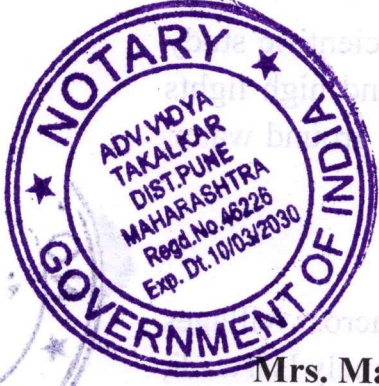


**BEFORE HON'BLE NATIONAL GREEN TRIBUNAL, WESTERN
ZONE BENCH, AT PUNE**

Original Application No. 222 of 2023 WZ.



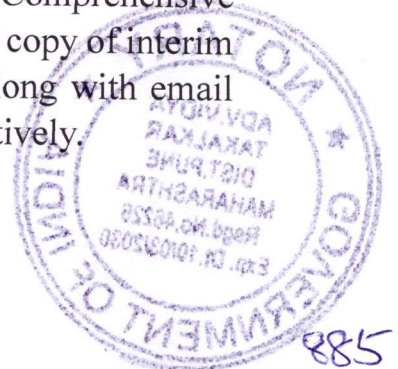
Mrs. Mangal W/O Vishnu Bodkhe & 4 Ors. ----- } Applicants.

Vs

M/s. Matrix Life Science Pvt. Ltd. & 3 Ors.----- } Respondents.

I, Achyut S. Nandvate, aged about 54 years, Occupation- Service, the Sub-Regional Officer , Chhatrapati Sambhajinagar, Maharashtra Pollution Control Board (R.No.2) is filing this Affidavit on the basis of interim report submitted by Committee constituted by Hon'ble NGT vide order dated 22/04/2024.

1. I say and submit that Hon'ble NGT issued Order dated 24/02/2026 and directed after perusal of joint committee report and directed MPCB to get study conducted through Institute for Chemical Technology (ICT) to identify the horizontal and vertical propagation as proposed in the Joint Committee Report, for which learned counsel for the MPCB seeks three months' time to submit the same" The copy of order is marked as Annex-1
2. I say and submit that the Respondent No. 2 Board has issued work order to ICT Mumbai dated 07/05/2026 to prepare comprehensive report to define contamination of ground water horizontally and vertically along with remedial measures to be adopted, the agriculture crop loss along with contamination of soil, technical audit of individual industry & assessment of the Environmental damage compensation.
3. I say and submit that ICT Mumbai have submitted interim Comprehensive Study report to MPCB vide email dated June 25, 2026. The copy of interim report received from ICT Mumbai dated June 25, 2026 along with email communication is enclosed and marked as Annex-3 collectively.



4. I say and submit that the interim primary comprehensive scientific study report prepared by ICT Mumbai is pre-monsoon report and high lights following aspects of environmental baseline specifically in ground water, soil in first phase.

5. Water Quality Monitoring Aspect:

(a) The comprehensive scientific study conducted across villages surrounding the MIDC Paithan Industrial Area, namely Isarwadi, Katpur, Wahegaon, Pachalgaon, Narayangaon, Rahatgaon, Karajkheda, Pimpalwadi, Mudhalwadi which is evidence-based assessment of groundwater quality, soil condition characteristics in the MIDC Paithan area during the pre-monsoon season (Phase I).

(b) The physicochemical analysis of Groundwater Quality from borewells and wells in the ten study villages reveals quality deterioration including increase in Hardness specifically Calcium hardness, Magnesium hardness and total hardness as CaCO_3 . There is deterioration of water quality across all villages, with the most severe exceedances recorded at Narayangaon (Total Hardness up to 4428 mg/L, approximately seven times the permissible limit), Wahegaon (Total Hardness up to 2592 mg/L) and Mudhalwadi (Total Hardness up to 2484 mg/L). 3. Total Dissolved Solids exceeded permissible limits at multiple locations in Wahegaon, Narayangaon, Mudhalwadi and Katpur, with values reaching up to 6700 mg/L at Narayangaon, more than three times the permissible limit.

(c) Nitrate as NO_3 (limit of 45 mg/L) exceeded the acceptable limit at all four sampling locations in Isarwadi, all four in Wahegaon, three of four in Pachalgaon and Rahatgaon, and at multiple locations in Mudhalwadi, Karajkheda and Pimpalwadi, confirming widespread and near-universal agricultural nitrogen contamination of the shallow aquifer across the study area.

(d) Chloride exceeded permissible limits at Narayangaon and Mudhalwadi, and Sulphate exceeded permissible limits at multiple locations across Wahegaon, Narayangaon, Katpur and Mudhalwadi, with Sample 6 in Katpur recording the single highest groundwater sulphate concentration at 1668.79 mg/L, more than four times the permissible limit, an anomaly that could not be explained by agricultural influence alone.

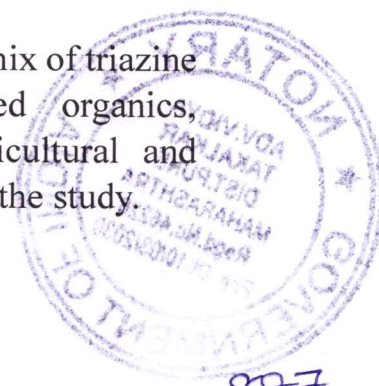
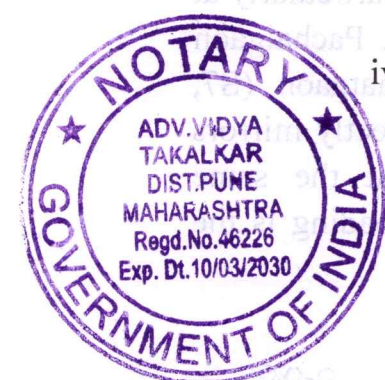




(e) Dissolved Oxygen is below the reference value at several locations including MIDC Back (1.20 mg/L, critically low), Narayangaon Sample 17 (3.60 mg/L) and Isarwadi Sample 4 (4.10 mg/L., borderline), indicating oxygen depletion consistent with organic loading. The MIDC Back square well (Sample 23) recorded the most extreme overall groundwater profile in the study, with Turbidity of 2067.44 NTU, TDS of 6552 mg/L and Dissolved Oxygen of only 1.20 mg/L, and given its location immediately adjacent to the MIDC industrial boundary, which represents the strongest physicochemical evidence of direct industrial impact on shallow groundwater.

6. **Advanced GCMS Analysis** : The Gas Chromatography-Mass Spectrometry analysis conducted on selected water samples from Mudhalwadi and the five priority locations provides the most critical findings of this study in terms of establishing an industrial contamination link.

- i) Across the Mudhalwadi samples, GCMS confirmed the presence of Pentachlorodibenzo-p-dioxins in Sample 67, which are among the most toxic and persistent organic pollutants known and are classified as Group 1 human carcinogens. BTEX compounds (xylenes) were confirmed at Sample 65, Endosulfan sulfate, a banned pesticide, was confirmed at Sample 63, and pharmaceutical synthesis intermediates and organometallic compounds were confirmed at Sample 71 (MIDC Back well).
- ii) Among the five priority samples, the MIDC Back well (Sample 23) showed the most chemically definitive industrial signature, with dichlorothiophene sulfonyl chloride and oxadiazolopyrimidine compounds exclusively associated with chemical synthesis processes.
- iii) Sample 9 from Wahegaon yielded the most unexpected finding, confirming a tungsten tetracarbonyl organometallic complex in a domestic well in a village not immediately adjacent to MIDC, indicating that industrial contamination pathways extend further into the surrounding area than proximity to the MIDC boundary alone would suggest.
- iv) Sample 6 from Katpur confirmed the presence of a mix of triazine herbicide derivatives and industrial chlorinated organics, providing the strongest evidence of mixed agricultural and industrial contamination at a single well location in the study.



7. Wastewater collection near BB Chemicals Compound wall :

The effluent sample collected from the open drainage line outside the BB Chemicals compound wall (Sample 70) recorded the most severe pollution values in the entire study, with BOD of 10,000 mg/L and COD of 30,144 mg/L, exceeding the CPCB Schedule VI discharge limits of 30 mg/L and 250 mg/L respectively by several hundred times. The pH of 9.67 and Total Alkalinity of 1200 mg/L confirmed an alkaline, highly reactive chemical waste stream being discharged directly into an open, untreated drain accessible to the surrounding environment. The GCMS analysis of this drain water conclusively identified 2,4,6-trimethylaniline (mesidine) as the dominant compound, accounting for nearly 94 percent of the total identified peak area, alongside o-Anisidine, both of which are synthetic aromatic amines used as industrial chemical intermediates and are classified as probable human carcinogens. This finding provides the clearest and most specific chemical evidence of illegal untreated industrial discharge identified anywhere in this study.

8. Soil Quality Monitoring:

- i) The soil quality assessment across the ten villages reveals two broad patterns of concern operating simultaneously. The first is a widespread and near-universal enrichment of Magnesium across all village soils, consistent with the geogenic weathering of basaltic Deccan Trap parent material, which is the natural background for this region and serves as confirmation that the Jayakwadi Dam reference site soil parameters provide a reliable baseline for the study area.
- ii) The second and more concerning pattern is the consistent elevation of Nitrate Nitrogen across most villages, particularly at Isarwadi (S11, 93.38%), Wahegaon (S65, 68.68%), Pachalgaon (S21, 68.44%), Pimpalwadi (S17, 68.44%), Rahatgaon (S7, 56.31%) and Mudhalwadi (S3, 81.37%), which directly mirrors the groundwater nitrate exceedances recorded at the same locations and confirms that agricultural nitrogen loading is the





primary driver of nitrate contamination across both soil and groundwater in the study area.

- iii) Sodium enrichment in soil was most severe at Wahegaon (S65, 2712.70 mg/kg, the highest in the study) and at multiple locations in Mudhalwadi, Rahatgaon and Narayangaon, consistent with long-term irrigation using high-TDS, high-sodium groundwater and indicating progressive sodification of agricultural land in these villages.
- iv) Lead values were highest at Karajkheda S19 (31.77 meq/L, the highest in the entire study) and Katpur S12 (31.77 meq/L), both requiring 94 further monitoring. Copper at multiple locations across Isarwadi, Mudhalwadi and Pimpalwadi exceeded the Jayakwadi Dam reference value of 61.39 mg/kg, pointing to a degree of anthropogenic copper enrichment beyond the geogenic baseline, most likely from copper-based fungicide application combined with possible industrial input at Mudhalwadi locations closest to the drainage corridor.
- v) Total Chromium was below the detection limit at all locations across all villages, indicating no detectable chromium contamination in the agricultural soils at the time of sampling.
- vi) Available Nitrogen was below the detection limit at every single location across the entire study area, indicating severely deficient immediately plant-available nitrogen in the soils of all villages despite elevated Nitrate Nitrogen percentages, suggesting that nitrogen in these soils is largely in an inorganic accumulated form rather than biologically active plant-available form, which has direct negative implications for agricultural productivity.

9. I say and submit that MPC Board have issued Clouser Direction to M/s. B.B. Chemicals, MIDC Paithan as per recommendations mentioned in Interim report by ICT, Mumbai. Copy enclosed herewith as Annexure-4 As per discussion with ICT team, Final Comprehensive Report to define contamination of ground water along with remedial measures, The agriculture crop loss & contamination of soil, technical audit of individual industry & assessment of the Environmental damage compensation is expected by end of Oct 2026.



10. I say and submit that the interim scientific study report prepared by ICT Mumbai is submitted herewith for kind perusal & consideration of Hon'ble Tribunal.

Solemnly affirmed on this 29th Day of June 2026 at Chhatrapati Sambhajanagar.

For and on behalf of

Maharashtra Pollution Control Board (R.No.2)

(Achyut S. Nandvate)

Sub Regional Officer, Chh. Sambhajanagar

AFFIDAVIT

Solemnly affirmed before me by
by Shri/Smt. Achyut S. Nandvate
R/o SRO MDCB CSN
Tq. CSN Dist CSN
Who identified by S. S. Patil
Whom He/She is personally Known.

Adv. Vidya Takalkar
Notary Govt. of India
Pune Dist. Maharashtra

29/06/2026

BEFORE ME

ADV. VIDYA TAKALKAR
NOTARY GOVT. OF INDIA
PUNE DIST. MAHARASHTRA
REG.NO.46226

29/06/2026

NOTED AND REGISTERED

SERIAL NUMBER.....16/12026

Date.....29/06/2026

Item No.11

Pune Bench

**BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE BENCH, PUNE**

THROUGH PHYSICAL HEARING (WITH HYBRID OPTION)

Original Application No.222/2023(WZ)

Mrs. Mangal W/o Vishnu Bodkhe & 4 Ors.

Applicants

Versus

M/s. Matrix Life Science Pvt Ltd & 3 Ors.

Respondents

Date of hearing: 24.02.2026

**CORAM: HON'BLE MR. JUSTICE DINESH KUMAR SINGH, JUDICIAL MEMBER
HON'BLE DR. SUJIT KUMAR BAJPAYEE, EXPERT MEMBER**

Applicants: Ms. Shriya Awale h/f Mr. Asim Sarode, Advocates

Respondents: Mr. Sachin Gore, Mr. Raghunath B. Mahabal, Advocates for R-1
Ms. Manasi Joshi and Ms. Pooja Natu, Advocates for R-2
Mr. Aniruddha Kulkarni, Advocate for R-3
Mr. Pushkal Mishra, Advocate for R-4
Mr. V.V. Gujar, Advocate for R-5

ORDER

1. Today, the Joint Committee Report is to be disposed of by us in the light of the objections made by the learned counsel for the applicant.

2. The Joint Committee Report which is annexed at pages no. 711 to 739 contains that water in the visited wells was found yellowish in colour. Industrial effluent and sewage generated from the industry located in MIDC Paithan area were said to be the main reason for depleting ground water quality. The District Agriculture Office's report suggested that contaminated ground water was the main reason for soil contamination of agricultural fields that decreased the crop yield mainly during the last 4 to 5 years. In-depth scientific study was recommended to be carried out through the expert technical institute in the field of ground water management under the supervision of Central Ground Water Authority

(CGWA) to identify the horizontal and vertical propagation of the contaminants in the ground water of the area.

3. The objection which has been raised by the applicant against the said report is dated 04.10.2025 in which it is mentioned that M/s. Matrix Global Specialty Private Limited and M/s. Dakshayani Chemicals Pvt. Ltd. are discharging untreated effluent in the open area of 1000 square meters but their names are not mentioned in the Joint Committee Report. Further, it is mentioned that the recommendation with respect to in-depth study by expert technical institute also has not been carried out, therefore, it is prayed in the reply that a direction may be issued to either VNIT and Joint Committee to further carry out in-depth study in order to identify the horizontal and vertical propagation of the contaminants in the ground water. Further, it is orally submitted by the learned counsel that the MPCB has already considerably delayed taking steps in the direction of conducting this study.

4. We have gone through the objections as well as the Joint Committee Report and are of the view that it would be appropriate to direct the MPCB to get study conducted through Institute for Chemical Technology (ICT) to identify the horizontal and vertical propagation as proposed in the Joint Committee Report, for which learned counsel for the MPCB seeks three months' time to submit the same. We grant her the said time.

5. Put up this matter for next consideration on 30.06.2026

Dinesh Kumar Singh, JM

Dr. Sujit Kumar Bajpayee, EM

February 24, 2026
Original Application No. 222/2023(WZ)
R



लोकसेवा हक्क कायदा
Right to Public Service Act



महाराष्ट्र प्रदूषण नियंत्रण मंडळ MAHARASHTRA POLLUTION CONTROL BOARD

कल्पतरू पॉइंट, २, ३ आणि ४ था मजला, मूव्हीमॅक्स सिनेमा समोर,
शीव सर्कल जवळ, शीव (पू), मुंबई - ४०० ०२२

Kalpataru Point, 2nd, 3rd and 4th floor, Opp. MovieMax Cinema,
Near Sion Circle, Sion (E), Mumbai - 400 022

Annex 2



LiFE
Lifestyle for
Environment



ईमेल / Email: robmw@mpcb.gov.in
संकेतस्थळ / Website: www.mpcb.gov.in

दूरध्वनी / Tel: 022-67808888

Ref. No.

Date:

To,
The Vice Chancellor,
Institute of Chemical Technology (ICT),
Matunga (East), Mumbai – 400019.

Kind Attn. : Dr. Dipak V. Pinjari

Sub : - Work Order for evaluation / adequacy report of industries in MIDC Paithan and preparation of comprehensive report in respect of Ground water contamination, Soil contamination and remedial measures thereof.

- Ref.: 1) Orders issued by Hon'ble NGT in matter OA no. 222 /2023 by M/s. Mangal Vishnu Bodke Vs. Matrix Life Science dated 22/04/2024, 08/05/2025 & 24/02/2026.
2) This office letter no. MPCB/ROBMW/B-204, Dated- 10/04/2026.
3) Meeting convened by MS, MPCB along with Board officials and officials of ICT Mumbai dated 07/05/2026.
4) The revised proposal submitted by you dated 07/05/2026.

M/s. Mangal Vishnu Bodke have filed OA no. 222/2023 against M/s. Matrix Life Science in Hon'ble NGT Pune with prayer to issue orders to respondents for compensation towards agriculture crop loss and associated aspect due to ongoing industrial operations of respondent in MIDC Paithan. In this matter, Hon'ble NGT issued various orders as referred above and directed MPCB to carry out evaluation / adequacy report of industries in MIDC Paithan and preparation of comprehensive report in respect of Ground water contamination, Soil contamination and remedial measures thereof.

Techno-Legal aspect - Hon'ble NGT in its order dated 05/08/2025 taken on record recommendations made by joint committee under the chairmanship of District Collector, Chhatrapati Sambhajanagar. It was recommended by joint committee to carry out performance evaluation and adequacy report of ZLD system of industries in MIDC Paithan, in depth scientific study of vertical and horizontal propagation of contaminations in ground water, remedial majors thereof and Environmental Damage compensation from noncompliant units. Hon'ble NGT vide order dated 05/08/2025 directed to carry out above stated work through expert technical institutes with specific orders about recovery of compensation based on past violation and allocation of amount as interim compensation for crop losses and initiation of remediation action.

Vide above referred letter at sr.no. 2, you were requested to submit your proposal for preparation of comprehensive report as directed by Hon'ble NGT. Further the meeting was convened by MS, MPCB along with Board officials and officials of ICT Mumbai dated 07/05/2026 in conference room of MPC Board wherein proposal submitted by you was technically evaluated and you were requested to submit revised proposal including various aspects as discussed during meeting. Thereafter, this office is in receipt of your revised proposal for above stated task.

2..

:2:

The proposal submitted by you is technically evaluated and work order for the said task is issued for immediate compliance as below:-

1. You shall carry out evaluation / adequacy report of industries in MIDC Paithan including process operations, effluent generation pathways, and performance of ETP/STP/ZLD systems, including identification of non-compliances, identification of contaminant sources and potential leakage/bypass points along with representative of CPCB Pune. Further you shall adopt scientific methodology of chemical fingerprinting, statistical analysis, and hydrogeological correlation to establish source-pathway-receptor relationships (source apportionment) and assign relative contributions of individual industries along with environmental damage compensation (EDC).
2. You shall carry out Horizontal (areal) spread of contamination across the region, Vertical (depth-wise) migration of contaminants within aquifer systems, Source identification, including industrial and non-industrial contributors, Remedial measures supported by scientific and engineering analysis, compensation mechanisms aligned with environmental damage of the area of MIDC Paithan and nearby vicinity in question. The detail report along with remedial measures and expenses incurred thereof shall be prepared for submission to Hon'ble NGT.
3. You shall carry out Assessment for changes in soil physio-chemical characteristics (salinity, alkalinity, nutrient imbalance), Quantifying degradation in soil fertility and structure, Establishing correlations between groundwater quality and soil degradation, Estimating crop yield losses and identifying affected crop systems in consultation with Soil Conservation Officer and District Agriculture Officer, Chh. Sambhajinagar.
4. You may utilize laboratory facilities of Maharashtra Pollution Control Board during office working hours with inhouse available logistics support and preintimation thereof to In-charge Lab.
5. The comprehensive report including above aspects shall be prepared in consultation with members of Central Pollution Control Board, District Agriculture Officer, representative of GSDA and Soil Conservation Officer within period of 90 days from receipt of this order.
6. The proposal submitted by you about evaluation / adequacy report of industries in MIDC Paithan and preparation of comprehensive report in respect of Ground water contamination, Soil contamination and remedial measures thereof amounting Rs. 1,12,70,000/- + Taxes (In words Rs. One Crore Twelve Lakh Seventy Thousand Only) is approved with payment terms as :-
 - i. 40 % advance at the time of acceptance of Work Order.
 - ii. 30 % after ground survey and collection of samples thereof.
 - iii. 20 % after submission of comprehensive report.
 - iv. 10 % after approval of report by Hon'ble NGT.

3..

:3:

7. The interim report about pre-monsoon sampling and associated finding shall be submitted before 15th June, 2026 so that it can be submitted to Hon'ble NGT for its hearing scheduled on 30/06/2026.
8. You shall complete the above-stated work as per proposal submitted by you within period of 90 days in compliance with various order issued by Hon'ble NGT in OA no. 222 of 2023 M/s. Mangal Vishnu Bodke Vs. Matrix Life Science.

This is issued with the approval of competent authority of the Board.

Digitally signed by
Sujit Suhas Dholam
Date: 07-05-2026

22:01:11
(Sujit Dholam)

Regional Officer (BMW)

Copy Submitted for information to:-

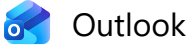
- 1) Hon'ble Chairman, MPC Board, Mumbai.
- 2) Hon'ble Member Secretary, MPC Board, Mumbai.
- 3) District Collector, Chh. Sambhajinagar.

Copy submitted to:-

- 1) Additional Director, CPCB Pune. – with request to depute officials for the task of evaluation / adequacy report of industries in MIDC Paithan and preparation of comprehensive report in respect of Ground water contamination, Soil contamination and remedial measures thereof as per directives issued by Hon'ble NGT.
- 2) District Superintendent of Agriculture Office / District Soil Conservation Officer, Chh. Sambhajinagar - with request to depute officials for the task of evaluation / adequacy report of industries in MIDC Paithan and preparation of comprehensive report in respect of Ground water contamination, Crop loss, Soil contamination and remedial measures thereof as per directives issued by Hon'ble NGT.
- 3) Principal Scientific Officer, MPC Board, Mumbai – With request to instruct SO, Navi Mumbai and SO, Pune and allow use of Lab facility.

Copy to :-

- 1) Regional Officer / Sub Regional Officer, Chh. Sambhajinagar. - with instructions to coordinate the task and extend necessary support to the teams assigned.
- 2) Scientific Officer, Chh. Sambhajinagar.- with instruction to allow for use of Lab facility for analysis and extend necessary support.



Re: पैठण औद्योगिक वसाहतीचा सद्यस्थितीदर्शक प्रदूषण व निवारण विषयक सर्वसमावेशक अंतरिम अहवाल तात्काळ सादर करणेबाबत....

From Dr. D. V. Pinjari <dv.pinjari@ictmumbai.edu.in>

Date Thu 25-06-2026 13:36

To SRO Chhatrapati Sambhaji Nagar <srochhatrapatisambhajinagar1@mpcb.gov.in>

Cc Member Secretary MPCB Mumbai <ms@mpcb.gov.in>; RO (BMW) <robmw@mpcb.gov.in>; RO Chhatrapati Sambhaji Nagar <rochhatrapatisambhajinagar@mpcb.gov.in>

1 attachment (22 MB)

Interim Report_MIDC Paithan Area_Dt. 26.6.2026 2.pdf;

Dear Shri Nandvate,
Please refer to the attachment for interim report of MIDC Paithan.

Thanks and regards
Dr. Pinjari

From: Dr. D. V. Pinjari <dv.pinjari@ictmumbai.edu.in>

Sent: Tuesday, 23 June 2026 14:13:05

To: SRO Chhatrapati Sambhaji Nagar <srochhatrapatisambhajinagar1@mpcb.gov.in>

Cc: Member Secretary MPCB Mumbai <ms@mpcb.gov.in>; RO (BMW) <robmw@mpcb.gov.in>; RO Chhatrapati Sambhaji Nagar <rochhatrapatisambhajinagar@mpcb.gov.in>; Jyoti Vedante <psms@mpcb.gov.in>; Dr. Vishwajeet Thakur <pso@mpcb.gov.in>; D.D.Lokhande <deepali.lokhande@mpcb.gov.in>; gsda <ddau.gsda@gmail.com>; Agriculture officer Aurangabad <dsaoabad@gmail.com>

Subject: Re: पैठण औद्योगिक वसाहतीचा सद्यस्थितीदर्शक प्रदूषण व निवारण विषयक सर्वसमावेशक अंतरिम अहवाल तात्काळ सादर करणेबाबत....

Dear Shri Nandvate,
We are in receipt of your email. We would like to inform you that we are very soon submitting the interim report in-spite of non-cooperation of MPCB laboratory. We expect the cooperation in the next phase of study.

Thanks and regards
Dr. Pinjari

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From: SRO Chhatrapati Sambhaji Nagar <srochhatrapatisambhajinagar1@mpcb.gov.in>

Sent: Tuesday, 23 June 2026 11:54:23

To: Dr. D. V. Pinjari <dv.pinjari@ictmumbai.edu.in>

Cc: Member Secretary MPCB Mumbai <ms@mpcb.gov.in>; RO (BMW) <robmw@mpcb.gov.in>; RO Chhatrapati Sambhaji Nagar <rochhatrapatisambhajinagar@mpcb.gov.in>; Jyoti Vedante <psms@mpcb.gov.in>; Dr. Vishwajeet Thakur <pso@mpcb.gov.in>; D.D.Lokhande

<deepali.lokhande@mpcb.gov.in>; gsda <ddau.gsda@gmail.com>; Agriculture officer Aurangabad
<dsaoabad@gmail.com>

Subject: Re: पैठण औद्योगिक वसाहतीचा सद्यस्थितीदर्शक प्रदूषण व निवारण विषयक सर्वसमावेशक अंतरिम अहवाल तात्काळ सादर करणेबाबत....

REMINDER / TIME BOUND

Sir,

The matter Mangal Vishnu Bodkhe Vs Matrix Life Science OA 222/2023 is scheduled for hearing in Hon'ble NGT on June 30th 2026. Please submit Interim report as assured by you during meeting held under Chairmanship of Hon'ble MS, MPCB

Thanks & Regards,

Achyut S. Nandvate,
Sub-Regional Officer,
Maharashtra Pollution Control Board,
Chhatrapati Sambhajanagar.



"SAVE PAPER"-THINK BEFORE YOU PRINT!

POWER BEHIND ENVIRONMENT...M.P.C.B.

From: SRO Chhatrapati Sambhaji Nagar <srochhatrapatisambhajanagar1@mpcb.gov.in>

Sent: 21 June 2026 22:15

To: Dr. D. V. Pinjari <dv.pinjari@ictmumbai.edu.in>

Cc: RO (BMW) <robmw@mpcb.gov.in>; RO Chhatrapati Sambhaji Nagar

<rochhatrapatisambhajanagar@mpcb.gov.in>; Jyoti Vedante <psms@mpcb.gov.in>; Dr. Vishwajeet Thakur

<pso@mpcb.gov.in>; D.D.Lokhande <deepali.lokhande@mpcb.gov.in>; gsda <ddau.gsda@gmail.com>;

Agriculture officer Aurangabad <dsaoabad@gmail.com>

Subject: पैठण औद्योगिक वसाहतीचा सद्यस्थितीदर्शक प्रदूषण व निवारण विषयक सर्वसमावेशक अंतरिम अहवाल तात्काळ सादर करणेबाबत....

महोदय,

मा. राष्ट्रीय हरित लवाद यांनी श्रीमती मंगल विष्णू बोडके विरुद्ध मॅट्रिक्स लाइफ सायन्स या २२२ / २०२३ या याचिकेमध्ये पैठण औद्योगिक वसाहती सभोवतालच्या परिसरातील भूगर्भातील पाण्याचे प्रदूषणाबाबत सर्वेक्षण करणे, पैठण औद्योगिक वसाहतीतील उद्योगांचे त्यांच्या प्रदूषण नियंत्रण यंत्रणांचे ऑडिट करणे, पैठण औद्योगिक वसाहती सभोवतालच्या शेतकऱ्यांच्या नुकसान भरपाईचा अहवाल तयार करणे इत्यादी बाबतचा सर्वसमावेशक अहवाल तयार करण्याबाबत आयसीटी मुंबई यांना आदेशित केले आहे.

सदर बाबत मा सदस्य सचिव यांच्या अध्यक्षतेखाली झालेल्या बैठकीत आपल्या संस्थेकडून सादर केलेल्या प्रस्तावाचे तांत्रिक परीक्षण ६ मे २०२६ रोजी करून मा राष्ट्रीय हरित लवाद यांनी आदेशित केल्याप्रमाणे पैठण औद्योगिक वसाहतीचा सद्यस्थितीदर्शक प्रदूषण व निवारण विषयक सर्वसमावेशक अहवाल तयार करण्याचे काम आपणास कार्यालयीन आदेश दिनांक ७ मे २०२६ रोजी पारित केले आहेत.

