Dalmia cement

cement! sugar! refractories! power!

DCBL/ENV/24-25/01

30th May 2024

To,

Deputy Director General of Forest (C)
Ministry of Environment, Forests & Climate Change
Govt. of India
Integrated Regional Office, Law – U –Sib,
Lumbatngen, Shillong – 793021, Meghalaya.

Subject: Half Yearly compliance report for the period October 2023 to March 2024, condition imposed in environment clearance vide letter F. No. J-11015/366/2009-IA.II (M) dated 2nd Jan, 2014 for mining lease **(128.52 ha Limestone mining lease and 19.33 ha outside dump) Block – V** of M/s Dalmia Cement (Bharat) Limited (Formerly Adhunik Cement Limited) at Vill- Thangskai, P.O. Lumshnong, Dist – East Jaintia Hills, Meghalaya-793200.

Ref: - Environment Clearance letter no. **F. No. J-11015/366/2009-IA.II (M) dated 2nd Jan, 2014**

Dear Sir,

With reference to above subject and referred letter no, we are submitting herewith half yearly compliance for mining lease **(128.52 ha Limestone mining lease and 19.33 ha outside dump) Block – V** of M/s Dalmia Cement (Bharat) Limited (Formerly Adhunik Cement Limited) at Vill- Thangskai, P.O. Lumshnong, Dist – East Jaintia Hills, Meghalaya-793200.

We request to kindly acknowledge the receipt of the same.

Thanking you,
Yours faithfully
For - Dalmia Cement (Bharat) Ltd.

Central Pollution Control Board ... 03/06/24

Authorized Signatory

Enclosure: Compliance report for the period October 2023 to March 2024.

CC to:

1). The Member Secretary, Meghalaya State Pollution Control Board, "Arden" Lumpyngad, and Shillong 793 014, Meghalaya.

2). The Regional Director, Central Pollution Control Board, North Eastern Zonal Office, BSNL Complex (CTO), Lachumiere, Shillong -793 001, Meghalaya.

MEGHALAYA STATE POLLUTION CONTROL BOARD ★ SHILLONG ★ 03/06/24

LIMESTONE MINE (BLOCK-V)

128.52 ha Mining lease and 19.33 ha outside dump, Production of 2.0 MTPA

of

M/S. DALMIA CEMENT (BHARAT) LIMITED

Umsoo Mootang, Vill. - Thangskai, P.O. Lumshnong, Dist. - East Jaintia Hills, Meghalaya 793 200

COMPLIANCE STATUS

Environment Clearance Letter No: - F. No. J-11015/366/2009-IA. II (M) dated: 2nd January 2014.

Period of Compliance: October 2023 to March 2024.

SL No.	Conditions	Compliance Status
A	**Specific Conditions**	
(i)	Environmental clearance is subject to obtaining clearance under the Wildlife (Protection) Act, 1972 from the competent authority, as may be applicable to this project.	As per ESZ notification vide Gazette notification SO:2942 dated 6th September 2017 our mines is located outside the ESZ boundary.
(ii)	The project proponent shall obtain Consent to Establish and Consent to Operate from the concerned State Pollution Control Board and effectively implement all the conditions stipulated therein.	Obtained CTE & CTO vide letter No. MPCB/CON -36-2014/2016-2017 / 11 dated 1st June 2016 and vide letter No. MPCB/CON -35 -2014 /2016-2017/14 dated 15th March 2017 and CTO is renewing time to time.
(iii)	A bund of about 5 meters height is to be made along the mining lease boundary on the village side with good width of green belt between the village and the mining area.	There does not exist any village in the immediate vicinity of the mining lease boundary. Hence creation of bund is not applicable. However, as per the applicable regulations, a safety barrier of about 7.5 meters has been left all around the ML boundary and plantation has been taken up in phased manner as per the approved mining plan. We request you to kindly exempt us from making Five-meter height bund. There already exist natural vegetation along the lease boundary. However, gap plantation has been done. Green belt along the mining lease boundary is implemented.
(iv)	Mining will not be done all sides of the village at any one time and will be sequential manner as per the Mining Plan approved by the IBM.	There does not exist any village in the immediate vicinity of the mining lease boundary. However, mining will be done as per approved mining plan.

(v)	During mining, pollution mitigation measures will be taken up to ensure that the impact on the village and the surrounding area will not occur. Small blasts will be conducted to reduce ground vibrations and noise. Blasted material heaps will be thoroughly wetted before loading to avoid fugitive dust during loading.	There does not exist any village in the immediate vicinity of the mining lease boundary however mitigative measures has been taken up and is in practice to mitigate pollution. Latest technology is used in blasting to reduce ground vibration and noise.
(vi)	Effective safeguard measures such as regular water sprinkling shall be carried out in critical areas prone to air pollution and having high levels of SPM and RPM such as haul road, loading and unloading point and transfer points. It shall be ensured that the Ambient Air Quality parameters conform to the norms prescribed by the Central Pollution Control Board in this regard. Main haul road in the mine will be provided with permanent water sprinklers and other roads will be wetted with water tanker fitted with sprinklers. Crusher and material transfer points will be provided with Bag filters and conveyor will be fully covered to avoid air borne dust.	Regular water sprinkling is carried out to reduce air pollution. A Water tanker fitted with sprinklers is deployed for water sprinkling in all area. Existing Crusher have been provided with bag filter and material is conveyed through fully covered conveyor belt. Permanent water sprinklers is installed in the mines main haul road. A 12 KL water tanker is also in use to sprinkle water on haulage road to suppress fugitive dust
(vii)	Regular monitoring of ground water level and quality shall be carried out in and around the mine lease by establishing a network of existing wells and installing new piezometers during the mining operation. The periodic monitoring [(at least four times in a year- pre-monsoon (April-May), monsoon (August), post-monsoon (November) and winter (January); once in each season)] shall be carried out in consultation with the State Ground Water Board/Central Ground Water Authority and the data thus collected may be sent regularly to the Ministry of Environment and Forests and its Regional Office Shillong, the Central Ground Water Authority and the Regional Director, Central Ground Water Board. If at any stage, it is observed that the groundwater table is getting depleted due to the mining activity, necessary corrective measures shall be carried out.	Piezometer is installed. However, there is no perfect water table in this area, only erratic water channels are observed. Hence mining will not intersect ground water table. There are no wells in and around the mine lease. We are not utilising any Groundwater for the operation of Mines nor there is any ground water seepage during operation of the mine because of the terrain as mine is located in Hilly area of Meghalaya. We have visited Central Ground Water Board, North East Regional Office, Guwahati and discussed the matter. We have also submitted one request letter on dated 28-3-2019, dated 4-8-2021 & 2-8-2022 to provide us with necessary recommendation for augmentation of ground water resources in our mining area. Further, we also visited their office in person dated 4-10-2022 and 30-5-23 and approach Regional Director, CGWB. The reply is awaited. Hydrological Feasibility study is conducted

		through Department of Geological Science, Guwahati University, copy enclosed as **Annexure - I**. As per the study it is found that ground water level of our mining area is below 171 m and our mining bottom most dept will be 165 m. therefore we will not intercept the ground water. Also requesting you to wave - off the stipulated conditions
(viii)	The project authority shall implement suitable conservation measures to augment ground water resources in the area in consultation with the Regional Director, Central Ground Water Board.	Working pit has been provided with bund and run-off due to rain flows into the pit and seeps down through bottom most bench without much accumulation as rocks is highly fractured. The accumulated silt is blended with limestone and used in cement manufacturing. This helps in arresting silt inside pit as a siltation pond and works effectively. There is no outside discharge. We have also submitted one request letter to Regional Director, Central Ground Water Board to provide us with necessary recommendation for augmentation of ground water resources in our mining area. We have also visited Central Ground Water Board, North East Regional Office, Guwahati on last 30th May 2023 and discussed the matter. Reply is awaited from Central Ground Water Board.
(ix)	Appropriate mitigative measures shall be taken to prevent pollution of the water stream and adjoining water bodies in consultation with the State Pollution Control Board.	Though, we have submitted one request letter to Meghalaya State Pollution Control Board, Shillong, on dated 6-4-2019 and reminder letter on 30-5-23 for providing us necessary recommendation to avoid pollution to water stream or water bodies adjoining our mining lease area. The reply is awaited from Meghalaya State Pollution Control Board. However, there is no adjoining water bodies and water stream. Further, there is no outside discharge from the mines. Therefore, we request you to kindly exempt us from this point.
(x)	Compliance status shall be submitted to the Ministry of Environment & Forests and its Regional Office located at Shillong on six monthly basis.	We are submitting compliance status report in every six month.
(xi)	Sewage treatment plant shall be installed for the colony. ETP shall also be provided for the workshop and waste water generated during the mining operation.	STP & ETP are operational in colony and workshop respectively. Please find attach latest performance test report of both STP & ETP as **Annexure – II & III** respectively.
(xii)	Digital processing of the entire lease area using remote sensing technique shall be	DGPS survey is completed. Drone survey also is completed and report received. Report of the

	carried out regularly once in three years for monitoring land use pattern and report submitted to Ministry of Environment and Forests and its Regional Office, Shillong.	DGPS survey and Drone Survey is also submitted to your good office vide letter dated 11-7-2023.
(xiii)	Regular monitoring of ambient air quality shall be carried out and records maintained.	Regular monitoring of ambient air quality is conducting. Please find attach last six months ambient air quality monitoring report as **Annexure – IV.**
(xiv)	Pre - placement medical examination and periodical medical examination of the workers engaged in the project shall be carried out and records maintained. For the purpose, schedule of health examination of the workers should be drawn and followed accordingly.	Complying. Please find attach some report as **Annexure – V.**
(Xv)	Implementation of Action plan on issues raised during Public Hearing.	Complied
A	**General Conditions**	
(i)	The project proponent shall ensure that no natural watercourse and/or water resources are obstructed due to any mining operations. Adequate measures shall be taken for protection of the 1st order and 2nd order streams, if any emanating/ passing through the mine lease during the course of mining operation.	There is no water course / streams of 1st & 2nd Order emanating /passing through the lease.
(ii)	The top soil, if any shall temporarily be stored at earmarked site(s) only and it should not be kept un - utilized for long. The topsoil shall be used for land reclamation and plantation.	Top soil generated is almost negligible in quantity however generated quantity is used for development of green belt.
(iii)	The over burden (OB) generated during the mining operation shall be stacked at earmarked dump site(s). Monitoring and management of rehabilitated areas should continue until the vegetation becomes self-sustaining. Compliance status should be submitted to the Ministry of Environment & Forests and its Regional Office, Shillong on six monthly basis.	Over burden generated is stacked in earmarked area. Total cumulative area covered 14.24 Ha so fat with a volume of 3648165 m3. We have initiated the process to do the plantation also.
(iv)	Catch drains and siltation ponds of appropriate size shall be constructed for the working pit, temporary OB and mineral dumps to arrest flow of silt and sediment directly into the adjoining river and other water bodies. The water so	Present mining operation does not intersect any water channel. However, bund has been erected along the working pit to use the same as siltation pond and accumulated silt is blended with Run of Mine. Highly fractured

	collected should be utilized for watering the mine area, roads, green belt development etc. The drains should be regularly de-silted particularly after the monsoon and maintained properly.	rock allows water to percolate down. Garage is provided with ETP and treated water is reused. No outside discharge. Working pit has been provided with bund and run-off due to rain flows into the pit and seeps down though bottom most bench without much accumulation as rocks is highly fractured. The accumulated silt is blended with limestone and used in cement manufacturing. This helps in arresting silt inside pit as a siltation pond and works effectively. Latest performance report of ETP is enclosed as **Annexure – III**.
(v)	Garland drains, settling tanks and check dams of appropriate size, gradient and length shall be constructed both around the mine pit and temporary over burden dumps to prevent run off of water and flow of sediments directly into the adjoining river and other water bodies and sump capacity should be designed keeping 50% safety margin over and above peak sudden rainfall (based on 50 years data) and maximum discharge in the area adjoining the mine site. Sump capacity should also provide adequate retention period to allow proper settling of silt material. Sedimentation pits should be constructed at the corners of the garland drains and desilted at regular intervals.	Present mining operation does not intersect any water channel. However, bund has been erected along the working pit to use the same as siltation pond and accumulated silt is blended with Run of Mine. Highly fractured rock allows water to percolate down. An action plan have been prepared and Approved by PWD department and PCCF, Shillong, Meghalaya. Same is followed and is in force.
(vi)	Dimension of the retaining wall at the toe of the temporary OB dumps and the OB benches within the mine to check run-off and siltation should be based on the rain fall data.	Overburden dump is active and is at initial stage. However, we have initiated the process of runoff management and bio diversity.
(vii)	Plantation shall be raised in a 7.5m wide green belt in the safety zone around the mining lease, back filled and reclaimed area, around water body, along the roads etc. by planting the native species in consultation with the local DFO/Agriculture Department. The density of the trees should be around 2500 plants per ha. Greenbelt shall be developed all along the mine lease area in a phased manner and shall be completed within first five years.	Natural vegetation is there in 7.5 meter safety zone. However, Green belt development is doing in phased manner by planting the native species in consultation with the local DFO as an where required. An action plan have been prepared and Approved by PWD department and PCCF, Shillong, Meghalaya. Same is under implementation as per approved plan.
(viii)	Effective safeguard measures, such as regular water sprinkling shall be carried	Water sprinkling is done to reduce air pollution. Water tanker fitted with sprinklers is

	out in critical areas prone to air pollution and having high levels of SPM and RSPM such as around crushing and screening plant, loading and unloading point and all transfer points. Extensive water sprinkling shall be carried out on haul roads. It should be ensured that the Ambient Air Quality parameters conform to the norms prescribed by the Central Pollution Control Board in this regard.	continuously deployed on the haul roads to suppress the dust. Existing Crusher have been provided with bag filter and material is transferred with fully covered conveyor belt. Latest Monitoring report Ambient Air Quality and monitoring report of all 12 parameter is enclosed as **Annexure – VI**.
(iX)	Vehicular emissions shall be kept under control and regularly monitored. Measures shall be taken for maintenance of vehicles used in mining operations and in transportation of mineral. The mineral transportation shall be carried out through the covered trucks only and the vehicles carrying the mineral shall not be overloaded.	Well equipped workshop is maintained for the regular maintenance of HEMM. Loaded trucks for mineral transporting doesn't pass through any public place or habitation. It is a captive mines and premises falls within the ownership of mine owner.
(X)	Controlled blasting shall be practiced. The mitigative measures for control of ground vibrations and to arrest fly rocks and boulders should be implemented.	Blasting is done by using latest technology like NONEL and slurry explosive in conjunction with ANFO, which controls the ground vibration and minimize the flying fragments. Almost every blast is monitored by using MINIMATE.
(xi)	Drills shall either be operated with dust extractors or equipped with water injection system.	Complied.
(xii)	Mineral handling area shall be provided with the adequate number of high efficiency dust extraction system. Loading and unloading areas including all the transfer points should also have efficient dust control arrangements. These should be properly maintained and operated.	Complied.
(xiii)	Provision shall be made for the housing of construction labor within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.	Complied.
(xiv)	The critical parameters such as SPM, RSPM (Particulate matter with size less than 10 micron i.e., PM_{10}), NOx in the ambient air within the impact zone, peak particle velocity at 300m distance or within the nearest habitation, whichever is closer shall be monitored periodically.	Regular Ambient Air quality monitoring & Water Quality Analysis is carried out. Latest monitoring report for Air and water is enclosed in **Annexure - IV** & **Annexure - VII** respectively.

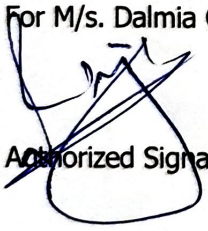
	Further, quality of discharged water shall also be monitored [(TDS, DO, PH and Total Suspended Solids (TSS)]. The monitored data shall be uploaded on the website of the company as well as displayed on a display board at the project site at a suitable location near the main gate of the Company in public domain. The circular No. J-20012/1/2006-IA.II (M) dated 27.05.2009 issued by Ministry of Environment and Forests, which is available on the website of the Ministry www.envfor.nic.in shall also be referred in this regard for its compliance.	Monitoring data is displayed at mining lease main gate.
(xv)	Final Mine Closure Plan along with details of Corpus Fund should be submitted to the Ministry of Environment & Forests 5 years in advance of final mine closure for approval.	Noted for Compliance.
(xvi)	No change in mining technology and scope of working should be made without prior approval of the Ministry of Environment & Forests.	Noted for Compliance.
(xvii)	No change in the calendar plan including excavation, quantum of mineral and waste should be made.	Noted for Compliance.
(xviii)	Conservation measures for protection of flora and fauna in the core & buffer zone should be drawn up in consultation with the local forest and wildlife department and effectively implemented.	A biodiversity plan for conservation and protection of flora and fauna in the core and buffer zone had been prepared and approved by Chief Wildlife Warden. A sum of about Rs. 58.098 lakh have been proposed for conservation of bio-diversity and schedule-I species and is in process of implementation as per the plan suggested therein. We have taken up the matter with State forest department. A letter dated, 20th December 2022 has been received from Principle Chief Conservator of Forest (Bio-Diversity & Wildlife) & Chief Wildlife warden to await some time till ready of Reginal Conservation Plan. Copy of the Said letter is enclosed as **Annexure – VIII.**
(xix)	Four ambient air quality-monitoring stations should be established in the core zone as well as in the buffer zone for RSPM, SPM, SO_2 & NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets and frequency of monitoring	Complied.

	should be undertaken in consultation with the State Pollution Control Board.	
(xx)	Data on ambient air quality (RSPM, SPM, SO_2 & NO_x) should be regularly submitted to the Ministry of Environment and Forests including its Regional office located at Shillong and the State Pollution Control Board / Central Pollution Control Board once in six months.	Complied
(xxi)	Fugitive dust emissions from all the sources should be controlled regularly. Water spraying arrangement on haul roads, loading and unloading and at transfer points should be provided and properly maintained.	Adequate number of dust extraction systems is installed in all Conveyor lines to minimize fugitive emissions. Regular water sprinkling is also carried out to reduce air pollution. Water tanker fitted with sprinklers is continuously deployed over the haul roads for the purpose. Latest Fugitive emission monitoring report is enclosed in **Annexure - IX.**
(xxii)	Measures should be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in operations of HEMM, etc. should be provided with ear plugs/muffs.	Complied
(xxiii)	Industrial waste water (workshop and waste water from the mine) should be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May, 1993 and 31st December, 1993 or as amended from time to time. Oil and grease trap should be installed before discharge of workshop effluents.	Complied. There is no outside discharge from the mines. Workshop has been provided with ETP for treating the industrial water and same is reused. There is no outside discharge from work shop.
(xxiv)	Personnel working in dusty areas should wear protective respiratory devices and they should also be provided with adequate training and information on safety and health aspects.	PPE is provided to all workers, In addition adequate training are imported to workmen on safety and health aspect.
(xxv)	Occupational health surveillance program of the workers should be undertaken periodically to observe any contractions due to exposure to dust and take corrective measures, if needed.	Occupational health surveillance program undertaken for workers on regular basis. The program includes Lung function test and sputum analysis, etc.
(xxvi)	A separate environmental management cell with suitable qualified personnel should be set-up under the control of a Senior Executive, who will report directly to the Head of the Organization.	Complied
(xxvii)	The funds earmarked for environmental protection measures should be kept in	Complied

	separate account and should not be diverted for other purpose. Year wise expenditure should be reported to the Ministry of Environment and Forests and its Regional Office located at Shillong.	
(xxviii)	The project authorities should inform to the Regional Office located at Shillong regarding date of financial closures and final approval of the project by the concerned authorities and the date of start of land development work.	Mining activities started after 06/09/2017 and are in initial stage of development.
(xxix)	The Regional Office of this Ministry located at Shillong shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information / monitoring reports.	Agree.
(xxx)	The project proponent shall submit six monthly reports on the status of compliance of the stipulated EC conditions including results of monitored data (both in hard copies as well as by e-mail) to the Ministry of Environment and Forests, its Regional Office Shillong, the respective Zonal Office of CPCB and the SPCB. The proponent shall upload the status of compliance of the EC conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of the Ministry of Environment and Forests, Shillong, the respective Zonal Office of CPCB and the SPCB.	Six monthly report on the status of compliance of EC is submitted both in Hard Copy as well as by E-Mail. Further we upload the status of compliance on our website.
(xxxi)	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zila Parisad / Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent.	Complied
(xxxii)	The State Pollution Control Board should display a copy of the clearance letter at the Regional office, District Industry Centre and the Collector's office/ Tehsildar's Office for 30 days.	Not applicable.

