Department of Mining and Geology
Government of Kerala
File No. DMG/8505/2021-T1

Kesavadasapuram,
Pattom Palace .P.O., Thiruvananthapuram
Dated 21.04.2026

The Ministry of Mines, Government of India vide D. O. letter No. 16/53/2019 – M.VI. Dated 11.10.2019 insisted that the State should use Drone technology for the regulation and monitoring of mining activities. The Government has examined the matter and found that measurements with regards to volume of minerals existed as resource in a quarry as well as the volume of minerals mined out from a quarry are very important in preventing the revenue loss and environmental deterioration. In order to bring transparency to the existing system of estimation, technology based survey using the Drone and LiDAR combination seems to be insisted to achieve the goal

Whereas, the Government vide GO(P) No. 4/2025/ID Dated 14.02.2025 has incorporated the provision for Drone – LiDAR in Kerala Minor Mineral Concession Rules and survey report has been made mandatory during the time of submission of mining plan, scheme of mining and mine closure plan.

Whereas, Sri. Maneesh P. Mohanan, Sri. Saji K. Elias and the Kerala Mining and Crushing Owners Association, (KMCOA) have approached the Hon'ble High Court of Kerala by filing a Writ Petition (C) No. 17010/2025, in which the petitioners submitted that the present mechanism of Lidar Survey Method is wholly unscientific and impracticable, and the same is not foolproof at all.

Whereas, the Hon'ble High Court of Kerala in its interim order dated 21.01.2026 in Writ Petition (C) No. 17010/2025 directed to draw a Standard Operating Procedure (SOP) for the effective implementation of the Drone Lidar Survey. The Hon'ble Court has also directed that the petitioners also will be given an opportunity of being heard before finalising the SOP.

Whereas, by adhering the direction of the Hon'ble High Court, the petitioners were given an opportunity of being heard on 11.02.2026, but nobody appeared. By considering the request of the Petitioners, another opportunity of being heard was given on 23.03.2026 and one of the Petitioners Sri. Maneesh P. Mohanan was present and requested to publish the draft SOP in website for inviting comments/ suggestions.

Accordingly a draft of the Standard Operating Procedure is enclosed herewith for comments/suggestions from all sectors. In view of the above, it is requested that comments/ suggestions on the enclosed Standard Operating Procedure may be sent on or before **10.05.2026.** The comments/ suggestions may be sent by e-mail in MS-Office Word file to the following ID:

director.dir.dmg@kerala.gov.in

Yours faithfully
Dr. K Harikumar IAS
DIRECTOR

Enclosure: As above

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Kishor M C
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Standard Operating Procedure for Survey of Mines and Quarries in Kerala through Drone LiDAR Technology

I. Introduction

The incorporation of geospatial technologies, particularly LiDAR (Light Detection and Ranging), has become indispensable in modern mining operations. LiDAR offers advanced capabilities in asset management, volumetric analysis, and terrain mapping, and when combined with unmanned aerial vehicles (UAVs), it provides a transformative approach to resource estimation and environmental management. For that, the Department of Mining and Geology, Government of Kerala, has amended the KMMC Rules. As per Rule 88A of the Kerala Minor Mineral Concession (Amendment) Rules, 2025, submission of a Drone–LiDAR Survey Report has now been made mandatory for quarrying permits and leases, thereby institutionalizing geospatial technology in mineral resource regulation. The rule requires submission of the survey report at the application stage after scrutiny of documents and site inspection, with extracted quantities included if the applied area is not virgin; for existing quarrying permit or lease holders at the time of filing the scheme of mining and mine closure plan; and in other situations where the competent authority may insist on a Drone–LiDAR Survey, subject to prior approval of the Government.

Drone LiDAR surveys enable precise topographic mapping and volumetric estimation of excavation and reclamation, while SONAR bathymetry surveys are integrated in waterlogged quarries to measure underwater terrain and ensure accurate computation of total reserves. This SOP codifies best practices, procedural guidelines, and quality control mechanisms to

ensure comprehensive and effective implementation.