सदर बैठकीत आपण सदर अहवालाचा अंतरिम अहवाल दिनांक १५ जून २०२६ पर्यंत मंडळास सादर करण्याचे आश्वासित केले होते जेणेकरून त्याबाबतची माहिती शपथपत्राद्वारे माननीय राष्ट्रीय हरित लवादास दिनांक २ जुलै २०२६ रोजीच्या सुनावणी दरम्यान सादर करता येईल. परंतु आपल्याकडून पैठण औद्योगिक वसाहतीतील प्रदूषण विषयक अंतरिम अहवाल अद्याप प्राप्त झालेला नाही. आपल्याकडून अंतरिम अहवाल प्राप्त झाल्यानंतर माननीय सदस्य सचिव यांच्या मान्यतेने शपथ पत्र माननीय राष्ट्रीय हरित लवादात सादर करणे गरजेचे आहे. म्हणून आपणास विनंती करण्यात येते की पैठण औद्योगिक वसाहतीतील प्रदूषण विषयक अंतरिम अहवाल तात्काळ सादर करण्यात यावा.

Thanks & Regards,

**Achyut S. Nandvate,
Sub-Regional Officer,
Maharashtra Pollution Control Board,
Chhatrapati Sambhajanagar.**



"SAVE PAPER"-THINK BEFORE YOU PRINT!

POWER BEHIND ENVIRONMENT...M.P.C.B.

From: SRO Chhatrapati Sambhaji Nagar <srochhatrapatisambhajanagar1@mpcb.gov.in>

Sent: Friday, May 22, 2026 15:21

To: gsda <ddau.gsda@gmail.com>; RO (BMW) <robmw@mpcb.gov.in>; RO Chhatrapati Sambhaji Nagar <rochhatrapatisambhajanagar@mpcb.gov.in>; Dr. D. V. Pinjari <dv.pinjari@ictmumbai.edu.in>; Jyoti Vedante <psms@mpcb.gov.in>; Agriculture officer Aurangabad <dsaoabad@gmail.com>; Shantilal Nagare <ssopunelab@mpcb.gov.in>; Shantilal Nagare <shantilal.nagare@mpcb.gov.in>; Dr. Padmanabh Khadkikar <icclab@mpcb.gov.in>; Dr. Padmanabh Khadkikar <padmanabh.khadkikar@mpcb.gov.in>

Subject: माननीय राष्ट्रीय हरित लवाद यांनी श्री. मंगल विष्णू बोडके विरुद्ध मॅट्रिक्स लाइफ सायन्स या 222 / 2023 याचिकेबाबत दिनांक 19 मे 2026 आढावा बैठकीचे इतिवृत्त

महोदय,

माननीय राष्ट्रीय हरित लवाद यांनी श्री. मंगल विष्णू बोडके विरुद्ध मॅट्रिक्स लाइफ सायन्स या 222 / 2023 याचिकेबाबत दिनांक 19 मे 2026 रोजी झालेल्या आढावा बैठकीचे इतिवृत्त आपल्या माहितीस्तव सादर करण्यात येत आहे. सदर इतिवृत्तामधे काही सुधारणा असल्यास सुचविण्यात याव्या अन्यथा स्वाक्षरी करून उलट टपाली पाठविण्यात यावे हि विनंती. आपल्या माहितीस्तव सादर.

Thanks & Regards,

**Achyut S. Nandvate,
Sub-Regional Officer,
Maharashtra Pollution Control Board,
Chhatrapati Sambhajanagar.**



"SAVE PAPER"-THINK BEFORE YOU PRINT!

POWER BEHIND ENVIRONMENT...M.P.C.B.

This email is sent from the Institute of Chemical Technology (ICT), Mumbai (<http://www.ictmumbai.edu.in/>); a Deemed University under Section 3 of UGC Act 1956 with Elite Status and Centre of Excellence of Govt. of Maharashtra, India. _____Are you an alumnus of UDCT/UICT/ICT? Join the long list of alumni and connect with your classmates and friends. BE PART OF ICT's 8-DECADES OF EXCELLENCE. Visit <http://udctalumni.org.in/> and register yourself.



INSTITUTE OF CHEMICAL TECHNOLOGY रसायन तंत्रज्ञान संस्था



Deemed to be University under Section-3 of UGC Act 1956

Elite Status & Centre of Excellence - Government of Maharashtra

Category I Deemed to be University (MHRD/UGC)

National Rank 1 in Atal Innovation Ranking (ARIIA), by MHRD, Category : Govt Aided Universities (2020)

ICT/DPSE/DVP/1829

Date: 25-06-2026

To,
Member Secretary
Maharashtra Pollution Control Board
Kalpataru Point, Opp. PVR Cinema,
Sion Circle, Sion (E),
Mumbai - 400 022

Subject: Submission of Interim Report on "Comprehensive Scientific Study on Groundwater, Soil, Agricultural and Public Health Impact in MIDC Paithan Area"

References: Work order no. MPCB/RO(BMW)/B-204 dated 10/04/2026 issued by the MPCB.

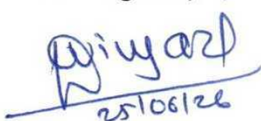
Dear Sir,

With reference to Work Order No. MPCB/RO(BMW)/B-204 dated 10/04/2026 issued by the Maharashtra Pollution Control Board (MPCB), and subsequent to the order passed by the Hon'ble National Green Tribunal in O.A. No. 222/2023, we are pleased to submit the interim report on the "Comprehensive Scientific Study on Groundwater, Soil, Agricultural, and Public Health Impact in the MIDC Paithan Area." The detailed interim report containing sampling data, photographic documentation, analytical results, observations, and preliminary recommendations is attached as Annexures.

This report encompasses the Phase I assessment conducted during the pre-monsoon season. The final report, incorporating findings from Phase II (monsoon/during-season), will be submitted subsequently.

We thank you for entrusting us with this crucial responsibility. We remain committed to contributing toward sustainable environmental management through scientific and transparent evaluations.

Warm regards,


25/06/26

Dr. Dipak V. Pinjari
Principal Investigator




25/06/2026

Prof. A. B. Pandit
Vice Chancellor

Enclosure

Annexure I: Geotechnical Assessment

Annexure II: Groundwater Analysis

Annexure III: Soil Analysis

Annexure IV: Advanced Characterization

VICE CHANCELLOR
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1. Background

1.1 Study Area: MIDC Paithan

The Maharashtra Industrial Development Corporation (MIDC) Paithan Industrial Area is located in Paithan Taluka, Chhatrapati Sambhajnagar District (formerly Aurangabad District), Maharashtra State, in the Marathwada region of India (PIN: 431148). Paithan is situated approximately 56 km south of Chhatrapati Sambhajnagar (Aurangabad) city, on the banks of the Godavari River. The MIDC industrial estate is located along the Aurangabad–Paithan Road (SH-148), north of the Paithan town centre.

1.2 Proximity to Jayakwadi Reservoir

The Jayakwadi Dam, an earthen dam impounding the Godavari River is located at coordinates 19°29'N 75°22'E, near the town of Paithan. It is one of the largest earthen dams in Maharashtra, with a total storage capacity of 2,909 MCM and a reservoir surface area of approximately 350 sq. km, known as Nath Sagar Jalashay. The MIDC Paithan Industrial Area is situated at an aerial distance of approximately 4 to 5 km to the north of the Jayakwadi reservoir (Nath Sagar). The reservoir thus lies in the southern direction from the MIDC area, making the proximity of industrial activity to this critical water body an important consideration for groundwater and soil quality assessment.

1.3 Visual Representation

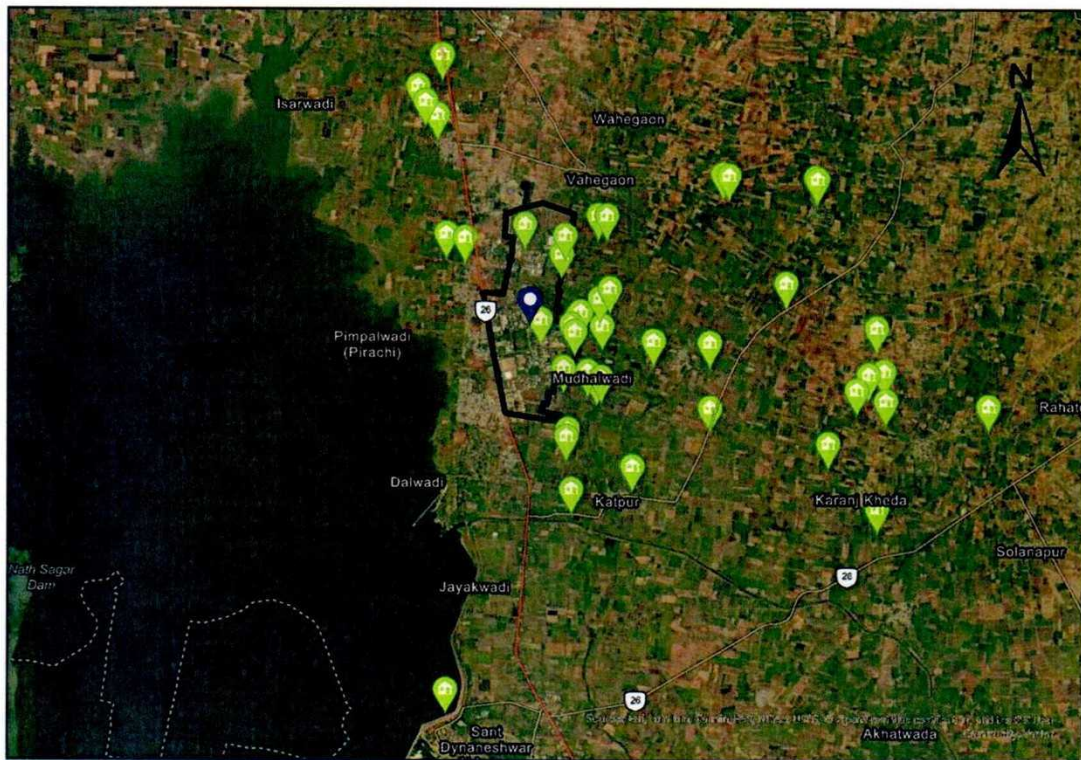


Figure 1: Location map of the MIDC Paithan study

Figure 1 provides a visual representation of the MIDC Paithan area, depicting the industrial zone boundary, surrounding villages, the Nath Sagar reservoir to the south, and sampling locations for the present study.

1.4 Surrounding Villages

The MIDC Paithan Industrial Area is surrounded by the following villages in its immediate vicinity (refer Figure 1):

S. No.	Village Name	Approximate Direction
1	Mudhalwadi	North / North-East
2	Katpur	North-East
3	Pimpalwadi (Pirachi)	East / South-East
4	Narayangaon	North / North-West
5	Isarwadi	East
6	Wahegaon	West / North-West
7	Pachalgaon	North-West
8	Karanj Kheda	South-West
9	Rahatgaon	South

These villages fall within the potential zone of influence of industrial effluents, leachate migration, and airborne emissions from the MIDC Paithan estate. The communities residing in these villages, along with the agricultural lands and groundwater resources in the area, form the primary subject of the present comprehensive scientific study.

1.6 ICT team visits MIDC Paithan.

The ICT team was officially entrusted with conducting the Comprehensive Scientific Study on Groundwater, Soil, Agricultural, and Public Health Impact in the MIDC Paithan Area, vide

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Work Order No. MPCB/RO(BMW)/B-204 dated 10/04/2026, issued by the Maharashtra Pollution Control Board (MPCB).

An initial site visit was conducted on 20/06/2026 by the ICT team accompanied by an official from the MPCB. During this visit, the team collected water and soil samples from various locations across the villages surrounding the MIDC Paithan area.

2. Methodology

The ICT team adopted a rigorous and structured methodology to comprehensively assess the environmental impact of industries operating within the MIDC Paithan area on groundwater and soil in the nearby area. This approach encompassed systematic sample collection, in-depth laboratory analysis and photographic documentation in order to assess its effectiveness in mitigating environmental impact.

2.1 Sample Collection

To ensure a thorough environmental assessment, the team strategically collected water and solid (soil) samples from various locations within and around the MIDC Paithan area. The selection of sampling sites was based on the data provided by SRO of MPCB Ch. Sambhajinagar and locations where environmental complaints had previously been raised by local residents. The water samples comprised groundwater from borewells and wells. A sample collected from a gutter (drain) located outside BB Chemicals. The solid (soil) samples were collected from locations adjacent to these groundwater sampling sites, enabling a co-located assessment of soil and water quality and a more accurate correlation between potential contamination pathways across the two media.

2.2 Community Concerns Regarding Groundwater Quality

During preliminary interactions and field visits conducted as part of the present study, residents from the villages surrounding the MIDC Paithan Industrial Area including Mudhalwadi, Katpur, Pimpalwadi (Pirachi), Narayangaon, Isarwadi, Wahegaon, Pachalgaon, Karanj Kheda, Rahatgaon have raised persistent concerns regarding the deteriorating quality of groundwater in their localities, which they attribute to the discharge of untreated or partially treated effluents from industrial units operating within the MIDC estate. Villagers report that groundwater drawn from wells and borewells located in proximity to industrial drains and natural nullahs exhibits noticeable changes in colour, odour, and taste, with several residents describing the water as having a foul smell, a yellowish or oily tinge, and an unpalatable or saline taste, rendering it unfit for drinking and domestic use.

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2.3 Concerns Regarding Soil Quality and Fertility

Farmers in the affected villages have reported a gradual but discernible deterioration in soil quality over recent years, which they associate with the prolonged use of irrigation water sourced from wells and drains suspected to carry industrial effluent. According to local observations, this has resulted in increased soil salinity and hardness, reduced water infiltration, and in certain patches, visible crusting, discoloration, or whitish efflorescence on the soil surface, particularly in fields situated closer to industrial drainage channels and low-lying areas where effluent is suspected to accumulate during the monsoon and post-monsoon periods.

2.4 Impact on Agricultural Crops

Farmers have further reported a marked decline in agricultural productivity, with crops such as cotton, sugarcane, and seasonal vegetables grown in the affected fields showing stunted growth, yellowing of leaves, reduced yield, and in some cases, complete crop failure. These effects are reported to be more pronounced in fields located closer to industrial drainage points and in areas irrigated directly with water from wells or channels believed to be affected by industrial discharge, leading to growing apprehension among the farming community regarding the long-term viability of agriculture in these villages.

2.5 Concerns Regarding Livestock Health

In addition to crop-related concerns, residents have voiced apprehensions regarding the health of livestock that consume water from the affected wells and graze on fodder grown in the suspected contaminated fields, citing instances of recurring illness among cattle. While these observations remain largely anecdotal, they reflect a broader perception within the community that the cumulative impact of industrial discharge extends beyond soil and crops to the health and well-being of farm animals dependent on local water and fodder sources.

2.6 Basis for the Present Study

These community level observations, while largely qualitative and based on lived experience, have prompted residents of the affected villages to seek scientific investigation and intervention from the regulatory authorities. They form an important basis for the present comprehensive study, which aims to scientifically verify these concerns through systematic sampling and analysis of groundwater, soil, and agricultural produce across the identified villages, and to establish whether a discernible correlation exists between the reported contamination and industrial discharge from the MIDC Paithan area.

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3 Analytical parameters

3.1 Water Quality Analysis

The water samples were subjected to an extensive range of physicochemical and biological tests to assess pollution levels.

- a. **pH @ 25°C:** Determines the acidity or alkalinity of water at a standard reference temperature, indicating potential chemical contamination.
- b. **Total Dissolved Solids (TDS):** Measures the concentration of dissolved inorganic salts and organic matter present in water, signifying the presence of pollutants.
- c. **Total Suspended Solids (TSS):** Evaluates the particulate matter present in water that can contribute to turbidity and adversely affect aquatic life.
- d. **Turbidity:** Assesses the cloudiness of water caused by suspended particles, often influenced by industrial discharges or soil erosion.
- e. **Total Alkalinity:** Indicates the water's capacity to neutralize acids, reflecting its buffering capacity and influencing pH stability.
- f. **Chloride:** Elevated chloride levels can indicate contamination from industrial effluents, sewage, or improper wastewater discharge.
- g. **Biochemical Oxygen Demand (BOD):** Measures the oxygen required by microorganisms to decompose organic matter present in water, serving as an indicator of the organic pollution load.
- h. **Chemical Oxygen Demand (COD):** Quantifies the total oxygen required to chemically oxidize biodegradable and non-biodegradable organic and inorganic matter, reflecting the overall pollution strength of the sample.
- i. **Dissolved Oxygen (DO):** Indicates the level of oxygen available in water to support aquatic life; low DO levels typically signal organic pollution and oxygen depletion.
- j. **Hardness (Calcium):** Measures the concentration of calcium salts present in water, contributing to its overall hardness.
- k. **Hardness (Magnesium):** Measures the concentration of magnesium salts present in water, contributing to its overall hardness.
- l. **Hardness (Total) as CaCO_3 :** Represents the combined concentration of calcium and magnesium salts, expressed as calcium carbonate equivalent, reflecting the overall hardness of water and its suitability for domestic and agricultural use.
- m. **Nitrate as NO_3 :** A key indicator of contamination from agricultural runoff (fertilizers), sewage, or industrial waste, with significant implications for drinking water safety.

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- n. **Sulphate as SO₄:** Elevated sulphate levels may indicate contamination from industrial effluents and can impart a laxative effect or unpleasant taste to drinking water at higher concentrations.
- o. **Oil and Grease:** Detects the presence of petroleum-based or fatty contaminants in water, typically associated with industrial effluent discharge.

3.2 Soil Quality Analysis

The solid (soil) samples were subjected to physicochemical analysis to assess soil fertility status, salinity, and potential contamination from heavy metals associated with industrial discharge:

- a. **pH:** Indicates the acidity or alkalinity of the soil, influencing nutrient availability and microbial activity, and reflecting potential impacts of acidic or alkaline industrial discharges.
- b. **Electrical Conductivity (EC):** Measures the soluble salt content of the soil; elevated values indicate salinization, often arising from irrigation with contaminated water or effluent infiltration.
- c. **Organic Content:** Reflects the proportion of organic matter present in the soil, influencing soil fertility, structure, and its capacity to bind and retain contaminants.
- d. **Available Phosphorous:** Indicates the level of plant-available phosphorus, an essential nutrient for crop growth; abnormal levels may signal fertilizer runoff or industrial influence.
- e. **Available Potassium:** Measures the plant-available potassium content, essential for crop health; deviations can indicate altered soil fertility due to contamination.
- f. **Available Nitrogen:** Assesses the nitrogen readily available for plant uptake, a critical nutrient for crop productivity; elevated levels may indicate agricultural runoff or effluent influence.
- g. **Calcium Carbonate:** Indicates the lime content of the soil, affecting soil pH, structure, and nutrient availability.
- h. **Nitrate Nitrogen:** A specific indicator of nitrate accumulation in soil, often associated with excessive fertilizer application, sewage, or industrial effluent infiltration, with implications for groundwater contamination through leaching.
- i. **Total Chromium:** Assesses contamination by chromium, a toxic heavy metal commonly associated with industrial effluents (e.g., from tanning, electroplating, or dyeing processes), which can pose serious risks to soil health and food chain safety.

Signature

- j. **Lead Content:** Evaluates the presence of lead, a toxic heavy metal that can accumulate in soil due to industrial discharge and poses significant health risks through crop uptake and food chain contamination.
- k. **Nickel Content:** Assesses nickel concentration in soil, a heavy metal associated with industrial effluents, which can be toxic to plants and accumulate in the food chain at elevated levels.
- l. **Copper Content:** Measures copper levels in soil; while an essential micronutrient at low concentrations, excessive copper from industrial sources can be toxic to soil microorganisms and plants.
- m. **Magnesium:** Indicates the magnesium content of the soil, an essential plant nutrient that also contributes to soil structure and cation exchange capacity.
- n. **Sodium:** Assesses sodium content in the soil; elevated levels can indicate sodicity or salinization, often resulting from irrigation with contaminated or saline water, adversely affecting soil structure and crop growth.
- o. **Zinc Content:** Measures zinc concentration in soil; while essential for plant growth at trace levels, elevated concentrations from industrial sources can be toxic to soil organisms and accumulate in crops.
- p. **Calcium:** Indicates the calcium content of the soil, an essential nutrient influencing soil structure, pH buffering, and plant cell wall development.

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ANNEXURE I: Geotechnical Assessment of the Study Area

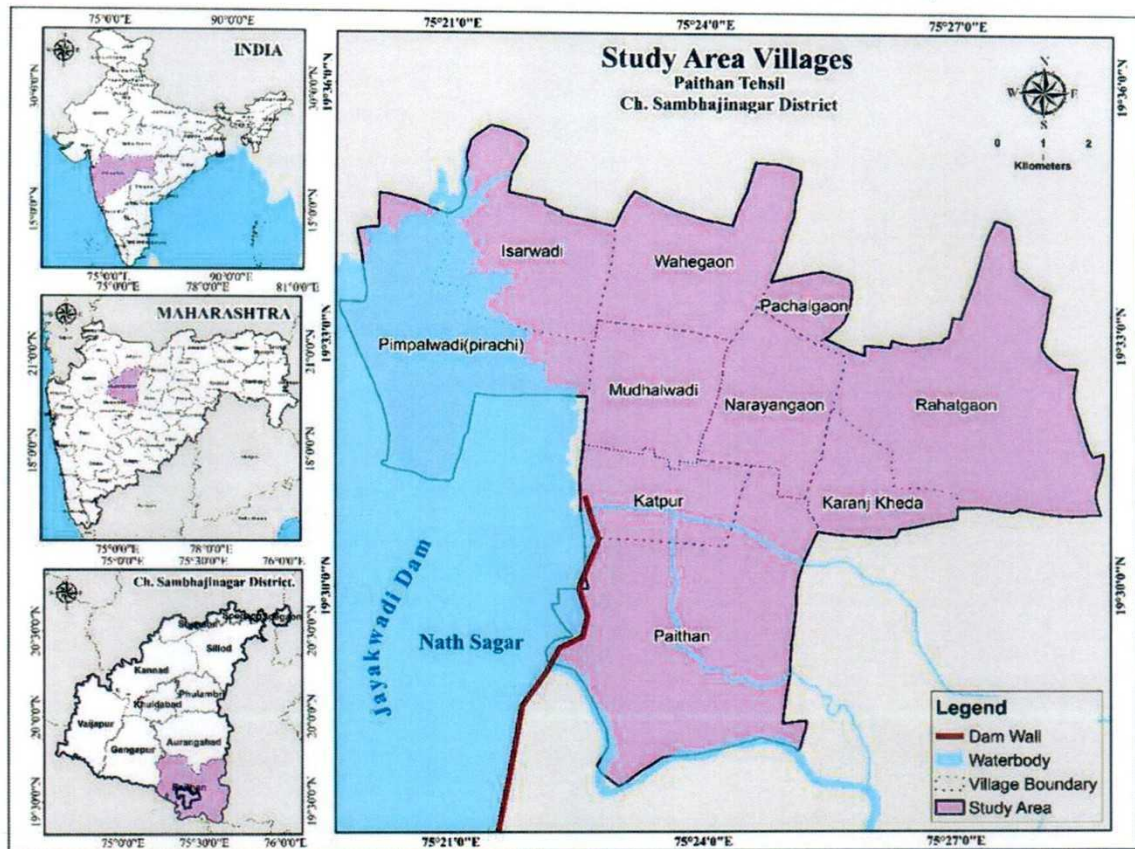


Figure 1.1 Location of the Study Area

The study area is in Paithan Tehsil of Chhatrapati Sambhajinagar (Aurangabad) District, Maharashtra, situated along the Jayakwadi Dam (Nath Sagar Reservoir) on the Godavari River. The map shows the geographical location of the selected villages surrounding the Paithan MIDC (Maharashtra Industrial Development Corporation) area, where the investigation of chemical pollution was undertaken. The study covers nine villages, namely Isarwadi, Wahegaon, Pachalagaon, Mudhalwadi, Narayangaon, Rahatgaon, Karanj Kheda, Katpur, and Pimpalwadi(Pirachi). Sample collection locations are represented by green triangular symbols and are distributed across the villages to ensure spatial coverage of the potentially affected area.

The selected villages lie within proximity to industrial activities and are influenced by local drainage systems and groundwater movement. Their location around the MIDC makes them vulnerable to contamination from industrial effluents and waste disposal practices. The presence of Nath Sagar Reservoir nearby further highlights the environmental significance of the area, as pollution may affect both surface water and groundwater resources. The spatial

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distribution of sampling points enables a comprehensive assessment of the extent and pattern of chemical pollution in the region.

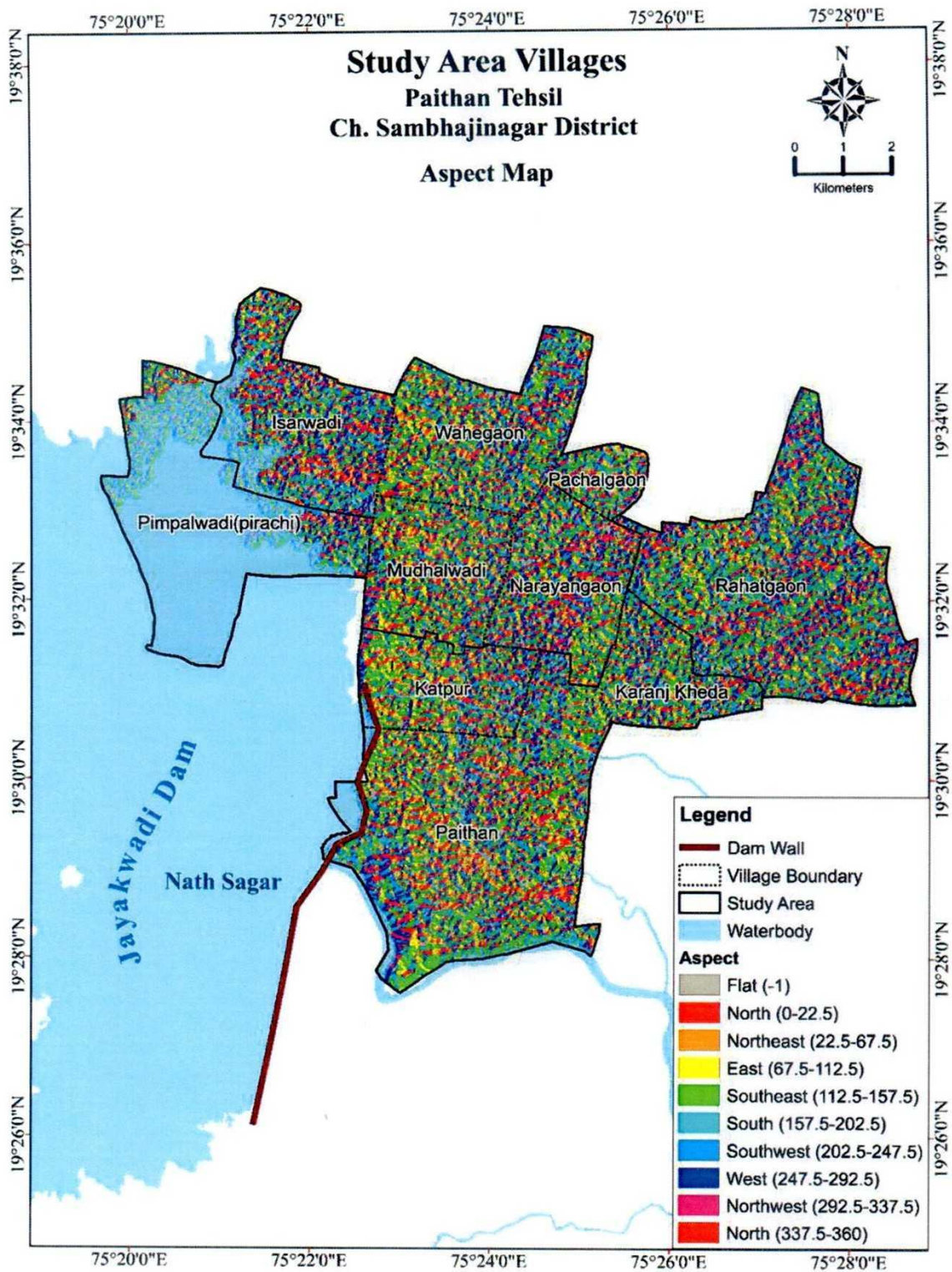


Figure 1.2 Aspect Map of the Study Area

The aspect map of the study area in Paithan Tehsil, Chhatrapati Sambhajanagar District, depicts the direction of slope orientation across the selected villages surrounding the Paithan MIDC. The map classifies terrain into nine aspect categories: flat, north, northeast, east, southeast, south, southwest, west, and northwest-facing slopes. The highly heterogeneous distribution of aspect classes indicates that the area is characterized by gently undulating terrain rather than a uniform slope direction.

