

BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH,

NEW DELHI

ORIGINAL APPLICATION NO. 619/2022

IN THE MATTER OF:

MAST RAM & ANR.

...APPLICANT

VERSUS

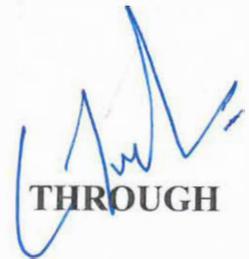
STATE OF HIMACHAL PRADESH AND ORS

...RESPONDENT

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PLACE: NEW DELHI

DATE: 16 .08.2024

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**ADDITIONAL COMPLIANCE REPORT ON BEHALF OF THE
RESPONDENT NO. 5 IN FURTHERANCE TO ADDITIONAL
COMPLIANCE REPORT FILED ON 29.04.2024.**

Most Respectfully Submitted:

Preliminary submissions and background:

1. The Project Proponent in furtherance of its additional compliance Report filed on 29.04.2024 is hereby filing an updated status of the compliances and action taken with reference to some of the remedial measures which were to be complied as per the recommendations of the Joint Committee as per its report dated 01.05.2023 as well as the checklists regarding the compliance status of CTO and EC as directed by the Hon'ble Tribunal, Principal Bench on the last date of hearing.

The same are as follows:

(2)

S. No	Joint Committee Recommendations	Compliance Status	Completion Date
1.	<p><u>Recommendation No 1 & 2:</u></p> <p>1. The industry is neither meeting the norms/conditions of Recycle (ZLD) prescribed in the CTO issued by HPPCB and nor meeting the inlet norms of CETP prescribed by the Himachal Government/PPCB for sending the effluent to CETP, in violation of the conditions of Consent to Operate.</p> <p>2. According to HPPCB Member <i>“though the ETP of the Industry has been found to be non-operational by the Joint Committee, the industry has been treating a part of effluent (10-15 m³/day) and sending the remaining untreated effluent without complying with the Inlet norms of CETP for the last 04 years, in violation of conditions of CTO”</i> The industry has been given ETP</p>	<p>Response:</p> <p>The Project Proponent has complied with all the regulatory requirements and has taken timely efforts as required and has achieved the ZLD status.</p> <p>The Project Proponent hereby confirms that the ETP is now adequate to treat the entire effluent and recycle it.</p> <p>That it is prayed that the Hon’ble NGT may order for a site inspection to check the compliance status and allow the industry to operate as per the existing CTO.</p>	<p>Completed on 11th February, 2024</p>

	<p>Upgradation Schedule to HPPCB, with a deadline of July, 2023 for achieving Zero Liquid discharge (ZLD), which is being monitored by HPPCB, which further confirm that ETP is not adequate to treat the entire effluent and recycle it i.e. ZLD.</p> <p><i>It is recommended that the validity period of the CTO granted to the industry by HPPCB, is linked with the deadline for the achieving Zero Liquid Discharge (ZLD) given by the industry.</i></p>		
2.	<p><u>Recommendation No 3</u></p> <p>As per record shared with the Joint Committee, the industry is paying 60-80 lacs per month to CETP Baddi for the last 04 years, for the treatment of its effluent, despite having its own ETP. This indicates that either the ETP installed by the industry is not adequate or it is not operated efficiently. <i>It is</i></p>	<p>The detailed adequacy study of the ETP has been conducted and the report has been received from IIT Ropar & Panjab University, Chandigarh. The perusal of the report confirms that the results are well within the limits for meeting the compliance criteria.</p> <p>The copy of the Adequacy Study of the ETP dated</p>	<p>Status: Completed. Adequacy Study dated 16th August 2024 is placed on record.</p>

(4)

	<p><i>therefore recommended that adequacy study of the ETP is done by some reputed institute, so as to find out the shortcomings and upgrade the same.</i></p>	<p>16.08.2024 is attached herewith as Annexure - 1.</p>	
<p>3.</p>	<p><u>Recommendation No 4</u></p> <p>In view of the fact that i) The industry has not obtained permission of CPCB for incineration of hazardous waste and therefore the incinerator installed by the Industry for incinerating the concentrated effluent is not in operation, ii) Industry is located at such a location without having any provision to contain contaminated storm/rain water passing through the plant, the discharge of untreated effluent is un-avoidable with the storm water and may lead to the contamination water. <i>It is therefore recommended that Industry is directed by HPPCB</i></p>	<p>i) The Project Proponent has shut down and isolated its incinerator due to not having proper SOP, hence the same is no longer in use. The Project Proponent had intimated it in writing in the month of October 2022, and the same has been verified by state PCB. The Project Proponent had applied to State PCB with a copy to CPCB in the month of April, 2023 for obtaining the SOP for spent residues after distillation to be utilised in captive incineration. A follow up request along with an online application was also submitted by the Project Proponent in the month of February 2024. Despite this, SOP</p>	<p>NA</p>

<p><i>to: a) Obtain permission from CPCB for incineration of Hazardous waste; b) make arrangements to contain the storm water contaminated with industrial effluent while passing through the plant and treat it before discharging in the nearby drain; b) to strictly follow the "Guidelines for using treated effluent for irrigation" with regard to treated storm water (contaminated with industrial effluent), prepared by CPCB under the directions of Hon'ble NGT dated 24/5/2019 in the matter of OA No. 348/2017; Shailesh Singh Vs Al-Dua Food Processing Pvt. Ltd.</i></p>	<p>has not yet been granted. It is pertinent to mention here that the incineration of spent residues after distillation will be advantageous for in house use.</p> <p>At the moment the Project Proponent has a valid authorization permit bearing No: HPSPCB/HWMR/10026 dated 25.07.2023 which is already been placed on the record of this Hon'ble Tribunal. Further, the copy of follow up request for obtaining the SOP along with an online application has also been placed on the record of this Hon'ble Tribunal.</p> <p>ii) That it is pertinent to mention here that the storm water drain system, and the process drain system are independent and there is no possibility of breach or cross contamination. Process effluent transfers through closed loop system using pipelines. During the period of rains, the storm</p>	
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		<p>water that falls within the premises flows through dedicated flow channel to a dedicated reservoir for collecting first 30-minute rainwater so that the rainwater if contaminated, could be tested before its release. In case the collected water has any trace of contaminants, it is rerouted to the effluent treatment plant through a permanent pipeline for treatment purposes. The layout of storm water drain system have been placed on record. The Images of storm drain above plant and Dyke wall have been placed on record.</p>	
4.	<p>Recommendation No 5</p> <p>The bio-magnification study conducted by the Joint Committee on the soil and two crop growing in the area during period indicates that:</p> <ul style="list-style-type: none"> • The concentration of Nickel and Zinc in the soil samples collected from downstream locations were found to be 	<p>The Project Proponent does not use Nickel and Zinc for manufacturing its products nor of the by-product of part of the effluent. However, in the public interest, Project Proponent agreed to conduct similar exercise for other staple crops existing in that</p>	Completed

<p>exceeding the limits specified by WHO. The high concentration of heavy metals (Zn and Ni) in the soil in the downstream locations despite low heavy metal concentration in the effluent samples collected by the Joint Committee, is an area of concern and indicates discharge to concentrated waste, although no discharge was observed by the Joint Committee at the time of visit.</p> <ul style="list-style-type: none"> • The transfer Factor and Health Risk Index was also determined by the Joint Committee. The values of HRI less than 1(<1), as determined by the Joint Committee, is considered safe for intake of food/vegetables. However, it is necessary to conduct similar exercise for the other staple crops in that area since the absorption of heavy metal varies for crop to 	<p>area since the absorption of heavy metal varies for crop to crop to avoid the values of HRI exceeding 1 (>1) over a passage of time.</p> <p>Project Proponent has conducted the soil and crop testing in consultation with the local PCB as per the season and availability of the crops.</p> <p>Soil and crop testing has been conducted by Thapar Institute, Patiala. The analysis of soil and crop samples shows no adverse impact for the industrial site and nearby area hence no adverse impact on the human health. A copy of the report of Soil and crop testing conducted by Thapar Institute has already been placed on record.</p>	
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	crop, to avoid the values of HRI exceeding 1 (>1) over a passage of time, in the interest of public health.		
5.	<p>Recommendation No 6</p> <p>It was observed during the site visit that industry has taken water connection from surface water supply meant for nearby villagers for irrigation, without obtaining any permission. It is recommended that Industry be directed to immediately disconnect this water connection till permission is obtained from the concerned authority.</p>	<p>There was an old surface water line which the unit had already removed in Jan 2024 and the same was verified by local PCB. A copy of electricity bill has been placed on record. The daily total water consumption of the Project Proponent is 100KLD, and to meet its daily freshwater requirements of (75-80KLD), the Project Proponent relies on its in-house borewell (10-15KLD) and commercial water tankers (65-70KLD) supply from a third party and is not dependent on the surface water from the nullah. However, 20-25KLD water requirements are met through recycling.</p> <p>The Project Proponent submits that earlier it was withdrawing</p>	NA

		<p>10-12KLD water from existing permitted borewell, however after carrying out re-development work of the existing borewell, the water withdrawal has increased from 10-12KLD to 20-25KLD to 30-35KLD now which is being monitored further for few more weeks to see the consistency.</p> <p>The Project Proponent has installed a Piezometer showing daily water level. The image of the Piezometer showing daily water level is attached herewith as Annexure - 2.</p> <p>Electro-magnetometer and Flowmeters are installed on the outlet of borewell line. One standard flowmeter has also been installed on the tanker water supply line.</p> <p>Copy of Permit/Approval letters for borewell of 100 KLD, water bills, real time images of water</p>	
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		<p>tankers are on the record of this Hon'ble Tribunal.</p> <p>Image of the borewell with new Electro-magnetometer and Flowmeter are on the record of this Hon'ble Tribunal.</p> <p>Image of Standard Flowmeter at the plant storage tank are on the record of this Hon'ble Tribunal.</p>	
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Additionally, on PCB's recommendation, the Project Proponent has installed 360-degree night vision CCTV showing live streaming through LED displayed at the main gate of the subject project. This is connected to PCB server for online monitoring of the effluent / or discharge if any through downstream nallah. The Purchase order for PTZ Camera and LED is attached herewith as **Annexure - 3**. The payment details for customized data acquisition software are attached herewith as **Annexure - 4**.

The 360-degree night vision CCTV is now fully operational and connected to PCB server for online monitoring of the effluent / or any discharge. The live streaming by CCTV is ON 24X7 now. The confirmation by vendor and image of downstream nallah is also attached herewith as **Annexure - 5**.



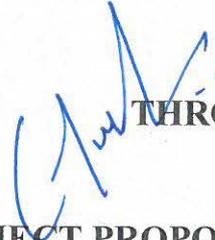
FOR PROJECT PROPONENT

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AUTHORIZED SIGNATORY



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COUNSEL FOR THE PROJECT PROPONENT

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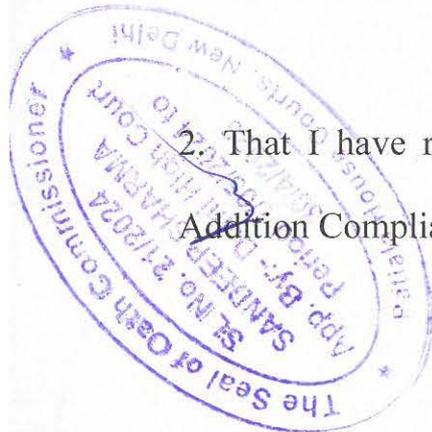
...RESPONDENT

AFFIDAVIT

I, Satish Pandey, S/o Late Shri B.D. Pandey aged about 48 years, authorized representative of The Project Proponent, having its office at 409, 4th Floor, Antriksh Bhawan, KG Marg, New Delhi-110001.

1. That I am the Authorized Representative of the Project Proponent and well conversant with the facts and circumstances of the present case as such and also fully competent to swear and affirm the present affidavit.

2. That I have read the Additional Compliance Report (filed in furtherance of Addition Compliance report filed on 29.04.2024) submitted on behalf of the Project



Proponent, the contents of the submissions have been read to me in my vernacular language.

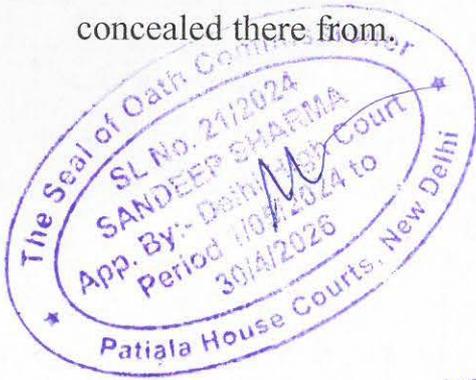
3. That the contents thereof are believed to be true upon my knowledge received from the record maintained by the Project Proponent in the normal course of business. The legal advice received by me is believed to be true. I say nothing material is concealed therefrom.

I identified the deponent who has signed in my presence

[Signature]
DEPONENT

VERIFICATION

Verified at New Delhi on this **16 AUG 2024** day of August, 2024 that the contents of the above affidavit are true upon my knowledge and that nothing material has been concealed therefrom.



[Signature]
DEPONENT

Solemnly sworn before me read over & explained to the deponent Admitted to be correct
[Signature]
Oath Commissioner, New Delhi

16 AUG 2024

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UPDATE ON PENDING CHECKLIST AND COMPLIANCE STATUS OF THE
TERMS AND CONDITIONS OF THE CONSENT TO OPERATE

CTO No: CTO/BOTH/RENEW/RO/2022/4535120

Sr No.	PARTICULARS	COMPLIANCE STATUS	JUSTIFICATION (With proof/document)
CONDITIONS UNDER AIR (PREVENTION & CONTROL OF POLLUTION) ACT, 1981.			
8	The unit shall ensure valid and approved on-site and off-site emergency plan, approved by the Chief Inspector of Factories, Himachal Pradesh (If applicable).	Not Complied	On-site emergency plan for the unit is in place. Application is already submitted with concerned authority to further approve it from the Chief Inspector of Factories, Himachal Pradesh Shimla. Copy of letter receipt and on-site Emergency Plan HAS BEEN PREVIOUSLY SUBMITTED.

FOR PROJECT PROPONENT



AUTHORIZED SIGNATORY



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COUNSEL FOR THE PROJECT PROPONENT

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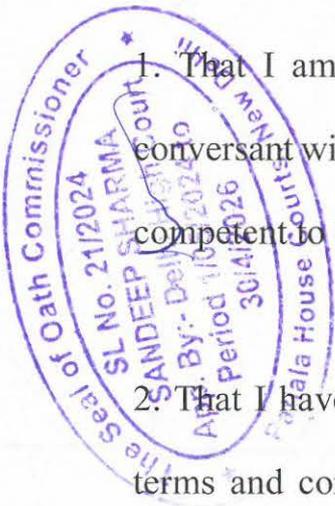
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1. That I am the Authorized Representative of the Project Proponent and well conversant with the facts and circumstances of the present case as such and also fully competent to swear and affirm the present affidavit.

2. That I have read the update on pending checklist and compliance status of the terms and conditions of the consent to operate (filed in furtherance of Addition Compliance report filed on 29.04.2024) submitted on behalf of the Project



Proponent, the contents of the submissions have been read to me in my vernacular language.

3. That the contents thereof are believed to be true upon my knowledge received from the record maintained by the Project Proponent in the normal course of business. The legal advice received by me is believed to be true. I say nothing material is concealed therefrom.

I identified the deponent who has signed in my presence

DEPONENT

VERIFICATION

7 6 AUG 2024

Verified at New Delhi on this _____ day of August, 2024 that the contents of the above affidavit are true upon my knowledge and that nothing material has been concealed there from.

I identified the deponent who has signed in my presence

DEPONENT



Solemnly sworn before me read over & explained to the deponent Admitted to be correct

Oath Commissioner, New Delhi

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UPDATE ON PENDING CHECKLIST AND COMPLIANCE STATUS OF
THE TERMS AND CONDITIONS OF THE ENVIRONMENT CLEARANCE

SAFETY HEALTH			
SR. NO.	PARTICULARS	COMPLIANCE STATUS	JUSTIFICATION
5	Provision shall be made for the housing of construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, creche etc. The housing may be in the form of temporary structures to be removed after the completion of the project	Not complied yet will do as steps for expansion are taken if applicable	Proper toilets, designed STP Plant for domestic effluent, drinking water facility and medical health care systems are in place.

ADDITIONAL CONDITIONS			
3	Green belt with 3500 trees per ha shall be created by the proponent.	Being Complied	Map of the plant clearly marking the green area – The layout of the Green belt area at Masulkhana site is attached herewith as Annexure - 6 . Apart from developing green area in the subject plant premises, the Project Proponent has carried out plantation at Naryal site, the layout map is attached herewith as Annexure 7 . The Purchase order for Green Belt plant is attached herewith as Annexure - 8 .
10	The project proponent shall provide three plastic waste shredders, three compactors & three plastic waste bailing machines to the concerned ULBs/ PRIs through Department of Environment, science & Technology, GoHP	Order Placed	PO copy was attached
WATER QUALITY MONITORING			
6	The Company shall harvest rainwater from the roof tops of	Complied	Rainwater harvesting storage capacity has been

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	the buildings and storm water drains to recharge the ground water and utilize the same for different industrial operations within the plant.		increased – The Reservoir of capacity 20KL is constructed and is operational. The water after treatment is being utilized by the Project Proponent. The photographs are attached herewith as Annexure -9 .
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FOR PROJECT PROPONENT



AUTHORIZED SIGNATORY



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1. That I am the Authorized Representative of the Project Proponent and well conversant with the facts and circumstances of the present case as such and also fully competent to swear and affirm the present affidavit.
2. That I have read the update on pending checklist and compliance status of the terms and conditions of the environment clearance (filed in furtherance of Addition Compliance report filed on 29.04.2024) submitted on behalf of the Project



22

Proponent, the contents of the submissions have been read to me in my vernacular language.

3. That the contents thereof are believed to be true upon my knowledge received from the record maintained by the Project Proponent in the normal course of business. The legal advice received by me is believed to be true. I say nothing material is concealed therefrom.

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I identified the deponent who has signed in my presence

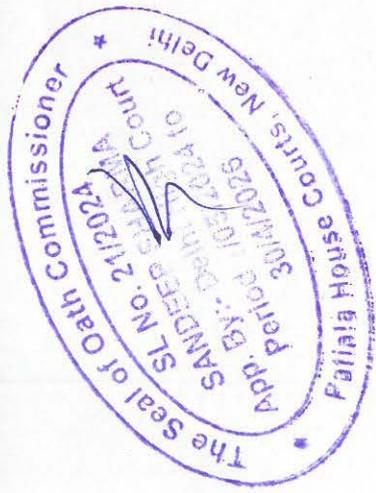
[Handwritten signature]
DEPONENT

VERIFICATION

Verified at New Delhi on this 16 day of August, 2024 that the contents of the above affidavit are true upon my knowledge and that nothing material has been concealed there from.

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LIST OF DOCUMENTS

S. NO.	PARTICIULARS	PAGE NOS.
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22, K.G. Marg, New Delhi- 110001****Email- officeofsrijantiwari@gmail.com****Mobile:9899966225****PLACE: NEW DELHI****DATE: 16 .08.2024**

**EVALUATION OF ADEQUACY OF ETP OF MOREPEN
LABORATORIES LIMITED AT MASULKHANA
(PARWANOO) TO MAKE THE FACILITY ZLD**

Final Technical Report

Submitted to

Morepen Laboratories Ltd. Masulkhana



Submitted By

PI/CI from

Panjab University Chandigarh and IIT Ropar

SUMMARY OF REPORT

The Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd. Masulkhana categorizes effluents based on Chemical Oxygen Demand (COD) levels to manage treatment effectively. High COD Effluent, ranging from 70,000 to 3,500,000 PPM, poses the greatest challenge due to its high organic pollutant concentration. Low COD Effluent, below 20,000 PPM, and Other Effluent from R&D and QC labs, below 10,000 PPM, are comparatively easier to treat. The plant employs a 12 KLD stripper for high COD effluent, essential for volatile organic compound removal. This process ensures vaporizing contaminants. Low COD effluent undergoes initial treatment in an equalization tank, optimizing subsequent processes for efficient wastewater management.

Teams from IIT Ropar and PU Chandigarh noted no suspended matter in the Effluent Collection Tank, likely due to exclusive use of a pumping system for effluent transfer. Regular maintenance ensures continuous and effective operation, with assurance that no significant debris enters subsequent treatment stages. The inlet section handles effluent from the bottom layer after stripper recovery and overflow, with upstream protection provided by an Oil Pit (Capacity = 1.7 KL).

The equalization tank at Morepen Laboratories Ltd. Masulkhana plays a pivotal role in wastewater management, providing substantial storage of 30.3 KL and a retention time of approximately 19.0 hours. It ensures uniformity in wastewater composition from sources like the Effluent Collection Tank and Floor Wash before onward processing. Controlled entry and outlet structures manage flow rates, preventing hydraulic shocks and maintaining operational efficiency. Manual sampling points monitor pH, temperature, and other parameters, ensuring compliance with operational limits and effective tank performance. Positioned strategically before primary treatment processes, the tank stabilizes influent flow and composition, optimizing downstream treatment units. Real-time level sensors facilitate automated monitoring and control, enhancing operational efficiency. While primarily for homogenizing wastewater, provisions for periodic sludge removal maintain tank effectiveness. Discussions with IIT Ropar and PU Chandigarh highlighted the need for extended effluent holding during maintenance, prompting the installation of additional storage tanks like Effluent Collection Tank with a capacity

of 769.6 m³ and alternate storage tank No T-5 (479.9 KL). These measures ensure uninterrupted treatment operations and environmental compliance during maintenance periods.

The primary treatment process at Morepen Laboratories Ltd. Masulkhana employs a system of six collection tanks designed to optimize wastewater treatment efficacy. These tanks, totaling 32.4 KL capacity with three tanks operating in series, facilitate crucial chemical flocculation for sedimentation. Proper flocculant dosing and uniform mixing within these tanks are essential for forming stable flocs that settle effectively in subsequent stages. Maintaining optimal pH levels further enhances coagulation efficiency. However, concerns raised by IIT Ropar and PU Chandigarh about direct routing of MEE overflow and other effluents to the primary treatment tank highlight potential challenges in maintaining process consistency. Morepen Laboratories clarifies that the three sequential tanks are strategically designed for lime, alum, and polymer dosing, ensuring treatment effectiveness. The remaining parallel tanks support efficient homogenization, offering adequate retention time for optimal treatment. This configuration balances operational efficiency and treatment effectiveness, meeting stringent wastewater treatment standards effectively.

The Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd. Masulkhana features three aeration tanks totalling 251 KL capacity, divided into ASP 1 and 2 (162 KL) and ASP 3 (89 KL). This design enhances treatment efficiency by employing staged aeration and two clarifiers, ensuring effective settling before progressing to subsequent phases. The aerobic treatment process effectively reduces Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), crucial for removing organic pollutants. Temperature control within the biological reactor optimizes microbial activity, while pH monitoring maintains ideal conditions for efficient treatment. Proper aeration and uniform mixing prevent anaerobic zones and dead spots, ensuring consistent pollutant degradation. Effective sludge management and potential bio-augmentation further enhance treatment efficacy. Concerns raised by IIT Ropar and PU Chandigarh regarding ASP performance prompted considerations such as nano-bubble aeration and stringent effluent parameter control to optimize microbial processes. Morepen Laboratories addressed high Total Dissolved Solids (TDS) effluent challenges through pre-treatment in PST and filtration using screw press filters, enhancing MEE efficiency and stability. These improvements reflect a commitment to maintaining high treatment standards and operational reliability in the ETP.

The sump at the plant ensures treated water meets processing standards by buffering flow fluctuations. It supports membrane system maintenance, preserving water integrity. Pumps

transfer treated effluent from the sump to its final destination, integral to the system's design for efficient water management and treatment.

Optimal pH management is critical across various stages of Morepen Laboratories LTD. Masulkhana's Effluent Treatment Plant (ETP) to maximize treatment efficiency. Strategic pH adjustments and continuous monitoring systems are pivotal to maintain stability and prevent disruptions from pH fluctuations. This approach enhances treatment consistency and efficacy by addressing key control points during primary and biological treatment phases. Effective pH control optimizes contaminant removal and supports microbial activity essential for organic matter degradation, ensuring compliance with discharge standards.

Managing Total Dissolved Solids (TDS) is equally crucial for ETP operations to uphold water quality and regulatory compliance. While the system effectively reduces TDS from 27,000 mg/L at the equalization tank to below 700 mg/L (after RO treatment), continuous monitoring remains essential to mitigate potential disruptions caused by high TDS levels. Controlling TDS is imperative for enhancing the suitability of treated water for reuse in various industrial applications, minimizing equipment damage from scaling and corrosion.

Dynamic Light Scattering (DLS) measurements provide valuable insights into particle size distribution dynamics within the treatment system. Variations in treatment conditions, feed composition, and nucleation processes significantly influence particle size, impacting treatment efficiency. Understanding these dynamics facilitates process optimization to achieve desired particle size distributions, enhancing overall treatment effectiveness.

Maintaining optimal Dissolved Oxygen (DO) levels is crucial in aerobic treatment processes to support microbial activity for organic pollutant degradation. Enhancing DO levels through efficient aeration methods such as fine bubble diffusers oxygenation improves treatment outcomes and water quality, ensuring effective pollutant removal.

Effective management of Chemical Oxygen Demand (COD) is essential to mitigate organic pollutant levels in treated water. Optimizing coagulant and flocculant usage improves sedimentation and filtration processes, reducing COD levels and ensuring compliance with discharge standards. Adjusting Hydraulic Retention Time (HRT) in biological treatment tanks further enhances organic matter degradation efficiency, promoting thorough wastewater treatment.

Developing an emergency response plan for sudden COD increases is crucial to maintaining treatment effectiveness. Such measures ensure rapid response and mitigation strategies to safeguard treated water quality and compliance during unexpected operational challenges.

Integrated management of Biological Oxygen Demand (BOD) alongside COD ensures comprehensive organic pollutant control, supporting consistent treatment outcomes and environmental protection. Utilizing Infrared (IR) spectroscopy for water quality assessment identifies specific contaminants, enabling targeted treatment strategies for improved water purity and regulatory compliance.

The Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd., Masulkhana has undergone substantial improvements following an extensive evaluation aimed at achieving regulatory compliance and enhancing operational efficiency. The initial phase of sampling identified critical areas requiring immediate attention to align with established environmental standards. To address these issues comprehensively, Morepen Laboratories engaged in a collaborative effort with academic institutions like PU Chandigarh and IIT Ropar for further sampling and analysis. This partnership yielded crucial feedback that guided subsequent improvements within the facility.

Key modifications were implemented across various sections of the ETP to streamline operations towards achieving Zero Liquid Discharge (ZLD), ensuring sustainable water management practices. The upgrades began with the pretreatment of incoming effluent in an equalization tank, crucial for stabilizing flow rates and Total Dissolved Solids (TDS) concentrations. The primary tube settler (PST) was enhanced to effectively remove suspended solids, preparing the effluent for further processing. A Screw Sludge Dewatering Machine was introduced to dewater sludge from the PST, reducing waste volume and improving overall treatment efficiency.

The Multi Effect Evaporator (MEE) underwent optimization with the installation of a steam flow controller to stabilize evaporation rates and enhance energy utilization. Vacuum stabilization measures further improved efficiency by maintaining optimal conditions within the evaporator chamber. Additionally, separate cooling water supplies were implemented for the Agitated Thin Film Dryer (ATFD) and MEE condenser to maximize thermal efficiency and minimize energy consumption.

In the Activated Sludge Process (ASP), instrumentation upgrades such as rotameters were installed to ensure precise flow control, promoting uniform air distribution critical for aerobic

microbial activity. Bioenzymes were introduced to enhance microbial degradation of organic pollutants, reducing retention times and improving treatment efficacy. Increased sampling frequency enabled better monitoring of key parameters like dissolved oxygen and biochemical oxygen demand (BOD), facilitating timely adjustments to optimize treatment processes.

The Reverse Osmosis (RO) system played a pivotal role in achieving stringent water quality standards by incorporating advanced pH control systems and balanced chemical dosing to reduce turbidity levels. RO permeate water was recycled within the polisher unit for secondary treatment, minimizing freshwater consumption and wastewater discharge.

In conclusion, Morepen Laboratories Ltd proactive approach to transforming their Effluent Treatment Plant (ETP) through strategic upgrades in pretreatment, Multi Effect Evaporator (MEE) optimization, Activated Sludge Process (ASP) improvements, and advanced Reverse Osmosis (RO) technology demonstrates a commitment to sustainable development. These enhancements have not only enabled the facility to meet current regulatory standards but also positioned it to effectively tackle future environmental challenges.

The systematic upgrades in pretreatment have ensured that incoming effluent undergoes thorough initial processing, stabilizing flow rates and reducing Total Dissolved Solids (TDS) to below 200 mg/L. The introduction of a Primary Tube Settler (PST) and screw Sludge Dewatering Machine has significantly improved the removal of suspended solids and sludge management, enhancing overall treatment efficiency.

Optimizing the MEE with advanced controls for steam flow and vacuum stabilization has boosted evaporation rates while conserving energy. The separate cooling water supplies to the ATFD and MEE condenser have maximized thermal efficiency, contributing to reduced operational costs and environmental impact.

Improvements in the ASP, including enhanced instrumentation and increased sampling frequency, have facilitated better control over critical parameters like Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD). These enhancements ensure robust microbial activity for efficient organic pollutant removal, resulting in treated water with BOD levels below 30 mg/L and COD levels below 240 mg/L.

The implementation of advanced RO technology with precise pH control and optimized chemical dosing has further improved water quality by reducing turbidity and ensuring the removal of harmful cations and anions. The recycling of RO permeate water within the polisher unit

underscores Morepen Laboratories Ltd commitment to water conservation and environmental stewardship.

Overall, these comprehensive upgrades not only align the ETP with stringent environmental regulations but also enhance its resilience to future challenges. By adopting a holistic and forward-thinking approach to wastewater treatment, Morepen Laboratories Ltd has set a benchmark for responsible corporate conduct in sustainable water management practices. This transformation not only safeguards environmental health but also supports long-term operational efficiency and corporate sustainability goals.

PART 1

ADEQUECY STUDY OF THE EXISTING ETP PLANT OF MOREPEN LABORATORIES LTD., MASULKHANA

There are several methods available for treating wastewater, ranging from small-scale solutions for individual facilities to large-scale wastewater treatment plants designed to handle the effluents of entire industrial complexes. Each method varies in complexity, efficiency, and the types of contaminants it can remove, making it essential to select the appropriate treatment process based on the specific requirements of the industry and the characteristics of the wastewater. In this context, Morepen Laboratories Ltd. has developed an Effluent Treatment Plant (ETP) that serves as a vital component of their environmental management strategy. In general; an Effluent Treatment Plant (ETP) is a specialized facility engineered to treat industrial wastewater by removing harmful contaminants before the effluent is either discharged into the environment or reused within the plant's operations. The design and operation of an ETP are critical for minimizing the environmental impact of industrial activities, ensuring that the wastewater released meets stringent regulatory standards. The treatment process typically involves several stages, including physical, chemical, and biological treatments, each targeting different types of pollutants. These stages collectively work to reduce key parameters such as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), and pH levels, all of which are crucial indicators of water quality.

A. ETP PLANT DESCRIPTIONS: MOREPEN LABORATORIES LTD. MASULKHANA

In the Effluent Treatment Plant (ETP) under discussion, the management and treatment of effluent streams are carefully organized based on the Chemical Oxygen Demand (COD) levels of the wastewater. The plant has identified three distinct categories of effluent:

High COD & TDS Effluent: This category includes effluents with extremely high COD levels, ranging from 70,000 to 3,500,000 parts per million (PPM) and TDS ranging from 20000 to 30000ppm. These effluents are typically the most challenging to treat due to the high concentration of organic pollutants.

Low COD & TDS Effluent: This stream consists of wastewater with COD levels below 20,000 PPM and TDS ranging from 7000 to 10000ppm. While still significant, the treatment of this stream is less complex compared to the high COD effluent.

Other Effluent: This category includes wastewater from Research and Development (R&D), Quality Control (QC) laboratories, and cooling towers, with COD levels generally below 10,000 PPM. These effluents are typically easier to manage due to their lower pollutant load.

For the high COD effluent, which represents the most concentrated and difficult-to-treat waste, the plant employs a stripper with a capacity of 12 Kilolitres per Day (KLD). A stripper is a vital component in the ETP, specifically designed to handle effluents with high levels of volatile organic compounds (VOCs) and other volatile contaminants. The operation of a stripper involves passing the contaminated water through a packed column. Within this column, air or steam is introduced, causing the VOCs and other volatile substances to vaporize and separate from the liquid phase. This process is crucial in reducing the concentration of harmful chemicals in the effluent, ensuring that the water meets the necessary standards before undergoing further treatment. Strippers are particularly effective for wastewater containing solvents, ammonia, and other volatile substances that are typically present in high COD effluents. By removing these contaminants, the stripper plays a critical role in ensuring that the treated water is safe for discharge or further processing. After the stripping process, the bottom layer, which consists of heavier, non-volatile components, is sent to the equalization chamber through an oil pit and an effluent collection tank. The treatment of low COD effluent also begins in the equalization tank. This tank serves as the initial stage for equalizing the wastewater before it undergoes further treatment processes. Like the high COD effluent, low COD wastewater is also directed to the equalization tank through the oil pit and an effluent collection tank. The equalization tank ensures that the wastewater is homogenized, reducing fluctuations in the flow and composition, which is essential for the efficiency of subsequent treatment stages.

