BEFORE THE NATIONAL GREEN TRIBUNAL

WESTERN ZONE BENCH, PUNE

ORIGINAL APPLICATION NO. 210/2024(WZ)

NOTARY
SURESH N. KAMBLE
DIST. THANE,
MAHARASHTRA
REGD. NO. 5742
EXP.DT.
21/04/2028
GOVT. OF INDIA

In the matter of

Sunil Ramchandra Shinde & Anr ..... Applicant

Versus

State of Maharashtra & Ors. ..... Respondents

AFFIDAVIT ON BEHALF OF MAHARASHTRA POLLUTION CONTROL BOARD IN COMPLIANCE OF ORDER PASSED BY HON'BLE TRIBUNAL 25.10.2024 and 23.12.2024.

I, **Raj S. Kamat**, aged 57 years, Occupation: Service, Sub Regional Officer, Raigad-2 of the Maharashtra Pollution Control Board (MPCB), with my office at Raigad Bhavan, C.B.D. Belapur, Navi Mumbai, do hereby submit this report on behalf of Maharashtra Pollution Control Board (MPCB), in compliance with the order dated **25.10.2024** and **23.12.2024** passed by the Hon'ble National Green Tribunal (NGT).

1. I say and submit that, the Applicant has stated that Matheran, a hill station in Maharashtra has faced serious environmental degradation due to the excessive use of horses for tourism and goods transportation. Further the present application highlights that there are 460 horses and 200 ponies operating daily, which is resulting in over 3 tonnes of horse dung being dumped across the valley, damaging the ecology. This resulted in air, water and land pollution, which in turn affects health of the people.

2. I say and submit that this Hon'ble Tribunal has passed order dated **25.10.2024** and instructed to the Maharashtra Pollution Control Board

(MPCB) to constitute a Joint Committee consisting of - (i) One representative of the Ministry of Environment, Forest & Climate Change (MoEF & CC) (ii) One representative of the Matheran Hill Station Municipal Council; and (iii) One representative of the Maharashtra Pollution Control Board (MPCB). The Maharashtra Pollution Control Board shall be the Nodal agency of the said Committee for coordination and logistic support with following terms of reference.

i) The Joint Committee to visit the site in question; assess the Environmental Damage caused by movement of horses; and recommend measures for minimizing impact thereof on Environment. The Committee will be free to hire services of any expert organization and the cost therefor will be borne by MPCB from EDC funds available with MPCB.

3. Pursuant to the order dated 25.10.2024, the MPCB has constituted a Joint Committee vide Office Order No. 0110 dtd. 04.11.2024, the Joint Committee consists of following members-

   I. Scientist-E, MoEF & CC.
   II. Sub-Regional Officer (Raigad-2), MPCB.
   III. Chief Officer, Matheran Municipal Council.

   to assess the Environmental damage caused by movement of horses and recommend measures for minimizing impact on the Environment. A copy of office order issued by MPCB is enclosed as **[Annexure - I]**.

4. I say and submit that the 1st and 2nd meetings of the Joint Committee has been held on **07.11.2024, 26.11.2024** through video conference to discuss the issue regarding Joint Committee formation and identified the four possible experts agencies to study the area and submit a study report

to Joint Committee. A copy of the minutes of the said meeting is enclosed as **[Annexure - II]**.

5. It is submitted that the 3rd meeting of the Joint Committee along-with MPCB HQ Official has been held on 04.12.2024 through video conference to discuss the issue regarding order passed by Hon'ble NGT dated 25.10.2024 and to call the technical presentations of the three experts institutes for detailed evaluation of their proposals on 10.12.2024 and select the institute for carrying out the assessment study. A copy of the minutes of the said meeting is enclosed as **[Annexure - III]**.

6. I say and submit that the Board has invited proposals from four expert institutes for the following terms of reference. The terms of reference for the proposals includes:

    I. Assessment of environmental damage caused by the movement of horses and horse dung in Matheran;

    II. Recommendations for minimizing environmental impact; and

    III. Suggesting best eco-friendly practices for managing horse dung.

The Board has issued letters to all these four (4) institutes as follows on 14.11.2024. A copy of said letter dated 14.11.2024 is enclosed as **[Annexure - IV]**.

I. Dr. Babasaheb Ambedkar Technological University (BATU), Mangaon, Dist.- Raigad;

II. Department of Environmental Science, Savitribai Phule Pune University;

III. Department of Environmental Science, Fergusson College, Pune;

IV. Bharati Vidyapeeth Institute of Environment Education and Research, Pune.

7. I say and submit that the Joint Committee has evaluated the proposals considering both the proposed outcomes and the financial details submitted by these institutes.

8. I say and submit that thereafter, the Joint Committee has conducted a site visit on 26.11.2024 to assess the environmental impact at key locations in Matheran. The committee inspected major areas associated with horse movements and parking, including Charlotte Lake, Simpson Park, the main marketplace, major streets, the bio-methanation plant, and the solid waste dump yard. A copy of the site visit of Joint Committee and minutes of second meeting is enclosed as **[Annexure - V].**

9. I say and submit that the proposals received from these Institutes have been evaluated thoroughly by the Joint Committee, which determined that the proposal submitted by Dr. Babasaheb Ambedkar Technological University (DBATU), Mangaon, Dist. Raigad is the most suitable. The said decision has been taken on the basis of technical and financial details provided, as well as the agency's prior experience in handling matters before the Hon'ble NGT and other courts.

10. I say and submit that based on the evaluation, the Joint Committee has recommended Dr. Babasaheb Ambedkar Technological University (DBATU), Mangaon, Dist. Raigad as the expert agency for conducting the study. The Board has issued letter vide letter No. MPCB/ROR/TB/2025-2806 dated 09.01.2025 to the said Institute to carry out work as per order passed by Hon'ble NGT. A copy of the said letter is enclosed as **[Annexure - VI].**

11. Accordingly, Dr. Babasaheb Ambedkar Technological University (DBATU), Mangaon, Dist. Raigad submitted Interim Report to Maharashtra Pollution Control Board, Raigad on 09.04.2025. In the said report concluded with following comments - "It may be seen that current level of investigation reveals need various measures to control the undesirable effects of horse dung presence in Matheran Area. The measures may be adoption of effective collection and disposal of horse dung, imposing control on number of horses, etc. Final report will be submitted after second phase of testing scheduled during September to December 2025 and subsequent evaluation of test results". A copy of the Interim Report is enclosed as **[Annexure - VII].**

Solemnly affirmed on this ....09th.... day of April 2025 at ....CBD, Navi Mumbai.

For and on behalf of Maharashtra
Pollution Control Board,

(Raj S. Kamat)
Sub Regional Officer,
MPCB, Raigad-2

BEFORE ME
9/4/2025
SURESH N. KAMBLE
ADVOCATE & NOTARY
(Govt. Of India)
- 9 APR 2025

Register Sr. No. 344/2025

Annexure-I

MAHARASHTRA POLLUTION CONTROL BOARD

Tel. No. 2757 6034
Fax No. 2756 2132
Web site: www.mpcb.gov.in Sion
Email:jdair@mpcb.gov.in

Kalpataru Point, 3rd & 4th Floor,
Opp. Cinemax theatre,
Circle, Sion (E), Mumbai-32.

No.BO/JD(APC)/B- 0109 Date :- 04/11/2024

OFFICE ORDER NO.0110 of 2024

Sub: Constitution of Committee in compliance of the order of the Hon'ble NGT dtd. 25.10.2024 in O.A. No. 210/2024 (WZ) filed by Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra & Ors.

Ref: Hon'ble NGT order dtd. 25.10.2024 in O.A. No. 210/2024 filed by Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra & Ors.

,,,,,,,,,,

Mr. Sachin R Shinde has filed OA no 210/2024 and raised the issue of the Eco Sensitive Zone at Matheran declared by the Gov of India in the year 2003. The Applicant has stated that Matheran has faced serious environmental degradation due to the excessive use of horses for tourism and goods transportation. The Application highlights that there are 460 horses and 200 ponies operating daily which is resulting over 3 tonnes of horse dung being dumped across the valley, damaging the ecology, which resulted in air, water and land pollution affects health of the people.

In this regard, the Hon'ble NGT has constituted a three-member joint committee to assess the environmental damage caused by movement of horses, and recommend measures for minimizing impact on the environment, consisting of the following members:-

1. Representative of the MoEF & CC, Govt. of India nominated by MoEF & CC - Chairman
2. Representative of the Matheran Hill Station Municipal Council nominated by Chief officer - Member
3. Sub Regional Officer- Raigad 2 -Member Conveyor

TERM OF REFERENCE FOR THE JOINT COMMITTEE ARE AS UNDER -

a) The Joint Committee shall visit the site in question, assess the environmental damage caused by movement of horses and recommend measures for minimizing the impact thereof on the environment.
b) The committee will be free to hire the services of any expert organization, and the cost therefore will be borne by MPCB from EDC funds available with MPCB. The committee shall submit its report within 6 weeks by email ngt-pune@gov.in.
c) MPCB shall be the nodal agency of the said committee for co-ordination and logistic support.

This is issued with the Competent Authority of the Board.

Yours faithfully,

(Dr.V.M Motghare) 04/11/24
JD(APC)

Encl: As above.

Copy for necessary action to:-

1. The Secretary, MoEF & CC, Govt. of India- with request to nominate the officials for the above committee.
2. The Chief Officer, Matheran Hill Station Municipal Council-with request to nominate the Officials for the above committee.

Copy for information and necessary action to-

1. Law Officer, (P & Divn-II), MPCB, Mumbai.
2. RO/SRO-II, MPCB, Raigad- They are directed to co-ordinate with the committee members and organize committee visits at the earliest & ensure compliance of the order in stipulated time.

~~Exhibit III~~
Annexure-II

Minutes of the First Meeting of Joint Committee Constituted In Compliance Of The Order Dated 25/10/2024 Passed By The Hon'ble National Green Tribunal In Original Application No. 210/2024 (WZ), Ramchandra Shinde & Anr. Vs. State of Maharashtra &Ors

Date: 07/11/2024 Time: 12.00 PM

The First meeting of joint committee constituted in compliance of Hon'ble National Green Tribunal (Western Zone) order dtd. 25/10/2024 in O.A. 210/2024 (WZ) wrt Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra &Ors was held on 07/11/2024 through video conference. Copy of the order is enclosed herewith as **Annexure 1**.

The Joint Committee members attended the meeting.

The Chief Officer, Matheran welcomed all the Committee members and briefed about the background of the subject matter. It was informed that the submissions of the applicants are that Matheran, a hill station in Maharashtra, is part of an Eco-Sensitive Zone (ESZ) declared by the Government of India in the year 2003, with its pristine environment, Matheran has faced serious environmental degradation due to the excessive use of horses for tourism and goods transportation. Further the present application highlights that there are 460 horses and 200 ponies operating daily, which is resulting in over 3 tonnes of horse dung being dumped across the valley, damaging the ecology. This resulted in air, water and land pollution, which, in turn, affects health of the people.

Hon'ble NGT vide its order dated 25.10.2024 has issued the following:

> *"9. In view of the submissions made in the present Original Application, we deem it appropriate to constitute a Joint Committee consisting of:*
>
> *i. One representative of the Ministry of Environment, Forest & Climate Change (MoEF&CC);*
>
> *ii. One representative of the Matheran Hill Station Municipal Council; and*
>
> *iii. One representative of the Maharashtra Pollution Control Board (MPCB).*
>
> *10. The Maharashtra Pollution Control Board shall be the Nodal agency of the said Committee for coordination and logistic support.*
>
> *11. The aforesaid Joint Committee is directed to visit the site in question; assess the environmental damage caused by movement of horses; and recommend measures for minimizing impact thereof on environment.*

12. The Committee will be free to hire services of any expert organization, and the cost therefor will be borne by MPCB from EDC funds available with MPCB. The Committee shall submit its report within 6(six) weeks by e-mail ngt-pune@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF."

Accordingly, following Committee has been constituted:

1. Shri. E. Thirunavukkarasu, Scientist 'E', Regional Office, MoEFCC, Nagpur
2. Shri Rahul Ingale, Chief Officer, Matheran Municipal Council
3. Smt Rutuja Bhalerao, Sub- Regional Officer, Raigad-2, Raigad Regional Office, MPCB.

Copies of the office orders of the appointment of these representatives are enclosed collectively as **Annexure 2.**

It was discussed that similar matter has been put up before Hon'ble NGT (Delhi) in O.A. 187/2023 wherein the area of Kufri, Himachal Pradesh and the report of the Joint Committee appointed by Hon'ble NGT is available. The said Committee had appointed Himalayan Forest Research Institute (HFRI) as Expert agency. Copy of the report is enclosed as **Annexure 3.**

MPCB representative informed that four possible expert agencies in this matter are identified namely Dr. Babasaheb Ambedkar Technological University (BATU), Mangaon, Dist.- Raigad; Department of Environmental Science, Savitribai Phule Pune University; Department of environmental science, Fergusson College, Pune and Bharati Vidyapeeth Institute of Environment Education and Research, Pune.

After detailed discussions, following decisions were taken by the Joint Committee:

i. Chief Officer, Matheran will submit the preliminary data regarding the Matheran site as follow-
   a. Number of Horses, Ponies presently used/engaged
   b. Present arrangement for dung management, if any?
   c. Any analysis report of water from Charlotte Lake and Simpson's Tank
   d. General Food given for Horses
   e. Horses dung – composition- likely impacts on environment
   f. Management of similar issues in the Country/ in the world

ii. MPCB shall communicate to the identified four expert agencies regarding following Terms of Reference and invite financial quotations and then the Committee will decide about the finalization of the expert agency.

a. Assessment of the environmental damage caused by movement of horses, horse dung at the Matheran

b. Recommend measures for minimizing impact thereof on environment

c. Recommend best eco-friendly practice for the management of Horse dung

iii. The Committee will visit the site along with the expert agency representatives.

iv. Maharashtra State Pollution Control Board will collect the samples from nearby water sources (if any), to assess the possibility of ground water contamination from horse dung.

v. Considering the ongoing state assembly elections and administrative work regarding appointment of expert agency and time period required for the expert agency work and sampling etc., the Joint Committee will request Hon'ble NGT to grant extended time period for submission of the report.

The meeting ended with vote of thanks to the Joint Committee members.

Minutes of the Second Meeting and site visit of Joint Committee Constituted in Compliance of The Order Dated 25/10/2024 Passed By The Hon'ble National Green Tribunal In Original Application No. 210/2024 (WZ), Ramchandra Shinde &Anr. Vs. State of Maharashtra &Ors

Date: 26/11/2024 Time: 02.00 PM

The second meeting and site visit of the joint committee constituted in compliance of Hon'ble National Green Tribunal (Western Zone) order dtd. 25/10/2024 in O.A. 210/2024 (WZ) wrt Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra &Ors was conducted on 26/11/2024 (Tuesday). All the members of the Joint Committee were present.

The Chief Officer, Matheran Municipal Council welcomed the Committee members and informed as follows:

1) BACKGROUND AND LOCATIONS OF HORSE/ PONIES

The population of Matheran Municipal Council (declared as eco-logically sensitive hill station by MoEF&CC, Govt. of India) is around 5139, whereas the number of tourists visiting the Council is around 8 lakhs per year. Currently there are two modes for all types of tourists + goods transportation i.e. the horses (around 460)/ ponies (around 250.) and the toy train from Dasturi point (last point of motorable road) to the Aman lodge at Matheran town. Presently, around 20 Electric rickshaws are deployed on trial run basis, in Matheran area of selected stretches.

The following three areas are the main locations of the horse movements/ parking at Matheran, which were inspected by the Committee during the visit.

(i) Charlotte Lake
(ii) Simpson Park
(iii) Main Market place with major horse movement in Matheran.

The map of these locations is enclosed as Annexure.