(xxxiii)	The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall also be sent to the Regional Office of the Ministry of Environment and Forests, Shillong by e-mail.	Environmental Statement for FY ending 31st March 2023 is submitted.
	The project authorities should advertise at least in two local newspapers widely circulated, one of which shall be in the vernacular language of the locality concerned, within 7 days of the issue of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution Control Board and also at web site of the Ministry of Environment and Forests at http://envfor.nic.in and a copy of the same should be forwarded to the Regional Office of this Ministry located at Shillong.	Complied Published in Mawphor, Shillong (local lang.) and The Shillong Times (English) dated. 14th Jan 2014. the copy of the same also submitted to your office.

Thanking You,
Yours Faithfully,
For M/s. Dalmia Cement (Bharat) Limited.



Authorized Signatory.

HYDROGEOLOGICAL FEASIBILITY STUDY OF UMSOO-MOOTANG LIMESTONE MINE, EAST JAINTIA HILLS, MEGHALAYA

[Dalmia Cement (Bharat) Ltd.]

DEPARTMENT OF GEOLOGICAL SCIENCES
GAUHATI UNIVERSITY

1. Introduction

The Umsoo-Mootang limestone mine (128.52Ha & 4.9Ha) with production capacity of 1,50,000 TPA is situated at Umsoo-Mootang area in Thangskai village, East Jaintia Hills District Meghalaya State. M/s Adhunik Cement Limited (now a wholly owned subsidiary of Dalmia Cement (Bharat) Ltd.) is operating. The hydrogeological feasibility study of the Umsoo-Mootang Limestone mine is carried out with following objectives:

(i) Study of the hydrological parameters of the area to find the probable impact of surface and groundwater on the stability of the mine and also likely impact of the mining activities on the local environ.

(ii) Collection of discontinuity data and geological inputs

2. Location and Accessibility

The Umsoo Mootang mine site is located in a non-forest area bounded by 92°20′31″-92°21′54″N longitudes and 25°10′34″-25°11′38″N latitudes in the easternmost part of the state of Meghalaya in the East Jaintia Hills District (Fig. 1). The mine falls in the Survey of India Toposheet No. 83C/8. The area is accessible via the Jowai-Badarpur Highway (NH#44), located 50 km from Jowai. From there, a well-paved road branches off to the right, leading to the mine site at a distance of 1.5 km. The closest major railway station is located in Badarpur, Chachar District, Assam, situated 88 km away along the Jowai-Badarpur Highway. Additionally, the nearest airport can be found in Silchar, which is approximately 100 km away along the same route. The area is very close to the Indo-Bangladesh border. The IKONOS multispectral image (available at Google Earth) showing Umsoo_Mootang limestone mine is given at Fig. 2. The photograph of the Umsoo-Mootang limestone mine is shown in the Fig. 3.

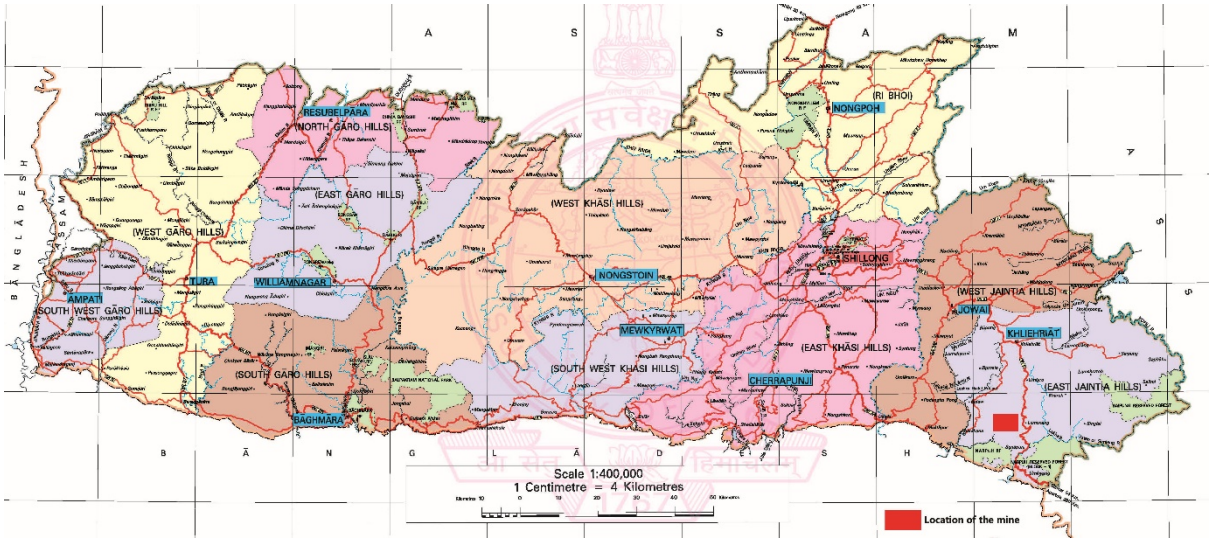


Fig. 1. The location of the Umsoo Mootang limestone mine is shown on the map of the state of Megalaya.

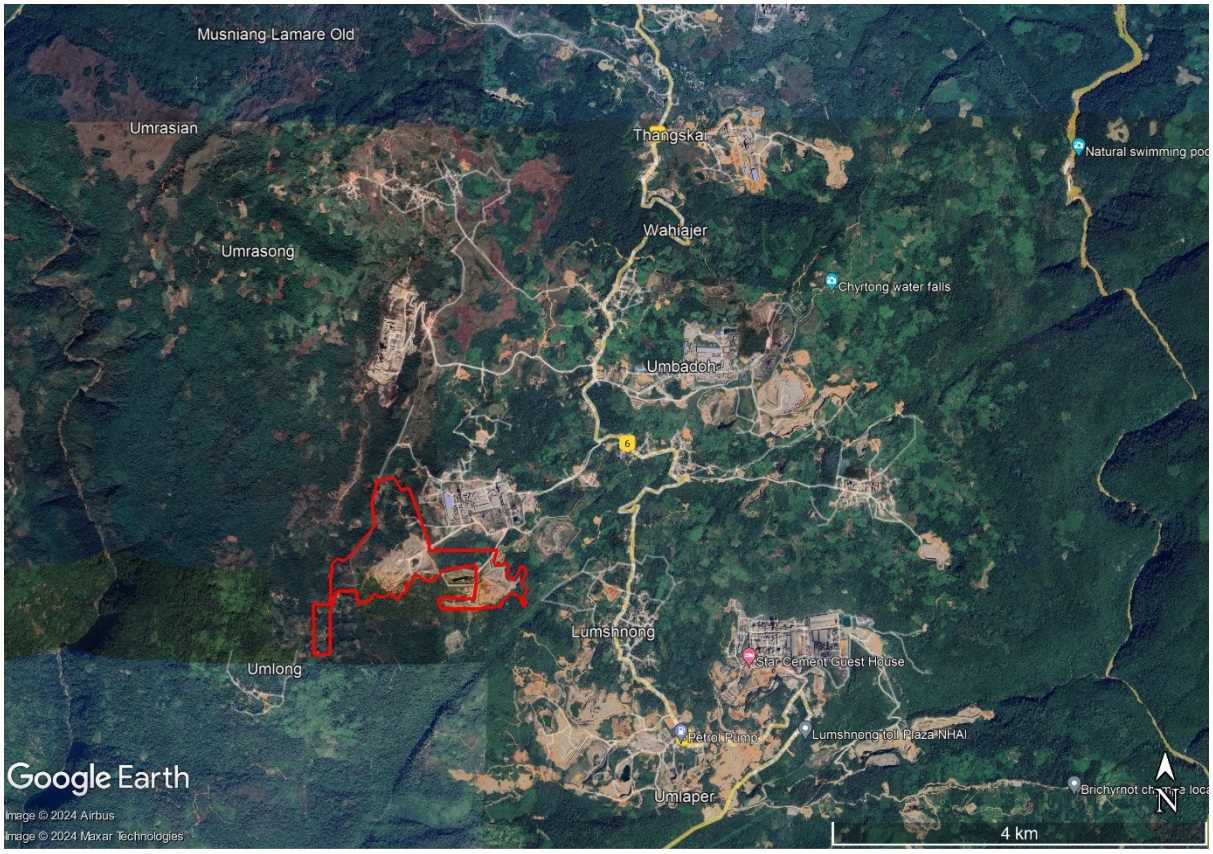


Fig. 2. The Google Earth image of the Umsoo Mootang limestone mine and its surrounding (mine boundary is shown in red colour).

3. Climate

The region's climate is predominantly shaped by the southwest monsoon, resulting in a humid-tropical to temperate climate. Variations in altitude contribute to diverse climate

conditions across the area. The northern part, characterized by higher altitudes, experiences a sub-temperate climate. Conversely, as one moves southward and altitude decreases, the climate transitions to a warm, humid-tropical one.

The region witnesses a significant influx of rainfall from the southwest monsoon, occurring predominantly between June and September, with an average annual precipitation exceeding 4000mm. Summer is marked by frequent thunderstorms, while winters are distinguished by fog. Pre-monsoon showers typically occur in March and April, paving the way for the regular monsoon rains from May to October. Winter rains are not uncommon.

January stands out as the coolest month, contrasting with July, which registers as the hottest. This climatic diversity, influenced by altitude and the seasonal monsoons, contributes to a dynamic and distinctive weather pattern in the region.

The rain gauge installed at the Umsoo Mootang mine records remarkably high annual rainfall, as outlined in Table 1 and depicted in Fig. 3. The dataset spans two consecutive years, namely 2020-21 and 2021-22, revealing annual precipitation ranging from 4438 to 7464mm. The notable discrepancy in rainfall between these two periods can be attributed to the subdued rainfall during the June-July period in the year 2021-22, an anomaly that affected the entire Northeast region. The data further underscores significant pre-monsoon rainfall activities during April-May, giving way to exceptionally high rainfall during the monsoon season (June-September). Conversely, the region experiences a marked decline in rainfall during the period from November to February.

Table 1. Rainfall intensity in the Umsoo Mootang mine area

Sl No.	Month	Rainfall intensity (mm)	
		2020-21	2021-22
1	April	230	258
2	May	1018	469
3	June	1667	1076
4	July	2002	569
5	August	743	1325
6	September	1196	116
7	October	319	180
8	November	57	0
9	December	0	9
10	January	0	20
11	February	2	30
12	March	230	386
13	Total	7464	4438

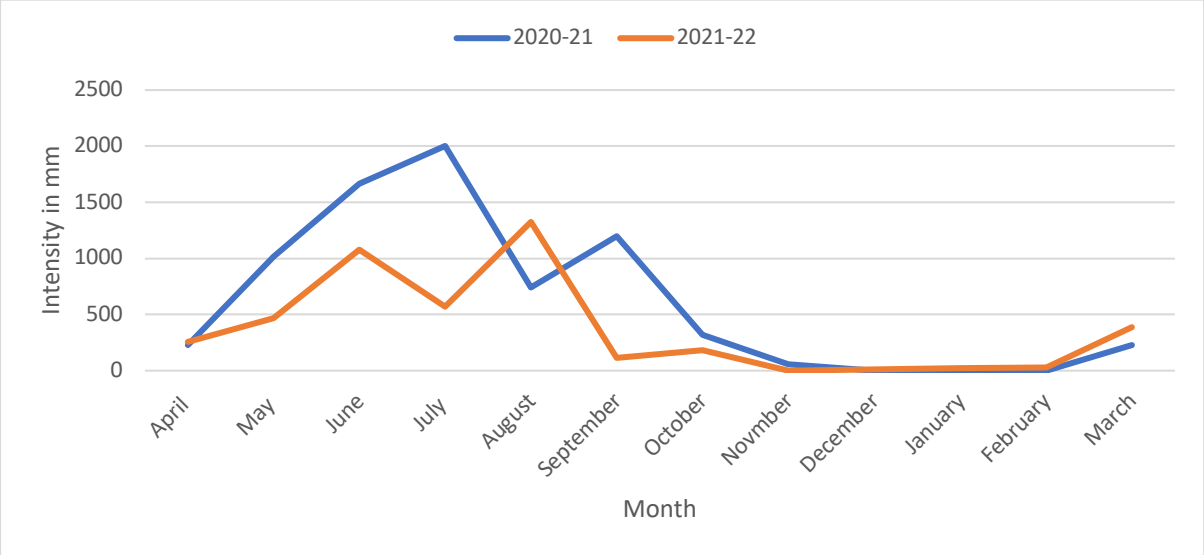


Fig. 3. Monthly distribution of rain in the Umsoo Mootang mine area.

4. Vegetation

The predominant vegetative cover in the region primarily consists of moist mixed deciduous forests with a semi-evergreen character. A comprehensive analysis of Normalized Difference Vegetation Index (NDVI) using the Sentinel 2 multispectral image dated 17-12-2023 (Fig. 4) reveals that the landscape is predominantly characterized by barren patches and sparsely vegetated lands covered by scrubs and grasses. Notably, dense forest patches are primarily concentrated along the sides of gorges. The specific area where the mining lease is located appears to be predominantly barren or sparsely vegetated, as indicated by the NDVI analysis. The dominance of barren land to sparse vegetation around the Umsoo Mootang mine points to the scarcity of groundwater to support thick and deciduous vegetation despite very high annual rainfall in the region.

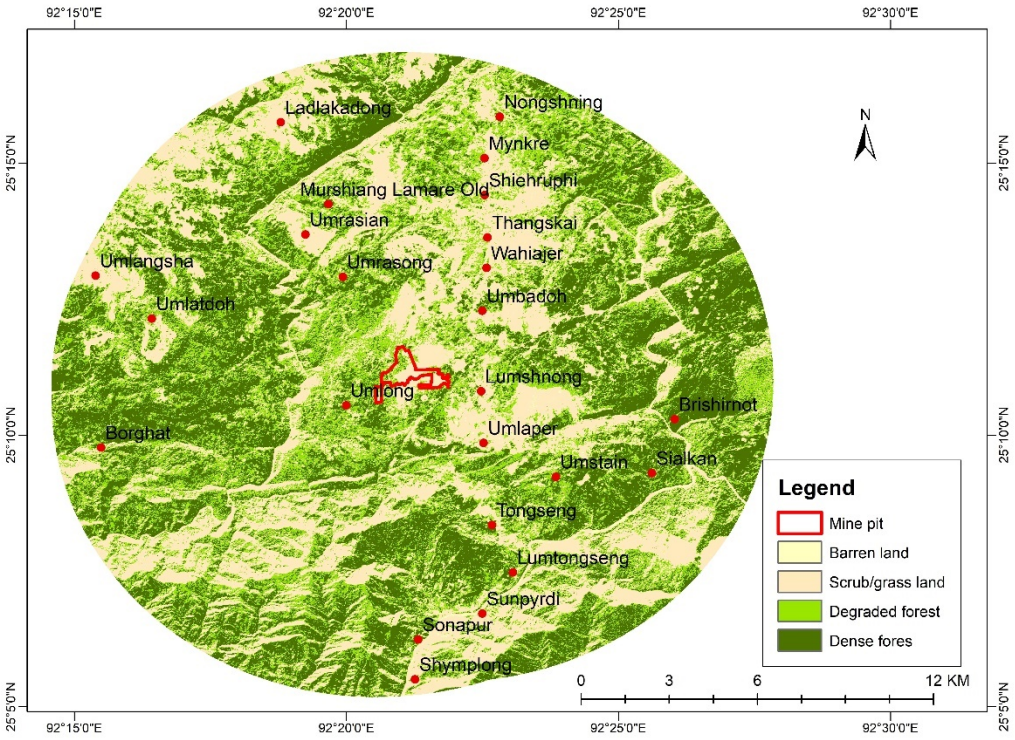


Fig. 4. Vegetation map of the Umsoo Mootang limestone mine and its 10km buffer region made from NDVI analysis of Sentinel 2 multispectral satellite image of 17-12-2023.

5. Physiography

The Umsoo Mootang limestone mine and its adjacent region showcase a gently undulating plateau with a southern gradient, intersected by deep gorges formed by the courses of the Lubha and Prang river systems (Fig. 5). Within the 10km buffer zone surrounding the mine, the elevation ranges from approximately 92m to 1040m above mean sea level, with elevated areas positioned in the northernmost section and the lowest points occurring at the base of the river gorges. This topographical pattern aligns with the predominant southerly flow direction of the rivers.