PLANT DESIGN DETAILS (As on 24/02/2024)	
Plant Capacity (Designed)	72 m ³ /day
Flow Rate (Designed)	3 m ³ /hr
Flow Rate (Currently)	1.6 m ³ /hr
COD (ETP Inlet)	<30000 ppm
BOD (ETP Inlet)	<13000 to 15000ppm
pH (ETP Inlet)	5 to 9
TDS (ETP Inlet)	20000 to 30000 ppm

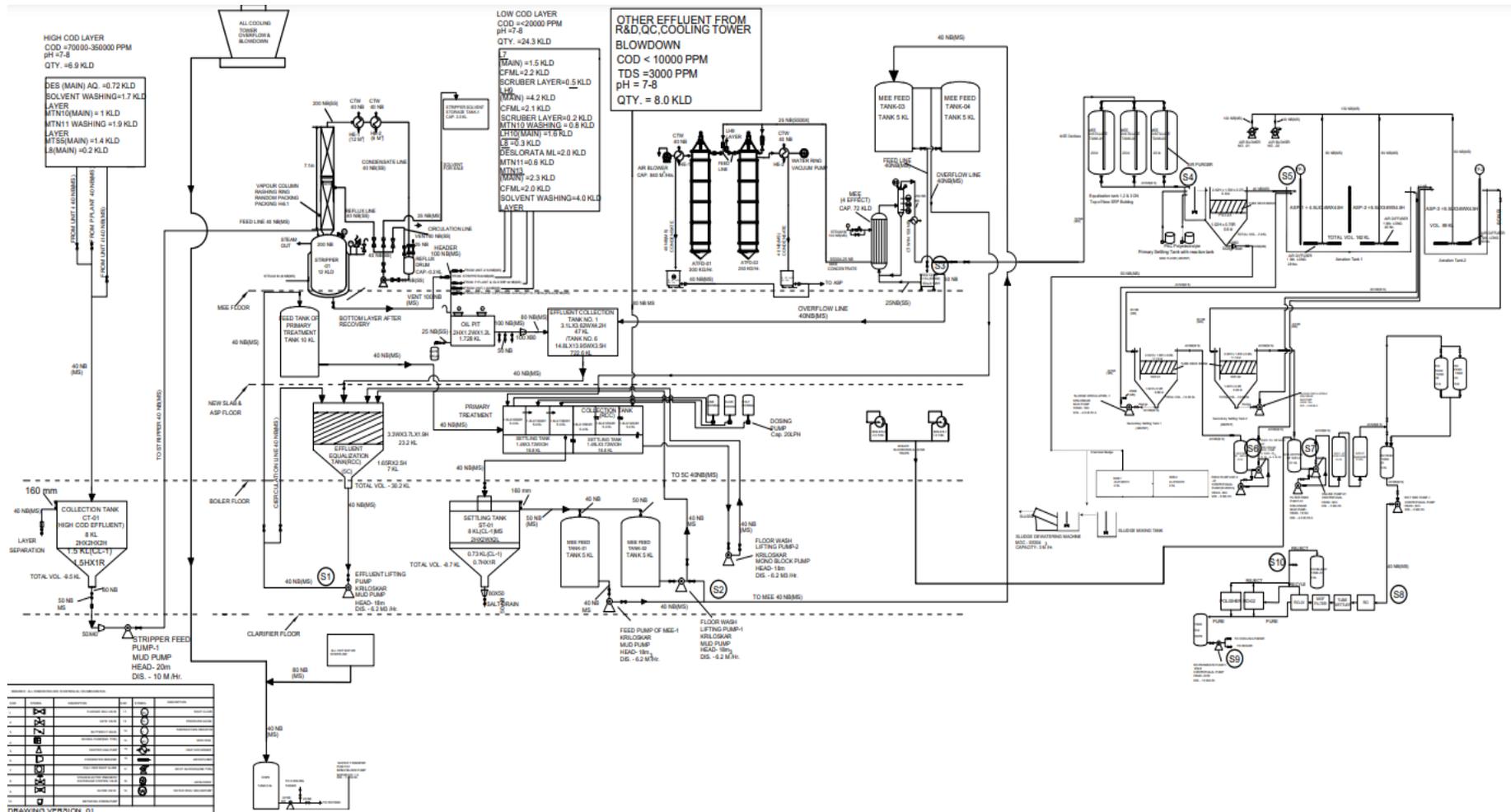


Figure 1A.1. Block Diagram of ETP plant existing on 24/02/24

EFFLUENT COLLECTION TANK: The inlet screening process is an essential and foundational step in the wastewater treatment process, designed to protect and ensure the smooth operation of the entire Effluent Treatment Plant (ETP). Positioned at the entrance of the ETP, inlet screens or gratings serve as the first line of defence against large debris and solid materials that might be present in the incoming wastewater. These screens are meticulously engineered with openings of specific sizes to effectively capture and retain sizable objects, preventing them from entering the treatment system. The primary function of inlet screening is to remove large debris such as sticks, leaves, plastics, rags, and other solid waste that could potentially cause significant problems if allowed to pass further into the treatment plant. These materials, if not intercepted, can lead to several operational challenges. For instance, large debris can become lodged in pumps, pipes, or other mechanical components of the treatment system, causing clogs and blockages. Such obstructions can severely disrupt the flow of wastewater, leading to inefficiencies in the treatment process and potentially causing damage to critical equipment. One of the most significant benefits of the inlet screening process is its role in protecting downstream equipment. Wastewater treatment plants rely on a variety of mechanical components, including pumps, aerators, and mixers, to effectively treat the wastewater. These components are designed to handle water and smaller particles, not large solid objects. By capturing large debris at the inlet, the screening process prevents these materials from reaching and damaging sensitive equipment, thereby reducing the likelihood of costly repairs and maintenance. Furthermore, preventing clogs in pumps and pipes through effective inlet screening has a direct impact on the overall efficiency of the treatment plant. Clogged pumps and pipes can lead to reduced flow rates, which in turn can slow down the entire treatment process. This can cause backups in the system, leading to overflow situations that are both hazardous and costly to manage. Additionally, clogs require manual removal, which increases the maintenance demands on the plant's operations team. This not only diverts resources but also increases the plant's operational costs. Inlet screening also plays a crucial role in protecting the biological and chemical treatment stages that follow in the wastewater treatment process. Large solid objects can interfere with the effectiveness of these processes, either by physically obstructing treatment tanks or by introducing materials that are difficult to break down. By removing large debris at the outset, inlet screening ensures that the subsequent treatment stages can operate at their full capacity, focusing on removing the finer particles, chemicals, and biological contaminants present in the wastewater.

The technical details of the Effluent Collection Tank have been tabulated below:

EFFLUENT COLLECTION TANK		
Number of Units	02	
Feed Flow Rate	1.6 m ³ /hr	
Tank Number	TANK No. 1	TANK No. 6
Capacity	47 m ³	722.6 m ³
Height / Depth	4.2 m	3.5 m
Area required	11.22 m ²	206.46 m ²
Length	3.62 m	14.8m
Width	3.1 m	13.95m
Free Board	0.5 m	0.5 m
Volume (Available)	4.2 m × 3.62 m × 3.1 m = 47 m ³	14.8 m × 13.95 m × 3.5 m = 722.6 m ³
MOC	RCC	RCC
Retention Time (With Current Flow Rate)	10.0 days Min; 19.00 days (Maximum)	
OIL PIT	Capacity	1.7 m ³
	Height / Depth	1.2 m
	Area required	1.44 m ²
	Length	1.2 m
	Width	1.2 m
	Volume (Available)	1.2 m × 1.2 m × 1.2 m = 1.7 m ³

Observations & Recommendations

The details of observations and recommendations of team IIT Ropar & PU Chandigarh are presented below:

- During visits by teams from IIT Ropar & PU Chandigarh: it was observed that there were not any suspended matter in the Effluent Collection Tank; this can be because all the effluents transfer through pipes with gravity only.
- At the moment; the concerned official has ensured that no significant debris are passing through to the subsequent treatment stages.

- The inlet section is designed to cater the effluent from: 1) Bottom layer after recovery from stripper, and 2) Overflow line of MEE plant. However; upstream of this tank is provided with the Oil Pit (Capacity = 1.7 KL) for effluent of 1.

EQUALIZATION TANK: An equalization tank, also known as an equalization basin or EQ tank, is a crucial component of an Effluent Treatment Plant (ETP). Its primary function is to stabilize and homogenize the characteristics of incoming wastewater, ensuring that the treatment processes downstream can operate efficiently and effectively. This tank is particularly beneficial in industrial settings where wastewater is generated intermittently or where there are significant variations in flow rate and composition. By serving as a buffer, the equalization tank helps to smooth out these fluctuations, creating a more consistent flow of wastewater into the treatment plant. One of the key roles of an equalization tank is to equalize the pH levels and temperatures within the wastewater. Industrial processes often produce wastewater with varying pH levels and temperatures, which can pose challenges to subsequent treatment stages. For instance, extreme pH values can inhibit biological treatment processes, while high temperatures can affect the solubility of gases and the activity of microorganisms. The equalization tank mitigates these issues by blending the incoming wastewater, resulting in a more uniform pH and temperature profile. This, in turn, protects the downstream treatment units from sudden shocks that could otherwise disrupt their operation. In addition to stabilizing pH and temperature, the equalization tank also plays a vital role in managing variations in the concentration of pollutants within the wastewater. Industrial discharges can vary significantly in their chemical composition, with some batches containing higher concentrations of contaminants than others. Without an equalization tank, these variations could lead to overloading of treatment units, potentially causing them to become inefficient or even fail. By mixing the wastewater and diluting high concentrations of pollutants, the equalization tank helps to ensure that the treatment plant receives a more consistent and manageable influent. Moreover, the equalization process reduces the risk of hydraulic overloading in the treatment plant. During periods of peak flow, the tank acts as a reservoir, temporarily holding excess wastewater and releasing it at a controlled rate. This prevents the treatment units from being overwhelmed and allows them to function optimally. In summary, the equalization tank is an essential element of an ETP, providing critical stabilization of wastewater characteristics, protecting downstream processes, and ensuring the overall efficiency and reliability of the treatment plant.

EQUALIZATION TANK		
Number of Units		01
Rectangular Part (Upper) Tank No-5C	Feed Flow Rate	1.6 m ³ /hr
	Capacity (Planned)	23.2 m ³ + 7.1 m ³ = 30.3 m ³ (Including peak flow factor)
	Retention Time (With Current Flow Rate)	18.9 hours
	Height	1.9 m
	Area required	206.46 m ²
	Length	3.7 m
	Width	3.3 m
	Volume (Available)	3.3 m × 3.7 m × 1.9 m = 23.2 m ³
	MOC	RCC with anticorrosive coating
Circular Cone Part (Lower)	Height	2.5 m
	Radius	1.65 m
	Volume (Available)	7.1 m ³
	MOC	RCC with anticorrosive coating
EQUALIZATION TANK BLOWER		
Capacity		Not applicable

Pressure	Not applicable
MOC	Not applicable
Aeration grid for equalization tanks	Not applicable
Coarse air diffusers for equalization tanks	Not Applicable
EFFLUENT TRANSFER PUMP	
Type	Gravity Flow
Capacity	Not Required
Head	Not Required
Suitable sized compressor for air operated diaphragm pumps	Not Required
LIME / NaOH / CHEMICAL DOSING	
Number of Units	Not Provided
Material Flow Rate	Not Applicable
Capacity	Not Applicable
MOC	Not Applicable

Observations & Recommendations

The details of observations and recommendations of team IIT Ropar & PU Chandigarh are presented below:

- The equalization tank at Morepen Laboratories Ltd. Masulkhana is designed with a substantial storage capacity of 30.3 KL, allowing for nearly 19.0 hours of retention time. This capacity ensures that incoming wastewater undergoes sufficient residence time to achieve homogeneity before advancing to subsequent processing stages. This homogenization is crucial as it promotes uniformity in the composition of the wastewater,

which is essential for consistent and effective treatment downstream. The equalization tank is designed to receive the effluent from: 1) Effluent Collection Tank, and 2) Floor Wash.

- Controlled entry structures positioned at the inlet of the equalization tanks serve a critical role in managing the introduction of wastewater. These structures regulate the flow rate and volume of wastewater entering the tank, which helps prevent hydraulic shock and ensures a steady flow conducive to effective equalization. Similarly, outlet structures carefully manage the discharge of equalized wastewater into subsequent treatment stages, maintaining operational efficiency throughout the treatment process.
- Manual sampling points integrated into the design of the equalization tanks allow for regular monitoring of key wastewater parameters. Parameters such as pH, temperature, and other relevant characteristics are measured and analyzed at these points. This monitoring ensures that the wastewater remains within specified operational limits, facilitating optimal performance of the equalization tank and subsequent treatment processes. Regular monitoring also enables prompt adjustments or interventions if deviations from desired parameters are detected.
- Strategically positioned before primary treatment processes such as sedimentation or biological treatment units, the equalization tank plays a crucial role in ensuring a smooth and consistent influent to these downstream units. By equalizing variations in flow rate and composition, the tank enables downstream units to operate efficiently and effectively. This positioning not only enhances treatment efficiency but also helps in maintaining the overall stability and reliability of the wastewater treatment system.
- To enhance operational automation within the plant, the installation of level sensors in the equalization tank can provide real-time monitoring of wastewater volume. This data is instrumental in controlling the flow rate into and out of the tank, optimizing operational efficiency, and ensuring that the tank operates within its designed capacity. Level sensors enable proactive management of wastewater levels, reducing the risk of overflow or underflow and supporting overall process stability.
- While the equalization tank primarily focuses on homogenizing wastewater and not on sludge management, some sludge may settle within the tank over time. However, the current Effluent Treatment Plant (ETP) includes provisions for removing any accumulated sludge if necessary. This periodic removal process ensures that the equalization tank continues to operate effectively without compromising its primary function of equalizing wastewater characteristics.

- **Query of IIT Ropar & PU Chandigarh Team:** If the plant requires maintenance, it becomes necessary to hold the effluent for a few days to ensure that no untreated wastewater is released into the environment during the maintenance period. Typically, this holding requirement is managed by the equalization tank, which is designed to temporarily store effluent until the plant can resume normal operations. However, in the current scenario, the equalization tank at the facility has a capacity that allows it to hold the effluent for only 19 hours, which is significantly less than the required duration for extended maintenance activities. This limited capacity poses a challenge, as it may not provide sufficient time for necessary repairs or upkeep without risking overflow or interruptions in the treatment process. Therefore, alternative strategies, such as using additional storage tanks or temporarily reducing wastewater generation, may need to be considered to address this shortfall during maintenance periods.
- **Response of Concerned Officials of Morepen Laboratories Ltd. Masulkhana:** The Effluent Treatment Plant (ETP) is now equipped with an Effluent Collection Tank with a total capacity of 769.6 m³ (722.6 m³ + 47 m³). This tank is designed to hold effluent for up to 19 days, based on the current flow rates, ensuring that there is adequate storage for effluent during maintenance or emergencies. As a result, the equalization tank is specifically designed for homogenizing the effluent rather than for long-term storage. The homogenization process ensures that the wastewater entering subsequent treatment stages is uniform in composition, which is crucial for effective treatment. To verify the effectiveness of the equalization process, the team from IIT Ropar and PU Chandigarh collected grab and composite samples from the equalization tanks. If the process were incomplete, there would be significant differences in the data from these samples. However, the observed deviations are within acceptable limits, indicating that the equalization is being completed within the time provided by the tank. Therefore, alternative strategies, such as using additional storage tanks or temporarily reducing wastewater generation has been considered. The ETP has an alternate storage tank No T-5 having capacity 479.9 KL to be considered to address this shortfall during maintenance periods.

PRIMARY TREATMENT: The Morepen Laboratories Ltd. in Masulkhana, the Effluent Treatment Plant (ETP) is a vital infrastructure that plays a significant role in ensuring the safe

and effective treatment of wastewater before it is released back into the environment or further processed. One of the key components of this ETP is the flocculation tank, which serves as a crucial element in the overall wastewater treatment process. The primary function of the flocculation tank is to facilitate the process of flocculation, a critical step in the treatment of wastewater. Flocculation is a process where fine, suspended particles in the wastewater, which are too small to settle on their own, are aggregated into larger, more easily settleable masses known as flocs. This aggregation process is essential because these small particles, if left untreated, can carry a variety of pollutants and impurities that would otherwise be difficult to remove in subsequent treatment stages. The formation of flocs is typically achieved by adding flocculants to the wastewater. Flocculants are chemicals, often polymers that encourage the fine particles to stick together. These chemicals work by creating bridges between the particles, thereby forming larger clusters or flocs. The flocculation tank provides a controlled environment where these flocculants can interact effectively with the wastewater, promoting the aggregation process. Within the flocculation tank, gentle agitation mechanisms are employed to enhance the effectiveness of the flocculation process. These mechanisms are designed to stir the wastewater just enough to encourage the collision and adherence of particles without breaking up the newly formed flocs. This controlled agitation is critical because it ensures that the flocs remain intact and continue to grow to a size that allows them to settle out of the water in subsequent treatment stages. Once the flocculation process is complete, the wastewater is typically directed to a settling tank, also known as a sedimentation tank. In the settling tank, the heavier flocs, now significantly larger than the original suspended particles, settle to the bottom of the tank due to gravity. This process separates the solid waste from the clarified water, with the solids forming a sludge layer at the bottom of the tank, and the clarified water rising to the top. The clarified water, now free from most of the suspended solids, is then directed to further treatment stages, where any remaining impurities are removed. Following the flocculation and settling processes, the wastewater moves to a primary clarifier, and another essential unit within the ETP. The primary clarifier plays a pivotal role in the initial physical treatment stage of the wastewater. As the wastewater enters the primary clarifier, it is evenly distributed across the tank, allowing for a controlled reduction in flow velocity. This slowdown in the flow allows the heavier particles and suspended solids to settle at the bottom of the clarifier, forming sludge. Simultaneously, lighter substances and particles, which may still be present in the wastewater, rise to the surface, forming a layer of scum. The primary clarifier is equipped with mechanisms designed to remove this floating material, ensuring that the clarified water, now largely free of suspended solids and scum, can proceed to the next stages of treatment. These subsequent

stages may include secondary or tertiary treatment processes, depending on the specific design and requirements of the ETP. The sludge collected at the bottom of the primary clarifier is typically directed to sludge handling units, where it undergoes further processing, such as thickening, digestion, or dewatering, before final disposal or reuse. Together, the flocculation tank and primary clarifier play critical roles in the initial stages of wastewater treatment at the ETP. They significantly reduce the pollutant loads in the wastewater, thereby enhancing the efficiency and effectiveness of the overall treatment process.

COLLECTION TANK		
TANK	Number of Units	06
	Feed Flow Rate	1.6 m ³ /hr
	Capacity (Planned)	6 X 5.4 m ³ = 32.4 m ³
	Retention Time (Each Tank)	3.3 hrs
	Depth / Height (Each Tank)	3.0 m
	Area required (Each Tank)	1.8 m ²
	Length (Each Tank)	1.8 m
	Width (Each Tank)	1.0 m
	Volume (Available)	5.4 m ³
	MOC	RCC
AGITATOR	Drive	Gear driven
	Type	Helical type
	MOC of Shaft	SS 304
	MOC of Base Frame	MS
PAC / PE DOSING SYSTEM		

TANK	Capacity	5.4KL
	MOC	RCC
PUMP	Capacity	By gravity
	MOC	NA
AGITATOR	Drive	Gear driven
	Type	Helical type
	MOC of Shaft	SS 304
	MOC of Base Frame	MS
LIME DOSING SYSTEM		
TANK	Capacity	5.4
	MOC	RCC
PUMP	Capacity	By gravity
	MOC	RCC
AGITATOR	Drive	Gear driven
	Type	Helical type
	MOC of Shaft	SS 304
	MOC of Base Frame	MS
ALUM DOSING SYSTEM		
TANK	Capacity	5.4KL
	MOC	RCC
PUMP	Capacity	By gravity

	MOC	NA
AGITATOR	Drive	Gear driven
	Type	Helical type
	MOC of Shaft	SS 304
	MOC of Base Frame	MS
SETTLING TANKS (Treatment cum settling tanks)		
TANKS	Number of Units	03
	Feed Flow Rate	1.6 m ³ /hr
	Capacity (Total)	16.6 m ³ + 16.6 m ³ + 8.7 m ³ = 41.9 m ³
Tank-1	Depth / Height	3.0 m
	Area required	5.54 m ²
	Length (Each Tank)	3.72 m
	Width (Each Tank)	1.49
	Volume (Available)	3.0 m × 3.72 m × 1.49 m = 16.6 m ³
	MOC	RCC
Tank-2	Depth / Height	3.0 m
	Area required	5.54 m ²
	Length (Each Tank)	3.72 m
	Width (Each Tank)	1.49

	Volume (Available)	3.0 m × 3.72 m × 1.49 m = 16.6 m ³	
	MOC	RCC	
Tank-3 Rectangular Part (Upper)	Height	2.0 m	
	Length	2.0 m	
	Width	2.0 m	
	Volume (Available)	2.0 m × 2.0 m × 2.0 m = 8.0 m ³	
	MOC	MS	
Tank-3 Circular Cone Part (Lower)	Height	0.7 m	
	Radius	1.0 m	
	Volume (Available)	0.73 m ³	
	MOC	MS	
SLUDGE TRANSFER PUMP	Capacity	Gravity Flow	
	Head	Not Required	
	MOC:	Not Required	
SLUDGE BED-1 / SLUDGE DEWATERING MACHINE-1		3.0 m ³ / hr	
SLUDGE BED-2 / SLUDGE DEWATERING MACHINE-2		0.5 m ³ / hr	

Observations & Recommendations

The details of observations and recommendations of team IIT Ropar are presented below:

- The primary treatment process at the facility includes a set of collection tanks specifically designed to facilitate effective wastewater treatment. These tanks are essential for the initial stages of the treatment process, where chemical flocculation plays a crucial role. The collection tanks provided for this purpose have a total capacity of 32.4 KL, distributed across six individual tanks, each with a capacity of 5.4 KL. With a feed flow rate of 1.6 m³ per hour, the available retention time in each tank is approximately 3.3 hours. This retention time is particularly well-suited for the formation of reasonably sized flocs, which are necessary for efficient sedimentation and subsequent treatment stages.
- In the context of the primary treatment process, chemical flocculation is a critical step. The effectiveness of flocculation depends heavily on the proper dosing of flocculants, which are the chemicals used to aggregate the fine suspended particles in the wastewater. Optimizing the dosage of these flocculants is vital to ensure that the particles come together to form flocs of the desired size. Additionally, uniform mixing of the feed within the collection tanks is essential to maximize the efficiency of the flocculation process. By achieving consistent mixing, the flocculants can interact evenly with the wastewater, promoting the formation of stable flocs that can be easily settled out in the subsequent sedimentation tanks.
- Maintaining the pH of the wastewater within a specific range is another crucial aspect of the primary treatment process, particularly for effective coagulation and sedimentation. The pH of the wastewater can significantly influence the efficiency of the flocculation process, as certain pH levels are more conducive to the formation of flocs. If the pH is not within the recommended range, the flocculants may not work as effectively, leading to suboptimal flocculation and poor sedimentation. Therefore, pH adjustment may be necessary, depending on the characteristics of the influent. To address this, it is recommended to introduce a pH monitoring system as part of the primary treatment process.
- The implementation of a pH monitoring system would provide real-time data on the pH levels of the wastewater, allowing for timely adjustments to be made as needed. This proactive approach not only ensures that the pH remains within the optimal range for

coagulation and sedimentation but also helps in conserving resources by avoiding the overuse of chemicals. By maintaining the required pH range, the overall efficiency of the primary treatment process can be significantly enhanced, leading to better wastewater quality and a more sustainable operation. This approach not only optimizes the use of flocculants but also ensures that the entire treatment process is more efficient and cost-effective.

- **Query of IIT Ropar & PU Chandigarh Team:** It has been observed that the overflow from the Multi Effect Evaporator (MEE) is being directly routed to the primary treatment tank instead of first passing through the equalization tank. Additionally, effluents from the R&D department, Quality Control (QC) labs, and the cooling tower are also being directly mixed with the primary treatment tank. This practice can have significant implications for the efficiency and uniformity of the primary treatment process. This bypassing the equalization tank, the varying characteristics of these effluents, such as different pH levels or concentrations of contaminants, may disrupt the consistency needed for optimal operation. The equalization tank is designed to homogenize the wastewater, ensuring that the primary treatment process receives a more uniform influent, which is crucial for maintaining the effectiveness of the treatment. Directly mixing these effluents with the primary treatment tank can lead to fluctuations in the process, potentially reducing the overall treatment efficiency and compromising the quality of the treated water.
- **Response of Concerned Officials of Morepen Laboratories Ltd, Masulkhana:** This response addresses the query from the team at IIT Ropar and PU Chandigarh regarding the operation of the six collection chambers in the primary treatment process. Contrary to the assumption that all six chambers operate in series, only the first three are connected in series. Each of these three chambers is dedicated to a specific dosing process: lime dosing, alum dosing, and polymer dosing, respectively. This sequence has been carefully designed based on our extensive experience to ensure optimal utilization and effectiveness of the treatment process. The remaining three chambers operate in parallel, providing a combined capacity of 16.2 KL (3 chambers x 5.4 KL each). With the current feed flow rate at 1.6 KL per hour, this setup offers approximately 10 hours of retention time, which is sufficient for the homogenization and effective operation of the primary treatment. This configuration has been chosen to balance efficiency and effectiveness, ensuring that the treatment process runs smoothly and meets the required standards for wastewater treatment.

AEROBIC TREATMENT (ACTIVATED SLUDGE PROCESS): Aerobic treatment is a widely utilized biological wastewater treatment process that operates in the presence of oxygen. In this method, microorganisms, primarily aerobic bacteria, use oxygen to metabolize and break down organic pollutants present in the wastewater. These organic pollutants, often referred to as biochemical oxygen demand (BOD), are converted into simpler, less harmful substances like carbon dioxide, water, and biomass. This process is fundamental to the secondary treatment stage of Effluent Treatment Plants (ETPs), where it serves to further reduce the concentration of organic matter in the wastewater following primary treatment. The primary purpose of aerobic treatment is to harness the natural metabolic activity of microorganisms to degrade organic pollutants. Various biological processes are employed to achieve this, with the most common being the activated sludge process. In this process, wastewater is introduced into an aeration tank, where it is mixed with a culture of microorganisms known as activated sludge. The aeration tank is designed to provide a continuous supply of oxygen, which is essential for the microorganisms to thrive and efficiently consume the organic pollutants. As these microorganisms metabolize the organic matter, they multiply and form a dense microbial community that enhances the overall treatment process. The aeration tank plays a crucial role in the aerobic treatment process. It is equipped with mechanisms, such as diffusers or mechanical aerators, which ensure a steady supply of oxygen is dissolved into the wastewater. This oxygen is vital for the survival and metabolic activity of the aerobic microorganisms. As the microorganisms break down the organic pollutants, they convert them into simpler compounds that are less harmful to the environment. The biological activity within the aeration tank significantly reduces the BOD of the wastewater, which is a key indicator of the organic pollution load. After the aerobic treatment phase, the mixture of treated water and microorganisms, commonly referred to as activated sludge, is transferred to a clarifier. In the clarifier, the activated sludge is allowed to settle, separating the treated water from the microbial biomass. The settled sludge is either recycled back into the aeration tank to maintain an adequate population of microorganisms or removed for further treatment or disposal. The clarified water, now with significantly reduced organic content and BOD, is sent for additional treatment processes, depending on the specific requirements of the ETP. In the context of an Effluent Treatment Plant, the biological reactor is a critical component that facilitates the biological treatment processes necessary for the degradation of organic pollutants. These reactors provide an optimal environment for microorganisms to efficiently break down pollutants. The

biological treatment process, including aerobic digestion, not only reduces the concentration of organic pollutants but also plays a crucial role in improving the overall quality of the treated water. This is achieved by significantly lowering the BOD, reducing ammonia and nitrogen compounds through nitrification and denitrification processes, and diminishing the population of harmful pathogens, thereby enhancing the safety of the treated effluent. Furthermore, secondary treatment processes, including aerobic treatment, often target the removal of suspended solids that may have bypassed primary treatment. The process ensures that fine particles and other residual contaminants are effectively removed, resulting in a higher quality of treated water. The clarified water, after undergoing aerobic treatment and settling in the clarifier, is substantially improved in terms of organic content and is typically ready for further treatment, depending on the ETP's design and environmental regulations.

A clarifier is a crucial component of an Effluent Treatment Plant (ETP) that plays a vital role in separating solids from liquids during the secondary stage of wastewater treatment. This stage follows treatment and is focused on further reducing the levels of suspended and dissolved organic matter in the effluent. The primary function of the clarifier is to facilitate the final separation and removal of biological sludge or flocs that have formed as a result of biological treatment processes. In biological treatment processes, such as activated sludge, trickling filters, or other biological reactors, microorganisms break down the organic pollutants present in the wastewater. This breakdown leads to the formation of flocs or biomass clumps. After the wastewater has undergone these biological processes, the partially treated effluent, which still contains suspended solids and biomass, is directed to the secondary clarifier. The clarifier consists of a large settling tank designed to slow down the flow of water, allowing gravity to separate the heavier particles. As the flow decelerates, the biological sludge and flocs, being denser, settle to the bottom of the clarifier. The clarified water, now mostly free of suspended solids, rises to the top and is collected for either further treatment or discharge. The sludge that settles at the bottom of the clarifier is typically managed in one of two ways: it is either returned to the biological treatment process as return activated sludge or sent for further processing, including dewatering. The effective removal of these remaining solids and biomass is essential to achieving the desired effluent quality, ensuring that the water is clean enough to meet regulatory standards for discharge into the environment. Clarifiers are integral to the success of the wastewater treatment process, as they ensure the final removal of solids after biological treatment, leading to a higher quality effluent. Their proper design, operation, and maintenance are critical for optimizing the separation of solids from water, thus enhancing the overall efficiency and effectiveness of the ETP. By efficiently managing the solids removal process,

clarifiers help maintain the balance and effectiveness of the entire treatment system, ultimately contributing to sustainable wastewater management.

AEROBIC TREATMENT		
PRE-TREATMENT	Distillate Holding Tank	Provided with a total capacity of $3 \times 20 \text{ m}^3 = 60 \text{ m}^3$
	Chemical Dossing	Provided provision for PAC Polyelectrolyte
	Chemical Mixing Tank	Provided with adequate capacity = 200 ltr
	Primary Settling Tank	Provided with a total capacity of 7.4 m^3 (With Tube Deck Media)
	Pre-Aeration Tank	Not Available
AERATION TANK-1&2 (ASP-1&2)	Feed Flow Rate	$1.6 \text{ m}^3/\text{hr}$
	Number of Units	01
	Capacity	162 m^3
	Retention Time	101 hr
	Depth	4.5 m
	Area required	36 m^2
	Length	10 m
	Width	3.6 m
	Free Board	0.46 m
	Volume	$10 \text{ m} \times 3.6 \text{ m} \times 0.46 \text{ m} = 16.56 \text{ m}^3$
MOC	RCC	
AERATION TANK-3 (ASP-3)	Feed Flow Rate	$1.6 \text{ m}^3/\text{hr}$
	Number of Units	01
	Capacity	89 m^3
	Retention Time	56 hr
	Depth	4.5 m
	Area required	19.8 m^2
	Length	5.5 m
	Width	3.6 m

	Free Board	0.46 m
	Volume	5.5 m × 3.6 m × 0.46 m = 9 m ³
	MOC	RCC
AIR BLOWER		
Capacity		840 M ³ /hr
Pressure		600 mbar
MOC		Silicon fine bubble air diffuser
Air diffusers		Size – 65 x 1020mm
SECONDARY SETTLING TANK-1 (SST-1)		
TANK	Number of Units	01
	Feed Flow Rate	1.6 m ³ /hr
	Type	Tube Deck Media
	Capacity	12.05 m ³
	Side Water Depth	2.02 m
	Clarifier width	1.8 m
	MOC	M S
SLUDGE TRANSFER PUMP	Capacity	4.5 m ³ /hr
	Head	18 m
	MOC: Casing	CI
	MOC: Impeller	MS
SECONDARY SETTLING TANK-2 (SST-2)		

TANK	Number of Units	01
	Feed Flow Rate	1.6 m ³ /hr
	Type	Tube Deck Media
	Capacity	12.05 m ³
	Side Water Depth	2.02 m
	Clarifier width	1.8 m
	MOC	M S
SLUDGE TRANSFER PUMP	Capacity	4.5 m ³ /hr
	Head	18 m
	MOC: Casing	CI
	MOC: Impeller	MS

Observations & Recommendations

The details of observations and recommendations of team IIT Ropar & PU Chandigarh are presented below:

- The Effluent Treatment Plant (ETP) at the facility includes three aeration tanks with a combined total capacity of 251 KL, divided into two stages: ASP 1 and 2 with a capacity of 162 KL, and ASP 3 with a capacity of 89 KL. The decision to utilize three separate tanks rather than a single 251 KL tank is a commendable design principle. This multi-tank system allows for more efficient management of the aeration process, providing a staged approach to treatment. By incorporating two clarifiers between the stages, the design ensures that materials are effectively settled before the effluent enters the next tank or phase. This setup not only enhances the overall treatment process but also allows for better control and flexibility in managing the wastewater treatment. The staged design reduces the risk of system overloads, ensures more uniform treatment, and improves the quality of the final effluent.

- Aerobic treatment has been found to be effective in present ETP for reducing the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in wastewater, which are key indicators of organic pollution. By efficiently breaking down organic pollutants through the activity of aerobic microorganisms, this process significantly improves the overall quality of the treated water.
- Maintaining the optimal temperature for microbial activity within the aerobic treatment process is crucial for ensuring the efficiency of the system. Different microorganisms need at specific temperature ranges, and the performance of the biological reactor can be significantly affected by temperature variations. Adjusting the temperature to suit the specific needs of the microorganisms present in the reactor ensures that they remain active and efficient in breaking down organic pollutants. This consideration is particularly important in environments where external temperature fluctuations might impact the internal conditions of the reactor. By carefully monitoring and controlling the temperature, the treatment process can be optimized, leading to improved pollutant degradation and overall system performance.
- The pH level within the biological reactor plays a vital role in the success of the aerobic treatment process. Most biological processes, including those involving aerobic microorganisms, operate best within a neutral to slightly alkaline pH range. Monitoring and controlling the pH level within this range is essential to maintaining an environment that supports optimal microbial activity. If the pH deviates too far from the ideal range, it can hinder the effectiveness of the microorganisms, leading to reduced treatment efficiency. Therefore, a reliable pH monitoring system has been maintained to ensure that the pH remains within the desired range, allowing the biological processes to function at their best and resulting in high-quality treated effluent.
- In aerobic biological reactors, providing sufficient aeration is crucial for maintaining adequate dissolved oxygen levels. A well-aerated environment supports the growth and activity of aerobic microorganisms, which are responsible for breaking down organic pollutants in the wastewater. The design of the aeration system must ensure that oxygen is evenly distributed throughout the reactor, preventing the formation of anaerobic zones where microbial activity would be significantly reduced. Proper aeration not only

enhances the efficiency of the treatment process but also helps prevent the buildup of harmful gases and odors. In this particular ETP; the optimal dissolved oxygen levels has been maintained, so the reactor can effectively degrade organic pollutants, leading to improved effluent quality and a more stable treatment process.

- The ETP design includes uniform mixing to prevent the formation of dead zones within the reactor, where pollutants could potentially accumulate and escape treatment. Uniform mixing ensures that all areas of the reactor are exposed to the same level of treatment, allowing the microorganisms to access and break down organic pollutants more effectively. This design feature is crucial for maintaining the efficiency of the treatment process, as it prevents the buildup of untreated or partially treated wastewater in certain areas of the reactor. By promoting even distribution of both the wastewater and the microorganisms, the uniform mixing system has been provided to achieve a more consistent and effective treatment outcome.
- The ETP has incorporated effective waste sludge handling and removal procedures to maintain the overall efficiency of the aerobic treatment process. Regular removal of excess sludge is essential to prevent the accumulation of inert material within the reactor, which can hinder the activity of the microorganisms and reduce the treatment efficiency. Proper sludge management ensures that the reactor remains in optimal condition, with sufficient space for active microorganisms to thrive and degrade organic pollutants. By implementing these procedures, the ETP has maintained a high level of treatment performance, resulting in better effluent quality and a more stable operation.
- In certain situations, bio-augmentation introducing specific microbial cultures or enzymes into the reactor can be considered to enhance the breakdown of targeted pollutants. This approach is particularly useful when the existing microbial community may be insufficient to effectively degrade certain contaminants present in the wastewater. By supplementing the reactor with specialized microorganisms or enzymes, the treatment process can be optimized to address specific challenges, leading to improved pollutant removal and better overall system performance. Bio-augmentation is a flexible tool that can be applied as needed to maintain the effectiveness of the aerobic

treatment process.

- **Query of IIT Ropar & PU Chandigarh Team:** Following the analysis of the first set of sampling data, it became evident that the Activated Sludge Process (ASP) was not performing within the desired operational range. This underperformance raised concerns about the efficiency of the microbial activities essential for the breakdown of organic pollutants in the wastewater. To address this issue, the team considered enhancing the microbial processes through two potential strategies. The first option involves the introduction of aeration via nano-bubbles, a technique that could significantly improve the oxygen transfer efficiency within the ASP. Nano-bubbles are ultra-fine bubbles that provide a greater surface area for oxygen dissolution, thereby increasing the availability of dissolved oxygen in the wastewater. This would extend the residence time, allowing microbes more time to metabolize organic matter, which could lead to improved treatment efficiency. The second option is to implement strict monitoring and control of the key parameters of the effluent entering the ASP. By closely regulating factors such as pH, temperature, and organic load, the treatment process could be optimized, ensuring that the conditions are ideal for microbial activity. This approach would help maintain the ASP within its optimal operating range, enhancing overall system performance.
- **Response of Concerned Officials of Morepen Laboratories Ltd. Masulkhana:** We have implemented several measures to manage the high Total Dissolved Solids (TDS) effluent effectively. Initially, the effluent is collected in an equalization tank to stabilize its flow. Prior to entering the Multi Effect Evaporator (MEE), it undergoes pre-treatment in a Primary Tube Settler (PST). The sediment settled at the bottom is filtered using a screw press filter, ensuring that only pretreated water reaches the MEE. These steps have notably reduced fouling in the MEE and improved its operational efficiency. Additionally, to stabilize steam supply and minimize fluctuations at the MEE, we have installed a steam flow controller. A Mass Flow Meter has also been integrated into the feed line, enhancing system monitoring and control. Vacuum stabilization has been implemented to further reduce fouling, particularly in the ATFD and MEE condenser cooling water supplies. These adjustments have collectively enabled the Effluent Treatment Plant (ETP) to

consistently meet required parameters.