(i) Charlotte Lake– According to Council, around 25 number of horses can be accommodated at the parking on peak days. The number of daily horses varies from 40 to 50 coming to Charlotte Lake. The day of the visit was non-holiday, and it was noted that around 10-12 horses were stationed at the horse parking near the lake. The Committee observed that the likelihood of stormwater, horse urine, and dung from the parking area reaching the lake is minimal due to its location. However, stormwater carrying urine or dung from other elevated areas near the lake could potentially flow into the water body. (**Photo-1).**

(ii). Simpson tank- During the visit, no tourist activity was observed. However, the Committee noted the presence of numerous pony stables in the upper area of Dasturi Naka, housing approximately 250 horses. These horses are brought to the tank to drink water. Since the tank is located downstream, stormwater from the upper area, including runoff from the stables containing urine and dung, can flow into the tank. Additionally, the water in the tank is not clear. (**Photo-2).**

It was also noted that in areas like Dasturi naka, Ram chauk, Regal naka, horses are parked along the roadsides. (**Photo-3).**

(iii). **Main Market place and other major streets of horse movement in Matheran-** Due to the non-holiday day, the horse movement was limited in the markets and streets and dried horse dung/ dung residue was observed on the road.

The Council reported that in general, there are a greater number of patients of Non-Communicable Diseases (NCD).

2. MANAGEMENT OF HORSE DUNG AT MATHERAN-

According to the Matheran Council, the dung from the stables, and the roads are regularly collected by the sanitary workers of the council using handheld trollies and is disposed of in the solid waste dump site **(photo-4).**

The total solid waste generation in the area is about Three Tonnes per day, out of which about 1.5 to 2 tonnes/day or wet waste, which is treated in bio-methanation plant. The dung is about one Ton/day, which is dumped at Plot No MP114 dumping site. The Council has established a bio-methanation plant of 5 T/day capacity, and all the wet waste generated from the Matheran is used in biogas generation. The gas generated is converted into energy through 40KVA Generator and the power is used for street lighting.

The Council reported that a separate digester was installed in 2019 to process horse and pony dung for biogas generation. However, the system experienced frequent blockages due to the high fiber content in the dung. As a result, the use of dung for biogas generation was discontinued in 2020. **(Photo -5).**

The plastic / recyclable waste is taken to the dump yard at Plot No. MP114, where the plastic bottles are bundled/ compactor and given to recyclers**. (Photo-6**).

As regards the generation of 3 tons of horse dung, it was reported that 460 horses are permitted, around 200 ponies are permitted and about one ton dung is generated, and it is collected and is disposed of at site.

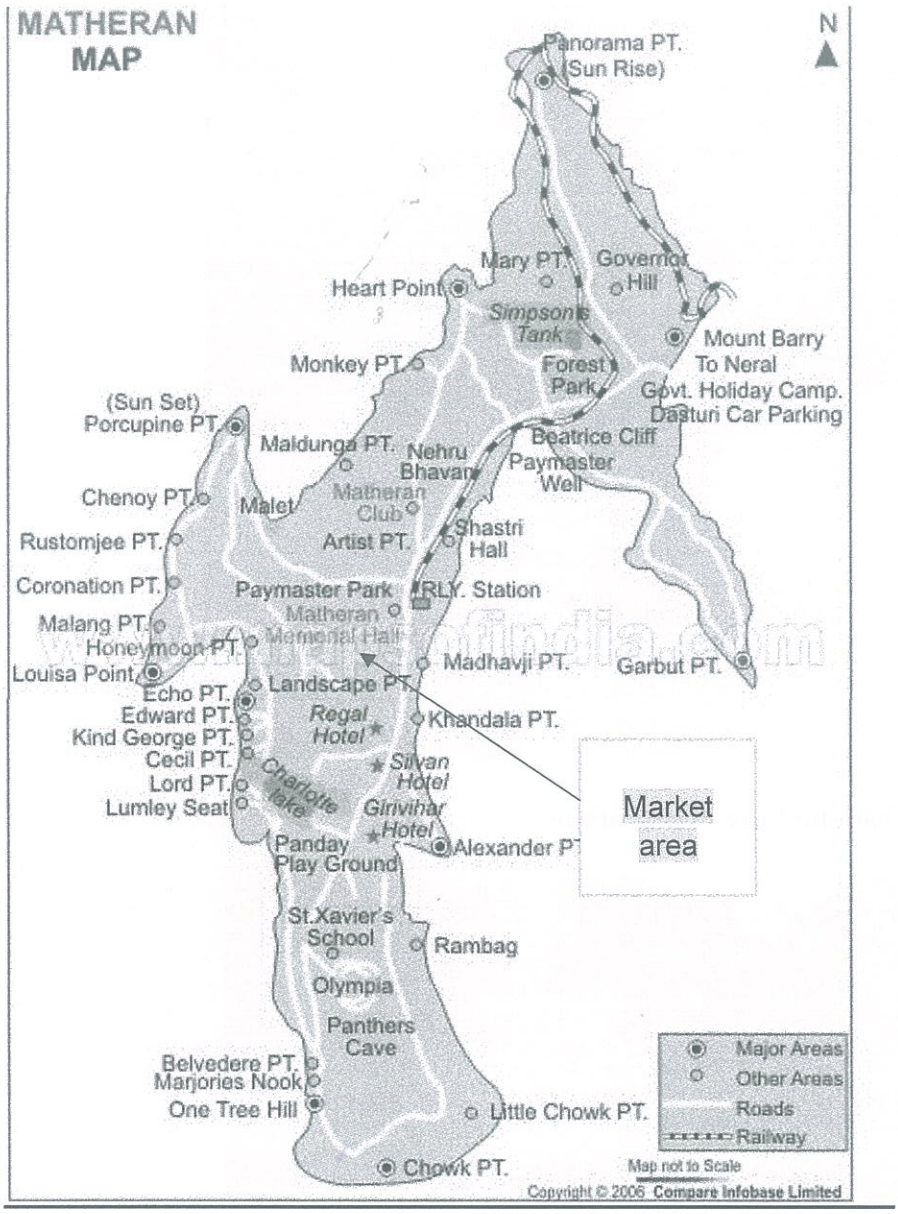
3. OBSERVATIONS AND RECOMMENDATIONS OF THE COMMITTEE:

1. There was a lot of dried dung with fiber form, along the roadsides.
2. Dust was observed on the unpaved portions of the roads due to the horse movement.
3. There is a significant possibility of stormwater, contaminated with horse/pony urine and cow dung from the Matheran area, flowing downstream into water reservoirs and tanks. As per available literature, horse dung is considered good manure. Therefore, converting it into manure could be a viable solution.
4. Introducing e-rickshaws on the most commonly used roads could reduce the number of horses, particularly on stretches such as Dasturi Naka to One Tree Hill Road.

5. To assess the environmental damage caused by movement of horses; and recommend measures for minimizing impact thereof on environment, a study by a reputed scientific institute, as directed by the Hon'ble NGT, is essential.
6. The selected expert institute shall conduct a detailed study and submit its report to the MPCB and the Matheran Council for implementation. Sub-Regional Officer, Raigad-2, MPCB informed that MPCB has invited proposals from five scientific institutes (namely Dr. Babasaheb Ambedkar Technological University (BATU), Mangaon, Dist.- Raigad; Department of Environmental Science, Savitribai Phule Pune University; Department of environmental science, Fergusson College, Pune, Bharati Vidyapeeth Institute of Environment Education and Research, Pune) and Veermata Jijabai Technological Institute (VJTI), Mumbai as decided in the first meeting of the Committee conducted on 07/11/2024. Except for the Department of Environmental Science at Savitribai Phule Pune University and VJTI, all three other institutes have submitted their proposals. The Committee decided to evaluate the proposals, conduct technical presentations from the institutes, and recommend a suitable expert institute.

The meeting of the Committee ended with a vote of thanks.

Annexure- Map of Matheran



(Source- https://www.mapsofindia.com/maps/maharashtra/matheran-map.html)

Photos of Matheran site visit of Joint Committee conducted on 26/11/2024

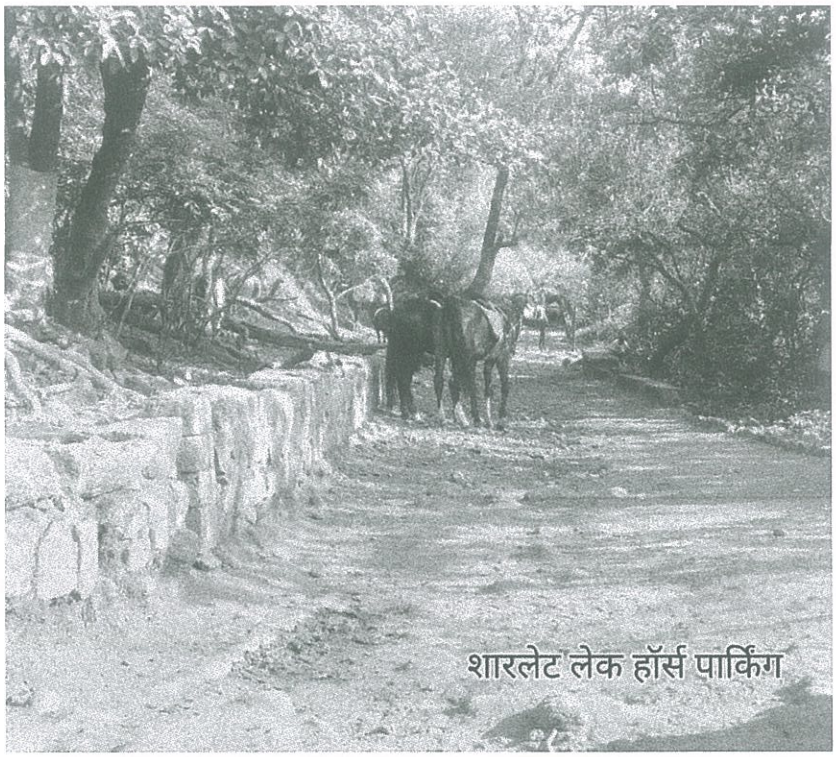


Photo 1: Charlotte Lake horse parking

Photo 2: Simpson Tank

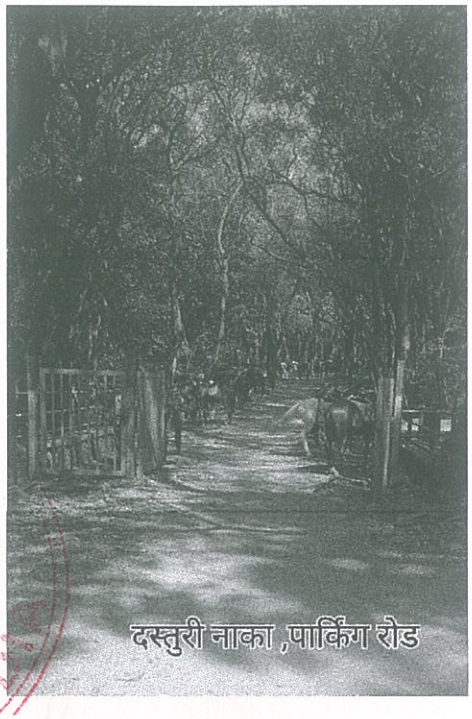


Photo 3.1: Dasturi Naka parking

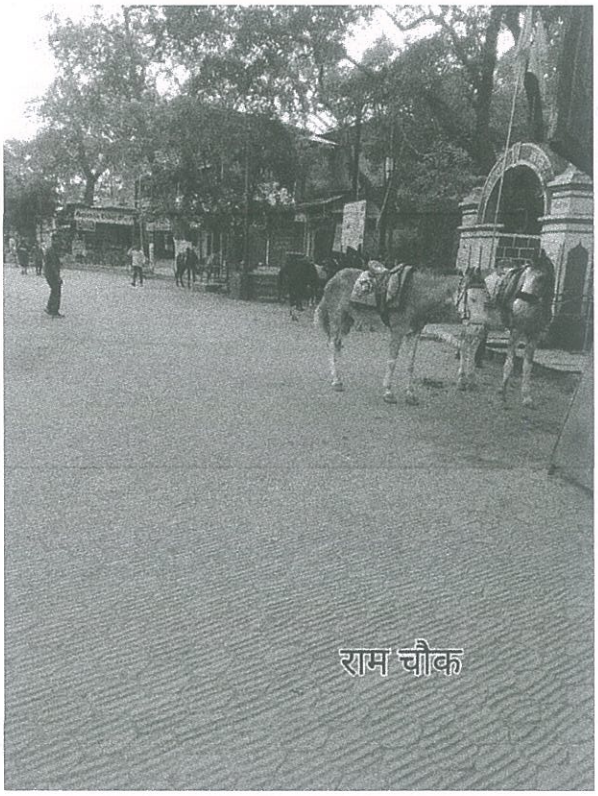


Photo 3.2 Horse parking at Ram Chouk

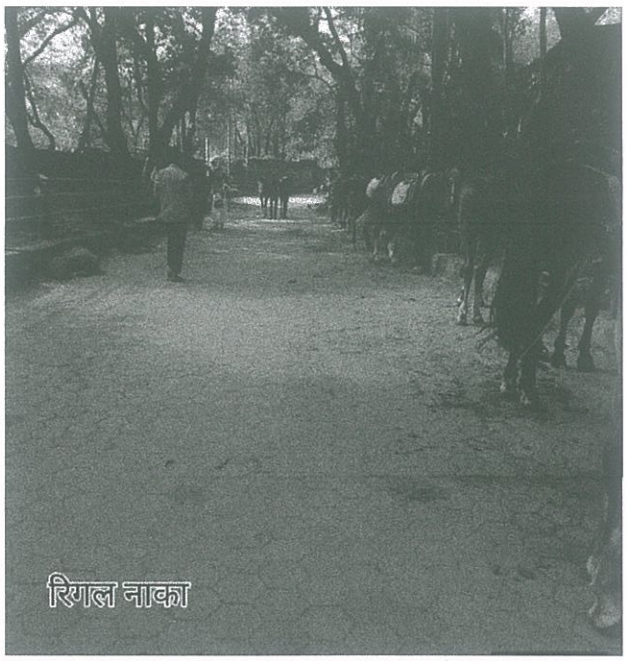


Photo 3.3: Horse parking at Regal Naka

Photo 4: Dung collection on roads by the sanitary workers of the council using handheld trollies