No single aspect dominates the landscape, suggesting considerable variation in micro-topography across villages such as Isarwadi, Wahegaon, Mudhalwadi, Narayangaon, Rahatgaon, Karanj Kheda, Katpur, and Pimpalwadi (Pirachi). This variation influences solar radiation, soil moisture retention, surface runoff, and groundwater recharge. In the context of chemical pollution studies, slope orientation plays an important role in determining the movement and accumulation of contaminants. Pollutants transported through runoff may follow different pathways depending on local slope directions, affecting the spatial distribution of contamination. The dispersed sampling locations across multiple aspect classes provide a comprehensive representation of terrain-controlled environmental processes and potential pollutant dispersion patterns in the study area.



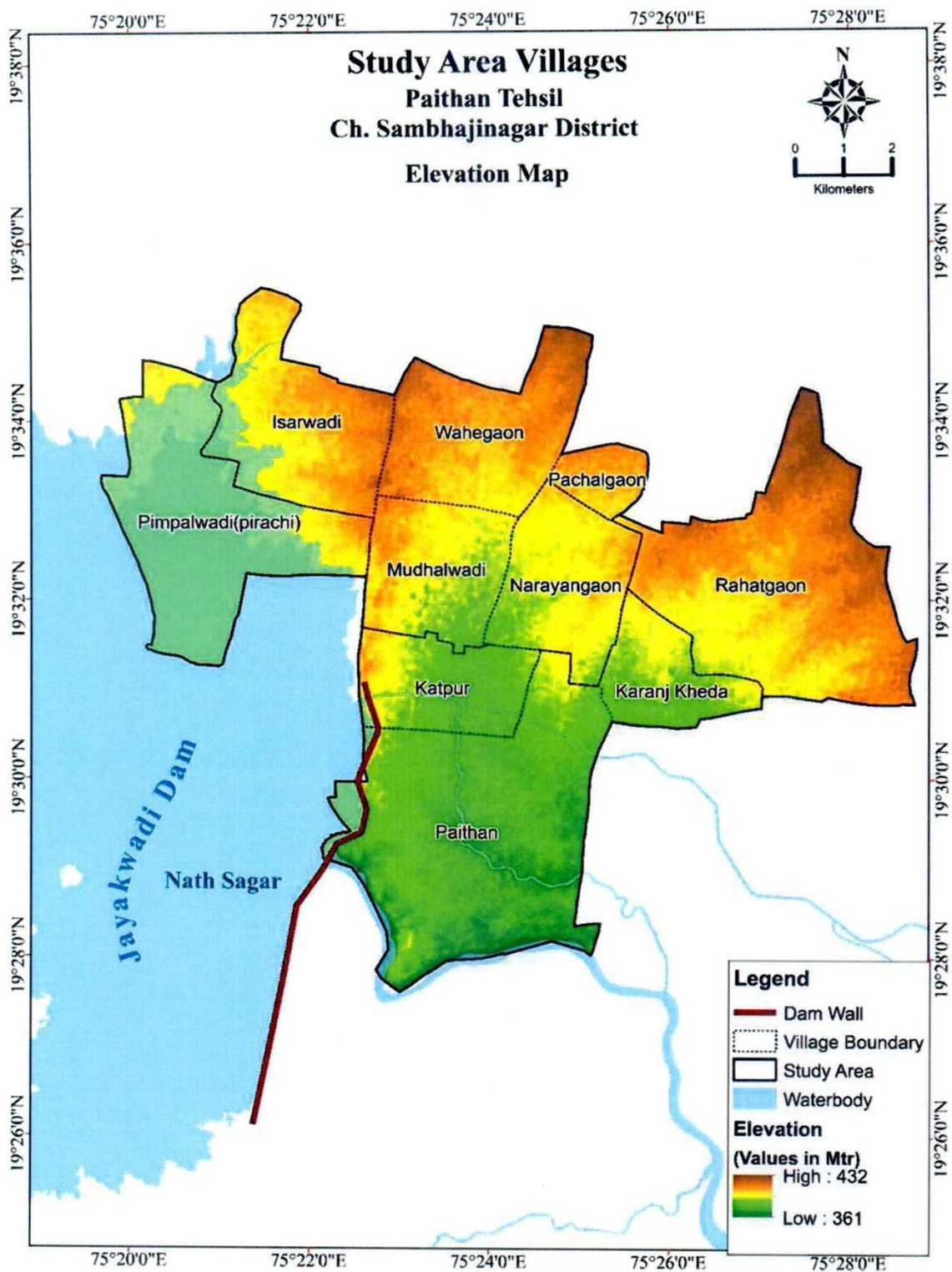


Figure 1.3 Elevation Map of the Study Area

The elevation map of the study area in Paithan Tehsil, Chhatrapati Sambhajinagar District, illustrates the variation in terrain height across the villages surrounding the Paithan MIDC. Elevation ranges from approximately 361 m to 432 m above mean sea level, indicating a

Signature

moderate relief difference of about 71 m within the study area. Higher elevations, represented by yellow to brown shades, are mainly observed in the northern and northeastern parts, including portions of Isarwadi, Wahegaon, Pachalagaon, and Rahatgaon. Lower elevations, shown in green shades, are concentrated in the southern and southwestern areas, particularly around Pimpalwadi (Priachi), Katpur, and Karanj Kheda.

The map suggests a general slope from the higher northern uplands towards the lower southern regions. This topographic gradient influences surface runoff, drainage patterns, groundwater movement, and pollutant transport. In the context of chemical pollution assessment, contaminants may migrate from elevated areas to lower-lying zones, making terrain elevation an important factor in understanding the spatial distribution and accumulation of pollutants across the study area.

The slope map of the study area in Paithan Tehsil, Chhatrapati Sambhajanagar District, depicts the spatial distribution of terrain gradients across the villages surrounding the Paithan MIDC. The slope values range from 0° to 27° , indicating predominantly gentle to moderate topography. Most of the study area is characterized by very gentle slopes ($0-2.9^{\circ}$), represented by dark and light green shades, covering villages such as Wahegaon, Mudhalwadi, Narayangaon, Rahatgaon, Karanj Kheda, Katpur, and Pimpalwadi (Priachi). Areas with moderate slopes ($3-8.2^{\circ}$) occur sporadically and are shown by yellow and orange colours, while steeper slopes ($8.3-27^{\circ}$) are limited to small patches, mainly along the southern and southwestern margins near Paithan and localized elevated zones.

The predominance of gentle slopes indicates favourable conditions for agriculture, groundwater infiltration, and settlement development. From an environmental perspective, low-gradient terrain may facilitate the accumulation of industrial pollutants in soil and water bodies due to slower runoff. Conversely, steeper areas may experience faster surface runoff, increasing the potential transport of contaminants. Therefore, slope characteristics play a significant role in controlling drainage behaviour and the spatial distribution of chemical pollution within the study area.

Priyanka

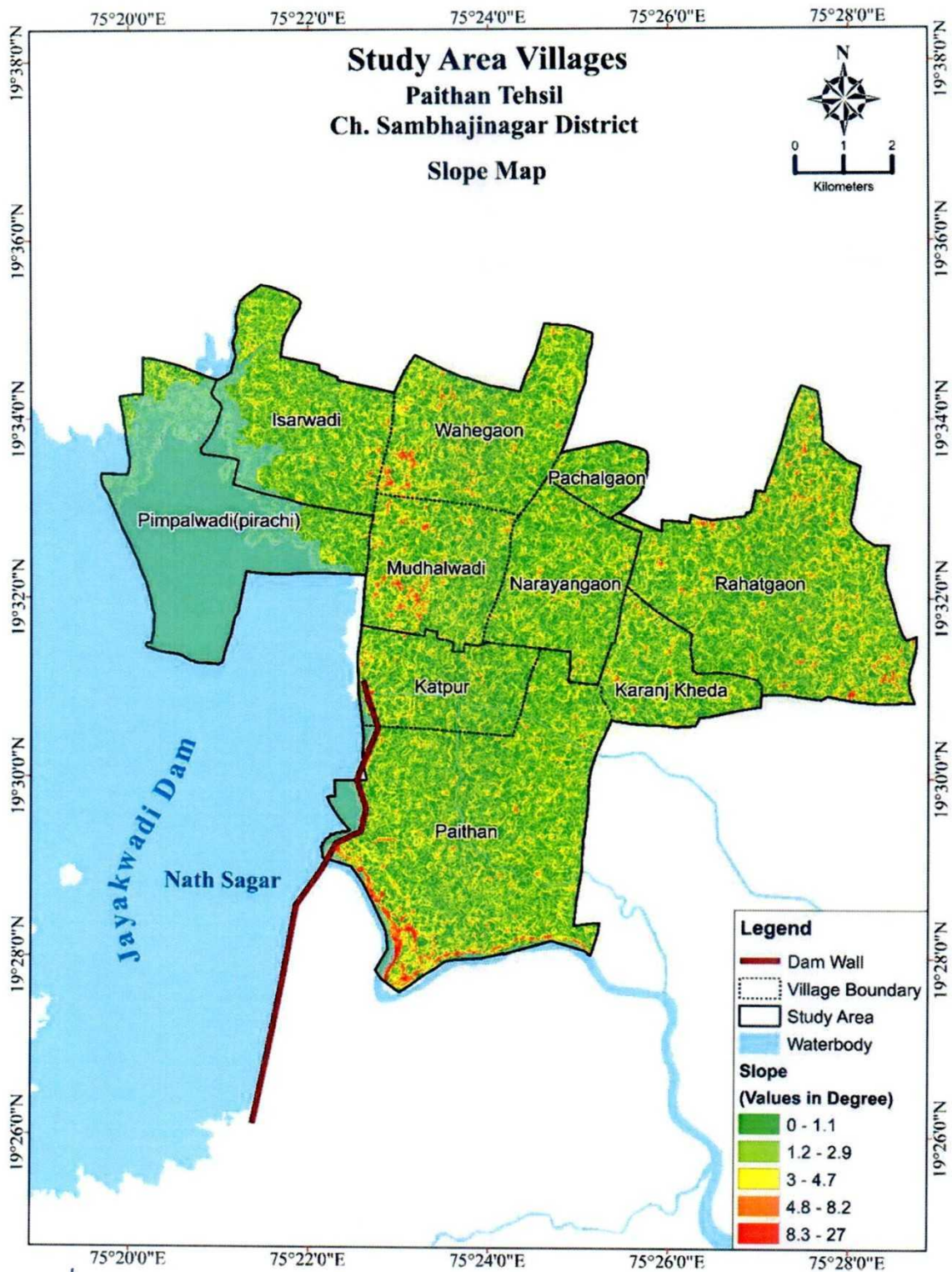


Figure 1.4 Slope Map of the Study Area

ANNEXURE II: Ground Water Analysis.

1. Isarwadi



Name of village			Isarwadi			
Sample collected from			Borewell	Well	Borewell	Well
Unique Identification Number			1	2	3	4
Sr. No	Parameters	Unit				
1	pH @ 25°C		7.43	7.48	7.03	7.33
2	Total Dissolved Solids	mg/l	858	960	1260	1310
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	6
4	Turbidity	NTU	0.92	0.98	<0.10	0.85
5	Total Alkalinity	mg/l	290	300	355	310
6	Chloride	mg/l	116.19	118.63	132.09	177.34
7	BOD	mg/l	9.67	<5.00	<5.00	<5.00
8	COD	mg/l	30.14	<5.00	<5.00	10.05
9	Dissolved Oxygen	mg/l	8.1	5.1	8.6	4.1
10	Hardness (Calcium)	mg/l	345.6	351	523.8	410.4
11	Hardness (Magnesium)	mg/l	248.4	243	221.4	361.8
12	Hardness (Total) as CaCO ₃	lmg/l	594	594	745.2	772.2

Signature

13	Nitrate as NO ₃	mg/	181.76	125.48	199.4	75.64
14	Sulphate as SO ₄	mg/l	107.54	98.99	131.22	203.91
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

Groundwater samples from Isarwadi (Samples 1–4) showed pH within the acceptable range (7.03–7.48). Total Dissolved Solids (858–1310 mg/L) exceeded the acceptable limit at all four locations but remained within the permissible limit. Turbidity, chloride and TSS were within acceptable limits throughout, and Dissolved Oxygen (4.1–8.6 mg/L) was generally adequate. BOD and COD were near the detection limit at Samples 2–4, but Sample 1 recorded a notably elevated BOD (9.67 mg/L) and COD (30.14 mg/L). Calcium hardness (345.6–523.8 mg/L), magnesium hardness (221.4–361.8 mg/L) and Total Hardness as CaCO₃ (594–772.2 mg/L) exceeded their permissible limits at all four locations, with Samples 3 and 4 also exceeding the Total Hardness permissible limit. Nitrate exceeded the acceptable limit of 45 mg/L at all four locations (75.64–199.40 mg/L), and Sample 4 also showed a marginal sulphate exceedance (203.91 mg/L).

Possible causes: The nitrate exceedance at all four locations strongly suggests intensive agricultural activity (fertilizer application and/or livestock waste) around Isarwadi as the dominant influence. The pronounced but relatively uniform hardness exceedance across all samples is most likely predominantly geogenic, reflecting weathering of calcium- and magnesium-bearing minerals typical of the basaltic (Deccan Trap) aquifer in this region, possibly intensified by evaporative concentration during the pre-monsoon period. The relatively moderate chloride and sulphate levels (mostly within acceptable limits) indicate that industrial effluent influence is likely secondary compared with agricultural and natural geogenic contributions in this village. The isolated BOD/COD spike at Sample 1 may point to a localized organic source, such as a nearby soak pit or cattle shed specific to that well rather than a village-wide pattern.

Prinyar

2. Katpur



polymer

Name of village			Katpur			
Sample collected from			Well	Well	Well	Well
Unique Identification Number			5	6	7	8
Sr. No	Parameters	Unit				
1	pH @ 25°C		8.29	8.7	8.54	8.22
2	Total Dissolved Solids	mg/l	812	2850	501	942
3	Total Suspended Solids	mg/l	<5.00	6	<5.00	<5.00
4	Turbidity	NTU	0.32	4.62	4.92	0.18
5	Total Alkalinity	mg/l	265	445	150	242.5
6	Chloride	mg/l	233.84	281.3	77.78	153.14
7	BOD	mg/l	<5.00	9.33	<5.00	<5.00
8	COD	mg/l	<5.00	30.14	9.54	<5.00
9	Dissolved Oxygen	mg/l	3.8	6.4	9.8	4.4
10	Hardness (Calcium)	mg/l	199.8	118.8	86.4	248.4
11	Hardness (Magnesium)	mg/l	264.6	577.8	162	270
12	Hardness (Total) as CaCO ₃	mg/l	464	696.6	248.4	518.4
13	Nitrate as NO ₃	mg/l	10.61	87.14	1.24	36.78
14	Sulphate as SO ₄	mg/l	100.3	1668.79	42.99	130.04
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

pH ranged from 8.22 to 8.70, with Samples 6 (8.70) and 7 (8.54) exceeding the acceptable upper limit of 8.5. TDS ranged from 501 to 2850 mg/L; all four exceeded the acceptable limit, and Sample 6 (2850 mg/L) also exceeded the permissible limit. Turbidity was elevated at Samples 6 and 7 (4.62 and 4.92 NTU, within permissible but above acceptable). Sample 6 stands out sharply: a measured BOD of 9.33 mg/L, COD of 30.14 mg/L, chloride of 281.30 mg/L (marginally exceeding acceptable), magnesium hardness of 577.8 mg/L, Total Hardness of 696.6 mg/L (exceeding permissible), nitrate of 87.14 mg/L, and an exceptionally high sulphate of 1668.79 mg/L over four times the permissible limit. Sample 5 recorded the lowest Dissolved Oxygen (3.8 mg/L), below the reference value of 4 mg/L. Calcium and magnesium hardness exceeded permissible limits at most locations, but Total Hardness exceeded permissible limits only at Sample 6.

guyard

Possible causes: The extreme, multi-parameter exceedance at Sample 6, particularly the very high sulphate combined with elevated BOD and COD is markedly different in character from the other three wells and points toward a localized point-source influence rather than a generalized aquifer condition. Such a combination may indicate seepage of industrial or wastewater effluent into this specific well, possibly via a fracture, unsealed casing, or proximity to a contaminated drain. The moderate nitrate exceedance at the same location suggests agricultural influence is also present, but the magnitude of sulphate and organic-load parameters suggests an anthropogenic/industrial contribution is at least as significant here. The reduced Dissolved Oxygen at Sample 5 may reflect a lesser degree of localized organic loading near that well.

3. Wahegaon



Prigay

Name of village			Wahegaon			
Sample collected from			Well	Borewell	Well	Borewell
Unique Identification Number			9	10	11	12
Sr. No	Parameters	Unit				
1	pH @ 25°C		7.49	7.07	7.21	7.51
2	Total Dissolved Solids	mg/l	4410	2794	5230	1800
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	<5.00
4	Turbidity	NTU	1.16	0.25	0.71	0.68
5	Total Alkalinity	mg/l	295	320	315	292.5
6	Chloride	mg/l	949.07	357	1031.17	270.34
7	BOD	mg/l	36	<5.00	<5.00	<5.00
8	COD	mg/l	110.53	8.48	11.66	7.42
9	Dissolved Oxygen	mg/l	8.8	4.2	7.6	4.6
10	Hardness (Calcium)	mg/l	1317.6	756	1512	588.6
11	Hardness (Magnesium)	mg/l	1036.8	594	1080	421
12	Hardness (Total) as CaCO ₃	mg/l	2354	1350	2592	1009.8
13	Nitrate as NO ₃	mg/l	52.72	149.59	100.12	113.07
14	Sulphate as SO ₄	mg/l	1048	791.59	1406.66	232.35
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

pH (7.07–7.51) was within acceptable limits at all four locations. TDS was severely elevated (1800–5230 mg/L); Samples 9, 10 and 11 exceeded the permissible limit of 2000 mg/L, and Sample 12 exceeded the acceptable limit. Chloride was elevated across the village (270.34–1031.17 mg/L), with Sample 11 (1031.17 mg/L) exceeding the permissible limit and the rest exceeding the acceptable limit. Sample 9 recorded a notably high BOD (36 mg/L) and COD (110.53 mg/L). Dissolved Oxygen (4.2–8.8 mg/L) was adequate throughout. Calcium hardness (588.6–1512 mg/L), magnesium hardness (421–1080 mg/L) and Total Hardness as CaCO₃ (1009.8–2592 mg/L) exceeded permissible limits by up to roughly 3 to 11 times at all four locations. Nitrate (52.72–149.59 mg/L) exceeded the acceptable limit at all four locations (1.2

Prigay

to 3.3 times), and sulphate exceeded the permissible limit at Samples 9, 10 and 11 (1048, 791.59 and 1406.66 mg/L).

Possible causes: The near-universal and severe exceedance of TDS, hardness, chloride and sulphate across all four samples reaching several times the permissible limits suggests a generalized, aquifer-wide mineralization issue rather than an isolated point source. While geogenic enrichment from the basaltic aquifer and evaporative concentration during the pre-monsoon period likely contribute to the baseline hardness, the consistently elevated chloride and sulphate at all four wells (parameters that are relatively conservative tracers of wastewater/effluent influence) also raise the possibility of a broader anthropogenic contribution for instance, prolonged irrigation with contaminated water or diffuse effluent infiltration accumulated over time. The universal nitrate exceedance further points to significant agricultural fertilizer influence across the village. The isolated, very high BOD and COD at Sample 9 stands apart and likely reflects a localized organic source specific to that well.



4. Pachalgaon



Name of village			Pachalgaon			
Sample collected from			Borewell	Well	Well	Borewell
Unique Identification Number			13	14	15	16
Sr. No	Parameters	Unit				
1	pH @ 25°C		7.32	8.11	8.07	8.29
2	Total Dissolved Solids	mg/l	1458	898	1298	1310
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	<5.00
4	Turbidity	NTU	1.55	1.21	0.56	0.32
5	Total Alkalinity	mg/l	255	180	207	280
6	Chloride	mg/l	265.45	146.76	196.53	242.16
7	BOD	mg/l	<5.00	<5.00	<5.00	<5.00
8	COD	mg/l	5.3	<5.00	5.3	<5.00

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9	Dissolved Oxygen	mg/l	10.6	8.4	8.6	8.4
10	Hardness (Calcium)	mg/l	432	340.2	378	442.8
11	Hardness (Magnesium)	mg/l	351	270	324	280.8
12	Hardness (Total) as CaCO ₃	mg/l	783	610.2	702	723.6
13	Nitrate as NO ₃	mg/l	78.26	29.24	59.77	68.72
14	Sulphate as SO ₄	mg/l	136.68	110.12	332.98	102.13
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

pH (7.32–8.29) was within acceptable limits at all four locations. TDS (898–1458 mg/L) exceeded the acceptable but remained within the permissible limit at all locations. Turbidity was marginally elevated at Samples 13 and 14 (1.55 and 1.21 NTU). Chloride exceeded the acceptable limit only at Sample 13 (265.45 mg/L). BOD was at or below the detection limit throughout, and Dissolved Oxygen (8.4–10.6 mg/L) was consistently good. Calcium hardness (340.2–442.8 mg/L), magnesium hardness (270–351 mg/L) and Total Hardness as CaCO₃ (610.2–783 mg/L) exceeded permissible limits at all four locations, generally by a factor of 1 to 2. Nitrate exceeded the acceptable limit at three of four locations Samples 13, 15 and 16 (78.26, 59.77 and 68.72 mg/L) while Sample 14 (29.24 mg/L) was within limits. Sulphate remained within acceptable limits except at Sample 15 (332.98 mg/L), which exceeded acceptable but remained within permissible.

Possible causes: The consistent hardness exceedance across all four samples, generally in the range of 1 to 2 times the permissible limit, is most likely predominantly geogenic, reflecting the basaltic aquifer character of the region, particularly since chloride and sulphate remained largely within acceptable limits at most locations indicating industrial influence is likely minimal here. The nitrate exceedance at three of four locations points toward agricultural fertilizer application as the most probable contributing factor, consistent with the predominantly agrarian land use around Pachalgaon. The absence of any BOD/COD exceedance and consistently high Dissolved Oxygen suggest minimal organic or sewage-related contamination in this village's groundwater.

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5. Narayangaon



Pritya

Name of village			Narayangaon			
Sample collected from			Borewell	Borewell	Borewell	Borewell
Unique Identification Number			17	18	19	20
Sr. No	Parameters	Unit				
1	pH @ 25°C		7.2	8.47	8.14	7.98
2	Total Dissolved Solids	mg/l	5860	760	6210	6700
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	<5.00
4	Turbidity	NTU	1.34	6.6	1.77	0.26
5	Total Alkalinity	mg/l	287.5	217.5	277.5	425
6	Chloride	mg/l	1123.06	91.89	934.39	1368.09
7	BOD	mg/l	5.6	<5.00	<5.00	<5.00
8	COD	mg/l	16.96	8.48	<5.00	<5.00
9	Dissolved Oxygen	mg/l	3.6	8.2	6.9	8.4
10	Hardness (Calcium)	mg/l	1404	259.2	1134	972
11	Hardness (Magnesium)	mg/l	2106	205.2	1819.8	3456
12	Hardness (Total) as CaCO ₃	mg/l	3510	464	2953.8	4428
13	Nitrate as NO ₃	mg/l	78.26	29.24	59.77	68.72
14	Sulphate as SO ₄	mg/l	136.68	110.12	332.98	102.13
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

pH (7.20–8.47) was within acceptable limits at all four locations, though Sample 18 was close to the upper limit. TDS was severely elevated: Samples 17, 19 and 20 (5860, 6210 and 6700 mg/L) exceeded the permissible limit by up to 3.35 times, while Sample 18 (760 mg/L) exceeded only the acceptable limit. Turbidity exceeded the permissible limit at Sample 18 (6.6 NTU) and the acceptable limit at Samples 17 and 19. Chloride exceeded the permissible limit at Samples 17 and 20 (1123.06 and 1368.09 mg/L) and the acceptable limit at Sample 19 (934.39 mg/L), while Sample 18 (91.89 mg/L) was within limits. Sample 17 recorded a Dissolved Oxygen of 3.6 mg/L (below the reference value of 4 mg/L) and a slightly elevated BOD (5.6 mg/L). Hardness values were the most extreme in the entire study: calcium hardness up to 1404 mg/L, magnesium hardness up to 3456 mg/L (nearly 35 times the permissible limit, at Sample 20), and Total Hardness up to 4428 mg/L at Samples 17, 19 and 20. Nitrate exceeded the acceptable limit only at Sample 18 (63.74 mg/L). Sulphate exceeded the permissible limit

at Samples 17, 19 and 20 (1043.21, 2182.03 and 600.61 mg/L), with Sample 19 reaching nearly 5.5 times the limit.

Possible causes: The magnitude and co-occurrence of extreme TDS, hardness, chloride and sulphate at Samples 17, 19 and 20 suggest that natural geogenic weathering alone may not fully account for these values, and that a significant external contribution potentially industrial effluent infiltration, evaporite-rich return flows from irrigation, or long-term accumulation of saline/sulphate-rich discharge in the shallow aquifer cannot be ruled out and required further investigation (e.g., hydrochemical fingerprinting to distinguish geogenic from anthropogenic sources). Sample 18, by contrast, shows comparatively moderate TDS and hardness but the highest nitrate (63.74 mg/L) among the four, suggesting this particular well may be more influenced by agricultural runoff than by whatever source is affecting the other three. The reduced Dissolved Oxygen and slightly elevated BOD at Sample 17 further point toward some degree of organic loading at that location, on top of its mineral-related exceedances.

Wingard

6. Rahatgaon



Name of village			Rahatgaon			
Sample collected from			Well	Well	Well	Well
Unique Identification Number			51	52	53	54
Sr. No	Parameters	Unit				
1	pH @ 25°C		7.55	8.24	8.28	8.53
2	Total Dissolved Solids	mg/l	780	770	878	560
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	28
4	Turbidity	NTU	1.89	1.02	0.91	10.66
5	Total Alkalinity	mg/l	207.5	205	280	150
6	Chloride	mg/l	92.14	103.12	111.54	74.02
7	BOD	mg/l	<5.00	<5.00	<5.00	5.4
8	COD	mg/l	<5.00	<5.00	8.48	16.69
9	Dissolved Oxygen	mg/l	6.7	6.2	7.8	6.4

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10	Hardness (Calcium)	mg/l	318.6	226.8	183.6	113.4
11	Hardness (Magnesium)	mg/l	167.4	226.8	286.2	135
12	Hardness (Total) as CaCO ₃	mg/l	486	453.6	469.8	248.4
13	Nitrate as NO ₃	mg/l	77.87	69.66	111.53	4.66
14	Sulphate as SO ₄	mg/l	139.57	41.43	59.47	43.36
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

pH (7.55–8.53) was within acceptable limits except Sample 54 (8.53), marginally above 8.5. TDS (560–878 mg/L) exceeded the acceptable but remained within permissible limits at all four locations. Turbidity exceeded the permissible limit at Sample 54 (10.66 NTU), which also recorded the highest TSS (28 mg/L); Samples 51 and 52 exceeded only the acceptable limit. Chloride was within acceptable limits throughout (74.02–111.54 mg/L). Sample 54 recorded a measured BOD of 5.4 mg/L (slightly exceeding the reference level), while the other three were at or below the detection limit. Dissolved Oxygen (6.2–7.8 mg/L) was adequate throughout. Calcium hardness exceeded the permissible limit at Samples 51 and 52 (318.6 and 226.8 mg/L), and magnesium hardness exceeded the permissible limit at all four locations (135–286.2 mg/L). Nitrate exceeded the acceptable limit at Samples 51, 52 and 53 (77.87, 69.66 and 111.53 mg/L), while Sample 54 (4.66 mg/L) was well within limits. Sulphate remained within acceptable limits throughout.

Possible causes: The elevated nitrate concentrations at Samples 51, 52 and 53 (1.5 to 2.5 times the acceptable limit), combined with the relatively moderate chloride and sulphate levels at the same locations, strongly suggest agricultural activity particularly nitrogenous fertilizer use as the dominant influence on groundwater quality in Rahatgaon, with industrial influence likely secondary. Sample 54, however, presents a markedly different profile elevated pH, the highest turbidity and TSS in the village, a measured BOD exceedance, but the lowest nitrate which may indicate this particular well is influenced by surface water ingress or sediment disturbance (e.g., a poorly sealed casing) rather than the agricultural leaching pattern affecting the other three wells. The generally moderate hardness across the village (mostly "warn" rather than severe exceedance) suggests a comparatively less mineral-enriched aquifer zone relative to villages such as Wahegaon and Narayangaon.