A closer examination of the 2km buffer region around the mine, illustrated in Fig. 6, reinforces the gently rolling nature of the terrain with a discernible southerly gradient. The Umsoo Mootang mine site itself exhibits an elevation range from 610m to 739m above mean sea level.

An intriguing feature in the vicinity of the Umsoo Mootang mine is the presence of a dip gorge located just 3km to the south (Fig. 7). This gorge, with a depth of approximately 450m from the ground level of the mine, assumes a crucial role in draining groundwater from the surrounding region. Coupled with the porous nature of the sandstones and the existence of

solution cavities and channels in the limestone that comprises the subsurface geology, the region experiences a scarcity of groundwater availability. This interconnected system highlights the intricate relationship between surface topography, geological composition, and groundwater dynamics in the Umsoo Mootang mining area.

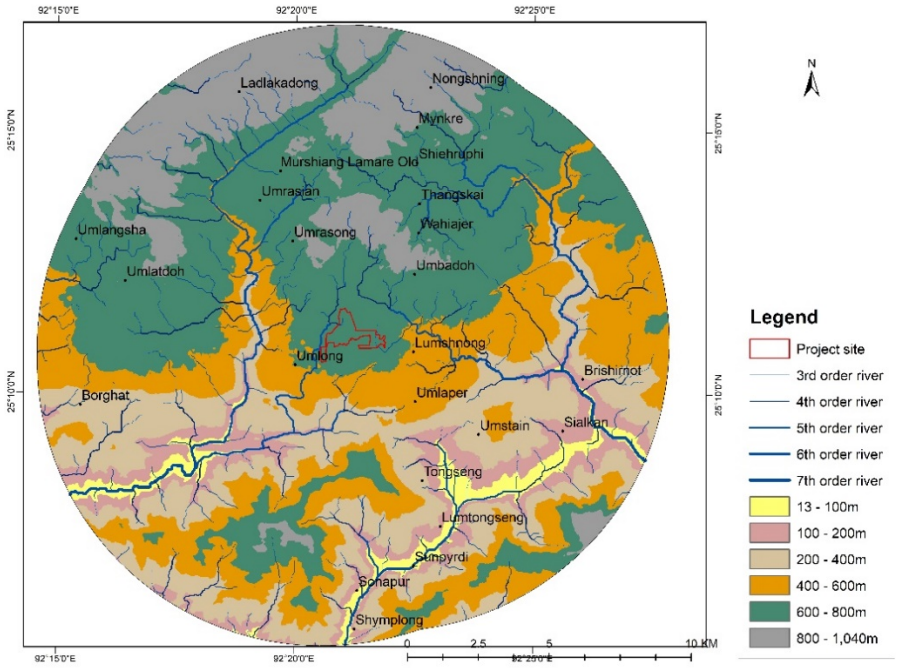


Fig. 5. The relief map of the 10km buffer area around the Umsoo Mootang limestone mine (prepared from the SRTM DEM of 30m spatial resolution).

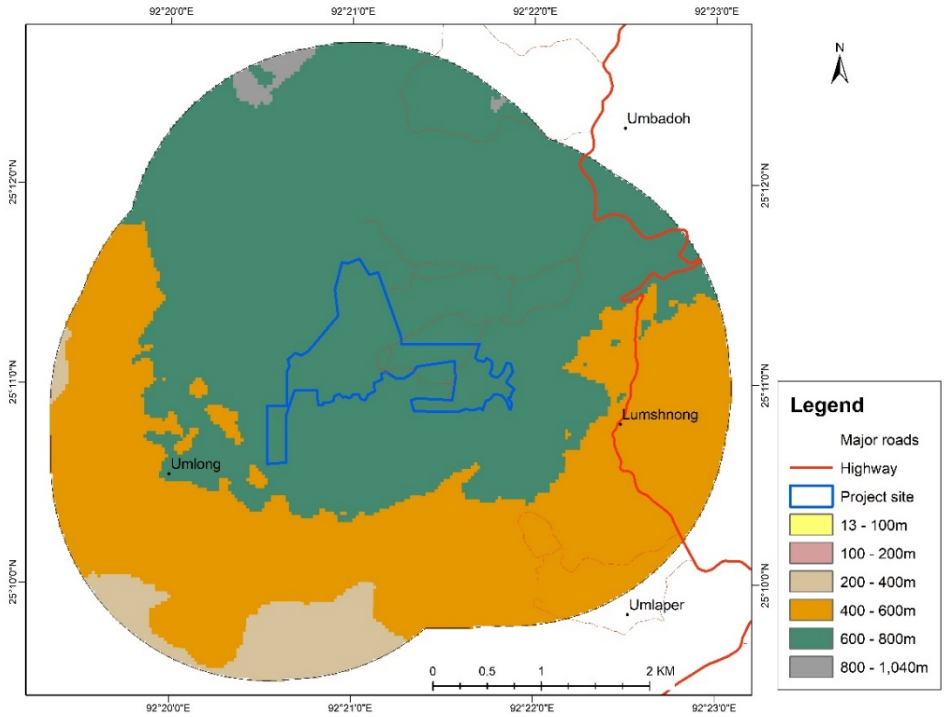


Fig. 6. The relief map of the area around 2km buffer area around Umsoo Mootang limestone mine (prepared from the SRTM DEM of 30m spatial resolution).

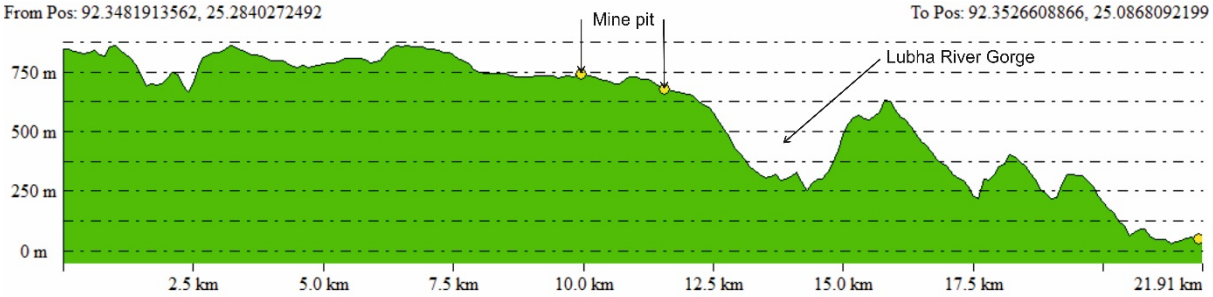


Fig.7. The North-South elevation profile section made across the 10km buffer area around the mine pit. The gorge formed by the upper course of the Prang River is seen on the immediate south of the mine lease.

The slope map of the 10km buffer region encompassing the Umsoo Mootang mine reveals a predominantly low ground slope, ranging from 0 to 5 degrees (Fig. 8). Elevated slope values, varying from 35 to 67 degrees, are primarily concentrated in areas corresponding to the deep river gorges. This distribution underscores the generally gentle topography of the region, with steeper slopes occurring primarily along the course of the river gorges.

Similarly, the slope map of the 2km buffer region surrounding the Umsoo Mootang mine (Fig. 9) also depicts a prevalence of very low ground slopes in the immediate vicinity of the mine. Higher slope values are again associated with the deep gorges formed by the river, emphasizing the continuity of the topographical features observed in the broader 10km buffer region.

This comprehensive slope analysis provides valuable insights into the overall terrain characteristics, with low ground slopes dominating the mining area while steeper slopes are mainly confined to the areas influenced by the deep river gorges. Such information is crucial for understanding the landscape dynamics and assessing the potential environmental implications of mining activities in the Umsoo Mootang region.

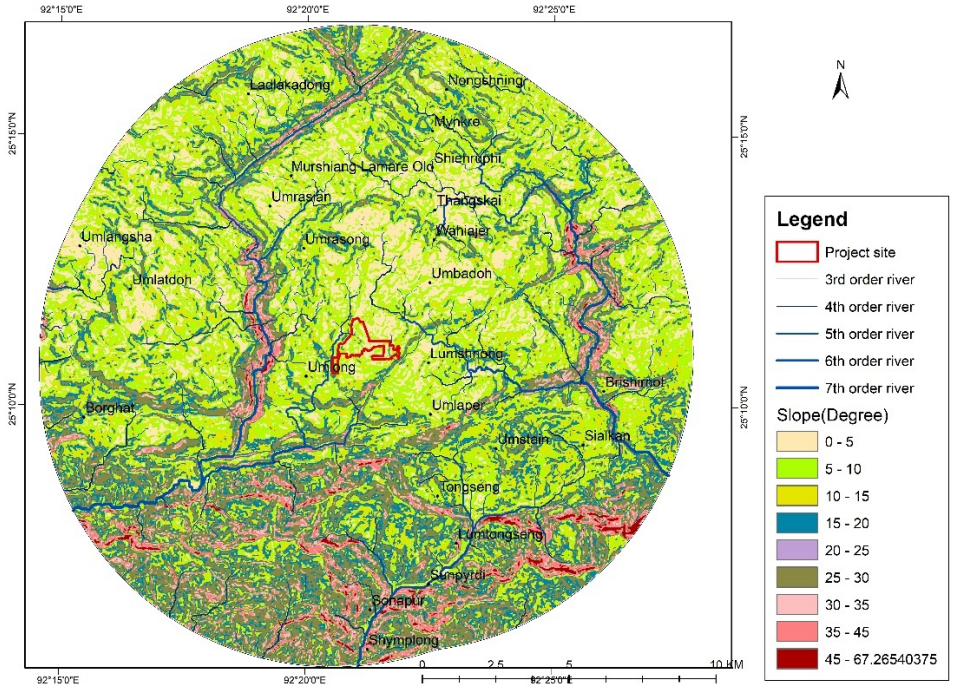


Fig. 8. The slope map of the 10km buffer region around the Umsoo Mootang mine (prepared from the SRTM DEM of 30m spatial resolution).

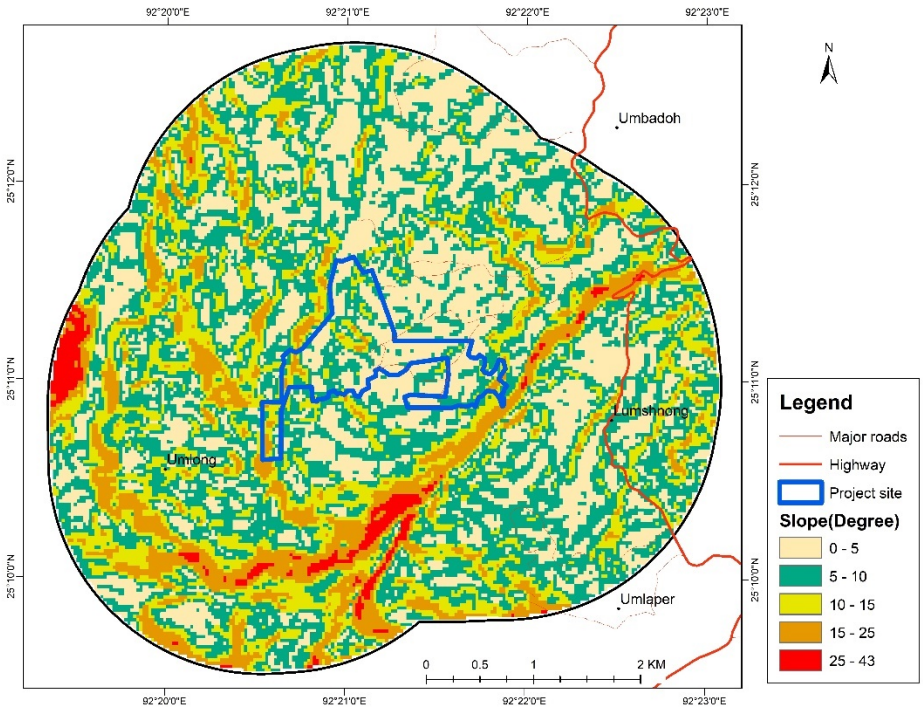


Fig. 9. The slope map of the 2km buffer region around the Umsoo Mootang mine (prepared from the SRTM DEM of 30m spatial resolution).

6. Drainage

The Umsoo Mootang mine is located near the watershed line that separates the south-flowing Lubha River to the east and the Shari Goyain River to the north, both of which carve deep gorges. Notably, the main channel of the Shari Goyan River lies beyond the 10km buffer area of the Umsoo Mootang mine. Instead, the mine area is primarily drained by the Wah Lariang River and its tributaries.

The southwestward-flowing Wah Lariang River eventually converges with the Prang River, which, in turn, joins the Shari Goyain River. The upper stretch of the Prang River is referred to as the Rashiang River. Additionally, a minor portion of the Umsoo Mootang mine area is drained by tributary streams that flow southeasterly into the Lubha River. The upper course of the Lubha River is also known as the Lukha River. No major stream or river cuts across the Umsoo Mootang limestone mine area.

The drainage pattern within most of the 10km buffer region surrounding the Umsoo-Mootang mine is dendritic, indicative of a gently undulating topography and consistent lithology (Fig. 10). However, a distinctive feature is observed in the northern part of the region, where the Rashiang River and its tributaries exhibit a rectangular drainage pattern. This unique pattern is attributed to the change in lithology and presence of joints, showcasing the influence of geology on the drainage network. The profound gorges and high drainage density in the region can be ascribed to elevated surface runoff, a consequence of exceptionally heavy rainfall in the area.

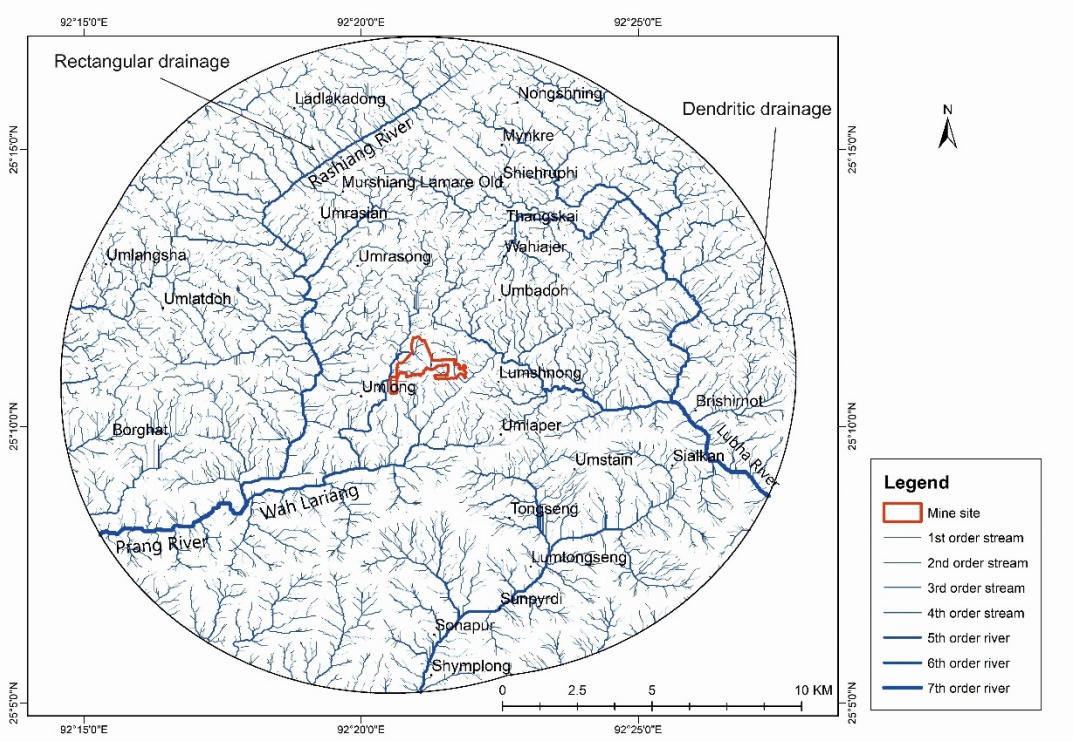


Fig. 10. The drainage map of the 10km buffer region around the Umsoo Mootang mine.

7. Land use/ land cover pattern

Land use refers to the way humans utilize the land for various purposes, such as residential, agricultural, industrial, or recreational activities. It encompasses the human activities that transform the natural landscape into a mosaic of urban, suburban, and rural areas. On the other hand, land cover deals with the physical attributes and natural features of the Earth's surface, including forests, wetlands, urban areas, and agricultural fields. Together, these two concepts provide a comprehensive understanding of the landscape and the human impact on it. Land use and land cover are essential components in understanding the complex interactions within the Earth's surface and play a pivotal role in assessing groundwater regimes. Both terms refer to the utilization and physical characteristics of the land, respectively, and their accurate analysis is crucial for sustainable water resource management. Different land cover types have varying permeabilities. For instance, natural vegetation and open soils generally allow better infiltration of rainfall, contributing to groundwater recharge. Natural vegetation promotes infiltration as plants help break the impact of rainfall and create pathways for water to penetrate the soil. Healthy and dense vegetation in an area is also a reflection of the presence of shallow and rich groundwater, while the predominance of barren and sparse vegetation reflects poor groundwater. The

aim of the land use/land cover classification around the Umsoo-Mootang mine was to assess groundwater availability in the region.

For land use/land cover classification, automated classifiers are available in image processing software, encompassing both supervised and unsupervised classification methods. However, these classifiers primarily rely on tone for categorization, leaving other crucial elements of image interpretation, such as texture, pattern, association, and shadow, unutilized. To address this limitation, a visual classification of the satellite image was performed, enabling the incorporation of all relevant elements in the classification process. This visual classification was carried out using a GIS platform. Ground truthing, involving fieldwork in the region, was conducted to validate the classification results. The classification utilized a multispectral image captured by the Sentinel-2 sensor on December 17, 2023, with a spatial resolution of 10 meters. The False Color Composite (FCC) applied for the classification employed a band combination of 8-4-3. The results are presented in two maps: one for the 10km buffer region around the Umsoo Mootang mine (Fig. 11) and the other for the 2km buffer region (Fig. 12).