As per the amendment rule, the Drone –LiDAR survey report is not required for the applications and concessions for laterite (building stone), ordinary earth, ordinary sand, ordinary clay, silica sand, lime shell, which are having an area less than 50 ares.

II. Purpose

- Evaluation of quarrying activities.
- GIS mapping of mining areas using geospatial drone LiDAR technology.
- Accurate quantification of reserves, mined volume, and ensuring transparency of operations.

III. Abbreviations

- CORS: Continuously Operating Reference Station
- DEM: Digital Elevation Model
- DGCA: Directorate General of Civil Aviation
- DGPS: Differential Global Positioning System
- DMG: Department of Mining & Geology
- DSM: Digital Surface Model
- DTM: Digital Terrain Model
- GBS: Granite Building Stone
- GDS: Granite Dimension Stone
- GIS: Geographic Information System
- KMMC Rules: Kerala Minor Mineral Concession Rules 2015
- LBS: Laterite Building Stone
- LiDAR: Light Detection and Ranging
- OB: Overburden
- RGB: RedGreenBlue imagery captured by drone cameras

- UIN: Unique Identification Number (for drones)

IV. Responsibilities

- Legalise the Drone LiDAR survey by incorporating necessary provisions in KMMC Rules 2015.
- Drone LiDAR surveys shall be conducted for fresh quarry applications, scheme approvals, and closure proposals of leases and permits.
- DMG shall receive the applications and notify KELTRON via the web portal for the Drone lidar survey
- KELTRON will conduct field surveys.
- Reports containing volume quantification shall be submitted exclusively through the designated web portal.

V. Methodology

Stage 1 – Pre-Survey

- The Department shall conduct a preliminary inspection of the applied area before survey initiation.
- Department shall transfer application details into the designated web portal promptly upon receipt.
- KELTRON shall analyze the application data and associated maps to prepare the field survey plan.
- Establishment of Ground Control Points (minimum five, evenly distributed).
- DGPS base setup with continuous logging; base coordinates derived using CORS (real-time or post-processed)
- Planning SONAR bathymetry survey for waterlogged quarries.

Stage 2 – Drone Survey

- Flight planning with required overlaps (80% front, 70%

side for photogrammetry; 40% side for LiDAR).
- Use of DGCA-approved drones with UIN, Remote Pilot License, and compliant sensors.
- LiDAR & RGB survey for leasehold area with 100 m buffer for all quarries; 500 m periphery survey using RGB only for fresh applications.

Stage 3 – Data Processing and Analysis

- Cleaning and classification of LiDAR point clouds.
- Generation of Digital Terrain Model (DTM), Digital Surface Model (DSM), orthomosaic, and contours.
- Validation of accuracy against GCPs.
- Volume estimation using analytical software and bench method.
- Integration of SONAR bathymetry data for submerged areas.

VI. Volume Estimation Procedures

- **Consolidated material**

Granite Building Stone (GBS), Granite Dimension Stone (GDS), and Laterite Building Stone (LBS): Benches shall be developed in a planned and systematic manner, commencing from the topmost level near the buffer boundary and advancing downward in stages. Regulation 106 of the Metalliferous Mines Regulations, 1961 provides the framework for safe working in opencast mines by requiring proper benching, controlled slope angles, and adequate bench dimensions to ensure stability and prevent slope failure. In particular, Regulation 106(2)(a) states that *"the height of any bench shall not exceed six metres while the breadth thereof shall not be less than the height."*

In line with these statutory provisions, a benching pattern of

5 metres height and 5 metres width (5 m × 5 m) is adopted, as the bench height is within the permissible limit and the width is equal to the height, thereby meeting the prescribed safety requirements. Further, guidance issued by the Directorate General of Mines Safety, including DGMS (Tech) (S&T) Circular No. 2 of 2001, observes that accidents in opencast mines have occurred where benches were excessively high and insufficiently wide, and emphasizes that maintaining proper bench geometry in accordance with statutory provisions is essential for slope stability and safety.