CLARIFLOCCULATOR: A clariflocculator is a specialized piece of equipment used during the sedimentation stage in water treatment processes. It effectively separates suspended solids from water by combining the principles of flocculation and clarification. The term "clariflocculator" is derived from the words "clarification" and "flocculation," reflecting its dual function. In the initial stage, a flocculating agent is added to the water to encourage the formation of flocs-larger particles formed by the aggregation of smaller suspended particles. These larger and denser flocs are easier to settle. The water containing these flocculated particles enters the clariflocculator through an inlet system, where it is evenly distributed within a central feed well. Inside the clariflocculator, a rapid mixing zone facilitates thorough mixing, promoting the coagulation of particles and aiding in the formation of larger flocs. The water then passes into a flocculation zone, where gentle swirling allows the flocs to grow as they collide and adhere to one another. Next, the water moves into a clarification zone, where the larger flocs settle under gravity, forming a sludge layer at the bottom. The clarified water rises to the top and is collected from the peripheral launder, ensuring it is free from most suspended solids. The accumulated sludge at the bottom is periodically removed to maintain system efficiency. Commonly used in water treatment plants for both drinking water purification and wastewater treatment, clariflocculators ensure that treated water meets quality and clarity standards. Their design and operation may vary depending on the specific treatment requirements and water characteristics.

CLARIFLOCCULATOR (In RO Plant)		
COAGULATION SECTION	Number of Units	1
	Feed Flow Rate	1.6 m ³ /hr
	Capacity	0.75 m ³
	Depth	1.5 m
	Area required	1 m ²
	Length	1 m

	Width	1 m
	MOC	M S
AGITATOR	Drive	Direct drive with gear box
	Type	Helical gear box
	MOC of Shaft	SS
	MOC of Base Frame	MS
PAC / PE DOSING SYSTEM (In RO Plant)		
Flocculation section	Capacity	0.200 m ³
	Number of Units	1
	MOC	HDPE
PUMP	Capacity	200 lph
	Quantity	1
	MOC	SS
AGITATOR	Drive	Direct drive with gear box
	Type	Helical gear box
	MOC of Shaft	SS
	MOC of Base Frame	MS
CLARIFIER (In RO Plant)		
SETTLING SECTION	Number of Units	1
	Feed Flow Rate	1.6 m ³ /hr

	Capacity	3.0 m ³
	Side Water Depth	1.5 m
	Clarifier Diameter / width	1.5 m
	Free Board	0.15 m
	MOC	M S
SLUDGE TRANSFER PUMP	Capacity	Gravity Flow
	Head	Not applicable
	Quantity	Not applicable
	MOC: Casing	Not applicable
	MOC: Impeller	Not applicable

TREATED EFFLUENT SUMP: A treated effluent sump is a containment or storage structure designed to hold treated wastewater, commonly known as effluent, after it has undergone various treatment processes in a wastewater treatment plant (WWTP) or effluent treatment plant (ETP). The term "sump" refers to a pit or reservoir used for the collection and storage of liquids. After undergoing primary, and secondary, processes, the wastewater is considered treated effluent. This effluent is directed to a sump for temporary storage before it is discharged or reused. The treated effluent sump allows for a final check on the quality of the water before its release into the next stage.

INLET SUMP		
Number of Units	As detailed below	
TREATED EFFLUENT SUMP-1(RO FEED TANK)	Feed Flow Rate	1.6 m ³ /hr
	Capacity	10 m ³ (Including peak flow factor)

	Proposed Depth	3.1m
	Area required	3.5 m ²
	Proposed Length	Cylindrical
	Proposed Width/ Diameter	2.1 m
	Free Board	0.2 m
	Volume	m × m × m = 0.69 m ³
TREATED EFFLUENT SUMP-2 (RO Permeate tank)	Feed Flow Rate	1.6 m ³ /hr
	Capacity	10 m ³ (Including peak flow factor)
	Retention Time	Not applicable Min-(Maximum)
	Proposed Depth	3.16 m
	Area required	3.54 m ²
	Proposed Length	Cylindrical
	Proposed Width/ Diameter	2.125 m
	Free Board	0 m
	Volume	m × m × m = 0 m ³

Observations & Recommendations

The details of observations and recommendations of team IIT Ropar & PU Chandigarh are presented below:

- Monitoring and testing can be performed to ensure that the treated water meets the standards for further processing. The sump provides a buffer or storage capacity to accommodate fluctuations in the treated effluent flow. This helps manage variations in the volume of treated water produced by the treatment plant.
- As per the concerned official of the plant; the sump is designed to use when the membrane system is under maintenances. It helps maintain the integrity of the treated water before its further projection to treatment.
- Depending on the specific design of the system, pumps have been used to transfer the treated effluent from the sump to the membrane system, before reaching to the final destination.

REVERSE OSMOSIS (RO) SYSTEM: Reverse osmosis (RO) represents a specialized filtration method that employs a semi-permeable, thin membrane with fine pores. This

membrane allows the passage of pure water while rejecting larger molecules like dissolved salts and impurities such as bacteria. The application of reverse osmosis is widespread, catering to drinking water systems, industrial boilers, food and beverage processing, cosmetics, pharmaceutical production, seawater desalination, and various other uses. Having been a recognized technology for over a century, it has been commercially employed since the 1960s. Key features of RO systems include simplicity in design and operation, low maintenance requirements, and modular characteristics. These systems effectively remove both inorganic and organic pollutants simultaneously. RO processes enable the recovery and recycling of waste process streams without affecting the material being recovered. Additionally, they often require less energy, offering lower capital and operating costs compared to many conventional treatment systems. RO contributes to reducing waste stream volumes, allowing for more efficient treatment by processes like incineration. RO systems can be integrated with other treatment processes, including oxidation, adsorption, stripping, or biological treatment, producing high-quality product water for reuse or discharge. Applications for RO processes encompass treating wastewater with organic matter, electroplating wastewater, metal finishing, pulp and paper, mining, petrochemical, textile, food processing industries, radioactive wastewater, municipal wastewater, and contaminated groundwater. The membranes used in reverse osmosis systems consist of a dense polymer barrier layer facilitating separation. Each membrane is a spiral-wound sheet of semi-permeable material, available in different diameters. RO water treatment plants remove unwanted particles like salts, improving fluid properties. Crossflow, an advanced RO technology, allows membranes to clean themselves continually. High-pressure pumps (HPP) are essential for pushing fluid through the membrane. For brackish water, approximately 10 to 20 bars of osmotic pressure are applied to separate saltwater as rejection and good water as a product. RO is effective in rejecting various substances, including sugar, bacteria, salts, proteins, particles, dyes, and other constituents. The process involves forcing water molecules through a 0.0001-micron semi-permeable membrane using water pressure. The high-pressure pump increases pressure on the salt side, forcing water across the membrane, leaving dissolved salts in the reject stream. Permeate or product water, with 95% to 99% of dissolved salts removed, is the result. The RO membrane must be housed to maintain pressure and supply energy to force water through, separating it from unwanted substances.

MULTI EFFECT EVAPORATOR: In the realm of efficient water evaporation, a multiple-effect evaporator stands as a notable apparatus, utilizing steam heat to evaporate water. The process unfolds in a sequence of vessels, each maintained at decreasing pressure levels. Water is boiled successively, and the vapour from one effect serves as the heating medium for the next, which operates at a lower boiling point. The latent heat in water vapour can be recycled by compressing the vapour thermally or mechanically to a higher pressure and temperature. Multi-Effect Evaporators combine two or more bodies to conserve steam, condensed solely in the first-effect heat exchanger. As water evaporates in the first-effect vapour body, it condenses in the second-effect heat exchanger, providing energy for evaporation in the second-effect vapour body and onward for additional effects. The vapour from the last effect is directed to a condenser. These evaporator bodies operate under vacuum to lower the boiling temperature. A multiple effect is an evaporation unit comprising linked evaporators, significantly reducing energy consumption. The first effect is directly heated, and subsequent effects are heated by vapours from preceding ones. The last effect's process vapours condense on a heat sink. Steam enters the steam compartment, and the feed flows down the tube walls. Vapour and liquids separate in the cyclone separator. The product is evenly distributed into heating tubes in the head, forming a thin film on the tube wall. As the liquid flows downward, it is rapidly heated, partially evaporated by heat transfer steam. Vapour and liquids are separated at the bottom. Concentrates are collected after each calendrias and sent to the Agitated thin film dryer for drying.

AGITATED THIN FILM DRYER (ATFD): An Agitated Thin Film Dryer (ATFD) is a specialized dryer used for the continuous transformation of liquid or slurry into a powder or granular form. This operates on the same principle as an Agitated Thin Film Evaporator (ATFE), forming a thin film on the surface of a heated drum or tube. In Effluent Treatment Plant (ETP), the ATFD plays a pivotal role in waste management. It consists of a cylindrical body with a heating jacket and a bladed rotor inside. Blades spread wet concentrate in a thin film over the heated wall, facilitating drying. Heat transfer occurs through steam, leaving dried solids at the bottom. Key benefits/advantages of Agitated Thin Film Dryer:

- Reduced evaporation time compared to solar pans.
- Elimination of manual waste salt handling, reducing manpower needs.
- Operational continuity during rainy seasons, avoiding overflow of solar pans.
- Smaller footprint compared to solar pans, preventing groundwater contamination.

- Reduction in sludge volume and weight, minimizing disposal costs.
- Mitigation of odour generation and potential environmental impacts.

RO PLANT: PRE-TREATMENT			
Components & Type	Multi Grade Filter (MGF)		Provided
	Activated Carbon Filter (ACF)		Provided
	Tube Settler		Provided
	UF MODULE		Not Provided
RO PLANT: MULTISTAGE MODULE			
RO FEED PUMP	Capacity		3.3 m ³ /hr
	Head		35 m
	MOC		SS 316
	Drive		Motor Driven
	Units		W
SMBS DOSING SYSTEM	Dosing Tank	Type	cylindrical
		Capacity	100 litres
		MOC	PE White
		Units	1
	Dosing Pump	Type	Metering
		Capacity	4 lph
		MOC	PP
		Units	W
ANTI SCALING DOSING SYSTEM	Dosing Tank	Type	cylindrical
		Capacity	200 litters
		MOC	LLDPE
		Units	1
	Dosing Pump	Type	Metering
		Capacity	4 lph
		MOC	PP
		Units	W+S
PRE-FILTRATION UNIT BEFORE RO SYSTEM	Capacity		3.3 m ³ /hr
	MOC		SS316

		Size	5 microns
HIGH PRESSURE PUMP FOR MULTISTAGE RO PLANT Stage-1	Type	Vertical	
	Capacity	6.5 m ³ /hr	
	MOC	SS316	
	Units	W	
	Head	250 m	
HIGH PRESSURE PUMP FOR MULTISTAGE RO PLANT Stage 2	Type	Reciprocating	
	Capacity	2.0 m ³ /hr	
	MOC	SS316	
	Units	W	
	Head	400 m	
HIGH PRESSURE PUMP FOR MULTISTAGE RO PLANT -Polisher	Type	vertical	
	Capacity	3.3 m ³ /hr	
	MOC	SS316	
	Units	W	
	Head	150 m	
RO MEMBRANE HOUSING RO- Stage-1	Size	8" X 40" unit-8	
	MOC	FRP	
	Units	8 (AS per OEM Design)	
RO MEMBRANE RO Stage-2	Size	4" X 40" unit-8	
	MOC	FRP	
	Units	8 (AS per OEM Design)	
RO MEMBRANE RO Polisher	Size	4" X 40" unit-12	
	MOC	FRP	
	Units	12 (AS per OEM Design)	
RO FLUSHING / CLEANING SYSTEM	Dosing Tank	Type	Cylindrical
		Capacity	500/200 liters
		MOC	LLDPE
		Units	2 set
	Pump	Type	Centrifugal
		Capacity	2.0 m ³ /hr
		MOC	SS316

		Units	1 set	
WATER	Reject	5 KL HDPE tank		
STORAGE TANK	Permeate	10 KL HDPE Tank		
Design basis for Evaporator		MEE	ATFD	
	Unit	Feed: RO Reject Water & High TDS effluent	Feed: Concentrate from Evaporator	
Feed Rate	M ³ /hr	3	0.3	
Initial Solid	%	1.5 to 3	3	
Concentrate final Solids	%	10 to 15%	10 to 15%	
Concentrate Output	Kg/hr	150-300	100	
Concentrate Outlet temperature	°C	80	80	
Water Evaporation Rate	Kg/hr	2700 to 2850	200	
Solids Recovery Rate	Kg/hr	Not Applicable	150 -300	
Utility for Evaporator and ATFD		Unit	Value	
Cooling Water	Cooling Water Inlet Temperature (MEE)	°C	<30	
	Cooling Water Inlet Temperature (ATFD)	°C	32	
	Cooling water for Evaporator	m ³ /hr	80	
	Cooling water for ATFD	m ³ /hr	26	
	Cooling Tower Capacity	TR	210	
Steam Parameters	Steam Pressure	Kg/cm ²	3 (G)	
	Steam Temperature	°C	130	
	Steam for Evaporator	Kg/hr	860	
	Steam for ATFD	Kg/hr	250	
	Total Steam Capacity	Kg/hr	1100	

B. MONITORING THE EFFICIENCY OF ETP OF MOREPEN LABORATORIES LTD. MASULKHANA THROUGH WATER QUALITY TESTING

The effectiveness of any Effluent Treatment Plant (ETP) is often gauged through the transparency of the treated water. However, solely relying on visual observations of the removal of suspended materials doesn't provide insight into the overall performance of the ETP from an environmental standpoint. To assess the efficiency of the ETP at Morepen Laboratories Ltd. Masulkhana, this technical report necessitated the evaluation of water quality parameters at various intervals. Sampling occurred during different periods of the day (morning, afternoon, and evening), with each sample undergoing triplicate analysis. Morepen Laboratories Ltd. Masulkhana staff, alongside teams from IIT Ropar, conducted the initial sampling on 24/02/24. Triplicate samples were gathered and tested at the three different laboratory of IIT Ropar and PU Chandigarh. The analysis focused on parameters like pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), as well as Cation and Anion Analysis. BIS protocols have been used for the determinations of these parameters. Additionally, an investigation into the nature of materials responsible for TDS, COD, and BOD was planned using IC Chromatography; and IR spectroscopic studies."

pH Control of ETP of Morepen Laboratories Ltd., Masulkhana: The management of pH levels in an Effluent Treatment Plant (ETP) holds paramount importance in the realm of wastewater treatment. pH, determining the acidity or alkalinity of a solution, employs considerable influence over the effectiveness of diverse treatment methodologies and the ecological impacts of treated effluent. Numerous biological treatment procedures, including activated sludge, exhibit sensitivity to pH levels. Sustaining pH within an optimum range amplifies the efficacy of microorganisms responsible for the decomposition of organic substances. The solubility of diverse chemicals in wastewater is subject to pH, accentuating the necessity of pH control. Strategic pH regulation proves pivotal in facilitating the precipitation of metals or nutrients during chemical treatment procedures like coagulation and precipitation. A steadfast adherence to the recommended pH range guarantees the attainment of desired

disinfection efficiency. Regulatory guidelines frequently outline acceptable pH levels for discharged effluent. Compliance with these standards is imperative, ensuring environmental adherence and averting adverse repercussions on receiving water bodies. The evaluation of pH of various stages of ETP of Morepen Laboratories Ltd. Masulkhana is detailed below in table.

Table 1B.1 pH analysis of water samples collected from the ETP under study.

Sr. No	Date	Time	Sample Name	Sample Code	pH Determination			
					1 st	2 nd	3 rd	Avg
1	24/02/2024	Morning	Equalization tank	V1-SS1-M	7.00	7.04	7.06	7.03
2	24/02/2024	Morning	MEE Feed Tank 01 Outlet	V1-SS2-M	7.16	7.18	7.22	7.19
3	24/02/2024	Morning	MEE feed Tank 03 and 04 outlet	V1-SS3-M	7.11	7.15	7.17	7.14
4	24/02/2024	Morning	Primary Settling tank Inlet	V1-SS4-M	12.23	12.21	12.19	12.21
5	24/02/2024	Morning	Primary Settling tank outlet	V1-SS5-M	10.57	10.59	10.59	10.58
6	24/02/2024	Morning	Secondary Settling tank 01 outlet	V1-SS6-M	7.86	7.89	7.91	7.89
7	24/02/2024	Morning	Secondary Settling tank 02 outlet	V1-SS7-M	7.92	7.96	7.97	7.95
8	24/02/2024	Morning	RO inlet at RO settler	V1-SS8-M	6.26	6.35	6.34	6.32
9	24/02/2024	Morning	RO reject	V1-SS9-M	7.22	7.30	7.31	7.28
10	24/02/2024	Morning	RO permeate	V1-SS10-M	7.22	7.21	7.16	7.20

11	24/02/2024	Evening	Equalization tank	V1-SS1-E	7.13	7.29	7.3	7.24
12	24/02/2024	Evening	MEE Feed Tank 01 Outlet	V1-SS2-E	7.13	7.18	7.19	7.17
13	24/02/2024	Evening	MEE feed Tank 03 and 04 outlet	V1-SS3-E	7.12	7.15	7.15	7.14
14	24/02/2024	Evening	Primary Settling tank Inlet	V1-SS4-E	10.14	10.11	10.08	10.11
15	24/02/2024	Evening	Primary Settling tank outlet	V1-SS5-E	10.05	10.59	10.06	10.23
16	24/02/2024	Evening	Secondary Settling tank 01 outlet	V1-SS6-E	7.96	7.99	7.99	7.98
17	24/02/2024	Evening	Secondary Settling tank 02 outlet	V1-SS7-E	7.78	7.79	7.80	7.79
18	24/02/2024	Evening	RO inlet at RO settler	V1-SS8-E	7.14	7.17	7.18	7.16
19	24/02/2024	Evening	RO reject	V1-SS9-E	7.94	8.00	8.02	7.99
20	24/02/2024	Evening	RO permeate	V1-SS10- E	7.49	7.45	7.40	7.45
21	24/02/2024	Composite	Equalization tank	V1-SS1-C	7.26	7.31	7.34	7.30
22	24/02/2024	Composite	MEE Feed Tank 01 Outlet	V1-SS2-C	7.51	7.56	7.65	7.57
23	24/02/2024	Composite	MEE feed Tank 03 and 04 outlet	V1-SS3-C	7.59	7.61	7.63	7.61
24	24/02/2024	Composite	Primary Settling tank Inlet	V1-SS4-C	11.59	11.55	11.56	11.57

25	24/02/2024	Composite	Primary Settling tank outlet	V1-SS5-C	10.55	10.53	10.54	10.54
26	24/02/2024	Composite	Secondary Settling tank 01 outlet	V1-SS6-C	7.96	7.99	7.99	7.98
27	24/02/2024	Composite	Secondary Settling tank 02 outlet	V1-SS7-C	7.89	7.94	7.94	7.92
28	24/02/2024	Composite	RO inlet at RO settler	V1-SS8-C	6.61	6.66	6.66	6.64
29	24/02/2024	Composite	RO reject	V1-SS9-C	7.56	7.61	7.63	7.60
30	24/02/2024	Composite	RO permeate	V1-SS10-C	7.80	7.61	7.59	7.67

TDS (Total dissolved solids) Control of ETP of Morepen Laboratories Ltd. Masulkhana:

The term Total Dissolved Solids (TDS) encompasses all inorganic and organic substances present in water, capable of passing through a 2-micron filter. Generally, TDS is the cumulative sum of cations and anions within water. Constituents of TDS typically involve ions and ionic compounds like carbonate, bicarbonate, chloride, fluoride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, and potassium. However, any ion present contributes to the overall total. Organic ions, including pollutants, herbicides, and hydrocarbons, are part of TDS. Additionally, soil organic matter compounds, such as humic/fulvic acids, are encompassed by TDS. Various methods exist for TDS measurement, with a straightforward approach involving water sample filtration followed by evaporation at 180 °C in a pre-weighed dish until weight stabilization. The weight increase of the dish indicates TDS, reported in mg/L. Alternatively, TDS can be estimated from the sample's electrical conductivity using a correlation equation dependent upon specific conductivity. Lastly, TDS calculation involves measuring individual ions and summing them. While TDS provides a quantitative measure of dissolved inorganic chemicals, it lacks specificity about their nature. The toxicity of individual solutes varies, yet TDS tests do not distinguish between them. Hence, further analysis of treated water through chromatography and spectroscopy has been planned to elucidate the nature of inorganic matter.

Table 1B.2. TDS analysis of water samples collected from the ETP under study.

Sr. No	Date	Time	Sample Name	Sample Code	TDS Determination			
					1 st	2 nd	3 rd	Avg (ppm)
1	24/02/2024	Morning	Equalization tank	V1-SS1-M	27688.05	27948.05	28013.05	27883.05
2	24/02/2024	Morning	MEE Feed Tank 01 Outlet	V1-SS2-M	28338.05	28403.05	28468.05	28403.05
3	24/02/2024	Morning	MEE feed Tank 03 and 04 outlet	V1-SS3-M	28728.05	29183.05	29248.05	29053.05
4	24/02/2024	Morning	Primary Settling tank Inlet	V1-SS4-M	4457.05	4535.05	4535.05	4509.05
5	24/02/2024	Morning	Primary Settling tank outlet	V1-SS5-M	3690.05	3729.05	3722.55	3713.88
6	24/02/2024	Morning	Secondary Settling tank 01 outlet	V1-SS6-M	4249.05	4301.05	4301.05	4283.72

7	24/02/2024	Morning	Secondary Settling tank 02 outlet	V1- SS7-M	2624.05	2630.55	2617.55	2624.05
8	24/02/2024	Morning	RO inlet at RO settler	V1- SS8-M	4899.05	4918.55	4905.55	4907.72
9	24/02/2024	Morning	RO reject	V1- SS9-M	9202.05	9228.05	9208.55	9212.88
10	24/02/2024	Morning	RO permeate	V1- SS10- M	647.00	647.65	649.60	648.08
11	24/02/2024	Evening	Equalization tank	V1- SS1-E	26973.05	26973.05	27103.05	27016.38
12	24/02/2024	Evening	MEE Feed Tank 01 Outlet	V1- SS2-E	28338.05	28793.05	28793.05	28641.38
13	24/02/2024	Evening	MEE feed Tank 03 and 04 outlet	V1- SS3-E	28663.05	28858.05	28858.05	28793.05
14	24/02/2024	Evening	Primary Settling tank Inlet	V1- SS4-E	3885.05	3872.05	3878.55	3878.55
15	24/02/2024	Evening	Primary Settling tank outlet	V1- SS5-E	3202.55	3202.55	3215.55	3206.88
16	24/02/2024	Evening	Secondary Settling	V1- SS6-E	4262.05	4314.05	4327.05	4301.05

			tank 01 outlet					
17	24/02/2024	Evening	Secondary Settling tank 02 outlet	V1- SS7-E	3540.55	3586.05	3586.05	3570.88
18	24/02/2024	Evening	RO inlet at RO settler	V1- SS8-E	3599.05	3657.55	3664.05	3640.22
19	24/02/2024	Evening	RO reject	V1- SS9-E	10476.05	10469.55	10469.55	10471.72
20	24/02/2024	Evening	RO permeate	V1- SS10-E	647.65	650.25	650.25	649.38
21	24/02/2024	Composite	Equalization tank	V1- SS1-C	27168.05	27363.05	27363.05	27298.05
22	24/02/2024	Composite	MEE Feed Tank 01 Outlet	V1- SS2-C	27558.05	27948.05	28078.05	27861.38
23	24/02/2024	Composite	MEE feed Tank 03 and 04 outlet	V1- SS3-C	27558.05	27948.05	28013.05	27839.72
24	24/02/2024	Composite	Primary Settling tank Inlet	V1- SS4-C	3235.05	3280.55	3274.05	3263.217
25	24/02/2024	Composite	Primary Settling tank outlet	V1- SS5-C	3365.05	3443.05	3449.55	3419.217
26	24/02/2024	Composite	Secondary	V1-	2520.05	2559.05	2559.05	2546.05

			Settling tank 01 outlet	SS6-C				
27	24/02/2024	Composite	Secondary Settling tank 02 outlet	V1-SS7-C	2338.05	2357.55	2357.55	2351.05
28	24/02/2024	Composite	RO inlet at RO settler	V1-SS8-C	4171.05	4223.05	4229.55	4207.88
29	24/02/2024	Composite	RO reject	V1-SS9-C	10528.05	10684.05	10697.05	10636.38
30	24/02/2024	Composite	RO permeate	V1-SS10-C	639.85	641.8	642.45	641.37

Ion Chromatography: Ion Chromatography is a technique used for separating and analysing ions in a liquid sample. It is a form of liquid chromatography that is widely employed in environmental testing, water analysis, and various research fields. IC is particularly useful for determining the concentration of ions in a sample, including both inorganic and organic ions. In the context of wastewater treatment and Effluent Treatment Plants (ETPs), Ion Chromatography can be utilized to assess the composition of effluent, measure the concentration of specific ions, and ensure compliance with environmental regulations. It helps in understanding the quality of treated water and identifying any potential contaminants that may be present in the effluent.

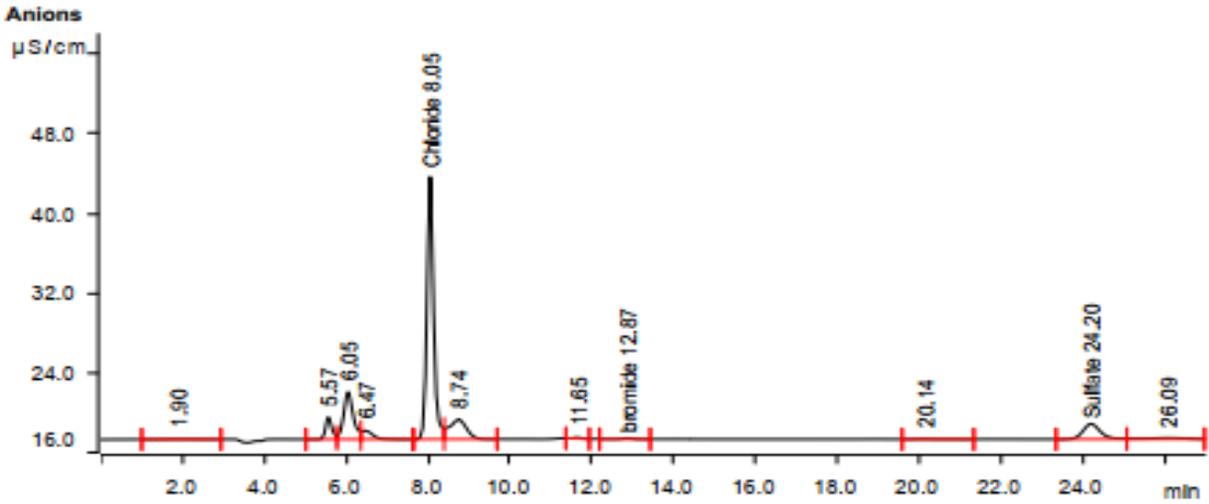


Figure 1B.1. Ion chromatogram of the sample collected as grab sample of the Morning of 24/02/2024 from R.O. (Permeate Tank).

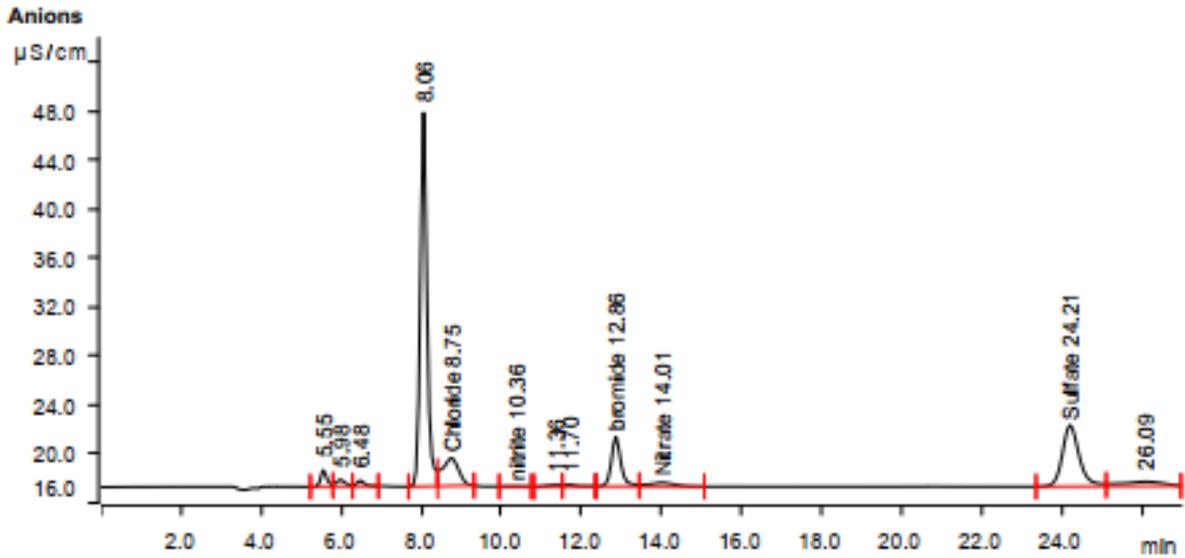


Figure 1B.2. Ion chromatogram of the sample collected as grab sample of the Evening of 24/02/2024 from R.O. (Permeate Tank).

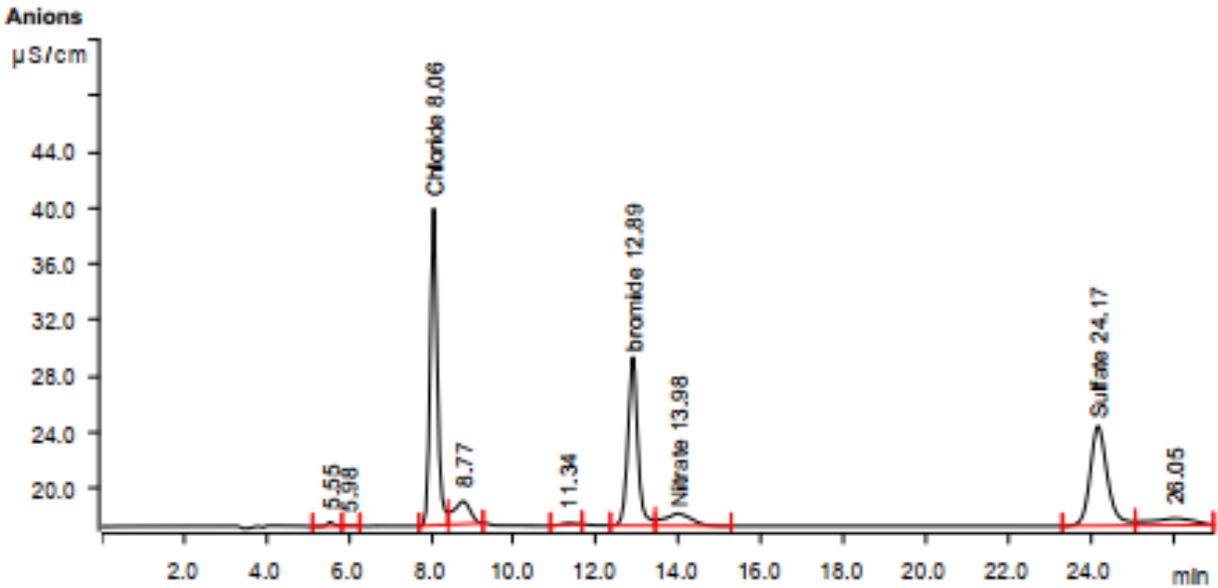


Figure 1B.3. Ion chromatogram of the sample collected as composite sample of 24/02/2024 from R.O. (Permeate Tank).

Table 1B.3. Metal ions analysis (Using ICP-MS) of water samples collected from from R.O. (Permeate Tank) of ETP in plant under study.

S. No.	Sample Name/ Code	Date	Time	Concentrations of Metal Ions in ppb				
				²³ Na	²⁴ Mg	³⁹ K	⁴⁴ Ca	⁵² Cr
1	RO permeate/ V1-SS10-M	24/02/2024	Morning	33614.465	33.649	8309.265	29.673	0.27
2	RO permeate/ V1-10-E	24/02/2024	Evening	30022.268	55.525	7559.7	53.308	0.076
3	RO permeate/	24/02/2024	Composite	25915.734	225.699	6780.381	867.866	0.648

	V1-10-C							
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S. No.	Sample Name/ Code	Date	Time	Concentrations of Metal Ions in ppb				
				⁵⁶ Fe	⁶⁰ Ni	⁷⁵ As	²⁰² Hg	²⁰⁷ Pb
1	RO permeate/ V1-SS10-M	24/02/2024	Morning	13.965	2.229	0.195	0.548	<0.000
2	RO permeate/ V1-10-E	24/02/2024	Evening	8.086	0.559	0.205	0.673	<0.000
3	RO permeate/ V1-10-C	24/02/2024	Composite	25.973	2.122	0.311	1.643	<0.000

Dissolved Oxygen of ETP of Morepen Laboratories Ltd. Masulkhana.: The significance of Dissolved Oxygen (DO) in wastewater treatment is paramount, with its relevance varying across different stages within an Effluent Treatment Plant (ETP). DO represents the quantity of oxygen dissolved in water, playing a pivotal role in supporting biological processes, especially those involving microorganisms engaged in breaking down organic pollutants. Preliminary treatment, focused on removing large solids and debris, does not typically prioritize dissolved oxygen. However, aeration or mixing in preliminary treatment may indirectly impact oxygen content. Primary treatment, centred on eliminating settle-able and floating solids through processes like sedimentation, doesn't primarily concern itself with maintaining adequate dissolved oxygen levels. Yet, oxygen concentrations may influence solid settling characteristics. Biological treatment processes, encompassing activated sludge, trickling filters, and sequencing batch reactors, heavily rely on dissolved oxygen. Microorganisms, primarily bacteria, utilize oxygen in aerobic respiration to consume organic pollutants, aiding in breaking down and stabilizing organic matter. Optimal DO levels are vital for maximizing biological treatment efficiency. Insufficient DO can result in reduced microbial activity, incomplete pollutant removal, and the generation of undesirable by-products. DO saturation levels reflect the maximum oxygen dissolution capacity in water under specific temperature and pressure conditions. Monitoring DO saturation ensures water's capability to support aerobic biological processes. Aeration systems, frequently employed to boost dissolved oxygen levels in treatment tanks, facilitate oxygen transfer from air to water, sustaining favourable conditions for microbial activity. Dissolved oxygen solubility is temperature-dependent, with warmer water holding less dissolved oxygen

than colder water. Seasonal variations or temperature changes merit consideration. Optimal DO levels hinge on specific biological processes within the treatment plant, generally aiming for concentrations above 2 mg/L for aerobic treatment. Continuous monitoring of DO levels is essential for adjusting aeration systems and ensuring efficient biological treatment.

COD (Chemical oxygen demand) Control of ETP of Morepen Laboratories Ltd.

Masulkhana.: An indispensable parameter in wastewater treatment, Chemical Oxygen Demand (COD) gauges the oxygen quantity necessary to chemically oxidize and disintegrate organic and inorganic compounds in water. The significance of COD monitoring fluctuates across diverse stages within an Effluent Treatment Plant (ETP). Evaluating influent wastewater COD offers a perspective on the overall organic load entering the treatment plant. Elevated influent COD levels may signal substantial organic pollutants, prompting the need for tailored treatment approaches. While primary treatment centres on physically removing settle-able solids through processes like sedimentation, COD might not be the primary concern in this stage. Nevertheless, heightened COD levels can contribute to the downstream treatment processes' overall load. COD holds critical importance in biological treatment processes (activated sludge, trickling filters, sequencing batch reactors), where microorganisms dismantle organic pollutants. Oversight and regulation of COD levels optimize microbial activity, ensuring the efficient elimination of organic matter. In some tertiary treatment processes, COD reduction remains a consideration for additional refinement and adherence to stringent effluent standards. Techniques such as filtration, chemical precipitation, and adsorption might be employed to address residual COD. The BOD-to-COD ratio provides insights into wastewater biodegradability, with a lower ratio suggesting the presence of less biodegradable or refractory organic compounds. COD serves as a pivotal indicator of the overall organic content in wastewater. Monitoring COD levels aids in gauging the treatment processes' efficiency in diminishing organic pollutants. Elevated COD levels can contribute to biological oxygen demand (BOD) and nutrient loading in receiving water bodies. Efficient COD removal plays a crucial role in mitigating environmental impact.

Table 1B.4. COD analysis of water samples collected from the ETP under study.