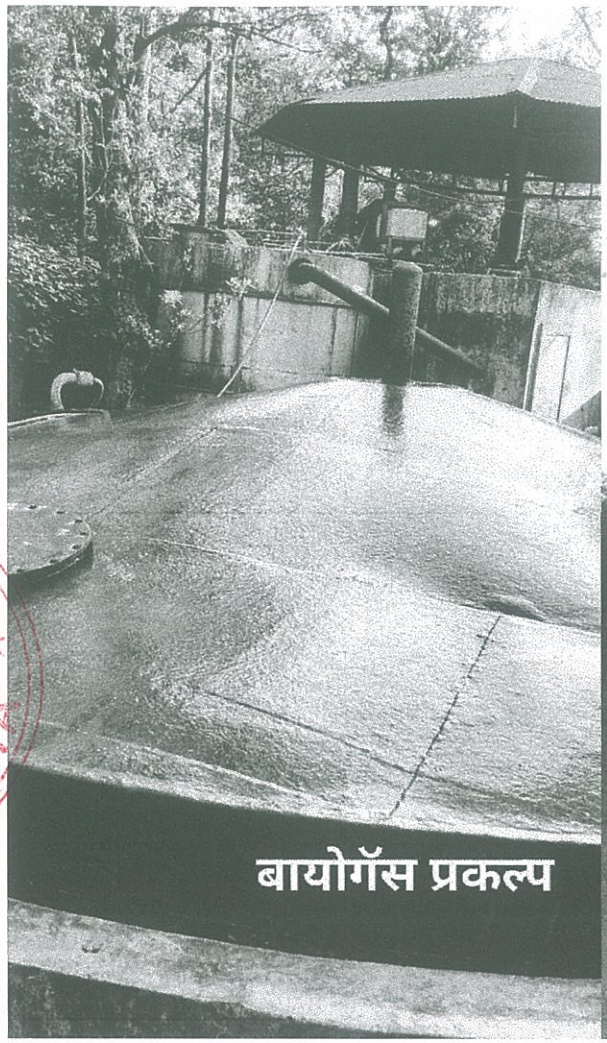


Photo 5.1: Biogas project at Matheran

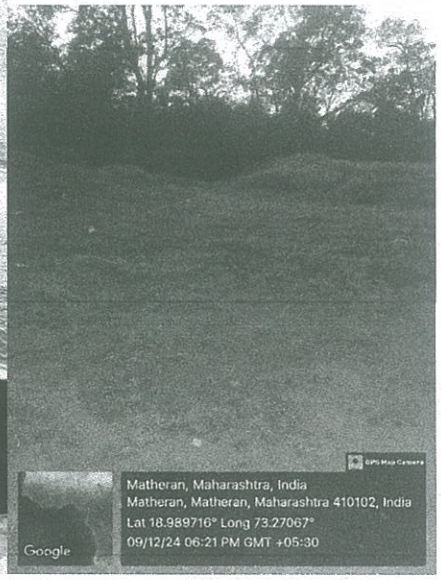


Photo 5.2: Dumping ground of the Council used for dumping of horse dung

Photo 6.1- Plastic waste collection by Matheran Municipal Council

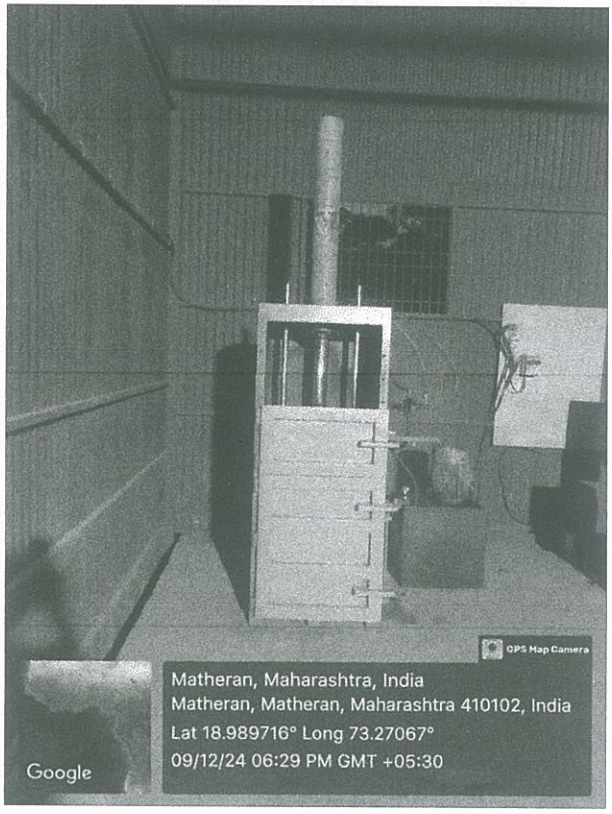


Photo 6.2- Plastic waste compactor

Annexure-III

Minutes of the Meeting of the Joint Committee Constituted in Compliance of The Order Dated 25/10/2024 Passed by Hon'ble National Green Tribunal In Original Application No. 210/2024 (WZ), Ramchandra Shinde &Anr. Vs. State of Maharashtra &Ors and MPCB officials

Date: 04/12/2024 Time: 11.30AM

The meeting of the joint committee constituted in compliance of Hon'ble National Green Tribunal (Western Zone) order dtd. 25/10/2024 in O.A. 210/2024 (WZ) wrt Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra &Ors and the MPCB officials was conducted on 04/12/2024 through Video conferencing. The following officials were present:

1) Joint Director (Air Pollution Control), MPCB, Head office, Sion
2) Shri. E. Thirunavukkarasu, Scientist 'E', Regional Office, MoEFCC, Nagpur
3) Regional Officer- Raigad, MPCB
4) Chief Officer, Matheran Municipal Council
5) Sub-Regional Officer, Raigad-2, Raigad Regional Office, MPCB

The Sub-Regional Officer, Raigad-2, MPCB welcomed all the attendees and informed about the background of the Hon'ble NGT order dtd. 25/10/2024 and updated regarding the status of the work done by the Committee till date as follow:

1) Order dated 25/10/2024 is passed by Hon'ble National Green Tribunal in Original Application No. 210/2024 (WZ), Ramchandra Shinde &Anr. Vs. State of Maharashtra &Ors (Matheran Horse related matter).
   a. Matheran, a hill station in Maharashtra, is part of an Eco-Sensitive Zone (ESZ) declared by the Government of India in the year 2003, with its pristine environment, Matheran has faced serious environmental degradation due to the excessive use of horses for tourism and goods transportation. This has resulted in air, water and land pollution, which, in turn, affects the health of the people as per the applicant.
   b. Hon'ble NGT has constituted a Joint Committee consisting of representatives of the Ministry of Environment, Forest & Climate Change (MoEF&CC); Matheran Hill Station Municipal Council; and Maharashtra Pollution Control Board (MPCB).
   c. Hon'ble NGT has directed the said Joint Committee to visit the site in question; assess the environmental damage caused by movement of horses; and recommend measures for minimizing impact thereof on environment.
   d. The Joint Committee can hire the services of any expert organization, and the cost therefore will be borne by MPCB from EDC funds available with MPCB.

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e. MPCB will be Nodal agency of Committee for coordination and logistic support.

f. The Committee is directed to submit its report within 06 (six) weeks.

2) Scientist E, Regional Office, MoEF&CC, Nagpur; Sub-Regional Officer (Raigad-2), MPCB and Chief Officer, Matheran Municipal Council are the members of the Joint Committee as per the official communication.

3) The First meeting of joint committee was conducted on 07/11/2024.

4) MPCB has invited proposals from the four expert institutes - Dr. Babasaheb Ambedkar Technological University (BATU), Mangaon, Dist.- Raigad; Department of Environmental Science, Savitribai Phule Pune University; Department of environmental science, Fergusson College, Pune and Bharati Vidyapeeth Institute of Environment Education and Research, Pune. Accordingly, three institutes have submitted their proposals except Department of Environmental Science, Savitribai Phule Pune University.

5) The Joint Committee submitted preliminary scrutiny of the three proposals.

6) The second meeting and site visit of the joint committee was conducted on 26/11/2024.

After due deliberation, following decisions were taken:

1) The Joint Committee to call the technical presentations of the three expert institutes for detailed evaluation of their proposals on 10/12/2024.

2) MPCB will carry out air quality monitoring at the dust prevalent area using the mobile vans due to horse movement in Matheran. MPCB will submit a request / application letter to the Matheran eco-sensitive zone monitoring committee constituted by MoEF&CC for allowing the use of mobile vans at the Matheran site.

3) Till the joint Committee submits its report to Hon'ble NGT, MPCB shall issue directions to Matheran Municipal Council as follow for immediate compliance-

   a. Ensure daily sweeping and provide water sprinkling arrangement at the dust prevalent area due to the horse movement.

   b. Collect the horse dung from the horse stables and regular locations of horse parking and provide composting pits for the dung.

The meeting ended with a vote of thanks.

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MAHARASHTRA POLLUTION CONTROL BOARD
SUB-REGIONAL OFFICE, RAIGAD-2

Annexure IV

Tel. No. 2757 2620
Fax No. 2756 2132
Email: sroraigad2@mpcb.gov.in
Visit us at:http://mpcb.gov.in

"Your Service is our Duty"

Raigad Bhavan, 6th Floor,
Sec-11, C.B.D. Belapur,
Navi Mumbai 400 614.

Ref No: MPCB/SROR-2 **Date: 14/11/2024**

To,

The Head of Department,
Civil Engineering Department,
Dr. Babasaheb Ambedkar Technological University (BATU), Mangaon, Dist.- Raigad
smpore@dbatu.ac.in

The Head of Department,
Department of Environmental Science, Savitribai Phule Pune University,
hodenvsci@unipune.ac.in

The Head of Department,
Department of Environmental Science, Fergusson College, Pune
environmentalscience@fergusson.edu

The Director,
Bharati Vidyapeeth Institute of Environment Education and Research, Pune
bvuniversity@bharatividyapeeth.edu

Subject: Request for Submission of Proposal

Dear Sir/ Madam,

Hon'ble National Green Tribunal (Western Zone) vide order dtd. 25/10/2024 in O.A. 210/2024 (WZ) wrt Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra &Ors has appointed a joint committee consisting of representatives of the Ministry of Environment, Forest & Climate Change (MoEF&CC), Matheran Hill Station Municipal Council; and Maharashtra Pollution Control Board (MPCB). Copy of the order is enclosed herewith.

The Committee desires to appoint an expert agency for following Terms of reference:

a. Assessment of the environmental damage caused by movement of horses, horse dung at the Matheran
b. Recommend measures for minimizing impact thereof on environment
c. Recommend best eco-friendly practice for the management of Horse dung

In view of above, you are requested to furnish your technical proposal for aforesaid Terms of Reference and provide financial quotation for this study, within 5 days, as the committee is required to submit report to Hon'ble NGT in time bound manner.

Yours Faithfully,

(Rutuja Bhalerao)
Sub-Regional Officer, Raigad-2

Copy to:

1) Regional Officer, Raigad, MPCB
2) Shri. E. Thirunavukkarasu, Scientist 'E', Regional Office, MoEFCC, Nagpur
3) Shri Rahul Ingale, Chief Officer, Matheran Municipal Council

Minutes of the Second Meeting and site visit of Joint Committee Constituted in Compliance of The Order Dated 25/10/2024 Passed By The Hon'ble National Green Tribunal In Original Application No. 210/2024 (WZ), Ramchandra Shinde &Anr. Vs. State of Maharashtra &Ors

Date: 26/11/2024 Time: 02.00 PM

The second meeting and site visit of the joint committee constituted in compliance of Hon'ble National Green Tribunal (Western Zone) order dtd. 25/10/2024 in O.A. 210/2024 (WZ) wrt Sunil Ramchandra Shinde & Anr. Vs. State of Maharashtra &Ors was conducted on 26/11/2024 (Tuesday). All the members of the Joint Committee were present.

The Chief Officer, Matheran Municipal Council welcomed the Committee members and informed as follows:

1) BACKGROUND AND LOCATIONS OF HORSE/ PONIES

The population of Matheran Municipal Council (declared as eco-logically sensitive hill station by MoEF&CC, Govt. of India) is around 5139, whereas the number of tourists visiting the Council is around 8 lakhs per year. Currently there are two modes for all types of tourists + goods transportation i.e. the horses (around 460)/ ponies (around 250.) and the toy train from Dasturi point (last point of motorable road) to the Aman lodge at Matheran town. Presently, around 20 Electric rickshaws are deployed on trial run basis, in Matheran area of selected stretches.

The following three areas are the main locations of the horse movements/ parking at Matheran, which were inspected by the Committee during the visit.

(i) Charlotte Lake
(ii) Simpson Park
(iii) Main Market place with major horse movement in Matheran.

The map of these locations is enclosed as Annexure.

(i) Charlotte Lake– According to Council, around 25 number of horses can be accommodated at the parking on peak days. The number of daily horses varies from 40 to 50 coming to Charlotte Lake. The day of the visit was non-holiday, and it was noted that around 10-12 horses were stationed at the horse parking near the lake. The Committee observed that the likelihood of stormwater, horse urine, and dung from the parking area reaching the lake is minimal due to its location. However, stormwater carrying urine or dung from other elevated areas near the lake could potentially flow into the water body. (**Photo-1).**

(ii). Simpson tank- During the visit, no tourist activity was observed. However, the Committee noted the presence of numerous pony stables in the upper area of Dasturi Naka, housing approximately 250 horses. These horses are brought to the tank to drink water. Since the tank is located downstream, stormwater from the upper area, including runoff from the stables containing urine and dung, can flow into the tank. Additionally, the water in the tank is not clear. (**Photo-2).**

It was also noted that in areas like Dasturi naka, Ram chauk, Regal naka, horses are parked along the roadsides. **(Photo-3).**

(iii). **Main Market place and other major streets of horse movement in Matheran-** Due to the non-holiday day, the horse movement was limited in the markets and streets and dried horse dung/ dung residue was observed on the road.

The Council reported that in general, there are a greater number of patients of Non-Communicable Diseases (NCD).

2. MANAGEMENT OF HORSE DUNG AT MATHERAN-

According to the Matheran Council, the dung from the stables, and the roads are regularly collected by the sanitary workers of the council using handheld trollies and is disposed of in the solid waste dump site **(photo-4).**

The total solid waste generation in the area is about Three Tonnes per day, out of which about 1.5 to 2 tonnes/day or wet waste, which is treated in bio-methanation plant. The dung is about one Ton/day, which is dumped at Plot No MP114 dumping site. The Council has established a bio-methanation plant of 5 T/day capacity, and all the wet waste generated from the Matheran is used in biogas generation. The gas generated is converted into energy through 40KVA Generator and the power is used for street lighting.

The Council reported that a separate digester was installed in 2019 to process horse and pony dung for biogas generation. However, the system experienced frequent blockages due to the high fiber content in the dung. As a result, the use of dung for biogas generation was discontinued in 2020. **(Photo -5).**

The plastic / recyclable waste is taken to the dump yard at Plot No. MP114, where the plastic bottles are bundled/ compactor and given to recyclers**. (Photo-6**).

As regards the generation of 3 tons of horse dung, it was reported that 460 horses are permitted, around 200 ponies are permitted and about one ton dung is generated, and it is collected and is disposed of at site.

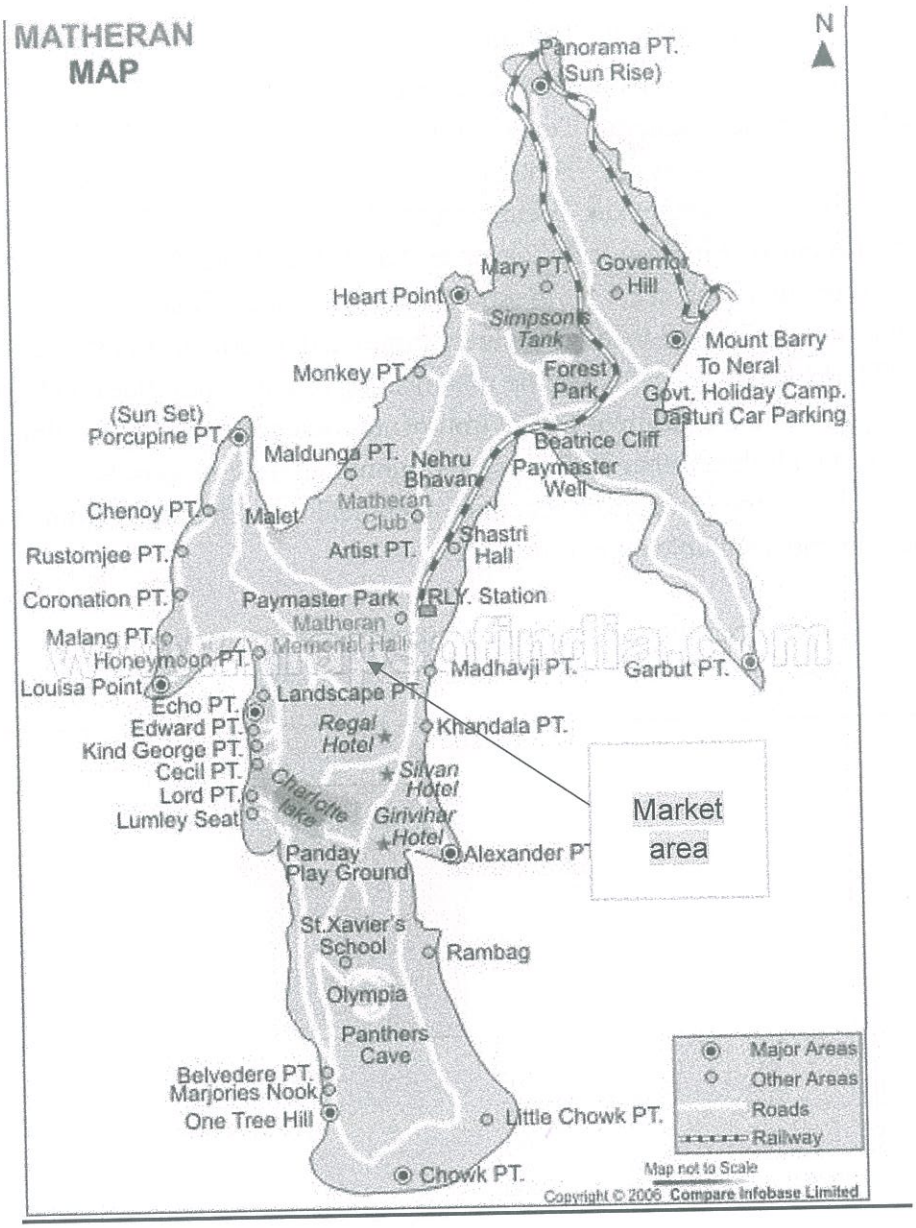
3. OBSERVATIONS AND RECOMMENDATIONS OF THE COMMITTEE:

1. There was a lot of dried dung with fiber form, along the roadsides.
2. Dust was observed on the unpaved portions of the roads due to the horse movement.
3. There is a significant possibility of stormwater, contaminated with horse/pony urine and cow dung from the Matheran area, flowing downstream into water reservoirs and tanks. As per available literature, horse dung is considered good manure. Therefore, converting it into manure could be a viable solution.
4. Introducing e-rickshaws on the most commonly used roads could reduce the number of horses, particularly on stretches such as Dasturi Naka to One Tree Hill Road.