P. Singh

7. Karajkheda



Name of village			Karaj kheda			
Sample collected from			Borewell	Well	Borewell	Well
Unique Identification Number			55	56	57	58
Sr. No	Parameters	Unit				
1	pH @ 25°C		8.56	8.64	7.8	8.67
2	Total Dissolved Solids	mg/l	1630	622	542	659
3	Total Suspended Solids	mg/l	<5.00	<5.0	8	<5.00
4	Turbidity	NTU	0.52	2.38	6	2.6
5	Total Alkalinity	mg/l	505.5	200	185	217.5
6	Chloride	mg/l	206.74	105.18	74.36	107.36
7	BOD	mg/l	<5.00	<5.00	6.4	<5.00
8	COD	mg/l	<5.00	5.3	20.1	<5.00

psigora

9	Dissolved Oxygen	mg/l	5	6.6	6.4	6.4
10	Hardness (Calcium)	mg/l	340.2	113.4	129.6	172.8
11	Hardness (Magnesium)	mg/l	561.6	237.6	91.8	270
12	Hardness (Total) as CaCO ₃	mg/l	901.8	351	221.4	442.8
13	Nitrate as NO ₃	mg/l	82.35	35.09	4.17	70.86
14	Sulphate as SO ₄	mg/l	420.39	1.92	47.92	19.62
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

pH (7.80–8.67) exceeded the acceptable upper limit of 8.5 at Samples 55, 56 and 58; only Sample 57 (7.80) was within range. TDS (542–1630 mg/L) exceeded the acceptable but remained within permissible limits at all four locations. Turbidity exceeded the permissible limit at Sample 57 (6.0 NTU) and the acceptable limit at Samples 56 and 58 (2.38 and 2.6 NTU). Chloride was within acceptable limits throughout (74.36–206.74 mg/L). Sample 57 recorded a measured BOD of 6.4 mg/L and the highest COD (20.1 mg/L) in the village. Dissolved Oxygen (5.0–6.6 mg/L) was adequate. Sample 55 recorded the highest values for several parameters: Total Alkalinity (505.5 mg/L), calcium hardness (340.2 mg/L, exceeding permissible), Total Hardness (901.8 mg/L, exceeding permissible), nitrate (82.35 mg/L, exceeding acceptable), and the village's only sulphate exceedance (420.39 mg/L, marginally above permissible). Magnesium hardness exceeded the permissible limit at Samples 55, 56 and 58 (561.6, 237.6 and 270 mg/L). Sample 58 also recorded an elevated nitrate (70.86 mg/L).

Possible causes: Sample 55 shows the most comprehensive exceedance profile in Karajkheda elevated pH, TDS, alkalinity, all three hardness parameters, nitrate, and the village's only sulphate exceedance — suggesting this borewell may be drawing from a zone with both higher natural mineral content and some anthropogenic input, possibly agricultural return flow given the concurrent nitrate exceedance. The nitrate exceedances at Samples 55 and 58, without corresponding chloride exceedances, again point toward fertilizer-derived nitrate as the more probable cause rather than sewage or industrial nitrogen sources, which would typically be accompanied by elevated chloride. The localized turbidity exceedance and measured BOD/COD at Sample 57 suggest a degree of organic and particulate loading specific to that well, potentially from surface infiltration through a compromised casing.

Prigard

8. Pimpalwadi



Name of village			Pimpalwadi		
Sample collected from			Well	borewell	borewell
Unique Identification Number			59	60	61
Sr. No	Parameters	Unit			
1	pH @ 25°C		7.97	7.8	7.98
2	Total Dissolved Solids	mg/l	1190	1050	990
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00
4	Turbidity	NTU	2.37	1.06	1.02
5	Total Alkalinity	mg/l	165	267.5	205
6	Chloride	mg/l	191.43	163.35	141.66
7	BOD	mg/l	<5.00	<5.00	<5.00
8	COD	mg/l	<5.00	<5.00	<5.00
9	Dissolved Oxygen	mg/l	9.2	4.6	7
10	Hardness (Calcium)	mg/l	480.6	437.4	226.8

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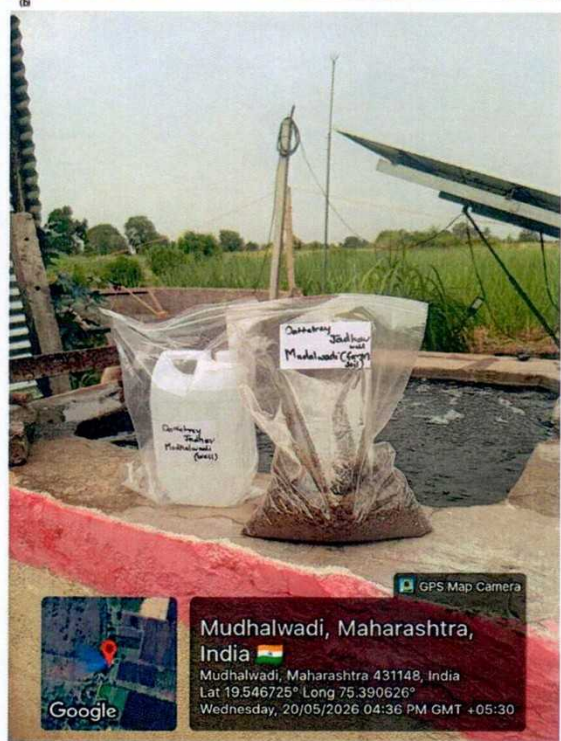
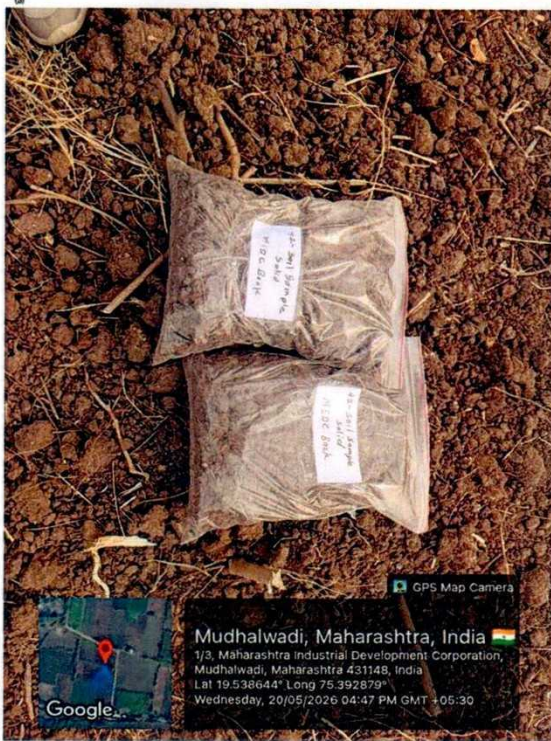
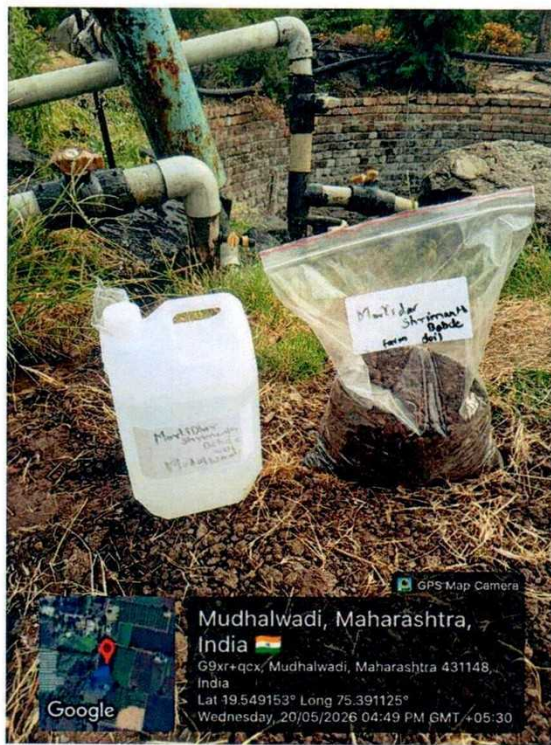
11	Hardness (Magnesium)	mg/l	232.2	248.4	226.8
12	Hardness (Total) as CaCO ₃	mg/l	712.8	685.8	453.6
13	Nitrate as NO ₃	mg/l	66.82	64.95	69.66
14	Sulphate as SO ₄	mg/l	199.48	132.13	66.72
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00

pH (7.80–7.98) was within acceptable limits at all three locations. TDS (990–1190 mg/L) exceeded the acceptable but remained within permissible limits. Turbidity (1.02–2.37 NTU) exceeded the acceptable but remained within permissible limits at all three. Chloride was within acceptable limits throughout (141.66–191.43 mg/L). BOD and COD were at or below the detection limit at all three locations, with Dissolved Oxygen (4.6–9.2 mg/L) adequate throughout. Calcium hardness (226.8–480.6 mg/L) and magnesium hardness (226.8–248.4 mg/L) exceeded permissible limits at all three locations. Total Hardness exceeded the permissible limit at Samples 59 and 60 (712.8 and 685.8 mg/L), while Sample 61 (453.6 mg/L) exceeded only the acceptable limit. Nitrate exceeded the acceptable limit at all three locations, falling within a narrow range of 64.95 to 69.66 mg/L (approximately 1.4 to 1.55 times the limit). Sulphate remained within acceptable limits, with Sample 59 (199.48 mg/L) close to the threshold.

Possible causes: Pipalwadi shows a remarkably uniform contamination pattern across all three samples. TDS, turbidity, hardness and nitrate exceed their respective limits to a broadly similar degree at every location, with nitrate in particular falling within a tight range across all three wells. This consistency suggests a relatively homogeneous, village-wide influence rather than a localized point source, and is consistent with widespread agricultural fertilizer application affecting the shallow aquifer uniformly across Pipalwadi. The elevated hardness, similarly consistent across all three samples, is likely predominantly geogenic given the absence of any corresponding chloride or BOD/COD exceedance that would suggest an industrial or sewage source.

Pipalwadi

9. Mudhalwadi



Pritya

Name of village			Mudhalwadi			
Sample collected from			Well	Well	Well	Well
Unique Identification Number			62	63	64	65
Sr. No	Parameters	Unit				
1	pH @ 25°C		8.34	8.68	7.5	7.29
2	Total Dissolved Solids	mg/l	1810	1880	1720	1210
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	<5.00
4	Turbidity	NTU	1.3	1.82	<0.10	0.84
5	Total Alkalinity	mg/l	377.5	175	372.5	262.5
6	Chloride	mg/l	449.22	500.27	324.15	1163.89
7	BOD	mg/l	<5.00	6.8	<5.00	13.78
8	COD	mg/l	<5.00	21.2	7.42	42.4
9	Dissolved Oxygen	mg/l	7.4	4	7	7
10	Hardness (Calcium)	mg/l	388.8	361.8	567	1242
11	Hardness (Magnesium)	mg/l	388.8	388.8	534.6	1080
12	Hardness (Total) as CaCO ₃	mg/l	777.6	750.6	1101.6	2322
13	Nitrate as NO ₃	mg/l	26.55	<1.00	12.93	60.53
14	Sulphate as SO ₄	mg/l	121.66	192.56	274.82	592.69
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

Name of village			Mudhalwadi			
Sample collected from			Well	Well	Well	Borewell
Unique Identification Number			66	67	68	69
Sr. No	Parameters	Unit				
1	pH @ 25°C		7.17	7.76	7.51	7.16
2	Total Dissolved Solids	mg/l	4590	1510	1380	2210
3	Total Suspended Solids	mg/l	<5.00	<5.00	<5.00	56

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4	Turbidity	NTU	1.48	0.12	1.3	5.26
5	Total Alkalinity	mg/l	277.5	310	267.5	415
6	Chloride	mg/l	770.82	334.36	311.39	484.32
7	BOD	mg/l	<5.00	<5.00	<5.00	10.91
8	COD	mg/l	9.54	5.3	10.6	34.98
9	Dissolved Oxygen	mg/l	9.4	9.2	4.6	8.4
10	Hardness (Calcium)	mg/l	1188	437.4	410.4	583.2
11	Hardness (Magnesium)	mg/l	1296	372.6	340.2	766.8
12	Hardness (Total) as CaCO ₃	mg/l	2484	810	750.6	1350
13	Nitrate as NO ₃	mg/l	49.66	1.91	8.1	71.67
14	Sulphate as SO ₄	mg/l	1163.13	240.74	76.43	394.23
15	Oil & Grease	mg/l	<10.00	<10.00	<10.00	<10.00

This was the largest sample set (nine locations) in the study. pH (6.71–8.68) exceeded the acceptable upper limit only at Sample 63 (8.68). TDS (1210–4590 mg/L) exceeded the acceptable limit at all nine locations; Samples 66, 69 and 71 (4590, 2210 and 4000 mg/L) also exceeded the permissible limit. Turbidity exceeded the permissible limit at Sample 69 (5.26 NTU) and the acceptable limit at Samples 62, 63, 66, 68 and 71. Chloride exceeded the permissible limit only at Sample 65 (1163.89 mg/L); all others exceeded the acceptable but remained within permissible limits. BOD exceeded the reference level with measured values at Sample 63 (6.8 mg/L), Sample 65 (13.78 mg/L) and Sample 69 (10.91 mg/L); the remaining six were at or below detection. COD was also notably elevated at Samples 65 and 69 (42.4 and 34.98 mg/L). Dissolved Oxygen (4.0–9.4 mg/L) was adequate throughout. Hardness exceeded permissible limits universally — calcium hardness (361.8–1242 mg/L), magnesium hardness (340.2–1296 mg/L) and Total Hardness (750.6–2484 mg/L) — at all nine locations, with Samples 65, 66 and 71 the most severe (Total Hardness 2322, 2484 and 2376 mg/L, up to 4.1 times the permissible limit). Nitrate exceeded the acceptable limit at Samples 65, 66 and 69 (60.53, 49.66 and 71.67 mg/L). Sulphate exceeded the permissible limit at Samples 65 and 66 (592.69 and 1163.13 mg/L), and the acceptable limit at Samples 64, 67 and 69.

Possible causes: The universal hardness exceedance across all nine samples likely reflects a geogenic baseline typical of the basaltic aquifer in this region; however, the more severely affected wells — Samples 65, 66, 69 and 71 — also show elevated chloride, sulphate,

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BOD/COD and (for 65, 66 and 69) nitrate, suggesting an additional anthropogenic loading at these specific locations, possibly linked to infiltration from the BB Chemicals drainage outlet sampled separately within this village, given Mudhalwadi's proximity to it. The co-occurrence of elevated chloride, sulphate, organic-load parameters and nitrate at Samples 65 and 66 (rather than nitrate alone) suggests these wells may be receiving a mixed agricultural-and-wastewater influence rather than agricultural fertilizer alone. By contrast, Samples 62, 64, 67 and 68 show comparatively lower nitrate, chloride and sulphate alongside the same hardness exceedance, supporting a primarily geogenic hardness baseline with localized anthropogenic "hotspots" at specific wells. Sample 69's high turbidity and TSS alongside elevated BOD/COD/nitrate suggest this borewell may have a compromised casing allowing surface ingress, while Sample 71's profile (high TDS/hardness/sulphate but low nitrate/BOD) is more consistent with a mineral-rich or inorganic discharge influence than an agricultural one.

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10. Jayakwadi Dam, Nath Sagar Reservoir

1



2





Paithan, Maharashtra, India 🇮🇳

Near Jayakwadi Dam, Sant Dnyaneshwar Udyaan, Paithan, Maharashtra 431107, India

Lat 19.489543° Long 75.374606° (Photo 1)

Lat 19.489556° Long 75.3746° (Photo 2)

Friday, 22/05/2026 12:17 PM GMT +05:30 (Photo 1)

Friday, 22/05/2026 12:13 PM GMT +05:30 (Photo 2)

GPS Map Camera



25° NE

1 Soil sample – Sample 25 (collected from reservoir shoreline)

2 Soil sample – Sample 25 (collected in reservoir water)

Pringal

Name of Location			Jayyakadi Dam
Sample collected from			Reservoir
Unique Identification Number			25
Sr. No	Parameters	Unit	
1	pH @ 25°C		8.49
2	Total Dissolved Solids	mg/l	501
3	Total Suspended Solids	mg/l	<5.00
4	Turbidity	NTU	3.35
5	Total Alkalinity	mg/l	155
6	Chloride	mg/l	77.3
7	BOD	mg/l	<5.00
8	COD	mg/l	10.05
9	Dissolved Oxygen	mg/l	10.8
10	Hardness (Calcium)	mg/l	124.2
11	Hardness (Magnesium)	mg/l	145.8
12	Hardness (Total) as CaCO ₃	mg/l	270
13	Nitrate as NO ₃	mg/l	<1.00
14	Sulphate as SO ₄	mg/l	49.85
15	Oil & Grease	mg/l	<10.00

The water sample collected from Jayakwadi Dam (Nath Sagar), used as the reference surface water source for this study, recorded pH 8.49, within the acceptable range. Total Dissolved Solids was 501 mg/L, marginally exceeding the acceptable limit of 500 mg/L for drinking water but remaining well within the permissible limit of 2000 mg/L. Total Suspended Solids was below the detection limit (less than 5.00 mg/L) and Turbidity was 3.35 NTU, within the permissible limit of 5 NTU though exceeding the acceptable limit of 1 NTU. Total Alkalinity was 155 mg/L and Chloride was 77.30 mg/L, well within acceptable limits. BOD was below the detection limit (less than 5.00 mg/L) and COD was 10.05 mg/L, both indicating good organic water quality consistent with a large, relatively unimpacted surface water reservoir. Dissolved Oxygen was 10.80 mg/L, the highest value recorded across the entire study and indicative of healthy, well-oxygenated surface water. Calcium hardness was 124.20 mg/L, Magnesium hardness was 145.80 mg/L and Total Hardness as CaCO₃ was 270 mg/L, all within

acceptable limits. Nitrate as NO₃ was below the detection limit (less than 1.00 mg/L). Sulphate was 49.85 mg/L. Oil and grease were below the detection limit (less than 10.00 mg/L). The Jayakwadi Dam sample shows good overall water quality across nearly all physicochemical parameters and serves as an appropriate background reference for the study area, confirming the reservoir itself is not significantly impacted by the surrounding industrial or agricultural activity at the time of sampling. The high Dissolved Oxygen (10.80 mg/L) and low BOD and COD values confirm minimal organic pollution loading in the reservoir. The marginal exceedance of TDS and turbidity above their acceptable limits is minor and likely reflects natural background mineralisation and seasonal sediment load rather than anthropogenic impact. The comparatively low hardness, chloride and sulphate values at this site, when contrasted against the severely elevated values recorded in several groundwater samples from villages such as Wahegaon, Narayangaon and Mudhalwadi, reinforce that those groundwater exceedances are not attributable to the regional surface water source and instead point toward localized contamination pathways specific to those villages, whether geogenic, agricultural or industrial in origin.

11. MIDC Backside



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Name of Location			MIDC Backside	
Sample collected from			Square well	well water
Unique Identification Number			23	71
Sr. No	Parameters	Unit		
1	pH @ 25°C		6.93	6.71
2	Total Dissolved Solids	mg/l	6552	4000
3	Total Suspended Solids	mg/l	224	12
4	Turbidity	NTU	2067.44	1.18
5	Total Alkalinity	mg/l	17.3	320
6	Chloride	mg/l	420	939.28
7	BOD	mg/l	8	<5.00
8	COD	mg/l	24.38	<5.00
9	Dissolved Oxygen	mg/l	1.2	7
10	Hardness (Calcium)	mg/l	1674	1134
11	Hardness (Magnesium)	mg/l	1674	1242
12	Hardness (Total) as CaCO ₃	mg/l	3348	2376
13	Nitrate as NO ₃	mg/l	5.45	9.49
14	Sulphate as SO ₄	mg/l	937.69	132.29
15	Oil & Grease	mg/l	<10.00	<10.00

This single sample recorded a pH of 6.93 (within acceptable limits), but the most severe overall contamination profile of any groundwater location in the study. TDS (6552 mg/L) exceeded the permissible limit by over three times. Turbidity (2067.44 NTU) was extraordinarily elevated over 400 times the permissible limit of 5 NTU and TSS (224 mg/L) was also far higher than at any other groundwater location. Chloride (420 mg/L) exceeded the acceptable but remained within permissible limits. BOD (8 mg/L) was a measured exceedance of the reference level. Dissolved Oxygen was critically low at 1.2 mg/L. Calcium hardness, magnesium hardness and Total Hardness (1674, 1674 and 3348 mg/L) all substantially exceeded their permissible limits (by 8.4, 16.7 and 5.6 times respectively). Nitrate (5.45 mg/L) was within limits, but sulphate (937.69 mg/L) exceeded the permissible limit by more than double.

Signature

Possible causes: The exceptionally high turbidity and TSS, combined with critically low Dissolved Oxygen and a measured BOD exceedance, together describe a sample that behaves more like surface drain water or a stagnant water body than typical confined groundwater, possibly indicating direct hydraulic connectivity between this well and a nearby surface drain, or structural deterioration of the well allowing ingress of turbid surface runoff and organic matter. Given the location's proximity to the MIDC industrial estate, the very high TDS, hardness and sulphate without a corresponding nitrate exceedance raise the possibility of industrial effluent or leachate influence at this location, distinct from the predominantly agricultural/geogenic pattern seen elsewhere. Given the unusual magnitude of these values, re-sampling and verification of this location is recommended.

12. BB Chemicals: Drainage Line Outside Compound Wall



Name of Location			BB Chemicals
Sample collected from			Drain Out line
Unique Identification Number			71
Sr. No	Parameters	Unit	

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1	pH @ 25°C		9.67
2	Total Dissolved Solids	mg/l	3060
3	Total Suspended Solids	mg/l	940
4	Turbidity	NTU	49
5	Total Alkalinity	mg/l	1200
6	Chloride	mg/l	949.49
7	BOD	mg/l	10000
8	COD	mg/l	30144
9	Dissolved Oxygen	mg/l	8.9
10	Hardness (Calcium)	mg/l	378
11	Hardness (Magnesium)	mg/l	324
12	Hardness (Total) as CaCO ₃	mg/l	702
13	Nitrate as NO ₃	mg/l	65.06
14	Sulphate as SO ₄	mg/l	490.1
15	Oil & Grease	mg/l	10

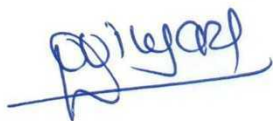
The water sample collected from the open drainage line (gutter) outside the BB Chemicals compound wall recorded pH 9.67, exceeding the acceptable effluent discharge range of 5.5 to 9.0. Total Dissolved Solids was 3060 mg/L and Total Suspended Solids was 940 mg/L, both substantially exceeding the effluent discharge limit of 100 mg/L for TSS. Turbidity was 49 NTU. Total Alkalinity was 1200 mg/L, an extremely high value. Chloride was 949.49 mg/L. BOD was 10,000 mg/L and COD was 30,144 mg/L, both representing the most extreme organic pollution load, far exceeding the CPCB Schedule VI discharge limits of 30 mg/L (BOD) and 250 mg/L (COD) by several orders of magnitude. Dissolved Oxygen was 8.90 mg/L. Calcium hardness was 378 mg/L, Magnesium hardness was 324 mg/L and Total Hardness as CaCO₃ was 702 mg/L. Nitrate as NO₃ was 65.06 mg/L. Sulphate was 490.10 mg/L. Oil and Grease was 10 mg/L, at the effluent discharge limit.

Signature

The BB Chemicals drainage sample represents the single most severely contaminated water sample collected in this entire study. The BOD of 10,000 mg/L and COD of 30,144 mg/L indicate an extremely high concentration of biodegradable and non-biodegradable organic pollutants being discharged directly into an open drain accessible outside the factory compound, with no evidence of any treatment prior to discharge. The alkaline pH (9.67) combined with very high Total Alkalinity (1200 mg/L) suggests the effluent may originate from an alkaline chemical process, such as saponification, neutralisation using lime or caustic soda, or an alkaline cleaning or extraction process. The presence of measurable Nitrate (65.06 mg/L) alongside the extreme organic load suggests the effluent may also carry nitrogenous chemical residues, possibly from nitrogen-containing intermediates or reagents used in the manufacturing process. Given that this drain is located outside the compound wall and directly accessible to the surrounding environment, and considering its proximity to multiple groundwater sampling locations.

Conclusion

The groundwater quality assessment indicates that industrial activities have likely contributed to elevated TDS, chloride, hardness, and sulphate concentrations in villages such as Narayangaon, Wahegaon, Mudhalwadi, MIDC Back Area. Whereas nitrate contamination observed in Isarwadi, Pachalgaon, Pipalwadi, Rahatgaon, and Karajkheda is primarily attributable to agricultural runoff and domestic wastewater infiltration. The spatial distribution of contaminants suggests that both industrial and agricultural activities are influencing groundwater quality; however, industrial impacts become increasingly evident through elevated salinity indicators (TDS, chloride, and sulphate) in villages located closer to the industrial estate. This indicates continued groundwater monitoring and implementation of appropriate pollution control measures.



ANNEXURE III - Soil Analysis

1. Isarwadi

Name of village			Isarwadi			
Unique Identification Number			S2	S4	S11	S61
Sr. No	Parameters	Unit				
1	pH	-	7.64	8.26	7.73	8.01
2	Electrical Conductivity	mS/cm	1114	1213	888	843
3	Organic Content	%	0.92	1.75	4.11	1.48
4	Available Phosphorous	%	238.81	58.98	902.3	166.4
5	Available Potassium	Kg/ha	45.63	41.4	201.88	375.83
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	8.53	27.68	14.98	13.42
8	Nitrate Nitrogen	%	21.84	18.78	93.38	50.03
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	<0.50	11.01	<0.50	7.95
11	Nickel Content	mg/Kg	46.32	38.59	35.63	32.52
12	Copper Content	mg/Kg	77.75	49.48	75.97	81.56
13	Magnesium	mg/Kg	11294.32	16385.05	13753.35	16082
14	Sodium	mg/Kg	479.25	671.41	299.95	605.28
15	Zinc Content	mg/Kg	37.2	24.83	95.49	57.17
16	Calcium	mg/Kg	473.69	811.89	286.27	505.34

Soil samples were collected from four locations in Isarwadi. All four samples results, providing a complete dataset for this village. Soil pH ranged from 7.64 at S2 to 8.26 at S4, indicating mildly to moderately alkaline conditions across the village, consistent with the black cotton soil (Vertisol) character typical of the Marathwada region. Electrical Conductivity was 1114 mS/cm at S2 and 1213 mS/cm at S4, indicating moderate salinity at these two locations, while S11 (888 mS/cm) and S61 (843 mS/cm) recorded lower but still appreciable salinity. Organic Content showed notable variation across the four samples: S11 recorded the highest value at 4.11% (high), S4 recorded a moderate value of 1.75%, S61 recorded 1.48% and S2 recorded 0.92% (low to medium), suggesting variable soil organic matter status across the village.

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Available Phosphorous was exceptionally high at S11 (902.30 kg/ha), the highest value recorded for Isarwadi, and substantially elevated at S61 (166.40 kg/ha) and S2 (238.81 kg/ha), while S4 (58.98 kg/ha) was comparatively lower. Available Potassium was very high at S61 (375.83 kg/ha) and moderate at S11 (201.88 kg/ha), S2 (45.63 kg/ha) and S4 (41.40 kg/ha). Available Nitrogen was below the detection limit (less than 0.10 kg/ha) at all four locations. Calcium Carbonate was highest at S4 (27.68 kg/ha) and lowest at S2 (8.53 kg/ha). Nitrate Nitrogen was the most striking finding in this village: S11 recorded 93.38%, the highest value in Isarwadi and one of the highest recorded across the entire study, followed by S61 (50.03%), S2 (21.84%) and S4 (18.78%). Total Chromium was below the detection limit (less than 0.50 meq/L) at all four locations, indicating no detectable chromium contamination. Lead was detectable at S4 (11.01 meq/L) and S61 (7.95 meq/L) but below detection at S2 and S11. Nickel was elevated at S2 (46.32 mg/kg) and moderate at S11 (35.63 mg/kg), S4 (38.59 mg/kg) and S61 (32.52 mg/kg). Copper was elevated at S2 (77.75 mg/kg), S11 (75.97 mg/kg) and S61 (81.56 mg/kg), with S61 recording the highest copper value in this village, while S4 (49.48 mg/kg) was lower. Magnesium was very high at S4 (16,385 mg/kg) and S61 (16,082 mg/kg), consistent with the basaltic parent material of the Deccan Traps, while S2 (11,294 mg/kg) and S11 (13,753 mg/kg) were moderately high. Sodium ranged from 299.95 mg/kg at S11 to 671.41 mg/kg at S4. Zinc was notably elevated at S11 (95.49 mg/kg), the highest zinc value in this village and one of the highest in the study, while S2 (37.20 mg/kg), S4 (24.83 mg/kg) and S61 (57.17 mg/kg) were within more typical ranges. Calcium ranged from 286.27 mg/kg at S11 to 811.89 mg/kg at S4.

Possible causes: The extremely elevated Nitrate Nitrogen at S11 (93.38%) along with the very high available Phosphorous (902.30 kg/ha) and elevated Zinc (95.49 mg/kg) at the same location strongly points toward intensive fertilizer application and possibly repeated use of zinc-containing micronutrient fertilizers at this specific field. The groundwater data for Isarwadi already confirmed nitrate exceedances up to 199.40 mg/L across all four wells, and the high soil Nitrate Nitrogen at S11 and S61 corroborates a shared agricultural nitrogen loading pattern across soil and water in this village. The elevated Copper at S2, S11 and S61 (75 to 82 mg/kg) compared to the Jayakwadi Dam reference site (61.39 mg/kg) suggests a moderate anthropogenic copper enrichment beyond the geogenic baseline, most likely from copper-based fungicide application which is common in cotton and vegetable cultivation in this region. The universally high Magnesium in soil mirrors the magnesium-dominated



groundwater hardness observed in Isarwadi, further corroborating geogenic weathering of basaltic mineral phases as the dominant background mineralisation influence.