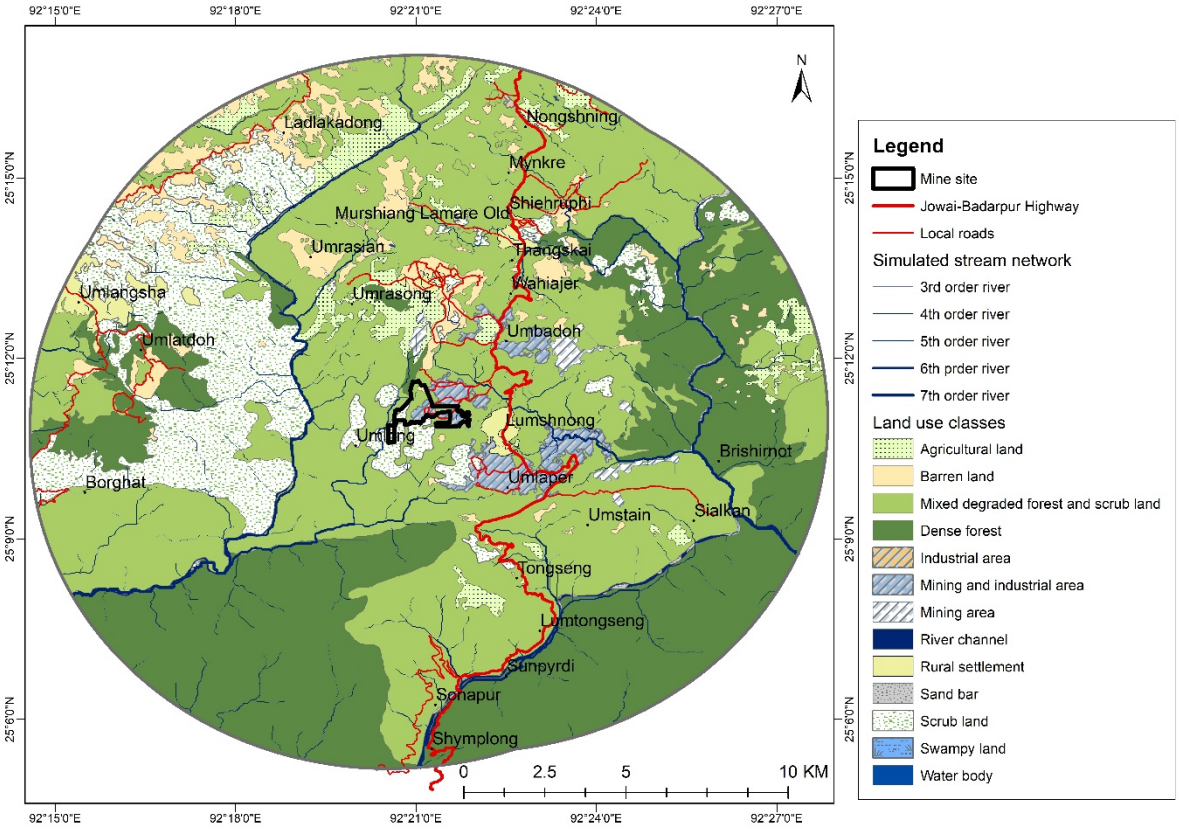


Fig. 11. The Land use/land cover map of the 10km buffer region around the Umsoo-Mootang mine.

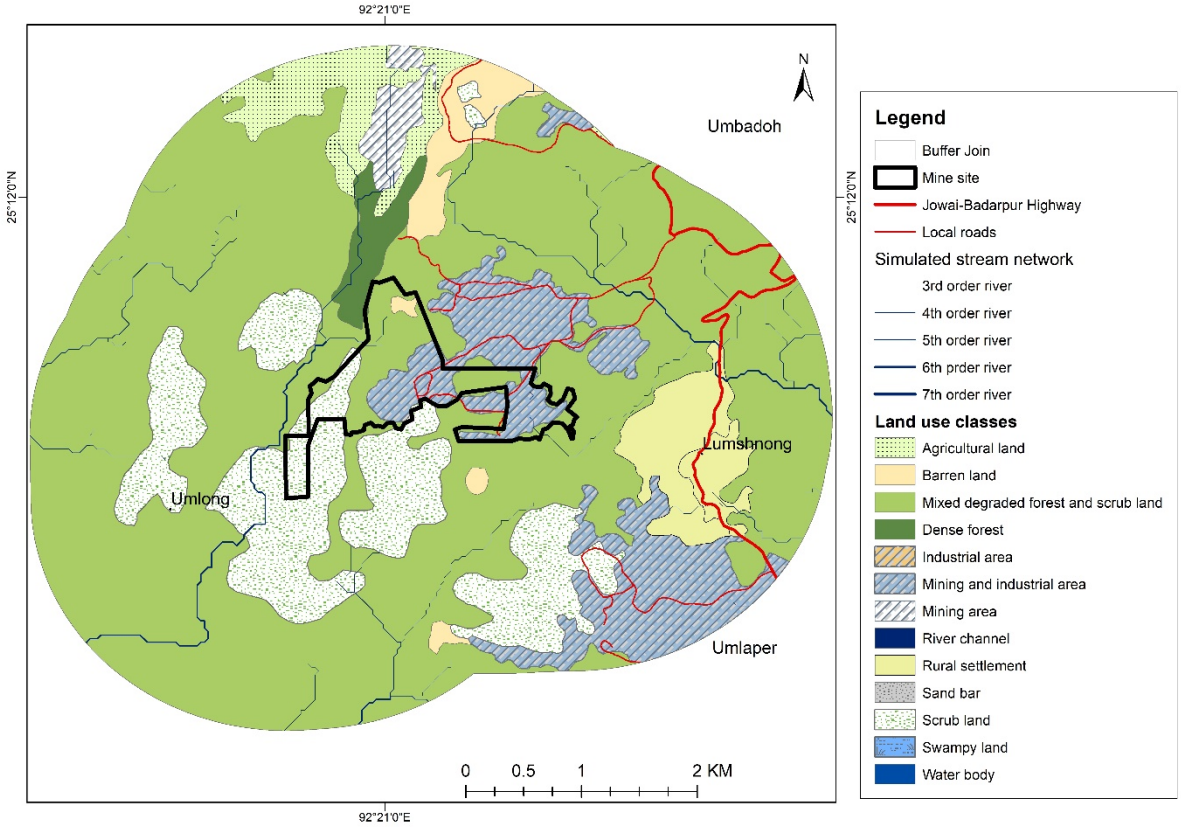


Fig. 12. The Land use/land cover map of the 10km buffer region around the Umsoo-Mootang mine.

7.1. Land use/land cover pattern of the 10km buffer region

The land-use classes within the 10km buffer region are illustrated in Fig. 13 and succinctly summarized in Table 2. Key categories include sparsely vegetated land/scrubland (55.91%), dense forest (30.79%), and barren land (5.16%), constituting the predominant land-use/land-cover classes in the region. Sparsely vegetated land/scrubland and barren land are predominantly situated in the central and northern sectors of the buffer region, while dense forests are primarily concentrated in the southern and southeastern peripheries. The relief map suggests that dense forests cluster in low-lying areas characterized by the presence of river gorges. Agricultural land accounts for a modest 3.76% of the total area, indicating limited agricultural activities. Approximately 2.21% of the region is allocated to mining and industrial activities. Only 1.34% of the total area of the 10km buffer region is characterized by human settlements reflecting very sparse population density in the region. An intriguing aspect of the region is the notably sparse distribution of water bodies, indicative of a constrained and deep groundwater regime.

Sparsely vegetated land denotes areas with a sparse distribution of trees and a very open canopy. The prevalence of sparsely vegetated land, scrubland, and barren land in the central and northern parts of the region implies a scarcity of soil cover and groundwater. Conversely, the dominance of dense forest in the southern periphery suggests ready availability of groundwater and a thicker soil cover.

Table 2. Land use/land cover classes in the 10km buffer region around the Umsoo-Mootang mine.

Sl No	Land use/land cover classes	Area in hectare	Percentage coverage
1	Agricultural land	1437.16	3.76
2	Barren land	1974.36	5.16
3	Dense forest	11783.02	30.79
4	Mining and industrial area	844.30	2.21
5	River channel	216.70	0.57
6	Rural settlement	513.83	1.34
7	Sand bar	101.87	0.27
8	Sparsely vegetated land/scrubland	21398.17	55.91
9	Swampy land	0.65	0.00
10	Water body	2.85	0.01

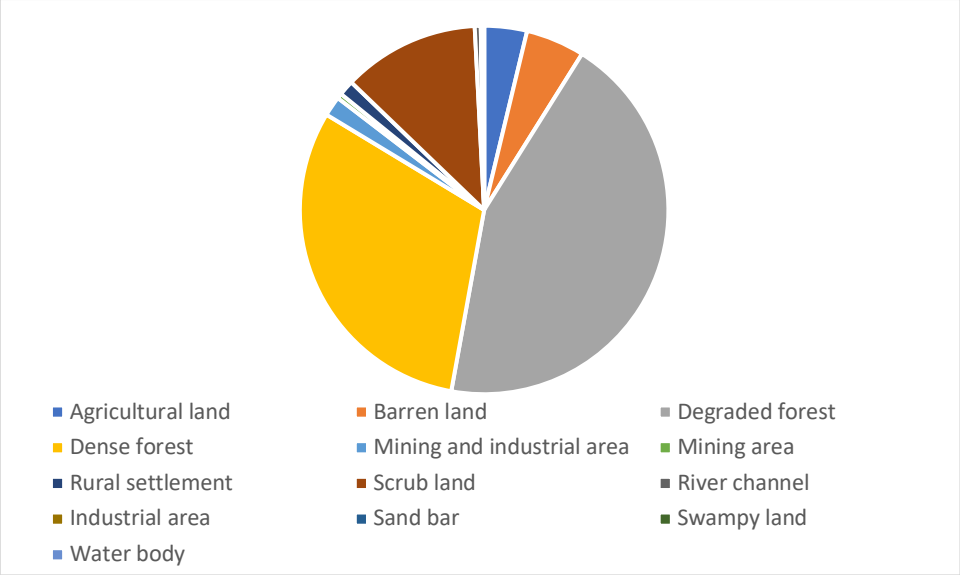


Fig. 13. Pie diagram showing distribution of land use/land cover classes in the 2km buffer region.

7.2. Land use/land cover pattern of the 2km buffer region

The land-use/land-cover classes within the 2km buffer region serve as an indicative reflection of the ground conditions within the Umsoo Mootang limestone mine area itself (Table 3 and Fig. 14). Sparsely vegetated land/scrubland (77.59%) emerges as the predominant land cover class in this buffer. Their predominance suggests a thin soil cover and limited groundwater availability in the immediate vicinity. Mining and associated industrial activities occupy 11.48% of the 2km buffer region, with human settlement covering 3.79% of the area, and agricultural activities encompassing 3.48%. Dense forest, comprising only 1.4% of the total area, is relatively limited in coverage. The dense forests are associated with the river gorges in the southern peripheral part of the 2km buffer region.

Table 3. Land use/land cover classes in the 2km buffer region around the Umsoo-Mootang mine.

Sl No.	Land use	Area in Hectare	Percentage coverage
1	Barren land	63.3	2.25
2	Dense forest	39.5	1.40
3	Rural settlement	106.7	3.79
4	Agricultural land	98.0	3.48
5	Sparsely vegetated land/scrubland	2185.0	77.59
6	Mining and industrial area	323.4	11.48

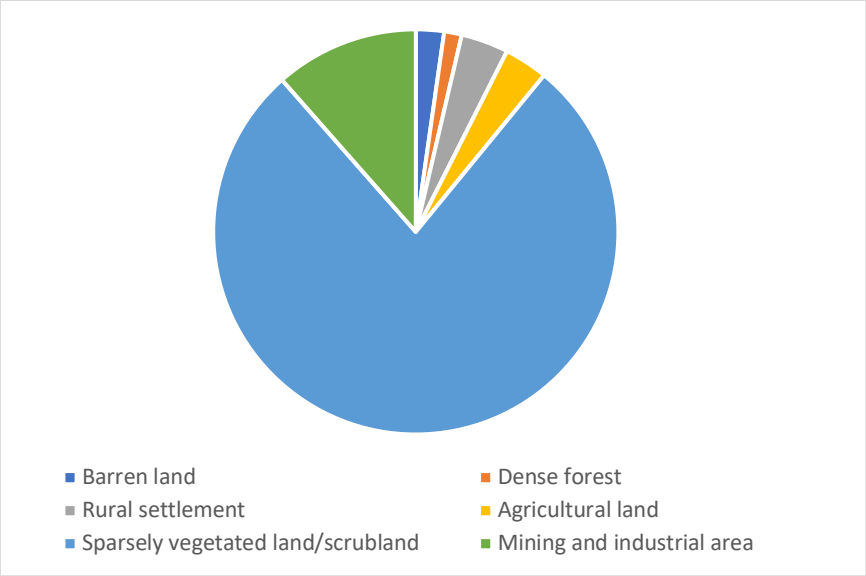


Fig.14. Pie diagram showing distribution of land use/land cover classes in the 2km buffer region.

8. Hydrogeomorphology

Hydrogeomorphology, at the intersection of hydrology, geology, and geomorphology, plays a crucial role in understanding the dynamic interactions between surface water and groundwater systems. This interdisciplinary field focuses on the influence of landforms and geological structures on the distribution, movement, and storage of water in the subsurface. By examining the intricate relationships between hydrological and geomorphic processes, hydrogeomorphology provides valuable insights into the behaviour of groundwater resources. Understanding the spatial and temporal variations in hydrogeological features is essential for effective water resources management, sustainable development, and addressing challenges such as water scarcity and contamination. In essence, hydrogeomorphology serves as a foundational tool in groundwater studies, offering a holistic perspective that enables scientists and policymakers to make informed decisions regarding water resource planning and environmental conservation.

The hydrogeomorphological units in the region around Umsoo Mootang Limestone mine were identified on Sentinel-2 multispectral satellite image of 10m resolution and a hillshade map prepared from SRTM DEM of 30m resolution. The units were delineated on GIS platform utilizing manual digitizing and field checking. The hydrogeological map is given in the Fig. 15. The characteristics of different hydrogeomorphological units are discussed below.

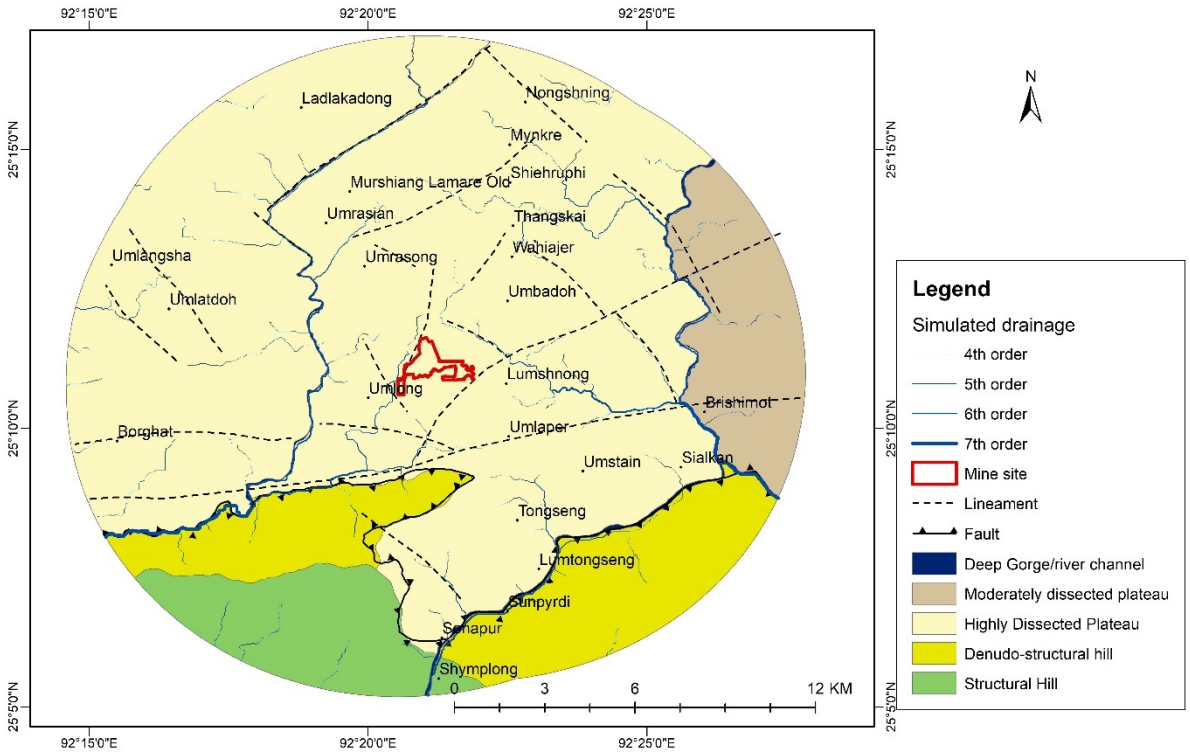


Fig. 15. The hydrogeomorphological map of the 10km buffer region around the Umsoo Mootang Limestone mine.

8.1. Structural Hill

The structural hill is a distinctive landform shaped by geological structures such as faults, folds, and fractures, which significantly influence the hydrological and geomorphological characteristics of the area. These hills are formed due to the differential weathering and erosion rates of rocks along structural features. The structural hills inside the 10km buffer region around the Umsoo Mootang limestone mine is situated in the southernmost extremity of the region and formed due to neotectonic activities associated with the Dauki Fault in the vicinity. Geologically the structural hills in this region are composed mostly of sandstones of the Barail Group of rocks with high porosity and permeability. The importance of structural hills in groundwater hydrogeology lies in their role as potential groundwater reservoirs and conduits. The geological structures within these hills create pathways for the movement of groundwater, influencing its flow and storage. Faults and fractures may act as preferential flow paths, facilitating the recharge and discharge of groundwater. Additionally, the lithological variations associated with structural hills can impact groundwater quality by influencing the composition of aquifers and the geochemical characteristics of the water. The structural hills in the study area are mostly occupied by dense forests as we see from the land use/land cover map.

8.2. Denudo-structural hills

The denuded structural hills exhibit clear indications of denudation, yet the erosional processes have not completely erased prominent structural features, such as dip facets and strike trends. Within the 10km buffer region surrounding the Umsoo Mootang mine, the denudo-structural hills are positioned to the south, forming a hydrogeomorphological unit that remains on the periphery of the more pronounced structural hills observed further to the south. The area occupied by denude-structural hills is also characterized by presence of faults of regional scale. This hydrogeomorphological unit is also composed of porous sandstones of the Barail Group. The land use/land cover map shows the area is mostly occupied by dense forest.

