_3$. The amount of CaO is around 2%. The fly ash in not having self-binding capacity. Some activator needed to be properly mixed and filled with overburden for proper binding.
- The water holding capacity of fly ash is 24 % and 25.36 % for Hindalco Renusagar and UPRVUNL Anpara respectively. It will increase the more water content in the dump material for longer time. Therefore, the haul road/ pathway become slippery and it will hamper the movement of dumper/tipper.
- The retention capacity of fly ash study at laboratory stage, conclude that there is ample water retention capacity in the fly ash. Hence when water availability will increase from 24% or more a swamp like condition will be created where in fly ash would be dumped.
- Fly ash used in this study is Class F (As per ASTM). Fly ash having low pozzolanic properties therefore mixing of this fly ash with overburden will not lead to hardening of material after some time. It requires a cementing agent (such as Portland cement, quicklime, or hydrated lime) in the presence of water in order to react and produce cementious compounds
- The highest concentration of toxic trace metal (Mg and Mn) are ranging from 41.69, and 41.39 mg/L in UPRVUNL Anpara fly ash sample whereas in Hindalco Renusagar fly ash sample the concentration of Mg and Ni is 46.48 and 53.90 mg/L respectively. The solubility of metal is more in acidic range of pH hence the migration of toxic metal in the soil and nearby land will also be enriched. Mixing of fly ash with Overburden will increase toxic trace metal in surrounding area.

Environmental and safety

- The transportation and dumping of fly ash will further increase the particulate matter concentration in the mining area. It will increase the chances of the accidental cases between earth moving machinery.
- Fly-ash will make the dump floor slippery when contact with water. It will hamper or reduce the movement of dumper and other heavy machinery in mine and dump area. It will also increase the chances of accident in rainy water during movement of dumper/tippers

- In very large open cast operating mines, it is difficult to mix fly ash with external and internal overburden dumps. Operational difficulties will be encountered with safety issues during heavy rains with slippery roads and sliding of dump benches owing to fly ash.
- Due to increase in stripping ratio in coal mines, the quantum of OB is increasing and its safe disposal has become a matter of concern in the coal sector.
- In operating opencast mines, fly ash will be required to be dumped in dry form in separate layers or by mixing with OB while dumping. Both these processes would require elaborate and complex scheduling of various activities/equipment, hampering mine production and creating unsafe conditions owing to high equipment density in limited space of mines.
- The adding of fly ash will increase the pollution level in the running mine, which may exceed the allowable limit of various pollution level.

Fly Ash Transportation

- The routes from the power plant to the mine are not adequately constructed for additional fly ash transportation. Hence it is not advisable under the present road condition to transport fly ash through these roads.
- Fly-ash carrying trucks will cause hindrance to movement of dumper carrying both O.B and Coal.
- Fly-ash will make the dump floor slippery in contact with water. It will limit the movement of dumper/tipper in the haul roads.
- The lead distance of each mine already optimizes based on present equipment and production. The adding of fly ash in same layout/road will increase the traffic density and reduce the distance between two subsequent tripper/dumper.

Geo-Mining conditions

- In operating opencast mines, fly ash will be required to be dumped in dry form in separate layers or by mixing with OB while dumping. Both these processes would require elaborate and complex scheduling of various activities/ equipment, hampering mine production and creating unsafe conditions owing to high equipment density in limited space of mines operations.
- The dumping with overburden required proper mixing of fly ash in the mine overburden itself. It requires huge logistic and space for mixing plant for OB and Fly ash.
- The quarry will be back filled and reclaimed as per mine plan of Khadia OCP. An area of 37 Ha would be left as void after filling the remaining area with dump material. In

due course of time, dip side of void will be filled with rain & ground water. This water reservoir may be developed for pisciculture. By adding fly ash to internal dumping/backfilled areas there could be possibility of fly ash leaching into the void/water reservoir rendering it unsuitable for pisciculture.

- The dump material consists of large quantity of fly ash material (if dumping is to be done with fly ash). Therefore, at end of mining around 80 Mcum of dump material will be left out (which have been accommodate in original plan in place of fly ash). Therefore, the mine closure plan should be change accordingly, so that the provision of accommodation of 80 Mcum of overburden material.
- It will change the mine closure plan and it will have environmental impact in surroundings. Therefore, as per mine closure plan the fly ash should not be advisable to dumped in internal dump.

Dump Slope stability

- The dump slope stability has been carried out based on finite element method. The factor of safety has been determined for height varying from 60m to 180m. It varies from 1.76 to 1.61 for overburden dump material.

- The factor of safety of mixed overburden (fly ash mixed with OB material) has also been determined. The simulation has been carried out considering that the fly ash has been put in alternative layers in the dump. The fly ash is mixed with layer in the ration of 80% overburden material and 20% fly ash. The factor of safety of mixed dump material in dry condition is varying from 1.79 to 1.61 for dump height from 60m to 180m.