2. Katpur

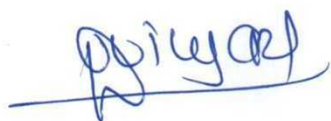
Name of village			Katpur			
Unique Identification Number			S1	S16	S64	S12
Sr. No	Parameters	Unit				
1	pH	-	8.16	7.92	7.96	7.27
2	Electrical Conductivity	mS/cm	728	10.37.00	1537	536
3	Organic Content	%	1.86	2.26	3.16	2.48
4	Available Phosphorous	%	111.33	1146.05	388.86	343.42
5	Available Potassium	Kg/ha	85.34	45.47	158.95	83.62
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	23.02	33.18	18.47	27.16
8	Nitrate Nitrogen	%	24.9	30.91	40.71	62.38
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	0.5	<0.50	16.4	<0.50
11	Nickel Content	mg/Kg	39.88	42.97	40.62	43.38
12	Copper Content	mg/Kg	66.14	52.32	62.55	52.81
13	Magnesium	mg/Kg	17575.41	26840.19	19498.47	26046.78
14	Sodium	mg/Kg	486.56	410.88	486.27	453.44
15	Zinc Content	mg/Kg	33.45	28.43	47.39	25.95
16	Calcium	mg/Kg	687.11	954.69	759.53	1353.97

Soil samples were collected from four locations in Katpur. Soil pH ranged from 7.27 at S12 to 8.16 at S1, showing wider variation than most other villages. Electrical Conductivity was 1537 mS/cm at S64 (moderate to high salinity), 728 mS/cm at S1 and 536 mS/cm at S12, while S16 recorded an unusual value of 10.37 mS/cm which may represent a data entry issue and should be verified against the original laboratory certificate. Organic Content was good at S64 (3.16%), moderate at S16 (2.26%) and S12 (2.48%), and moderate at S1 (1.86%), suggesting reasonable organic matter across the village. Available Phosphorous was very high at S16 (1146.05 kg/ha), the highest value recorded across all villages in the entire study, and high at

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S64 (388.86 kg/ha) and S12 (343.42 kg/ha), while S1 (111.33 kg/ha) was moderate. Available Potassium was moderate at S1 (85.34 kg/ha) and S12 (83.62 kg/ha) and lower at S64 (158.95 kg/ha) and S16 (45.47 kg/ha). Available Nitrogen was below detection throughout. Calcium Carbonate was highest at S16 (33.18 kg/ha) and lowest at S1 (23.02 kg/ha). Nitrate Nitrogen was elevated at S12 (62.38%), moderate at S64 (40.71%) and S16 (30.91%) and lower at S1 (24.90%). Total Chromium was below detection at all four samples. Lead was below detection at S2 and S16, moderate at S64 (16.40 meq/L) and very high at S19 (31.77 meq/L), the highest lead value recorded across the entire study. Nickel at S1 recorded 39.88 mg/kg, S16 (42.97 mg/kg), S64 (40.62 mg/kg) and S12 (43.38 mg/kg) recorded values within normal background ranges. Copper ranged from 50.14 mg/kg at S19 to 66.14 mg/kg at S1, all within the elevated but plausible range. Magnesium was very high at S16 (26,840 mg/kg) and S12 (26,047 mg/kg), consistent with the geogenic pattern across the study area, and moderate at S1 (17,575 mg/kg) and S64 (19,498 mg/kg). Sodium ranged from 410.88 to 486.56 mg/kg across all four samples. Zinc ranged from 25.95 at S12 to 47.39 mg/kg at S64. Calcium was notably very high at S12 (1353.97 mg/kg) and S19 (2725.93 mg/kg, the highest calcium value in the entire study), while S1 (687.11 mg/kg) and S64 (759.53 mg/kg) were within moderate ranges.

Possible causes: The extraordinarily high available phosphorus at S16 (1146.05 kg/ha) is the highest recorded value in the entire study and strongly suggests historical over-application of phosphatic fertilizers at this location, which can result in phosphorus accumulation in soil far exceeding crop requirements. Such phosphorus saturation can also mobilise heavy metals such as lead and cadmium in the soil profile over time. The very high lead at S19 (31.77 meq/L) alongside the highest calcium (2725.93 mg/kg) at the same location may reflect geogenic enrichment from calcium-rich parent material combined with gradual anthropogenic accumulation from irrigation with mineral-bearing groundwater, since Katpur groundwater Sample 6 recorded severely elevated sulphate (1668.79 mg/L) and TDS.



3. Wahegaon

Name of village			Wahegaon	
Unique Identification Number			S52	S65
Sr. No	Parameters	Unit		
1	pH	-	7.33	7.49
2	Electrical Conductivity	mS/cm	10.96	20.8
3	Organic Content	%	1.94	1.63
4	Available Phosphorous	%	105.09	81.88
5	Available Potassium	Kg/ha	85.83	36.42
6	Available Nitrogen	Kg/ha	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	24.21	24.71
8	Nitrate Nitrogen	%	18.74	68.68
9	Total Chromium	meq/L	<0.50	<0.50
10	Lead Content	meq/L	16.61	17.15
11	Nickel Content	mg/Kg	12.75	<0.50
12	Copper Content	mg/Kg	38.24	55.35
13	Magnesium	mg/Kg	21583.77	32013.56
14	Sodium	mg/Kg	887.49	2712.7
15	Zinc Content	mg/Kg	40.66	41.99
16	Calcium	mg/Kg	791.02	738.41

Both soil samples from Wahegaon showed results as follows. Soil pH was 7.33 at S52 and 7.49 at S65, both mildly alkaline but notably lower than the regional pattern observed across most other villages in this study, which may reflect differences in soil texture or a higher degree of organic acid activity at these locations. Electrical conductivity was low at both locations, recording 10.96 mS/cm at S52 and 20.8 mS/cm at S65, which contrasts sharply with the severely elevated TDS and ionic content observed in Wahegaon's groundwater. Organic Content was moderate at both locations, recording 1.94% at S52 and 1.63% at S65. Available Phosphorus was moderate at S52 (105.09 kg/ha) and S65 (81.88 kg/ha). Available Potassium was moderate at S52 (85.83 kg/ha) and low at S65 (36.42 kg/ha). Available Nitrogen was below the detection limit at both locations. Nitrate Nitrogen was low at S52 (18.74%) but substantially

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elevated at S65 (68.68%), which is the highest Nitrate Nitrogen value recorded across all Wahegaon samples and one of the higher values in the study as a whole. Total Chromium was below the detection limit at both locations. Lead was 16.61 mg/kg at S52 and 17.15 mg/kg at S65. Nickel was 12.75 mg/kg at S52, among the lowest nickel values recorded in the entire study, and was below the detection limit (less than 0.50 mg/kg) at S65. Copper was 38.24 mg/kg at S52 and 55.35 mg/kg at S65, and Zinc was 40.66 mg/kg at S52 and 41.99 mg/kg at S65, both within background ranges. Magnesium was very high at both locations, recording 21,584 mg/kg at S52 and 32,014 mg/kg at S65, with S65 being among the highest magnesium values across the entire study. Sodium was exceptionally high at S65 (2712.7 mg/kg), the highest sodium value recorded in the entire study, while S52 showed a moderate value of 887.49 mg/kg. Calcium was moderate at both locations, ranging from 738 to 791 mg/kg.

Possible causes: The extremely high sodium at Sample S65 (2712.7 mg/kg) is the most striking soil finding in Wahegaon and is consistent with the severe sodification expected from long-term irrigation with Wahegaon's groundwater, which itself recorded the highest TDS (up to 5230 mg/L) and chloride (up to 1031 mg/L) values among all groundwater samples in this study. Prolonged irrigation with such highly saline and sodium-rich water would progressively enrich the soil exchange complex with sodium, displace calcium and magnesium, and eventually lead to structural degradation of the soil including loss of aggregation, reduced permeability, and surface crusting, all of which would severely impact crop productivity over time. The high Nitrate Nitrogen at S65 (68.68%) combined with elevated soil sodium suggests this particular field may be receiving both saline irrigation water and significant nitrogen inputs simultaneously, a combination that would severely stress crop physiology and may partly explain the crop failure complaints reported by farmers in this village. The low EC in the soil despite highly saline groundwater in the area is somewhat counter-intuitive and may reflect recent rainfall flushing or indicate that the samples were taken from an upper soil horizon not yet fully saturated with dissolved salts from groundwater. Only two soil samples were collected from Wahegaon and additional sampling, particularly closer to drainage channels and areas confirmed to receive groundwater irrigation, would considerably strengthen the soil contamination assessment for this village.



4. Pachalgaon

Name of village			Pachalgaon			
Unique Identification Number			S20	S21	S53	S54
Sr. No	Parameters	Unit				
1	pH	-	7.74	7.63	7.04	8.18
2	Electrical Conductivity	mS/cm	1046	1009	2.71	2.13
3	Organic Content	%	2.19	2.18	0.88	1.67
4	Available Phosphorous	%	396.96	318.52	67.74	50.88
5	Available Potassium	Kg/ha	378.28	78.19	48.36	40.45
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	26.58	23.79	20.68	27.26
8	Nitrate Nitrogen	%	43.86	68.44	18.78	24.98
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	28.24	16.31	8.49	<0.50
11	Nickel Content	mg/Kg	43.29	46.3	31.9	36.23
12	Copper Content	mg/Kg	63.55	62.48	54.74	56.31
13	Magnesium	mg/Kg	25092.47	14705.88	19606.45	12920.85
14	Sodium	mg/Kg	854.07	313.38	453	674.35
15	Zinc Content	mg/Kg	53.72	47.46	40.58	60.44
16	Calcium	mg/Kg	924.68	562.09	836.64	917.01

All four soil samples from Pachalgaon resulted pH ranged from 7.04 at S53 (near neutral) to 8.18 at S54 (moderately alkaline), with S20 (7.74) and S21 (7.63) being mildly alkaline, reflecting some variability in soil conditions across the village. Electrical Conductivity was elevated at S20 (1046 mS/cm) and S21 (1009 mS/cm), indicating moderate salinity, while S53 (2.71 mS/cm) and S54 (2.13 mS/cm) were very low, suggesting significant within-village variation in soluble salt accumulation. Organic Content was moderate to good at S20 (2.19%) and S21 (2.18%) and low at S53 (0.88%) and S54 (1.67%). Available Phosphorous was very high at S20 (396.96 kg/ha) and S21 (318.52 kg/ha), moderate at S53 (67.74 kg/ha) and low at S54 (50.88 kg/ha). Available Potassium was high at S20 (378.28 kg/ha) and low to moderate at S21 (78.19 kg/ha), S53 (48.36 kg/ha) and S54 (40.45 kg/ha). Available Nitrogen was below

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the detection limit at all four samples. Nitrate Nitrogen was elevated at S21 (68.44%) and moderately elevated at S20 (43.86%), while S53 and S54 recorded lower values of 18.78% and 24.98% respectively. Total Chromium was below the detection limit at all four samples. Lead was 28.24 mg/kg at S20, 16.31 mg/kg at S21, 8.49 mg/kg at S53 and below the detection limit at S54. Nickel (31.9 to 46.3 mg/kg), Copper (54.74 to 63.55 mg/kg) and Zinc (40.58 to 60.44 mg/kg) were within background to slightly elevated ranges across all four samples. Magnesium was high across all four locations, ranging from 12,921 mg/kg at S54 to 25,092 mg/kg at S20. Sodium ranged from 313 to 854 mg/kg across the village.

Possible causes: The sharp contrast between Samples S20 and S21 (high EC, high phosphorous, high Nitrate Nitrogen and good organic content) compared to Samples S53 and S54 (low EC, lower phosphorous, lower Nitrate Nitrogen and lower organic content) within the same village likely reflects differences in farming intensity and irrigation practices. S20 and S21 may belong to more intensively cultivated, well-irrigated fields, while S53 and S54 may represent drier or less fertilizer-intensive plots. The elevated lead at S20 (28.24 mg/kg) is among the higher lead values recorded in this study and may indicate some degree of metal accumulation from repeated irrigation with groundwater carrying trace metal concentrations, particularly since the groundwater in Pachalgaon showed consistent TDS and hardness exceedances. The elevated nitrate nitrogen in two of four samples is consistent with groundwater data for Pachalgaon, where nitrate exceedances were confirmed at three of four wells, collectively pointing to agricultural nitrogen loading as the primary driver of nitrogen enrichment in both soil and water in this village.



5. Narayangaon

Name of village			Narayangaon			
Unique Identification Number			Soil sample	Soil sample	Soil sample	Soil sample
Sr. No	Parameters	Unit	S18	S22	S57	S63
1	pH	-				
2	Electrical Conductivity	mS/cm	7.43	7.66	7.64	7.86
3	Organic Content	%	630	1674	5.85	1728
4	Available Phosphorous	%	1.41	2.66	0.73	1.31
5	Available Potassium	Kg/ha	151.89	451.8	21.32	20.48
6	Available Nitrogen	Kg/ha	54.18	106.98	42.44	40.23
7	Calcium Carbonate	Kg/ha	<0.10	<0.10	<0.10	<0.10
8	Nitrate Nitrogen	%	8.12	33.08	24.62	20.63
9	Total Chromium	meq/L	50.13	43.73	50.13	31.25
10	Lead Content	meq/L	<0.50	<0.50	<0.50	<0.50
11	Nickel Content	mg/Kg	11.09	19.95	12.82	23.81
12	Copper Content	mg/Kg	40.75	40.46	35.98	37.21
13	Magnesium	mg/Kg	60.02	52.79	42.82	58.29
14	Sodium	mg/Kg	16004.77	31777.83	21069.61	31162.14
15	Zinc Content	mg/Kg	312.04	512.22	673.64	597
16	Calcium	mg/Kg	48.16	47.53	39.6	37.11

Soil pH was mildly to moderately alkaline across all four locations, ranging from 7.43 at S18 to 7.86 at S63, consistent with the regional soil character of the area. Electrical Conductivity showed considerable variation: S22 and S63 recorded high values of 1674 and 1728 mS/cm respectively, while S57 showed an unusually low value of 5.85 mS/cm, possibly indicating a different soil texture or a sampling location with lower soluble salt accumulation, and S18 recorded an intermediate value of 630 mS/cm. Organic Content ranged from 0.73% at S57 (low) to 2.66% at S22 (medium to high), reflecting heterogeneity in organic matter distribution across the village. Available Phosphorous was very high at S22 (451.8 kg/ha), moderate at S18 (151.89 kg/ha), and low at S57 (21.32 kg/ha) and S63 (20.48 kg/ha), suggesting differential

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fertilizer application histories across the sampled fields. Available Potassium was low across all four samples, ranging from 40.23 to 106.98 kg/ha. Available Nitrogen was below the detection limit throughout. Nitrate Nitrogen was markedly elevated at S18 and S57 (50.13% at both), moderate at S22 (43.73%) and lower at S63 (31.25%). Total Chromium was below the detection limit at all four samples. Lead was detectable at all four locations, ranging from 11.09 mg/kg at S18 to 23.81 mg/kg at S63, with S63 recording the highest lead value in this village. Nickel (35.98 to 40.75 mg/kg), Copper (42.82 to 60.02 mg/kg) and Zinc (37.11 to 48.16 mg/kg) were broadly consistent across all four samples and within typical background ranges for this region. Magnesium was very high, particularly at S22 and S63 (31,778 and 31,162 mg/kg respectively), consistent with the geogenic pattern seen throughout the study area. Sodium was moderate, ranging from 312 to 674 mg/kg, and Calcium ranged from 619 to 899 mg/kg.

Possible causes: The elevated Nitrate Nitrogen at three of four locations in Narayangaon, combined with the groundwater data already showing severe nitrate and TDS exceedances in this village, strongly indicates a coupled soil-water contamination scenario where nitrogen-bearing inputs such as fertilizers or effluent-influenced irrigation are accumulating in the soil and simultaneously leaching into the already stressed groundwater. The notable variation in Electrical Conductivity across samples, with two showing values consistent with salinization while another is near background, suggests that the degree of anthropogenic impact may vary significantly even within a small geographic area, possibly reflecting which specific fields are being irrigated with contaminated groundwater. The elevated lead at Sample S63 (23.81 mg/kg), while still below crisis thresholds, is notable given that the corresponding groundwater sample from this location recorded the most extreme hardness and TDS values in the entire study, raising the possibility that metal-bearing saline groundwater has gradually enriched this particular soil over time with repeated irrigation.



6. Rahatgaon

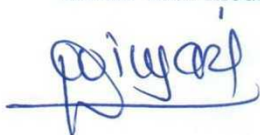
Name of village			Rahatgaon			
Unique Identification Number			S5	S7	S9	S23
Sr. No	Parameters	Unit				
1	pH	-	8.11	8.1	7.84	8.12
2	Electrical Conductivity	mS/cm	607	510	757	710
3	Organic Content	%	1.4	0.14	0.31	0.72
4	Available Phosphorous	%	<10.00	31.32	138.64	159.73
5	Available Potassium	Kg/ha	42.92	37.05	51.69	19.98
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	16.91	18.82	9.82	31.58
8	Nitrate Nitrogen	%	25.08	56.31	18.6	25.03
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	10.66	7.08	<0.50	15.05
11	Nickel Content	mg/Kg	39.18	38.16	45.77	39.22
12	Copper Content	mg/Kg	55.67	68.69	60.75	61.62
13	Magnesium	mg/Kg	16829.9	17840.28	12903.12	25002.96
14	Sodium	mg/Kg	606.87	773.41	291.71	564.64
15	Zinc Content	mg/Kg	38.56	44.37	23.55	37.86
16	Calcium	mg/Kg	577.42	635.64	505.71	1254.16

Soil pH ranged from 7.84 at S9 to 8.12 at S5 and S23, consistently alkaline throughout. Electrical Conductivity ranged from 510 mS/cm at S7 to 757 mS/cm at S9 and 710 mS/cm at S23, indicating low to moderate salinity across all four locations. Organic Content ranged from a critically low 0.14% at S7 to 1.94% at S5, with S9 (0.31%) also being very low. Available Phosphorous was below detection (less than 10.00 kg/ha) at S5, low to moderate at S7 (31.32 kg/ha), moderate at S9 (138.64 kg/ha) and moderate at S23 (159.73 kg/ha). Available Potassium was low to moderate across all four samples, ranging from 19.98 kg/ha at S23 to 85.83 kg/ha at S5. Available Nitrogen was below detection throughout. Calcium Carbonate ranged from 9.82 kg/ha at S9 to 31.58 kg/ha at S23. Nitrate Nitrogen was substantially elevated at S7 (56.31%), moderate at S23 (25.03%), S5 (25.08%) and lower at S9 (18.60%). Total

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Chromium was below detection at all four locations. Lead was detectable at S5 (10.66 meq/L), S7 (7.08 meq/L) and S23 (15.05 meq/L) and below detection at S9. Nickel was broadly consistent across S5 (39.18 mg/kg), S7 (38.16 mg/kg), S9 (45.77 mg/kg) and S23 (39.22 mg/kg). Copper ranged from 38.24 mg/kg at S5 to 68.69 mg/kg at S7, with S9 (60.75 mg/kg) and S23 (61.62 mg/kg) moderate. Magnesium was high at S5 (16,830 mg/kg) and S7 (17,840 mg/kg) and very high at S23 (25,003 mg/kg), while S9 (12,903 mg/kg) was moderately high. Sodium ranged from 291.71 mg/kg at S9 to 773.41 mg/kg at S7. Zinc was low at S9 (23.55 mg/kg) and moderate at S5 (38.56 mg/kg), S7 (44.37 mg/kg) and S23 (37.86 mg/kg). Calcium ranged from 505.71 mg/kg at S9 to 1254.16 mg/kg at S23.

Possible causes: The critically low organic content at S7 (0.14%) is the second lowest value recorded in the entire study and is agronomically significant, as organic matter below 0.5% is generally considered deficient and leads to severely reduced soil fertility, poor water retention and increased susceptibility to erosion. The elevated Nitrate Nitrogen at S7 (56.31%) despite this very low organic content strongly suggests inorganic nitrogen accumulation from external fertilizer or wastewater inputs rather than naturally mediated organic nitrogen cycling, indicating possible disruption of the soil's natural fertility processes at this location. Similarly, the very low organic content at S9 (0.31%) combined with relatively low Nitrate Nitrogen (18.60%) suggests a generally depleted soil condition at that point, which may reflect minimal agricultural inputs and poor baseline fertility. The groundwater nitrate exceedances confirmed at Rahatgaon water samples 51, 52 and 53 are corroborated by the elevated soil Nitrate Nitrogen at S7 and S23, pointing to agricultural fertilizer application as the dominant nitrogen source across both media.



7. Karajkheda

Name of village			Karajkheda			
Unique Identification Number			S6	S8	S15	S19
Sr. No	Parameters	Unit				
1	pH	-	8.12	8.31	8.38	8.23
2	Electrical Conductivity	mS/cm	1053	500	665	820
3	Organic Content	%	1.49	0.94	1.36	1.82
4	Available Phosphorous	%	<10.00	27.09	52.35	168.83
5	Available Potassium	Kg/ha	51.92	45.43	55.35	53.45
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	16.45	20.91	29.47	34.48
8	Nitrate Nitrogen	%	31.28	18.8	49.88	24.74
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	0.56	16.14	<0.50	31.77
11	Nickel Content	mg/Kg	31.79	34.52	39.68	34.57
12	Copper Content	mg/Kg	41.07	55.25	54.3	50.14
13	Magnesium	mg/Kg	10005.57	15478.42	15019.77	27959.58
14	Sodium	mg/Kg	358.39	785.18	625.9	480.4
15	Zinc Content	mg/Kg	32.28	41.09	32.77	48.04
16	Calcium	mg/Kg	547.62	894.84	1551.13	2725.93

Soil pH was consistently moderately alkaline across all four samples, ranging from 8.12 at S6 and S19 to 8.38 at S15, the highest pH recorded in Karajkheda. Electrical Conductivity ranged from 500 mS/cm at S8 to 1053 mS/cm at S6, indicating low to moderate salinity across the village. S6, S8, S15 & S19 recorded a Magnesium of Karajkheda samples (10,006 to 27,960 mg/kg) and the regional range (10,000 to 32,000 mg/kg), Organic Content ranged from a critically low 0.14% at S8 to 1.82% at S19, with S6 (1.49%) and S15 (1.36%) in the low to moderate range. Available phosphorus was below detection (less than 10.00 kg/ha) at S6, low at S8 (27.09 kg/ha) and S15 (52.35 kg/ha) and moderate at S19 (168.83 kg/ha). Available Potassium was low across all four samples (37.05 to 55.35 kg/ha). Available Nitrogen was below detection throughout. Calcium Carbonate was highest at S19 (34.48 kg/ha) and lowest

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at S6 (16.45 kg/ha). Nitrate Nitrogen was substantially elevated at S15 (49.88%) and moderate at S6 (31.28%), with S8 (18.80%) and S19 (24.74%) recording lower values. Total Chromium was below detection at all four. Lead was very low at S6 (0.56 meq/L) and below detection at S15, while S8 recorded 16.14 meq/L and S19 recorded 31.77 meq/L, the highest lead value recorded across the entire study. Nickel was broadly consistent across S8 (34.52 mg/kg), S15 (39.68 mg/kg), S19 (34.57 mg/kg) and S6 (31.79 mg/kg). Copper ranged from 41.07 mg/kg at S6 to 55.25 mg/kg at S8 and 54.30 mg/kg at S15. Magnesium was very high at S19 (27,960 mg/kg) and S8 (15,478 mg/kg) and high at S6 (10,006 mg/kg), while S15 (1509.77 mg/kg) was anomalously low as noted above. Sodium ranged from 358.39 mg/kg at S6 to 785.18 mg/kg at S8. Zinc ranged from 32.28 mg/kg at S6 to 48.04 mg/kg at S19. Calcium was very high at S19 (2725.93 mg/kg) and S15 (1551.13 mg/kg), while S8 (894.84 mg/kg) and S6 (547.62 mg/kg) were moderate.

Possible causes: The lead value of 31.77 meq/L at S19 is the highest recorded across the entire study and merits immediate attention. While the Indian agricultural soil threshold for lead is generally cited at 250 mg/kg, the consistently elevated lead at this location alongside the very high calcium (2725.93 mg/kg) and magnesium (27,960 mg/kg) suggests a combination of geogenic mineral enrichment from the basaltic parent material and possible gradual anthropogenic accumulation, particularly if this field has been irrigated over a prolonged period with groundwater carrying trace metals originating from the MIDC industrial area. The critically low organic content at S8 (0.14%) mirrors the pattern seen at Rahatgaon S7 and indicates a broader issue of soil organic matter depletion in specific field locations across multiple villages surrounding the MIDC, possibly related to the use of saline or chemically contaminated irrigation water which suppresses microbial activity and impairs organic matter formation. The elevated Nitrate Nitrogen at S15 (49.88%) combined with moderate available phosphorous suggests agricultural fertilizer loading at that location, consistent with the groundwater nitrate exceedances recorded across Karajkheda water samples.



8. Pimpalwadi

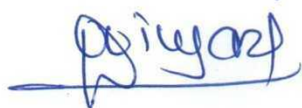
Name of village			Pimpalwadi		
Unique Identification Number			S17	S55	S56
Sr. No	Parameters	Unit			
1	pH	-	7.48	7.75	7.59
2	Electrical Conductivity	mS/cm	2.49	2.31	3.62
3	Organic Content	%	2.91	1.31	1.93
4	Available Phosphorous	%	230.56	441.08	29.9
5	Available Potassium	Kg/ha	53.07	199.22	45.25
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	10.8	18.57	16.56
8	Nitrate Nitrogen	%	31.13	43.71	50.08
9	Total Chromium	meq/L	<0.50	<0.50	<0.50
10	Lead Content	meq/L	<0.50	16.66	8.87
11	Nickel Content	mg/Kg	46.85	29.94	47.82
12	Copper Content	mg/Kg	75.76	66.75	72.08
13	Magnesium	mg/Kg	20435.34	17632.24	20484.12
14	Sodium	mg/Kg	587.39	858.36	609.35
15	Zinc Content	mg/Kg	55.1	64.33	63.01
16	Calcium	mg/Kg	430.02	750.05	619.3

All three soil samples from Pimpalwadi returned results. Soil pH ranged from 7.48 at S17 to 7.75 at S55, both mildly alkaline, while S56 recorded 7.59; all three values were notably lower than the regional alkaline pattern observed in most other villages. Electrical Conductivity was very low at all three locations (2.31 mS/cm at S55, 2.49 mS/cm at S17 and 3.62 mS/cm at S56), indicating minimal soluble salt accumulation in the soil. Organic Content was good at S17 (2.91%), moderate at S56 (1.93%) and low to moderate at S55 (1.31%). Available phosphorus was very high at S55 (441.08 kg/ha), high at S17 (230.56 kg/ha) and low at S56 (29.90 kg/ha), representing a large contrast within the same village. Available Potassium was moderate at S55 (199.22 kg/ha) and low at S17 (53.07 kg/ha) and S56 (45.25 kg/ha). Available Nitrogen was below detection at all three locations. Calcium Carbonate ranged from 10.80 kg/ha at S17 to 18.57 kg/ha at S55. Nitrate Nitrogen was elevated at S56 (50.08%) and S55 (43.71%) and

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moderate at S17 (31.13%), with S56 recording the highest value in this village. Total Chromium was below detection at all three. Lead was below detection at S17 and moderate at S55 (16.66 meq/L) and S56 (8.87 meq/L). Nickel was highest at S56 (47.82 mg/kg), moderate at S17 (46.85 mg/kg) and lower at S55 (29.94 mg/kg). Copper was elevated at all three locations, recording 75.76 mg/kg at S17, 66.75 mg/kg at S55 and 72.08 mg/kg at S56, with S17 recording the highest copper value in this village and one of the higher values in the study. Magnesium was high at S55 (17,632 mg/kg), S56 (20,484 mg/kg) and S17 (20,435 mg/kg). Sodium ranged from 587.39 mg/kg at S17 to 858.36 mg/kg at S55. Zinc was elevated at S55 (64.33 mg/kg) and S56 (63.01 mg/kg) and moderate at S17 (55.10 mg/kg). Calcium ranged from 430.02 mg/kg at S17 to 750.05 mg/kg at S55.