8.3. Plateau

The plateau lies to the north of the denuded structural hills, encompassing the entire northern and central regions within the 10km buffer around the Umsoo Mootang limestone mine. Characterized by gently rolling topography, the plateau exhibits a gradual and low topographical gradient towards the north. Notably, the Umsoo Mootang mine is exclusively situated on this plateau. Further classification of the plateau is based on its degree of dissection, resulting in the identification of highly dissected and moderately dissected plateau zones. The entirety of the north and central region to the west of the Lukha River course within the 10km buffer of the Umsoo Mootang limestone mine is deemed a highly dissected plateau. Conversely, the terrain to the east of the Lukha River is categorized as a moderately dissected plateau. This segment of the plateau has likely been influenced by neotectonic activities linked to the Dauki Fault. Despite the gently rolling topography, the southern gradient and ample rainfall contribute to extensive dissection and soil profile depletion, marked by the presence of deep gorges. The immediate substratum comprises sandstones and limestones of the Sylhet Formation, leading to a region that is generally deficient in groundwater due to the porous nature of the sandstones, presence of underground channels, and solution cavities in the limestones. Consequently, the plateau is characterized by sparse vegetation and scrubland owing to the limited groundwater availability in this region. The Umsoo Mootang limestone mine is situated entirely on highly dissected plateau.

8.4. Deep gorges and river channels

Several rivers in the region, namely the Lubha River, Prang River, and Rahsiang rivers, have carved deep gorges into the plateau. The genesis of these gorges is intricately linked to the upliftment of the plateau during the post-Miocene time, coupled with the region's high rainfall. The antecedent rivers have systematically incised the plateau through headward erosion, giving rise to these gorges, owing to the gradual and consistent rise of the plateau and the substantial precipitation. Notably, the gorge associated with the upstream section of the Prang River courses through the terrain in an ENE-WSW direction, just 3km south of the Umsoo-Mootang limestone mine (Fig. 7). Remarkably, this gorge plunges to a depth of approximately 450m from the ground level at the mine site. The gorge's orientation is perpendicular to both the general topographic gradient of the terrain and, hence, the groundwater flow movement. This unique configuration effectively drains groundwater from the Umsoo Mootang mine area, resulting in a scarcity of groundwater in the region. In two boreholes within the mine area, groundwater was conspicuously absent up to a depth of 150m. The piezometer wire was lowered to study the aquifer properties in both monsoon and post-monsoon periods, with no discernible groundwater table encountered.

9. Geological setup

The region around Umsoo Mootang limestone mine is characterized by and Upper Cretaceous to Oligocene sedimentary sequence of the South Shillong Shelf of the Assam-Arakan Basin that unconformably overlies the Precambrian Gneissic Basement. The Upper Cretaceous-Oligocene sedimentary sequence shows a low. However, the dip increases as one approaches the Dauki Fault that runs east-west along the periphery of the South Shillong Shelf. The rock formations that are exposed in the in the 10km buffer region around the Umsoo Mootang mine is discussed below. The stratigraphic succession (modified after Deshpande et al, 1993) of the region is given in the Table 4. The geological map is given in the Fig. 16.

Table 4. Stratigraphical succession of the region around the Umsoo-Motang limestone mine.

Age	Group	Formation	Member	Lithology
Oligocene	Barail Group	Unclassified		Coarse grained sandstones, shales, minor coal lenses with carbonaceous shale.
Paleocene to Eocene	Jaintia Group	Kopili Formation		Alteration of dark grey coloured carbonaceous shale, siltstone and fine-grained sandstone and occasional mark beds followed by thick bedded
		Sylhet Limestone Formation	Prang Limestone	Bluish grey and highly fossiliferous limestone.
			Narpuh Sandstone	Ferruginous to calcareous, medium to coarse grained friable sandstones with an impersistent coal seam near Lumshnong.
			Umlatdoh Limestone	Dark grey coloured, highly fossiliferous, hard and compact limestone.
			Lakadong Sandstone	Fine to medium grained, well bedded, ferruginous, quartzose sandstones with clays and coal seams.
			Lakadong Limestone	Grey to pink, hard and massive limestone beds prolific calcite veins at the basal part. It grades into calcareous sandstone towards top.
		Therria Formation		Limestone beds with calcareous sandstone, siltstone and shale
Upper Cretaceous	Mahadek Formation			Medium to coarse grained arkosic, glauconitic sandstone with conglomerate beds
Precambrian Gneissic Basement				Gneisses, schists, quartzites, intruded by Neo Proterozoic to Cambrian granite plutons and unconformably overlain by the supracrustal rocks of the Meso- to Neoproterozoic Shillong Group

9.1. Precambrian Gneissic Basement

The Precambrian Gneissic Basement is composed of migmatites, gneisses, schists, quartzites and amphibolites with granitic and basic intrusive bodies. The supracrustal rocks of the Shillong Group represented by quartzites and phyllites Meso- to Neoproterozoic age. The rocks show several generations of deformation. In the 10km buffer region around the Umsoo Mootang limestone mine the Precambrian Basement is generally concealed under the sedimentary sequence of South Shillong Shelf. However, the basement rocks are exposed in linear patches along the deep river gorges. On the top of the Precambrian Basement the thickness of the sedimentary sequence of the South Shillong Shelf shows thickness between 170 to 300m. In the Umsoo Mootang mine the Precambrian Basement is situated at a depth of 229m from the ground surface as the borehole drilled in the mine site revealed.

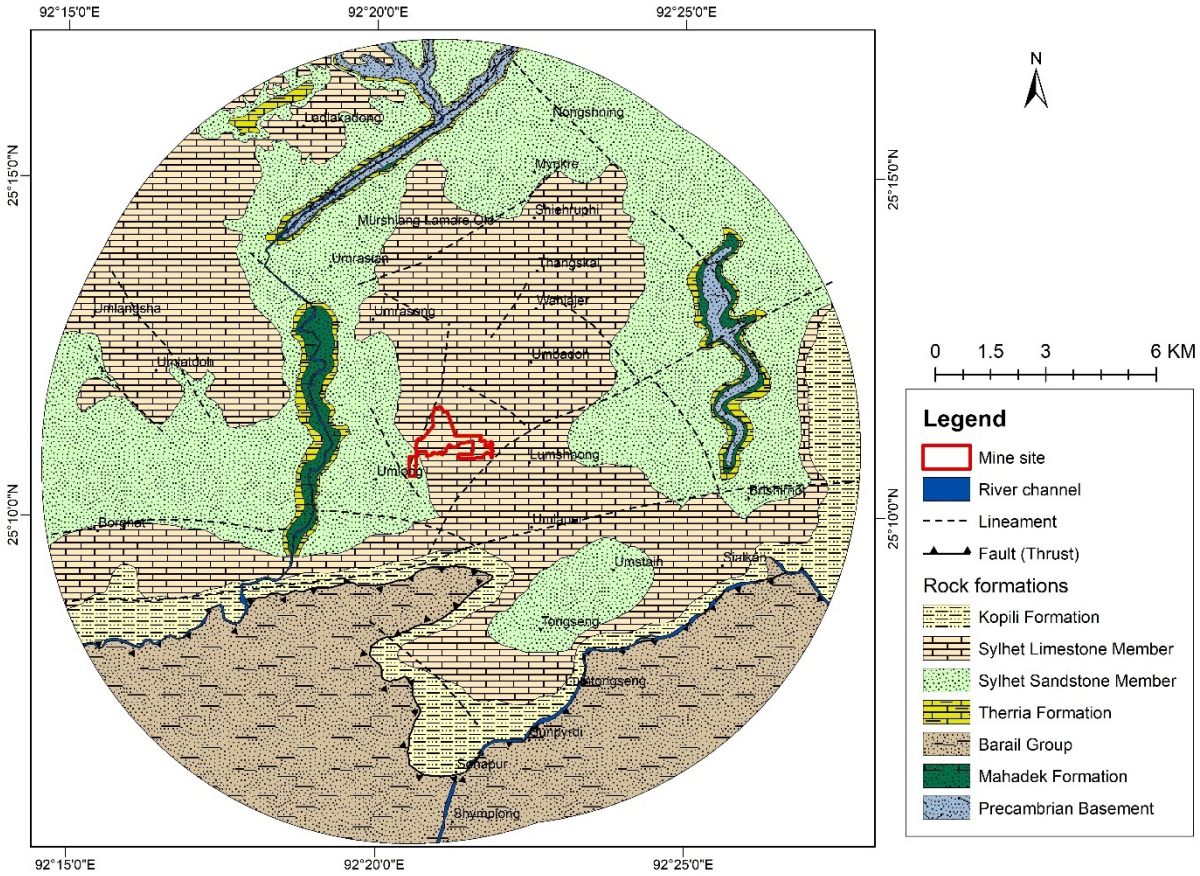


Fig. 16. The geological map of the 10km buffer region around the Umsoo Mootang limestone mine.

9.2. Mahadek Formation

The Mahadek Formation of the Upper Cretaceous age unconformably overlies the Precambrian Gneissic Basement in the Jaintia Hills. The type section of the Mahadek Fomation is the Mahadek village, about 8.5 km south of Cherrapunji.

The base of the Mahadek Formation is characterized by presence of conglomerate consisting of boulders and pebbles of quartzite and trap cemented in whitish calcareous sandy matrix. The conglomerates are overlain by purple or violet, massive sandstones with greenish blotches. Sandstones are medium to coarse grained, glauconitic, gritty and arkosic. The outcrops of Mahadek Formation are nearly horizontal in the north, whereas in the south it shows a southerly dip on the monoclinal flexure of the plateau. The Mahadek Formation is classified into a lower fluvial unit (LMS) and an upper marine unit (UMS). A hard lateritic ground represents the discontinuity surface between the fluvial, reduced uranium-mineralized facies (LMS) and the marine, oxidized facies (UMS) (Kak and Subramanyam, 2002). In the 10km buffer region around the Umsoo-Motang mine, the Mahadek Formation is capped everywhere by the younger Eocene sedimentary sequence

except in the deep river gorges where it is exposed above the Precambrian Basement at the base of the gorges.

9.3. Jaintia Group

The term Jaintia Series was applied to the Eocene strata by Evans (1932), though the age boundaries were not precisely defined. Stratigraphically the rocks overlying the Langpar Formation and underlying the Barail Group are designated as the Jaintia Group in the South Shillong Shelf. The Jaintia Group as presently defined is constituted of four distinct lithological units, *viz.*, Therria, Sylhet and Kopili Formations.

9.3.1. Therria Formation

The beds of arkosic sandstones with unfossiliferous limestones that conformably overlies the Langpar Formation or Mahadek Formation is known as the Therria Formation. The exposures of the Therria Formation are seen between the Lubha River to the east and Jadukata River to the west. The formation in the composed of two units, *viz.*, a lower limestone unit (70m) and an upper sandstone unit (30m). The top of the formation is characterized by a highly bioturbated sandy band (Garg and Khowaja-Ateequzzaman, 2000). The formation is best exposed in the Umsohrynkew River section and around Cherrapunji area. It attains the maximum thickness of 213, near Umstew.

9.3.2. Sylhet Formation

The sequence of fossiliferous limestones alternating with sandstones outcropping along the southern fringe of the Shillong Plateau were named as Nummulitic Series by Medlicott (1869). Evans (1932) used the name Sylhet Stage for this limestone-sandstone sequence. Wilson and Metre (1953) recognised the Lakadong Limestone, Lakadong Sandstone, Umlatdoh Limestone, Nurpuh Sandstone and Prang Limestone from base to top as distinct lithological units within the 'Sylhet Stage'. The Sylhet Formation conformably overlies the Therria Formation in the Khasi and Jaintia Hills.

Since individual members of the Sylhet Limestone Formation are thin and not mappable in 1:50,000 scale, these members broadly divided into two members including Lakadong Limestone and Lakadong Limestone Members in the Lower Sylhet Member and Umlatdoh Limestone, Narpur Sandstone and Prang Limestone Members in the Upper Sylhet Member for the ease of preparation of the geological map (Fig. 16).

The Basal Member of the Sylhet Formation is Lakadong Limestone Member. It is composed of grey to pink, hard and massive limestone beds prolific calcite veins at the basal part. It grades into calcareous sandstone towards top. This is observed in a section near Lumshnong IB. The type section is present near Lakadong in Jaintia Hills (Nagappa, 1954).

The Lakadong Sandstone conformably overlies the Lakadong Limestone Member in the Khasi and Jaintia Hills. It is in turn conformably overlain by the Umlatdoh Limestone Member. The Lakadong Sandstone is composed of fine to medium grained, well bedded, ferruginous, quartzose sandstones with clays and coal seams. It houses the workable coal seams in Khasi and Jaintia Hills region.

The Umlatdoh Limestone Member is composed of highly fossiliferous, hard and compact limestone beds. This member is well exposed near the village Siropi on the Shillong-Badarpur Road section in Jaintia Hills. In the east Khasi Hills region this member is well exposed between Mawlong and Ishamati on the Cherrapunji-Shella Road section. The thickness of Umlatdoh Limestone in the Prang River section is 40 metres.

The Umlatdoh Limestone is conformably overlain by the Narpuh Sandstone Member. It is composed of ferruginous, medium to coarse grained friable sandstones. The colour of the sandstones is black near the contact with the Umlatdoh Limestone and white at the top. Basal part is calcareous. The basal part contains a thin impersistent coal seam near Lumshnong. The type area named after the Narpuh Reserve Forest of the Jaintia Hills in Meghalaya.

The Prang Limestone Member conformably overlies the Narpuh Sandstone. It is the uppermost member of the Sylhet Limestone Formation. It is composed of highly fossiliferous grey to bluish grey limestones with calcareous sandstone and fossiliferous shale at the top.

9.3.3. Kopili Formation

Medlicott (1869) had grouped the Eocene rocks of the South Shillong Plateau in his Nummulitic Series. Evans (1932) separated a dominantly shaly sequence overlying the Sylhet Stage and named it as Kopili Stage. Mathur and Evans (1964) retained the same. Chakraborty et al. (1974) gave it a lithostratigraphic status with formation rank. Presently Kopili is defined to contain a shale dominated sequence occupying a position between the

underlying Sylhet Formation and the overlying Barail Group. The Kopilis are exposed as narrow linear outcrops in the Garo, Khasi and Jaintia Hill, along the southern edge of Shillong PlateauIn the southern foothills of Shillong plateau in Khasi and Jaintia Hills the Kopilis are represented by shale with intercalated sandstone. The shales are brown to grey, sometimes iron stained, hard and splintery. The intercalated sandstones are brown, fine grained, moderately sorted, often hard and massive or flaggy. The thickness of the formation gradually decreases from the east to west of the Shillong Plateau. In Jaintia Hills the thickness of the formation is 500m. The Barail Group conformably overlies the Kopili Formation. The type are lies on the bank of Kopili River in Jaintia Hills near Khorungma village.

9.4. Barail Group

The Oligocene Barail Group of rocks conformably overlies the Kopili Formation in most of the parts of the Assam-Arakan Basin. However, in the region south of the Umsoo Mootang limestone mine the contact between the Barail and Kopili is thrusted. The Barail Group is the Jaintian Hills region is not classified into formations. It is composed of coarse-grained sandstones, shales, minor coal lenses with carbonaceous shale.

The stratigraphic succession of the 10km buffer region around the Umsoo Mootang mine is give in the Table 4 below.

9.5. Geology of the Umsoo Mootang mine

The Umsoo-Mootang Limestone mine pit exposes the Sylhet Limestone Formation. The stratigraphic succession and individual thickness of the members of the Sylhet Limestone Formation are given in the Table 5 below.

Table 5. Stratigraphic succession of the Umsoo-Motan mine.

Group	Formation	Members	Thickness
Red Soil			0-16.4m
Jaintia Group (Paleocene to Eocene)	Sylhet Limestone Formation (Middle Eocene)	Narpuh Sandstone	5-35m
		Umlatdoh Limestone	2.5-59.5 (avg 29.7m)
		Lakadong Sandstone	7-25m (avg 17.11m)
		Lakadong Limestone	4-91m (avg 48.60m)
Base not exposed			

9.5.1. Lakadong Limestone

The Lakadong Limestone is not exposed at the surface within the mine site; it lies beneath the 657mRL. It is exposed at the deeper benches within the mine pit (Fig. 17). The Lakadong Limestone exhibits an average thickness of 48.60m, ranging from 4.0m to a maximum of 91m. Borehole data indicates that the Lakadong Limestone is notably rich in CaO, boasting a content of 50.54%, while displaying low levels of silica and magnesia.

9.5.2. Lakadong Sandstone

The Lakadong Sandstone conformably overlies the Lakadong Limestone within the mine pit (Fig. 17). The thickness of the Lakadong Sandstone varies from 7.0 to 25.0m, averaging at 17.11m. It is composed of greyish white to yellow brown coloured medium to coarse grained, friable quartzose sandstones. Bedding planes are indistinct and often shows planner cross bedding. Medium to coarse grained and friable nature of the sandstone indicates high porosity and permeability of the Lakadong Sandstone.

Fig. 17. Lakadong Limestone overlain by Lakadong Sandstone in the mine benches.

9.5.3. Umlatdoh Limestone

The Umlatdoh Limestone conformably overlies the Lakadong Sandstone within the mine pit. The Umaldoh limestone in the area comprise hard, massive and a very thick foramiferal-algal carbonates with dolomite sandstone and thin shale sequences of early Eocene (Fig. 18, 19b). The Umaldoh Limestone varies in thickness, based on the borehole intersections, between 2.5 and 59.5 m with an average of 29.7 m. It is exposed in the upper benches of the mine pit. It is richer in magnesia than the Lakadong Limestone. It has siliceous lower grade limestone at the top and magnesia limestone at the bottom. In between, the limestone is, on average, high grade but with elevated magnesia content.

Fig. 18. Umlatdoh Limestone exposed in the mining benches.

9.5.4. Narpuh Sandstone

The Narpuh Sandstone occupies the area above 685 m altitude and below this level the Umladoh limestone is exposed at surface. It conformably overlies the Umladoh Limestone. Sandstone highly weathered in nature. The Narpuh Sandstone is calcareous in nature. It is dark grey in colour near the boundary with the Umladoh Limestone and greyish white at the top. The dark grey variety has more calcareous material and hard, while greyish white variety is friable. The grain size ranges from medium to coarse (Fig. 19a, b).

The Upper part of the Eocene succession is not present in the mine site proper. The Narpuh sandstone is capped by a red soil with a thickness up to 16.4m.

Fig. 19a. Thick beds of Nurpuh Sandstone with cross bedding in the Mine pit.

Fig. 19b. The exposure of the Umlatdoh Limestone and Narpuh Sandstone at the top benches of the mine pit.