Sr. No	Date	Time	Sample Name	Sample Code	COD Determination			
					1 st	2 nd	3 rd	Avg

								(mg/l)
1	24/02/2024	Morning	Equalization tank	V1-SS1-M	51430.4	52326.4	51968	51908.3
2	24/02/2024	Morning	MEE Feed Tank 01 Outlet	V1-SS2-M	48115.2	48652.8	49100.8	48622.9
3	24/02/2024	Morning	MEE feed Tank 03 and 04 outlet	V1-SS3-M	39692.8	40230.4	40499.2	40140.8
4	24/02/2024	Morning	Primary Settling tank Inlet	V1-SS4-M	30464	29478.4	28851.2	29597.9
5	24/02/2024	Morning	Primary Settling tank outlet	V1-SS5-M	22668.8	24192	23296	23385.6
6	24/02/2024	Morning	Secondary Settling tank 01 outlet	V1-SS6-M	18368	19174.4	18816	18786.1
7	24/02/2024	Morning	Secondary Settling tank 02 outlet	V1-SS7-M	13888	13798.4	13350.4	13678.9
8	24/02/2024	Morning	RO inlet at RO settler	V1-SS8-M	10483.2	10214.4	10572.8	10423.5
9	24/02/2024	Morning	RO reject	V1-SS9-M	17830.4	17382.4	17113.6	17442.1
10	24/02/2024	Morning	RO permeate	V1-SS10-M	6361.6	5734.4	6182.4	6092.8

11	24/02/2024	Evening	Equalization tank	V1-SS1-E	56985.6	56806.4	57702.4	57164.8
12	24/02/2024	Evening	MEE Feed Tank 01 Outlet	V1-SS2-E	50086.4	50982.4	50444.8	50504.5
13	24/02/2024	Evening	MEE feed Tank 03 and 04 outlet	V1-SS3-E	43276.8	42470.4	41932.8	42560
14	24/02/2024	Evening	Primary Settling tank Inlet	V1-SS4-E	33420.8	32614.4	34406.4	33480.5
15	24/02/2024	Evening	Primary Settling tank outlet	V1-SS5-E	26342.4	25446.4	26790.4	26193.1
16	24/02/2024	Evening	Secondary Settling tank 01 outlet	V1-SS6-E	18278.4	18636.8	19532.8	18816
17	24/02/2024	Evening	Secondary Settling tank 02 outlet	V1-SS7-E	14694.4	14963.2	14246.4	14634.7
18	24/02/2024	Evening	RO inlet at RO settler	V1-SS8-E	11737.6	12275.2	12006.4	12006.4
19	24/02/2024	Evening	RO reject	V1-SS9-E	21414.4	20966.4	21683.2	21354.7
20	24/02/2024	Evening	RO permeate	V1-SS10-E	8243.2	7974.4	7526.4	7914.7

21	24/02/2024	Composite	Equalization tank	V1-SS1-C	56806.4	56358.4	55731.2	56298.7
22	24/02/2024	Composite	MEE Feed Tank 01 Outlet	V1-SS2-C	49728	49190.4	49459.2	49459.2
23	24/02/2024	Composite	MEE feed Tank 03 and 04 outlet	V1-SS3-C	40588.8	41126.4	41574.4	41096.5
24	24/02/2024	Composite	Primary Settling tank Inlet	V1-SS4-C	32883.2	32614.4	32076.8	32524.8
25	24/02/2024	Composite	Primary Settling tank outlet	V1-SS5-C	24998.4	24550.4	23654.4	24401.1
26	24/02/2024	Composite	Secondary Settling tank 01 outlet	V1-SS6-C	19622.4	19174.4	18726.4	19174.4
27	24/02/2024	Composite	Secondary Settling tank 02 outlet	V1-SS7-C	13798.4	14246.4	13350.4	13798.4
28	24/02/2024	Composite	RO inlet at RO settler	V1-SS8-C	10214.4	10662.4	11110.4	10662.4
29	24/02/2024	Composite	RO reject	V1-SS9-C	17830.4	18278.4	18726.4	18278.4
30	24/02/2024	Composite	RO permeate	V1-SS10-C	7078.4	7526.4	6988.8	7197.9

BOD (Biological oxygen demand) Control of ETP of Morepen Laboratories Ltd. Masulkhana.: BOD, or Biochemical Oxygen Demand, serves as a fundamental metric measuring the dissolved oxygen required by microorganisms for breaking down organic matter in water through biological processes. This parameter is a crucial indicator of the presence of organic pollutants in wastewater, typically denoted in milligrams of oxygen consumed per litre of water (mg/L) over a specific period, often 5 days (BOD₅) at 20 degrees Celsius. In an Effluent Treatment Plant (ETP), the BOD concentration undergoes influence from diverse factors. The initial BOD level in influent wastewater is determined by the types and concentrations of organic pollutants. Industrial discharges, introducing high-strength organic wastewater, notably impact influent BOD. Preliminary treatment processes, such as screening and grit removal, primarily target the physical removal of large solids and debris. Although these processes don't directly reduce BOD, they safeguard downstream treatment units from interference and damage. Primary treatment involves physically separating settle-able solids through processes like sedimentation. While the primary goal is solids removal, there may be some reduction in BOD as suspended organic matter settles. Biological treatment processes, like activated sludge, are engineered for the biological degradation of organic pollutants. Microorganisms metabolize organic matter, resulting in reduced BOD levels. Adequate aeration and mixing prove crucial for sustaining microbial activity and optimizing BOD removal efficiency. BOD levels in the effluent from biological treatment units are contingent on microbial process efficiency and the extent of organic matter decomposition. Tertiary treatment processes, encompassing filtration, adsorption, or chemical precipitation, may further diminish BOD levels in the treated effluent. Filtration physically removes remaining suspended solids and organic matter, while adsorption processes target dissolved organic compounds.

Table 1B.5. BOD analysis of water samples collected from the ETP of Morepen Laboratories Ltd. Masulkhana.

Sr. No	Date	Time	Sample Name	Sample Code	BOD Determination			
					1 st	2 nd	3 rd	Avg (mg/l)

1	24/02/2024	Morning	Equalization tank	V1-SS1-M	9982.6	10156.5	10087	10075.4
2	24/02/2024	Morning	MEE Feed Tank 01 Outlet	V1-SS2-M	8950	9050	9133.3	9044.4
3	24/02/2024	Morning	MEE feed Tank 03 and 04 outlet	V1-SS3-M	7875.6	7982.2	8035.6	7964.5
4	24/02/2024	Morning	Primary Settling tank Inlet	V1-SS4-M	4857.1	4700	4600	4719
5	24/02/2024	Morning	Primary Settling tank outlet	V1-SS5-M	3489.7	3724.1	3586.2	3600
6	24/02/2024	Morning	Secondary Settling tank 01 outlet	V1-SS6-M	2779.7	2901.7	2847.5	2843
7	24/02/2024	Morning	Secondary Settling tank 02 outlet	V1-SS7-M	2032.8	2019.7	1954.1	2002.2
8	24/02/2024	Morning	RO inlet at RO settler	V1-SS8-M	1485.7	1447.6	1498.4	1477.2
9	24/02/2024	Morning	RO reject	V1-SS9-M	2567.7	2503.2	2464.5	2511.8
10	24/02/2024	Morning	RO permeate	V1-SS10-M	901.6	812.7	876.2	863.5
11	24/02/2024	Evening	Equalization	V1-	11060.9	11026.1	11200	11095.7

			tank	SS1-E				
12	24/02/2024	Evening	MEE Feed Tank 01 Outlet	V1- SS2-E	9316.7	9483.3	9383.3	9394.4
13	24/02/2024	Evening	MEE feed Tank 03 and 04 outlet	V1- SS3-E	8586.7	8426.7	8320	8444.5
14	24/02/2024	Evening	Primary Settling tank Inlet	V1- SS4-E	5328.6	5200	5485.7	5338.1
15	24/02/2024	Evening	Primary Settling tank outlet	V1- SS5-E	4055.2	3917.2	4124.1	4032.2
16	24/02/2024	Evening	Secondary Settling tank 01 outlet	V1- SS6-E	2766.1	2820.3	2955.9	2847.4
17	24/02/2024	Evening	Secondary Settling tank 02 outlet	V1- SS7-E	2150.8	2190.2	2085.2	2142.1
18	24/02/2024	Evening	RO inlet at RO settler	V1- SS8-E	1663.5	1739.7	1701.6	1701.6
19	24/02/2024	Evening	RO reject	V1- SS9-E	3083.9	3019.4	3122.6	3075.3
20	24/02/2024	Evening	RO permeate	V1- SS10-E	1168.3	1130.2	1066.7	1121.7
21	24/02/2024	Composite	Equalization tank	V1- SS1-C	11026.1	10939.1	10817.4	10927.5

22	24/02/2024	Composite	MEE Feed Tank 01 Outlet	V1- SS2-C	9250	9150	9200	9200
23	24/02/2024	Composite	MEE feed Tank 03 and 04 outlet	V1- SS3-C	8053.3	8160	8248.9	8154.1
24	24/02/2024	Composite	Primary Settling tank Inlet	V1- SS4-C	5242.9	5200	5114.3	5185.7
25	24/02/2024	Composite	Primary Settling tank outlet	V1- SS5-C	3848.3	3779.3	3641.4	3756.3
26	24/02/2024	Composite	Secondary Settling tank 01 outlet	V1- SS6-C	2969.5	2901.7	2833.9	2901.7
27	24/02/2024	Composite	Secondary Settling tank 02 outlet	V1- SS7-C	2019.7	2085.2	1954.1	2019.7
28	24/02/2024	Composite	RO inlet at RO settler	V1- SS8-C	1447.6	1511.1	1574.6	1511.1
29	24/02/2024	Composite	RO reject	V1- SS9-C	2567.7	2632.3	2696.8	2632.3
30	24/02/2024	Composite	RO permeate	V1- SS10-C	1003.2	1066.7	990.5	1020.1

Particle size analysis of water samples collected from R.O. (Permeate Tank) at ETP of Morepen Laboratories Ltd. Masulkhana: Dynamic Light Scattering (DLS) plays a crucial role

in evaluating the impact of tertiary treated water, especially in assessing the size distribution of particles or colloids present in the water. DLS, measures the Brownian motion of particles in a fluid by analysing the fluctuations in scattered light. The speed of the Brownian motion is related to the size of the particles. DLS provides information about the particle size distribution in the tertiary treated water. It can detect particles in the nanometre to micrometre range, which is critical for understanding the nature of suspended particles or colloids. By analysing the particle size distribution, DLS assists in monitoring the efficiency of tertiary treatment processes. It helps evaluate whether the treatment methods applied are effectively reducing the size and concentration of particles in the water. DLS is used to evaluate the potential environmental impact of treated water discharge. It helps identify any remaining particulate matter in the water that could have ecological consequences. The quality of treated water is often associated with the presence and characteristics of suspended particles. DLS aids in assessing the quality by providing insights into the size and distribution of these particles.

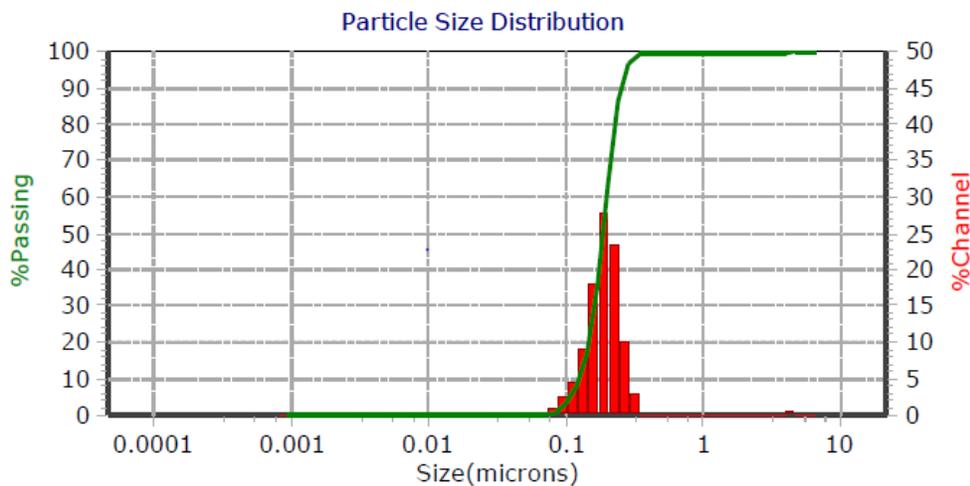


Figure 1B.4 DLS analysis for particle size determination of the sample collected as grab sample of the Morning of 24/02/2024 from R.O. (Permeate Tank).

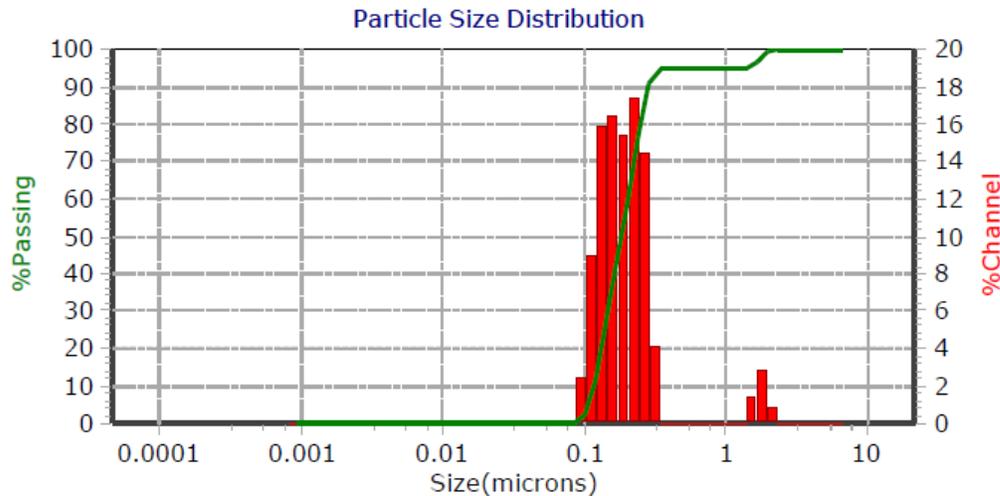


Figure 1B.5. DLS analysis for particle size determination of the sample collected as grab sample of the Evening of 24/02/2024 from R.O. (Permeate Tank)..

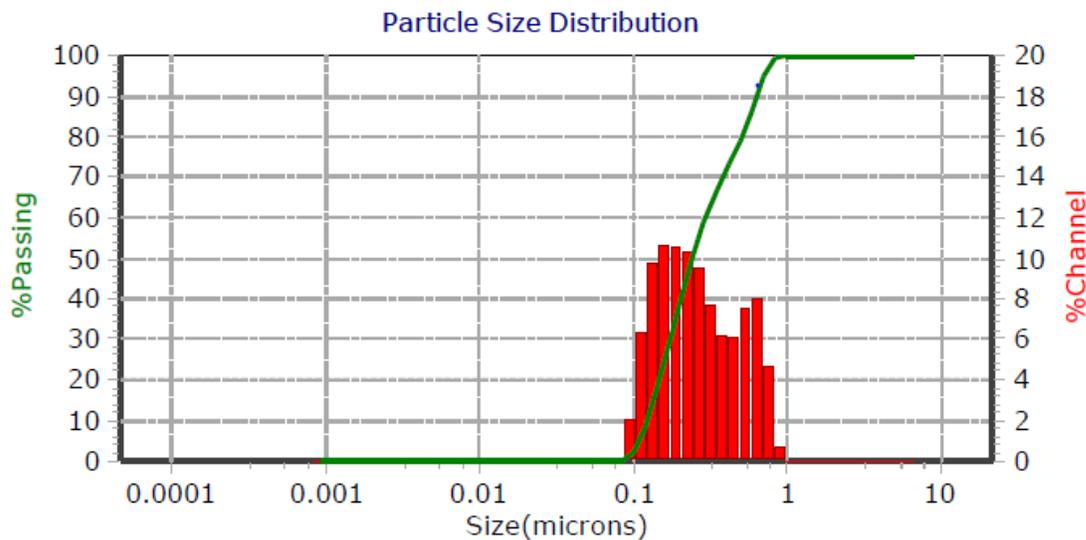


Figure 1B.6. DLS analysis for particle size determination of the sample collected as composite sample of 24/02/2024 from R.O. (Permeate Tank).

Functional groups analysis materials present in the water samples collected from R.O. (Permeate Tank) at ETP of Morepen Laboratories Ltd. Masulkhana: In Effluent Treatment Plant (ETP) water analysis, Infrared (IR) spectroscopy is a valuable analytical technique used to

study the composition of water samples. IR spectroscopy is based on the principle that different chemical bonds absorb infrared radiation at characteristic frequencies. IR spectroscopy helps identify functional groups present in organic compounds within the water sample. Common functional groups, such as hydroxyl (-OH), carbonyl (C=O), and amino (-NH₂), exhibit distinct absorption peaks. IR spectra provide information about the concentration of specific compounds based on the intensity of absorption bands. This enables quantitative analysis of various organic and inorganic constituents in the water. IR spectroscopy is particularly useful for monitoring organic contaminants, including oils, solvents, and other pollutants. The technique can detect the presence of specific organic compounds by analysing characteristic absorption peaks.

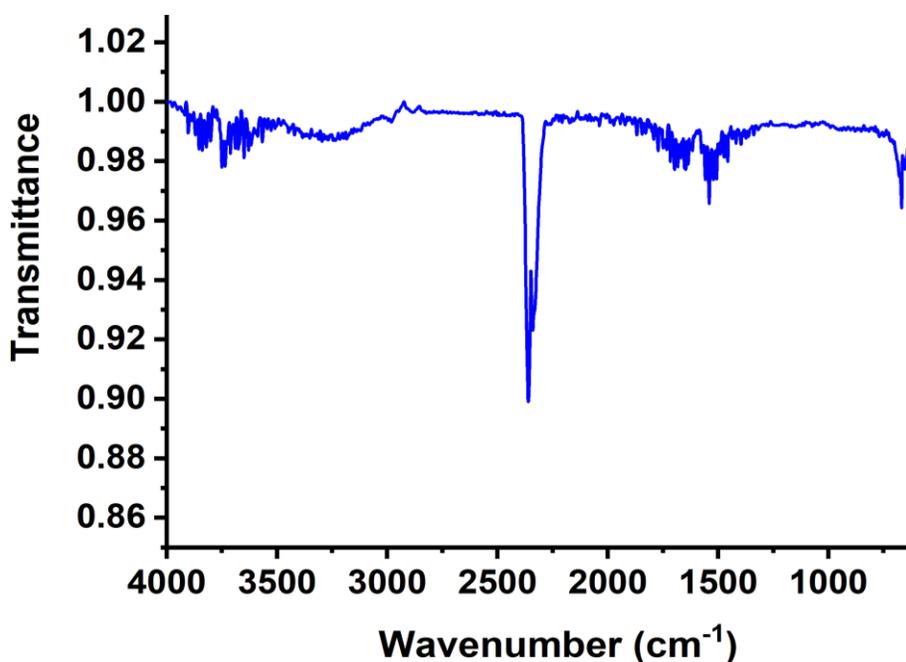


Figure 1B.7. IR analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Morning of 24/02/2024 from R.O. (Permeate Tank).

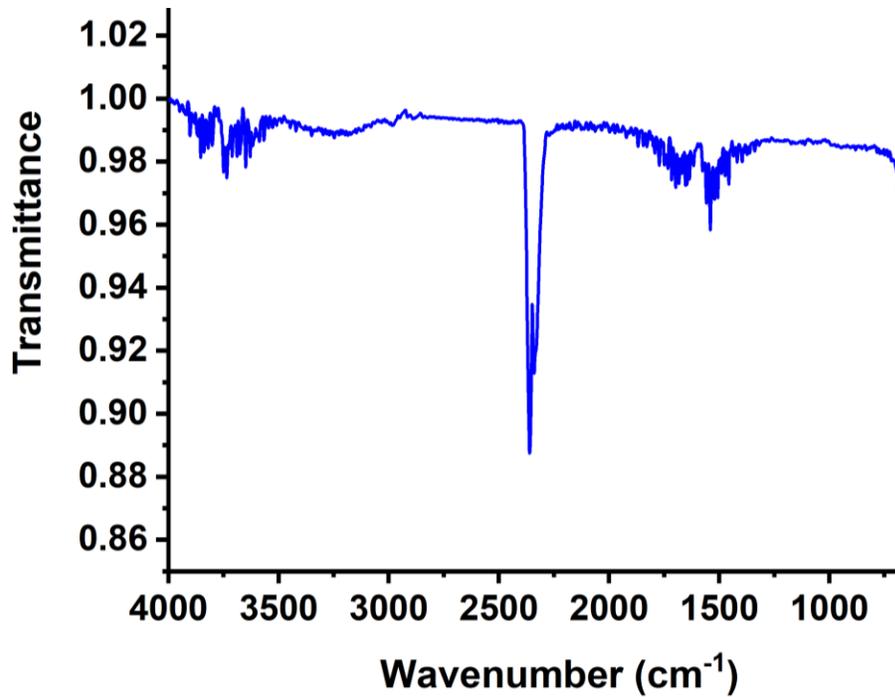


Figure 1B.8. IR analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Evening of 24/02/2024 from R.O. (Permeate Tank).

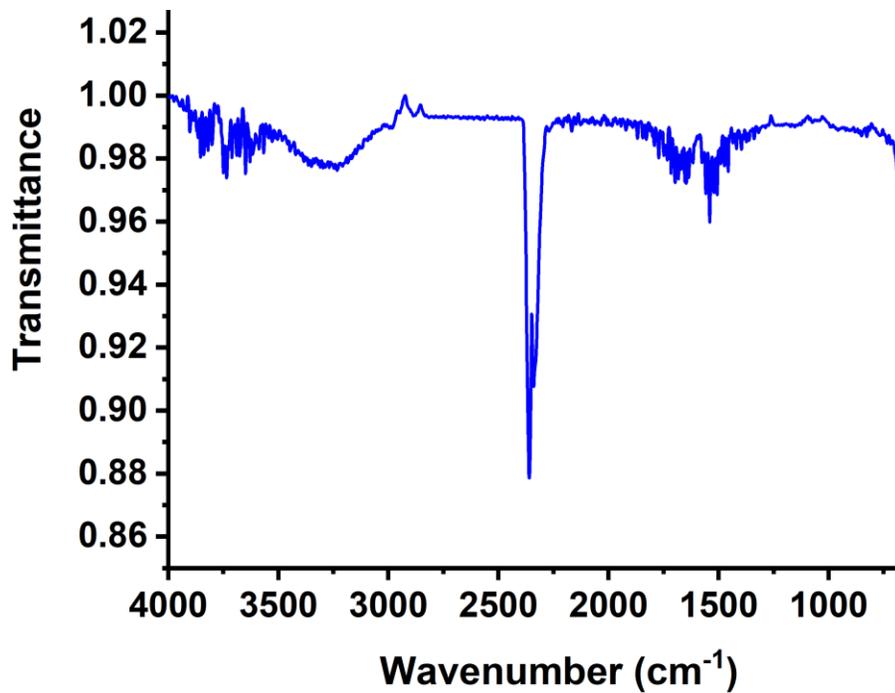


Figure 1B.9. IR analysis (pre-concentrated through SPME) for the sample collected as composite sample of 24/02/2024 from R.O. (Permeate Tank).

UV-Vis Absorption Spectroscopy and Water Quality: UV-Vis absorption spectroscopy is a powerful analytical technique employed in the monitoring of treated water to assess the quality of the water post-treatment. This method relies on the absorption of ultraviolet (UV) and visible (Vis) light by chemical substances present in the water, providing valuable insights into the concentration of specific compounds. UV-Vis absorption spectroscopy is based on the principle that molecules absorb light in the UV-Vis region as electrons transition from lower to higher energy states. The absorption of light is characteristic of specific chemical bonds and allows the identification and quantification of substances in the water.

UV-Vis spectroscopy is particularly effective in detecting and quantifying organic compounds, such as humic substances and dissolved organic matter, which can impact water quality. Peaks in the UV region indicate the presence of aromatic compounds, allowing for the assessment of the efficiency of the water treatment process in removing such contaminants. UV-Vis spectroscopy assists in measuring colour and turbidity in water. High absorbance values in the visible region may indicate the presence of particulate matter or colloidal substances.

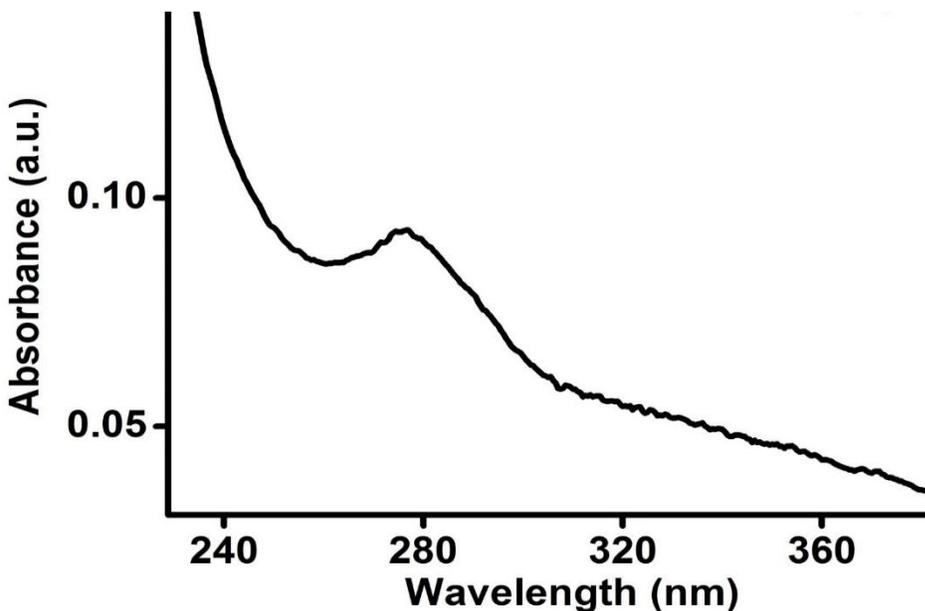


Figure 1B.10. UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Morning of 24/02/24 from R.O. (Permeate Tank).

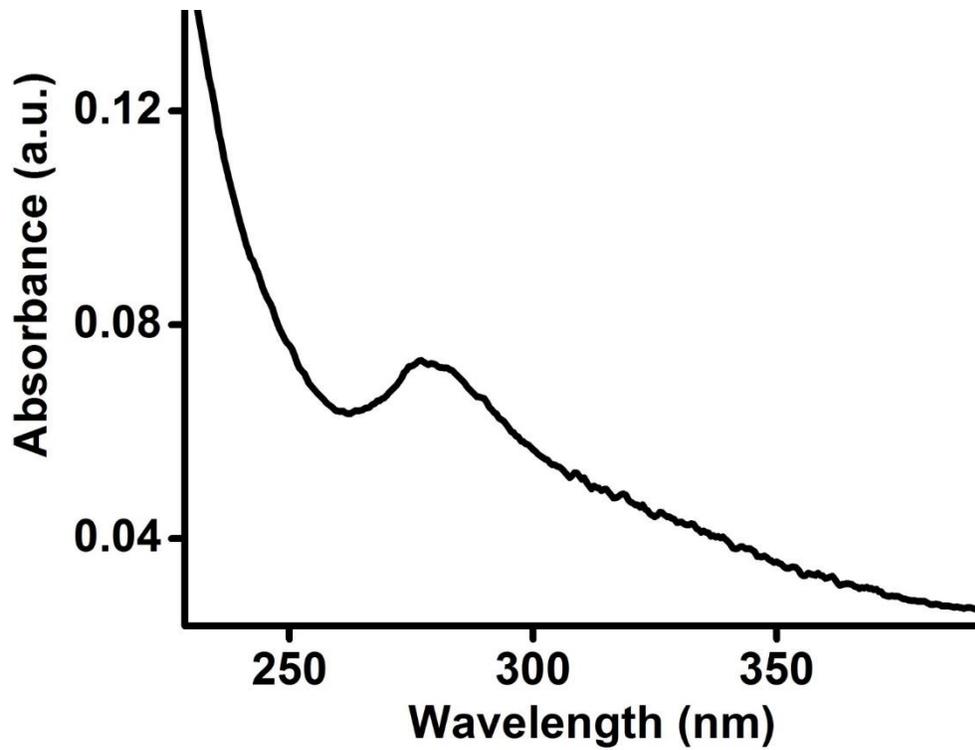


Figure 1B.11 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Evening of 24/02/24 from R.O. (Permeate Tank).

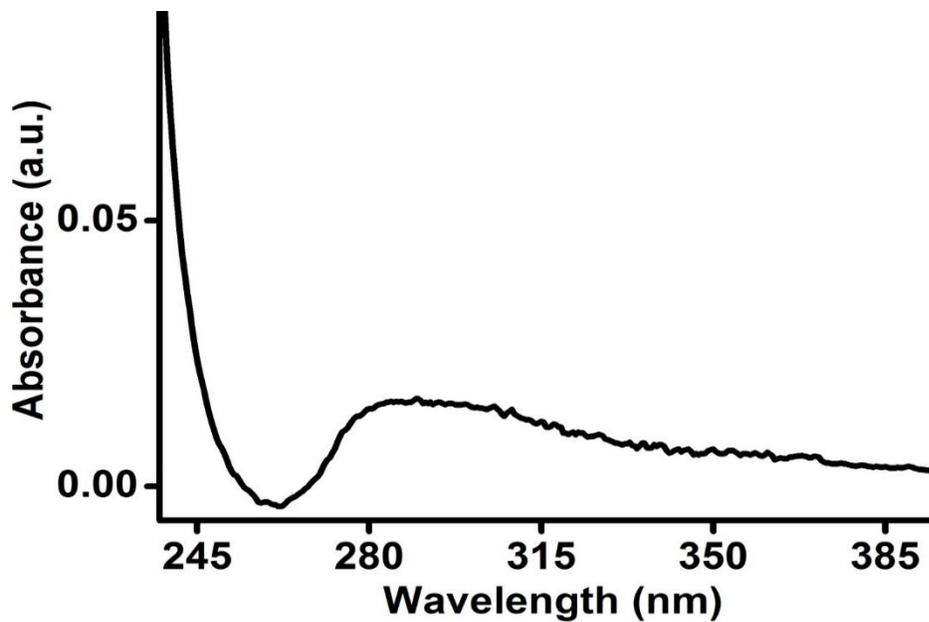


Figure 1B.12 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as composite sample of 24/02/24 from R.O. (Permeate Tank).

Observations & Recommendations

The details of observations and recommendations of team IIT Ropar and PU Chandigarh are presented below:

Optimal pH adjustment is advised at multiple junctures within Morepen Laboratories Ltd. Masulkhana. This is critical because maintaining the pH within the appropriate range at various stages of the treatment process can significantly enhance the efficiency of the treatment system. In addition to regular pH adjustments, it is further recommended to introduce a pH monitoring system that is strategically placed throughout the treatment sequence. These monitoring points should be situated at key stages of the process where pH fluctuations are most likely to occur, ensuring that any deviations from the optimal pH range are detected and corrected in real-time. This proactive approach not only helps in maintaining the stability of the treatment process but also prevents any potential disruptions that could arise from pH imbalances, ultimately leading to a more effective and consistent treatment outcome.

- Different phases of the treatment process are earmarked as pH control points, signifying areas where pH adjustment may be necessary. This approach is primarily implemented at two critical stages: the primary treatment and biological treatment phases. During the primary treatment, pH control is crucial for optimizing the removal of suspended solids, oil, grease, and other contaminants. In the biological treatment phase, maintaining the pH within a specific range is essential for the survival and activity of microorganisms that degrade organic matter. If the pH deviates from the optimal range, the efficiency of these biological processes can be compromised, leading to incomplete treatment and potential violations of discharge standards. By identifying and focusing on these control points, the treatment process can be fine-tuned to achieve better overall performance.

- Managing Total Dissolved Solids (TDS) in an Effluent Treatment Plant (ETP) holds significant importance for upholding water quality within acceptable thresholds and adhering to environmental regulations. Elevated TDS concentrations can disrupt treatment procedures, particularly during the biological treatment phases, where high TDS levels can inhibit microbial activity and reduce the overall efficiency of the treatment process. Controlling TDS is crucial to ensuring that the treatment system operates effectively and meets the required discharge standards. Under the present investigation, it has been found that at the equalization tank, the

TDS levels remain in the range of 27,000 mg/L, and the treatment system is able to restore the required TDS level of treated water below 700 mg/L. This demonstrates the system's ability to handle high TDS concentrations effectively, but continuous monitoring and management are essential to prevent any potential issues.

- In ETPs targeting treated water for reuse, controlling TDS becomes paramount. Elevated TDS levels can impact the suitability of water for diverse industrial and non-potable applications, such as cooling towers, boilers, and irrigation. High TDS can lead to scaling, corrosion, and reduced efficiency of equipment, making the treated water less desirable for reuse. Therefore, if TDS can be controlled before the RO system by adopting any of the following strategies: a) implementing a UF membrane system; b) inserting a sand filter; or c) modulating the flow rate, it can significantly extend the lifespan of the RO membrane and improve the overall efficiency of the treatment system. These measures not only protect the RO system but also enhance the quality of the treated water, making it more suitable for various reuse applications.

- Although the treated water was free from many heavy metal ions or detected with only a few ppb concentrations, IC studies revealed the presence of some anions in the treated water. These anions have a correlation with the TDS, indicating that while the heavy metals have been effectively removed, there are still some dissolved salts present that contribute to the overall TDS levels. The presence of these anions, suggests that further optimization of the treatment process may be necessary to reduce TDS levels even further. By identifying the specific anions present, targeted treatment strategies can be developed to address these residual contaminants, ensuring that the treated water meets all regulatory standards and is of the highest quality.

- Consequently, it is advised to continually assess TDS levels using TDS meters or conductivity meters, which provide an estimate based on water electrical conductivity. Regular monitoring of TDS is essential for maintaining the effectiveness of the treatment process and ensuring compliance with discharge regulations. By keeping a close eye on TDS levels, operators can quickly identify any deviations from the norm and take corrective action before these issues escalate. This proactive approach helps to prevent potential problems, such as scaling in downstream equipment, and ensures that the treated water is of consistently high quality.

Continuous and periodic Dynamic Light Scattering (DLS) measurements have provided valuable insights into changes in particle size distribution over time, offering a detailed understanding of

the underlying processes occurring within the system. These fluctuations in particle size distribution can be attributed to several key factors.

- Firstly, variations in the treatment process itself can significantly impact particle size. Changes in parameters such as temperature, pH, or the addition of coagulants and flocculants can alter the conditions under which particles form, grow, or aggregate. For instance, if the treatment process is modified to improve efficiency or to address a particular issue, this could lead to a shift in the size distribution of particles as the conditions under which they are stabilized or destabilized change.
 - Secondly, variations in the feed composition play a crucial role. The feed entering the treatment process may have differing concentrations of dissolved solids, organic matter, or contaminants at different times. These variations can influence how particles form and grow, leading to changes in the size distribution. For example, an increase in the concentration of certain ions or organic molecules could promote the formation of larger particles through aggregation or could cause existing particles to break down into smaller sizes.
 - Lastly, the presence of specific components that can initiate nucleation—such as certain ions, molecules, or even pre-existing particles—may trigger the formation of new particles. This nucleation process can lead to a significant shift in the particle size distribution, as newly formed particles grow and evolve over time. Such components can act as seeds, around which other materials aggregate, leading to the formation of particles of various sizes and contributing to the observed changes in distribution.
- Improving the dissolved oxygen (DO) levels in an Effluent Treatment Plant (ETP) is crucial for promoting the health of aquatic organisms and the overall effectiveness of the treatment process. In aerobic treatment processes, the DO levels play a significant role in supporting the growth and activity of aerobic microorganisms that break down organic pollutants. During the initial stages of aeration, the DO levels remain around 0.7 mg/L in the first tank, and with further aeration, they increase to 1.6 mg/L. To enhance oxygen transfer and improve the efficiency of the treatment process, fine bubble diffusers are often more effective than coarse bubble diffusers. Fine bubbles provide a larger surface area for oxygen transfer, resulting in higher DO levels. Additionally, consider adding oxygenation systems such as nano-bubbles, which inject

pure oxygen into the treatment process. This method can be more efficient than relying solely on air for aeration, leading to improved treatment outcomes and better water quality.

- Variations in COD levels have been observed at the equalization tank, with values ranging from around 45,000 to 50,000 mg/L. The aerobic treatment process has been found to be successful in lowering the COD levels during the treatment of wastewater, while the RO system has not been as efficient in managing the COD of treated water. One possible reason for this inefficiency is that water with higher COD levels is entering the RO system, exceeding the system's capacity to handle such high organic loads. To address this issue, it is advised to control the COD levels before the effluent enters the RO system. This could involve pre-treatment processes that reduce the COD levels, ensuring that the RO system operates within its design parameters and effectively removes any remaining contaminants.