Accordingly, the 5 m × 5 m benching system is adopted as a safe and conservative practice suited to the geological conditions in Kerala, ensuring improved slope stability, safer working conditions, efficient excavation and blasting operations, and safe movement of men and machinery. This benching system shall apply exclusively to GBS, GDS, and LBS. It is further clarified that a statutory buffer zone of 7.5 metres from the lease boundary shall be excluded from mining operations, and only the remaining mineable reserve within the lease area will be calculated and extracted using the prescribed 5 m × 5 m benching system.

- **Unconsolidated material**

  For workings in unconsolidated material (alluvial soil, morum gravel, clay, debris, Ordinary Earth or other similar unconsolidated ground), reserve measurements and excavation shall be carried out strictly in accordance with Regulation 106(1) of the Metalliferous Mines Regulations, 1961. In such opencast operations, the following precautions shall be observed: "*In alluvial soil, morum gravel, clay, debris or other similar ground – (a)(i) the sides shall be sloped at an angle of safety not exceeding 45*

degrees from the horizontal or such other angle as the Regional Inspector may permit by an order in writing and subject to such conditions as he may specify therein; or (ii) the sides shall be kept benched and the height of any bench shall not exceed 1.5 metres and the breadth thereof shall not be less than the height." Accordingly, the 5 m × 5 m benching system is not permitted for Ordinary Earth; if unconsolidated, benches must be limited to a maximum height of 1.5 metres with a minimum width equal to the height. This ensures compliance with statutory requirements, eliminates ambiguity, and maintains stability against collapse in unconsolidated formations.

- **Depth of Geological Reserve Calculation (GBS, GDS, LBS):**

  The geological reserve shall be calculated within the lease boundary upto a maximum depth at which the last safe bench can be formed. The maximum reserve in the applied area will be calculated by KELTRON. However, in the case of LBS, while the maximum reserve in the applied area may be calculated, the reserve reflected in the mining plan must be based on the actual availability of the mineral in situ, rather than theoretical maximums.

- **Depth Restriction for Ordinary Earth:**

  Reserve estimation shall be strictly limited in accordance with the Ministry of Environment & Forests (MoEF) Guidelines, 2013 (Office Memorandum No. L-11011/47/2011-IA.II(M), dated 24 June 2013), issued pursuant to the direction of Honourable Supreme Court's directions in Deepak Kumar vs. State of Haryana (2012) under the EIA Notification, 2006. These guidelines mandate that mining of ordinary earth and brick earth shall not exceed a depth of 2 metres below the lowest

contour in the applied lease area, irrespective of lease size. This restriction is legally binding to minimize environmental degradation, ensure slope stability, and regulate minor mineral extraction.

VII. Initial Surface Consideration

In quarries where a drone LiDAR survey has already been conducted, KELTRON shall adopt the initial surface saved from earlier survey data as the baseline for computing excavated volumes. In the absence of prior drone or LiDAR survey data, the initial surface shall be established using contour plans duly issued by the Department of Mining & Geology (DMG). Where such contour plans are unavailable, particularly in the case of quarries worked before 2015, reference shall be made to Survey of India toposheets. All correspondence relating to initial surface verification shall be communicated by KELTRON to the concerned Geologist strictly through official email channels, and processing of excavated volume computation and valuation shall commence only after formal confirmation of the initial surface by the Geologist. This methodology ensures that the valuation of excavated minerals is based on verifiable, authoritative sources, thereby maintaining transparency, reliability, and regulatory consistency.

VIII. Field Verification and Department Coordination

KELTRON's drone survey shall be treated strictly as a technical tool employed by the Department of Mining & Geology for both mineable reserve estimation in applied areas and for assessing excavated mineral quantities in quarries or lease areas. The responsibility for defining survey requirements rests entirely with the Department,