9.6. Geological Structures

The alternating limestone and sandstone beds in the Umsoo Mootang limestone mine is sub horizontal in nature without any structural complexities. The sequence possesses a general dip varying from 3° to 4° towards SE. The secondary structures observed in the area are joints and pinnacle at some places. Three sets of joints are developed within limestone, out of which two are vertical to sub-vertical.

10. Regional hydrogeology

The sandstone and limestone beds within the Sylhet Limestone Formation serve as the primary aquifers in the East Jaintia Hills District (Fig. 20). The medium to coarse-grained texture of the sandstones, coupled with the presence of solution cavities and subterranean channels in the limestones, facilitates the development of key aquifers in the region. According to the Comprehensive Groundwater Assessment conducted by the CCWB in the East Jaintia Hills District for the year 2017-18, groundwater is found in unconfined, semi-confined, and confined conditions. Groundwater near the surface is predominantly in a phreatic condition (CGWB, 2017-18).

10.1. Regional Aquifers

According to the CCWB report for the year 2017-18, shallow aquifers in the East Jaintia Hills District have depths ranging from 5 to 40 meters below ground level, existing in unconfined and semi-confined conditions. Deeper aquifers, found in limestone and sandstone beds, are in semi-confined to confined conditions and extend between 80.3 to 200 meters below ground level.

The depth of the weathered zone fluctuates from 4 to as high as 40 meters below the ground level, with sandstones dominating the region around the Umsoo Mootang mine. Groundwater occurrence in sandstone aquifers is predominantly influenced by factors such as the depth of the weathered zone, porosity, permeability of the sandstones, and secondary fractures like joints.

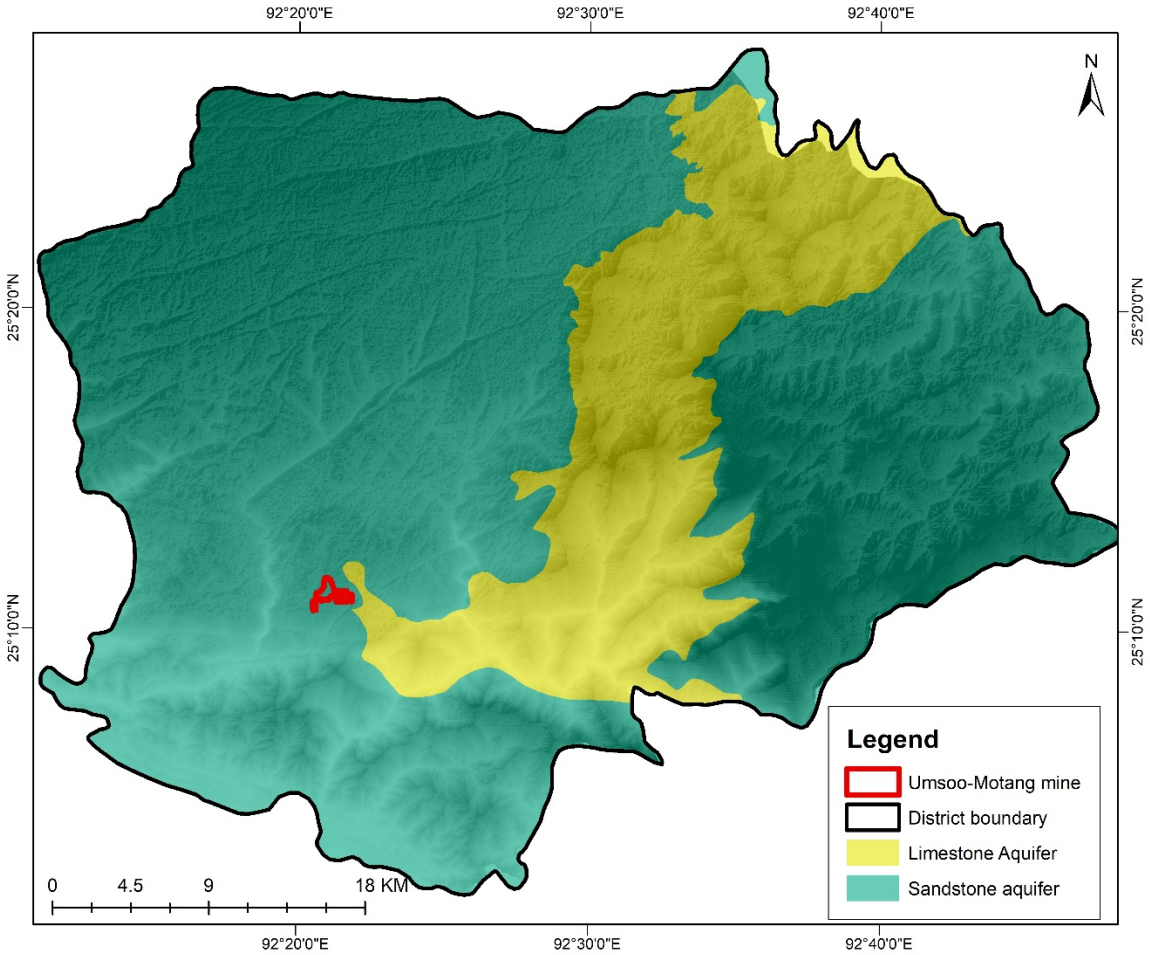


Fig. 20. Type of principal aquifers in East Jaintia Hills District. The Umsoo Mootang mine boundary is shown in the map. The location of streams from which samples were collected for analysis are also shown on the map (modified after CGWB, 2017-18).

The East Jaintia Hills District features numerous springs, essentially representing the surface discharge of groundwater. The occurrence of these springs is closely linked to the presence of gorge sections in the study area, where groundwater from aquifer beds emerges when they intersect with the gorges. These springs are most prevalent during the monsoon season, marked by increased discharge. During the dry winter months, the discharge typically diminishes, and some springs may even temporarily vanish as winter progresses. According to the CCWB report for 2017-18, the discharge of springs in the East Jaintia Hills District varies from 0.36 to 6.6 litres per minute during the pre-monsoon season and expands to 1.02 to 27 litres per minute in the post-monsoon season.

10.3. Hydrogeology of the Umsoo Mootang mine area

The possible aquifers in the area around the mine are the limestone and sandstone beds of the Sylhet Limestone Formation. The Lakadong Sandstone and Narpuh Sandstones exhibit a

medium to coarse-grained texture, with moderate friability. Fossiliferous qualities are noticeable in the Lakadong Limestone, Umladoh Limestone, and Prang Limestones. Neomorphism effects are subtly present, likely owing to their relatively youthful geological age. Calcite veins and crystals are infrequent, with some occurrence limited to the basal section of the Lakadong Limestone, that possesses some crystalline character.

The limestone formations exhibit susceptibility to solution cavities, and subterranean channels are widespread, creating favourable conditions for groundwater storage and flow. The regional drainage pattern follows a southward trajectory, aligning with the overall topographic gradient. The rock sequence around the Umsoo Mootang mine features a low southerly dip, mirroring the contours of the ground surface. The presumed direction of groundwater flow, thus, corresponds to this southerly trend.

Approximately 3 km south of the Umsoo Mootang mine, a significant geological feature emerges—a 450 m deep gorge carved by the upper course of the Prang River (Fig. 6). This gorge traverses the entire sedimentary sequence above the Precambrian Basement. The permeable nature of the sandstone and limestone beds, along with solution cavities and subterranean channels, likely facilitates rapid drainage of groundwater towards the gorge.

This distinctive geological setting, coupled with a high drainage density in the vicinity, leads to a scarcity of groundwater around the Umsoo Mootang mine despite substantial precipitation. As a result, local communities in villages surrounding the mine heavily depend on surface water sources such as springs and rivers. The limited availability of groundwater is further evident in the sparse vegetation and barren land in the region, as revealed in the land use/land cover analysis.

A key characteristic of the Umsoo Mootang limestone mine region is the appearance of springs in the gorge sections, which are essentially underground channels within the limestone beds. These streams play a pivotal role in discharging groundwater from the aquifers to the gorges, contributing to a general lowering of the groundwater level in the Umsoo Mootang mine vicinity.

10.3.1. Aquifers

There are three wells in the Umsoo Mootang limestone mine area and that were selected for studying the piezometric head. The piezometer was lowered in two seasons *viz.*

September (monsoon) and December (post monsoon). However, the groundwater table was not reached till the base of the wells at about 171m bgl and 106m bgl (Fig. 21-22) even during the monsoon (September). The photograph of the mine pit is shown in the Fig. 23, which was taken in the September during the monsoon. The mine pit is very dry, that also proves that the groundwater table is far below the deepest level of the mine pit. The benches in the mine are also very dry without any groundwater seepages. This observation points to the fact that the groundwater regime in the area does not pose any threat to the stability of the mine.

The conclusion from these observations shows that the regional shallow unconfined aquifer observed around the region is absent in the Umsoo Mootang mine area, while the deep confined aquifer is present at a depth which is deeper than the deepest level of the mine pit. The gorge of the upper course of the Prang River at two km south of the mine pit, that flows transversely to the groundwater flow and topographical slope possibly cause draining of water from the shallow unconfined aquifer regime. The solution channel ways in limestones and high porosity and permeability of the associated sandstones possibly facilitates it.

Fig. 21. Lowering of piezometer at the borehole#1 with a depth of 171bgl in the location 92°21' 42.45"E - 25°10'58.65"N at the Umsoo Mootang mine in September, 2023.

Fig. 22. Lowering of piezometer at the borehole#2 with depth of 106m bgl in the location 92°21' 32.4"E - 25°10' 58.62"N at the Umsoo Mootang mine in September, 2023.

Fig. 23. Dry mine pit and benches in the Umsoo Mootang limestone mine during monsoon in September 2023.

10.3.2. Hydrogeochemistry of Umsoo-Motang mine vicinity

The water sources used by local population for drinking water have been identified and samples were taken in two seasons, viz. September (monsoon) and December (post monsoon) for water quality studies. The water sample # 1 (Fig. 25) was collected from a stream in the immediate vicinity of the mine. The water sample #2 (Fig. 26) is taken from a stream near Thangskai. This stream is also used by a government water supply unit to supply tapped drinking water to the nearby region. The water sample #3 (Fig. 27) is taken from a large spring that appear out of an underground channel of a limestone bed at a small gorge section in the vicinity of Murshiang Lamare. The first two samples represent surface water while the third one represents groundwater. The locations of the water samples are also shown in the map showing the regional aquifers (Fig. 25).

The Results are summarized in the Table 6 and 7. The results show all the parameters are except aluminium for Water Sample#1 collected from the stream near Thangskai are within permissible limit. The limestones of the Lakadong Limestone and Umladoh limestone in the Umsoo-Mootang area are alumina poor (avg. 2.11%; Final EIA Report). The alumina in the stream is possibly leached from weathered feldspar minerals in rocks of the Precambrian Basement in the upper catchment of the stream.

Fig. 25. Location of the Water sample #1 (stream) near immediate vicinity of the mine (92°22.511′E - 25°11.810′N).

Fig. 26. Location of Water sample #2 (stream) near Thangskai (92°22.621’E - 25°13.292’N).

Fig. 27. Location of water sample #3 (spring) near Mushing Lamare 92°21.500’E-25°13.264’N.

Table 6. Chemical quality of stream and spring water in the vicinity of Umsoo-Mootang limestone mine (sample collected on 17-09-2023).

Sl No.	Parameters	Water sample#1	Water sample#2	Water sample#3	Maximum limit (MRL) ppm as per IS 10500:2012
1	Aluminium	158.97	Not detected	6.07	30
2	Antimony	Not detected	Not detected	Not detected	5
3	Arsenic	0.15	0.24	0.07	10
4	Cadmium	0.02	Not detected	0.07	3
5	Chromium	4.98	Not detected	0.66	50
6	Copper	2.19	Not detected	0.73	50
7	Iron	Not detected	Not detected	Not detected	100
8	Lead	0.18	Not detected	0.01	10
9	Mercury	Not detected	Not detected	Not detected	1
10	Nickel	Not detected	Not detected	Not detected	20
11	Selenium	0.53	0.18	0.18	10
12	Silver	Not detected	0.04	Not detected	1

Table 7. Chemical quality of stream and spring water in the vicinity of Umsoo-Mootang limestone mine (sample collected on 3-12-2023).

Sl No.	Parameters	Water sample#1	Water sample#2	Water sample#3
1	pH	7.85	7.643	8.072
2	TDS	143	144	54
3	Carbonate (CO_3^{-2})	BDL	BDL	BDL
4	Bicarbonate	18.31	18.31	18.31
5	Total alkalinity (as $CaCO_3$)	18.31	18.31	18.31
6	EC(µs/cm) 25°C	302.5	346.2	159.9
7	Turbidity (BTU)	BDL	BDL	BDL
8	Nitrate (NO_3^-)	3.952	2.853	1.848
9	Fluoride (F^-)	0.049	0.021	0.288
10	Ca (Ca^{+2}) as $CaCO_3$	46.04	48.04	24.02
11	Mg (Mg^{+2}) as $MgCO_3$	13.33	15.75	4.84
12	Total hardness TH (as $CaCO_3$)	170.00	185.00	80.00
13	K	1.87	0.17	0.12

12. Conclusion

- The Umsoo-Motang mine, positioned at the southern edge of the Shillong Plateau near the Dauki Fault, is distinguished by deep gorge sections along the Lubha and Prang River courses. Perched at an elevation of 610-740m above mean sea level, the local exhibits a pronounced southerly ground gradient and drainage flow, indicative of a prevailing southerly groundwater regime. The topography of the area around the mine in gentle undulating. Hydrogeomorphologically, the mine site is situated on highly dissected plateau with depleted soil cover without any surface water bodies.
- While the area is predominantly characterized by sparsely vegetated and barren land, denoting limited groundwater availability, the southern plateau edge, a few kilometers south of the mine site, boasts lush vegetation, suggesting a potential groundwater reservoir with the lowering of topographical relief.
- The groundwater dynamics within the East Jaintia Hills District reflect a complex interplay of geological factors, featuring aquifers in sandstone and limestone formations at depths ranging from 5 to 200 meters. Shallow aquifers, in unconfined and semi-confined conditions (5-40m), contrast with deeper aquifers in limestone and sandstone beds (80.3-200m), which exist in semi-confined to confined conditions.
- At the Umsoo-Motang mine site, the piezometer study substantiates the absence of a saturated groundwater zone up to 171m depth, exceeding the deepest bench level. This indicates a scarcity of groundwater at the mine site. The presence of a 450m deep gorge approximately 3km south of the pit likely drains the shallow semi-confined/unconfined aquifers, while the deeper semi-confined/confined aquifers exist at depths surpassing 171m below ground level. The dearth of groundwater is further underscored by the dry mine pit and the absence of water seepage in the mine benches during the monsoon season, affirming that future bench instability in the mine pit won't be precipitated by groundwater dynamics.
- The absence of rivers or streams traversing the mine site reduces the risk of slope failure due to surface water inflow during intense precipitation events or due to excessive pore pressure.

- Furthermore, the hydrogeochemistry analysis of surrounding stream and spring water attests to its potability and indicates no adverse effects from mining activities.

13. Recommendations

The groundwater table is much lower than the deepest bench of the Umsoo-Mootang. Hence, the mine benches would not be affected by groundwater seepages, except after very high precipitation events. The accumulation of water on the benches would mostly cause by precipitation as the area is characterized by very high rainfall. Accumulation of water on the benches may develop pore water pressure and may create instability problem. During monsoon season some drainage arrangement should be developed with proper gradient away from the mining area.

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Name of the Industry: Dalmia Cement (Bharat) Limited Date: 28.03.2024

Date of Sample Collection: 17.03.24

Source : STP Outlet

Report No.: DCBL/ETP - WT/23-24/02.

WATER QUALITY ANALYSIS

S. No.	Parameter	Standards	Results
1	Suspended Solids (mg/1) max	100	**31**
2	pH value	5.5-9.0	**7.0**
3	Temperature	Shall not exceed 5°C above the receiving water temperature	**4**
4	Oil & grease	10	**2**
5	Total Residual Chlorine mg/1 max	1	**0.1**
6	Ammonical Nitrogen (asN) mg/1 max	50	**12**
7	Total kjeldahl Nitrogen (asN) mg/1 max	100	**21**
8	Free Ammonia (asNH3) mg/ 1 max	5	**2.0**
9	Biochemical Oxygen Demand (3 days at 27°C) mg/1 max	30	**4**
10	Chemical Oxygen Demand, mg/l	250	**20**

Remarks: The parameter monitored was found within the permissible limits.

For **EHS Assurance Consultancy Services**

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ISO 9001 DNV Certified
OHSAS 18001 DNV Certified

Name of the Industry: Dalmia Cement (Bharat) Limited

Date: 28.3.2024

Source: Oil & Grease Trap – Out let

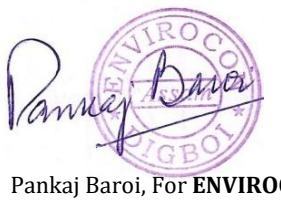
Date of Sample Collection: 23.03.24

Report No.: DCBL/B- V/23-24/04

Oil & Grease Trap - Outlet – Water Quality Analysis

S. No.	Parameter	Standards	Results
1	Suspended Solids (mg/1) max	100	**22**
2	pH value	5.5-9.0	**7.0**
3	Temperature	Shall not exceed 5°C above the receiving water temperature	**3**
4	Oil & grease	10	**5**
5	Total Residual Chlorine mg/1 max	1	**ND**
6	Ammonical Nitrogen (asN) mg/1 max	50	**ND**
7	Total kjeldahl Nitrogen (asN) mg/1 max	100	**ND**
8	Free Ammonia (asNH3) mg/ 1 max	5	**ND**
9	Biochemical Oxygen Demand (3 days at 27°C) mg/1 max	30	**11**
10	Chemical Oxygen Demand, mg/l	250	**111**

Remarks: The parameter monitored was found within the permissible limits.