- It was expected that factor of safety will increase due to increase in cohesion of mixed material. However, it has been observed that the increase in factor of safety for fly ash mixed dump is marginal i.e. 0.04 for 60m and 0.01 for 180m dump height. The reason for marginal increase in the factor safety is due to reduction in friction angle of mixed material. The impact of mixing of fly ash on overburden will not affect the stability in dry condition.

- Water has important role to play in stability of dump material. Study has also been carried out to determine the factor of safety of dump as well as of mixed dump. The material will get saturated due to water and the shear strength reduces significantly depending upon amount of water and material type.

- The table given below summarize the factor of safety of varying % of fly ash and degree of saturation.

Sr. no	% of saturation	Factor of safety of mixed material			
		0% fly ash	5% fly ash	10% fly ash	20% fly ash
1	10	1.56	1.64	1.64	1.65
2	25	1.56	1.60	1.63	1.54
3	50	1.37	1.36	1.36	1.31
4	100	1.04	1.04	1.02	0.93

It is obvious form above table that mixed dump will not be stable in high saturation condition if fly ash is mixed more than 10%. The formation of layers of fly ash in layer may lead to formation of weak shear failure zones which may lead to dump slope failure.

- Generally, the cracks are generated in the top surface of overburden dump. The rain water entering in the crack will create water pressure, waters generally get drained from the dump material. However, the water pressure will be created in crack of overburden dump with fly ash as water will get retained which lead to low factor of safety.

Therefore, it is technically not feasible to dump the 25% fly ash in Mine dump in Khadia OCP due to geo mining conditions, high stripping ratio, and huge rate of OB removal and instability of dump during rainy season in present condition.

(Dr Rajesh Rai) (Professor B K Shrivastva) (Professor A Jamal)

DISCLAIMER

The report is based on field reconnaissance, laboratory tests as per IS codes on small size soil samples and analysis results using Phase2 slope stability analysis software. Neither IIT (BHU) nor any of its employees makes any warranty, express or implied or assume any legal liability or responsibility for the accuracy completeness or use of the result of such information, product or process in the report KHADIA OCP

	Parameters	Details
		possibility of dumping of fly ash in backfilled are as per MOEF&CC guideline.
8.10	**Abandonment Cost and Financial Assurance**	
8.10.1	**Abandonment Cost**	

Proposed Cost break-up for carrying out progressive and final mine closure activities as per the yardstick of CMPDI formulated based on the revised mine closure guidelines is as given below:

Head	Activities	Unit	Quantity	Rate (Rs./Unit)	Amount (Rs. Lakh)
Progressive Closure (Balance as on 01.04.2023)	Water quality management	No.	2592	3300	85.54
	Air quality management	No.	5760	28000	1612.80
	Noise Quality Management	No.	2304	11000	253.44
	Waste Management	Mm3	633.00	2400000.00	15192.00
	Barbed wire fencing around dump	m	1935	800	15.48
	Barbed wire fencing around the pit	m	1080	800	8.64
	Filling of Void - Rehandling of Crown dump				
	Top Soil Management	Mm3	0.75	50000000.00	375.00
	Technical and Biological Reclamation of Mined out of land and OB Dump	Ha	274	550000	1507.00
	Plantation over virgin area including green belt	Ha	25	550000	137.50
	Manpower Cost and Supervision	Emp	19800	848	167.90
	Total wall around the dump	m	677	4200	28.43
	Garland drain	m	155	4500	6.98
	Garland drain around the dump	m	1935	4500	87.08
	Any other Activity (Grazing Facilities etc.)	LS			
	TOTAL				**19477.78**
Dismentaling of infrastrucure & Disposal/ rehabilitation of mining Machinery	Dismentaling of workshop	LS			50.00
	Rehabilitation of the dismentaled facilities				
	Dismentaling of pump and pipes/ other facilities.	LS			20.00
	Dismentaling of stowing bunker, provisioning of pumps for borewell pumping arrangement				
	Dismentaling of UG equipment				
	Rearranging water pipeline to dump top park/Agriculture land	LS			50.00
	Dismentaling of power lines.				
	Any other Activity				
	TOTAL				**120.00**
Safety and Security	Barbed wire fencing around dump				
	Barbed wire fencing around the pit				
	Barbed wire fencing with masonry piller				
	Concrete wall with masonry piller around the pit	m	4500	4200	189.00
	Securing air shaft and installation of borewall pump				
	Securing of incline				
	Concrete wall fencing around the water body				
	Boundary wall around the water body				
	Stabilisation (viz benching, pitching etc) of side walls of the water body				
	Toe wall around the dump				