Possible causes: The elevated Copper at all three locations (66.75 to 75.76 mg/kg), combined with elevated Nickel at S56 (47.82 mg/kg) and S17 (46.85 mg/kg) and high Zinc at S55 and S56 (63 to 64 mg/kg), presents a pattern consistent with anthropogenic metal enrichment beyond the geogenic baseline, since the Jayakwadi Dam reference site recorded Copper at 61.39 mg/kg, Nickel at 40.92 mg/kg and Zinc at only 10.49 mg/kg. The notably elevated Zinc across all three Pimpalwadi samples compared to the reference site is particularly significant and suggests a substantial anthropogenic zinc input, most likely from zinc-containing fertilizers or zinc-based agrochemicals applied to crops in the area. Copper-based fungicide application, widely used in cotton and horticultural cultivation in this region, may explain the elevated copper values. The Nitrate Nitrogen exceedances at S55 and S56, combined with the groundwater nitrate exceedances at all three Pimpalwadi water sampling points, collectively confirm agricultural nitrogen loading as the primary driver of nitrogen enrichment across both soil and water in this village.



9. Mudhalwadi

Name of village			Mudhalwadi				
Unique Identification Number			S3	S13	S14	S51	S58
Sr. No	Parameters	Unit					
1	pH	-	7.86	8.22	7.68	7.7	7.93
2	Electrical Conductivity	mS/cm	1034	614	2.64	4.8	8.3
3	Organic Content	%	3.04	1.76	1.86	1.23	1.22
4	Available Phosphorous	%	120.76	56.67	195.54	105	61.89
5	Available Potassium	Kg/ha	170.43	51.22	49.24	36.73	47.14
6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	19.69	28.88	25.54	25.92	21.99
8	Nitrate Nitrogen	%	81.37	49.68	31.27	37.48	37.63
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	13.46	<0.50	21.17	8.55	17.1
11	Nickel Content	mg/Kg	35.7	40.61	52.68	23.75	24.85
12	Copper Content	mg/Kg	67.72	40.48	55.35	58.32	36.08
13	Magnesium	mg/Kg	19336.15	24094.06	33511.17	18878.23	16176.32
14	Sodium	mg/Kg	626.27	461.32	527.68	1010.6	876.65
15	Zinc Content	mg/Kg	37.58	28.66	44.18	47.21	26.14
16	Calcium	mg/Kg	1204.16	1544.2	1254.17	1268.99	1316.67

Name of village			Mudhalwadi				
Unique Identification Number			S59	S60	S62	S66	S71
Sr. No	Parameters	Unit					
1	pH	-	7.89	8.09	7.75	8.14	7.95
2	Electrical Conductivity	mS/cm	5.27	1606	2.53	3.85	4.16
3	Organic Content	%	1.29	1.9	2.15	0.6	2.12
4	Available Phosphorous	%	65.22	27.02	45.61	102.33	<10.00
5	Available Potassium	Kg/ha	52.41	25.49	49.91	41.23	46.85

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6	Available Nitrogen	Kg/ha	<0.10	<0.10	<0.10	<0.10	<0.10
7	Calcium Carbonate	Kg/ha	11.81	17.58	22.67	16.57	20.16
8	Nitrate Nitrogen	%	50.16	21.93	34.38	31.36	28.21
9	Total Chromium	meq/L	<0.50	<0.50	<0.50	<0.50	<0.50
10	Lead Content	meq/L	16.81	14.9	23.69	16.93	8.9
11	Nickel Content	mg/Kg	38.8	34.39	26.02	33.28	39.24
12	Copper Content	mg/Kg	68.12	74.93	50.18	57.99	43.29
13	Magnesium	mg/Kg	16248.04	25077.96	29521.49	20995.37	17865.97
14	Sodium	mg/Kg	862	664.41	864.66	1070.2	709.7
15	Zinc Content	mg/Kg	52.58	45.91	47.1	57.99	38.35
16	Calcium	mg/Kg	547.99	767.93	1193.73	806.44	854

Mudhalwadi had the largest number of soil samples collected in this study, covering ten locations, all of which returned results providing a complete dataset. Soil pH ranged from 7.68 at S14 to 8.22 at S13, consistently mildly to moderately alkaline throughout the village. Electrical Conductivity showed a sharp bifurcation across the village: S60 (1606 mS/cm), S3 (1034 mS/cm) and S13 (614 mS/cm) showed moderate to relatively high salinity, while the remaining seven samples (S14, S51, S58, S59, S62, S66 and S71) recorded very low EC values between 2.53 and 8.30 mS/cm, indicating significant spatial variability in soluble salt accumulation. Organic Content ranged from 0.60% at S66 (low) to 3.04% at S3 (high), with S3 recording the highest organic content in the village. Available Phosphorous was highest at S14 (195.54 kg/ha) and S3 (120.76 kg/ha), moderate at S66 (102.33 kg/ha), S51 (105 kg/ha), S59 (65.22 kg/ha) and S58 (61.89 kg/ha), low at S62 (45.61 kg/ha) and S13 (56.67 kg/ha), and below detection at S71. Available Potassium was uniformly low across all ten samples, ranging from 25.49 kg/ha at S60 to 170.43 kg/ha at S3. Available Nitrogen was below the detection limit (less than 0.10 kg/ha) at all ten locations throughout. Calcium Carbonate ranged from 11.81 kg/ha at S59 to 28.88 kg/ha at S13. Nitrate Nitrogen showed the widest range of any village in the study: S3 recorded 81.37%, the highest in Mudhalwadi and one of the highest in the entire study, followed by S59 (50.16%), S13 (49.68%), S58 (37.63%), S51 (37.48%), S62 (34.38%), S66 (31.36%), S14 (31.27%), S71 (28.21%) and S60 (21.93%). Total Chromium was below the detection limit (less than 0.50 meq/L) at all ten locations. Lead was detectable at S3 (13.46 meq/L), S14 (21.17 meq/L), S51 (8.55 meq/L), S58 (17.10 meq/L), S59 (16.81 meq/L), S60 (14.90 meq/L), S62 (23.69 meq/L), S66 (16.93 meq/L) and S71 (8.90 meq/L),

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while S13 recorded Lead below the detection limit. The highest Lead value in the village was recorded at S62 (23.69 meq/L). Nickel ranged from 23.75 mg/kg at S51 to 52.68 mg/kg at S14, with all other samples recording values between 24.85 and 40.61 mg/kg. Copper ranged from 36.08 mg/kg at S58 to 74.93 mg/kg at S60, with S60 recording the highest copper value in Mudhalwadi. Magnesium was very high across all ten locations. S14 recorded the highest value in the village at 33,511.17 mg/kg, followed by S62 (29,521.49 mg/kg), S60 (25,077.96 mg/kg), S13 (24,094.06 mg/kg) and S66 (20,995.37 mg/kg), with the remaining samples ranging from 16,176 to 19,878 mg/kg. While the value at S14 is the highest recorded across the entire study, it may reflect a localised higher enrichment from the basaltic substrate at that point and should be confirmed against the original laboratory certificate. Sodium was notably elevated at S51 (1010.60 mg/kg), S66 (1070.20 mg/kg), S62 (864.66 mg/kg), S59 (862 mg/kg) and S58 (876.65 mg/kg), while S14 (527.68 mg/kg), S71 (709.70 mg/kg), S60 (664.41 mg/kg), S3 (626.27 mg/kg) and S13 (461.32 mg/kg) recorded moderate values. Zinc ranged from 26.14 mg/kg at S58 to 57.99 mg/kg at both S60 and S66. Calcium ranged from 547.99 mg/kg at S59 to 1544.20 mg/kg at S13.

Possible causes: The highest Nitrate Nitrogen in the village at S3 (81.37%, tri-junction point) reflects convergence of agricultural runoff from multiple field boundaries at this location, consistent with its role as a surface drainage confluence point. The elevated sodium at five specific locations (S51, S58, S59, S62 and S66), all recording values between 862 and 1070 mg/kg, is consistent with progressive sodification from repeated irrigation using the high-TDS, high-sodium groundwater confirmed across Mudhalwadi water samples, and is expected to gradually reduce soil infiltration capacity, impair soil structure and adversely affect agricultural productivity if left unaddressed. The elevated Available Phosphorous at S14 (195.54 kg/ha), the highest in the village, combined with a moderate Nitrate Nitrogen (31.27%) and very low EC (2.64 mS/cm) at the same location, suggests this field receives intensive fertilizer inputs but is not impacted by saline irrigation water to the same extent as the higher EC locations. The highest Nickel at S14 (52.68 mg/kg) is notable and while within broadly acceptable ranges, is the highest value recorded in Mudhalwadi and may require monitoring. The copper value at S60 (74.93 mg/kg) is the highest in the village and, given this location's proximity to the MIDC industrial boundary and the BB Chemicals drainage corridor, merits further investigation to determine whether the elevated copper reflects anthropogenic industrial input, fungicide application or the natural geogenic baseline from the basaltic parent material. The Magnesium value at S14 (33,511.17 mg/kg), while the highest in the village, may reflect localised

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enrichment from the basaltic substrate and should be confirmed by the laboratory before drawing conclusions. The GCMS analysis of water samples from Mudhalwadi independently confirmed the presence of industrial organic compounds including BTEX compounds, chlorinated aromatics, dioxin precursors and pharmaceutical synthesis intermediates in groundwater from nearby wells, reinforcing the strong possibility that industrial contamination has reached not only the groundwater but may also be affecting the topsoil at specific locations within this village, particularly those adjacent to drainage channels closest to the MIDC industrial boundary.



10. Jayakwadi Dam

Name of Location			Jayakwadi Dam
Unique Identification Number			S25
Sr. No	Parameters	Unit	
1	pH		8.69
2	Electrical Conductivity	mg/l	498
3	Organic Content	mg/l	0.77
4	Available Phosphorous	NTU	<10.00
5	Available Potassium	mg/l	44.42
6	Available Nitrogen	mg/l	<0.10
7	Calcium Carbonate	mg/l	17.52
8	Nitrate Nitrogen	mg/l	37.55
9	Total Chromium	mg/l	<0.50
10	Lead Content	mg/l	11.14
11	Nickel Content	mg/l	40.92
12	Copper Content	mg/l	61.39
13	Magnesium	mg/l	18746.36
14	Sodium	mg/l	988.15
15	Zinc Content	mg/l	10.49
16	Calcium	mg/Kg	552.22

A soil sample was collected from the vicinity of the Jayakwadi Dam (Nath Sagar) having a soil pH of 8.69, the highest pH value recorded in the entire study, reflecting the highly alkaline bank sediment character near the reservoir. Electrical Conductivity was 498 mS/cm, indicating low to moderate salinity. Organic Content was 0.77% (low). Available Phosphorous was below the detection limit, and Available Potassium was moderate (44.42 kg/ha). Available Nitrogen was below the detection limit. Nitrate Nitrogen was 37.55%. Total Chromium was below the detection limit. Lead was 11.14 mg/kg, Nickel was 40.92 mg/kg, Copper was 61.39 mg/kg, Magnesium was 18,746 mg/kg, Sodium was 988.15 mg/kg, Zinc was 10.49 mg/kg, which is the lowest zinc value recorded in the entire study, and Calcium was 552.22 mg/kg. The Jayakwadi Dam sample provides a useful geogenic and background baseline for comparison

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against the village soil data. The values for Nickel (40.92 mg/kg), Copper (61.39 mg/kg) and Magnesium (18,746 mg/kg) are broadly in line with what is observed across most village soils, confirming that these levels are largely consistent with the regional geogenic background of the basaltic Deccan Trap terrain rather than representing solely anthropogenic enrichment. The very low Zinc at the dam reference site (10.49 mg/kg) compared to village soils which typically recorded 24 to 64 mg/kg is particularly notable, as it suggests that the elevated zinc concentrations observed across the village fields may have a significant anthropogenic component such as fertilizer inputs, zinc-based fungicide use or irrigation with metal-bearing water, rather than being purely geogenic in origin. The relatively high copper at the reference site itself (61.39 mg/kg) indicates that the regional geogenic copper baseline is naturally elevated in this area due to the basaltic parent material, and this should be factored carefully into the interpretation of the village-level copper values before attributing any observed elevation solely to industrial or other anthropogenic sources.



Annexure IV: Advanced Characterization.

Gas Chromatography-Mass Spectrometry (GCMS) Analysis

1. Introduction

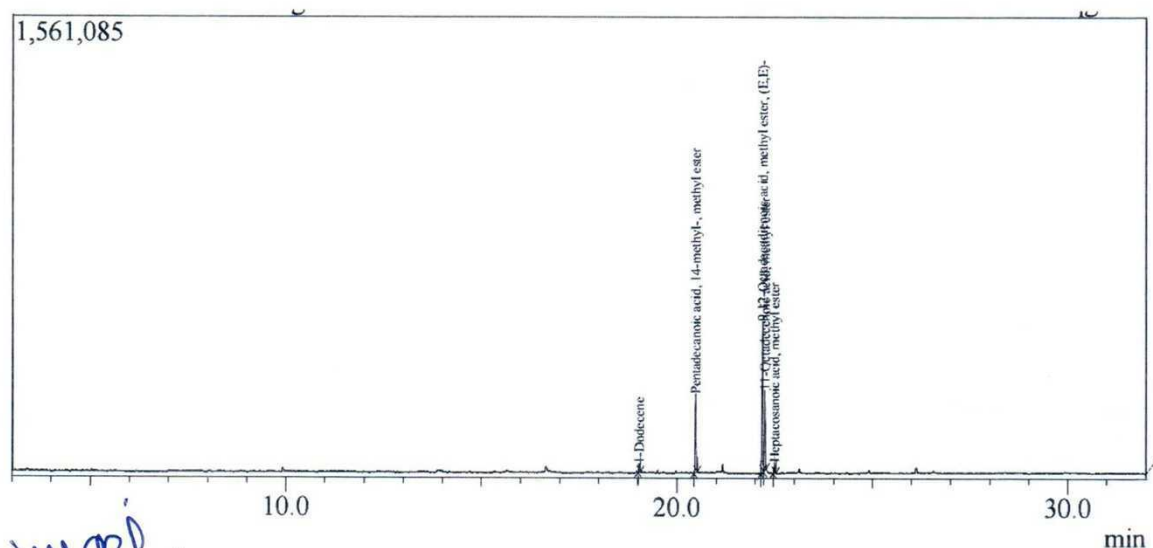
To supplement the physicochemical groundwater quality assessment and investigate the presence of organic contaminants not detectable by conventional parameters, selected water samples from Mudhalwadi village were subjected to Gas Chromatography-Mass Spectrometry (GC-MS) analysis. Mudhalwadi was prioritized for advanced GCMS study given its location in immediate proximity to the MIDC Paithan industrial boundary & the anomalous multi-parameter exceedances recorded during physicochemical analysis. Samples were identified using the NIST spectral library and probable compound names were matched against chromatographic peaks at their respective retention times. The chromatograms for each sample are presented in the respective figures below.

2. Methodology

GCMS analysis was carried out on water samples. Water samples were extracted using liquid-liquid extraction with Ethyl acetate solvent and analyzed on an instrument model QP 2010 Single Quadrupole using an RTX 5 Column. SH-I-5Sil MS cap column 30m, 0.25mm ID, 0.25um. Compounds were identified by matching mass spectra against the NIST library.

The all chromatogram presented in the report shows compounds identified solely through automated spectral matching against the NIST (National Institute of Standards and Technology) Mass Spectral Library integrated within the GCMS software.

3. Sample 62 : Well Water, Mudhalwadi



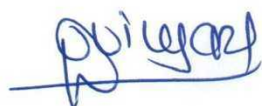
Physicochemical Context: Sample 62 recorded pH 8.34, TDS 1810 mg/L, Chloride 449.22 mg/L, Total Hardness 777.6 mg/L as CaCO₃ and Sulphate 121.66 mg/L. BOD and COD were at the detection limit (5 mg/L each). All values indicate moderate mineral enrichment without a strong organic contamination signature from conventional parameters alone.

GCMS Findings:

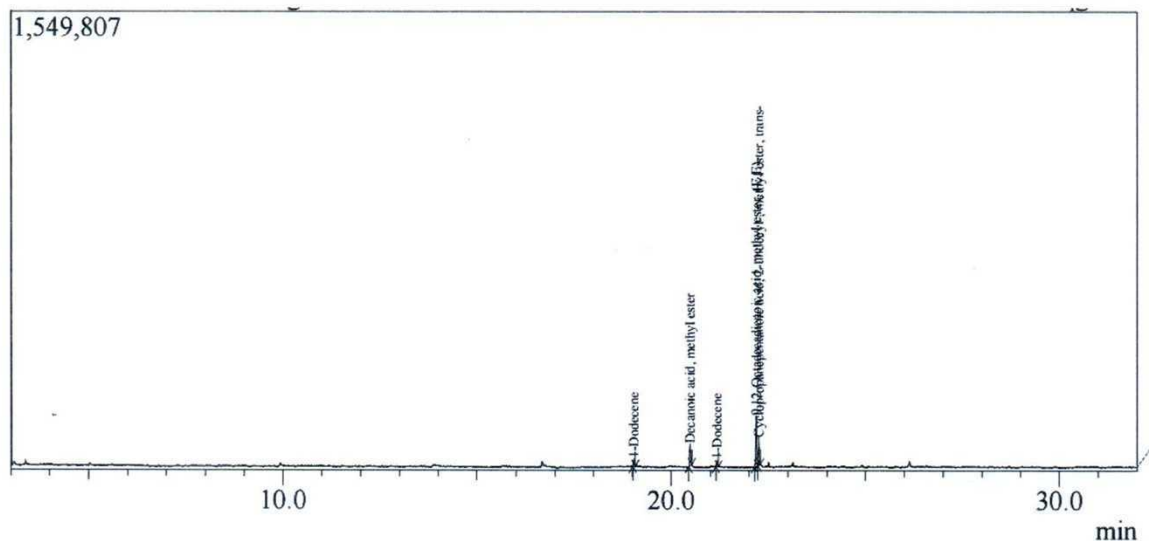
The GCMS analysis of Sample 62 (designated as FAME — Fatty Acid Methyl Esters analysis) identified the following compounds at respective retention times:

Retention Time (min)	Probable Compound(s) Identified
20.76	Hexadecanoic acid, methyl ester (Palmitic acid FAME)
22.71	9,12-Octadecadienoic acid methyl ester (Linoleic acid FAME); 8,11-Eicosadienoic acid methyl ester; cis-11,14-Eicosadienoic acid methyl ester
22.84	Methyl stearate (Stearic acid FAME); Hexadecanoic acid 15-methyl methyl ester

Discussion: The compounds identified in Sample 62 are predominantly long-chain fatty acid methyl esters (FAMES), specifically palmitic (C16:0), stearic (C18:0) and linoleic (C18:2) acid derivatives. These are characteristic markers of biological organic matter degradation, most commonly associated with decomposing plant material, animal waste, cooking oil residues or sewage-derived lipid matter entering the groundwater through poorly sealed well infrastructure. The presence of FAMES in a domestic well water sample, though not acutely toxic, indicates microbial organic loading from surface infiltration. This is consistent with the BOD at the detection limit but not alarming from an industrial contamination standpoint. Correlation with physicochemical data suggests that Sample 62 is predominantly impacted by geogenic mineralization and domestic organic inputs rather than industrial chemical discharge.



4. Sample 63: Circular Well, Mudhalwadi



Physicochemical Context: Sample 63 recorded pH 8.68 (exceeding acceptable limit), TDS 1880 mg/L, Chloride 500.27 mg/L, BOD 6.8 mg/L, COD 21.2 mg/L and DO at exactly 4.0 mg/L (borderline). Total Hardness was 750.6 mg/L as CaCO₃. The measured BOD and COD exceedances suggested possible organic contamination beyond background levels.

GCMS Findings:

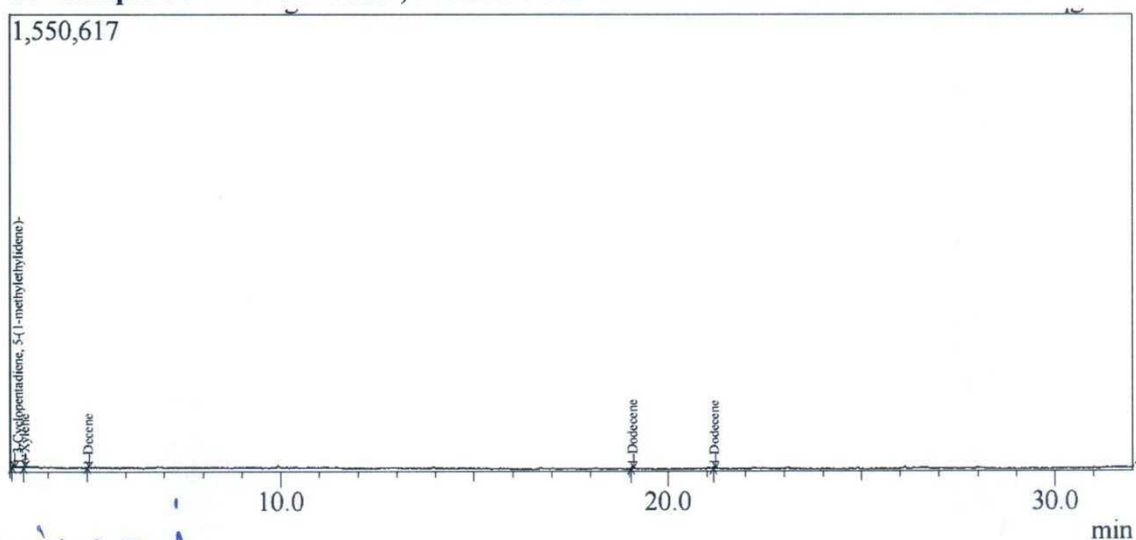
Retention Time (min)	Probable Compound(s) Identified
6.915	7-Carbomethoxy-5,8-dimethoxy-1-tetralone; Hydrazine derivative with tert-butylphenoxy group; Thiazole-indolyl formylamino derivative; 1,3-Benzodioxole-5-acetic acid hydroxy-methoxy derivative; 4-Methyl-N-(2-thiazolyl)phthalimide
12.225	Diethylmalonic acid bromo-trifluoropropyl decyl ester; Diethylmalonic acid bromo-trifluoropropyl heptadecyl ester; Diethylmalonic acid dimethyloctyl heptadecyl ester
21.57	Isonipecotic acid N-(4-nitrobenzoyl) decyl ester; Terephthalic acid heptafluorobutyl hexyl ester; 4-Cyclohexyl-5-pyridin-3-yl triazolyl sulfanyl acetic acid ethyl ester

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24.09	Endosulfan sulfate; Pentazocine TMS derivative; Decanedioic acid
26.63	Dibromodimethyl indole derivatives; m-Xylylene diisocyanate; Amino-oxo-quinazoline carboxamide derivative

Discussion: Sample 63 presents the most toxicologically significant GCMS profile among the well water samples in Mudhalwadi. The identification of Endosulfan sulfate at retention time 24.09 min is particularly important. Endosulfan is a persistent organochlorine pesticide, banned in India since 2011 under the Stockholm Convention. Its persistence in groundwater, particularly in its sulfate metabolite form, indicates historical agricultural application in the surrounding fields and confirms long-term accumulation in the shallow aquifer. The presence of m-Xylylene diisocyanate (an industrial isocyanate compound used in polyurethane and resin manufacture) at 26.63 min is a notable industrial marker potentially linked to chemical manufacturing activity in MIDC. The terephthalic acid ester at 21.57 min is significant as terephthalic acid is a key raw material in PET plastic and polyester manufacturing, suggesting possible leachate contribution from MIDC-based polymer or chemical industries. Diethylmalonic acid derivatives (12.225 min) are associated with pharmaceutical or agrochemical synthesis. The combined profile of this sample strongly suggests a mixed contamination source combining residual agricultural pesticides with industrial organic compounds, which is consistent with the location's proximity to both agricultural fields and the MIDC boundary. The measured BOD (6.8 mg/L) and COD (21.2 mg/L) from physicochemical analysis are corroborated by the diverse organic load detected by GCMS.

5. Sample 64 — Well Water, Mudhalwadi



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Physicochemical Context: Sample 64 recorded pH 7.50, TDS 1720 mg/L, Chloride 324.15 mg/L, Sulphate 274.82 mg/L (exceeding acceptable limit), Total Hardness 1101.6 mg/L as CaCO₃ (exceeding permissible limit) and COD 7.42 mg/L. BOD was at the detection limit.

GCMS Findings:

Retention Time (min)	Probable Compound(s) Identified
19.03	1-Dodecene; Dichloroacetic acid 2-pentadecyl ester
20.47	Pentadecanoic acid 14-methyl methyl ester; Hexadecanoic acid methyl ester; Decanoic acid methyl ester; Tridecanoic acid methyl ester
21.19	9,12-Octadecadienoic acid methyl ester (E,E); 11,14-Eicosadienoic acid methyl ester; 7,10-Hexadecadienoic acid methyl ester
22.25	11-Octadecenoic acid methyl ester; Oleic acid; 9-Octadecenoic acid (Z) methyl ester
22.49	Heptacosanoic acid methyl ester; Docosanoic acid methyl ester; Eicosanoic acid methyl ester; Methyl stearate

Discussion: Sample 64 shows a predominantly fatty acid methyl ester profile similar to Sample 62, suggesting biological organic matter as the primary organic input. However, the detection of Dichloroacetic acid 2-pentadecyl ester at 19.03 min is noteworthy. Dichloroacetic acid (DCA) is a halogenated organic compound classified as a disinfection byproduct and is also used as a chemical intermediate in industrial synthesis. Its presence in groundwater may suggest either chlorination-related contamination from treated water cross-contamination or more likely industrial halogenated compound infiltration given the absence of any municipal water chlorination in this area. The presence of 1-Dodecene, a linear alpha olefin used in detergent and polymer manufacture, further supports a possible industrial organic input component at this location. The physicochemical data showing sulphate exceedance and high hardness at this well is consistent with long-term groundwater modification from the same anthropogenic sources.

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Chromatogram showing three peaks at 18.9, 26.1, and 30.1 minutes. The peaks are labeled with their respective chemical names: 1,4-bis[2-(2-hydroxy-2-phenylethyl)-2-oxoethyl]piperazine, 1,4-bis[2-(2-hydroxy-2-phenylethyl)-2-oxoethyl]piperazine, and 1,4-bis[2-(2-hydroxy-2-phenylethyl)-2-oxoethyl]piperazine.

GCMS Findings:

Retention Time (min)	Probable Compound(s) Identified
3.07	o-Xylene; Benzene 1,3-dimethyl (m-Xylene); p-Xylene; 1,3-Cyclopentadiene 5-(1-methylethylidene)
3.37	o-Xylene; p-Xylene; m-Xylene
5.03	1-Decene; 1-Nonanol; 1-Dodecene; 1-Undecene; 2-Undecanethiol 2-methyl
19.07	1-Dodecene; 2-Tridecene (Z); 1-Undecene; Trichloroacetic acid 2-tetradecyl ester

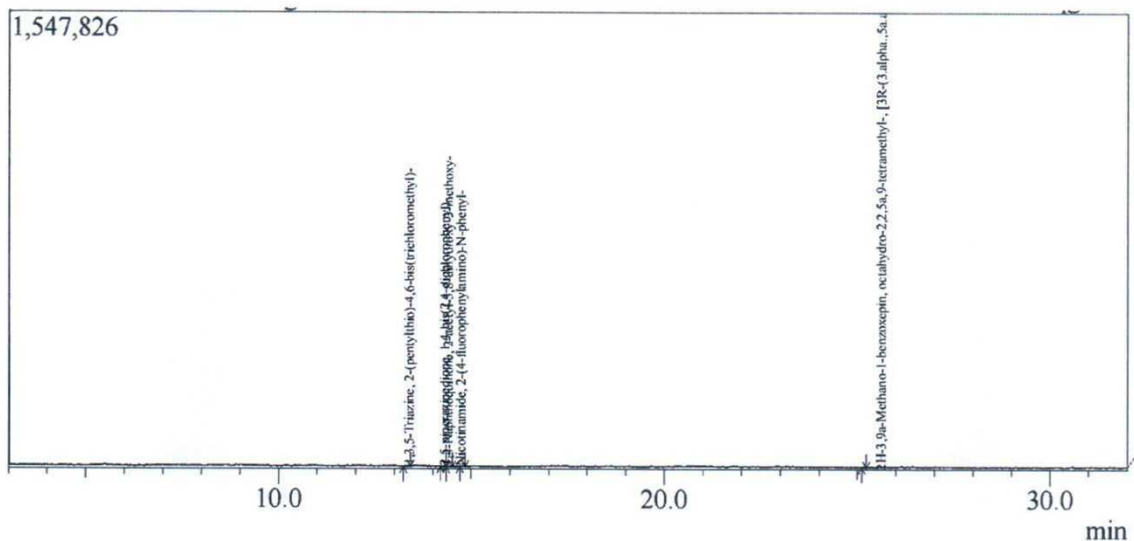
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21.19	1-Dodecene; Oxalic acid allyl octadecyl ester; Trichloroacetic acid 2-tetradecyl ester; 1-Dodecanol
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Discussion: Sample 65 presents the most significant and industrially relevant GCMS profile among all Mudhalwadi groundwater samples. The detection of BTEX compounds (specifically o-Xylene, m-Xylene and p-Xylene) at early retention times of 3.07 and 3.37 min is of critical importance. BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) are volatile aromatic hydrocarbons characteristic of petroleum products, solvents and industrial chemical manufacturing. Their presence in a domestic well water sample in a village adjacent to an active MIDC industrial estate is a strong indicator of industrial solvent or petroleum-derived contamination reaching the shallow groundwater. The detection of Trichloroacetic acid 2-tetradecyl ester at 19.07 and 21.19 min adds further concern, as trichloroacetic acid is a highly toxic halogenated organic compound associated with industrial chemical synthesis, pesticide manufacturing and chlorination processes. The presence of multiple linear alpha olefins (1-Decene, 1-Dodecene, 1-Undecene) and 2-Undecanethiol further supports the hypothesis of petroleum refinery or specialty chemical manufacturing discharge influencing this well. Taken together with the physicochemical data showing the highest BOD (13.78 mg/L), COD (42.4 mg/L), sulphate (592.69 mg/L) and chloride (1163.89 mg/L) exceedances among all Mudhalwadi groundwater samples, the GCMS results for Sample 65 strongly corroborate an industrial contamination pathway from the MIDC boundary into this domestic well. This sample represents the strongest chemical evidence available in this study for direct industrial impact on residential groundwater and is recommended for further confirmatory analysis.