5. To assess the environmental damage caused by movement of horses; and recommend measures for minimizing impact thereof on environment, a study by a reputed scientific institute, as directed by the Hon'ble NGT, is essential.
6. The selected expert institute shall conduct a detailed study and submit its report to the MPCB and the Matheran Council for implementation. Sub-Regional Officer, Raigad-2, MPCB informed that MPCB has invited proposals from five scientific institutes (namely Dr. Babasaheb Ambedkar Technological University (BATU), Mangaon, Dist.- Raigad; Department of Environmental Science, Savitribai Phule Pune University; Department of environmental science, Fergusson College, Pune, Bharati Vidyapeeth Institute of Environment Education and Research, Pune) and Veermata Jijabai Technological Institute (VJTI), Mumbai as decided in the first meeting of the Committee conducted on 07/11/2024. Except for the Department of Environmental Science at Savitribai Phule Pune University and VJTI, all three other institutes have submitted their proposals. The Committee decided to evaluate the proposals, conduct technical presentations from the institutes, and recommend a suitable expert institute.

The meeting of the Committee ended with a vote of thanks.

Annexure- Map of Matheran



Source- https://www.mapsofindia.com/maps/maharashtra/matheran-map.html)

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Photos of Matheran site visit of Joint Committee conducted on 26/11/2024

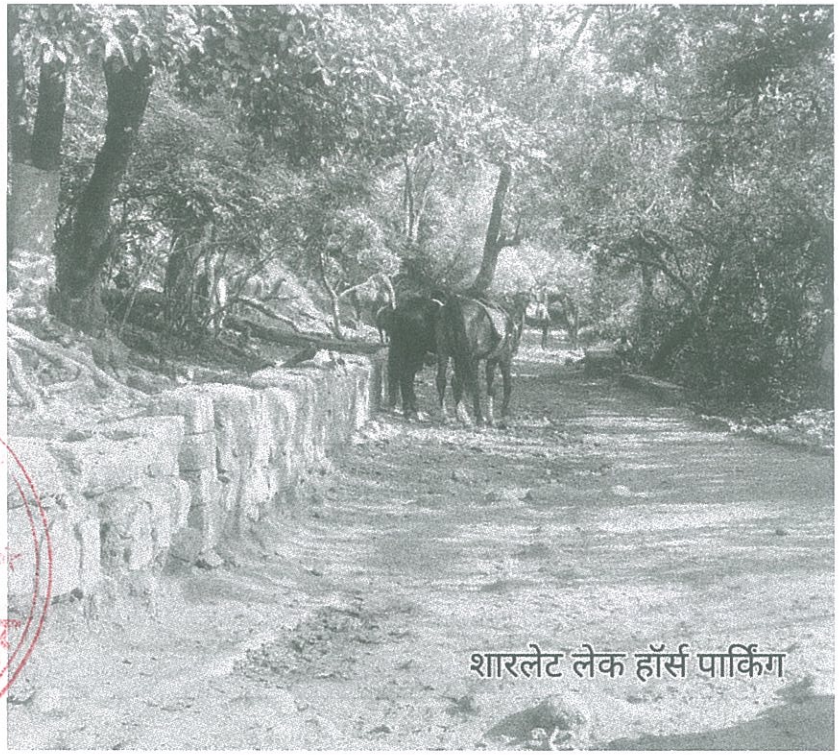


Photo 1: Charlotte Lake horse parking

Photo 2: Simpson Tank

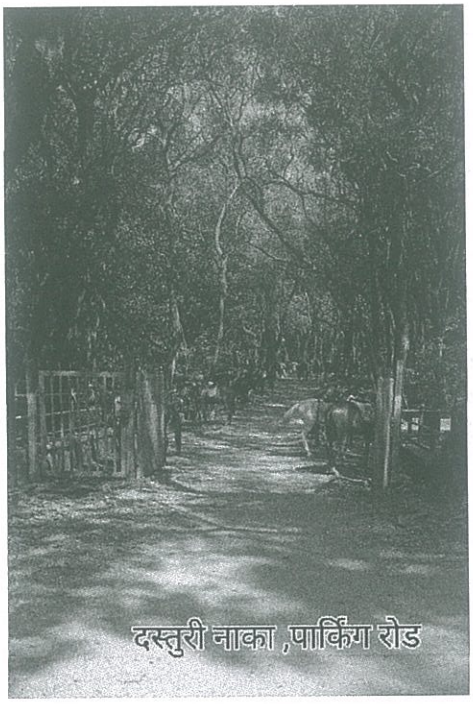


Photo 3.1: Dasturi Naka parking

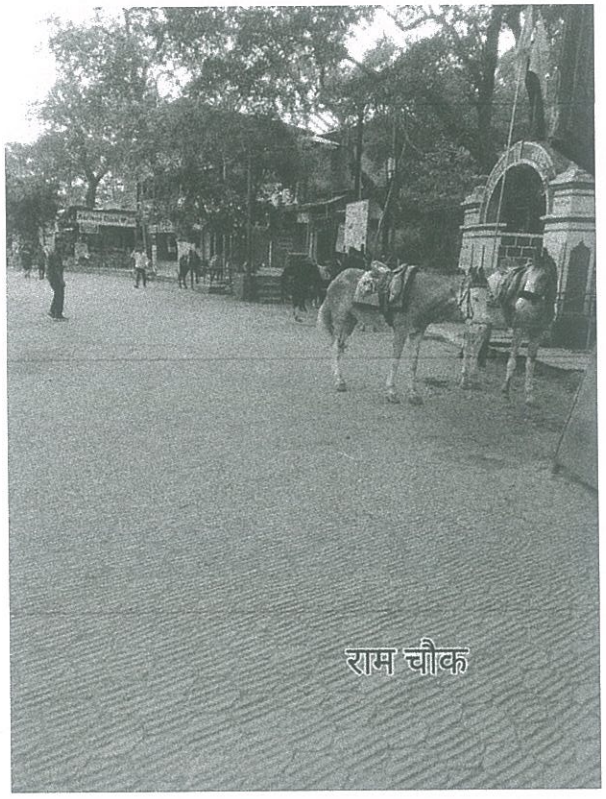


Photo 3.2 Horse parking at Ram Chouk

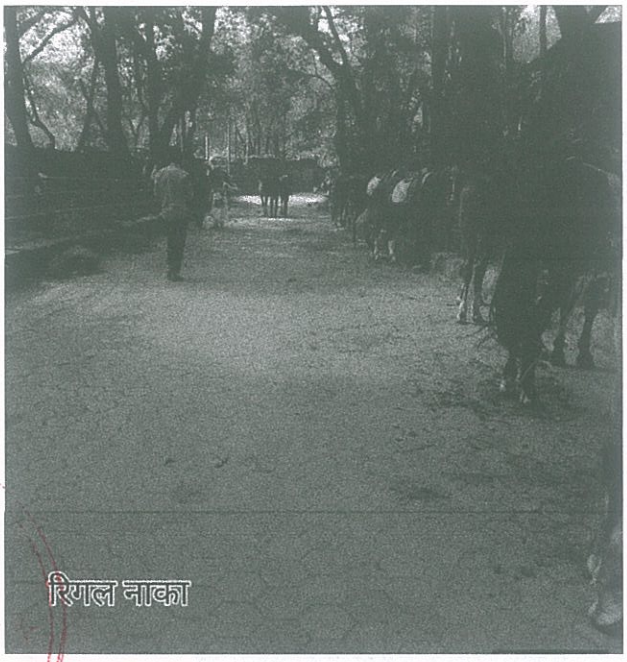
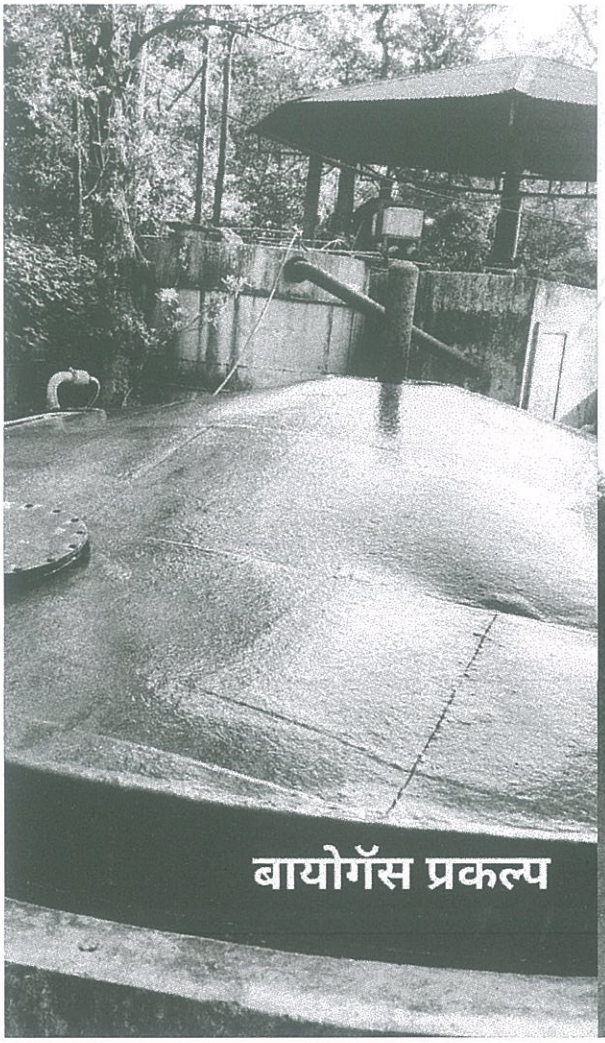


Photo 3.3: Horse parking at Regal Naka

Photo 4: Dung collection on roads by the sanitary workers of the council using handheld trollies



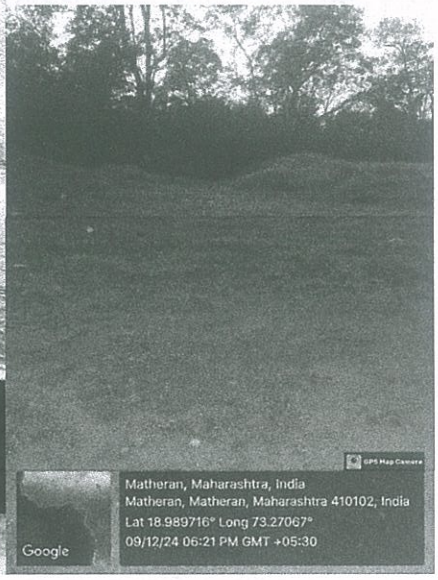


Photo 5.1: Biogas project at Matheran

Photo 5.2: Dumping ground of the Council used for dumping of horse dung

Photo 6.1- Plastic waste collection by Matheran Municipal Council

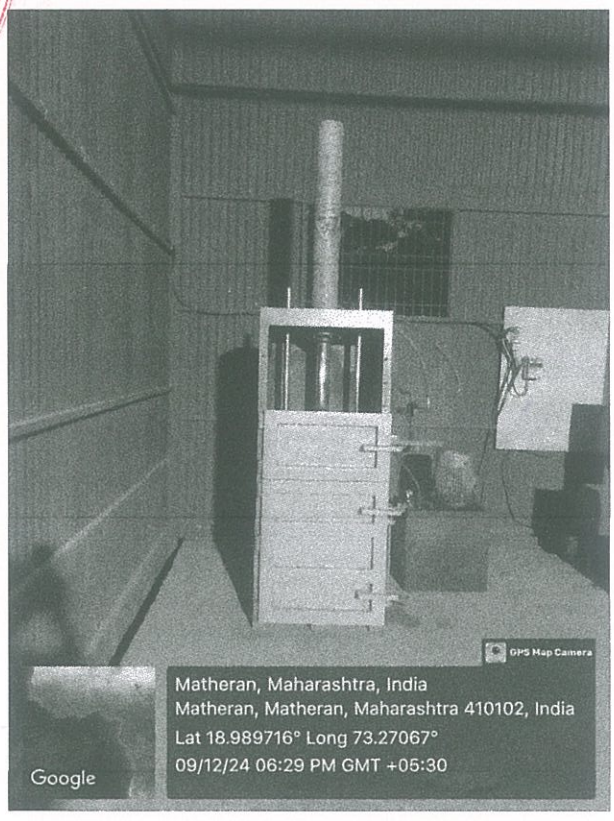


Photo 6.2- Plastic waste compactor

Annexure-VI

MAHARASHTRA POLLUTION CONTROL BOARD

REGIONAL OFFICE - RAIGAD

Tel. No. 2757 6034
Fax No. 2756 2132
Email: roraigad@mpcb.gov.in
Visit us at: mpcb.gov.in

Raigad Bhavan, 6th Floor,
Sec-11, C.B.D. Belapur, Navi
Mumbai 400 614.

"Your Service is our Duty"

MPCB/ROR/TB/2025- 2806 **Date: 09.01.2025**

To,
The Dean (R&D) and Professor,
Department of Civil Engineering,
Dr. Babasaheb Ambedkar Technological University (BATU),
Village:- Lonere,Tal:- Mangaon, Dist.- Raigad- 402103.

Subject: - **To carry out work as per order passed by the Hon'ble National Green Tribunal (WZ) dated 25.10.2024 in Original Application No. 210 / 2024 (WZ), (Matheran Horse related matter)**

Reference:
1. Order passed by the Hon'ble NGT in OA No. No. 210/2024 (WZ), (Matheran Horse related matter)
2. Your proposal dated 24.11.2024.
3. Presentation held on before joint committee dtd. 10.12.2024
4. Office Note submitted by the Sub-Regional Officer, Raigad-II on 27.12.2024, which was duly approved by the competent authority of the Board.

Sir,

The Hon'ble National Green Tribunal (WZ) has issued an order on 25.10.2024 in Original Application No. 210/2024 (WZ), Ramchandra Shinde & Anr. Vs. State of Maharashtra & Ors. As per the order passed by Hon'ble NGT, the Joint Committee was constituted. This committee consisting of One representative of the Ministry of Environment, Forest & Climate Change (MoEF&CC); One representative of the Matheran Hill Station Municipal Council; and One representative of the Maharashtra Pollution Control Board (MPCB).

Accordingly, Presentation was held on 10.12.2024 vide ref no.3. Further, MPC Board has decided to award works of "to carrying out work as per Order Dated 25.10.2024 Passed by Hon'ble NGT in Original Application No. 210/2024 (WZ)", with following Objectives, Scope of Work and Deliverables with payment terms and conditions: -

e environmental damage caused by movement of horses,

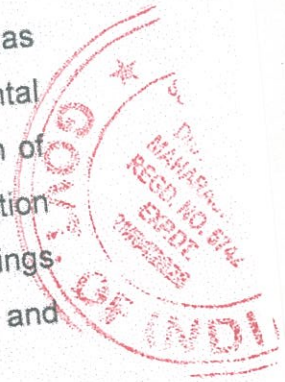
: Matheran

asures for minimizing impact thereof on environment

best eco-friendly practices for the management of Horse

work:

horse dung in sensitive ecological zones, such as shtra, poses significant challenges to environmental lung contributes to air pollution through the emission of a, soil pollution via nutrient overload, and water pollution itrates and pathogens. This review synthesizes findings dies to explore the impacts of horse dung on air, soil, and



ammonia (NH_3), methane (CH_4), volatile organic compounds nd particulate matter (PM_{10} and $PM_{2.5}$) emissions from horse atheran.