Pankaj Baroi, For **ENVIROCON**

Annexure IV

Dalmia Cement Bharat Ltd.
Ambient Air Quality Monitoring Report
Limestone Mines Block - V
Month: October 2023 – March 2024

Location →	Near Mines office				Near Drilling Point				Near Rock Breaking Point				Near Loading Point				Near Mines View Point			
Parameters →	PM_{10}	$PM_{2.5}$	SO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	NO_x	PM_{10}	$PM_{2.5}$	SO_2	NO_x
Month																				
Oct – 23	55.2	22.4	8.0	2.5	55.1	20.8	8.2	7.1	55.2	22.0	8.2	7.3	56.1	25.4	5.5	0.8	56.6	22.8	9.1	8.2
Nov – 23	56.1	22.8	8.2	2.1	55.2	20.5	8.0	8.0	55.0	22.8	8.4	7.1	56.5	25.1	5.1	1.7	51.6	20.8	9.3	8.0
Dec – 23	55.2	22.0	8.4	2.5	52.3	20.8	8.2	8.2	57.2	22.2	8.8	7.0	55.6	25.3	8.7	2.8	53.2	20.5	9.2	8.2
Jan – 24	56.1	22.6	8.2	2.1	55.2	21.8	8.0	8.0	57.3	22.4	8.2	7.1	56.1	25.4	8.2	2.0	51.4	20.3	9.1	8.9
Feb – 24	55.2	22.4	8.0	2.2	55.6	21.1	8.2	8.2	57.4	22.8	8.0	7.3	56.6	25.1	8.2	2.5	55.2	20.8	9.0	8.8
Mar - 24	55.6	21.4	8.2	2.1	52.3	20.5	8.3	8.3	55.2	22.0	8.2	7.1	55.2	25.3	8.0	2.8	56.1	21.8	7.1	8.4

OHC DALMIA CEMENT (BHARAT) LTD

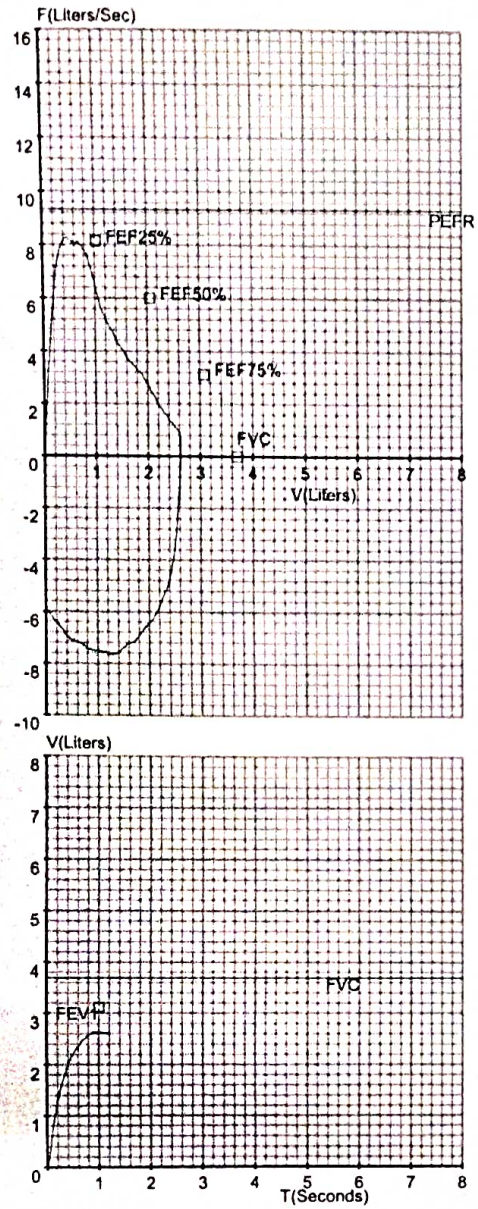
OHC DALMIA CEMENT (BHARAT) LTD

Umsoo Mootang, Thangskai (Vill), East Jaintia Hills District, Meghalaya-793210

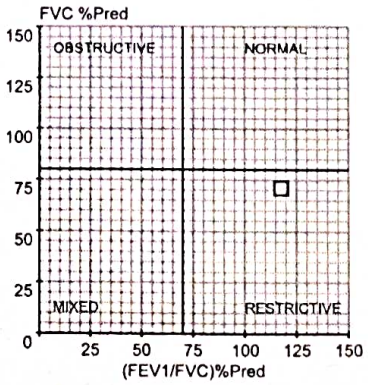
503 - BALA JEE PANDEY
30 Years / Male / Ht 172 Cms /79 Kgs / Non-Smoker

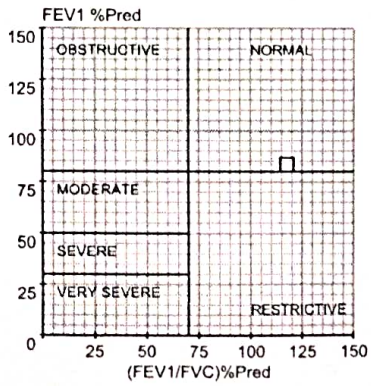
FVC TEST
Date: 16-04-2024 (T1)

Pred Eqn : CLARITY Eth.Corr : 100 Temp : 0°C
Ref By : NONE



Parameter		Pred	Pre	Pre%	Post	Post%	Imp%
FVC	[L]	3.69	2.62	71	--	--	--
FEV1	[L]	3.12	2.60	83	--	--	--
FEV.5	[L]	--	2.25	--	--	--	--
FEV3	[L]	3.58	--	--	--	--	--
FEV6	[L]	--	--	--	--	--	--
PEFR	[L/s]	9.34	8.24	88	--	--	--
FEF25-75	[L/s]	4.43	5.15	116	--	--	--
FEF75-85	[L/s]	--	2.45	--	--	--	--
FEF.2-1.2	[L/s]	7.67	7.04	92	--	--	--
FEF25%	[L/s]	8.15	9.19	113	--	--	--
FEF50%	[L/s]	5.97	5.31	89	--	--	--
FEF75%	[L/s]	3.16	3.04	96	--	--	--
FEV.5/FVC	[%]	--	85.96	--	--	--	--
FEV1/FVC	[%]	84.55	99.41	118	--	--	--
FEV3/FVC	[%]	97.00	--	--	--	--	--
FEV6/FVC	[%]	--	--	--	--	--	--
FEV1/FEV6	[%]	--	--	--	--	--	--
FET	[S]	--	1.21	--	--	--	--
ExplTime	[S]	--	0.07	--	--	--	--
LungAge	[Y]	30.00	35.00	117	--	--	--
FIVC	[L]	--	3.37	--	--	--	--
PIFR	[L/s]	--	7.65	--	--	--	--
FIF25%	[L/s]	--	8.79	--	--	--	--
FIF50%	[L/s]	--	4.45	--	--	--	--
FIF75%	[L/s]	--	1.68	--	--	--	--
FIV.5	[L]	--	0.02	--	--	--	--
FIV1	[L]	--	1.71	--	--	--	--
FIV3	[L]	--	--	--	--	--	--
FIV.5/FIVC	[%]	--	0.47	--	--	--	--
FIV1/FIVC	[%]	--	50.69	--	--	--	--
FIV3/FIVC	[%]	--	--	--	--	--	--





- Pre Medication Report :

Spirometery shows Mild Restriction as FVC% < 80 A nd FEV1/FVC% > 70

- Pre COPD Severity Report:

COPD Severity within Normal range

- Doctor's Comments :

Dr. Ramanand Prasad

Not For Medico-Legal Purpose

DALMIA CEMENT (BHARAT) LTD, MEGHALAYA

Medical Laboratory Report, OHC

Name : Balajee Pandey
Age : 30
Gender : M

Report Date : 16/4/24
Sample collection Date : 16/4/24
Lab Report No : 11

Sl. No.	Test Name	Results	Unit	Normal Range
	Blood			
1	Blood glucose (Random)	101	mg/dL	< 140
2	AFB Stalning	Seen/Not seen		

:End of Report:

Clarity

Dalmia Cement (Bharat) Ltd.

Dalmia Cement (Bharat) Ltd.

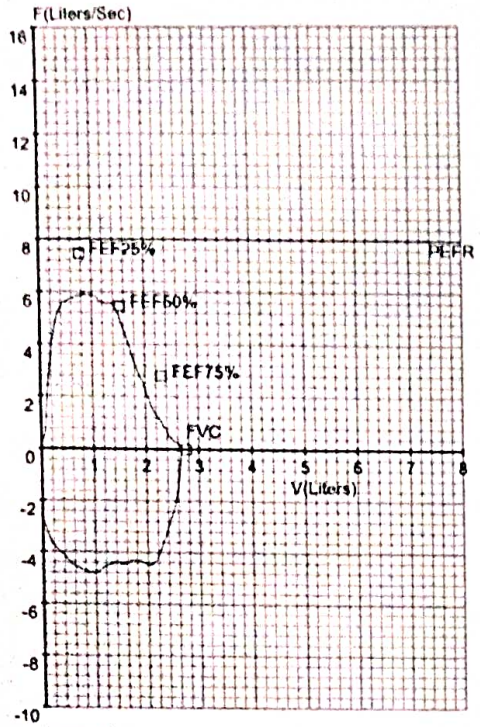
Umsoo Mootang, Thangskai (Vill), East Jaintia Hills District, Meghalaya-793210

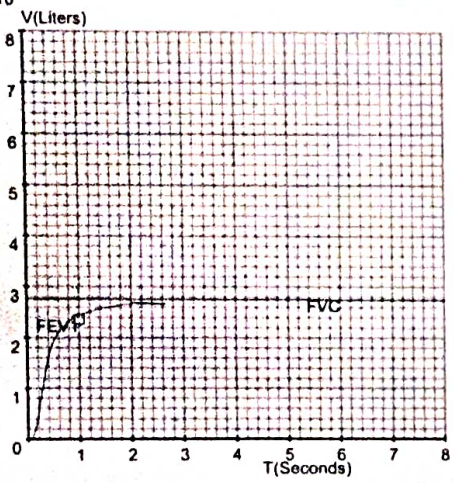
372 - GOLDEN STAR RYMBAI
32 Years / Male / Ht 154 Cms /53 Kgs / Non-Smoker

FVC TEST

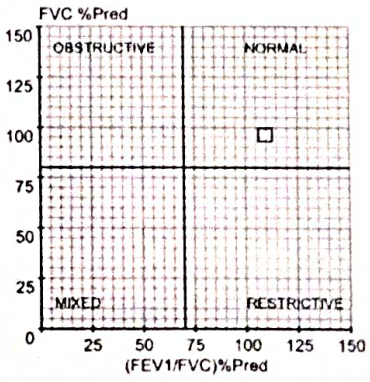
Date: 27-03-2024 (T1)

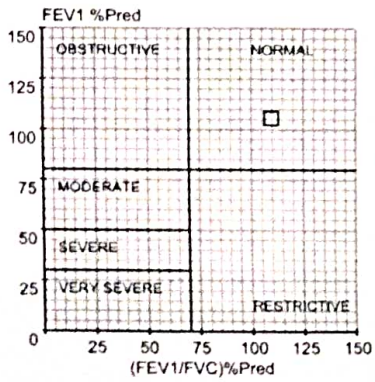
Pred Eqn : CLARITY Eth.Corr : 100 Temp : 0°C
Ref By : NONE





Parameter		Pred	Pre	Pre%	Post	Post%	Imp%
FVC	[L]	2.76	2.66	96	--	--	--
FEV1	[L]	2.36	2.49	106	--	--	--
FEV.5	[L]	--	2.14	--	--	--	--
FEV3	[L]	2.68	--	--	--	--	--
FEV6	[L]	--	--	--	--	--	--
PEFR	[L/s]	7.99	5.92	74	--	--	--
FEF25-75	[L/s]	4.00	5.00	125	--	--	--
FEF75-85	[L/s]	--	1.72	--	--	--	--
FEF.2-1.2	[L/s]	6.62	5.43	82	--	--	--
FEF25%	[L/s]	7.48	6.60	88	--	--	--
FEF50%	[L/s]	5.44	6.23	114	--	--	--
FEF75%	[L/s]	2.82	2.32	82	--	--	--
FEV.5/FVC	[%]	--	80.19	--	--	--	--
FEV1/FVC	[%]	85.37	93.53	110	--	--	--
FEV3/FVC	[%]	97.00	--	--	--	--	--
FEV6/FVC	[%]	--	--	--	--	--	--
FEV1/FEV6	[%]	--	--	--	--	--	--
FET	[S]	--	2.58	--	--	--	--
ExplTime	[S]	--	0.25	--	--	--	--
LungAge	[Y]	32.00	30.00	94	--	--	--
FIVC	[L]	--	2.94	--	--	--	--
PIFR	[L/s]	--	4.80	--	--	--	--
FIF25%	[L/s]	--	6.66	--	--	--	--
FIF50%	[L/s]	--	6.32	--	--	--	--
FIF75%	[L/s]	--	2.14	--	--	--	--
FIV.5	[L]	--	2.00	--	--	--	--
FIV1	[L]	--	2.94	--	--	--	--
FIV3	[L]	--	--	--	--	--	--
FIV.5/FIVC	[%]	--	68.10	--	--	--	--
FIV1/FIVC	[%]	--	100.00	--	--	--	--
FIV3/FIVC	[%]	--	--	--	--	--	--





- Pre Medication Report :

Spirometery within Normal range as FVC% >= 80 And FEV1/FVC% > 70

- Pre COPD Severity Report:

COPD Severity within Normal range

- Doctor's Comments :

Dr. Ramanand Prasad

Not For Medico Legal Purpose

DALMIA CEMENT (BHARAT) LTD, MEGHALAYA

Medical Laboratory Report, OHC

Name : Goldenstar Rymbai
Age : 32
Gender : M

Report Date : 27/03/24
Sample collection Date : 27/03/24
Lab Report No : 6

Sl. No.	Test Name	Results	Unit	Normal Range
	Blood			
1	Blood glucose (Random)	98 ✓	mg/dL	< 140
2	AFB Staining	Seen/Not seen		

End of Report

Clarity
mia Cement (Bharat) Ltd.

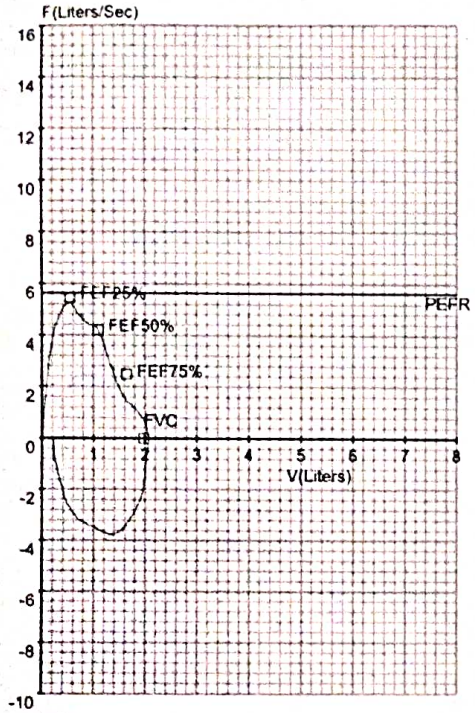
Dalmia Cement (Bharat) Ltd.

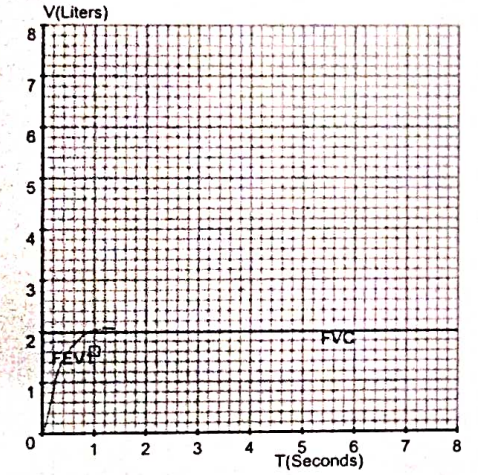
Umsoo Mootang, Thangskai (Vill), East Jaintia Hills District, Meghalaya-793210

429 - PHERLIN LITING
31 Years / Female / Ht 145 Cms /55 Kgs / Non-Smoker

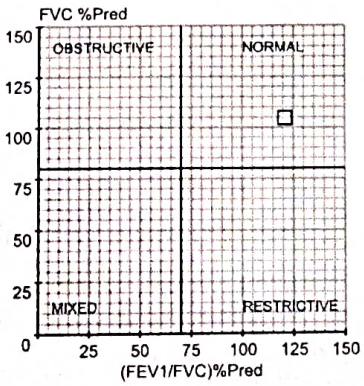
FVC TEST
Date: 04-04-2024 (T1)

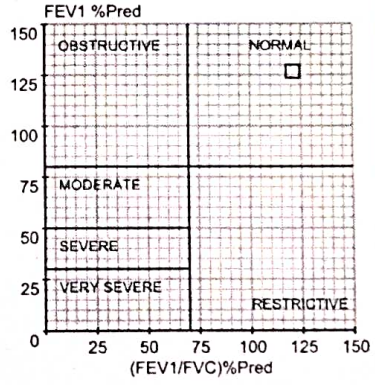
Pred Eqn : CLARITY Eth.Corr : 100 Temp : 0°C
Ref By : NONE





Parameter		Pred	Pre	Pre%	Post	Post%	Imp%
FVC	[L]	1.97	2.06	105	--	--	--
FEV1	[L]	1.62	2.04	127	--	--	--
FEV.5	[L]	--	1.69	--	--	--	--
FEV3	[L]	1.91	--	--	--	--	--
FEV6	[L]	--	--	--	--	--	--
PEFR	[L/s]	5.66	5.30	94	--	--	--
FEF25-75	[L/s]	2.54	3.93	154	--	--	--
FEF75-85	[L/s]	--	1.52	--	--	--	--
FEF.2-1.2	[L/s]	4.74	4.47	94	--	--	--
FEF25%	[L/s]	5.48	5.96	109	--	--	--
FEF50%	[L/s]	4.23	4.96	117	--	--	--
FEF75%	[L/s]	2.44	1.71	70	--	--	--
FEV.5/FVC	[%]	--	81.99	--	--	--	--
FEV1/FVC	[%]	82.06	99.24	121	--	--	--
FEV3/FVC	[%]	97.00	--	--	--	--	--
FEV6/FVC	[%]	--	--	--	--	--	--
FEV1/FEV6	[%]	--	--	--	--	--	--
FET	[S]	--	1.33	--	--	--	--
ExplTime	[S]	--	0.13	--	--	--	--
LungAge	[Y]	31.00	23.00	74	--	--	--
FIVC	[L]	--	1.84	--	--	--	--
PIFR	[L/s]	--	3.78	--	--	--	--
FIF25%	[L/s]	--	5.89	--	--	--	--
FIF50%	[L/s]	--	5.08	--	--	--	--
FIF75%	[L/s]	--	3.19	--	--	--	--
FIV.5	[L]	--	0.03	--	--	--	--
FIV1	[L]	--	1.59	--	--	--	--
FIV3	[L]	--	--	--	--	--	--
FIV.5/FIVC	[%]	--	1.68	--	--	--	--
FIV1/FIVC	[%]	--	86.27	--	--	--	--
FIV3/FIVC	[%]	--	--	--	--	--	--