- Monitoring the role of different coagulants and flocculants is essential to augment the removal of suspended solids and colloidal particles, which are significant contributors to COD. By optimizing the use of coagulants and flocculants, the efficacy of sedimentation and filtration processes can be enhanced, leading to more efficient removal of these particles from the wastewater. This, in turn, can help to reduce the overall COD levels, improving the performance of the subsequent treatment stages and ensuring that the treated water meets the required discharge standards.

- Optimizing the performance of biological treatment processes, such as activated sludge systems or bio-filters, is crucial for effectively reducing organic pollutants responsible for elevated COD levels. These biological processes rely on microorganisms to break down organic matter, and their efficiency can be influenced by various factors, including the composition of the wastewater, the concentration of pollutants, and the operating conditions of the treatment system. By fine-tuning these processes, it is possible to achieve higher removal rates of organic pollutants, leading to lower COD levels and better overall treatment outcomes.

- Adjusting the hydraulic retention time (HRT) in biological treatment tanks is another important strategy to ensure adequate contact time for microbial degradation of organic pollutants. If the HRT is too short, the microorganisms may not have enough time to fully break down the organic matter, leading to higher COD levels in the treated water. By optimizing the HRT, it is possible

to enhance the efficiency of the biological treatment process, ensuring that the wastewater is treated thoroughly before being discharged or subjected to further treatment.

- Developing an emergency response plan to address abrupt increases in COD levels is essential for maintaining the effectiveness of the treatment process. Such a plan could involve contingency measures or temporary adjustments to treatment processes to handle sudden spikes in organic load. For example, if different chemical processes are in place, it may be necessary to monitor, segregate, and mitigate the COD of effluent at plant-level collection pits. This approach allows for rapid response to unexpected changes in wastewater composition, minimizing the impact on the overall treatment system and ensuring that the treated water remains within acceptable quality parameters.

- Variations in BOD levels have been observed to coincide with those of COD. Given this correlation, it is recommended to follow all the points mentioned for COD management. Effective management of BOD is crucial for ensuring the overall quality of the treated water, as high BOD levels can indicate the presence of biodegradable organic matter that could consume oxygen in receiving waters, leading to environmental harm. By addressing the factors that influence both COD and BOD levels, it is possible to achieve more consistent and reliable treatment outcomes, ensuring that the effluent meets all regulatory requirements.

- IR spectroscopy aids in quality control by assessing the purity of water, offering a detailed analysis of the water's chemical composition. This technique can identify impurities or contaminants that may be present in the water, helping ensure compliance with regulatory standards. The presence of specific peaks in the IR spectrum, such as those in the region of 1400-1750 cm^{-1} , indicates the presence of aromatic and/or carbonyl compounds, while bands in the region of 2500 cm^{-1} suggest the presence of aliphatic materials. Each compound has a unique IR spectrum, acting like a fingerprint, which allows for the identification of specific contaminants or compounds present in the water. This capability facilitates targeted treatment strategies, as the IR spectrum can be matched with known data to determine the exact nature of the compounds in question. By identifying these compounds, the treatment process can be adjusted to specifically target and remove them, improving the overall quality of the treated water and ensuring that it meets all necessary regulatory standards.

PART 2

ADEQUACY STUDY OF THE UPDATED ETP PLANT OF MOREPEN LABORATORIES LTD., MASULKHANA

In light of the findings from the initial phase of sampling, the analysis has highlighted the necessity for a thorough overhaul of the Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd., Masulkhana, to ensure compliance with regulatory standards. The results have identified several areas requiring immediate attention to align operations with established norms. Consequently, it has been decided that Morepen Laboratories Ltd., Masulkhana, will address all issues highlighted in the first part of the report. To facilitate this process, a collaborative effort involving teams from PU Chandigarh and IIT Ropar was engaged to conduct further sampling. The findings has provided critical feedback to guide ongoing improvements at the facility. The objective was clear: to continue refining operations until the ETP consistently meets regulatory requirements. This involvement ensured that the next phase of sampling will be conducted rigorously, with a focus on validating the effectiveness of the corrective measures undertaken by Morepen Laboratories Ltd., Masulkhana. Throughout this endeavor, ongoing communication and collaboration between all stakeholders has proven to be very important. With the support of academic institutions and a clear roadmap for improvement, the company is poised to achieve sustainable operations that align with prescribed standards. This concerted effort not only strengthens operational efficiency but also emphasizes a commitment to environmental stewardship, setting a benchmark for responsible corporate conduct in the industry. The details of the modifications of the plant are presented below:

A. MEASURES TAKEN FOR STREAMLINING OF ETP PLANT FOR ZLD IN MASULKHANA

Several control measures have been implemented to upgrade the Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd., Masulkhana, aimed at enhancing its operational efficiency and compliance with regulatory standards.

Pretreatment of incoming effluent: The crucial measure involves the initial collection of incoming high Total Dissolved Solids (TDS) effluent in an equalization tank. This step is pivotal

as it allows for the leveling out of flow rates and concentrations, thereby optimizing subsequent treatment processes.

- The effluent undergoes pretreatment in a Primary Tube Settler (PST), before feeding to MEE. This stage serves to separate suspended solids and other contaminants from the wastewater, facilitating cleaner and more manageable effluent for further processing. The sedimentation process in the PST enables the removal of particulate matter, thereby preparing the effluent for more efficient treatment downstream.
- The sludge collected at the bottom of the PST undergoes filtration in a Screw Dewatering Machine. This filtration step is essential in extracting excess water from the sludge, resulting in a drier and more concentrated solid residue. By effectively separating solids from liquids, the Screw Dewatering Machine not only minimizes waste volume but also enhances the overall efficiency of the treatment process.
- The pretreated water, now significantly clarified and free from excess solids, is then fed into a MEE. By evaporating water under controlled conditions, the MEE reduces the volume of wastewater to be discharged while concentrating pollutants for more effective disposal or reuse.
- These integrated control measures yield several benefits crucial to the ETP's performance. Firstly, by reducing the initial TDS levels through equalization and pretreatment, the likelihood of fouling in subsequent processes, particularly the MEE, is significantly minimized. This reduction in fouling not only enhances the operational lifespan of equipment but also ensures smoother and more consistent treatment performance over time.

MEE Optimization: To optimize the MEE at Morepen Laboratories Ltd., Masulkhana, several strategic measures have been implemented, to enhancing efficiency and performance in wastewater treatment.

- Firstly, a steam flow controller has been installed to ensure a consistent and reliable supply of steam to the MEE. This controller effectively minimizes fluctuations in steam supply, thereby stabilizing the evaporation process and optimizing energy utilization. By maintaining a steady steam flow, the MEE operates more efficiently, achieving better evaporation rates and overall system performance.
- In addition to the steam flow controller, a mass flow meter has been integrated into the feed line of the MEE. This meter accurately measures the mass flow rate of the incoming wastewater, providing essential data for monitoring and controlling the treatment

process. With precise measurement capabilities, operators can adjust process parameters as necessary, ensuring optimal conditions for evaporation and concentration of contaminants.

- Furthermore, vacuum stabilization measures have been implemented following reduced fouling of the MEE system. By stabilizing the vacuum levels within the evaporator chamber, the system can operate at optimal efficiency levels consistently. Vacuum stabilization not only improves the evaporation efficiency but also enhances the reliability and longevity of equipment, reducing maintenance requirements and operational downtime.
- Moreover, a critical enhancement involves the separate supply of cooling water to the Agitated Thin Film Dryer (ATFD) and the MEE condenser. This segregation ensures that each component receives the appropriate cooling capacity required for optimal performance. By optimizing the cooling water supply, heat exchange processes within both the ATFD and MEE condenser are maximized, thereby improving overall thermal efficiency and reducing energy consumption.

Activated sludge Process: To enhance the efficiency and performance of the Activated Sludge Process (ASP) within the Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd., Masulkhana, following strategic improvements have been introduced. These advancements aim to optimize the biological treatment of wastewater, ensuring effective removal of contaminants while maintaining operational reliability and environmental compliance.

- The significant instrumentation upgrades have been implemented throughout the ASP process. Rotameters have been installed in the feed line, providing precise measurement and control of the flow rate of influent wastewater into the treatment system. This enhancement ensures that the ASP receives a consistent and controlled influx of wastewater, optimizing the biological treatment process for maximum efficiency and performance.
- The rotameters have been strategically installed in air lines within the ASP. These devices facilitate the even distribution of air throughout the aeration tanks, crucial for maintaining optimal oxygen levels essential for aerobic microbial activity. By ensuring uniform air distribution, the ASP can achieve uniform mixing and sufficient oxygenation, enhancing the biological degradation of organic pollutants in the wastewater.

- Furthermore, brine circulation systems have been incorporated to control temperature within the ASP. Temperature control is critical for maintaining the optimal operating conditions required by the microbial communities responsible for biodegradation. The introduction of brine circulation systems enables precise temperature regulation, ensuring that the ASP operates within the optimal temperature range to support microbial activity and overall treatment efficiency.
- To strengthen operational oversight and process control, the frequency of sampling and analysis has been increased to twice daily. This intensified monitoring schedule allows for more frequent assessment of key parameters such as dissolved oxygen levels, pH, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). By enhancing the frequency of sampling and analysis, operators can promptly identify any fluctuations or deviations in process parameters, enabling timely adjustments to optimize treatment performance and maintain compliance with regulatory standards.
- In addressing the handling of sludge from the tube settler, a Screw Dewatering Machine filtration system has been installed. This equipment efficiently separates and dewater sludge collected at the bottom of the settler, reducing its moisture content and volume. By utilizing a Screw Dewatering Machine, Morepen Laboratories Ltd. minimizes sludge disposal costs and facilitates the recovery of valuable resources from the wastewater treatment process.
- The bioenzymes have been introduced to fortify the microbial populations within the ASP. These bioenzymes serve to enhance the metabolic activities of bacteria responsible for biodegradation. By augmenting microbial activity, bioenzymes accelerate the breakdown of organic pollutants, improving treatment efficiency and reducing the overall retention time required for effective wastewater treatment.

Reverse Osmosis (RO) system: The implementation of Reverse Osmosis (RO) technology at Morepen Laboratories Ltd., Masulkhana, has significantly enhanced the efficiency and effectiveness of their Effluent Treatment Plant (ETP). These improvements for sustainable water management and compliance with stringent environmental standards are detailed below:

- To optimize the treatment process, an online caustic pH control system has been integrated into the tube settler stage. This system allows for precise and automated dosing of caustic soda directly into the settler via a pipeline. By maintaining the pH level within the optimal range, the efficiency of solids settling is improved, ensuring better

separation of suspended solids from the wastewater. This enhancement not only enhances treatment efficiency but also minimizes chemical usage, contributing to operational cost savings and environmental benefits.

- In addition to pH control, effective and balanced chemical dosing has been implemented to control turbidity in the wastewater. Turbidity levels have been successfully reduced to less than 50 NTU (Nephelometric Turbidity Units). The strategic application of chemicals ensures that suspended particles and colloids are adequately flocculated and settled out, further improving the overall clarity and quality of treated effluent.
- Furthermore, the RO system incorporates water recycling practices, particularly in the polisher unit. RO permeate water, which is purified through membrane filtration, is recycled within the polisher for secondary treatment. This recycling reduces freshwater consumption and minimizes wastewater discharge, thereby conserving water resources and reducing the environmental impact of plant operations. The recycled RO water undergoes further polishing to remove residual contaminants, ensuring that the treated effluent meets or exceeds regulatory standards before final discharge.

The advancements made in the Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd. highlight the company's proactive position towards sustainable water management. Through comprehensive upgrades across key components such as the Primary Settling Tank (PST), Multi Effect Evaporator (MEE), Activated Sludge Process (ASP), and Reverse Osmosis (RO) system, Morepen Laboratories has significantly enhanced treatment efficiency and regulatory compliance.

Beginning with the PST, the introduction of advanced instrumentation including rotameters for precise flow measurement and control has optimized the initial stage of wastewater treatment. This ensures that incoming effluent is evenly distributed and processed, leading to more effective sedimentation and separation of solids. In parallel, enhancements in the MEE have included the installation of a steam flow controller to maintain a consistent supply, crucial for stable evaporation rates and energy efficiency. The ASP has seen significant improvements with increased sampling and analysis frequencies, now conducted twice daily. This heightened monitoring allows for better control over key parameters such as dissolved oxygen levels and pH, essential for fostering robust microbial activity and efficient organic pollutant removal. Furthermore, the RO system has been pivotal in achieving stringent water quality standards.

The updated design and operational details of the ETP, including the Block Diagram depicted in Figure 2A.1 as of July 20th, 2024, encapsulate these advancements. This visual

representation highlights the integrated approach adopted by Morepen Laboratories, aligning technological innovation with environmental responsibility.

PLANT DESIGN DETAILS (As on 20th July 2024)	
Plant Capacity (Designed)	72 m ³ /day
Flow Rate (Designed)	3 m ³ /hr
Flow Rate (Currently)	1.6 m ³ /hr
COD (ETP Inlet)	<30000 ppm
BOD (ETP Inlet)	<13000 to 15000ppm
pH (ETP Inlet)	5 to 9
TDS (ETP Inlet)	20000 to 30000 ppm
COD (Treated Water)	<250 ppm
BOD (Treated Water)	<30 ppm
pH (Treated Water)	7 to 7.5
TDS (Treated Water)	< 200 ppm

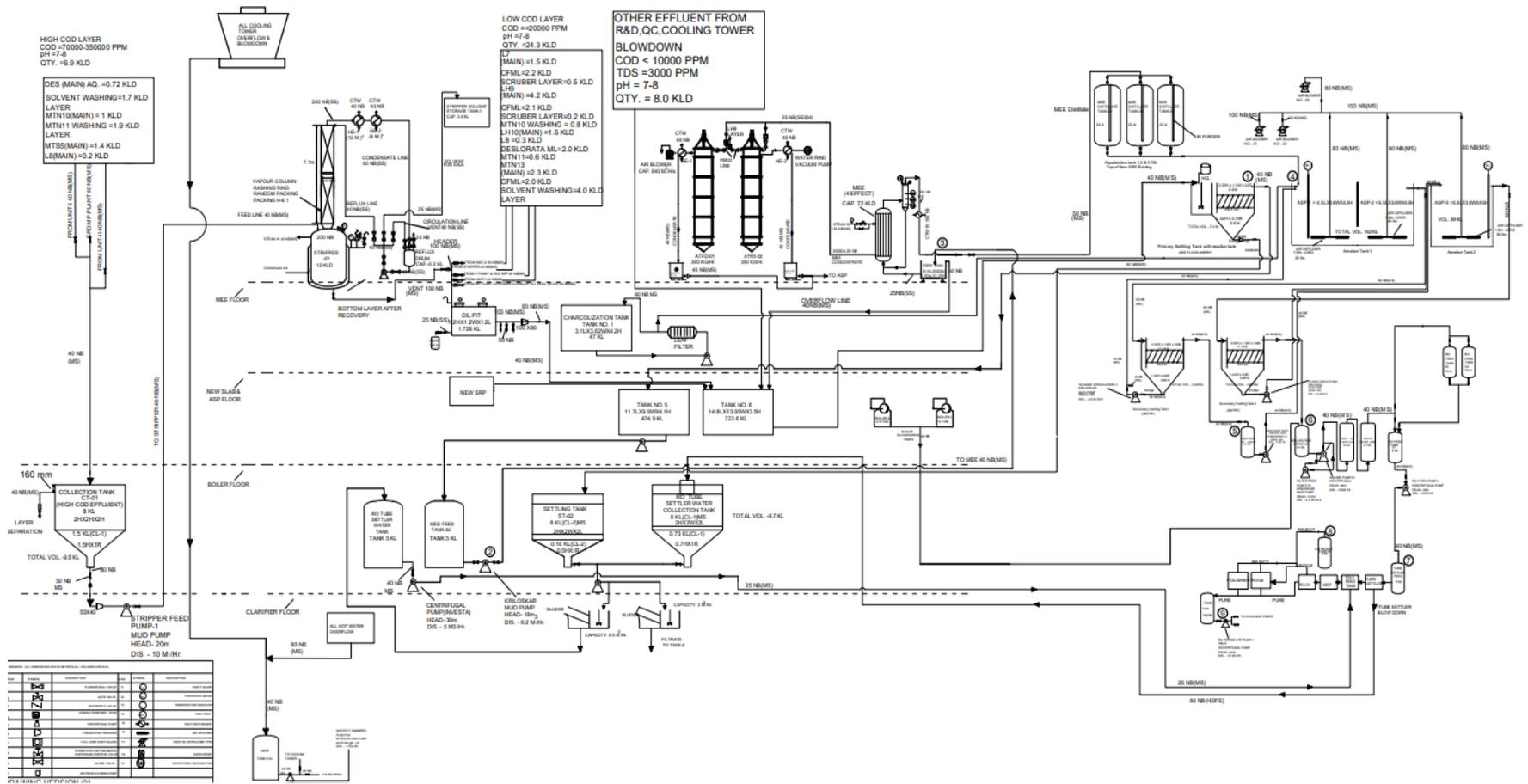


Figure 2A.1. Block Diagram of Updated ETP System

B. MONITORING THE EFFICIENCY OF ETP OF MOREPEN LABORATORIES LTD. MASULKHANA THROUGH WATER QUALITY TESTING

To accurately assess the efficiency of the Effluent Treatment Plant (ETP) at Morepen Laboratories Ltd. Masulkhana, this technical report provides a thorough evaluation of various water quality parameters across multiple intervals. Initial sampling, conducted on 24/02/24, involved staff from Morepen Laboratories Ltd. Masulkhana working with teams from IIT Ropar and PU Chandigarh, with samples analyzed at PU Chandigarh and IIT Ropar's laboratory. On the light of the results of first sampling; the team has suggested some changes in the plant and subsequent set of samplings occurred on 10/06/2024 and 20/07/2024, carried out by Morepen Laboratories Ltd. Masulkhana staff in collaboration with teams from IIT Ropar & PU Chandigarh. While the clarity of treated water is a common measure of an ETP's performance, relying solely on visual inspection of suspended material removal does not offer a complete view of the ETP's environmental effectiveness. Therefore, the report includes a detailed analysis of parameters such as pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and Cation and Anion Analysis, following BIS standards and each sample analysed in three different labs. Additionally, plans are included in the updated report to investigate the specific materials responsible for TDS, COD, and BOD using IC Chromatography, and Infrared Spectroscopy. Sampling was performed at different times of the day: morning, afternoon, and evening; with each sample undergoing triplicate testing.

pH Control of ETP of Morepen Laboratories Ltd. Masulkhana: Proper regulation of pH is essential for effective chemical treatments like coagulation and precipitation. pH, which measures a solution's acidity or alkalinity, plays a significant role in the performance of various treatment methods and the environmental impact of the treated effluent. Many biological treatment processes, including activated sludge and biological processes, are particularly sensitive to pH fluctuations. Maintaining pH within an optimal range enhances the efficiency of microorganisms responsible for breaking down organic matter. Additionally, pH affects the solubility of various chemicals in wastewater, highlighting the necessity of pH control. Adhering to the recommended pH range ensures effective disinfection and compliance with regulatory standards for discharged effluent, thus safeguarding the environment and preventing adverse effects on receiving water bodies. The pH levels at different stages of the ETP at Morepen Laboratories Ltd. Masulkhana are detailed in the table below.

Table 2.1. pH analysis of water samples collected from the ETP under study.

Sr. No	Date	Time	Sample Name	Sample Code	pH Determination			
					1 st	2 nd	3 rd	Avg
1.	10/06/2024	Morning	Primary Settling tank Inlet	V2-SS1-M	13.02	13.03	13.02	13.02
2.	10/06/2024	Morning	MEE feed Tank 01 Outlet	V2-SS2-M	11.36	11.37	11.28	11.34
3.	10/06/2024	Morning	MEE feed Tank 03 and 04 outlet	V2-SS3-M	11.38	11.37	11.32	11.36
4.	10/06/2024	Morning	Primary Settling tank Outlet	V2-SS4-M	10.97	10.92	11.1	11.00
5.	10/06/2024	Morning	Secondary Settling tank 01 outlet	V2-SS5-M	7.47	7.45	7.63	7.52
6.	10/06/2024	Morning	Secondary Settling tank 02 outlet	V2-SS6-M	7.56	7.58	7.59	7.58
7.	10/06/2024	Morning	RO inlet at RO settler	V2-SS7-M	7.58	7.59	7.71	7.63
8.	10/06/2024	Morning	RO reject	V2-SS8-M	7.67	7.7	7.64	7.67
9.	10/06/2024	Morning	RO permeate	V2-SS9-M	6.7	6.74	6.65	6.70
10.	10/06/2024	Afternoon	Primary Settling tank Inlet	V2-SS1-A	12.9	12.92	13.02	12.95

11.	10/06/2024	Afternoon	MEE feed Tank 01 Outlet	V2-SS2-A	11.53	11.53	11.52	11.53
12.	10/06/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V2-SS3-A	11.55	11.54	11.57	11.55
13.	10/06/2024	Afternoon	Primary Settling tank Outlet	V2-SS4-A	11.03	10.99	11.07	11.03
14.	10/06/2024	Afternoon	Secondary Settling tank 01 outlet	V2-SS5-A	7.61	7.58	7.6	7.60
15.	10/06/2024	Afternoon	Secondary Settling tank 02 outlet	V2-SS6-A	7.28	7.25	7.2	7.24
16.	10/06/2024	Afternoon	RO inlet at RO settler	V2-SS7-A	7.68	7.69	7.60	7.66
17.	10/06/2024	Afternoon	RO reject	V2-SS8-A	7.72	7.73	7.62	7.69
18.	10/06/2024	Afternoon	RO permeate	V2-SS9-A	6.81	6.86	6.93	6.87
19.	10/06/2024	Evening	Primary Settling tank Inlet	V2-SS1-E	11.57	11.55	11.57	11.56
20.	10/06/2024	Evening	MEE feed Tank 01 Outlet	V2-SS2-E	12.51	12.55	12.59	12.55
21.	10/06/2024	Evening	MEE feed Tank 03 and 04 outlet	V2-SS3-E	12.49	12.49	12.54	12.51
22.	10/06/2024	Evening	Primary Settling tank Outlet	V2-SS4-E	10.82	10.81	11.11	10.91

23.	10/06/2024	Evening	Secondary Settling tank 01 outlet	V2-SS5-E	7.63	7.6	7.8	7.68
24.	10/06/2024	Evening	Secondary Settling tank 02 outlet	V2-SS6-E	7.38	7.4	7.42	7.40
25.	10/06/2024	Evening	RO inlet at RO settler	V2-SS7-E	7.89	7.91	7.80	7.87
26.	10/06/2024	Evening	RO reject	V2-SS8-E	7.69	7.69	7.6	7.66
27.	10/06/2024	Evening	RO permeate	V2-SS9-E	7.08	7.06	7.1	7.08
28.	10/06/2024	Composite	Primary Settling tank Inlet	V2-SS1-C	12.67	12.66	12.71	12.68
29.	10/06/2024	Composite	MEE feed Tank 01 Outlet	V2-SS2-C	11.99	11.99	12.11	12.03
30.	10/06/2024	Composite	MEE feed Tank 03 and 04 outlet	V2-SS3-C	11.9	11.9	11.96	11.92
31.	10/06/2024	Composite	Primary Settling tank Outlet	V2-SS4-C	10.85	10.81	11	10.89
32.	10/06/2024	Composite	Secondary Settling tank 01 outlet	V2-SS5-C	7.74	7.76	8	7.83
33.	10/06/2024	Composite	Secondary Settling tank 02 outlet	V2-SS6-C	7.63	7.65	7.93	7.74
34.	10/06/2024	Composite	RO inlet at RO settler	V2-SS7-C	7.75	7.78	7.70	7.74

35.	10/06/2024	Composite	RO reject	V2-SS8-C	7.83	7.82	7.76	7.80
36.	10/06/2024	Composite	RO permeate	V2-SS9-C	6.89	6.91	7.27	7.02
37.	20/7/2024	Morning	Primary Settling tank Inlet	V3-SS1-M	7.59	7.58	7.7	7.62
38.	20/7/2024	Morning	MEE feed Tank 01 Outlet	V3-SS2-M	7.63	7.63	7.64	7.63
39.	20/7/2024	Morning	MEE feed Tank 03 and 04 outlet	V3-SS3-M	7.62	7.61	7.58	7.60
40.	20/7/2024	Morning	Primary Settling tank Outlet	V3-SS4-M	7.07	7.05	7.09	7.07
41.	20/7/2024	Morning	Secondary Settling tank 01 outlet	V3-SS5-M	7.45	7.5	7.47	7.47
42.	20/7/2024	Morning	Secondary Settling tank 02 outlet	V3-SS6-M	7.12	7.17	7.1	7.13
43.	20/7/2024	Morning	RO inlet at RO settler	V3-SS7-M	7.27	7.2	7.21	7.23
44.	20/7/2024	Morning	RO reject	V3-SS8-M	7.67	7.66	7.56	7.63
45.	20/7/2024	Morning	RO permeate	V3-SS9-M	7.48	7.49	7.4	7.46
46.	20/7/2024	Afternoon	Primary Settling tank Inlet	V3-SS1-A	7.52	7.53	7.54	7.53
47.	20/7/2024	Afternoon	MEE feed Tank 01	V3-SS2-A	7.63	7.62	7.66	7.64

			Outlet					
48.	20/7/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V3-SS3-A	7.46	7.48	7.51	7.48
49.	20/7/2024	Afternoon	Primary Settling tank Outlet	V3-SS4-A	7.28	7.24	7.21	7.24
50.	20/7/2024	Afternoon	Secondary Settling tank 01 outlet	V3-SS5-A	7.32	7.34	7.36	7.34
51.	20/7/2024	Afternoon	Secondary Settling tank 02 outlet	V3-SS6-A	7.15	7.16	7.18	7.16
52.	20/7/2024	Afternoon	RO inlet at RO settler	V3-SS7-A	7.5	7.5	7.51	7.50
53.	20/7/2024	Afternoon	RO reject	V3-SS8-A	7.39	7.4	7.43	7.41
54.	20/7/2024	Afternoon	RO permeate	V3-SS9-A	7.32	7.33	7.33	7.33
55.	20/7/2024	Evening	Primary Settling tank Inlet	V3-SS1-E	7.58	7.59	7.61	7.59
56.	20/7/2024	Evening	MEE feed Tank 01 Outlet	V3-SS2-E	7.52	7.51	7.5	7.51
57.	20/7/2024	Evening	MEE feed Tank 03 and 04 outlet	V3-SS3-E	7.52	7.52	7.54	7.53
58.	20/7/2024	Evening	Primary Settling tank Outlet	V3-SS4-E	7.38	7.32	7.27	7.32

59.	20/7/2024	Evening	Secondary Settling tank 01 outlet	V3-SS5-E	7.16	7.17	7.18	7.17
60.	20/7/2024	Evening	Secondary Settling tank 02 outlet	V3-SS6-E	7.07	7.1	7.14	7.10
61.	20/7/2024	Evening	RO inlet at RO settler	V3-SS7-E	7.39	7.38	7.39	7.39
62.	20/7/2024	Evening	RO reject	V3-SS8-E	7.27	7.32	7.34	7.31
63.	20/7/2024	Evening	RO permeate	V3-SS9-E	7.16	7.18	7.2	7.18
64.	20/7/2024	Composite	Primary Settling tank Inlet	V3-SS1-C	7.67	7.63	7.65	7.65
65.	20/7/2024	Composite	MEE feed Tank 01 Outlet	V3-SS2-C	7.54	7.57	7.57	7.56
66.	20/7/2024	Composite	MEE feed Tank 03 and 04 outlet	V3-SS3-C	7.55	7.57	7.56	7.56
67.	20/7/2024	Composite	Primary Settling tank Outlet	V3-SS4-C	7.14	7.12	7.11	7.12
68.	20/7/2024	Composite	Secondary Settling tank 01 outlet	V3-SS5-C	7.24	7.28	7.25	7.26
69.	20/7/2024	Composite	Secondary Settling tank 02 outlet	V3-SS6-C	6.99	7.01	7.02	7.01
70.	20/7/2024	Composite	RO inlet at RO settler	V3-SS7-C	7.2	7.22	7.25	7.22

71.	20/7/2024	Composite	RO reject	V3-SS8-C	7.42	7.44	7.47	7.44
72.	20/7/2024	Composite	RO permeate	V3-SS9-C	7.17	7.16	7.17	7.17

TDS (Total dissolved solids) Control of ETP of Morepen Laboratories Ltd. Masulkhana:

Total Dissolved Solids (TDS) refers to all inorganic and organic substances in water that can pass through a 2-micron filter. TDS is essentially the total concentration of cations and anions present in the water. Common TDS constituents include ions and ionic compounds such as carbonate, bicarbonate, chloride, fluoride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, and potassium. Organic ions, including pollutants, herbicides, and hydrocarbons, as well as soil organic matter compounds like humic and fulvic acids, are also part of TDS. TDS can be measured using various methods. A simple approach involves filtering the water sample, evaporating it at 180°C in a pre-weighed dish until the weight stabilizes, and then calculating TDS based on the weight increase of the dish, reported in mg/L. Alternatively, TDS can be estimated from the sample's electrical conductivity using a correlation equation specific to conductivity. Another method involves summing the concentrations of individual ions. While TDS provides a general measure of dissolved inorganic substances, it does not specify the nature of these substances. Since TDS tests do not differentiate between individual solutes, further analysis through chromatography and spectroscopy is planned to better understand the nature of the inorganic matter present.

Table 2.2. TDS analysis of water samples collected from the ETP under study.

Sr. No	Date	Time	Sample Name	Sample Code	TDS Determination			
					1 st	2 nd	3 rd	Avg (ppm)
1.	10/06/2024	Morning	Primary Settling tank Inlet	V2-SS1-M	107004.95	106809.95	118964.95	110926.62

2.	10/06/2024	Morning	MEE feed Tank 01 Outlet	V2- SS2-M	56304.95	56239.95	56239.95	56261.62
3.	10/06/2024	Morning	MEE feed Tank 03 and 04 outlet	V2- SS3-M	47984.95	48049.95	61504.95	52513.28
4.	10/06/2024	Morning	Primary Settling tank Outlet	V2- SS4-M	2939.95	2933.45	3141.45	3004.95
5.	10/06/2024	Morning	Secondary Settling tank 01 outlet	V2- SS5-M	1048.45	1054.95	1015.95	1039.78
6.	10/06/2024	Morning	Secondary Settling tank 02 outlet	V2- SS6-M	1951.95	1925.95	1925.95	1934.62
7.	10/06/2024	Morning	RO inlet at RO settler	V2- SS7-M	2094.95	2101.45	2114.45	2103.62
8.	10/06/2024	Morning	RO reject	V2- SS8-M	7912.45	7918.95	7879.95	7903.78
9.	10/06/2024	Morning	RO permeate	V2- SS9-M	190.45	190.45	196.95	192.62
10.	10/06/2024	Afternoon	Primary Settling tank Inlet	V2- SS1-A	117079.95	117014.95	129169.95	121088.28

11.	10/06/2024	Afternoon	MEE feed Tank 01 Outlet	V2- SS2-A	64559.95	64429.95	64819.95	64603.28
12.	10/06/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V2- SS3-A	58644.95	58774.95	63519.95	60313.28
13.	10/06/2024	Afternoon	Primary Settling tank Outlet	V2- SS4-A	2783.95	2757.95	3095.95	2879.28
14.	10/06/2024	Afternoon	Secondary Settling tank 01 outlet	V2- SS5-A	957.45	950.95	937.95	948.78
15.	10/06/2024	Afternoon	Secondary Settling tank 02 outlet	V2- SS6-A	1750.45	1743.95	1782.95	1759.12
16.	10/06/2024	Afternoon	RO inlet at RO settler	V2- SS7-A	2003.95	2003.95	2413.45	2140.45
17.	10/06/2024	Afternoon	RO reject	V2- SS8-A	4616.95	4590.95	4564.95	4590.95
18.	10/06/2024	Afternoon	RO permeate	V2- SS9-A	203.45	209.95	170.95	194.78
19.	10/06/2024	Evening	Primary Settling tank Inlet	V2- SS1-E	78794.95	78924.95	92184.95	83301.62

20.	10/06/2024	Evening	MEE feed Tank 01 Outlet	V2- SS2-E	77884.95	77819.95	98489.95	84731.62
21.	10/06/2024	Evening	MEE feed Tank 03 and 04 outlet	V2- SS3-E	72749.95	71969.95	95174.95	79964.95
22.	10/06/2024	Evening	Primary Settling tank Outlet	V2- SS4-E	1958.45	1945.45	2881.45	2261.78
23.	10/06/2024	Evening	Secondary Settling tank 01 outlet	V2- SS5-E	879.45	866.45	1249.95	998.62
24.	10/06/2024	Evening	Secondary Settling tank 02 outlet	V2- SS6-E	1639.95	1639.95	1964.95	1748.28
25.	10/06/2024	Evening	RO inlet at RO settler	V2- SS7-E	1899.95	1932.45	2432.95	2088.45
26.	10/06/2024	Evening	RO reject	V2- SS8-E	2569.45	2536.95	3329.95	2812.12
27.	10/06/2024	Evening	RO permeate	V2- SS9-E	313.95	320.45	300.95	311.78
28.	10/06/2024	Composite	Primary Settling tank Inlet	V2- SS1-C	98294.95	97839.95	124294.95	106809.95

29.	10/06/2024	Composite	MEE feed Tank 01 Outlet	V2- SS2-C	59814.95	60269.95	75219.95	65101.62
30.	10/06/2024	Composite	MEE feed Tank 03 and 04 outlet	V2- SS3-C	61309.95	60854.95	78079.95	66748.28
31.	10/06/2024	Composite	Primary Settling tank Outlet	V2- SS4-C	2731.95	2705.95	3069.95	2835.95
32.	10/06/2024	Composite	Secondary Settling tank 01 outlet	V2- SS5-C	846.95	840.45	1087.45	924.95
33.	10/06/2024	Composite	Secondary Settling tank 02 outlet	V2- SS6-C	905.45	918.45	957.45	927.12
34.	10/06/2024	Composite	RO inlet at RO settler	V2- SS7-C	2153.45	2166.45	2393.95	2237.95
35.	10/06/2024	Composite	RO reject	V2- SS8-C	4512.95	4493.45	4733.95	4580.12
36.	10/06/2024	Composite	RO permeate	V2- SS9-C	170.95	177.45	274.95	207.78
37.	20/7/2024	Morning	Primary Settling tank Inlet	V3- SS1-M	10959	10952.5	10959	10956.83

38.	20/7/2024	Morning	MEE feed Tank 01 Outlet	V3- SS2-M	10965.5	10972	10972	10969.83
39.	20/7/2024	Morning	MEE feed Tank 03 and 04 outlet	V3- SS3-M	10913.5	10946	10978.5	10946.00
40.	20/7/2024	Morning	Primary Settling tank Outlet	V3- SS4-M	442.65	445.9	440.05	442.87
41.	20/7/2024	Morning	Secondary Settling tank 01 outlet	V3- SS5-M	363.35	364	354.25	360.53
42.	20/7/2024	Morning	Secondary Settling tank 02 outlet	V3- SS6-M	345.8	345.8	344.5	345.37
43.	20/7/2024	Morning	RO inlet at RO settler	V3- SS7-M	473.85	472.55	471.9	472.77
44.	20/7/2024	Morning	RO reject	V3- SS8-M	1181.05	1180.4	1172.6	1178.02
45.	20/7/2024	Morning	RO permeate	V3- SS9-M	152.95	160.1	158.8	157.28
46.	20/7/2024	Afternoon	Primary Settling tank Inlet	V3- SS1-A	11180	11199.5	11180	11186.50

47.	20/7/2024	Afternoon	MEE feed Tank 01 Outlet	V3- SS2-A	11212.5	11180	11167	11186.50
48.	20/7/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V3- SS3-A	11167	11160.5	11180	11169.17
49.	20/7/2024	Afternoon	Primary Settling tank Outlet	V3- SS4-A	423.15	425.75	423.8	424.23
50.	20/7/2024	Afternoon	Secondary Settling tank 01 outlet	V3- SS5-A	357.5	356.85	357.5	357.28
51.	20/7/2024	Afternoon	Secondary Settling tank 02 outlet	V3- SS6-A	345.15	342.55	344.5	344.07
52.	20/7/2024	Afternoon	RO inlet at RO settler	V3- SS7-A	464.1	463.45	461.5	463.02
53.	20/7/2024	Afternoon	RO reject	V3- SS8-A	1186.9	1186.25	1185.6	1186.25
54.	20/7/2024	Afternoon	RO permeate	V3- SS9-A	152.3	152.3	151.65	152.08
55.	20/7/2024	Evening	Primary Settling tank Inlet	V3- SS1-E	8450	8398	8378.5	8408.83

56.	20/7/2024	Evening	MEE feed Tank 01 Outlet	V3- SS2-E	8352.5	8404.5	8411	8389.33
57.	20/7/2024	Evening	MEE feed Tank 03 and 04 outlet	V3- SS3-E	8411	8430.5	8391.5	8411.00
58.	20/7/2024	Evening	Primary Settling tank Outlet	V3- SS4-E	430.95	429.65	429.65	430.08
59.	20/7/2024	Evening	Secondary Settling tank 01 outlet	V3- SS5-E	360.75	360.1	362.05	360.97
60.	20/7/2024	Evening	Secondary Settling tank 02 outlet	V3- SS6-E	351.65	349.7	348.4	349.92
61.	20/7/2024	Evening	RO inlet at RO settler	V3- SS7-E	470.6	469.95	467.35	469.30
62.	20/7/2024	Evening	RO reject	V3- SS8-E	1202.5	1215.5	1216.8	1211.60
63.	20/7/2024	Evening	RO permeate	V3- SS9-E	145.15	145.15	145.8	145.37
64.	20/7/2024	Composite	Primary Settling tank Inlet	V3- SS1-C	10972	10991.5	11011	10991.50

65.	20/7/2024	Composite	MEE feed Tank 01 Outlet	V3- SS2-C	11238.5	11193	11206	11212.50
66.	20/7/2024	Composite	MEE feed Tank 03 and 04 outlet	V3- SS3-C	11193	11160.5	11154	11169.17
67.	20/7/2024	Composite	Primary Settling tank Outlet	V3- SS4-C	430.3	430.3	430.95	430.52
68.	20/7/2024	Composite	Secondary Settling tank 01 outlet	V3- SS5-C	360.1	358.15	358.15	358.80
69.	20/7/2024	Composite	Secondary Settling tank 02 outlet	V3- SS6-C	339.95	339.3	338	339.08
70.	20/7/2024	Composite	RO inlet at RO settler	V3- SS7-C	462.8	462.15	461.5	462.15
71.	20/7/2024	Composite	RO reject	V3- SS8-C	1201.85	1205.1	1204.45	1203.80
72.	20/7/2024	Composite	RO permeate	V3- SS9-C	149.7	148.4	147.75	148.62

Ion Chromatography: Ion Chromatography (IC) is a specialized analytical technique used to separate and analyze ions present in liquid samples. As a subset of liquid chromatography, IC is extensively utilized across various fields, including environmental testing, water analysis, and research. This method excels in quantifying both inorganic and organic ions in a sample,

making it invaluable for assessing the ion composition of complex mixtures. In the realm of wastewater treatment and Effluent Treatment Plants (ETPs), Ion Chromatography plays a crucial role. It enables the detailed analysis of effluent composition by measuring the concentration of specific ions, which is essential for evaluating the quality of treated water. This analysis is pivotal for ensuring that wastewater treatment processes meet stringent environmental regulations and standards. IC aids in identifying potential contaminants within the effluent, thereby contributing to the overall understanding of the treatment efficiency and the safety of the discharged water. By providing precise data on ion concentrations, IC supports the optimization of treatment processes and the management of environmental impact. This capability makes Ion Chromatography a key tool for maintaining compliance with regulatory requirements and safeguarding water quality.