:

s: 5 different areas with high horse activity (e.g., stables, s) and 5 areas with minimal horse activity (controls) will be

mples per Site: 2–3 samples per site to ensure spatial variation. ct samples at 1.5 m (human breathing zone)

lan :

ssess nutrient overload (nitrogen, phosphorus), microbial ination (E. coli, Salmonella spp.), and heavy metals in soils d by horse dung.

433

Sampling Locations:

- Sampling Sites:
- 5 stables or manure dumping areas such as horse movement routes
- 5 control sites away from horse activity.
- Number of Samples per Site: 5 samples/site (5 subsamples pooled into one per site).

3. Water Sampling Plan :

Objective: To monitor nutrient leaching (nitrates, phosphates), microbial contamination (E. coli, Salmonella spp.), and chemical contamination (heavy metals, antibiotics) in water bodies near horse activity zones.

4. Sampling Locations:

- 5 runoff areas near horse routes.
- 5 control locations upstream or unaffected by horse activity.
- Number of Samples per Site: 2–3 water samples/site for spatial variability

5. Sampling Summary Table :

Parameter	Air (25 Samples)	Soil (25 Samples)	Water (25 Samples)
Objective	Gaseous emissions, PM levels	Nutrient, microbial, and heavy metals	Nutrient, microbial, and heavy metals
Sites	10 sites (5 affected, 5 control)	10 sites (5 affected, 5 control)	10 sites (5 affected, 5 control)
Sample Count	25 total	25 total	25 total
Key Analysis	NH_3, CH_4, PM_{10}, $PM_{2.5}$	N, P, microbes, heavy metals	N, P, microbes, heavy metals, antibiotics
Storage	Filters	Plastic/sterile bags	Acid-preserved bottles, sterile bottles

This comprehensive sampling plan ensures robust data collection for evaluating the environmental impacts of horse dung on air, soil, and water quality.

C. **Project Duration**:

- The time duration of the project shall be 08 weeks from receipt of the work order. The final report along with recommendations shall be submitted within 15 days from the date of completion of the whole project.

D. **Support from MPC Board**:

- Representative from MPCB for guidance and technical co-ordination. MPCB shall take the review of the work progress on monthly basis.

E. **Payment Terms:**

1. Air Sampling Costs :

Item	Unit Cost (₹)	Quantity	Total Cost (₹)
Gas analysers (NH_3 and CH_4)	5,000/day	5 days	25,000
High-volume air samplers (PM_{10}/$PM_{2.5}$)	5000/day/unit	5 days	25,500
Filters for PM analysis	500/filter	50	25,000
Laboratory analysis (PM_{10}/$PM_{2.5}$)	1,500/sample	25	37,500
Subtotal (Air Sampling)			1,12,500
Add Contingencies		Lumpsum	17,500
		Total	**1,30,500/-**

2. Soil Sampling Costs :

Item	Unit Cost (₹)	Quantity	Total Cost (₹)
Soil auger rental	5,000/day	3 days	15,000
Sample bags	60/bag	50	3,000
Laboratory analysis (nutrients)	1,500/sample	25	37,500
Laboratory analysis (microbial)	2,000/sample	25	50,000
Laboratory analysis (heavy metals)	2,500/sample	25	62,500
Subtotal (Soil Sampling)			1,68,000
Add Contingencies		Lumpsum	12,000
		Total	**1,80,000/-**

3. Water Sampling Costs :

Item	Unit Cost (₹)	Quantity	Total Cost (₹)
Polyethylene/glass bottles	100/bottle	50	5,000
Sterile bottles	150/bottle	25	3,750
Field filtration units	500/day/unit	5 days	2,500
Laboratory analysis (nutrients)	1,500/sample	25	37,500
Laboratory analysis (microbial)	2,000/sample	25	50,000
Laboratory analysis (heavy metals)	2,500/sample	25	62,500
Laboratory analysis (antibiotics)	3,000/sample	25	75,000
Subtotal (Water Sampling)			2,36,250
Add Contingencies		Lumpsum	13,7750
		Total	**2,50,000/-**

4. Consultancy Charges :

Item	Unit Cost (₹)	Quantity	Total Cost (₹)
Environmental consultant (site visits)	10,000/day	5 days	50,000
Data analysis and report writing	20,000/report	1	20,000
Expert review and recommendations	15,000/review	1	15,000
One time consultancy charges of expert/s		Lumpsum	5,00,000
Subtotal (Consultancy)		**Total**	**5,85,000/-**

5. Total Cost Estimate:

Category	Cost (₹)
Air Sampling	1,30,500/-
Soil Sampling	1,80,000/-
Water Sampling	2,50,000/-
Consultancy Charges	5,85,000/-
Total	**11,45,500/-**
(+ GST 18%)	**2,06,100/-**
Grand Total	**13,51,100/-**

- 25% along with work order
- 25% on submission of Interim Report
- 50% on submission of Final Report

In view of the above, you are hereby requested to start the work on issuance of this work order and submit a report after completion of the work in a timely manner.

This is issued with the approval of the Competent Authority of the Board.

For AND ON BEHALF OF
M.P.C. BOARD,

(Sanjay R. Bhosale)
Regional Officer, Raigad.

Copy for favor of information to :-

1. The PA to Hon'ble Chairman, MPC Board, Mumbai.
2. The PA to Hon'ble Member Secretary, MPC Board, Mumbai
3. The Joint Director (APC), MPC Board, Mumbai
4. The Chief Account Officer, MPC Board, Mumbai

   – You are requested to release payment in favor of M/s. BATU, Lonere, Raigad.

Copy for necessary action to:-

1. The Sub-Regional Officer, Raigad-II

   —You are directed to assist the M/s. BATU, Lonere, Raigad team during the studies carried out in the field.

Annexure-VII

(Phase –I / Interim Report)

Environmental Impact Assessment of Horse Dung on Air, Soil, and Water Pollution in Matheran Area

1. PREAMBLE

Matheran is a renowned hill station in Maharashtra. It is a unique fueled vehicle free zone celebrated for its natural serenity and tourist attraction. The continued reliance on horse-based transportation for goods and services in this ecosystem has led to necessity of studying environmental and public health concerns. The unregulated accumulation and disposal of horse dung along trekking paths, near stables, and in runoff zones have raised concerns to direct and cumulative impact on air, soil, and water quality.

In recent years, a visible surge in equine movement—peaking at over about 800 horses per day during tourist seasons raise question mark on capacity of natural and municipal systems to manage the resulting waste. This waste-load contributes to a range of environmental problems including methane and ammonia emissions, nutrient leaching, pathogen contamination in runoff and waterbodies, and fine particulate dispersion. These effects have background of heavy rainfall and the densely woody hilly topography of the region.

Recognizing the urgent need for scientific evaluation and sustainable management, a study is initiated in 2025 by **Dr. Babasaheb Ambedkar Technological University (DBATU), Lonere** in collaboration with **Nagesh Karajagi Orchid College of Engineering and Technology, Solapur** as a consultancy project. This activity is taken up on request of **Maharashtra Pollution Control Board (MPCB)** vide letter no. MPCB/ROR/TB/2025-2806 dated 09/01/2025.

The **first stage of this assessment (Pre- Monsoon)**, involving **air, water, and soil sampling**, has been completed. Data has been systematically collected from ecologically sensitive and high-risk areas such as horse stables, trekking trails, runoff sites, and control zones. These samples were tested for a suite of critical indicators including:

- **Air Quality:** Particulate matter ($PM_{2.5}$, PM_{10}),Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2)
- **Soil Health:** Nutrient overload (nitrogen, phosphorus), microbial contamination (E. coli), selected heavy metals
- **Water Pollution:** Nitrate/phosphate leaching, presence of solids, fecal pathogens, and overall chemical contamination.

The sampling methodologies, executed in line with national standards and global best practices, provide a reliable baseline to quantify the environmental effects caused by horse dung and horse urine in Matheran area. These findings also integrate real-time observations of zoonotic risks, ecosystem degradation, and socioeconomic pressures linked to the current waste disposal mechanisms.

This proposal, therefore, aims to present the scientific, technical, and policy roadmap for:

1. **Evaluating the environmental damage** caused by horse dung accumulation in Matheran;
2. **Recommending eco-friendly, viable, and scalable waste management practices** such as composting, biochar production, anaerobic digestion, and constructed wetlands;
3. **Establishing the ecological carrying capacity** of horse-based transportation in Matheran to ensure sustainable tourism;
4. **Transitioning toward greener alternatives**, such as alternative regulated transport systems that balance livelihood, tourism, and ecological integrity.

This multi-dimensional approach combines field-based environmental science with actionable strategies for pollution mitigation, ecosystem restoration, and compliance with the National Green Tribunal's directives on eco-sensitive zones.

2. ENVIRONMENTAL IMPACTS OF ANIMAL DUNG IN ECO-SENSITIVE AREAS: A LITERATURE REVIEW

Eco-sensitive areas, characterized by their unique biodiversity and ecological sensitivity, are increasingly loaded by anthropogenic pressures. A significant contributor to environmental parameters in this zone is the improper management of animal dung, particularly from livestock operations. This report synthesizes findings from ten recent studies to clarify the multifaceted impacts of animal dung on vegetation, public health, wildlife, and water resources, highlighting critical parameters and relevant environmental standards.

Environmental Impacts of Livestock Excreta (Zhang et al., 2021):

Zhang et al. (2021) conducted a comprehensive assessment of the risks associated with livestock excreta, focusing on contamination from heavy metals, residual antibiotics, and zoonotic pathogens. Their study revealed that untreated excreta significantly contributed to soil degradation, evidenced by elevated concentrations of heavy metals such as lead (Pb), cadmium (Cd), and arsenic (As) exceeding regulatory limits in some areas. Furthermore, the presence of residual antibiotics, including tetracyclines and sulfonamides, in soil and water samples indicated potential for antibiotic resistance dissemination. The study emphasized the critical need for proper treatment methods, such as composting and anaerobic digestion, to mitigate these risks.

Impact on Runoff Water Quality (Gessel et al., 2004):

Gessel et al. (2004) examined the impact of animal waste application on runoff water quality. Their research demonstrated that over-application of manure resulted in substantial leaching of nitrogen (N) and phosphorus (P), leading to

eutrophication in nearby water bodies. Specifically, they measured nitrate-nitrogen (NO_3--N) concentrations exceeding 20 mg/L in runoff samples, surpassing the WHO's recommended limit of 10 mg/L. Elevated phosphorus levels, exceeding 0.5 mg/L in some streams, promoted algal blooms and oxygen depletion. The study also highlighted the importance of bacterial source tracking, which identified fecal coliform and E. coli contamination originating from animal waste, emphasizing the need for targeted mitigation strategies.

Environmental Contamination from Animal Waste (Kumar et al., 2018):

Kumar et al. (2018) analyzed the consequences of improper disposal of animal waste, focusing on nitrogen losses through leaching and runoff. Their findings showed that significant amounts of nitrogen were lost, resulting in elevated nitrate levels in groundwater sources, particularly in rural areas. Nitrate concentrations exceeding 15 mg/L were detected in some drinking water wells, posing significant health risks. The study underscored the importance of implementing proper waste management practices to prevent groundwater contamination and protect public health.

Water Quality Issues from CAFOs (Burkholder et al., 2007):

Burkholder et al. (2007) evaluated the impacts of Concentrated Animal Feeding Operations (CAFOs) on water quality.[2] Their research highlighted that poor waste management practices in CAFOs led to severe water contamination, particularly in regions with shallow aquifers and flood-prone areas.[3] During rainfall events, nutrient and pathogen transport was significantly heightened, resulting in elevated levels of fecal coliform bacteria and nitrate in surface and groundwater. They reported fecal coliform counts exceeding 10,000 CFU/100 mL in some water samples, far surpassing regulatory standards.

Pollutant Effects of Animal Manure (Yilmaz et al., 2022):

Yilmaz et al. (2022) provided a comprehensive review of pollution linked to

animal manure, outlining how excessive nutrient loading, heavy metals, and microbial agents caused ecological stress. Findings indicated that nutrient loading, particularly nitrogen and phosphorus, led to eutrophication and algal blooms in aquatic ecosystems. Heavy metal contamination, including copper (Cu) and zinc (Zn), resulted in soil and water pollution, affecting plant growth and aquatic life. The study advocated for advanced manure treatment strategies, such as composting and anaerobic digestion, to reduce environmental risks.

Animal Waste and Human Health (World Health Organization, 2012):

The World Health Organization (2012) published evidence demonstrating the underestimated public health risks associated with animal feces.The report highlighted that animal dung contained a similar spectrum of pathogens as human feces, including Salmonella, E. coli, and Cryptosporidium, posing comparable risks for gastrointestinal diseases. In areas with poor sanitation infrastructure, the risk of disease transmission was significantly elevated.

Biodiversity Loss from Waste Mismanagement (FAIRR, 2021):

FAIRR (2021) identified how untreated animal waste from industrial farms accelerated biodiversity loss and intensified climate-related risks.Their analysis revealed that weak regulatory frameworks allowed animal waste to remain under-regulated compared to human waste, leading to unchecked environmental impacts. The study emphasized the role of animal waste in contributing to habitat degradation and the decline of native species.

Environmental Effects of Livestock Manure Storage (Chadwick et al., 2002):

Chadwick et al. (2002) evaluated various manure storage methods and identified runoff and leaching risks associated with open storage systems. Their study suggested that covered and lined storage options significantly reduced nutrient losses to the environment. They reported that open storage resulted in nitrogen

losses of up to 50% through ammonia volatilization and leaching, while covered storage reduced these losses to less than 10%.

Impact on Air Quality and Community Health (Zhang, 2011):

Zhang (2011) studied the effects of manure application on air quality. Findings indicated that gaseous emissions, such as ammonia (NH3), methane (CH4), and volatile organic compounds (VOCs), contributed to community-level health issues. Ammonia concentrations exceeding 100 $\mu g/m^3$ were recorded in areas near manure application sites, contributing to respiratory irritation. The study highlighted the need for improved manure management practices to reduce air pollution and protect public health.

Excess Fertilizer and Manure on Water Quality (Keena, 2017):

Keena (2017) reported that over-application of manure and fertilizers increased the risk of algal blooms, oxygen depletion in surface waters, and contamination with fecal pathogens and nitrates in drinking water.[7] The study underscored the importance of nutrient budgeting and soil testing to guide application rates, preventing excessive nutrient loading and subsequent water quality degradation.

Environmental Impact of Animal-Based Food Production (Alsaffar, 2022):

Alsaffar (2022) highlighted the unsustainable nature of current animal-based food production, emphasizing its contribution to climate change. The study reported that livestock agriculture was responsible for approximately 14.5% of global anthropogenic greenhouse gas emissions, with methane (CH4) emissions from enteric fermentation and manure storage being a significant contributor. Methane, with a global warming potential 25 times that of carbon dioxide (CO2), was released at rates that drastically increased atmospheric concentrations. Additionally, nitrous oxide (N_2O) emissions, primarily from manure and fertilizer application, also contributed substantially.

Livestock Waste and Its Impact on the Environment (Amon et al., 2012):

Amon et al. (2012) examined the environmental implications of livestock waste, highlighting air and water pollution. The study indicated that ammonia (NH3) volatilization from manure storage and land application led to atmospheric deposition of nitrogen, contributing to acidification and eutrophication of ecosystems. They found that up to 60-80% of nitrogen in manure was lost as ammonia, depending on storage and application methods. Water pollution, including nitrate leaching and pathogen contamination, was also significant, with nitrate concentrations in groundwater exceeding 50 mg/L in some areas.