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7. Sample 66: Well Water, Mudhalwadi



Physicochemical Context: Sample 66 recorded the highest TDS in Mudhalwadi (4590 mg/L, exceeding permissible limit), Total Hardness 2484 mg/L as CaCO₃, Sulphate 1163.13 mg/L (nearly three times the permissible limit), Chloride 770.82 mg/L and Nitrate 49.66 mg/L (exceeding acceptable limit).

GCMS Findings:

Retention Time (min)	Probable Compound(s) Identified
13.38	1,3,5-Triazine 2-(pentylthio)-4,6-bis(trichloromethyl); Ethanol 2-butoxy phosphate (3:1) (Tributoxyethyl phosphate); Fumaric acid 4-chlorophenyl undecyl ester; Retinoic acid 5,8-epoxy-5,8-dihydro; Oxalic acid monoamide N-(4-ethylphenyl) undecyl ester
14.31	2,5-Piperazinedione 1,4-bis(2,4-dichlorophenyl); Silane methylvinyl heptyloxy derivative; 2-(5-Ethyl-2-quinuclidinyl)-3-(2-hydroxyethyl)-5-methoxyindole; 4-Dichloromethyldimethylsilyloxyhexadecane
14.4	1,4-Naphthoquinone 2-acetyl-5,8-dihydroxy-3-methoxy; Digitoxin; 4-Methoxyiminomethyl tetramethyl imidazoline oxide

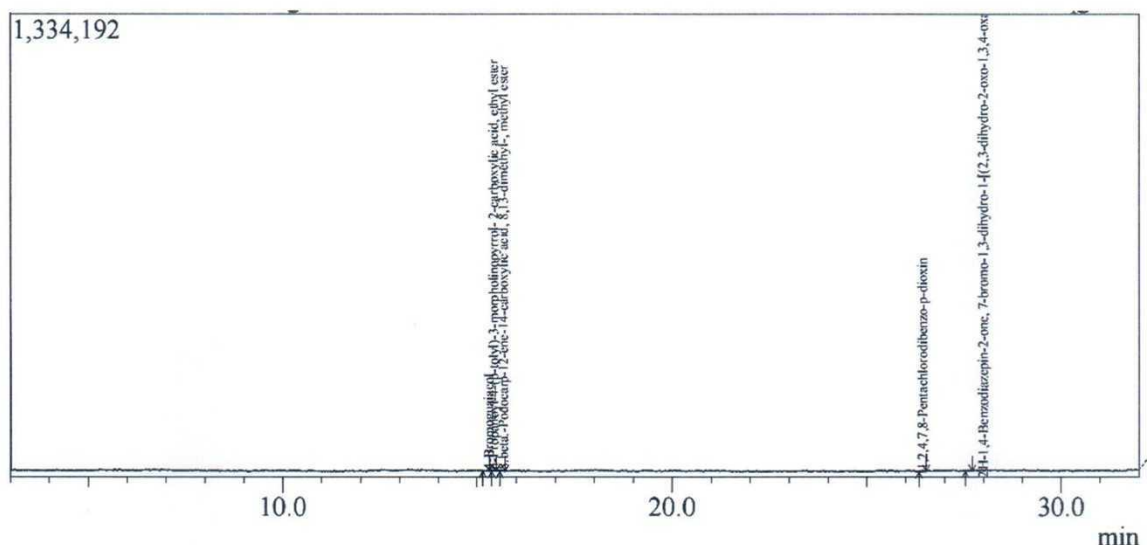
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14.73	1,4-Bis(trichloromethyl)tetrafluorobenzene; 1,3-Bis(trichloromethyl)tetrafluorobenzene; 5-Bromo-4-ethoxy-2,1,3-benzoxadiazole; Silane dimethyl(3-fluorophenoxy)nonyloxy
25.2	Betulin; 2H-3,9a-Methano-1-benzoxepin octahydro tetramethyl derivative

Discussion: Sample 66 shows a complex and toxicologically important GCMS profile. The detection of 1,3,5-Triazine with pentylthio and trichloromethyl groups at 13.38 min is significant, as triazine derivatives are widely used as herbicides (atrazine, simazine family) and industrial biocides. Their presence in groundwater at this concentration suggests either agricultural herbicide runoff or industrial biocide use. Tributoxyethyl phosphate (Ethanol 2-butoxy phosphate) detected at the same retention time is an organophosphate flame retardant and plasticiser widely used in manufacturing, strongly suggesting industrial origin. The detection of multiple chlorinated aromatic compounds including 1,4-Bis(trichloromethyl)tetrafluorobenzene and 1,3-Bis(trichloromethyl)tetrafluorobenzene at 14.73 min is particularly concerning, as polychlorinated aromatic compounds are persistent, bioaccumulative and potentially carcinogenic. These compounds are typically associated with chemical manufacturing, pesticide synthesis or chlorination-based industrial processes rather than agricultural activity. The detection of 1,4-Naphthoquinone derivative at 14.4 min is also significant, as naphthoquinone compounds are used as fungicides, dye intermediates and in pharmaceutical manufacturing. Betulin detected at 25.2 min is a naturally occurring triterpene from plant material and represents a background natural organic input. Overall, the GCMS profile of Sample 66 corroborates the physicochemical finding of extremely high TDS and sulphate, pointing to a complex mixture of industrial chemical infiltration and agricultural herbicide contamination. The presence of flame-retardant compounds and chlorinated aromatics is consistent with proximity to MIDC industrial operations.

Signature

8. Sample 67: Well Water, Mudhalwadi



Physicochemical Context: Sample 67 recorded pH 7.76, TDS 1510 mg/L, Chloride 334.36 mg/L, Sulphate 240.74 mg/L (exceeding acceptable limit) and Total Hardness 810 mg/L as CaCO₃. BOD and COD were at or near detection limits. This sample showed a comparatively less severe physicochemical profile than Samples 65 and 66.

GCMS Findings:

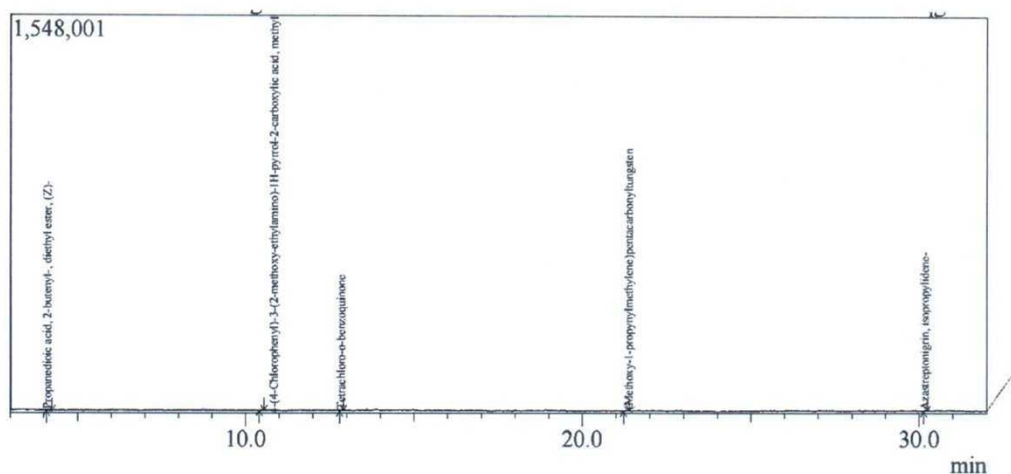
Retention Time (min)	Probable Compound(s) Identified
15.28	n-Propanoyl-4-(p-tolyl)-3-morpholinopyrrol-2-carboxylic acid ethyl ester; Cholest-5-ene-3 β ,19-diol 3-p-toluenesulfonate; Hexaethoxydisiloxane; Disiloxane pentaethoxymethoxy; Disiloxane tetraethoxydimethoxy
15.42	8 β -Podocarp-12-ene-14-carboxylic acid methyl ester; D:A-Friedooleanan-28-oic acid 3 β -hydroxy; 1,4-Naphthalenediol 2,3-dichloro-5-nitro
15.66	1,2,4,7,8-Pentachlorodibenzo-p-dioxin; 1,2,3,7,8-Pentachlorodibenzodioxin; Ferrocene 1,2,3,4,5-pentachloro
26.42	1H-Indene-1,3(2H)-dione 4,5,6,7-tetrachloro; 2H-1,4-Benzodiazepin-2-one bromo derivative; 1,3-Dithiolo pyridine carbonitrile dioxo derivative

Signature

Discussion: Sample 67 contains the most acutely alarming compounds detected in this entire GCMS study. The identification of 1,2,4,7,8-Pentachlorodibenzo-p-dioxin and 1,2,3,7,8-Pentachlorodibenzodioxin at retention time 15.66 min is of the highest regulatory and public health significance. Polychlorinated dibenzo-p-dioxins (PCDDs) belong to the group of persistent organic pollutants (POPs) classified under the Stockholm Convention, and several congeners including 1,2,3,7,8-PentaCDD are classified as Group 1 human carcinogens by the International Agency for Research on Cancer (IARC). Even at trace concentrations, dioxins are hazardous due to their extreme persistence, bioaccumulation in fatty tissues and potential to cause endocrine disruption, immunotoxicity and carcinogenicity with long-term exposure. The detection of these compounds in a domestic well water source in Mudhalwadi is a finding of utmost concern and required immediate further confirmatory analysis using high-resolution GCMS with isotope dilution, as recommended by USEPA Method 1613. The physicochemical data for Sample 67, while not showing dramatic exceedances in conventional parameters, likely underestimates the contamination at this location precisely because dioxins and related compounds are not measured by standard BOD/COD/TDS analysis. The detection of Pentachloroferrocene and tetrachloroindene-dione derivatives at 26.42 min further supports a pattern of persistent chlorinated organic contamination at this location. The source of dioxin contamination is most likely attributable to incomplete combustion of chlorinated materials, possible incineration of chemical waste, or manufacturing processes involving chlorophenol or chlorobenzene chemistry within the MIDC industrial area. Immediate escalation of this finding to MPCB and the NGT is recommended.



9. Sample 68: Well Water, Mudhalwadi



Physicochemical Context: Sample 68 recorded pH 7.51, TDS 1380 mg/L, Chloride 311.39 mg/L, Sulphate 76.43 mg/L, Total Hardness 750.6 mg/L as CaCO₃ and DO 4.6 mg/L. BOD and COD were at or near detection limits. This sample presented a relatively moderate physicochemical profile.

GCMS Findings:

Retention Time (min)	Probable Compound(s) Identified
4.1	4-(4-Chlorophenyl)-3-(2-methoxyethylamino)-1H-pyrrol-2-carboxylic acid methyl ester; Copper bis(2,4-pentanedionato) — Copper acetylacetonate; Benzene pentachloro(trichloroethenyl); Benzenamine 2-bromo-4,6-dinitro; Tetrachloro-o-benzoquinone; 3,4,5,6-Tetrachloropyridazine
10.42	Propanedioic acid 2-butenyl diethyl ester (Z); N'-[1-(4-Methoxyphenyl)ethylidene]-2,2-diphenyl-1-cyclopropanecarbohydrazide
12.83	[Complex organometallic and halogenated derivatives]
21.37	9,10,12,13-Tetrabromooctadecanoic acid; Silane dimethyl(2,3,5,6-tetrachlorophenoxy)nonyloxy; (Methoxy-1-propynylmethylene)pentacarbonyltungsten

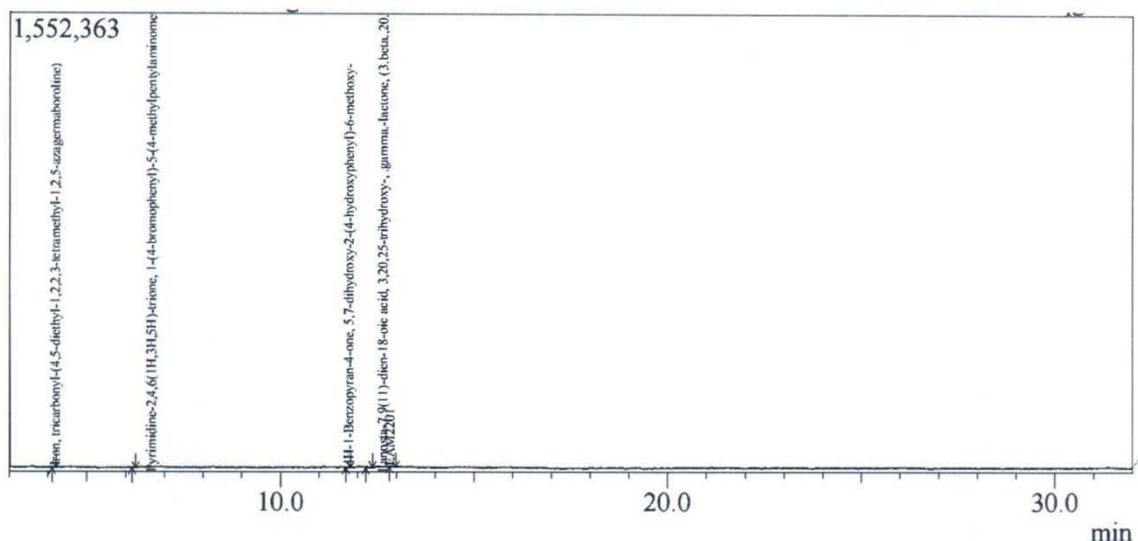
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30.16	1H-Dibenzo[a,i]fluorene decahydronaphthalenyl derivative
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Discussion: Sample 68 presents a highly complex GCMS profile notable for the detection of several heavy metal-organic complexes and chlorinated aromatic compounds. The identification of Copper bis(2,4-pentanedionato) — commonly known as Copper acetylacetonate — at 4.1 min is significant, as this is an organometallic copper complex used in chemical vapour deposition, catalyst manufacturing and industrial chemical synthesis. Its presence in groundwater is not a naturally occurring phenomenon and strongly indicates industrial chemical leachate influence at this location. The detection of Benzene pentachloro(trichloroethenyl), Tetrachloro-o-benzoquinone and 3,4,5,6-Tetrachloropyridazine at the same retention time represents a cluster of highly chlorinated aromatic compounds that are industrial in origin, most likely associated with agrochemical, pharmaceutical or specialty chemical manufacturing processes within the MIDC. The detection of 9,10,12,13-Tetrabromooctadecanoic acid at 21.37 min is a brominated fatty acid, a class of compounds associated with marine organism contamination or industrial bromination processes. The dibenzofluorene derivative at 30.16 min is a polycyclic aromatic hydrocarbon (PAH) derivative, often associated with incomplete combustion of organic matter or petroleum products. The physicochemical data for this sample does not reflect severe contamination in conventional parameters, reinforcing the critical value of GCMS analysis in detecting organic contamination that is invisible to standard physicochemical tests. The organometallic and chlorinated compound profile here is consistent with a diffuse industrial leachate plume reaching this well from the MIDC boundary.

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10. Sample 69: Borewell, Mudhalwadi



Physicochemical Context: Sample 69 recorded pH 7.16, TDS 2210 mg/L (exceeding permissible limit), TSS 56 mg/L, Turbidity 5.26 NTU (exceeding permissible limit), BOD 10.91 mg/L, COD 34.98 mg/L, Nitrate 71.67 mg/L (exceeding acceptable limit), Sulphate 394.23 mg/L (near permissible limit) and Total Hardness 1350 mg/L as CaCO₃. This borewell showed the most severe conventional parameter profile in Mudhalwadi after Samples 65 and 66.

GCMS Findings:

Retention Time (min)	Probable Compound(s) Identified
—	Iron tricarbonyl azagermaboroline complex; trans- α -[3-Chlorophenyl]-5-chloro-2-aminocinnamic acid; 1H,3H-2a,5a-Methanocycloprop[f]indene tetrabromohexahydro derivative
4.18	Pyrimidine-2,4,6(1H,3H,5H)-trione 1-(4-bromophenyl)-5-(4-methylpentylaminomethylene); 1,3,5-Triazine 2,4,6-trimethoxy; Carbamic acid N-[2-(4-methylcyclohex-3-enyl)prop-2-yl] 2,2,2-trichloroethyl ester
6.24	4H-1-Benzopyran-4-one 5,7-dihydroxy-2-(4-hydroxyphenyl)-6-methoxy (a flavonoid compound); Vinclozoline; Hafnium bis(cyclooctatetraene)

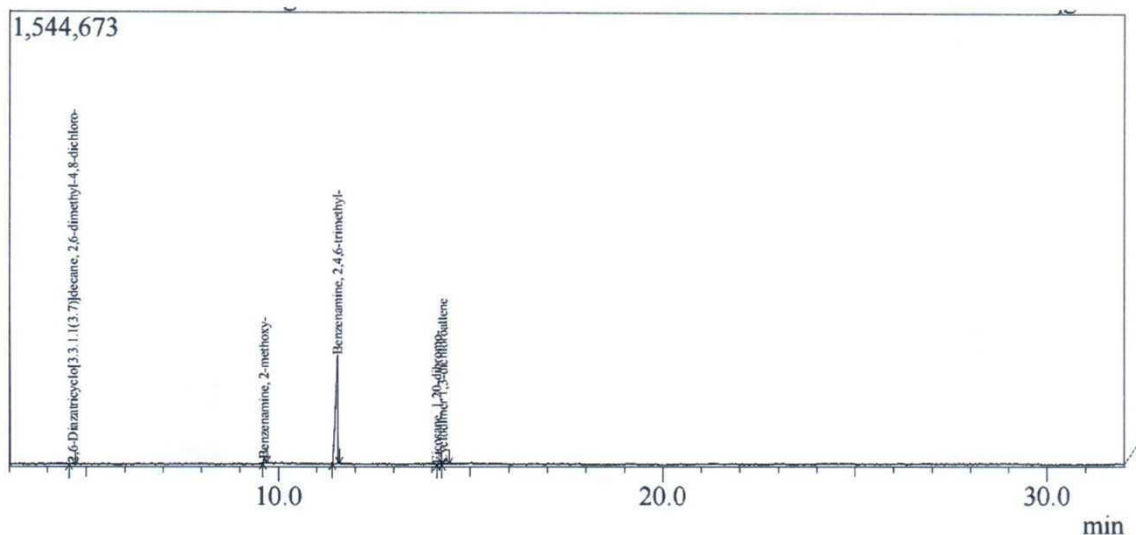
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11.77	Lanosta-7,9(11)-dien-18-oic acid triol lactone (Lanostane triterpenoid)
12.23	EAM2201 (a synthetic cannabinoid); Thionaphthene 2-[1-(1-azacycloheptyl)cyclohexyl]
12.83	[Steroidal and bile acid derivatives]

Discussion: Sample 69 presents a GCMS profile of considerable toxicological and regulatory significance. The detection of Vinclozoline at 6.24 min is of particular concern. Vinclozoline is a dicarboximide fungicide that is classified as an endocrine disruptor, with demonstrated anti-androgenic activity and transgenerational epigenetic effects. While Vinclozoline was used in agricultural fungicide applications, its detection in groundwater from a borewell is significant and raises concerns about either legacy agricultural application in surrounding fields or possible industrial origin from a pharmaceutical or agrochemical manufacturing unit within the MIDC. The identification of EAM2201 at 12.23 min is a notable finding. EAM2201 belongs to the synthetic cannabinoid class, which is not expected in agricultural or naturally occurring groundwater samples. While the GCMS library match requires confirmatory analysis, the identification of this compound class in groundwater required immediate attention as it suggests the possible disposal or leaching of synthetic chemical waste in proximity to this borewell. The detection of Carbamic acid with trichloroethyl ester at 4.18 min (a carbamate class compound) is consistent with carbamate pesticide or pharmaceutical intermediate contamination. The 1,3,5-Triazine 2,4,6-trimethoxy compound is a triazine herbicide-related structure, again pointing to agricultural chemical input. The complex organometallic compounds identified (iron carbonyls, hafnium organometallics) are purely industrial in origin and have no natural pathway into groundwater other than through industrial waste disposal or leachate migration. The physicochemical data for this borewell, with BOD 10.91 mg/L, COD 34.98 mg/L and TDS 2210 mg/L, is fully consistent with the complex organic load detected by GCMS.

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11. BB Chemicals (Sample 70): Drainage Line Outside Compound Wall



Physicochemical Context: Sample 70 recorded pH 9.67, exceeding the acceptable effluent discharge range. Total Dissolved Solids was 3060 mg/L and Total Suspended Solids was 940 mg/L, both well above the effluent discharge limit of 100 mg/L for TSS. Total Alkalinity was 1200 mg/L, an extremely high value. BOD was 10,000 mg/L and COD was 30,144 mg/L, the most severe organic pollution load recorded across the entire study. Nitrate was 65.06 mg/L and Sulphate was 490.10 mg/L, both exceeding their respective reference limits.

GCMS Findings:

Peak	Retention Time (min)	Area %	Compound Identified
1	4.650	1.08	2,6-Diazatricyclo[3.3.1.1(3,7)]decane, 2,6-dimethyl-4,8-dichloro derivative
2	9.625	2.30	Benzenamine, 2-methoxy- (o-Anisidine)
3	11.540	93.94	Benzenamine, 2,4,6-trimethyl- (2,4,6-Trimethylaniline)
4	14.130	1.12	Eicosane, 1,20-dibromo-
5	14.294	1.56	Cyclodimer 1,3-dichloroallene

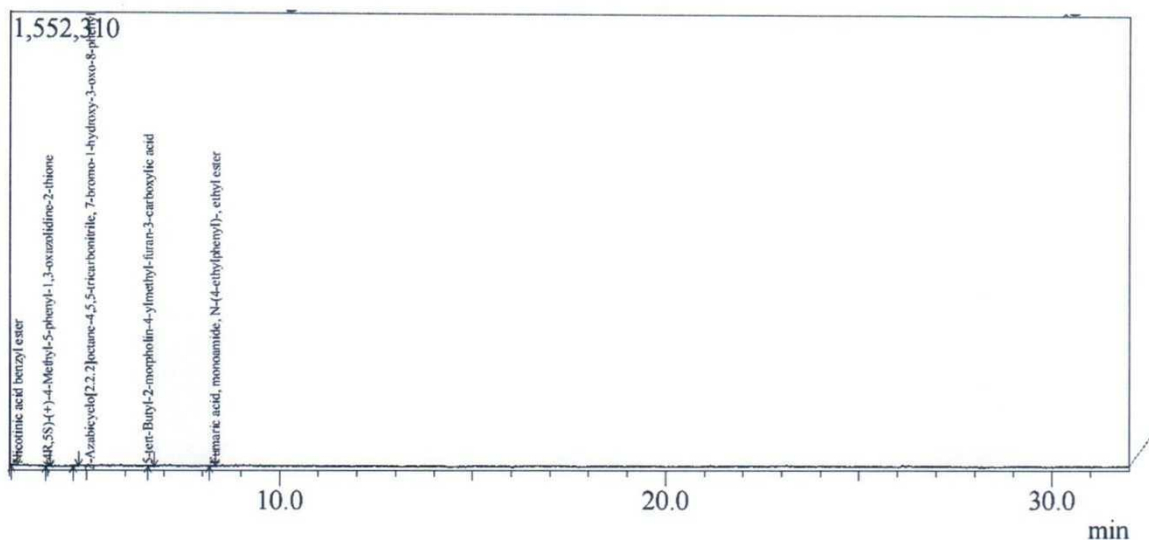
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Discussion: The GCMS profile of Sample 70 is dominated overwhelmingly by a single compound, Benzenamine 2,4,6-trimethyl (also known as 2,4,6-trimethylaniline or mesidine), which accounts for nearly 94 percent of the total identified peak area. This is a highly significant finding. Trimethylaniline is a synthetic aromatic amine used almost exclusively as a chemical intermediate in the manufacture of dyes, pesticides, pharmaceuticals and rubber chemicals, and has no natural or agricultural source. Aromatic amines of this type are also of toxicological concern, as several compounds in this chemical class are classified as suspected carcinogens and can cause methemoglobinemia and other blood related toxicity on exposure. The presence of a second aniline derivative, o-Anisidine (Benzenamine 2-methoxy), at 2.30 percent further supports a shared industrial source, as o-Anisidine is also a known dye and chemical intermediate and is classified as a probable human carcinogen by IARC. The detection of a dichloro substituted diazatricyclic decane compound and a dichloroallene cyclodimer adds further chlorinated organic content consistent with chemical synthesis byproducts. The dibromoeicosane compound, a long chain brominated hydrocarbon, is unusual and may indicate the use of brominated flame retardants or brominated intermediates in processes at this facility.

The near total dominance of trimethylaniline in this sample, combined with the extreme BOD and COD values recorded in the physicochemical analysis, gives the clearest chemical signature in this entire study of a single, specific industrial source rather than a diffuse or mixed contamination pattern. The compound profile is consistent with discharge from a dye, pesticide intermediate or specialty amine manufacturing process, and aligns directly with this sample being collected from an open drain immediately outside the BB Chemicals compound wall, with no evidence of treatment prior to discharge. Given the toxicological concern associated with aromatic amine compounds, particularly their potential carcinogenicity and blood toxicity, this finding strengthens the case for urgent regulatory action regarding discharge from this facility and supports the need for confirmatory quantitative analysis of trimethylaniline and o-anisidine levels in this drain and in the nearby groundwater wells in Mudhalwadi.



12. Sample 71: Well Water, MIDC Backside



Physicochemical Context: Sample 71 (MIDC Back well) recorded pH 6.71 (lowest in Mudhalwadi), TDS 4000 mg/L (exceeding permissible limit), Chloride 939.28 mg/L (near permissible limit), Total Hardness 2376 mg/L as CaCO₃, BOD at detection limit (5 mg/L) and Nitrate 9.49 mg/L (within limits). The very low pH and extremely high TDS and hardness at this well, located immediately behind the MIDC boundary, made it a priority candidate for GCMS.