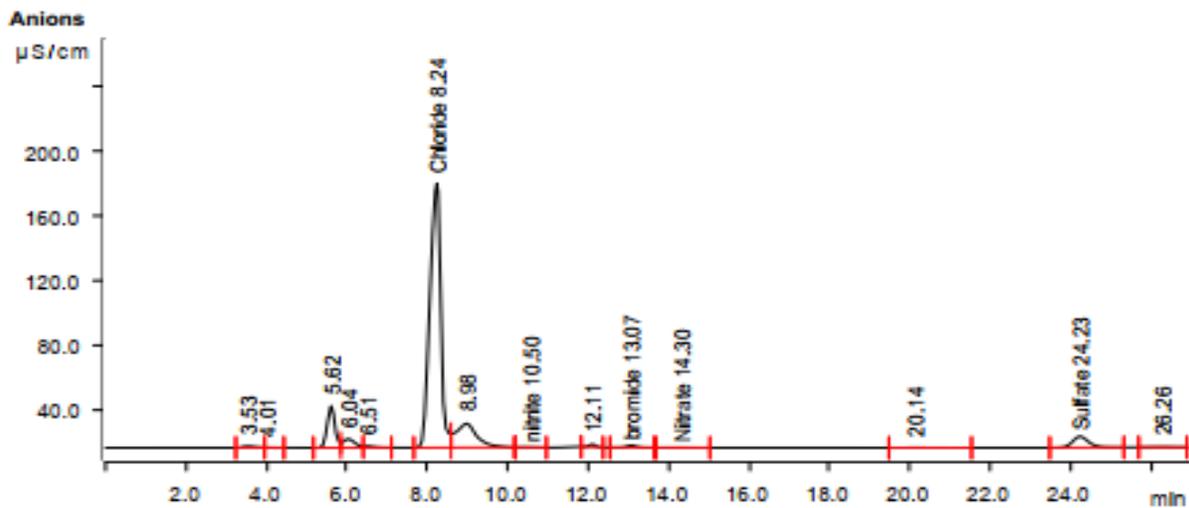


Figure 2B.1. Ion chromatogram of the sample collected as grab sample of the Morning of 10/06/2024 from R.O. (Permeate Tank).

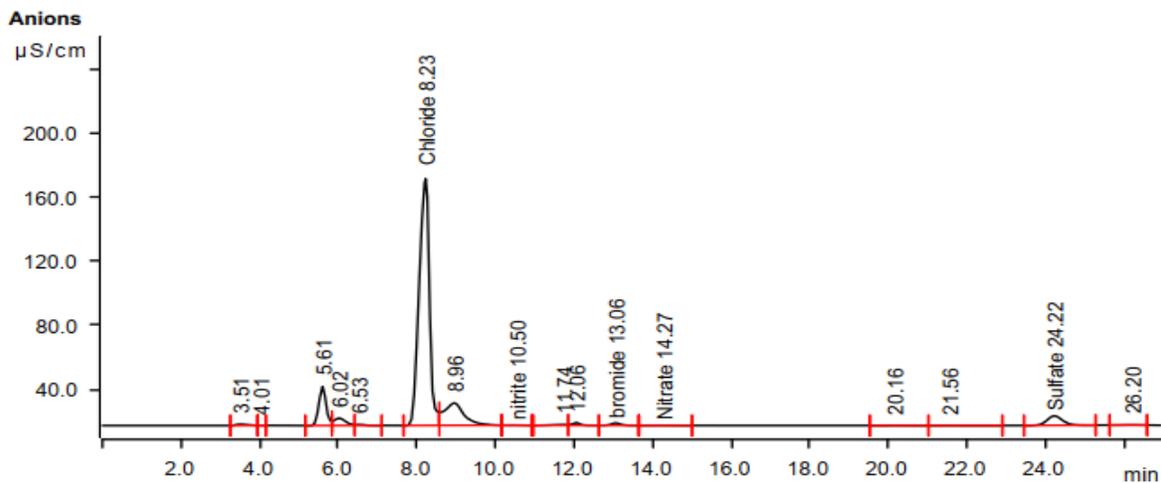


Figure 2B.2. Ion chromatogram of the sample collected as grab sample of the Afternoon of 10/06/2024 from R.O. (Permeate Tank).

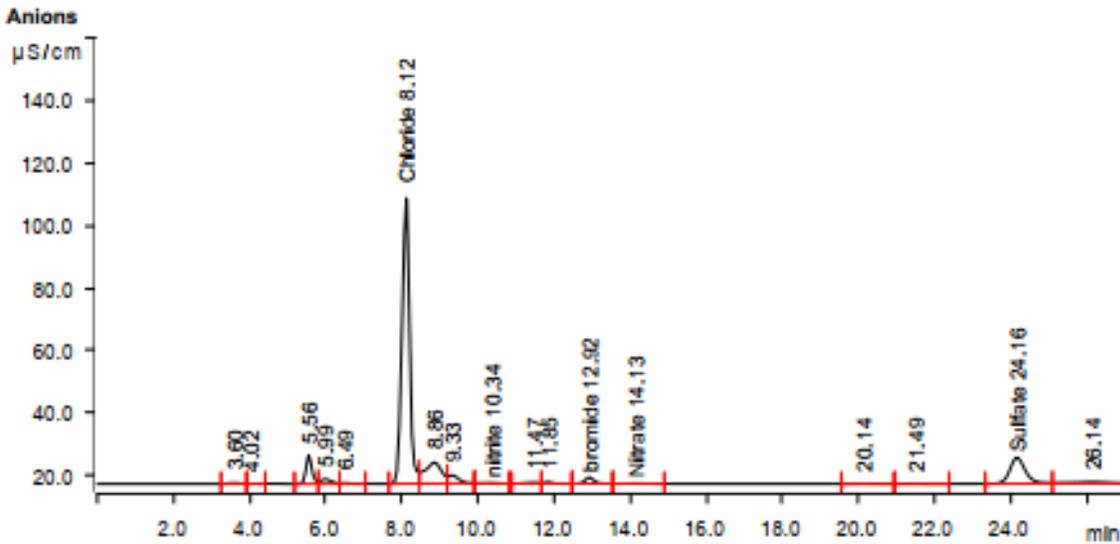


Figure 2B.3. Ion chromatogram of the sample collected as grab sample of the Evening of 10/06/2024 from R.O. (Permeate Tank).

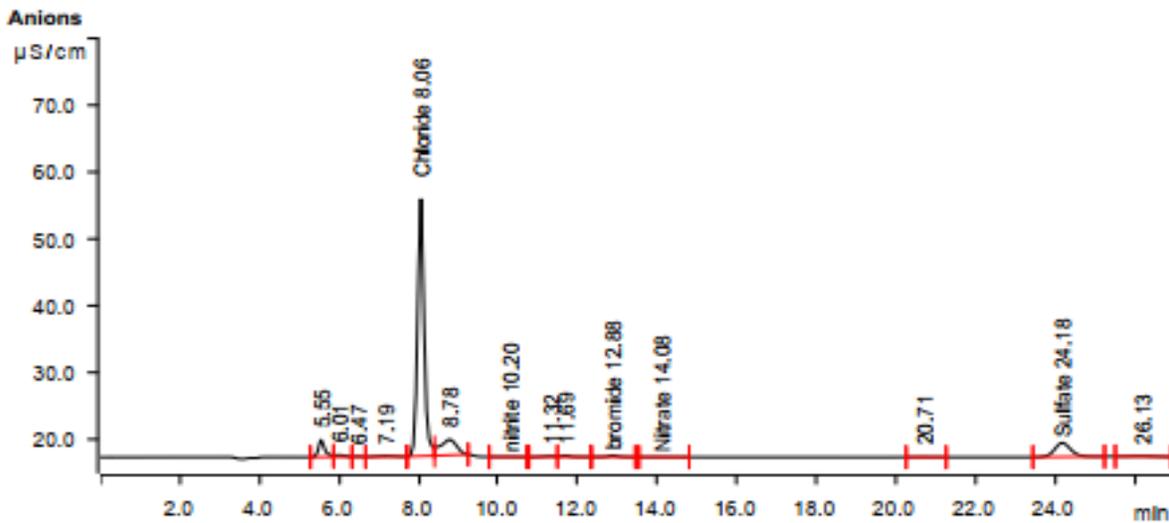


Figure 2B.4. Ion chromatogram of the sample collected as composite sample of 10/06/2024 from R.O. (Permeate Tank).

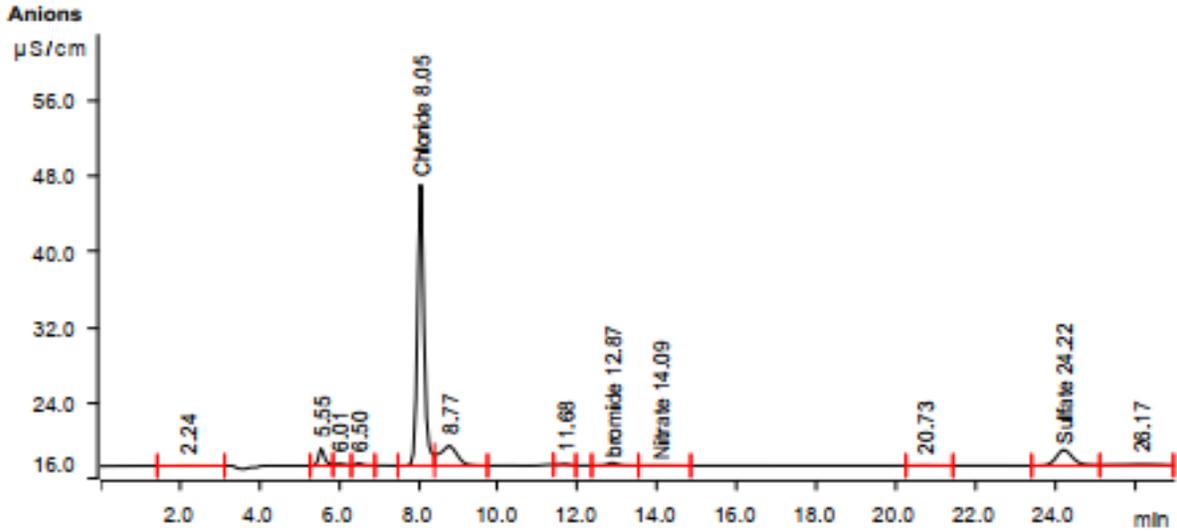


Figure 2B.5. Ion chromatogram of the sample collected as grab sample of the Morning of 20/07/2024 from R.O. (Permeate Tank).

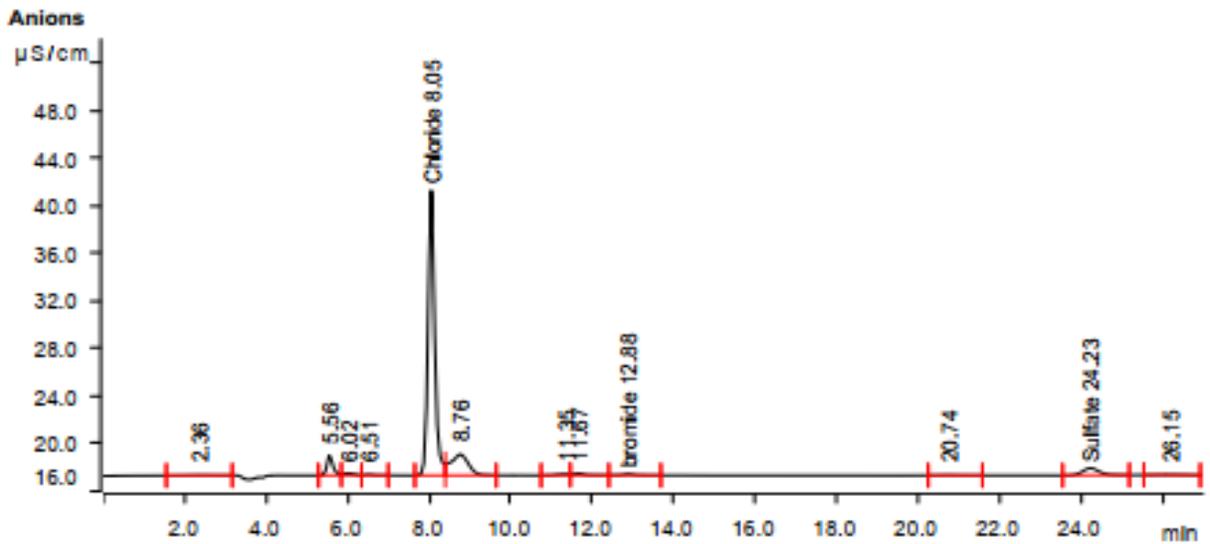


Figure 2B.6. Ion chromatogram of the sample collected as grab sample of the Afternoon of 20/07/2024 from R.O. (Permeate Tank).

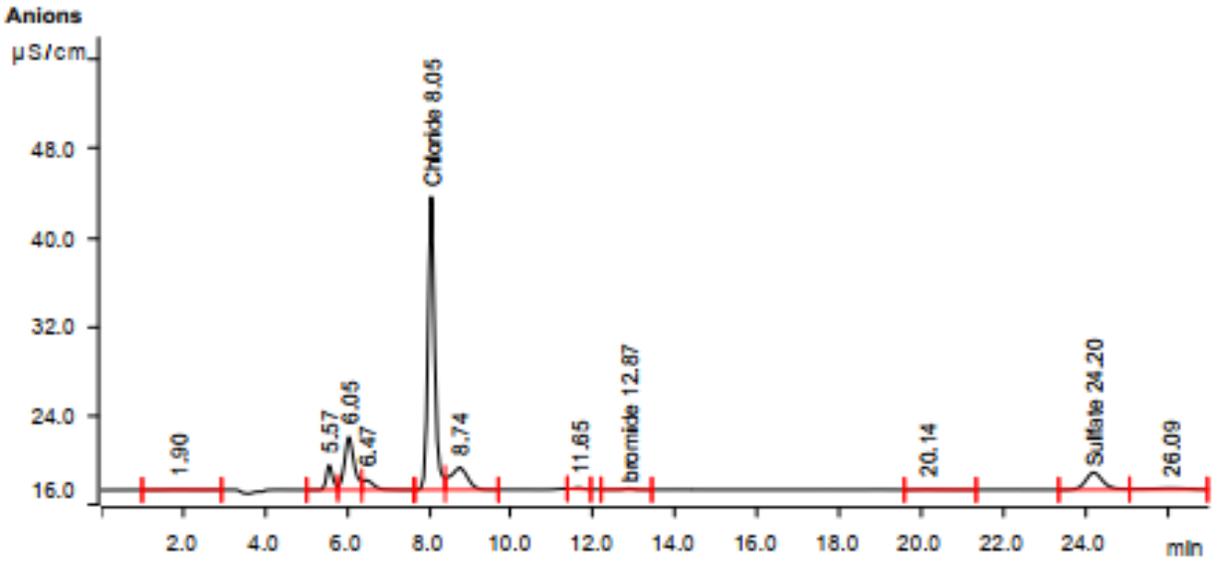


Figure 2B.7. Ion chromatogram of the sample collected as grab sample of the Evening of 20/07/2024 from R.O. (Permeate Tank).

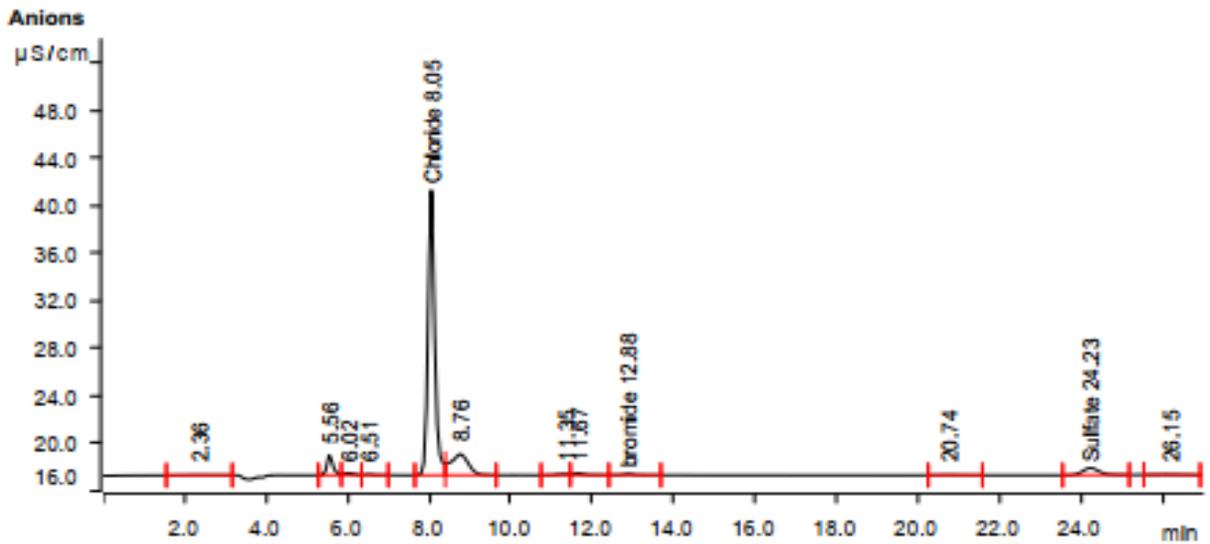


Figure 2B.8. Ion chromatogram of the sample collected as composite sample 20/07/2024 from R.O. (Permeate Tank).

Table 2.3. Metal ions analysis (Using ICP-MS) of water samples collected from Final Discharge of ETP in plant under study.

S. No.	Sample Name/ Code	Date	Time	Concentrations of Metal Ions in ppb				
				²³ Na	²⁴ Mg	³⁹ K	⁴⁴ Ca	⁵² Cr
1	RO permeate/ V2-SS9-M	10/06/2024	Morning	20786.52	213.999	15359.25	250.388	0.329
2	RO permeate/ V2-SS9-A	10/06/2024	Afternoon	19431.79	162.144	13726.98	160.024	0.000
3	RO permeate/ V2-SS9-E	10/06/2024	Evening	16676.1	216.776	11854.2	174.451	0.000
4	RO permeate/ V2- SS9-C	10/06/2024	Composite	15662.97	184.854	12158.15	304.927	0.196
5	RO permeate/ V3-SS9-M	20/7/2024	Morning	29641.96	13088.94	1680.546	15514.27	0.548
6	RO permeate/ V3-SS9-A	20/7/2024	Afternoon	29907.72	13077.67	1652.119	15274.44	0.000
7	RO permeate/ V3-SS9-E	20/7/2024	Evening	27501.58	11988.64	1660.788	14591.32	0.413
8	RO permeate/ V3- SS9-C	20/7/2024	Composite	24346.21	10900.3	1567.477	14217.26	0.000

S. No.	Sample Name/ Code	Date	Time	Concentrations of Metal Ions in ppb				
				⁵⁶ Fe	⁶⁰ Ni	⁷⁵ As	²⁰² Hg	²⁰⁷ Pb
1	RO permeate/ V2-SS9-M	10/06/2024	Morning	6.885	0.445	0.308	0.463	0.187
2	RO permeate/ V2-SS9-A	10/06/2024	Afternoon	0.000	0.129	0.327	1.971	0.000
3	RO permeate/ V2-SS9-E	10/06/2024	Evening	0.000	0.186	0.364	0.514	0.056
4	RO permeate/ V2- SS9-C	10/06/2024	Composite	76.266	0.713	0.344	0.977	0.089
5	RO permeate/ V3-SS9-M	20/7/2024	Morning	0.000	0.272	1.088	12.607	0.000
6	RO permeate/ V3-SS9-A	20/7/2024	Afternoon	0.000	0.499	1.392	0.894	0.000
7	RO permeate/ V3-SS9-E	20/7/2024	Evening	2.704	0.562	1.432	1.343	0.014
8	RO permeate/ V3- SS9-C	20/7/2024	Composite	0.000	0.41	1.432	1.08	0.000

Dissolved Oxygen of ETP of Morepen Laboratories Ltd, Masulkhana.: Dissolved Oxygen (DO) is critically important in wastewater treatment, with its significance varying at different stages of an Effluent Treatment Plant (ETP). DO measures the amount of oxygen dissolved in water and is crucial for supporting biological processes, particularly those involving microorganisms that break down organic pollutants. While preliminary treatment, which focuses on removing large solids and debris, does not directly prioritize DO levels, aeration or mixing during this phase can indirectly affect oxygen content. In primary treatment, which targets the removal of settleable and floating solids through sedimentation, maintaining high levels of

dissolved oxygen is not a primary concern. However, oxygen levels can influence the efficiency of solid settling. The biological treatment stages, including activated sludge systems, trickling filters, and sequencing batch reactors, rely heavily on DO. Here, microorganisms, mainly bacteria, use oxygen in aerobic respiration to break down organic matter. Maintaining optimal DO levels is essential for maximizing the efficiency of these biological processes. Low DO can lead to reduced microbial activity, incomplete pollutant removal, and the formation of unwanted by-products. DO saturation indicates the maximum amount of oxygen that can dissolve in water under specific temperature and pressure conditions. Monitoring DO saturation is crucial for ensuring that water can support aerobic biological processes. Aeration systems are often used to increase DO levels in treatment tanks, facilitating the transfer of oxygen from the air to the water and creating ideal conditions for microbial activity. Since DO solubility decreases as water temperature increases, temperature variations must be considered. Optimal DO levels, typically above 2 mg/L for aerobic processes, are essential for effective biological treatment. Continuous monitoring of DO is necessary to adjust aeration systems and maintain efficient treatment.

COD (Chemical oxygen demand) Control of ETP of Morepen Laboratories Ltd.

Masulkhana: Chemical Oxygen Demand (COD) is a vital parameter in wastewater treatment that measures the amount of oxygen required to chemically oxidize and break down both organic and inorganic compounds in water. The importance of monitoring COD varies at different stages of an Effluent Treatment Plant (ETP). By assessing the COD of influent wastewater, one can predict the overall organic load entering the treatment system. High influent COD levels may indicate significant organic pollution, necessitating specific treatment strategies. During primary treatment, which focuses on physically removing settleable solids through sedimentation, COD is not usually the main focus. However, elevated COD levels can still impact the overall load of subsequent treatment stages. In biological treatment processes; such as activated sludge systems, trickling filters, and sequencing batch reactors; the COD is crucial as microorganisms use oxygen to break down organic pollutants. Managing and controlling COD levels is essential for optimizing microbial activity and effectively removing organic matter. In some tertiary treatment stages, reducing COD is important for further refinement and compliance with stringent discharge standards. Techniques like filtration, chemical precipitation, and adsorption may be used to address remaining COD. The ratio of BOD to COD provides insights into the biodegradability of wastewater, with a lower ratio indicating less biodegradable or more resistant organic compounds. Overall, COD is a key

indicator of the organic content in wastewater, and monitoring it helps assess the effectiveness of treatment processes in reducing organic pollutants. High COD levels can contribute to increased biological oxygen demand (BOD) and nutrient loading in receiving water bodies, making efficient COD removal crucial for minimizing environmental impact.

Table 2.4. COD analysis of water samples collected from the ETP under study.

Sr. No	Date	Time	Sample Name	Sample Code	COD Determination			
					1 st	2 nd	3 rd	Avg (mg/l)
1.	10/06/2024	Morning	Primary Settling tank Inlet	V2-SS1-M	28116	27834.8	27561.6	27837.5
2.	10/06/2024	Morning	MEE feed Tank 01 Outlet	V2-SS2-M	21621.6	21405.4	21700.8	21575.9
3.	10/06/2024	Morning	MEE feed Tank 03 and 04 outlet	V2-SS3-M	18612	18425.9	18532.8	18523.6
4.	10/06/2024	Morning	Primary Settling tank Outlet	V2-SS4-M	13780.8	13643	13543.2	13655.7
5.	10/06/2024	Morning	Secondary Settling tank 01 outlet	V2-SS5-M	10296	10193	10137.6	10208.9
6.	10/06/2024	Morning	Secondary Settling tank	V2-	8712	8624.9	8157.6	8498.2

			02 outlet	SS6-M				
7.	10/06/2024	Morning	RO inlet at RO settler	V2- SS7-M	5860.8	5802.2	6494.4	6052.5
8.	10/06/2024	Morning	RO reject	V2- SS8-M	10296	10193	9504	9997.7
9.	10/06/2024	Morning	RO permeate	V2- SS9-M	2376	2352.2	2217.6	2315.3
10.	10/06/2024	Afternoon	Primary Settling tank Inlet	V2- SS1-A	26532	26266.7	24948	25915.6
11.	10/06/2024	Afternoon	MEE feed Tank 01 Outlet	V2- SS2-A	22730.4	22503.1	20988	22073.8
12.	10/06/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V2- SS3-A	17344.8	17171.4	18770.4	17762.2
13.	10/06/2024	Afternoon	Primary Settling tank Outlet	V2- SS4-A	14295.6	14152.6	14652	14366.7
14.	10/06/2024	Afternoon	Secondary Settling tank 01 outlet	V2- SS5-A	11761.2	11643.6	11008.8	11471.2
15.	10/06/2024	Afternoon	Secondary Settling tank	V2- SS6-A	9781.2	9683.4	9424.8	9629.8

			02 outlet					
16.	10/06/2024	Afternoon	RO inlet at RO settler	V2- SS7-A	6692.4	6625.5	6732	6683.3
17.	10/06/2024	Afternoon	RO reject	V2- SS8-A	9702	9605	10058.4	9788.5
18.	10/06/2024	Afternoon	RO permeate	V2- SS9-A	2138.4	2117	2217.6	2157.7
19.	10/06/2024	Evening	Primary Settling tank Inlet	V2- SS1-E	24274.8	24032.1	24076.8	24127.9
20.	10/06/2024	Evening	MEE feed Tank 01 Outlet	V2- SS2-E	19918.8	19719.6	19958.4	19865.6
21.	10/06/2024	Evening	MEE feed Tank 03 and 04 outlet	V2- SS3-E	15958.8	15799.2	15998.4	15918.8
22.	10/06/2024	Evening	Primary Settling tank Outlet	V2- SS4-E	13503.6	13368.6	14097.6	13656.6
23.	10/06/2024	Evening	Secondary Settling tank 01 outlet	V2- SS5-E	9622.8	9526.6	10216.8	9788.7
24.	10/06/2024	Evening	Secondary Settling tank	V2- SS6-E	7246.8	7174.3	6652.8	7024.6

			02 outlet					
25.	10/06/2024	Evening	RO inlet at RO settler	V2- SS7-E	4870.8	4822.1	4672.8	4788.6
26.	10/06/2024	Evening	RO reject	V2- SS8-E	7484.4	7409.6	7761.6	7551.9
27.	10/06/2024	Evening	RO permeate	V2- SS9-E	1623.6	1607.4	1663.2	1631.4
28.	10/06/2024	Composite	Primary Settling tank Inlet	V2- SS1-C	24987.6	24737.7	24631.2	24785.5
29.	10/06/2024	Composite	MEE feed Tank 01 Outlet	V2- SS2-C	22294.8	22071.9	22413.6	22260.1
30.	10/06/2024	Composite	MEE feed Tank 03 and 04 outlet	V2- SS3-C	19324.8	19131.6	18691.2	19049.2
31.	10/06/2024	Composite	Primary Settling tank Outlet	V2- SS4-C	14374.8	14231.1	14810.4	14472.1
32.	10/06/2024	Composite	Secondary Settling tank 01 outlet	V2- SS5-C	12196.8	12074.8	12276	12182.5
33.	10/06/2024	Composite	Secondary Settling tank	V2- SS6-C	8434.8	8350.5	8791.2	8525.5

			02 outlet					
34.	10/06/2024	Composite	RO inlet at RO settler	V2- SS7-C	6692.4	6625.5	6890.4	6736.1
35.	10/06/2024	Composite	RO reject	V2- SS8-C	9820.8	9722.6	10296	9946.5
36.	10/06/2024	Composite	RO permeate	V2- SS9-C	2098.8	2077.8	2296.8	2157.8
37.	20/7/2024	Morning	Primary Settling tank Inlet	V3- SS1-M	16869.6	16700.9	17028	16866.2
38.	20/7/2024	Morning	MEE feed Tank 01 Outlet	V3- SS2-M	15008.4	14858.3	15404.4	15090.4
39.	20/7/2024	Morning	MEE feed Tank 03 and 04 outlet	V3- SS3-M	13741.2	13603.8	13899.6	13748.2
40.	20/7/2024	Morning	Primary Settling tank Outlet	V3- SS4-M	9068.4	8977.7	9226.8	9091
41.	20/7/2024	Morning	Secondary Settling tank 01 outlet	V3- SS5-M	2708.6	2681.6	2787.8	2726
42.	20/7/2024	Morning	Secondary Settling tank	V3- SS6-M	2201.8	2179.7	2122.6	2168

			02 outlet					
43.	20/7/2024	Morning	RO inlet at RO settler	V3- SS7-M	1972.1	1952.4	1908.7	1944.4
44.	20/7/2024	Morning	RO reject	V3- SS8-M	3231.4	3199	3342.2	3257.5
45.	20/7/2024	Morning	RO permeate	V3- SS9-M	182.2	180.3	150.5	171
46.	20/7/2024	Afternoon	Primary Settling tank Inlet	V3- SS1-A	18889.2	18700.3	18612	18733.8
47.	20/7/2024	Afternoon	MEE feed Tank 01 Outlet	V3- SS2-A	16948.8	16779.3	16671.6	16799.9
48.	20/7/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V3- SS3-A	14731.2	14583.9	15008.4	14774.5
49.	20/7/2024	Afternoon	Primary Settling tank Outlet	V3- SS4-A	9860.4	9761.8	9464.4	9695.5
50.	20/7/2024	Afternoon	Secondary Settling tank 01 outlet	V3- SS5-A	3469	3434.3	3500.6	3468
51.	20/7/2024	Afternoon	Secondary Settling tank	V3- SS6-A	2708.6	2681.6	2787.8	2726

			02 outlet					
52.	20/7/2024	Afternoon	RO inlet at RO settler	V3- SS7-A	2154.2	2132.7	2217.6	2168.2
53.	20/7/2024	Afternoon	RO reject	V3- SS8-A	3912.5	3873.4	4007.5	3931.1
54.	20/7/2024	Afternoon	RO permeate	V3- SS9-A	194	192.1	190.1	192.1
55.	20/7/2024	Evening	Primary Settling tank Inlet	V3- SS1-E	17938.8	17759.4	18176.4	17958.2
56.	20/7/2024	Evening	MEE feed Tank 01 Outlet	V3- SS2-E	14929.2	14779.9	15404.4	15037.8
57.	20/7/2024	Evening	MEE feed Tank 03 and 04 outlet	V3- SS3-E	13582.8	13447	13780.8	13603.5
58.	20/7/2024	Evening	Primary Settling tank Outlet	V3- SS4-E	9979.2	9879.4	10018.8	9959.1
59.	20/7/2024	Evening	Secondary Settling tank 01 outlet	V3- SS5-E	2534.4	2509.1	2328.5	2457.3
60.	20/7/2024	Evening	Secondary Settling tank	V3- SS6-E	2027.5	2007.2	2075	2036.6

			02 outlet					
61.	20/7/2024	Evening	RO inlet at RO settler	V3- SS7-E	1687	1670.1	1726.6	1694.5
62.	20/7/2024	Evening	RO reject	V3- SS8-E	3231.4	3199	2993.8	3141.4
63.	20/7/2024	Evening	RO permeate	V3- SS9-E	130.7	129.4	142.6	134.2
64.	20/7/2024	Composite	Primary Settling tank Inlet	V3- SS1-C	18374.4	18190.7	18572.4	18379.2
65.	20/7/2024	Composite	MEE feed Tank 01 Outlet	V3- SS2-C	15285.6	15132.7	15523.2	15313.8
66.	20/7/2024	Composite	MEE feed Tank 03 and 04 outlet	V3- SS3-C	13028.4	12898.1	13424.4	13117
67.	20/7/2024	Composite	Primary Settling tank Outlet	V3- SS4-C	9028.8	8938.5	9345.6	9104.3
68.	20/7/2024	Composite	Secondary Settling tank 01 outlet	V3- SS5-C	3231.4	3199	3025.4	3151.9
69.	20/7/2024	Composite	Secondary Settling tank 02 outlet	V3- SS6-C	2534.4	2509.1	2486.9	2510.1
70.	20/7/2024	Composite	RO inlet at RO settler	V3- SS7-C	1964.2	1944.5	2075	1994.6

71.	20/7/2024	Composite	RO reject	V3-SS8-C	3310.6	3277.5	3421.4	3336.5
72.	20/7/2024	Composite	RO permeate	V3-SS9-C	166.3	164.7	146.5	159.2

BOD (Biological oxygen demand) Control of ETP of Morepen Laboratories Ltd.