Dung Midden Ecology and Environmental Implications (Attum et al., 2006):

Attum et al. (2006) explored the ecological roles of dung middens, focusing on their influence on grazing patterns and soil composition. The study found that dung middens altered soil nutrient distribution, with localized increases in nitrogen and phosphorus concentrations. This led to patchy vegetation growth and reduced plant diversity. They also observed that dung middens served as focal points for insect activity, affecting nutrient cycling and decomposition rates.

Agricultural Pollution from Animal Waste (Carpenter et al., 1998):

Carpenter et al. (1998) provided a comprehensive overview of agricultural pollution from animal waste. The study emphasized that improper manure management led to significant nutrient runoff, with phosphorus concentrations in surface waters exceeding 1 mg/L in some agricultural areas. This contributed to eutrophication, with dissolved oxygen levels dropping below 2 mg/L in affected water bodies. They also noted that ammonia emissions from manure exceeded 100 $\mu g/m^3$ near animal farms.

Environmental Impacts of Animal Agriculture (Herrero et al., 2015):

Herrero et al. (2015) delved into the environmental impacts of animal agriculture, particularly concerning water pollution. The research highlighted that animal

d to nutrient runoff, leading to eutrophication and degradation They reported that in regions with intensive livestock farming, groundwater exceeded 50 mg/L, and phosphorus levels in ached 0.5 mg/L, promoting algal blooms and oxygen depletion.

mpact of Pig Farming (Thorne, 2007):

amined the environmental impact of pig farming, focusing on es. The research highlighted how waste from pig farms carried naceuticals, and nutrients. They found that fecal coliform f from pig farms exceeded 10,000 CFU/100 mL, and sidues, such as antibiotics, were detected in groundwater at several µg/L.

ultry Manure Contaminants (Burkholder et al., 2007):

2007) reviewed contaminants found in livestock and poultry r environmental impacts. The research emphasized the ens, nutrients, and pharmaceuticals in animal waste. They gen and phosphorus levels in runoff from animal farms L and 10 mg/L, respectively, and that antibiotic-resistant ently found in manure-contaminated waters.

mmunity Health Impacts (Zhang, 2011):

tigated the effects of animal manure management on air uity health. The research indicated that manure storage and duced odors, greenhouse gases, microbes, and particulate hat ammonia emissions from manure exceeded 100 µg/m³ and particulate matter ($PM_{2.5}$) concentrations reached 30 munities.

Pollutant Effects and Management of Animal Manure (Yilmaz et al., 2022):

Yilmaz et al. (2022) provided a comprehensive review of pollution originating from animal manure. The research discussed current management strategies and emphasized the need for research and development to mitigate environmental impacts effectively. They found that composting and anaerobic digestion reduced nitrogen losses by up to 80% and methane emissions by up to 90%.

Impact of Animal Waste on Environment (Kumar et al., 2018):

Kumar et al. (2018) discussed how improper disposal of animal waste led to nitrogen loss through leaching and runoff, contaminating drinking water sources with high nitrate concentrations. They reported that nitrate levels in groundwater near improperly managed animal waste sites exceeded 50 mg/L, posing significant health risks.

Summary Ill Effects Based on Above Literature:

- **Vegetation:** Excessive nutrients alteres soil chemistry, suppresses native flora, and favors invasive nitrophilous species, leading to biodiversity loss (Yilmaz et al., 2022). Nutrient overload leads to soil acidification and reduced plant diversity.
- **Human Health:** Nitrate-contaminated water contributes to methemoglobinemia and gastrointestinal diseases. Airborne particulates from dried manure exacerbated asthma and bronchial disorders (Zhang, 2011; WHO, 2012). Pathogen exposure causes gastrointestinal illnesses; airborne emissions exacerbate respiratory issues
- **Animal Health:** Livestock consuming forage near contaminates runoff zones exhibited signs of heavy metal toxicity and parasitic infections (Burkholder et al., 2007). Contaminated water leads to diseases and reduced productivity.

The studies referred to as above, highlight the significant environmental impacts of animal dung droppings in eco-sensitive areas. Improper management of animal waste leads to soil and water contamination, air pollution, and biodiversity loss, posing significant risks to human and animal health.[8] Implementing proper waste treatment strategies, adhering to regulatory standards, and promoting sustainable agricultural practices are crucial for mitigating these impacts and preserving the ecological integrity of these sensitive zones. Adhering to Indian standards like IS 10500:2012 and NAAQS 2009, coupled with advanced manure treatment technologies, is crucial for mitigating these impacts and ensuring environmental sustainability.

3. Materials and Methods

3.1 Study Area

Matheran, a notified eco-sensitive region in the Western Ghats of Maharashtra, is a hill station characterized by its ban on motorized / fuel powered vehicles. Equine transportation is the primary means of conveyance for goods and tourists, leading to the accumulation of horse dung and urine along trekking paths, stables, and parking zones. The study is conducted to assess temporal variability in environmental parameters.

3.2 Air Quality Sampling

Following are the details of sampling locations and parameters analysed and their sampling duration for analysis of Air Quality. Table 1 shows details of air quality sampling stations at Matheran.

Table 1: Air Monitoring Details

Sampling Location	Parameters analyzed	Total Sampling period (24 hrs)
1. Dasturi Naka, Parking area (AS1)	PM10	Every 8 hrs

2. In front of railway station, Main MArket area (AS2)	PM2.5 SO2 NO2	24 hrs Every 4 hrs Every 4 hrs
3. Nagar Parishad (AS3)		

Above sample codes are used in this report for easy reference.

3.2.1 Parameters and Rationale

Ambient air samples were collected to monitor **Particulate Matter (PM_{10} and $PM_{2.5}$)**, **Sulphur Dioxide (SO_2)**, and **Nitrogen Dioxide (NO_2)**, in accordance with the National Ambient Air Quality Standards (CPCB, 2009; CPCB, 2011). These pollutants were selected due to their relevance in areas with bio-organic decay, including the anaerobic decomposition of dung which emits ammonia, methane, and VOCs contributing to secondary aerosol formation.

3.2.2 Sampling Locations and Frequency

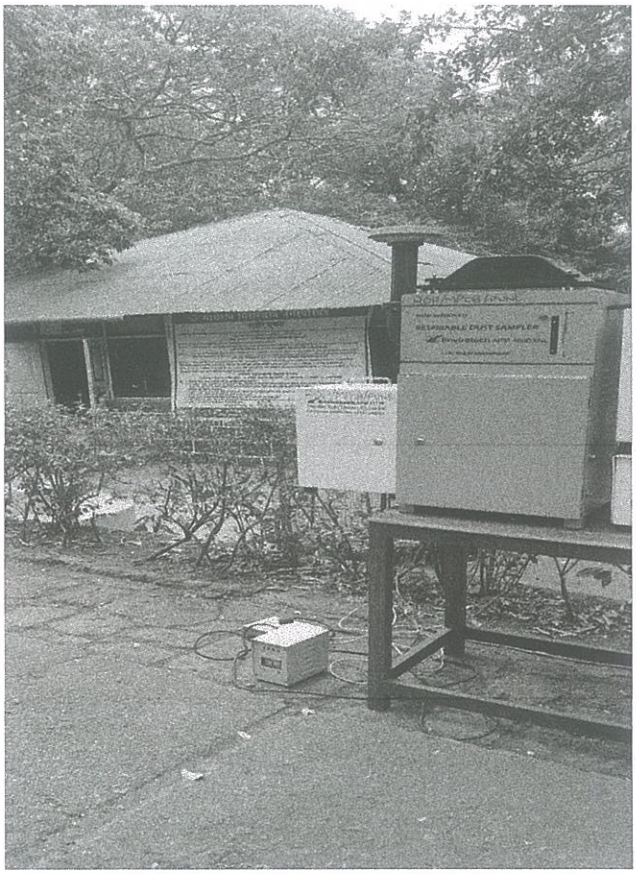
Three air monitoring sites were selected, comprising two horse-impacted zones (near stables, along horse trails, and waiting areas - Dasturi naka and Railway station) and one non-impacted control site (Nagar parishad). Sampling was carried out for three consecutive days in dry conditions to minimize confounding due to rainfall and humidity (MoEFCC, 2017).

3.2.3 Equipment and Setup

- **PM_{10}** was sampled using a **Respirable Dust Sampler** (Envirotec Make) equipped with pre-weighed glass fiber filter papers.
- **$PM_{2.5}$** was sampled with a **Fine Particulate Sampler** (Envirotec make) using PTFE membrane filters.
- **SO_2** and **NO_2** were collected using impinger-based sampling with absorbing solutions as per the **Modified West-Gaeke** and **Jacobs & Hochheiser** methods respectively (CPCB, 2011).

All samplers were installed at **1.5 to 2.0 m** above ground level to represent the human breathing zone, and sampling was conducted continuously for **24 hours**.

Following photographs shows air sampling at different locations and status of paved roads.

	
Sampling Near Nagar Parishad (AS3)	**Sampling Near Railway station (AS2)**

Sampling Near Dasturi Naka (AS1)

Dust accumulation on paved surfaces

3.2.4 Sample Handling and Analysis

After sampling, filters were stored in **desiccators** and weighed using a **microbalance** with 10 µg precision. Absorbing solutions were preserved at 4°C and analyzed using **spectrophotometric methods** within 24 hours (APHA, 2017; CPCB, 2011).

3.3 Water Quality Sampling

Following table shows sampling codes and details of sampling locations for water samples. Table 2 shows details of water sampling locations

Table 2: Details of Water Sampling at Matheran

Sample Code	Details of location
WS1	Charlotte lake water near to Dashkriya shade
WS2	Charlotte lake near steps of Dashkriya shade

WS3	Charlotte lake away from steps
WS4	Upstream side of lake in small stream near bridge
WS5	Simpson tank near parking area

Above sample codes are used in this report for easy reference.

GOVT.

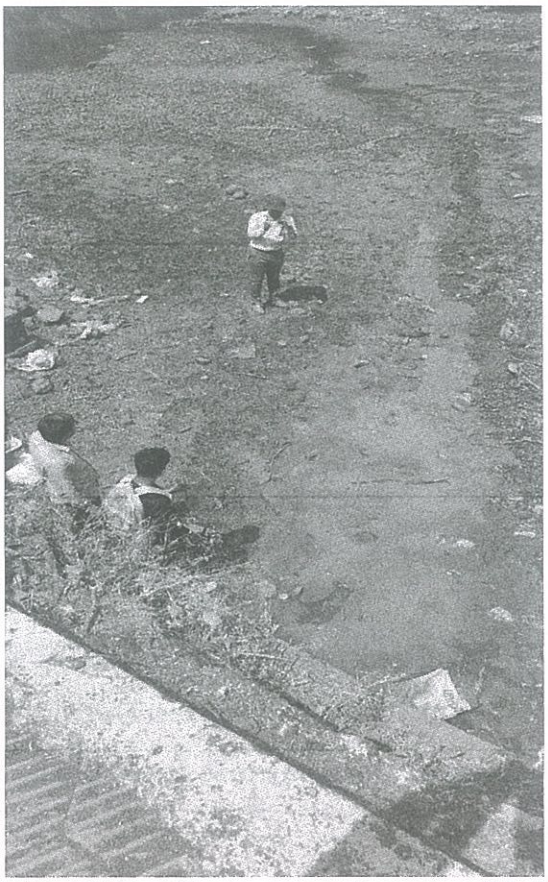
3.3.1 Sampling Strategy

Ten water sampling sites were selected: five at **runoff-prone horse-affected locations** (e.g., drains, trenches near horse stables) and five **upstream control locations**. Water samples were collected from surface water bodies and stagnant rain-fed pools, during periods of anticipated contamination (CPCB, 2008).

Following Photographs shows glimpses of water sampling at various locations

Joint sampling in presence of Nagar Parishad and MPCB Officials

LIBRARY
KAMBLE
NANE,
ASHTRA
NO. 5742
PDT.
04/2025
OF INDIA



Water Sampling at upstream of lake

3.3.2 Collection and Preservation

- Samples for **physicochemical analysis** were collected in **1 L acid-washed polyethylene bottles**.
- **Microbiological samples** were collected in **250 mL sterile glass bottles** with headspace and transported in ice-boxes.

Preservation techniques included:

- **Acidification** (pH<2 using HNO_3) for heavy metal analysis (USEPA, 2016).
- **Refrigeration at 4°C** for **nutrients and bacteriological** analysis.
- **Bacteriological parameters** (E. coli, total coliforms) (APHA, 2017).

3.3.3 Parameters Analyzed: Tests were conducted in accordance with **IS 10500:2012** (BIS, 2012) i and included:

- **Physical**: pH, TDS, turbidity, color, EC, temperature.
- **Chemical**: Nitrate, phosphate, ammonia, sulphate, fluoride, chloride, Fe, and trace heavy metals (Pb, As, Zn, Cu, Cd).
- **Biological**: Enumeration of **total coliforms and E. coli** using **membrane filtration** on selective agar.

Spectrophotometric, titrimetric, and **AAS** methods were used for chemical and metal analysis (Trivedy and Goel, 1986; USEPA, 2016).

3.4 Soil Sampling

Following table shows sampling codes and details of sampling locations for soil samples. Seven Samples were collected in first phase of study. Table 3 shows details of soil sampling locations

Table 3: Soil Samples Details

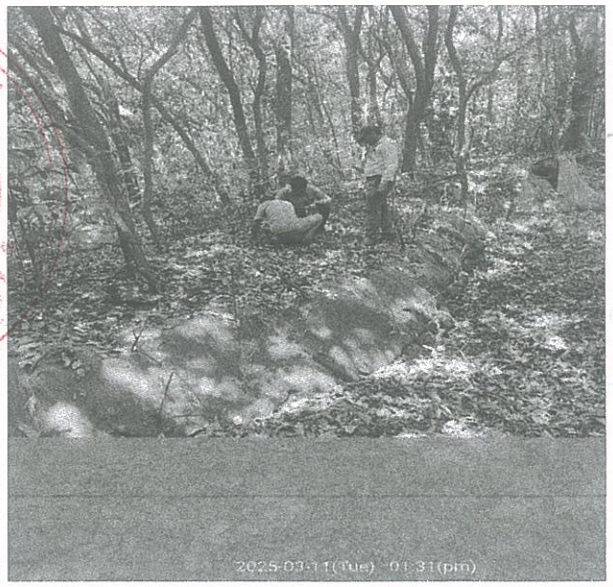
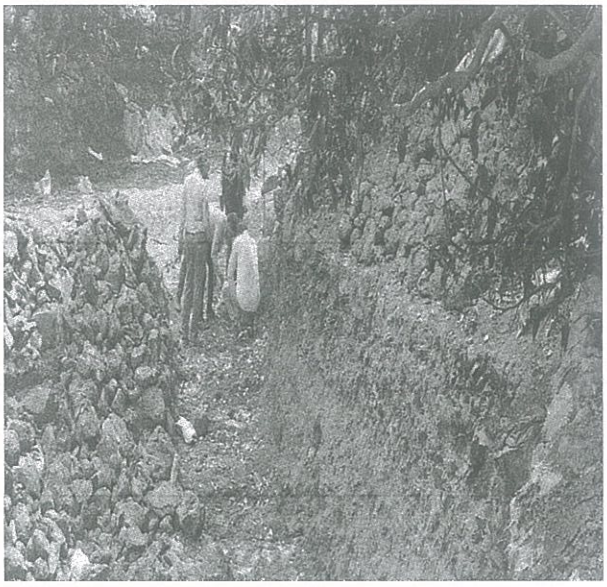
Sample code	Details of Soil Sample locations
SS1	Opposite to Nagar Parishad
SS2	Forest area on the way to charlotte lake
SS3	Downstream side of lake
SS4	Ash from horse stable
SS5	Upstream Side of lake
SS6	Pashu Vaidyakiya Dawakhana area (horse stable)
SS7	Dasturi Naka, parking area

Above sample codes are used in this report for easy reference.

3.4.1 Sampling Design

Soil sample is collected from seven locations: 4 dung-affected areas and 3 control locations. At each location, samples were collected randomly as per standard procedure (ICAR, 2010).