GCMS Findings:

Retention Time (min)	Probable Compound(s) Identified
—	Nicotinic acid benzyl ester; Acetamide 2-chloro-N,N-bis(phenylmethyl); 1,3-Cyclopentadiene 5-(1-methylethylidene); Nicotinic acid benzyl ester
3.06	(4R,5S)-(+)-4-Methyl-5-phenyl-1,3-oxazolidine-2-thione; 3-Chloro-2,6-dimethylpyrido[1,2-a]pyrimidin-4-one; N,N-Dimethyl-7-(2-phenylethynyl)-2,1,3-benzoxadiazol-5-amine; Pyrrolo[1,2-a]quinoxaline tricarboxylic acid trimethyl ester

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3.99	2-Azabicyclo[2.2.2]octane tricarbonitrile bromo hydroxy oxo phenyl derivative; 6-Bromo-4-(2-chlorophenyl)-2,2-dimethyl-1,2-dihydroquinazolinone; Pyrimidine-5-carboxylic acid dimethoxyphenyl methyl derivative; Lycoramine 3-bromo-desoxy-6-O-desmethyl
4.67	5-tert-Butyl-2-morpholin-4-ylmethyl-furan-3-carboxylic acid; 4-Acetyl-10-bromophenanthrene; 3-Pyridinecarboxylic acid 2,5-dichloro ethyl ester; 2,5-Cyclohexadien-1-one 2,6-dichloro-4-(chloroimino)
6.59	Fumaric acid monoamide N-(4-ethylphenyl) ethyl ester; Benzamide N,N-bis(2-ethylhexyl)-2,3,4-trifluoro; 2,5-Dibromo-3,6-difluorobenzenesulfonyl chloride

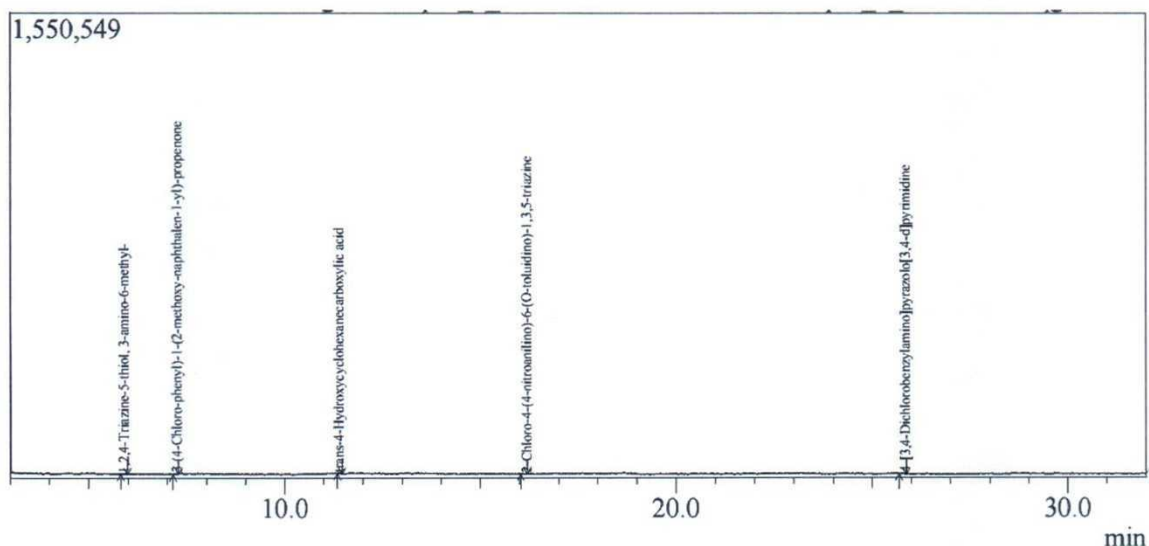
Discussion: Sample 71 from the MIDC Back well presents the most chemically complex organic profile in terms of nitrogen-containing heterocyclic compounds and halogenated aromatics, which is consistent with its immediate proximity to the MIDC industrial boundary. The detection of multiple nitrogen-heterocyclic compounds including pyrido-pyrimidinones, quinoxaline derivatives, benzimidazole-related structures and pyridinecarboxylic acid esters at early retention times (3.06 to 6.59 min) points strongly toward pharmaceutical manufacturing or fine chemical synthesis as a contamination source, since these structural classes are characteristic building blocks and intermediates in active pharmaceutical ingredient (API) production. This is significant because MIDC Paithan hosts pharmaceutical and specialty chemical manufacturing units, and API synthesis generates complex nitrogen heterocyclic waste streams that are highly challenging to treat in ETPs. The detection of 4-Acetyl-10-bromophenanthrene and 2,5-Dibromo-3,6-difluorobenzenesulfonyl chloride at 4.67 and 6.59 min respectively, representing halogenated PAH and sulfonyl chloride derivatives, further supports a pharmaceutical or specialty chemical manufacturing origin rather than agricultural or geogenic sources. The detection of Nicotinic acid benzyl ester (a niacin derivative used in pharmaceutical synthesis) is consistent with pharmaceutical manufacturing discharge. The chlorinated and fluorinated aromatic sulfonyl compound (2,5-Dibromo-3,6-difluorobenzenesulfonyl chloride) detected at 6.59 min is exclusively an industrial synthetic chemical with no agricultural or natural occurrence. The physicochemical profile of this well, showing TDS 4000 mg/L, Chloride 939 mg/L and the lowest pH (6.71) in Mudhalwadi despite low BOD, is now well explained by the GCMS findings: the contamination at this location is

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primarily from industrial organic chemicals rather than biological organic matter, which would not necessarily elevate BOD/COD but would contribute to ionic load, acidification and complex dissolved organic carbon not captured by conventional parameters.

Following the physicochemical screening of all groundwater samples across the study area, five locations were identified as priority candidates for advanced GCMS analysis based on anomalous parameter combinations that could not be fully explained by agricultural or geogenic influence alone. These samples were selected from Katpur, Wahegaon, Narayangaon and MIDC Back, representing villages at varying distances from the MIDC Paithan industrial boundary. The objective was to determine whether organic compounds of industrial origin are present in groundwater beyond what conventional physicochemical parameters alone could reveal. Compounds were identified by matching mass spectra against the NIST library. The chromatogram for each sample is presented in the respective figure below.

13. Sample 6 (Katpur, Well Water)



Physicochemical Context: Sample 6 recorded pH 8.70 (exceeding the acceptable upper limit), TDS 2850 mg/L (exceeding the permissible limit), BOD 9.33 mg/L, COD 30.14 mg/L, Magnesium hardness 577.80 mg/L, Nitrate 87.14 mg/L (exceeding the acceptable limit) and Sulphate 1668.79 mg/L, the highest sulphate value recorded among groundwater samples in the entire study, exceeding the permissible limit by more than four times. This combination of extreme sulphate alongside measurable organic load made Sample 6 the top priority for GCMS investigation.

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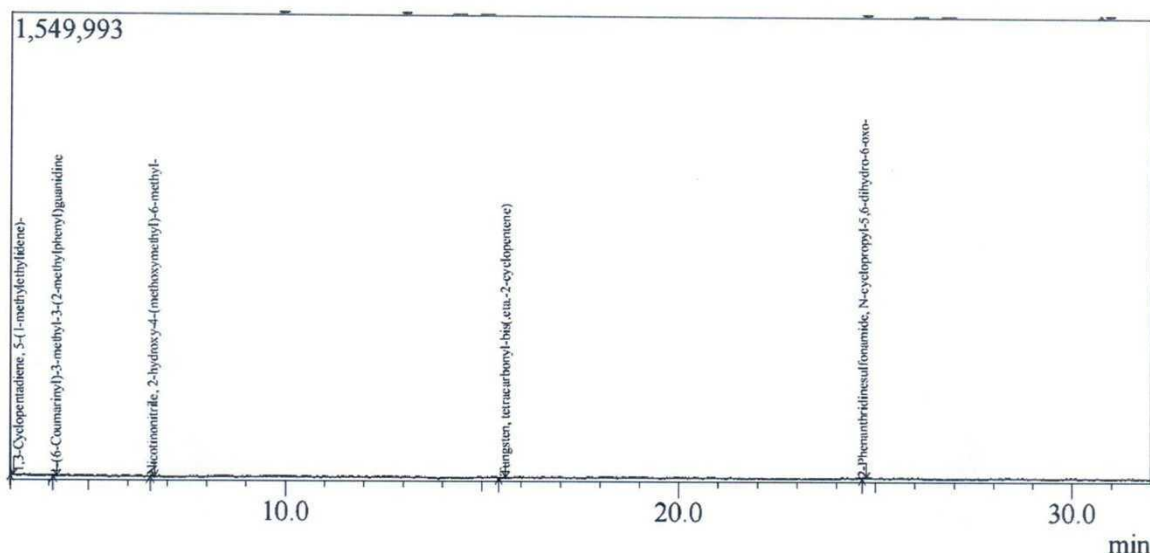
GCMS Findings:

Sample Name	RT	Compound Name
Katpur_6	5.8	a) 1,2,4-Triazine-5-thiol, 3-amino-6-m
	7.1	b) 3-(4-Chloro-phenyl)-1-(2-methoxy
	11.3	c) trans-4-Hydroxycyclohexanecarboxylic acid
	16.17	d) 2-Chloro-4-(4-nitroanilino)-6-(O-to
	25.84	e) 4-[3,4-Dichlorobenzylamino]pyrazo

Discussion: The compound profile at Sample 6 reveals a triazine derivative, consistent with herbicide or agricultural runoff influence, alongside multiple chlorinated organic compounds including a dichlorobenzylamino pyrazole derivative and a chloro nitroanilino tolyl compound, which are more consistent with industrial effluent or biocide origin than with agricultural sources alone. The presence of trans-4-hydroxycyclohexanecarboxylic acid, an organic acid residue, further points toward synthetic chemical degradation or waste byproducts. Taken together, this represents a highly concentrated mixture combining agricultural and industrial signatures at the same location. This finding directly corroborates the physicochemical data, where Sample 6 showed the most extreme sulphate exceedance among all groundwater samples alongside a measurable organic load (BOD and COD), confirming that this well is impacted by more than one contamination pathway simultaneously. The combination of agricultural triazine residues with industrial chlorinated organics suggests Sample 6 may be receiving both fertilizer-laden agricultural runoff and a degree of industrial effluent infiltration, possibly through a shared drainage or seepage pathway in this part of Katpur.



14. Sample 9 (Wahegaon, Well Water)



Physicochemical Context: Sample 9 recorded the highest BOD (36 mg/L) and COD (110.53 mg/L) among all groundwater samples in the entire study excluding industrial point sources, along with TDS 4410 mg/L, Chloride 949.07 mg/L, Total Hardness 2354 mg/L and Sulphate 1048 mg/L, all severely exceeding their respective permissible limits. This unusually high organic load in a domestic well, with no obvious industrial neighbour, made this sample a high priority candidate for GCMS.

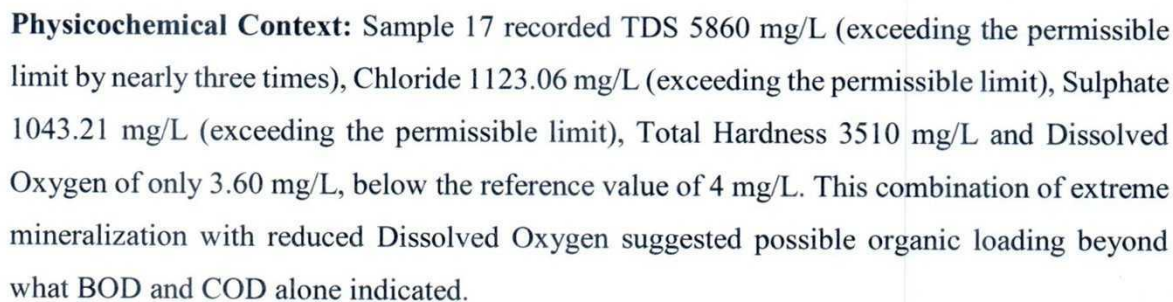
GCMS Findings:

Sample Name	RT	Compound Name
Wahegaon_9	3.04	a) 1,3-Cyclopentadiene, 5-(1-methylet
	4.1	b) 1-(6-Coumarinyl)-3-methyl-3-(2-me
	6.6	c) Nicotinonitrile, 2-hydroxy-4-(metho
	15.5	c) Nicotinonitrile, 2-hydroxy-4-(metho
	24.68	e) 2-Phenanthridinesulfonamide, N-cyc

Discussion: The GCMS profile at Sample 9 is one of the most industrially significant findings in this study. The detection of a Tungsten tetracarbonyl organometallic complex is particularly notable, as organometallic tungsten compounds have no natural environmental source and are exclusively associated with specialty chemical manufacturing, catalysis or metal complex

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15. Sample 17 (Narayangaon, Borewell)



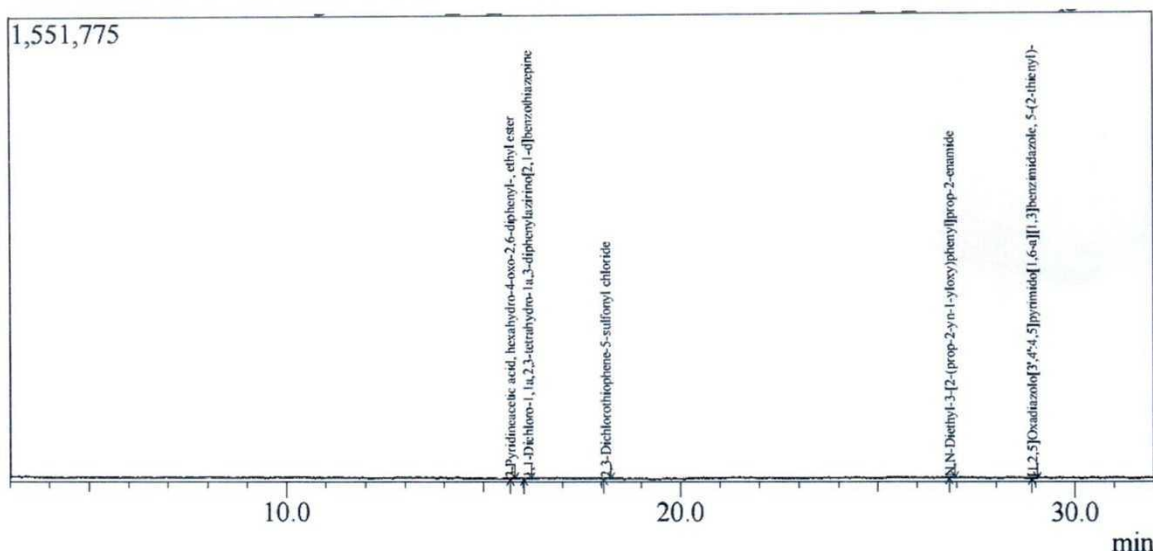
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Sample Name	RT	Compound Name
Narayangaon_17	3.2	a) 2H-1,4-benzoxazin-2-one, 3,6,8-trime
	3.3	b) o-Xylene
	9.2	c) Ethanedial, dioxime
	17.68	d) 1H-Indole, 2-methoxy-3,5-dimethyl
	31.1	e) Fumaric acid, cyclohexyl heptadecyl

Discussion: The GCMS analysis of Sample 17 reveals a complex mixture combining petroleum hydrocarbons, pesticide or herbicide derivatives, and industrial plasticiser or additive compounds. The detection of o-Xylene is significant, as xylene is a volatile aromatic hydrocarbon (BTEX compound) characteristic of petroleum products and industrial solvents, and is not expected in groundwater from natural or agricultural sources. The benzoxazinone derivative is structurally associated with plant defense compounds but also overlaps with certain herbicide chemistries, while the indole derivative may reflect either natural organic matter degradation or synthetic intermediate residues. The fumaric acid cyclohexyl heptadecyl ester is consistent with industrial plasticiser or additive chemistry, commonly used in polymer and rubber manufacturing. The combination of a volatile aromatic hydrocarbon with agricultural residues and polymer additive compounds confirms mixed environmental pollution at this location, consistent with the severe mineralisation, low Dissolved Oxygen and elevated sulphate recorded during physicochemical analysis. This finding supports the earlier interpretation that Narayangaon's groundwater is influenced by more than purely geogenic weathering, with a discernible industrial organic component now confirmed through GCMS.

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16. Sample 23 (MIDC Back, Square Well)



Physicochemical Context: Sample 23 recorded the most severe overall contamination profile of any groundwater sample in the entire study, with TDS 6552 mg/L, Turbidity 2067.44 NTU (over 400 times the permissible limit), Total Suspended Solids 224 mg/L, Total Hardness 3348 mg/L, Sulphate 937.69 mg/L and a critically low Dissolved Oxygen of 1.20 mg/L. This well is the closest groundwater sampling point to the MIDC industrial boundary and was the top priority for GCMS confirmation of industrial impact.

GCMS Findings:

Sample Name	RT	Compound Name
MIDC_23	15.68	a) 3-Pyridineacetic acid, hexahydro-4
	16.14	b) 1,1-Dichloro-1,1a,2,3-tetrahydro-1a,3
	18.11	c) 2,3-Dichlorothiophene-5-sulfonyl
	26.82	d) N, N-Diethyl-3-[2-(prop-2-yn-1-yloxy
	28.92	e) [1,2,5]Oxadiazolo[3',4':4,5]pyrimid

Discussion: Sample 23 presents the most chemically conclusive evidence of industrial contamination found in this study. The compound profile is dominated by heavily functionalized halogenated, chlorinated and sulfur-bearing aromatic structures, including a dichloro tetrahydro derivative and a dichlorothiophene sulfonyl chloride compound. Sulfonyl chloride derivatives in particular are reactive synthetic intermediates used almost exclusively

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in industrial organic synthesis, including pharmaceutical, dye and agrochemical manufacturing, and have no natural or agricultural source. The oxadiazolo-pyrimidine compound is a complex heterocyclic structure typical of pharmaceutical or agrochemical active ingredient synthesis. This structurally definitive profile is consistent with direct, untreated industrial wastewater discharge heavily laden with synthetic organic synthesis materials, and represents the clearest chemical fingerprint of industrial impact identified anywhere in this study. Combined with the physicochemical findings of extreme turbidity, total suspended solids and critically low Dissolved Oxygen, this well shows the strongest evidence of direct hydraulic connectivity to an industrial contamination source, most likely linked to the MIDC industrial estate given this well's immediate proximity to the boundary. This finding should be treated as the most significant evidence in the study for establishing a direct link between MIDC industrial activity and groundwater contamination in the surrounding villages.

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Concluding Remarks

The comprehensive scientific study conducted across villages surrounding the MIDC Paithan Industrial Area, namely Isarwadi, Katpur, Wahegaon, Pachalgaon, Narayangaon, Rahatgaon, Karajkheda, Pimpalwadi, Mudhalwadi under the directions of the Hon'ble National Green Tribunal in OA No. 222/2023 and vide Work Order No. MPCB/RO(BMW)/B-204 dated 10/04/2026, presents a detailed and evidence-based assessment of groundwater quality, soil condition characteristics in the MIDC Paithan area during the pre-monsoon season (Phase I).

Groundwater Quality

The physicochemical analysis of groundwater samples collected from borewells and wells across the ten study villages reveals a widespread and consistent pattern of quality deterioration. Hardness parameters, including Calcium hardness, Magnesium hardness and Total Hardness as CaCO_3 , exceeded their respective permissible limits at virtually every groundwater location across all villages, with the most severe exceedances recorded at Narayangaon (Total Hardness up to 4428 mg/L, approximately seven times the permissible limit), Wahegaon (Total Hardness up to 2592 mg/L) and Mudhalwadi (Total Hardness up to 2484 mg/L). Total Dissolved Solids exceeded permissible limits at multiple locations in Wahegaon, Narayangaon, Mudhalwadi and Katpur, with values reaching up to 6700 mg/L at Narayangaon, more than three times the permissible limit. Nitrate as NO_3 exceeded the acceptable limit of 45 mg/L at all four sampling locations in Isarwadi, all four in Wahegaon, three of four in Pachalgaon and Rahatgaon, and at multiple locations in Mudhalwadi, Karajkheda and Pimpalwadi, confirming widespread and near-universal agricultural nitrogen contamination of the shallow aquifer across the study area. Chloride exceeded permissible limits at Narayangaon and Mudhalwadi, and Sulphate exceeded permissible limits at multiple locations across Wahegaon, Narayangaon, Katpur and Mudhalwadi, with Sample 6 in Katpur recording the single highest groundwater sulphate concentration at 1668.79 mg/L, more than four times the permissible limit, an anomaly that could not be explained by agricultural influence alone. Dissolved Oxygen fell below the reference value at several locations including MIDC Back (1.20 mg/L, critically low), Narayangaon Sample 17 (3.60 mg/L) and Isarwadi Sample 4 (4.10 mg/L, borderline), indicating oxygen depletion consistent with organic loading. The MIDC Back square well (Sample 23) recorded the most extreme overall groundwater profile in the study, with Turbidity of 2067.44 NTU, TDS of 6552 mg/L and Dissolved Oxygen of only 1.20 mg/L, and given its location immediately adjacent to the MIDC industrial

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boundary, represents the strongest physicochemical evidence of direct industrial impact on shallow groundwater.

The effluent sample collected from the open drainage line outside the BB Chemicals compound wall (Sample 70) recorded the most severe pollution values in the entire study, with BOD of 10,000 mg/L and COD of 30,144 mg/L, exceeding the CPCB Schedule VI discharge limits of 30 mg/L and 250 mg/L respectively by several hundred times. The pH of 9.67 and Total Alkalinity of 1200 mg/L confirmed an alkaline, highly reactive chemical waste stream being discharged directly into an open, untreated drain accessible to the surrounding environment. The GCMS analysis of this drain water conclusively identified 2,4,6-trimethylaniline (mesidine) as the dominant compound, accounting for nearly 94 percent of the total identified peak area, alongside o-Anisidine, both of which are synthetic aromatic amines used as industrial chemical intermediates and are classified as probable human carcinogens. This finding provides the clearest and most specific chemical evidence of illegal untreated industrial discharge identified anywhere in this study.

Soil Quality

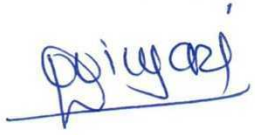
The soil quality assessment across the ten villages reveals two broad patterns of concern operating simultaneously. The first is a widespread and near-universal enrichment of Magnesium across all village soils, consistent with the geogenic weathering of basaltic Deccan Trap parent material, which is the natural background for this region and serves as confirmation that the Jayakwadi Dam reference site soil parameters provide a reliable baseline for the study area. The second and more concerning pattern is the consistent elevation of Nitrate Nitrogen across most villages, particularly at Isarwadi (S11, 93.38%), Wahegaon (S65, 68.68%), Pachalgaon (S21, 68.44%), Pimpalwadi (S17, 68.44%), Rahatgaon (S7, 56.31%) and Mudhalwadi (S3, 81.37%), which directly mirrors the groundwater nitrate exceedances recorded at the same locations and confirms that agricultural nitrogen loading is the primary driver of nitrate contamination across both soil and groundwater in the study area. Sodium enrichment in soil was most severe at Wahegaon (S65, 2712.70 mg/kg, the highest in the study) and at multiple locations in Mudhalwadi, Rahatgaon and Narayangaon, consistent with long-term irrigation using high-TDS, high-sodium groundwater and indicating progressive sodification of agricultural land in these villages. Lead values were highest at Karajkheda S19 (31.77 meq/L, the highest in the entire study) and Katpur S12 (31.77 meq/L), both requiring further monitoring. Copper at multiple locations across Isarwadi, Mudhalwadi and Pimpalwadi



exceeded the Jayakwadi Dam reference value of 61.39 mg/kg, pointing to a degree of anthropogenic copper enrichment beyond the geogenic baseline, most likely from copper-based fungicide application combined with possible industrial input at Mudhalwadi locations closest to the drainage corridor. Total Chromium was below the detection limit at all locations across all villages, indicating no detectable chromium contamination in the agricultural soils at the time of sampling. Available Nitrogen was below the detection limit at every single location across the entire study area, indicating severely deficient immediately plant-available nitrogen in the soils of all villages despite elevated Nitrate Nitrogen percentages, suggesting that nitrogen in these soils is largely in an inorganic accumulated form rather than biologically active plant-available form, which has direct negative implications for agricultural productivity.

Advanced GCMS Analysis

The Gas Chromatography-Mass Spectrometry analysis conducted on selected water samples from Mudhalwadi and the five priority locations provides the most critical findings of this study in terms of establishing an industrial contamination link. Across the Mudhalwadi samples, GCMS confirmed the presence of Pentachlorodibenzo-p-dioxins in Sample 67, which are among the most toxic and persistent organic pollutants known and are classified as Group 1 human carcinogens. BTEX compounds (xylenes) were confirmed at Sample 65, Endosulfan sulfate, a banned pesticide, was confirmed at Sample 63, and pharmaceutical synthesis intermediates and organometallic compounds were confirmed at Sample 71 (MIDC Back well). Among the five priority samples, the MIDC Back well (Sample 23) showed the most chemically definitive industrial signature, with dichlorothiophene sulfonyl chloride and oxadiazolopyrimidine compounds exclusively associated with chemical synthesis processes. Sample 9 from Wahegaon yielded the most unexpected finding, confirming a tungsten tetracarbonyl organometallic complex in a domestic well in a village not immediately adjacent to MIDC, indicating that industrial contamination pathways extend further into the surrounding area than proximity to the MIDC boundary alone would suggest. Sample 6 from Katpur confirmed the presence of a mix of triazine herbicide derivatives and industrial chlorinated organics, providing the strongest evidence of mixed agricultural and industrial contamination at a single well location in the study.



Annex 4

**MAHARASHTRA POLLUTION CONTROL BOARD**

Regional Office, Paryavaran Bhavan, A-4/1, MIDC
Area, Chikalthana, Behind Daynik Lokpatra, Near
Seth Nandlal Dhoot Hospital, Jalna Road,
Chh.Sambhajinagar-431 210.



Tal: - 0240-2993004 Email ID- rochhatrapatisambhajinagar@mpcb.gov.in Website:- www.mpcb.gov.in

MPCB/CHH.S./ CD / 2606290001/ 2026

Date: - 29/06/2026

To,
M/s: B.B. Chemicals,
Plot No.- B-53 MIDC Paithan,
Tal- Paithan, Dist- Chhatrapati Sambhajinagar.

Sub: - Closure Directions u/s 33A of the Water (Prevention & Control of Pollution) Act, 1974
and/or u/s 31A of the Air (Prevention & Control of Pollution) Act, 1981.

Ref:- 1. Consent granted by the Board vide no. Format1.0/AS(T)/ UAN No. 0000126491/
CR/2202001685 dtd. – 25.02.2022 which is valid upto 30.11.2026.
2. Conditional Restart issued by the Board on dtd. – 18.06.2024.
3. Interim Report received from ICT Dtd. 25.06.2026.
4. Visit of Board officials to your unit on 25.06.2026.
5. Approval for Closure Direction received from HQ through legal module No. MPCB-
LEGAL_ ACTIONS-080524026 on dtd. 29.06.2026.

.....

WHEREAS, the Maharashtra Pollution Control Board has granted Consent to Operate u/s 26 of the Water (Prevention and Control of Pollution) Act, 1974 and u/s 21 of the Air (Prevention and Control of Pollution) Act, 1981 & Authorization under Rule 6 of the Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules, 2016, on 25.02.2022, which is valid upto 30.11.2026 subject to certain terms and conditions.

AND WHEREAS, it was also obligatory on your part to provide adequate and efficient pollution control devices and take adequate measures to control air & water pollution, so as to achieve the consented standards.

AND WHEREAS, the Maharashtra Pollution Control Board has issued Conditional Restart Direction vide letter dated 18.06.2024 to you and directed to comply with the same, and visit was carried out by the Board official for verification of Conditional Restart Direction and Consent Conditions and the following non-compliances were observed during visit:-

1. You are discharging black color waste water outside factory premises through flexible pipe line and the same water found lodged in nalla adjacent to factory during the visit of ICT representatives.
2. You have provided inadequate Effluent Treatment Plant with underground neutralization tank which is not allowed as per CEPI guidelines.
3. You have not installed full fledged Effluent Treatment Plant for treatment of strong and weak COD / TDS stream.
4. You are disposing high COD stream / untreated waste water in soak pit through flexible pipe line.
5. You have not connected Scrubbing Media / Effluent in ETP collection tank.
6. You have not upgraded Air Pollution Control System for pulveriser and blending section as lot of dust observed accumulated within work environment.
7. You are using wood as fuel in boiler without obtaining permission from the Board.
8. You have not provided scrubbing system to acid storage tank.
9. You have not provided dyke wall for storage of various chemicals.
10. You are discharging untreated waste water from various pin points sources outside in storm water drain and at back side of the factory.

11. You have not provided dedicated storage for Hazardous Waste generated and same found stored in unscientific manner in work place.
12. You have not produced details of Hazardous Waste disposal to Common Hazardous Waste Treatment and Disposal Facility.

NOW THEREFORE, as per above report of SRO and report received from ICT Matunga it has being observed that you are discharging black colored waste water bearing BOD values of 10,000 mg/L and COD of 34,000 mg/L indicating highly polluted discharge let directly into open drain leading outside factory premises through flexible pipes.

AND WHEREAS, inspite of earlier Proposed Directions. Interim Directions followed by Direction of Closure & Conditional Restart you are continuing the non- compliances and causing serious pollution thereof and even after giving reasonable opportunity, you have failed to comply with the above Directions and consent conditions and also failed to provide adequate pollution control devices.

NOW THEREFORE, in view of serious continued non- compliances you are hereby directed to stop your manufacturing activity forthwith within 72 hours, till corrective and remedial measures are taken to restore the environmental pollution, failing which, the appropriate competent authorities are directed to disconnect electricity & water supply to your unit, which may please be noted, failing which, the Board will have no option than to initiate appropriate legal action under the provisions of the Water (Prevention & Control of Pollution) Act, 1974 and the Air (Prevention & Control of Pollution) Act, 1981. You shall undertake safe closure steps so as to ensure that no-serious damage including environmental hazard is caused in the surrounding areas.

This is issued with the approval of competent authorities of the Board.

Digitally signed by
Manish Sopan Holkar
Date: 29-06-2026
13:22:11

(Manish Holkar)
**Regional Officer-
Chhatrapati Sambhajnagar.**

Copy submitted for information to: The Member Secretary, MPCB, Mumbai

Copy f.w.cs.to:-

1. Principal Scientific Officer /Law Officer (P & L Division), MPCB, Sion Mumbai.
2. The Executive Engineer- / Addl. Engineer, Maharashtra State Electricity Distribution Co. Ltd., Paithan MIDC area, Office - Opp. Garware Stadium MIDC Chikaltana - He is directed to disconnect electricity supply to the aforesaid unit forthwith & inform this office accordingly.
3. The Executive Engineer-Water Supply Paithan MIDC- He is directed to disconnect the water supply to the aforesaid unit forthwith & inform this office accordingly.

Copy to: The Sub Regional Officer, MPCB- Chhatrapati Sambhajnagar- He is directed to serve personally the Directions to the industry as well as competent authorities and ensure compliance of Directions by reporting it to HQ under intimation to this Office.