- Pre Medication Report :
Spirometery within Normal range as FVC% >= 80 And FEV1/FVC% > 70

- Pre COPD Severity Report:
COPD Severity within Normal range

- Doctor's Comments :

Dr. Ramanand Prasad

Not For Medico Legal Purpose

DALMIA CEMENT (BHARAT) LTD, MEGHALAYA

Medical Laboratory Report, OHC

Name : Phellin Lyngdoh
Age : 31
Gender : F Female

Report Date : 4.4.24
Sample collection Date : 4.4.2024.
Lab Report No : 6

Sl. No.	Test Name	Results	Unit	Normal Range
	Blood			
1	Blood glucose (Random)	103	mg/dl	< 140
2	AFB Staining	Seen/Not seen		

End of Report

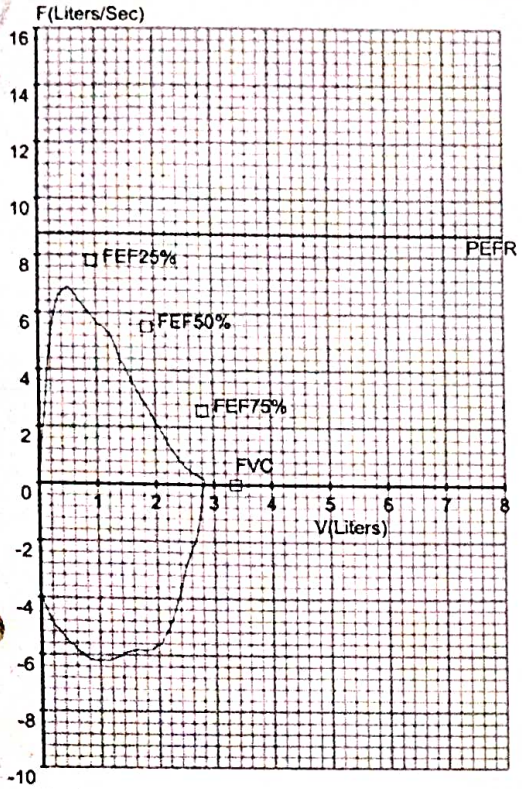
OHC DALMIA CEMENT (BHARAT) LTD

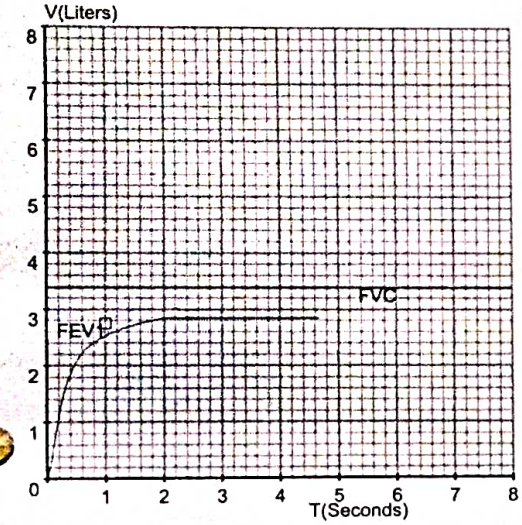
MIA CEMENT (BHARAT) LTD Umsoo Mootang, Thangskai (Vill), East Jaintia Hills District, Meghalaya-793210

BISHU ROY
ears / Male / Ht 169 Cms /53 Kgs / Smoker

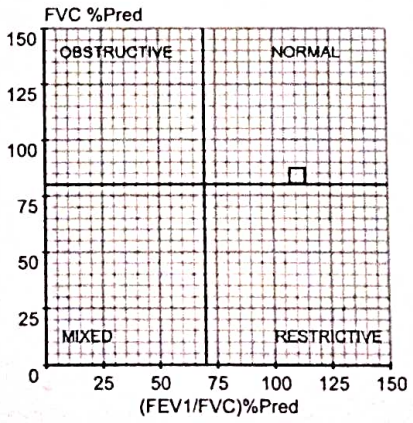
FVC TEST
Date: 20-04-2024 (T1)

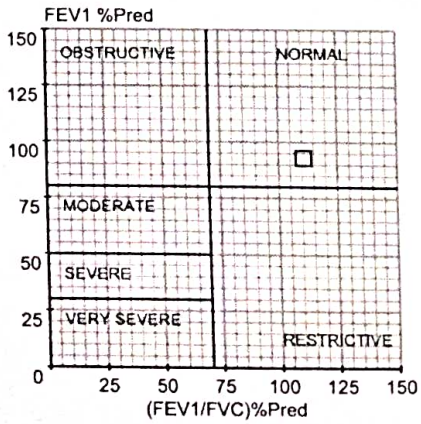
Pred Eqn : CLARITY Eth.Corr : 100 Temp : 0°C
Ref By : NONE





Parameter		Pred	Pre	Pre%	Post	Post%	Imp%
FVC	[L]	3.37	2.84	84	--	--	--
FEV1	[L]	2.75	2.56	93	--	--	--
FEV.5	[L]	--	2.12	--	--	--	--
FEV3	[L]	3.27	2.56	78	--	--	--
FEV6	[L]	--	--	--	--	--	--
PEFR	[L/s]	8.71	6.87	79	--	--	--
FEF25-75	[L/s]	3.83	4.36	114	--	--	--
FEF75-85	[L/s]	--	1.34	--	--	--	--
FEF.2-1.2	[L/s]	6.70	5.94	89	--	--	--
FEF25%	[L/s]	7.81	7.10	91	--	--	--
FEF50%	[L/s]	5.53	4.90	89	--	--	--
FEF75%	[L/s]	2.62	1.75	67	--	--	--
FEV.5/FVC	[%]	--	74.87	--	--	--	--
FEV1/FVC	[%]	81.49	90.08	111	--	--	--
FEV3/FVC	[%]	97.00	90.08	93	--	--	--
FEV6/FVC	[%]	--	--	--	--	--	--
FEV1/FEV6	[%]	--	--	--	--	--	--
FET	[S]	--	4.63	--	--	--	--
ExplTime	[S]	--	0.10	--	--	--	--
LungAge	[Y]	42.00	45.00	107	--	--	--
FIVC	[L]	--	3.31	--	--	--	--
PIFR	[L/s]	--	6.24	--	--	--	--
FIF25%	[L/s]	--	7.17	--	--	--	--
FIF50%	[L/s]	--	4.35	--	--	--	--
FIF75%	[L/s]	--	1.14	--	--	--	--
FIV.5	[L]	--	0.94	--	--	--	--
FIV1	[L]	--	3.18	--	--	--	--
FIV3	[L]	--	--	--	--	--	--
FIV.5/FIVC	[%]	--	28.46	--	--	--	--
FIV1/FIVC	[%]	--	96.27	--	--	--	--
FIV3/FIVC	[%]	--	--	--	--	--	--





- Pre Medication Report :

Spirometery within Normal range as FVC% >= 80 And FEV1/FVC% > 70

N

- Pre COPD Severity Report:

COPD Severity within Normal range

- Doctor's Comments :

DALMIA CEMENT (BHARAT) LTD, MEGHALAYA

Medical Laboratory Report, OHC

Name : Bishu Roy
Age : 42
Gender : Male

Report Date : 20/4/24
Sample collection Date : 20/4/24
Lab Report No : 2

Sl. No.	Test Name	Results	Unit	Normal Range
	Blood			
1	Blood glucose (Random)	130	mg/dL	< 140
2	AFB Staining	Seen/Not seen		

:End of Report:

Clarity

ia Cement (Bharat) Ltd.

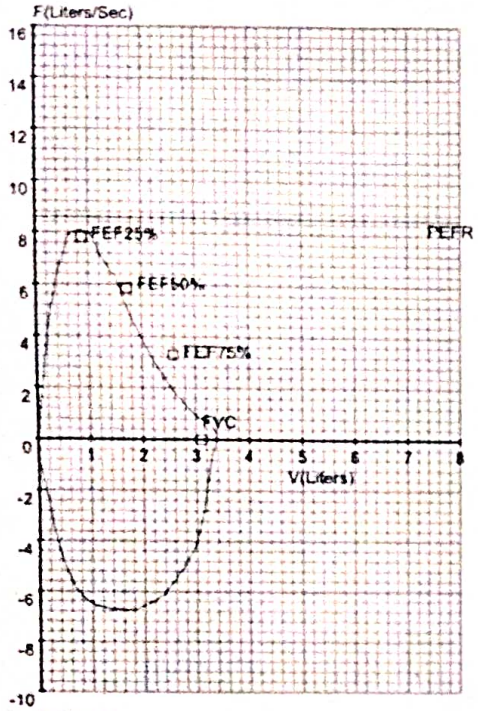
Dalmia Cement (Bharat) Ltd.

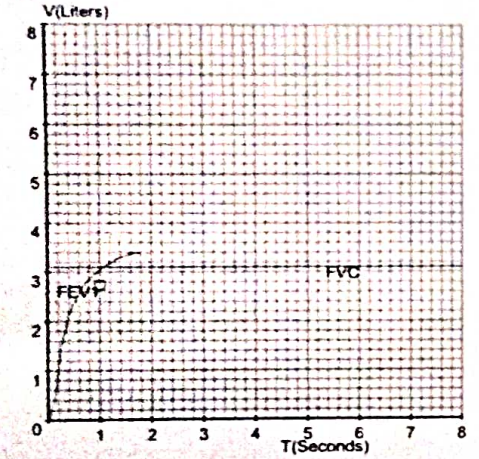
Umsoo Mootang, Thangskai (Vill), East Jaintia Hills District, Meghalaya-793210

428 - MILON SINHA
22 Years / Male / Ht 158 Cms /54 Kgs / Non-Smoker

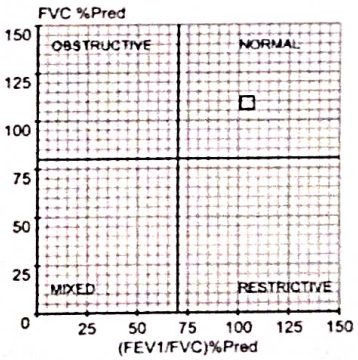
FVC TEST
Date: 04-04-2024 (T1)

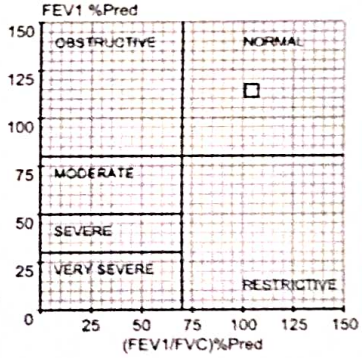
Pred Eqn : CLARITY Eth.Corr : 100 Temp : 0°C
Ref By : NONE





Parameter		Pred	Pre	Pre%	Post	Post%	Imp%
FVC	[L]	3.10	3.39	109	--	--	--
FEV1	[L]	2.73	3.11	114	--	--	--
FEV.5	[L]	--	2.54	--	--	--	--
FEV3	[L]	3.01	--	--	--	--	--
FEV6	[L]	--	--	--	--	--	--
PEFR	[L/s]	8.63	8.15	94	--	--	--
FEF25-75	[L/s]	4.52	5.35	118	--	--	--
FEF75-85	[L/s]	--	1.66	--	--	--	--
FEF.2-1.2	[L/s]	7.50	7.03	94	--	--	--
FEF25%	[L/s]	7.82	9.22	118	--	--	--
FEF50%	[L/s]	5.85	5.83	100	--	--	--
FEF75%	[L/s]	3.29	2.08	63	--	--	--
FEV.5/FVC	[%]	--	75.01	--	--	--	--
FEV1/FVC	[%]	87.94	91.73	104	--	--	--
FEV3/FVC	[%]	97.00	--	--	--	--	--
FEV6/FVC	[%]	--	--	--	--	--	--
FEV1/FEV6	[%]	--	--	--	--	--	--
FET	[S]	--	1.71	--	--	--	--
ExplTime	[S]	--	0.17	--	--	--	--
LungAge	[Y]	22.00	19.00	86	--	--	--
FIVC	[L]	--	3.38	--	--	--	--
PIFR	[L/s]	--	6.77	--	--	--	--
FIF25%	[L/s]	--	9.17	--	--	--	--
FIF50%	[L/s]	--	6.99	--	--	--	--
FIF75%	[L/s]	--	2.88	--	--	--	--
FIV.5	[L]	--	0.66	--	--	--	--
FIV1	[L]	--	3.28	--	--	--	--
FIV3	[L]	--	--	--	--	--	--
FIV.5/FIVC	[%]	--	19.64	--	--	--	--
FIV1/FIVC	[%]	--	96.83	--	--	--	--
FIV3/FIVC	[%]	--	--	--	--	--	--





- Pre Medication Report :

Spirometery within Normal range as FVC% >= 80 And FEV1/FVC% > 70

N

- Pre COPD Severity Report:

COPD Severity within Normal range

- Doctor's Comments :

Dr. Ramanand Prasad

Not For Medico Legal Purpose

DALMIA CEMENT (BHARAT) LTD, MEGHALAYA

Medical Laboratory Report, OHC

Name : Milon Sinha
Age : 22Y
Gender : male

Report Date : 4/4/24
Sample collection Date : 4/4/24
Lab Report No : 4

Sl. No.	Test Name	Results	Unit	Normal Range
	Blood			
1	Blood glucose (Random)	111	mg/dL	< 140
2	AFB Staining	Seen/Not seen		

End of Report

Name of the Industry: Dalmia Cement (Bharat) Limited Date: 28.3.2024

Monitoring Location: Limestone Mines Block - III

Date of Monitoring: 22.03.24 to 23.03.24

Report No.: DCBL/B- III/23-24/02

AMBIENT AIR QUALITY SURVEY REPORT

Pollutants	Locations & Analysis Results					Permissible Limits (in μg/m^3)
	Near Mines Office	Near Drilling Point	Near Rock Breaking Point	Near Loading Point	Near Mines View Point	
Particulate Matter size less than 10 μ (PM 10)	56.1	ND	ND	ND	55.7	100*
Particulate Matter size less than 2.5 μ (PM 2.5)	22.2	ND	ND	ND	22.8	60*
Sulfur dioxide (SO2)	7.0	ND	ND	ND	7.3	80*
Oxides of Nitrogen (NOx)	8.2	ND	ND	ND	8.2	80*
Carbon Monoxide (CO)	ND	ND	ND	ND	0.2	4**
Ammonia (NH3)	ND	ND	ND	ND	ND	400
Ozone (O3)	ND	ND	ND	ND	ND	180
Lead (Pb)	ND	ND	ND	ND	ND	1.0
Benzene (C3H3)	ND	ND	ND	ND	ND	5
Benzo (a) Pyrene (BaP)	ND	ND	ND	ND	ND	01
Arsenic (As)	ND	ND	ND	ND	ND	06
Nickel (Ni)	ND	ND	ND	ND	ND	20

Remarks: The parameters analyzed were found to be within the permissible limits of Ambient Air Quality Standards (National) for Industrial, Residential, Rural and Other Areas as per National Ambient Air Quality Standards, Notification dated 18th November 2009.

Annexure - VII

WATER QUALITY ANALYSIS

Parameters	Unit	Locations & Analysis Results		Standard for Inland Surface Water*
		Nearby Stream Water (upstream)	Nearby Stream Water (downstream)	
Temperature	^{o}C	4.8	4.8	Shall not exceed the 5 ^{o}C above the receiving water temperature
pH Value		7.0	7.1	5.5-9.0
Suspended Solid	mg/l	43.4	44.0	100
Total Hardness (as $CaCO_3$), mg/l	mg/l	112	115	300 [IS:100500, Desirable] 600 [IS:100500, Permissible]
Oil & Grease	mg/l	Nil	Nil	10
Total Residual Chlorine	mg/l	Nil	Nil	1.0
Ammonical Nitrogen (as N)	mg/l	12	14	50
Total Kjeldahl Nitrogen (as NH3)	mg/l	47	48	100
Free Ammonia (as NH3)	mg/l	1.1	1.1	5.0
BOD	mg/l	2.2	2.1	30
COD	mg/l	25.1	25.7	250

GOVERNMENT OF MEGHALAYA
OFFICE OF THE PRINCIPAL CHIEF CONSERVATOR OF FORESTS,
(BIODIVERSITY & WILDLIFE) & CHIEF WILDLIFE WARDEN,
MEGHALAYA, SHILLONG.

No FWC/CLEARANCE/15/3677 Dated Shillong, the 20th December, 2022

To,

The Dalmia Cement (Bharat) Limited,
Umsoo Mootang, Vill-Thangskai, P.O Lumshnong,
East Jaintia Hills, District

Sub: Deposit of fund for Implementation of Biodiversity Conservation Plan approved by the Chief Wildlife Warden, Forest Department of Meghalaya, to comply the condition of Environment Clearance.

Ref: No. Nil, dt 24.11.2022.

Sir,

With reference to your letter and subject cited above, I am to inform you that a Regional Conservation Plan to minimise and mitigate impacts of Developmental Projects on wild animals and their habitats in East Jaintia Hills District is being prepared by the Department. Hence you are requested to await for the completion of the said Regional Conservation Plan which is under process.

This is for your information and necessary action.

Yours faithfully,

(F. S. Wann, MFS),
Deputy Conservator of Forests,
Wildlife, Meghalaya: Shillong

Memo No FWC/CLEARANCE/15 Dated Shillong, the __ December, 2022

Copy to: -
The Divisional Forest Officer, Jaintia Hills Wildlife Division, Jowai for information and necessary action.

Deputy Conservator of Forests,
Wildlife, Meghalaya: Shillong

Sylvan House, Lower Lachumiere
Shillong 793001
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Annexure – IX

Dalmia Cement Bharat Ltd.
Fugitive Monitoring Report
Limestone Mines Block - V
Month: October 2023 – March 2024

Location → / Month	Near Mines Office (µg/m3)	Near Rock Breaking Point (µg/m3)	Near Loading Point (µg/m3)	Inside Hyva (µg/m3)
Oct – 23	224	218	215	235
Nov – 23	228	217	213	230
Dec – 23	224	210	233	237
Jan – 24	228	211	224	230
Feb – 24	224	210	228	235
Mar - 24	228	217	226	232