Masulkhana: Biochemical Oxygen Demand (BOD) is a key measure of the amount of dissolved oxygen needed by microorganisms to decompose organic matter in water through biological processes. This metric is essential for assessing the presence of organic pollutants in wastewater, typically expressed in milligrams of oxygen consumed per liter of water (mg/L) over a specified period, often 5 days (BOD₅) at 20 degrees Celsius. In an Effluent Treatment Plant (ETP), BOD concentrations are influenced by various factors. The initial BOD level of influent wastewater depends on the types and amounts of organic pollutants present. Industrial discharges with high organic content can significantly raise the influent BOD. Preliminary treatment stages, such as screening and grit removal, focus on the physical elimination of large solids and debris. Although these processes do not directly reduce BOD, they prevent damage and interference in subsequent treatment stages. Primary treatment aims to remove settleable solids through processes like sedimentation. While its primary objective is to eliminate solids, this stage can also lead to a slight reduction in BOD as suspended organic matter settles out. Biological treatment stages, such as activated sludge systems, are designed for the microbial breakdown of organic pollutants, resulting in a reduction of BOD levels. Effective aeration and mixing are critical for maintaining microbial activity and optimizing BOD removal efficiency. BOD levels in the effluent from biological treatment depend on the effectiveness of the microbial processes and the degree of organic matter decomposition. Tertiary treatment processes, including filtration, adsorption, or chemical precipitation, may further reduce BOD levels. Filtration removes any remaining suspended solids and organic matter, while adsorption targets dissolved organic compounds.

Table 2.5. BOD analysis of water samples collected from the ETP of Morepen Laboratories Ltd. Masulkhana.

Sr. No	Date	Time	Sample Name	Sample Code	BOD Determination			
					1 st	2 nd	3 rd	Avg. (mg/l)
1.	10/06/2024	Morning	Primary Settling tank Inlet	V2-SS1-M	6761.9	6457.1	6628.6	6615.9
2.	10/06/2024	Morning	MEE feed Tank 01 Outlet	V2-SS2-M	5200	5466.7	5219	5295.2
3.	10/06/2024	Morning	MEE feed Tank 03 and 04 outlet	V2-SS3-M	4177.8	4355.6	4160	4231.1
4.	10/06/2024	Morning	Primary Settling tank Outlet	V2-SS4-M	3237.2	3423.3	3181.4	3280.6
5.	10/06/2024	Morning	Secondary Settling tank 01 outlet	V2-SS5-M	2000	1769.2	1969.2	1912.8
6.	10/06/2024	Morning	Secondary Settling tank 02 outlet	V2-SS6-M	1660.4	1434	1554.7	1549.7
7.	10/06/2024	Morning	RO inlet at RO settler	V2-SS7-M	1208.2	1387.8	1338.8	1311.6
8.	10/06/2024	Morning	RO reject	V2-SS8-M	2000	2076.9	1846.2	1974.4
9.	10/06/2024	Morning	RO	V2-SS9-M	452.8	362.3	422.6	412.6

			permeate					
10.	10/06/2024	Afternoon	Primary Settling tank Inlet	V2-SS1-A	6381	6323.8	6000	6234.9
11.	10/06/2024	Afternoon	MEE feed Tank 01 Outlet	V2-SS2-A	5466.7	5276.2	5047.6	5263.5
12.	10/06/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V2-SS3-A	3893.3	4088.9	4213.3	4065.2
13.	10/06/2024	Afternoon	Primary Settling tank Outlet	V2-SS4-A	3358.1	3293	3441.9	3364.3
14.	10/06/2024	Afternoon	Secondary Settling tank 01 outlet	V2-SS5-A	2284.6	2346.2	2138.5	2256.4
15.	10/06/2024	Afternoon	Secondary Settling tank 02 outlet	V2-SS6-A	1864.2	1743.4	1796.2	1801.3
16.	10/06/2024	Afternoon	RO inlet at RO settler	V2-SS7-A	1379.6	1346.9	1387.8	1371.4
17.	10/06/2024	Afternoon	RO reject	V2-SS8-A	1884.6	1961.5	1953.8	1933.3
18.	10/06/2024	Afternoon	RO permeate	V2-SS9-A	407.5	483	422.6	437.7

19.	10/06/2024	Evening	Primary Settling tank Inlet	V2-SS1-E	5838.1	6028.6	5790.5	5885.7
20.	10/06/2024	Evening	MEE feed Tank 01 Outlet	V2-SS2-E	4790.5	5019	4800	4869.8
21.	10/06/2024	Evening	MEE feed Tank 03 and 04 outlet	V2-SS3-E	3582.2	3760	3591.1	3644.4
22.	10/06/2024	Evening	Primary Settling tank Outlet	V2-SS4-E	3172.1	3414	3311.6	3299.2
23.	10/06/2024	Evening	Secondary Settling tank 01 outlet	V2-SS5-E	1869.2	2007.7	1984.6	1953.8
24.	10/06/2024	Evening	Secondary Settling tank 02 outlet	V2-SS6-E	1381.1	1230.2	1267.9	1293.1
25.	10/06/2024	Evening	RO inlet at RO settler	V2-SS7-E	1004.1	906.1	963.3	957.8
26.	10/06/2024	Evening	RO reject	V2-SS8-E	1453.8	1361.5	1507.7	1441
27.	10/06/2024	Evening	RO permeate	V2-SS9-E	309.4	324.5	317	317
28.	10/06/2024	Composite	Primary	V2-SS1-C	6009.5	6181	5923.8	6038.1

			Settling tank Inlet					
29.	10/06/2024	Composite	MEE feed Tank 01 Outlet	V2-SS2-C	5361.9	5190.5	5390.5	5314.3
30.	10/06/2024	Composite	MEE feed Tank 03 and 04 outlet	V2-SS3-C	4337.8	4248.9	4195.6	4260.8
31.	10/06/2024	Composite	Primary Settling tank Outlet	V2-SS4-C	3376.7	3302.3	3479.1	3386
32.	10/06/2024	Composite	Secondary Settling tank 01 outlet	V2-SS5-C	2369.2	2338.5	2384.6	2364.1
33.	10/06/2024	Composite	Secondary Settling tank 02 outlet	V2-SS6-C	1607.5	1532.1	1675.5	1605
34.	10/06/2024	Composite	RO inlet at RO settler	V2-SS7-C	1379.6	1281.6	1420.4	1360.5
35.	10/06/2024	Composite	RO reject	V2-SS8-C	1907.7	1984.6	2000	1964.1
36.	10/06/2024	Composite	RO permeate	V2-SS9-C	400	369.8	437.7	402.5
37.	20/7/2024	Morning	Primary Settling tank	V3-SS1-M	3872.7	3972.7	3909.1	3918.2

			Inlet					
38.	20/7/2024	Morning	MEE feed Tank 01 Outlet	V3-SS2-M	3525.6	3590.7	3618.6	3578.3
39.	20/7/2024	Morning	MEE feed Tank 03 and 04 outlet	V3-SS3-M	3017.4	3095.7	3052.2	3055.1
40.	20/7/2024	Morning	Primary Settling tank Outlet	V3-SS4-M	1948.9	2042.6	1983	1991.5
41.	20/7/2024	Morning	Secondary Settling tank 01 outlet	V3-SS5-M	558.4	545.3	574.7	559.5
42.	20/7/2024	Morning	Secondary Settling tank 02 outlet	V3-SS6-M	404.4	386.9	389.8	393.7
43.	20/7/2024	Morning	RO inlet at RO settler	V3-SS7-M	406.5	401.6	393.5	400.5
44.	20/7/2024	Morning	RO reject	V3-SS8-M	627.7	643.1	649.2	640
45.	20/7/2024	Morning	RO permeate	V3-SS9-M	29.7	29.9	28.7	29.4
46.	20/7/2024	Afternoon	Primary Settling tank Inlet	V3-SS1-A	4336.4	4381.8	4272.7	4330.3

47.	20/7/2024	Afternoon	MEE feed Tank 01 Outlet	V3-SS2-A	3981.4	3962.8	3916.3	3953.5
48.	20/7/2024	Afternoon	MEE feed Tank 03 and 04 outlet	V3-SS3-A	3234.8	3156.5	3295.7	3229
49.	20/7/2024	Afternoon	Primary Settling tank Outlet	V3-SS4-A	2119.1	2085.1	2034	2079.4
50.	20/7/2024	Afternoon	Secondary Settling tank 01 outlet	V3-SS5-A	715.1	702	721.6	712.9
51.	20/7/2024	Afternoon	Secondary Settling tank 02 outlet	V3-SS6-A	497.5	503.3	512	504.3
52.	20/7/2024	Afternoon	RO inlet at RO settler	V3-SS7-A	444.1	455.5	457.1	452.2
53.	20/7/2024	Afternoon	RO reject	V3-SS8-A	760	766.2	778.5	768.2
54.	20/7/2024	Afternoon	RO permeate	V3-SS9-A	28.3	28.7	28.2	28.4
55.	20/7/2024	Evening	Primary Settling tank Inlet	V3-SS1-E	4118.2	4081.8	4172.7	4124.2
56.	20/7/2024	Evening	MEE feed	V3-SS2-E	3507	3581.4	3618.6	3569

			Tank 01 Outlet					
57.	20/7/2024	Evening	MEE feed Tank 03 and 04 outlet	V3-SS3-E	2982.6	3017.4	3026.1	3008.7
58.	20/7/2024	Evening	Primary Settling tank Outlet	V3-SS4-E	2144.7	2119.1	2153.2	2139
59.	20/7/2024	Evening	Secondary Settling tank 01 outlet	V3-SS5-E	522.4	512.7	480	505
60.	20/7/2024	Evening	Secondary Settling tank 02 outlet	V3-SS6-E	372.4	357.8	381.1	370.4
61.	20/7/2024	Evening	RO inlet at RO settler	V3-SS7-E	347.8	357.6	355.9	353.8
62.	20/7/2024	Evening	RO reject	V3-SS8-E	627.7	593.8	581.5	601
63.	20/7/2024	Evening	RO permeate	V3-SS9-E	24.9	21.9	27.2	24.7
64.	20/7/2024	Composite	Primary Settling tank Inlet	V3-SS1-C	4218.2	4172.7	4263.6	4218.2
65.	20/7/2024	Composite	MEE feed Tank 01	V3-SS2-C	3590.7	3637.2	3646.5	3624.8

			Outlet					
66.	20/7/2024	Composite	MEE feed Tank 03 and 04 outlet	V3-SS3-C	2860.9	2843.5	2947.8	2884.1
67.	20/7/2024	Composite	Primary Settling tank Outlet	V3-SS4-C	1940.4	2025.5	2008.5	1991.5
68.	20/7/2024	Composite	Secondary Settling tank 01 outlet	V3-SS5-C	666.1	643.3	623.7	644.4
69.	20/7/2024	Composite	Secondary Settling tank 02 outlet	V3-SS6-C	465.5	430.5	456.7	450.9
70.	20/7/2024	Composite	RO inlet at RO settler	V3-SS7-C	404.9	409.8	427.8	414.2
71.	20/7/2024	Composite	RO reject	V3-SS8-C	643.1	667.7	664.6	658.5
72.	20/7/2024	Composite	RO permeate	V3-SS9-C	26.7	26.4	26.9	26.7

Particle size analysis of water samples collected from R.O. (Permeate Tank) at ETP of Morepen Laboratories Ltd Masulkhana: Dynamic Light Scattering (DLS) is essential for evaluating the effectiveness of tertiary treated water, particularly in analyzing the size distribution of particles or colloids in the water. Also known as Photon Correlation Spectroscopy, DLS measures the Brownian motion of particles by examining fluctuations in scattered light. The

rate of this motion is indicative of particle size. DLS provides detailed information on the particle size distribution in tertiary treated water, detecting particles ranging from nanometers to micrometers. This is crucial for understanding the nature of suspended particles or colloids present. By analyzing particle size distribution, DLS helps monitor the efficiency of tertiary treatment processes, assessing whether these methods effectively reduce the size and concentration of particles. Additionally, DLS is valuable for evaluating the potential environmental impact of treated water discharge. It identifies any residual particulate matter in the water that could pose ecological risks. The overall quality of treated water is often linked to the presence and characteristics of suspended particles, and DLS contributes by offering insights into their size and distribution.

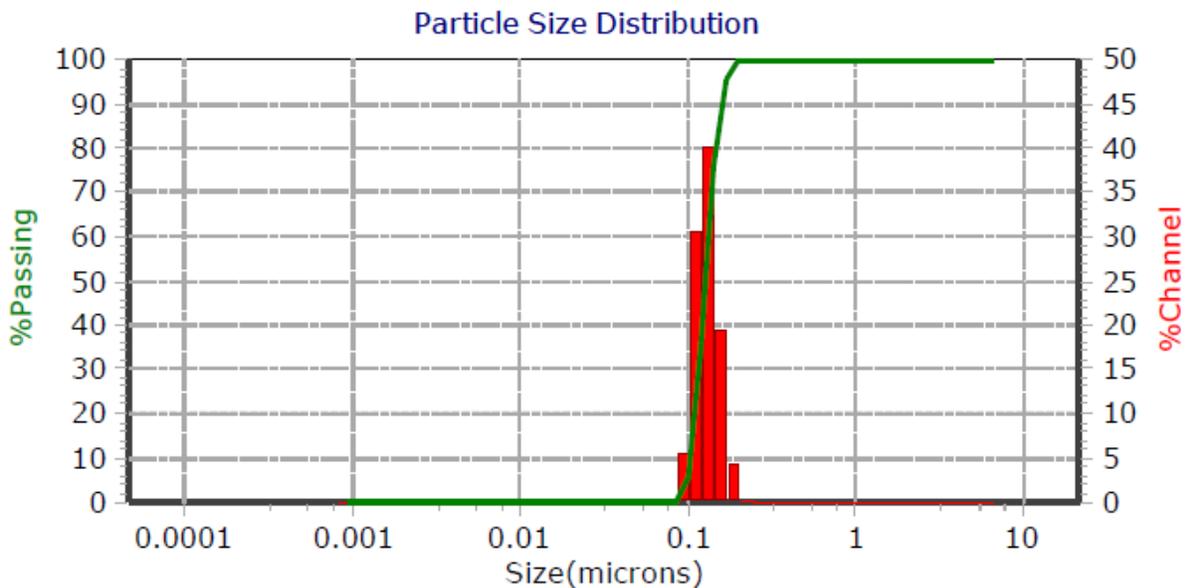


Figure 2B.9 DLS analysis for particle size determination of the sample collected as grab sample of the Morning of 10/06/2024 from R.O. (Permeate Tank).

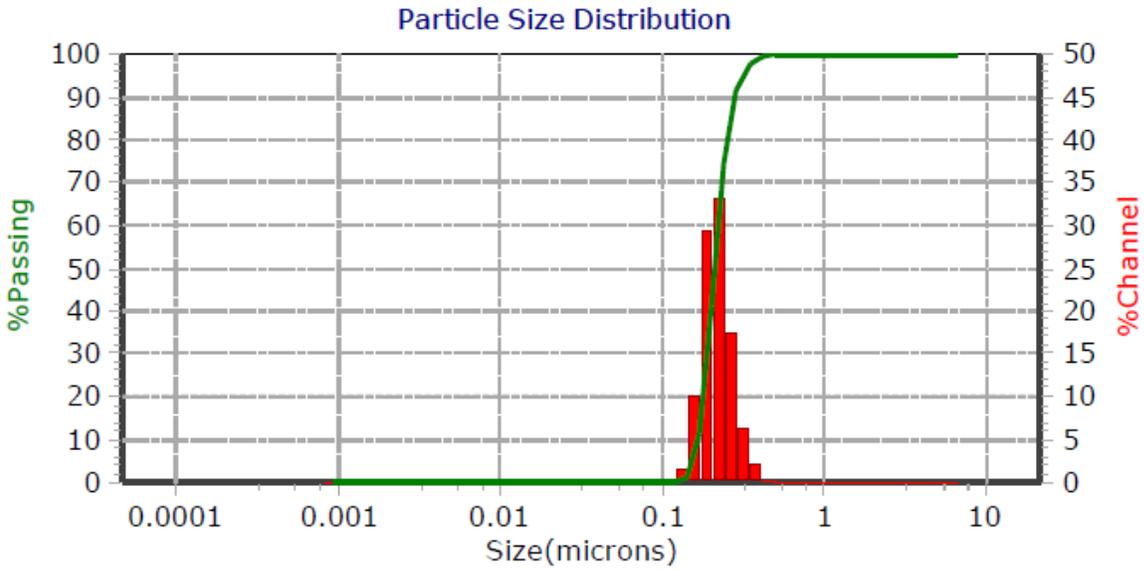


Figure 2B.10 DLS analysis for particle size determination of the sample collected as grab sample of the Afternoon of 10/06/2024 from R.O. (Permeate Tank).

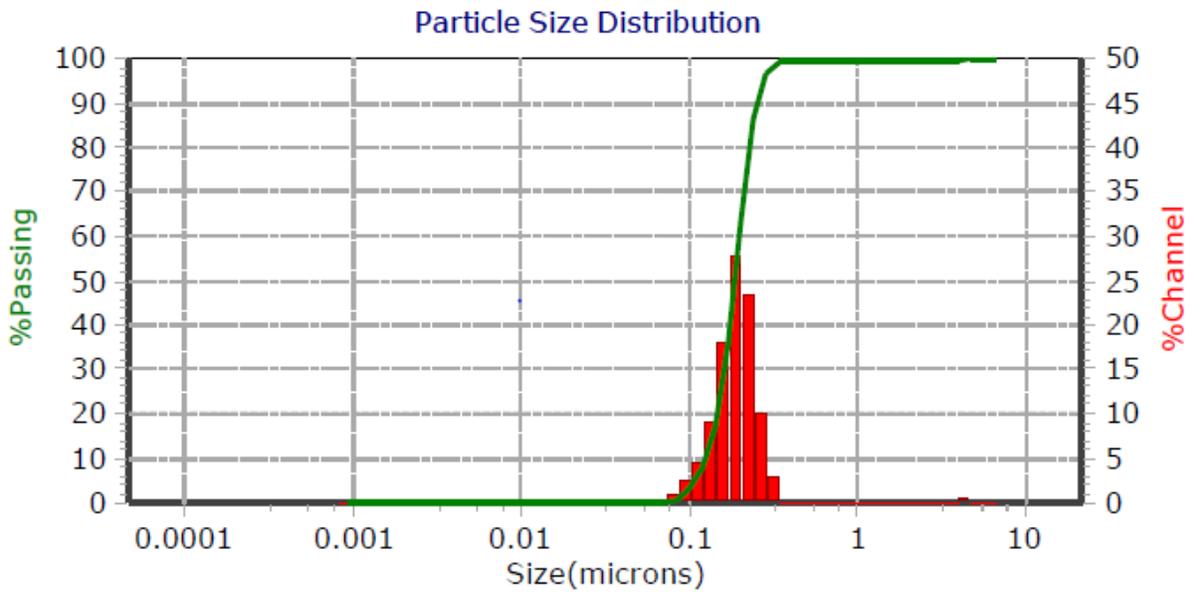


Figure 2B.11 DLS analysis for particle size determination of the sample collected as grab sample of the Evening of 10/06/2024 from R.O. (Permeate Tank).

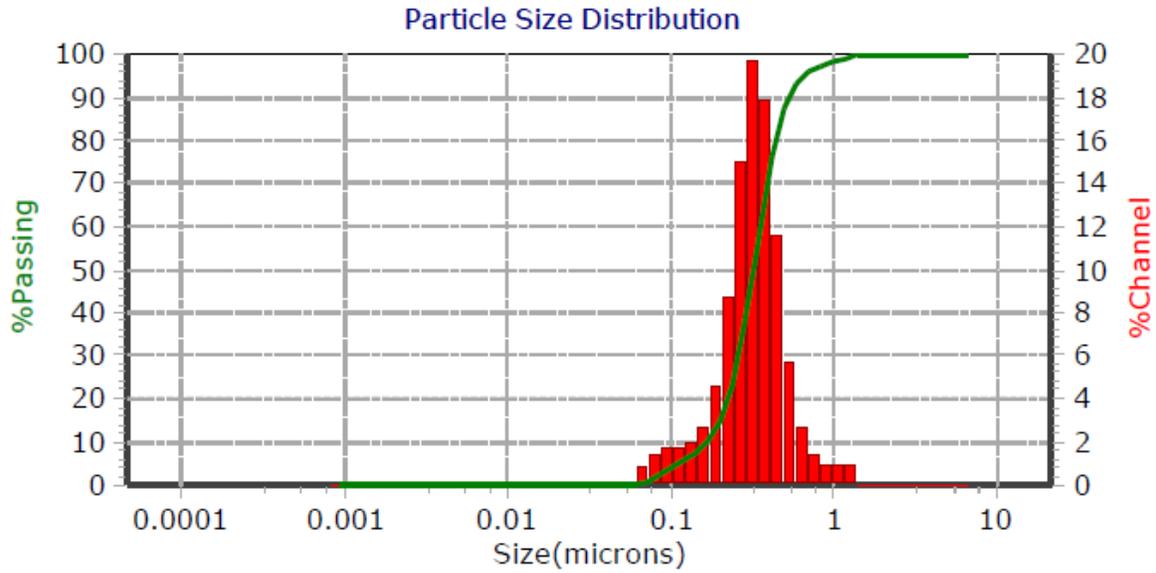


Figure 2B.12 DLS analysis for particle size determination of the sample collected as composite of 10/06/2024 from R.O. (Permeate Tank).

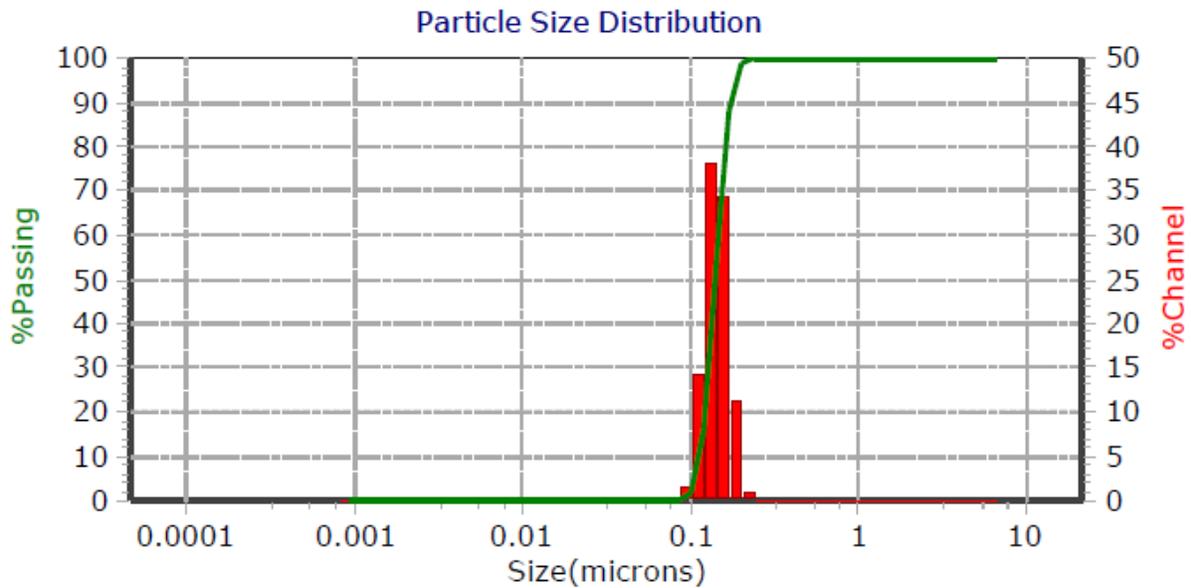


Figure 2B.13 DLS analysis for particle size determination of the sample collected as grab sample of the Morning of 20/07/2024 from R.O. (Permeate Tank).

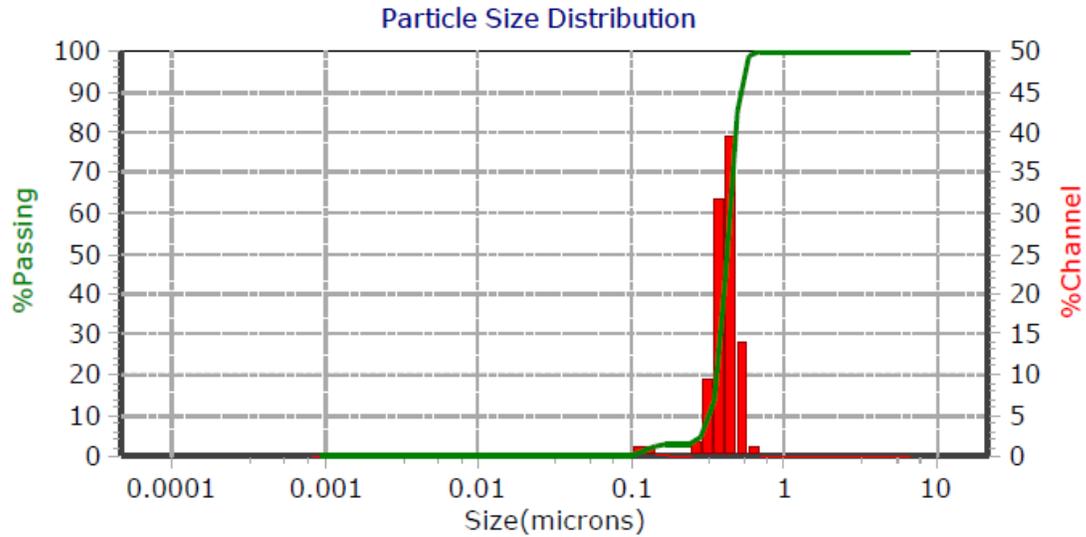


Figure 2B.14 DLS analysis for particle size determination of the sample collected as grab sample of the Afternoon of 20/07/2024 from R.O. (Permeate Tank).

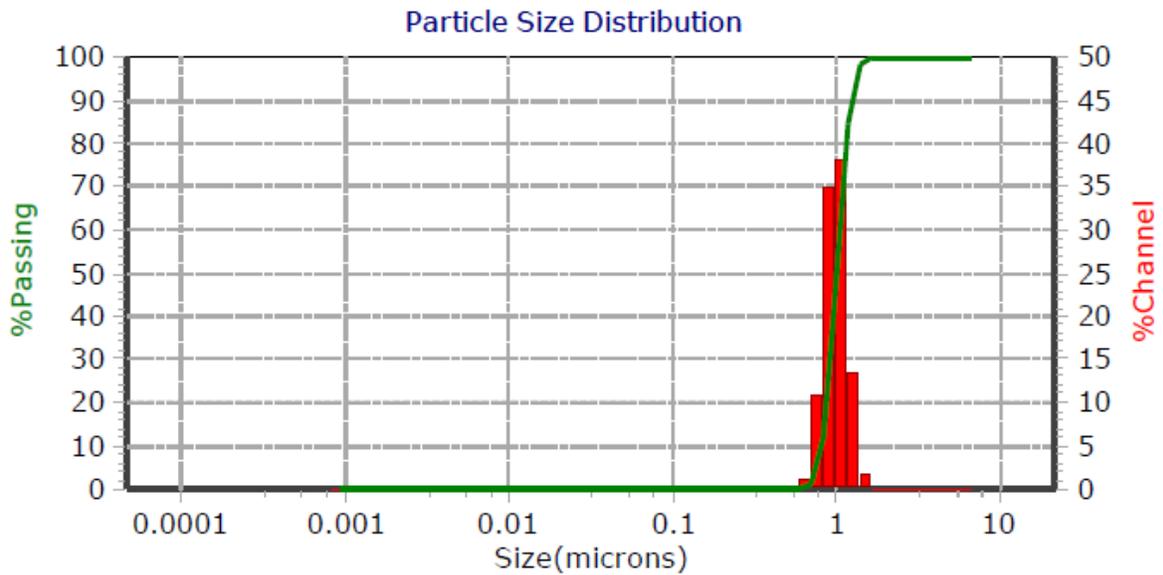


Figure 2B.15 DLS analysis for particle size determination of the sample collected as grab sample of the Evening of 20/07/2024 from R.O. (Permeate Tank).

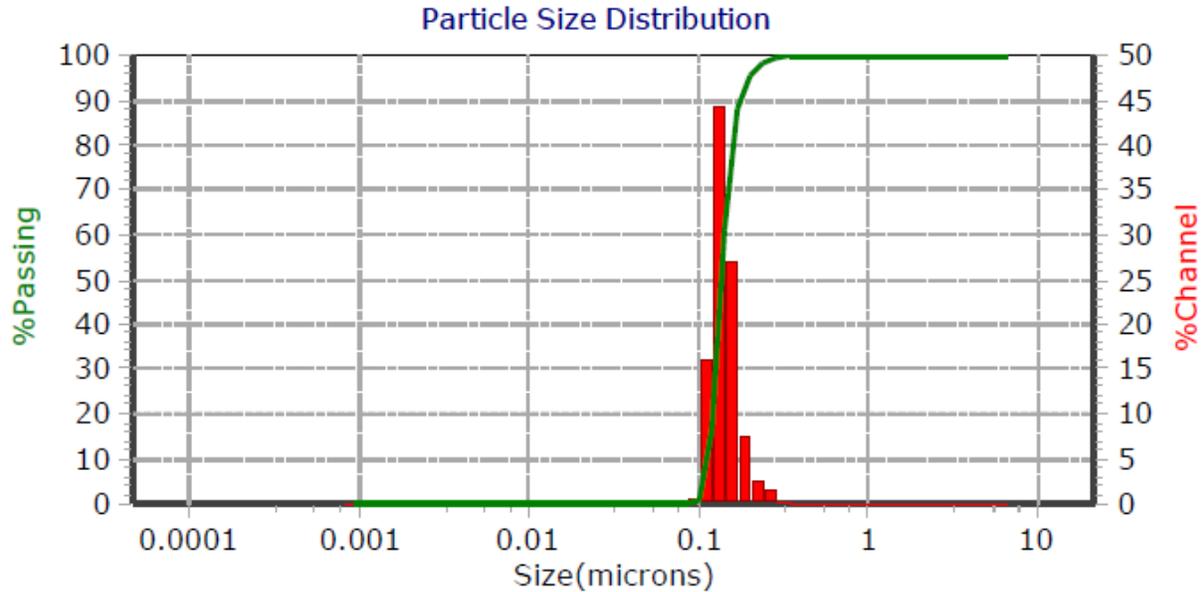


Figure 2B.16 DLS analysis for particle size determination of the sample collected as composite sample of 20/07/2024 from R.O. (Permeate Tank).

Functional groups analysis materials present in the water samples collected from R.O. (Permeate Tank) at ETP of Morepen Laboratories Ltd. Masulkhana: In water analysis for Effluent Treatment Plants (ETPs), Infrared (IR) spectroscopy is a crucial analytical method for examining the composition of water samples. IR spectroscopy operates on the principle that different chemical bonds absorb infrared radiation at specific frequencies. This technique identifies functional groups in organic compounds present in the water sample, such as hydroxyl (-OH), carbonyl (C=O), and amino (-NH₂), each of which has unique absorption peaks. The IR spectra reveal the concentration of these compounds by analyzing the intensity of these absorption bands, allowing for a quantitative assessment of both organic and inorganic components. IR spectroscopy is particularly effective for detecting organic contaminants, such as oils, solvents, and other pollutants, by analyzing their distinctive absorption peaks.

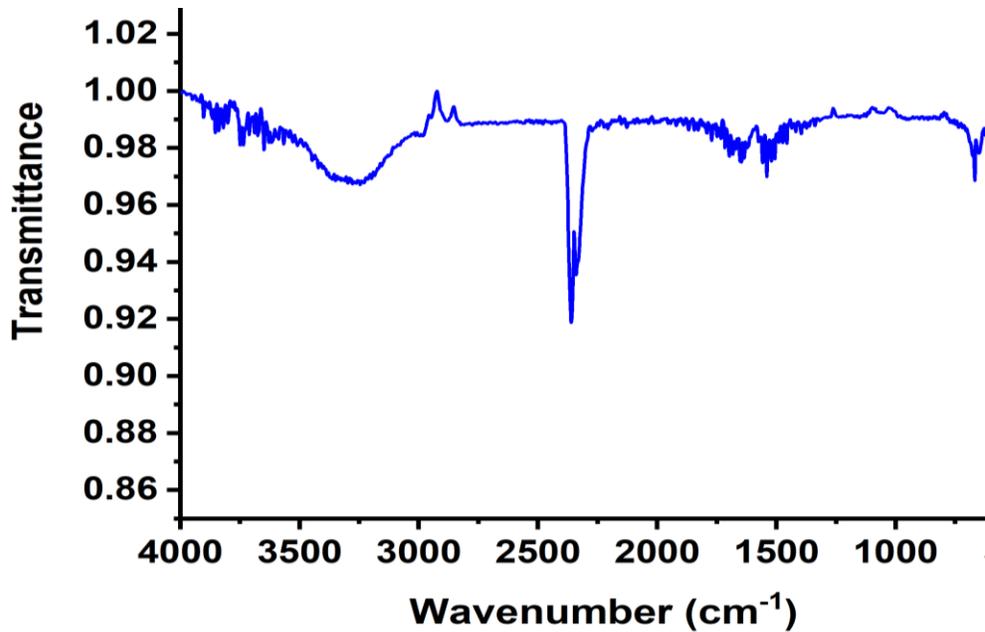


Figure 2B.17 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as grab sample of the Morning of 10/06/2024 from R.O. (Permeate Tank).

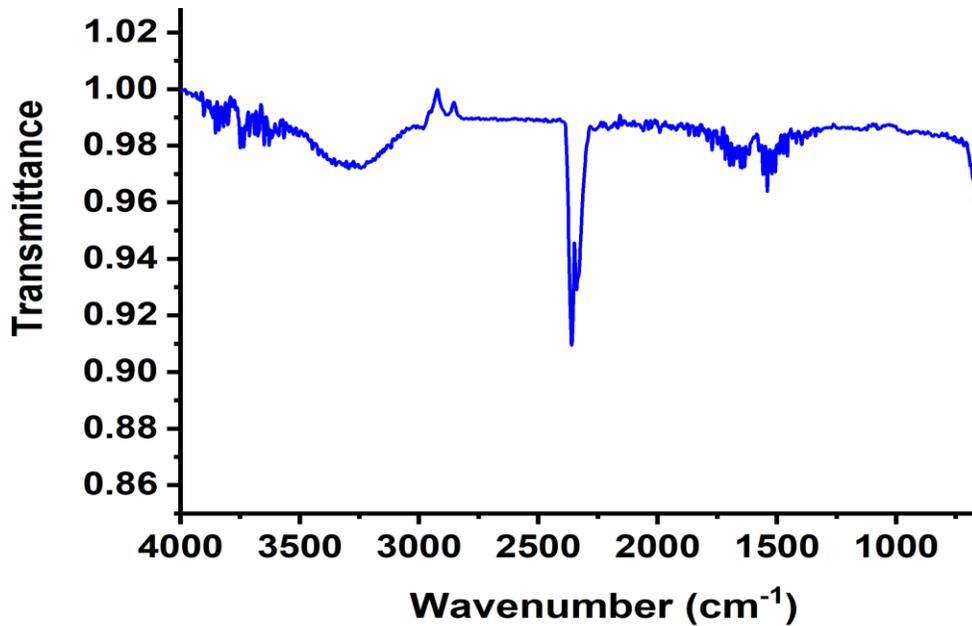


Figure 2B.18 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as grab sample of the Afternoon of 10/06/2024 from R.O. (Permeate Tank).

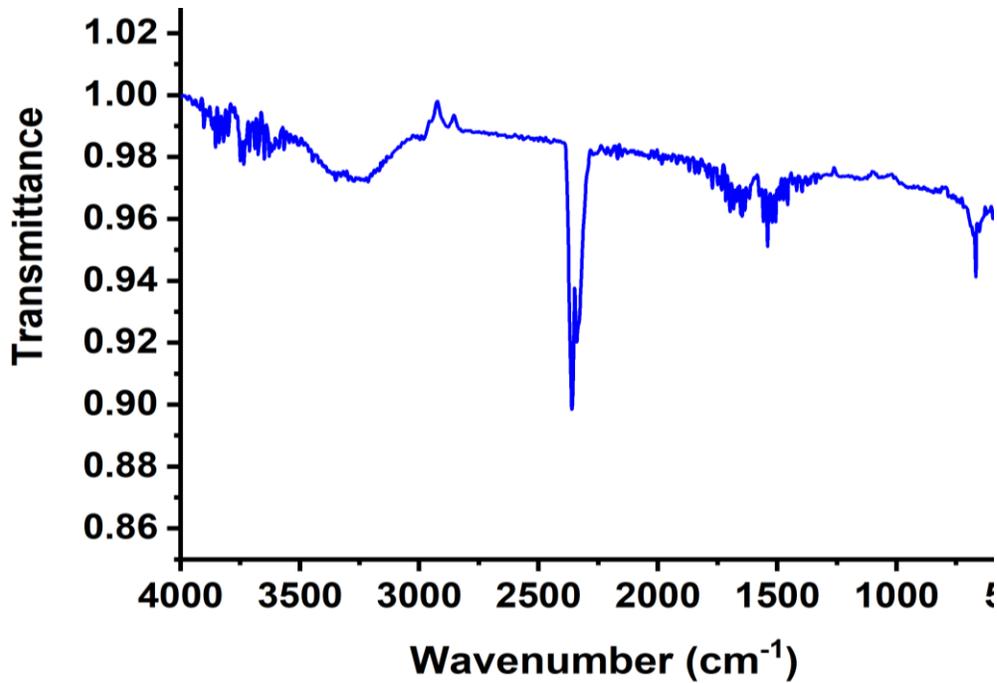


Figure 2B.19 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as grab sample of the Evening of 10/06/2024 from R.O. (Permeate Tank).