Following photographs shows soil sampling at different locations.

	
Soil sampling in Forest area near charlotte lake	**Soil sampling at upstream side of charlotte lake**

3.4.2 Sample Collection and Handling

- Topsoil (0–20 cm) was collected using **stainless steel augers** and stored in **thick, labelled polythene zip-lock bags** for physicochemical and heavy metal testing.
- **Microbiological samples** were placed in **sterile bags** and refrigerated at 4°C for further processing..

3.4.3 Parameters Tested

- **Physicochemical**: pH, EC, organic carbon, available phosphorus, organic carbon. and potassium.
- **Heavy metals**: Cu, Zn are determined using **Atomic Absorption Spectrophotometry (AAS)**.
- **Microbiological**: E. coli and Salmonella spp. assessed by dilution and plating on **selective growth media** (APHA, 2017).

4. RESULTS AND DISCUSSION

4.1 Ambient Air Quality Analysis

Ambient air quality analysis plays a crucial role in the analysis of eco-sensitive zones like Matheran. Table 4 shows PM_{10} and $PM_{2.5}$ values for three stations

Table 4 : PM_{10} and $PM_{2.5}$ particulate matter

Sample Code	8-Hourly Value of PM_{10}			8-Hourly max of PM_{10} ($\mu g/m^3$)	PM_{10} (24 hrs average) ($\mu g/m^3$)	$PM_{2.5}$ (24 hrs value) ($\mu g/m^3$)
	6 AM-2 PM	02 PM-10 PM	10 PM-06 AM			
AS1	137.87	161.84	133.52	161.84	144.41	76.00
AS2	192.09	176.48	147.24	192.09	171.93	64.00
AS3	158.07	148.91	118.41	158.07	141.80	71.00

Table 5 shows NAAQS for PM_{10} and $PM_{2.5}$ particulates

Table 5 : NAAQS (CPCB, 2009) for PM in Eco-Sensitive Zones

Pollutant	Averaging Time	Standard ($\mu g/m^3$)
PM_{10}	24-hour average	100
$PM_{2.5}$	24-hour average	60

These values apply to **eco-sensitive** & **residential/rural** areas. Matheran, being an **eco-sensitive zone (MESZ Notification, 2003)**, falls under these limits.

Interpretation of results

- **All stations (AS1, AS2, AS3) show significant exceedance** of both PM_{10} and $PM_{2.5}$ levels relative to CPCB limits.
- **PM_{10} (24-hr)** levels are **40–72% higher** than the standard (100 $\mu g/m^3$).
- **$PM_{2.5}$ (24-hr)** levels exceed the standard (60 $\mu g/m^3$) by **6–18%**.

- **8-Hourly PM_{10} max values** (161.84–192.09 µg/m³) represent high pollution episodes, particularly during daytime activity (6 AM – 2 PM and 2 PM – 10 PM), likely due to horse movements and tourist load.

Implications for Eco-Sensitive Zone

1. **Violation of NAAQS**:
   - Prolonged exceedance in ESZ indicates **regulatory non-compliance** under CPCB and Ministry of Environment norms.
   - Possible triggers for **intervention by MPCB or NGT** under the Air (Prevention and Control of Pollution) Act, 1981.
2. **Likely Sources**:
   - **Dung drying**, **hoof-induced dust**, and **unpaved trails**.
   - Tourist footfall and horse movement during the **daylight hours** is consistent with 8-hourly peak PM values.
3. **Health Impact**:
   - As per WHO and ICMR research, prolonged exposure to **$PM_{2.5}$ above 60 µg/m³** increases risks of **asthma, bronchitis, COPD, and cardiovascular diseases**.

Table 6 shows results of Sulphur Dioxide monitoring at various locations

Table 6 : Sulphur Dioxide in Ambient air

Sample Code	4-Hourly Value of SO_2 (µg/m³)						SO_2 (4hrs Max) (µg/m³)	SO_2 (24hrs average) (µg/m³)
	Shifts							
	I	II	III	IV	V	VI		
AS1	21.79	22.06	40.95	24.38	9.12	7.26	40.95	23.79
AS2	26.87	26.80	45.13	27.89	11.26	7.17	45.13	27.18
AS3	15.02	36.77	39.98	24.39	9.26	8.82	39.98	24.89

Table 7 shows results of Nitrogen Dioxide monitoring at various locations.

Table 7 : Nitrogen Dioxide in Ambient air

Sample Code	4-Hourly Value of NO_2 (µg/m³)						4-Hourly max of NO_2 (µg/m³)	No_2_24 hrs average (µg/m³)
	Shifts							
	I	II	III	IV	V	VI		
AS1	29.16	56.56	44.93	63.11	24.08	22.31	63.11	43.32
AS2	59.71	43.21	49.75	46.33	27.13	23.46	59.71	44.19
AS3	26.42	43.35	48.45	40.74	23.04	21.66	48.45	36.02

Table 8 shows NAAQS for SO_2 and NO_2 gases

Table 8 : NAAQS (CPCB, 2009) for SO_2 and NO_2 in Eco-Sensitive Zones

Pollutant	Averaging Time	Standard (µg/m³)
SO2	24-hour average	80
NO2	24-hour average	80

This study analyzes ambient air quality monitoring results for Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) in Matheran, benchmarked against the 2009 National Ambient Air Quality Standards (NAAQS), within the context of its Eco-Sensitive Zone (MESZ) status. While current levels of SO_2 and NO_2 are within NAAQS limits, the unique ecological fragility and high tourist footfall of Matheran necessitate stricter environmental vigilance.

Interpretation and Eco-Sensitive Context

- While SO_2 and NO_2 levels are within NAAQS, localized emissions, likely from equine dung decomposition, indicate potential risks, especially in enclosed areas.
- NO_2 levels are relatively higher than SO_2, suggesting moderate exposure, potentially exacerbated by humidity and stagnant air.

- Matheran's MESZ status necessitates stricter vigilance due to:
  - Ecological fragility and sensitivity of endemic species.
  - High tourist exposure, increasing inhalation risks.
  - Cumulative impacts of SO_2, NO_2, particulate matter (PM), ammonia (NH_3), and volatile organic compounds (VOCs).

. Environmental and Health Implications

- **SO_2:** Respiratory irritation, aggravated asthma, amplified by humidity.
- **NO_2:** Reduced lung function, airway inflammation, exacerbated by dung dust and ammonia.

4.2 Water Quality analysis

This section presents an assessment of water quality parameters at various locations in Matheran, Maharashtra, in comparison with the Bureau of Indian Standards (BIS: IS 10500:2012, revised 2018) norms for drinking water. The analysis highlights deviations, potential environmental concerns.

Table 9 shows water quality analysis of various samples collected at Matheran.

Table 9: Water Quality Analysis Results

Parameter	WS1	WS2	WS3	WS4	WS5
pH	6.51	6.73	7.14	6.34	6.9
Turbidity (NTU)	2	0	4	550	27
EC (µS/cm)	58.63	60.6	74.04	64.04	86.09
Alkalinity (mg/L)	48	52	56	92	96
Chloride (mg/L)	18.01	24	28	34	26
Nitrates (NO_3), mg/L	8.40	10.7	5.50	14.3	21.2
Phosphates (PO_4), mg/L	0.35	0.54	0.50	2.60	0.91
E. coli /100 mL	5	5	10	25	100
Zinc (Zn), mg/L	0.13	0.07	0.09	0.47	0.25

Copper (Cu), mg/L	0.12	0.10	0.17	0.31	0.16
Lead (Pb), mg/L	0.03	0.02	0.02	0.15	0.08
TSS (mg/L)	40.8	97.6	43.2	277.2	34.4
TDS (mg/L)	113.6	151.6	114.0	160.8	337.6

Interpretation of Results

1. pH

- **BIS Acceptable Range**: 6.5 – 8.5
- **Findings**: All samples fall within the acceptable range, except WS4 (6.34) which is slightly acidic.

Interpretation:

Mild acidity in WS4 could be attributed to **organic acid production** from decomposing horse dung and urine. A pH below 6.5 may enhance **heavy metal solubility** (especially Pb and Zn), increasing toxicity risk. Soil leachates and stormwater runoff carrying humic acids and decaying biomass likely contribute to this acidity in WS4.

2. Turbidity (NTU)

- **BIS Acceptable Limit**: 1 NTU (desirable), 5 NTU (permissible)
- **Findings**:
  - WS4 has **extremely high turbidity (550 NTU)** – a severe exceedance.
  - WS5 (27 NTU) and WS3 (4 NTU) also exceed limits.

Interpretation:

WS4 is clearly affected by **suspended organic matter**, likely horse dung, sediment, or runoff containing decaying vegetation. Turbidity levels this high **impair disinfection efficiency**, encourage microbial growth, and degrade

aesthetic water quality. For Matheran's tourist ecosystem, this is unacceptable and necessitates **source control and sediment filtration**.

3. Electrical Conductivity (EC, µS/cm)

- **No direct BIS limit**, but <500 µS/cm is generally acceptable.
- **Findings**: All values are below 100 µS/cm.

Interpretation:

These low values suggest **dilute ionic strength**, typical of hill station environments with high rainfall. However, EC increases in WS5 and WS3 may indicate **ion leaching from animal waste**, which includes urea and salts from sweat or urine.

4. Alkalinity (mg/L as $CaCO_3$)

- **BIS Desirable Limit**: 200 mg/L
- **Findings**: All samples are within permissible range (48–96 mg/L).

Interpretation:

Alkalinity indicates **buffering capacity** of water. Moderate levels observed are expected in natural hill streams. However, the higher values in WS4 and WS5 might reflect **urine-derived ammonium salts** or **decomposing dung nitrogen**, both influencing alkalinity.

5. Chloride (mg/L)

- **BIS Acceptable Limit**: 250 mg/L (desirable), 1000 mg/L (max)
- **Findings**: All values well within limits.

Interpretation: These levels pose no direct risk. Minor elevations in WS4 and WS5 may indicate **anthropogenic inputs**, including **organic excreta or feed additives** for horses.

6. Nitrates (NO_3^-)

- **BIS Permissible Limit**: 45 mg/L (max), 10 mg/L (safe threshold) for infants.
- **Findings**: WS2, WS4, and **WS5 (21.2 mg/L)** exceed the safe limit for vulnerable populations.

Interpretation:

These elevated nitrate levels are consistent with **runoff from horse dung and urine**, rich in nitrogen. The impact is amplified during monsoon or wash-off events. High nitrates promote **eutrophication** in lakes and can impair **drinking water safety** due to **blue baby syndrome** risks.

7. Phosphates (PO_4^{3-})

- **No BIS standard**, but ecologically important.
- **Findings**: WS4 (2.6 mg/L) is critically high.

Interpretation:

Phosphate is a **limiting nutrient** in aquatic systems; high levels, as in WS4 and WS5, can trigger **algal blooms** and **oxygen depletion**. These readings strongly suggest **surface contamination** from horse waste deposits. Phosphate also acts as an indicator of **domestic or animal organic pollution**.

8. E. coli (CFU/100 mL)

- **BIS Requirement**: **Must be 0/100 mL** for drinking water.
- **Findings**: All samples fail. WS5 (100 CFU/100 mL) is extremely contaminated.

Interpretation:

This is a **serious health violation**, confirming **direct fecal contamination**. The microbial load in WS5 and WS4 renders water **unfit even for recreational use**. Pathogens like E. coli can spread **zoonotic diseases**, affecting both residents and tourists. This supports PETA and Animal Rahat's concern on **poor dung management in equine routes**Report-Equine Health Ca....

9. Heavy Metals – Lead (Pb), Copper (Cu), Zinc (Zn)

- **Lead**: Max 0.01 mg/L
  - WS4 (0.15 mg/L) & WS5 (0.08 mg/L) **exceed BIS limits**, posing toxic risks.
- **Copper**: Desirable 0.05 mg/L, Max 1.5 mg/L
  - Within limits, but slightly elevated in WS4.
- **Zinc**: Max 5 mg/L
  - All values within safe range.

Interpretation: Lead exceedance is the most concerning, especially in WS4 and WS5. Likely sources include:

- **Degraded metal tack and tools** used on horses,
- Leaching from surrounding contaminated soils,
- Enhanced mobility due to acidic pH (notably in WS4).

Lead toxicity is irreversible and can lead to **neurological, developmental, and renal effects**. Copper and zinc, while essential trace elements, can bioaccumulate and affect aquatic organisms at elevated level

10. TSS & TDS

- **TSS**: No BIS guideline, but >100 mg/L generally considered turbid.
- **TDS**: BIS Desirable Limit: 500 mg/L
  - WS5 at **337.6 mg/L** is elevated but within limits.

Interpretation: WS4 shows **extremely high TSS (277.2 mg/L)**, confirming visual turbidity. It is consistent with the 550 NTU turbidity and microbial content

–an indicator of organic-solid loading from horse trails or runoff collection points.

WS5's high TDS likely reflects **dissolved salts, urea, and microbial metabolites**. These solids contribute to **ecosystem stress** and **aesthetic and taste issues** if used for consumption.

Integrated Environmental Implications

The convergence of nutrient enrichment, microbial loading, and toxic heavy metal presence signifies a **cumulative ecological degradation** scenario. This not only threatens local biodiversity, especially in streams and forested riparian zones, but also undermines soil stability and water quality across the landscape. Such pollution levels can trigger:

- **Soil nutrient imbalance** and acidity, leading to the proliferation of invasive species.
- **Possible Algal blooms** in water bodies, impairing aquatic life.
- **Loss of public access to safe water** for drinking, washing, or recreation.
- **Tourist discomfort and complaints**, especially due to visible sludge, foul odor, and unsanitary conditions.

Table 10 shows Environmental risk table for water quality

Table 10: Overall Environmental Risk Assessment

Sample	Risk Level	Contaminants of Concern
WS-2	Moderate-High	Nitrates, E. coli, Phosphates
WS-4	**High Risk**	Nitrates, Phosphates, E. coli, Pb, Zn, Cu, High solids
WS-5	**High Risk**	Nitrates, Pb, Zn, E-Coli, High solids
WS-1	Moderate	E. coli, Nitrates
WS-3	Low- moderate	All parameters within limits except E.Coli

4.3 Soil analysis

Analysis of soil quality can give status of soil pollution due to mismanagement of equine urine, dung and movements.

Table 11 shows results of soil testing for all samples

Table 11 : Results of Soil quality analysis

Parameter	Unit	Standard	SS1	SS2	SS3	SS4	SS5	SS6	SS7
pH	pH	6.5-7.5	6.95	6.25	6.29	6.35	6.42	7.29	6.98
EC	mc/cm	0-1	0.9	0.27	1.78	0.022	1.8	0.77	0.38
OC	%	0.40-0.60	0.5	2.35	0.79	0.75	1.12	0.89	1.05
P	Kg/hec.	14-21	15.94	10.41	9.69	12.94	13.52	18.11	14.51
K	Kg/hec.	150-200	184.21	154.62	212.36	139.45	231.36	198.69	214.21
CaCO3	%	2.5-5.0	3.37	4.12	5.74	9.74	4.37	5.99	4.96
Ca	ml %	4-9.99	8.69	3.4	5.9	6.8	4.8	5.2	4.9
Mg	ml %	0.50-3.99	2.45	0.47	3.3	3.6	2.4	2.9	3.1
Zn	ppm	0.61-99.99	0.49	2.12	1.12	0.48	0.53	0.84	1.04
Cu	ppm	0.20-99.99	0.18	0.47	0.45	0.75	0.48	0.99	0.97
Fe	ppm	4.5-99.99	1.34	4.8	5.6	2.47	1.91	4.21	2.81
Mn	ppm	2.0-99.99	1.32	2.24	1.19	0.89	1.06	1.01	1.89

Interpretation of Results

The data is evaluated against established soil quality benchmarks to assess potential environmental degradation, with a focus on the possible influence of horse dung accumulation and equine movement.

1. Soil pH

- **Standard:** 6.5–7.5
- **Findings:** Samples S2 (6.25), S3 (6.29), and S4 (6.35) exhibit pH values below the optimal range, indicating slight acidity. The remaining samples are within the acceptable range.