and it is the duty of the concerned Geologist or Assistant Geologist to communicate to KELTRON what specific measurements are to be taken during each survey. In areas with dense vegetation, a drone-based LiDAR survey is recommended to improve ground penetration; however, wherever feasible, the Area of Interest (AOI) shall be cleared of heavy vegetation prior to survey to enhance ground point density and ensure accurate terrain modeling, as dense canopy may significantly reduce ground-reflected returns. KELTRON's drone system generates volumetric results without differentiating between types of material, such as overburden, granite building stone, or other minerals; classification of outputs shall be made only based on instructions provided by the Department. Accordingly, if the Department instructs KELTRON to compute the volume of overburden stacked in a particular area and to report it separately, KELTRON shall provide that output. In quarry assessment, the presence of a Department official is strictly required, since KELTRON cannot independently determine whether excavation has extended beyond the permitted lease boundary. It is the Department official who must identify and point out any portion excavated outside the lease area, define its limits, and communicate these details to KELTRON for accurate measurement. Furthermore, during quarry surveys conducted exclusively to determine excavated quantities, KELTRON shall ensure that pillar points are referenced from the approved mining plan records. Any other field-level measurements or clarifications deemed necessary shall be undertaken only upon direction from the Department official present at the site. This protocol ensures that survey outputs remain accurate, transparent, and aligned with departmental

oversight, while clearly establishing that KELTRON's role is limited to technical measurement and data processing under instructions from the Department.

IX. Role of the Department of Mining & Geology

- Authority & Oversight: The Department is the controlling authority; KELTRON's drone survey is only a tool used under departmental instructions.
- Defining Requirements: The Geologist/Assistant Geologist must specify what measurements KELTRON should take (e.g., total excavation, stacked overburden, boundary checks).
- Presence at Site: A Department representative must be physically present during every survey to supervise, clarify geological features, and ensure quarry boundaries are correctly identified.
- Boundary Clarification: In quarry assessments, the Department official must point out if excavation has extended outside the permitted lease area and define its limits for KELTRON to measure.
- Classification of Volumes: Since KELTRON provides raw volume data without distinguishing material types, the Department decides how outputs are categorized (e.g., OB vs. GBS).
- Pillar Point Verification: Officials ensure that reference pillar points are taken from the approved mining plan records.
- Communication: All instructions, clarifications, and confirmations must be formally communicated to KELTRON through official departmental channels (email)

X. Role of KELTRON

- Technical Execution: Establish a reference point, operate

the drone LiDAR survey, processes data, and generates volumetric results.

- Neutral Measurement: Provides raw volume outputs without differentiating between mineral types unless instructed by the Department.
- Compliance with Instructions: Measures stacked overburden, excavation volumes, or any other features only when directed by the Department official.
- Data Integrity: Ensures that survey baselines (e.g., pillar points) are taken from mining plan records, not from field markers that may have been altered.
- Reporting: Submits processed results to the Department after confirmation of survey parameters and instructions.
- Support Role: Functions purely as a technical service provider; does not interpret lease boundaries, excavation legality, or mineral classification independently.

XI. Post-Survey and preparation of final survey report

- Raw and processed data preserved in formats specified in deliverables (.las, .tiff, .shp, .csv).
- Report shall contain topographical details, DGPS based geo-positions, slope map, Applied area including extracted area with relevant features in and around, DTM Generation, Volume computation.
- Final survey report will be submitted via web portal.

XII. Deliverables

- Survey maps (orthomosaic, contours, DEM/DTM)
- Reserve estimation report (geological reserves, mineable volume, blocked reserves, pit volume).
- GCP data, raw LiDAR/RGB data, SONAR data.

XIII. Confidentiality

- All data shall be treated as confidential, preserved as per departmental guidelines, and used exclusively for regulatory and operational purposes.

XIV.Complaint Redressal Mechanism

Complaints related to the Drone–LiDAR Survey will be processed in two stages to ensure transparency and fairness.

First Level (District Level):

If an applicant has disputes regarding their Drone–LiDAR Survey Report, they may communicate the matter to the District Geologist. The district office will examine the issue, and if the claim is found logical and relevant, the District Geologist will communicate with KELTRON to resolve the matter. If the dispute raised is not relevant, the District Geologist may dismiss the complaint.

Second Level (Directorate Level):

If the issue cannot be resolved at the district level, it will be escalated to the Directorate of Mining and Geology. The Directorate will review the matter in detail and take appropriate steps to address and resolve the complaint.