	Parameters	Details				
		Garland Drain				
		Garland Drain around the dump				
		Drainage channel from main Ob dump	m	500	4500	22.50
		Any other Activity				
		TOTAL				**211.50**
	Technical and Biological Reclamation of mined out of land and OB Dump	Filling of Void				
		Top soil management				
		OB Rehandling for backfilling	Mm3	50	2400000.00	1200.00
		Terracing, blanketing with soil and vegetation of External OB Dump				
		Paripharel road, gates, view point, cemented steps on bank				
		Expenditure on development of Agriculture land	Ha			
		Landscaping and Plantation	LS			200.00
		Any other Activity				
		TOTAL				**1400.00**
	Post Closure management and supervision	Power Cost	LS			150.00
		Post mining water quality management	LS			80.00
		Post mining air quality management	LS			150.00
		Subsidence monitoring for 5 years				
		Waste management	LS			100.00
		Manpower Cost and supervision	LS			50.00
		Any other Activity				
		TOTAL				**530.00**
	Others	Enterprenuership development(vocational/skill development training for sustainable income of affected people)	LS			100.00
		Golden Handshake/Retrenchment benefits to 100 employees of OC				132.36
		Golden Handshake/Retrenchment benefits to 200 employees of UG				
		Onetime financial grant to societies/ institutions/ organisations which is dependent upon the project	LS			100.00
		Provide Jobs in other mines of company				
		Continuation of other services like running of school etc.	LS			100.00
		Any other Activity (Development of Solar Park, eco-friendly Parks, fish farming pond, picnic spot and sport compound)	LS			640.90
		TOTAL				**1073.26**
		G TOTAL				**22812.54**
	Note:	**Above G Total Amt. includes Closing Balance of Rs. 8749.96 Lakh as on 31.03.2023 and Amt. to be deposited Rs. 14062.58 Lakh in ESCROW Account.**				

कार्यालय क्षेत्रीय वन अधिकारी, खड़िया प्रोजेक्ट, रेनुकूट वन प्रभाग, (सोनभद्र)

पत्रांक- 17 /रेनुकूट/29(वृक्षारोपण) दिनांक, रेनुकूट, सितम्बर, 14 2024

सेवा में,

महाप्रबन्धक,
एन.सी.एल. खड़िया प्रोजेक्ट ।

विषयः- वृक्षारोपण वर्ष-2024-25 (वर्षाकाल 2024) में रोपित किये गये पौधों का प्रजातिवार विवरण के सम्बन्ध में ।

महोदय,

उपरोक्त विषयक के क्रम में सादर अवगत कराना है कि एन.सी.एल. खड़िया प्रोजेक्ट द्वारा वृक्षारोपण वर्ष-2024-25 (वर्षाकाल 2024) में 18175 पौधों के रोपण हेतु लक्ष्य आवटित किया गया था, उक्त आवटित लक्ष्य के अनुरुप प्रजातिवार पौधों का रोपण निम्न विवरण के अनुसार किया गया है-

वृक्षारोपण वर्ष-2024-25 (वर्षाकाल 2024) में रोपित पौधों का प्रजातिवार विवरणः-

क्र0सं0	प्रजाति	रोपित पौध संख्या
1	शीशम	1500
2	बोगनबेलिया	500
3	चिलबिल	700
4	कनेल	200
5	कंजी	2000
6	अकेसिया अरि0फा0	500
7	बांस	800
8	केसियास्यामिया	500
9	कचनार	100
10	आंवला	600
11	केसियाग्लूका	500
12	प्रोसोपिस	500
13	बेल	100
14	पेल्टोफार्म	2200
15	जगल जलेबी	100
16	सुबबूल	200
17	अमरुद	100
18	जामुन	200
19	आम	150
20	महुआ	300
21	अनार	100
22	ग्रेवेलिया	1500
23	अशोक	100
24	नीम	2200
25	कोरईया	200
26	सेमल	300
27	बकायन	1500
28	अन्य प्रजाति	525
	योग-	18175

अतः महोदय की सेवा में सूचनार्थ एवं आवश्यक कार्यवाही हेतु रिपोर्ट प्रेषित है।

भवदीय

(धीरेन्द्र कुमार मिश्र)
क्षेत्रीय वन अधिकारी,
खड़िया प्रोजेक्ट रेंज,
रेनुकूट वन प्रभाग, रेनुकूट

नॉर्दर्न कोलफील्ड्स लिमिटेड
[kfM+;k ifj;kstuk
(मिनिरत्न कंपनी)
(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)

एन सी एल
NCL

Northern Coalfields Limited
Khadia Project
(A Miniratna Company)
(A subsidiary of Coal India Limited)

Digital India

Office of Staff Officer (Mining)

स्वच्छ भारत

CIN- U10102MP1985GOI003160
An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company
Fkkuk&"'kfDruxj] ftyk&lksuHkknz ¼m0iz0½ fiu&231222/ Thana-Shaktinagar, Dist. Sonebhadra (U.P.) Pin- 231222
Phone: 05446- 232274, (FAX) 05446- 232274 Email: cgm.khd@gmail.com, website : www.nclcil.in

No. KHD/M/Env./Plant Distr./S.O./24-25/11 Date : 29.06.2024

Supply Order

To,
M/S Harit Sone Nursery,
Karhiya (Dibulganj),
Renukut - Anpara road, Anpara,
Sonebhadra (U.P.).