4.3 Soil analysis

Analysis of soil quality can give status of soil pollution due to mismanagement of equine urine, dung and movements.

Table 11 shows results of soil testing for all samples

Table 11 : Results of Soil quality analysis

Parameter	Unit	Standard	SS1	SS2	SS3	SS4	SS5	SS6	SS7
pH	pH	6.5-7.5	6.95	6.25	6.29	6.35	6.42	7.29	6.98
EC	mc/cm	0-1	0.9	0.27	1.78	0.022	1.8	0.77	0.38
OC	%	0.40-0.60	0.5	2.35	0.79	0.75	1.12	0.89	1.05
P	Kg/hec.	14-21	15.94	10.41	9.69	12.94	13.52	18.11	14.51
K	Kg/hec.	150-200	184.21	154.62	212.36	139.45	231.36	198.69	214.21
CaCO3	%	2.5-5.0	3.37	4.12	5.74	9.74	4.37	5.99	4.96
Ca	ml %	4-9.99	8.69	3.4	5.9	6.8	4.8	5.2	4.9
Mg	ml %	0.50-3.99	2.45	0.47	3.3	3.6	2.4	2.9	3.1
Zn	ppm	0.61-99.99	0.49	2.12	1.12	0.48	0.53	0.84	1.04
Cu	ppm	0.20-99.99	0.18	0.47	0.45	0.75	0.48	0.99	0.97
Fe	ppm	4.5-99.99	1.34	4.8	5.6	2.47	1.91	4.21	2.81
Mn	ppm	2.0-99.99	1.32	2.24	1.19	0.89	1.06	1.01	1.89

Interpretation of Results

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1. Soil pH

- **Standard:** 6.5–7.5
- **Findings:** Samples S2 (6.25), S3 (6.29), and S4 (6.35) exhibit pH values below the optimal range, indicating slight acidity. The remaining samples are within the acceptable range.

- **Interpretation:** The localized acidity observed in S2, S3, and S4 is likely attributable to the formation of organic acids during the decomposition of horse dung and the leaching of urine. Acidic soil conditions can impede nutrient uptake by plants and adversely affect the health of native vegetation.

2. Electrical Conductivity (EC)

- **Standard:** 0–1 mS/cm
- **Findings:** Samples S3 (1.78 mS/cm) and S5 (1.80 mS/cm) show elevated EC values, indicating increased salinity.
- **Interpretation:** The elevated EC in S3 and S5 suggests a buildup of salinity. This can be attributed to the accumulation of manure and the leaching of dissolved salts, which can negatively impact soil structure and plant growth.

3. Organic Carbon (OC)

- **Standard:** 0.40–0.60%
- **Findings:** With exception of S1 (0.50%), all samples exceed recommended OC range. Sample S2 exhibits a particularly high value of 2.35%.
- **Interpretation:** The high OC content across most samples indicates significant organic loading, primarily from decomposing horse dung. While organic carbon is essential for soil fertility, excessive levels can disrupt nutrient balance and lead to excessive microbial activity.

4. Available Phosphorus (P)

- **Standard:** 14–21 kg/ha
- **Findings:** Samples S2 (10.41 kg/ha), S3 (9.69 kg/ha), S4 (12.94 kg/ha), and S5 (13.52 kg/ha) are below the optimal phosphorus threshold.
- **Interpretation:** The phosphorus deficiency, despite high organic carbon levels, suggests phosphorus fixation or leaching. This indicates inefficient nutrient cycling, potentially exacerbated by inadequate dung management practices.

5. Available Potassium (K)

- **Standard:** 150–200 kg/ha
- **Findings:** Samples S3 (212.36 kg/ha), S5 (231.36 kg/ha), and S7 (214.21 kg/ha) show potassium levels exceeding the standard, while S4 (139.45 kg/ha) is below.

- **Interpretation:** The variable potassium levels likely reflect uneven manure distribution and the potential for potassium leaching from areas with high urine concentration.

6. Calcium Carbonate ($CaCO_3$)

- **Standard:** 2.5–5.0%
- **Findings:** Samples S4 (9.74%) and S6 (5.99%) exceed the permissible limits for calcium carbonate.
- **Interpretation:** Elevated $CaCO_3$ levels indicate calcareous soil conditions, which can reduce the bioavailability of micronutrients and alter the soil's pH buffering capacity.

7. Exchangeable Calcium (Ca) and Magnesium (Mg)

- **Standard:** Ca (4-9.99 ml%), Mg (0.50-3.99 ml%)
- **Findings:** Sample S2 exhibits deficiencies in both calcium (3.4 ml%) and magnesium (0.47 ml%).
- **Interpretation:** Deficiencies in these essential secondary nutrients may compromise soil fertility and suggest prolonged leaching or the application of low-quality manure.

8. Micronutrients

- **Standard:** Zn (0.61-99.99 ppm), Cu (0.20-99.99 ppm), Fe (4.5-99.99 ppm), Mn (2.0-99.99 ppm)
- **Findings:**
  - Zinc (Zn): Deficient in S1 (0.49 ppm) and S4 (0.48 ppm).
  - Copper (Cu): Slightly low in S1 (0.18 ppm).
  - Iron (Fe): Below standard in S1 (1.34 ppm) and S5 (1.91 ppm).
  - Manganese (Mn): Suboptimal in S1 (1.32 ppm), S3 (1.19 ppm), S4 (0.89 ppm), and S5 (1.06 ppm).
- **Interpretation:** These micronutrient deficiencies point to potential antagonistic interactions resulting from excessive organic matter and elevated pH or salinity levels in certain areas. Such imbalances can directly impair plant health and indicate soil degradation associated with unmanaged animal waste.

Conclusions and Implications

- **Soil Health Degradation:** The consistently high organic carbon, elevated salinity (EC), and uneven nutrient distribution highlight significant ecological stress in zones affected by equine movement.
- **Link to Dung Accumulation:** The data supports the established impacts of unmanaged horse dung, including increased EC, nutrient overload, localized acidification, and microbial imbalance.
- **Zonal Priority for Intervention:**
    - **High Concern:** S2, S3, S4, and S5 – These sites exhibit multiple indicators of degradation, including acidity, elevated EC, and imbalanced nutrient profiles.
    - **Moderate Impact:** S1 and S6 – These sites require continued monitoring and targeted remediation efforts.

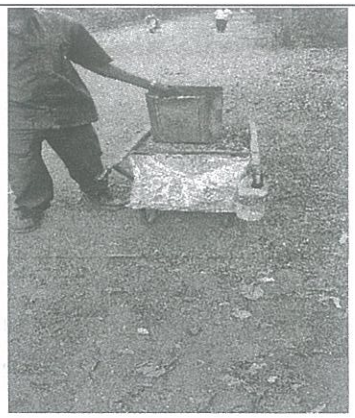
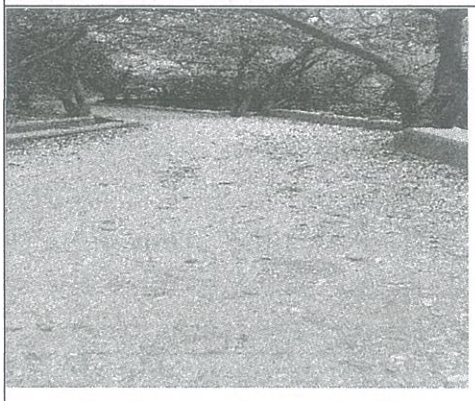
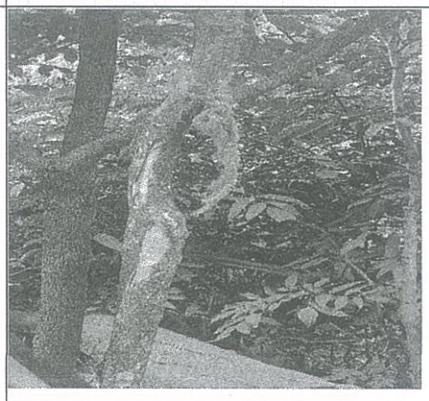
Table 12 shows overall risk assessment on the basis of soil sample analysis

Table 12 : Overall Risk assessment Table

Sample	Risk Level	Contaminants of Concern
SS1	Moderate	Zinc (Zn), Copper (Cu), Iron (Fe), Manganese (Mn)
SS2	**High**	Low pH (acidic), High Organic Carbon (OC), Low Phosphorus (P), Low Calcium (Ca), Low Magnesium (Mg)
SS3	**High**	Low pH (acidic), High EC (salinity), High Potassium (K), Low Phosphorus (P), Low Manganese (Mn)
SS4	**High**	Low pH (acidic), High Calcium Carbonate ($CaCO_3$), Low Potassium (K), Zinc (Zn), Manganese (Mn)
SS5	**High**	High EC (salinity), High Potassium (K), Low Phosphorus (P), Iron (Fe), Manganese (Mn)
SS6	**Moderate**	High Calcium Carbonate ($CaCO_3$), Elevated Organic Carbon (OC)
SS7	**Low to Moderate**	High Potassium (K), Elevated Organic Carbon (OC)

4.4 Observations During Sampling Visits

Following set of photographs shows observations regarding status of various places with reference to horse and dung impacts.

	
Common spots with horse dung accumulation	**Contractual Labour deployed for dung collection**
	
Unauthorized Open burning of horse dung on trail paths	**Horse dung accumulation on trail paths (Dried state)**
	
Dusty paved roads with dried horse dung particulates	**Damage to vegetation by horses (Eating of stem)**

5. Importance of Monsoon Season Soil, Water, And Air Sampling for the Matheran Project

Monsoon season sampling of soil, water, and air is of critical importance for the Matheran Environmental Impact Assessment, particularly concerning the impact of horse dung in this ecologically sensitive region. Monsoon conditions provide a dynamic and informative period for understanding pollutant behavior and transport within the environment.

During the monsoon, rainfall events facilitate the leaching of nutrients, specifically nitrogen and phosphorus, from accumulated horse dung and urine into the underlying soil and adjacent water bodies. This runoff can also transport pathogenic microorganisms, such as E. coli and Salmonella, as well as dissolved salts and potentially heavy metals, leading to the contamination of both surface water and groundwater resources. Consequently, collecting water samples during periods of active runoff is essential to accurately measure peak contaminant concentrations and evaluate the risks of eutrophication, waterborne diseases, and ecological disruption in downstream ecosystems.

Monsoon season soil sampling is equally important for assessing nutrient loss, soil compaction, and shifts in microbial communities resulting from increased soil saturation, runoff, and the decomposition of organic waste. The interaction of manure with high moisture levels can accelerate anaerobic microbial activity, leading to the release of greenhouse gases such as methane and ammonia. Dry season sampling may underestimate these emissions. Therefore, air sampling during and immediately following rainfall, particularly in areas with fresh dung deposits, is crucial for obtaining accurate data on SO_2, NO_2 and particulate matter ($PM_{2.5}$ and PM_{10}). These parameters are key indicators of air quality degradation and potential respiratory health risks for both residents and tourists.

Furthermore, monsoon sampling facilitates the identification of critical source areas, such as stables, parking areas, and sloped trails, where contaminant loading is likely to be highest due to increased runoff velocity and dung accumulation. The data obtained is essential for accurately assessing the real-time environmental impact of equine activities and for the development of effective management strategies, including vegetative buffer zones, sediment traps, composting facilities, and constructed wetlands.

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In short, monsoon season sampling provides the most representative, realistic, and ecologically significant data, which is indispensable for generating scientifically sound and regulatory-compliant conclusions within the Matheran project. Therefore, monsoon sampling is planned in July/August 2025.

6. Interim Conclusion and Further Scope

6.1 Air Monitoring

The ambient air quality analysis conducted during the pre-monsoon season in Matheran reveals a mixed pattern. While **Sulphur Dioxide (SO_2)** and **Nitrogen Dioxide (NO_2)** levels remain within the **National Ambient Air Quality Standards (NAAQS, 2009)** limit of 80 µg/m³, significant exceedances were observed for **Particulate Matter (PM_{10} and $PM_{2.5}$)**. PM_{10} values at AS2 reached 192.09 µg/m³, nearly double the permissible limit (100 µg/m³), while $PM_{2.5}$ levels exceeded the standard (60 µg/m³) by 6–18% at all sites.

The primary contributors include:

- Aerosolized dried dung particles.
- Dust generation from hoof impacts on unpaved roads.
- Ammonia and methane volatilization during dung decomposition.

This data, though compliant on gaseous pollutants, indicates a localized deterioration in air quality due to bio-organic waste emissions.

6.2 Water Quality Analysis

The assessment of surface water bodies and runoff zones in and around Matheran paints a concerning picture. Notable findings include:

- **Turbidity** values as high as 550 NTU (WS4) — well above the BIS desirable limit of 5 NTU.
- **E. coli** contamination in all samples, with WS5 registering 100 CFU/100 mL (against a permissible limit of 0 CFU/100 mL).
- **Nitrate and phosphate** levels exceed ecological safety limits, especially in WS4 and WS5, indicating nutrient runoff from dung piles.
- Presence of **heavy metals** such as Lead (Pb) in WS4 and WS5 exceeding BIS thresholds, raising concerns over long-term bioaccumulation and toxicity.

These indicators confirm **direct fecal contamination, nutrient enrichment, and potential health hazards**. The findings suggest the urgent need for **buffer zones, bioremediation wetlands**, and **stormwater management infrastructure** to arrest contaminant flow into Charlotte Lake and other sensitive water bodies.

6.3 Soil Quality Analysis

The soil analysis corroborates the impacts of unmanaged equine waste. Key findings include:

- **Excessive Organic Carbon (OC)** in 6 of 7 locations, with SS2 at 2.35%, far exceeding the standard range (0.40–0.60%).
- **Localized acidification** at SS2–SS4, indicating the influence of urine and dung leachate.
- **Elevated Electrical Conductivity (EC)** in SS3 and SS5 (>1.78 mS/cm), reflecting salinity stress.
- **Micronutrient imbalances**, particularly in Zn, Mn, and Fe—suggesting soil fatigue and altered microbial ecology.

These findings support the conclusion that **soil health degradation is progressing**, especially in high horse-traffic zones. The risks include **loss of native flora**, **poor seed germination**, and **pathogen persistence**. Long-term exposure can lead to irreversible soil structure damage and reduced fertility.

6.4 Further Proposed Scope

To address the critical gaps and seasonal variation in pollutant behavior, the following actions are planned:

1. **Monsoon Sampling Campaign (July–August 2025)**:
    - Comprehensive air, water & soil sampling during active rainfall events.
    - Special focus on runoff behavior and various parameter spikes in surface waters.
2. **Public Health Linkage**:
    - Collection and correlation of citizen health records (respiratory, gastrointestinal diseases) from Nagar Parishad and local clinics.
    - Identifying hotspots of disease prevalence near equine routes.

3. **Integrated Data Analysis**:
    - Comparative assessment of pre-monsoon vs. monsoon datasets.
    - Identification of persistent contamination sites and high-risk zones.
4. **Policy and Technical Recommendations**:
    - Drafting detailed action plans for equine waste management, including composting trials, dung biochar production, and stormwater control systems and rotation of trails or other appropriate techniques etc.
    - Recommendation of **carrying capacity** limits (≤300 horses/day) to ensure environmental sustainability.
5. **Final Report and Executive Summary**:
    - Submission to Maharashtra Pollution Control Board (MPCB), Sion, Mumbai
    - Dissemination to stakeholders, NGOs, and tourism boards.

It may be seen that current level of investigation reveals need various measures to control the undesirable effects of horse dung presence in Matheran Area. The measures may be adoption of effective collection and disposal of horse dung; imposing control on number of horses, etc. Final report will be submitted after second phase of testing scheduled during September to December 2025 and subsequent evaluation of test results

ACKNOWLEDGEMENT

We extend our sincere gratitude to the officials and staff of Maharashtra Pollution Control Board, Raigad and Giristhan Nagar Parishad, Matheran for their invaluable support and cooperation. Their assistance in facilitating field sampling and providing essential logistical arrangements played a crucial role in the smooth execution of the first part of this study. Their commitment to

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