Sub. : Supply order for "Distribution of plant saplings among employees of Khadia Area and Nearby Population."
Ref. : KHD/Min/Committee/Plant Dist./2024/10 dated 25.06.2024

Dear Sir,

It is to inform you that your offer has been accepted for the work "Distribution of plant saplings among employees of Khadia Area and Nearby Population" as per details given below in accordance with the terms and conditions given here under :-

S.NO.	Particulars	Quantity	Rate	Amount (in Rs.)
1	Distribution of plant saplings among employees of Khadia Area and Nearby Population	4500 nos.	As per enclosed BoQ	198600.00

Terms & Conditions

1. Total order value	:	Rs. 198600.00 (Rupees One Lakh Ninty Eight Thousands Six Hundred Only) (including GST)
2. Work Completion	:	Within 03 days from issuance of Work Order
3. Payment terms	:	100% payment within 21 days on completion of work or submission of bill whichever is later through e-payment for which bank details should be mentioned on the body of your bill.
4. Taxes & Duties	:	Inclusive of all taxes in the above quoted rates.
5.Consignee	:	Staff Officer (Mining), Khadia Area

6. Paying authority	:	Area Finance Manager, Khadia Area
7. Submission of Bills	:	Bills in duplicate in GST format to be submitted to the consignee and GST no. of Khadia Area, NCL must be mentioned on it.
8. Inspection	:	The Work must be completed as per specification and under supervision of Staff Officer (Mining), Khadia Area or his representative. They will inspect the work and have the right to reject the work, if is found below specification.

9. All Other terms and conditions will be followed as per NIT & General terms and conditions of NCL.

Yours faithfully,

29/6/24

Staff Officer (Mining)
Khadia Area.

CC : (1) The G.M., Khadia Area
(2) The AFM, Khadia (FC/AFM/KHD/2024-25/ENVIRONMENTALEXP / 91 / 16 for Rs. 198600.00 and Dated 29-06-2024)
(3) Nodal Officer (Environment), Khadia Area

Gmail

NCL Khadia Area CSR <csrkhadia@gmail.com>

Information regarding Virtual Reality Device laboratory

2 messages

NCL Khadia Area CSR <csrkhadia@gmail.com> Fri, Jan 31, 2025 at 2:20 PM
To: CDO Sonbhadra <cdoson.up@gmail.com>
Cc: cgm.khd@gmail.com, sopkhd ncl <sopkhdncl@gmail.com>, khddavssps@gmail.com

Dear Mam,

This is to inform you that NCL khadai under its CSR initiative has developed a science laboratory equipped with Virtual Reality Device. DAV Khadia is the resource school for addressing the students with respect to same.

This laboratory can cater the academic needs of students and has more than 40 laboratory practical module for Std. IXth & Xth.

Accordingly, the students from across the districts can pay a visit to DAV Khadai and take benefits of this innovative Science practical laboratory in consultation with CSR cell Khadia and DAV Khadia.

--
Thanking you.
Regards.

Amrendra Kumar
Nodal Officer (CSR & PR).
NCL Khadia Area.
Uttar Pradesh
Pin: 231222
Mobile: 09406966223

Sandhya Pandey <khddavssps@gmail.com> Fri, Jan 31, 2025 at 3:58 PM
To: NCL Khadia Area CSR <csrkhadia@gmail.com>
Cc: CDO Sonbhadra <cdoson.up@gmail.com>, Cgm Khadia <cgm.khd@gmail.com>, sopkhd ncl <sopkhdncl@gmail.com>

Sir,
Thank you very much for choosing DAV Khadia as the resource centre for Sci Lab and enriching it by providing Virtual Reality device .
The School shall provide all support towards catering to needs of academic excellence in nearby area students.

The School requests you to provide training to our nominated teachers and updation of Software in English too.

Warm regards

Principal
[Quoted text hidden]

Subject	Data
Title	Financial assistance to UPNEDA, Sonbhadra for installation of 15 Nos. of High Mast Solar light & 200 Nos. of Solar Street light in the vicinity of NCL.
Category	Others
Department	0
Status	**Pending at admin side**
Expected Amount(In Lac)	62.72
Added Date	02/02/2025 12:37
Approved Date	
Rejected Date	
Last Update Date	02/02/2025 12:37
Description	
Review By	0
Review Date	
Review Comments	
Comment by Admin	
Comment by Department	