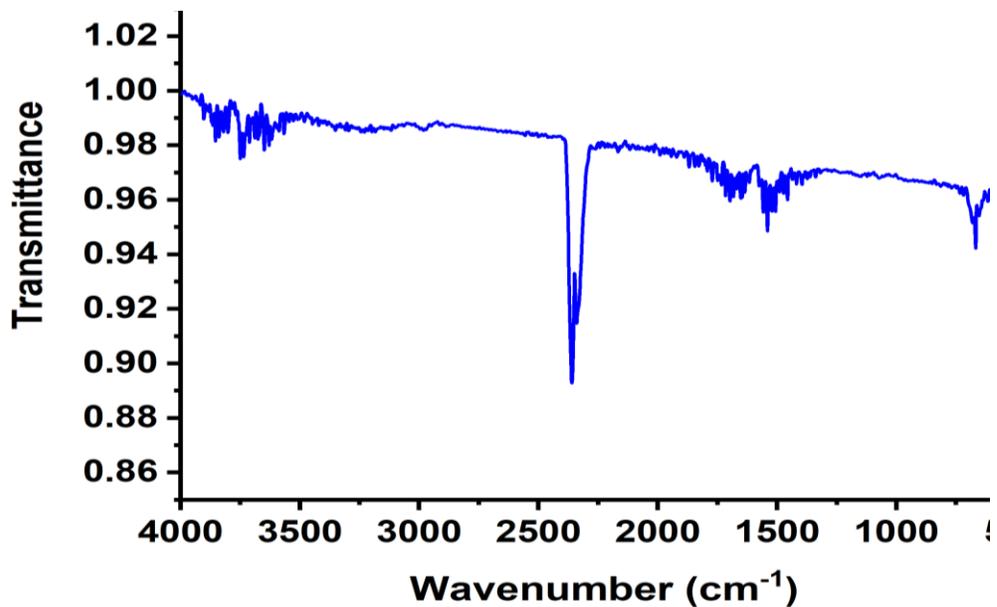


Figure 2B.20 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as composite sample of 10/06/2024 from R.O. (Permeate Tank).

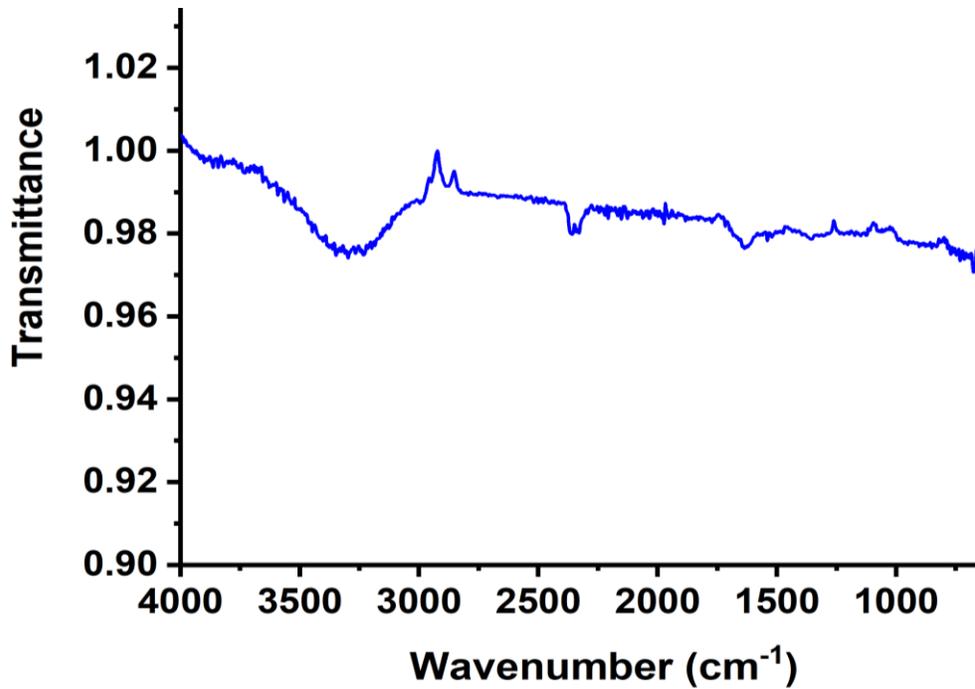


Figure 2B.21 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as grab sample of the Morning of 20/07/2024 from R.O. (Permeate Tank).

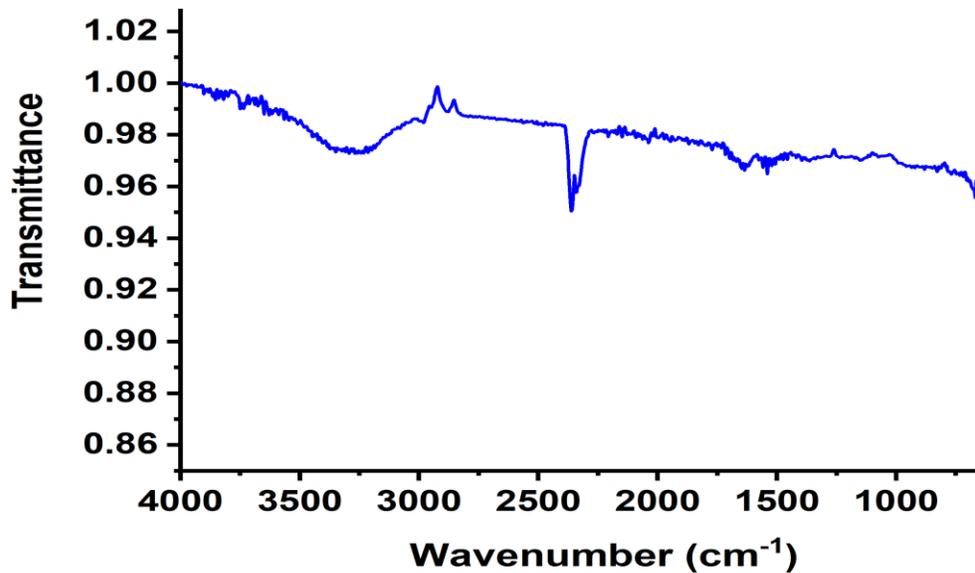


Figure 2B.22 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as grab sample of the afternoon of 20/07/2024 from R.O. (Permeate Tank).

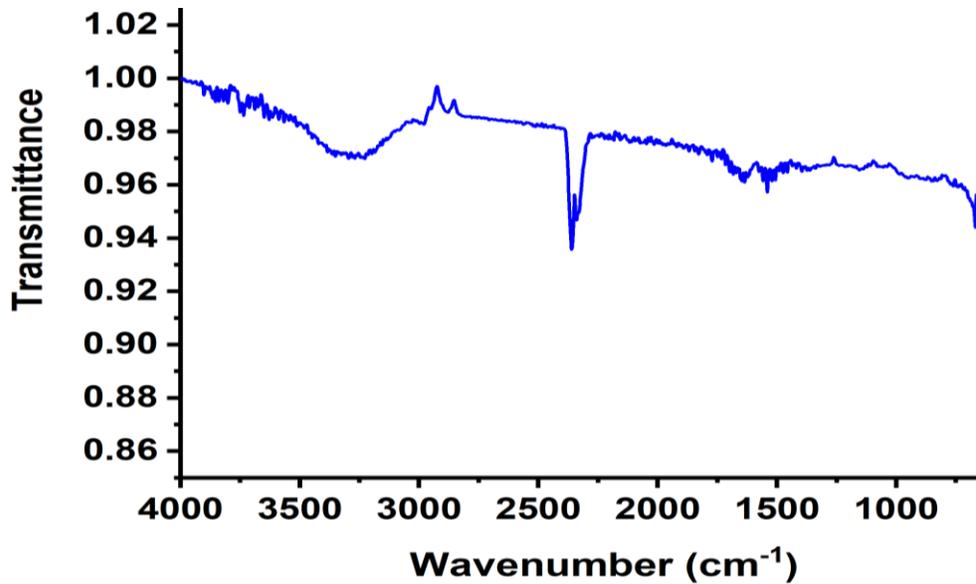


Figure 2B.23 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as grab sample of the Evening of 20/07/2024 from R.O. (Permeate Tank).

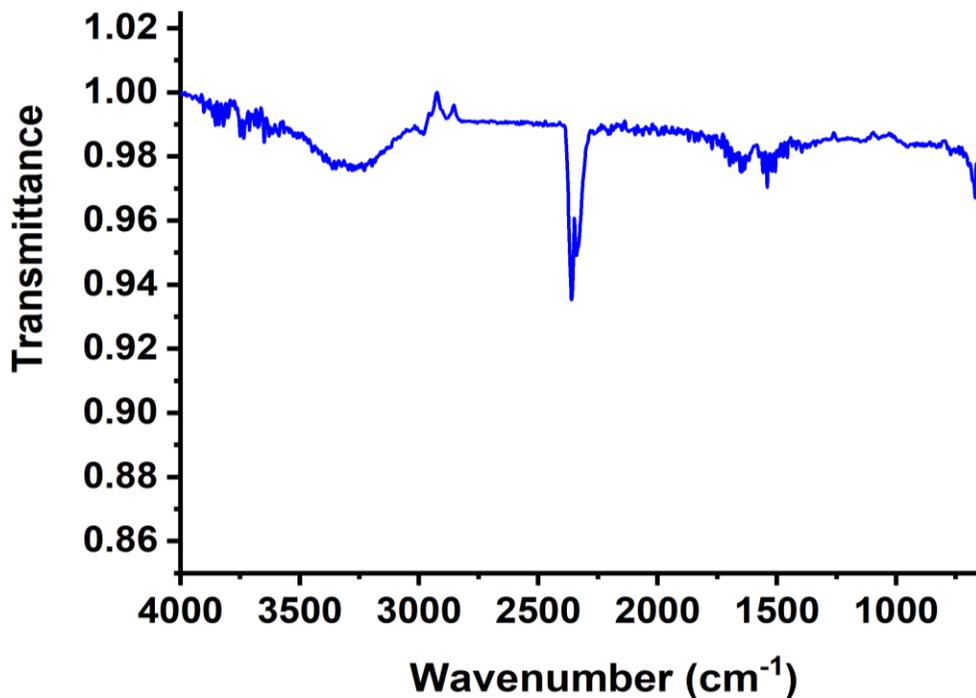


Figure 2B.24 IR Spectroscopic analysis for functional group determination of the sample collected (pre-concentrated through SPME) as composite sample of 20/07/2024 from R.O. (Permeate Tank).

UV-Vis Absorption Spectroscopy and Water Quality: UV-Vis absorption spectroscopy is a robust analytical method used to evaluate the quality of treated water after treatment. This technique measures how ultraviolet (UV) and visible (Vis) light is absorbed by chemical substances in the water, offering insights into the concentration of specific compounds. The method operates on the principle that molecules absorb light within the UV-Vis spectrum as electrons move from lower to higher energy levels. The specific patterns of light absorption are indicative of particular chemical bonds, enabling the identification and quantification of various substances in the water. UV-Vis spectroscopy is especially effective for detecting and quantifying organic compounds such as humic substances and dissolved organic matter, which can affect water quality. Absorption peaks in the UV range can reveal the presence of aromatic compounds, helping to evaluate how well the water treatment process removes these contaminants. Additionally, UV-Vis spectroscopy is useful for assessing water color and turbidity, as high absorbance in the visible spectrum may suggest the presence of particulate matter or colloidal substances.

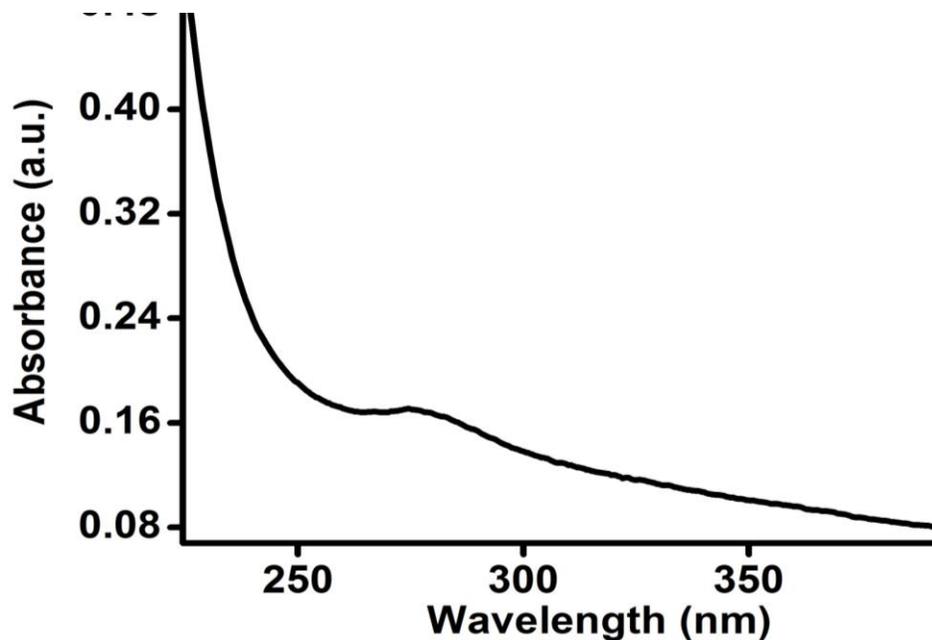


Figure 1B.25 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Morning of 10/06/24 from R.O. (Permeate Tank).

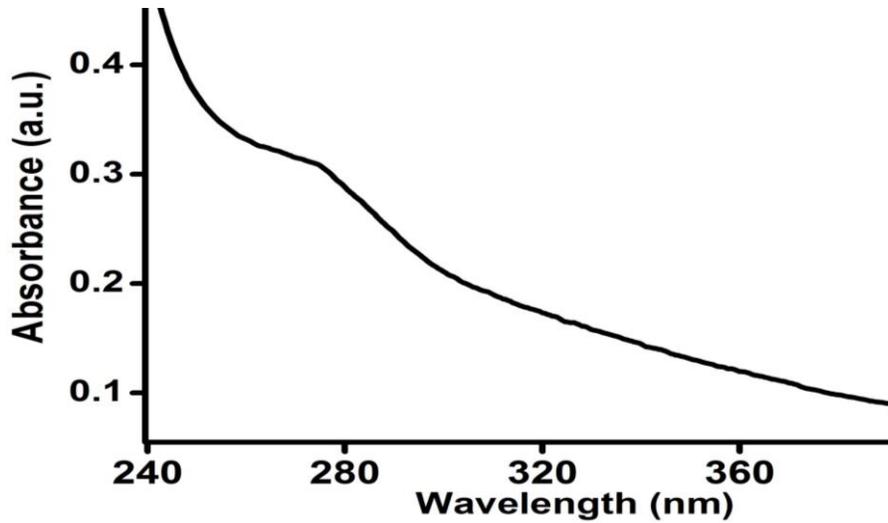


Figure 1B.26 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Afternoon of 10/06/24 from R.O. (Permeate Tank).

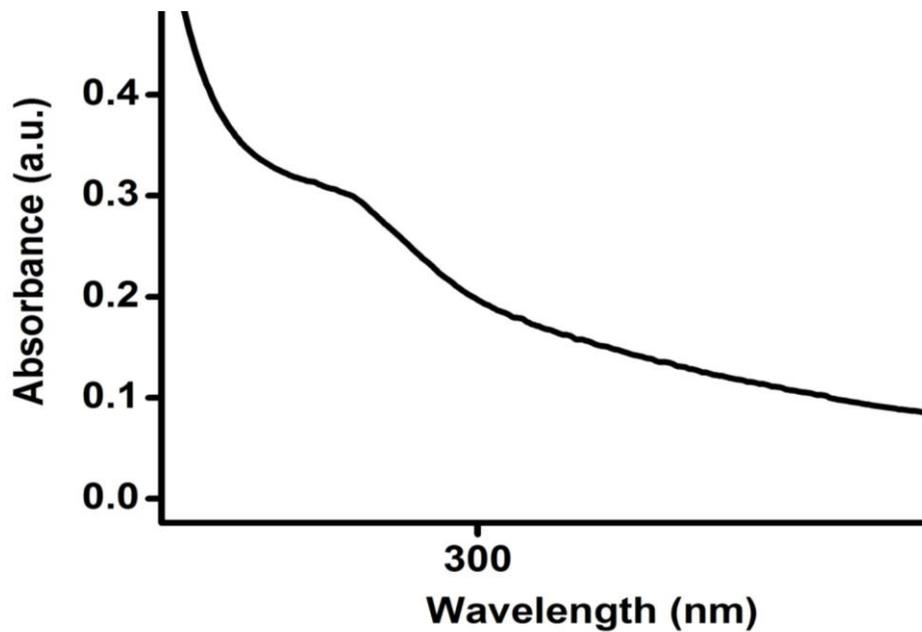


Figure 1B.27 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Evening of 10/06/24 from R.O. (Permeate Tank).

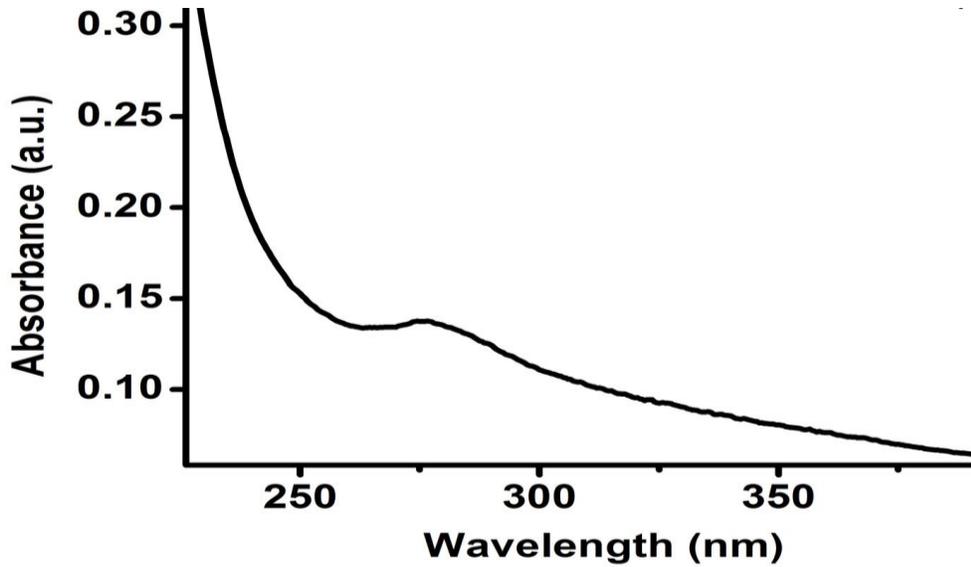


Figure 1B.28 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as composite sample of 10/06/24 from R.O. (Permeate Tank).

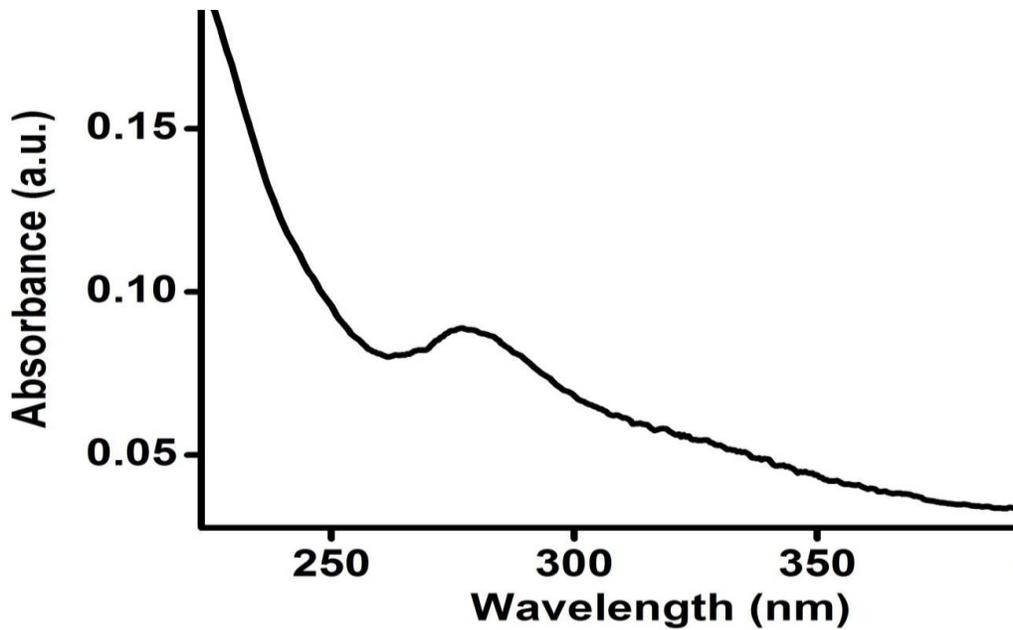


Figure 1B.29 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Morning of 20/07/24 from R.O. (Permeate Tank).

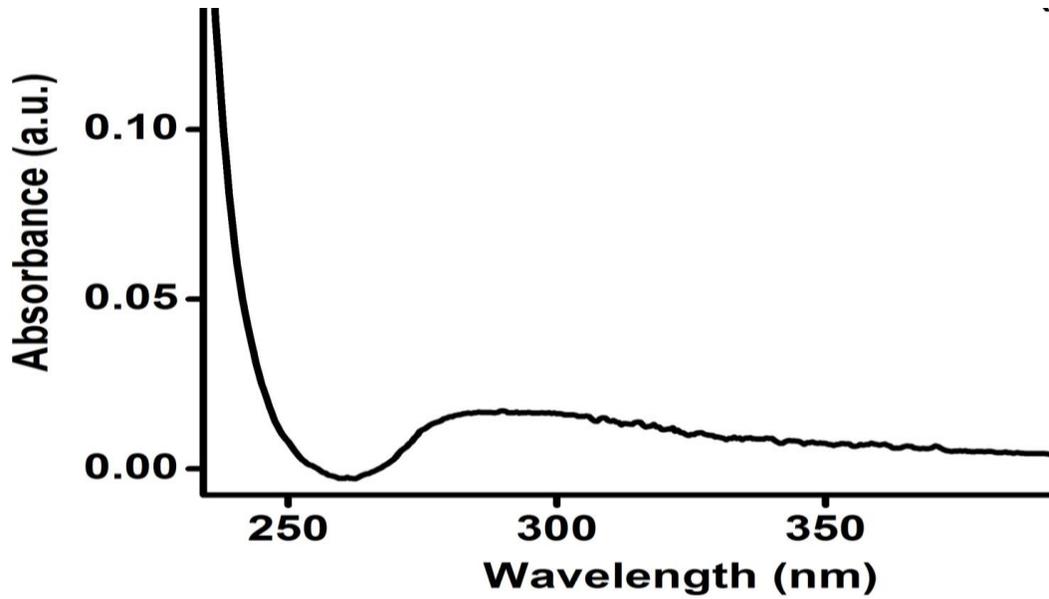


Figure 1B.30 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Afternoon of 20/07/24 from R.O. (Permeate Tank).

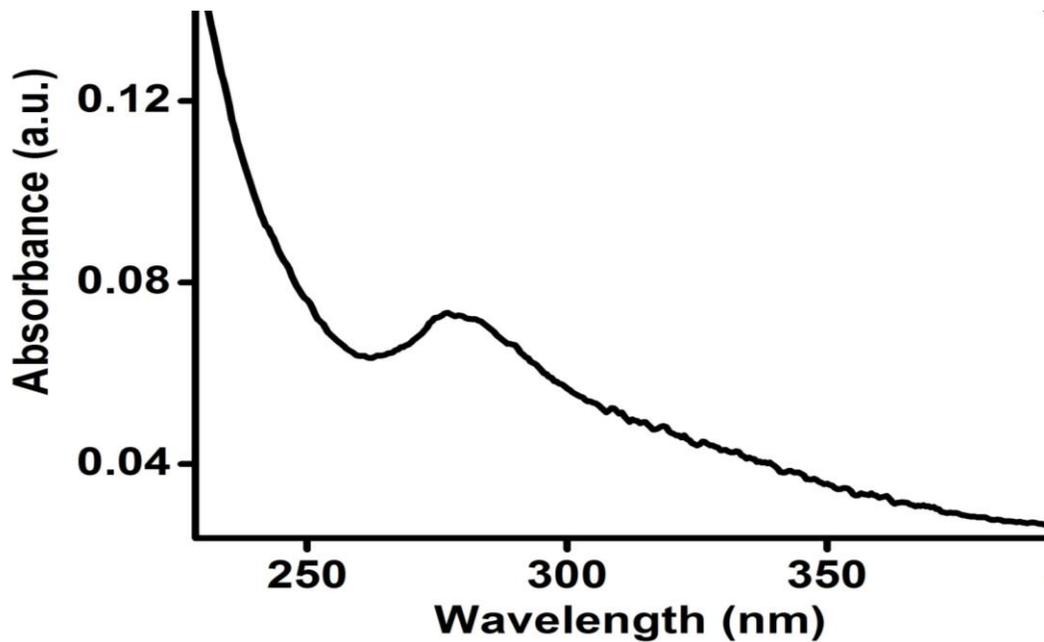


Figure 1B.31 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as grab sample of the Evening of 20/07/24 from R.O. (Permeate Tank).

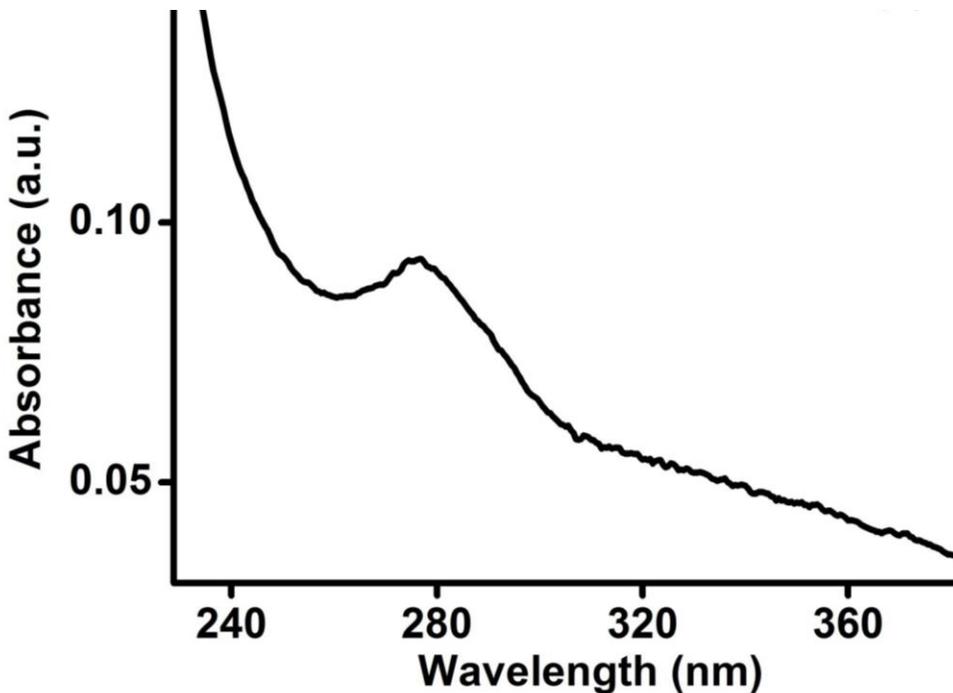


Figure 1B.32 UV-Vis Absorption Spectroscopic analysis (pre-concentrated through SPME) for the sample collected as composite sample of 20/07/24 from R.O. (Permeate Tank).

CONCLUSION

Morepen Laboratories Ltd., Masulkhana has embarked on a transformative journey towards sustainable development through strategic enhancements across its Effluent Treatment Plant (ETP). The comprehensive upgrades in pretreatment, Multi Effect Evaporator (MEE) optimization, Activated Sludge Process (ASP) improvements, and advanced Reverse Osmosis (RO) technology underscore their proactive stance in meeting stringent regulatory standards and preparing for future environmental challenges. The initial phase of sampling highlighted critical areas necessitating immediate attention to align with environmental norms. Collaborating with academic institutions like PU Chandigarh and IIT Ropar for further analysis provided invaluable insights that guided subsequent improvements. These efforts culminated in a robust framework aimed at achieving Zero Liquid Discharge (ZLD) and ensuring sustainable water management practices. Pretreatment initiatives, including the installation of a Primary Tube Settler (PST) and Screw Dewatering Machine, have significantly enhanced the removal of suspended solids and organic matter. This has been pivotal in stabilizing effluent flow rates and reducing Total Dissolved Solids (TDS) to below 200 mg/L, thus optimizing downstream

treatment processes and minimizing environmental impact. Optimizations in the MEE, such as advanced steam flow control and vacuum stabilization measures, have improved evaporation rates and energy efficiency. The separate cooling water systems for the ATFD and MEE condenser further underscore Morepen Laboratories Ltd mucommitment to minimizing resource consumption while maximizing operational efficiency. Enhancements in the ASP, marked by increased sampling frequency and the introduction of bioenzymes, have fostered robust microbial activity critical for organic pollutant degradation. This has resulted in treated water with BOD levels below 30 mg/L and COD levels below 240 mg/L, surpassing regulatory requirements and ensuring environmental compliance. The deployment of advanced RO technology, featuring precise pH control and optimized chemical dosing, has further bolstered water quality by reducing turbidity and effectively removing harmful contaminants. The recycling of RO permeate within the polisher unit not only conserves freshwater resources but also minimizes wastewater discharge, reinforcing Morepen Laboratories Ltd commitment to sustainable water management practices. These systematic upgrades not only align the ETP with current environmental standards but also fortify its resilience against future challenges. By adopting a holistic approach to wastewater treatment, Morepen Laboratories Ltd has not only safeguarded environmental health but also bolstered operational efficiency and sustainability across its facilities. Looking ahead, continual monitoring and adaptation will be crucial to maintaining these high standards and adapting to evolving regulatory requirements. Morepen Laboratories Ltd proactive stance and collaborative efforts with academic partners exemplify a commitment to innovation and responsible corporate citizenship in environmental stewardship. These efforts set a benchmark for industry peers, demonstrating that environmental sustainability and business success can go hand in hand.

In short, Morepen Laboratories Ltd., Masulkhana's ETP transformation stands as a testament to the power of strategic planning, technological innovation, and collaborative partnerships in achieving sustainable development goals. This journey highlights their operational excellence, and long-term corporate sustainability. As they continue to lead by example, they inspire others in the industry to prioritize environmental stewardship and embrace sustainable practices for a healthier future.

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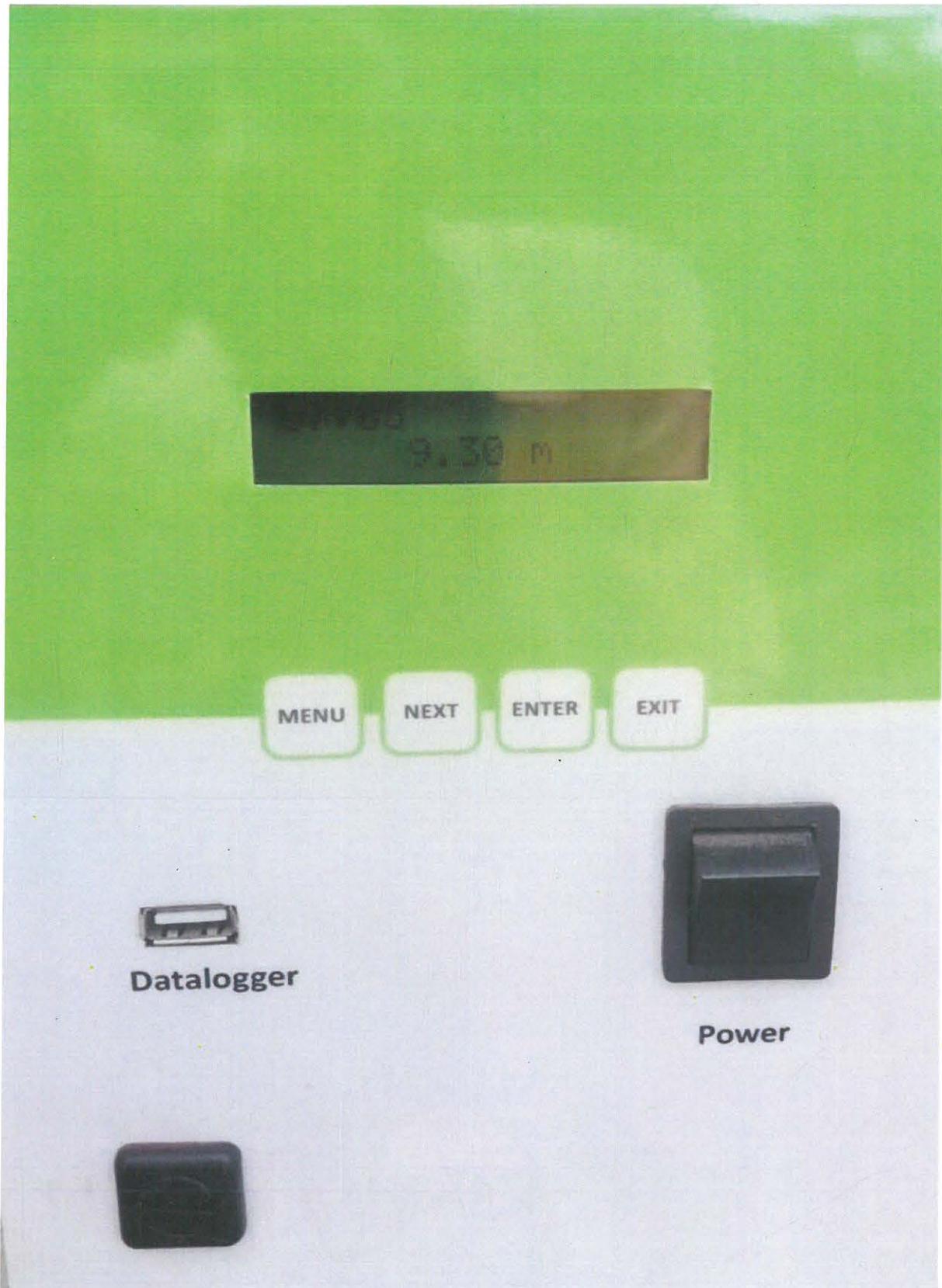
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-----END OF REPORT-----

Daily water level reading shown by Piezometer



MOREPEN LABORATORIES LIMITED

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DRAFT PURCHASE ORDER

PO No.	MSL/2024-25/5584
PO Date	18-07-24

Name	VIKING SOLUTIONS
Address	PLOT NO.24/8 INDUSTRIAL AREA, PHASE-2 CHANDIGARH-160002 ,CHANDIGARH
State	Chandigarh
Country	INDIA
Contact	

S- N o	Item Name	UOM	Qty	Price	HSN	Disco unt %	Discoun t Value	Taxable Value	SGST %	SGST Amt	CGST %	CGST Amt	IGST %	IGST Amt
1	LED TV TCL 65P8	Nos	1	56000	8528			56000.00	0	0	0	0	18	10080.00
2	Rack 4 U NVR BOX	Nos	1	2200	8473			2200.00	0	0	0	0	18	396.00
3	Camera Tiandy 5MP PTZ	Nos	1	37500	8525			37500.00	0	0	0	0	18	6750.00
4	NVR 64 CH HIKVISION 8664 MODEL (8 SATA) (Tiandy 4 ch NVR)	Nos	1	4500	8536			4500.00	0	0	0	0	18	810.00
5	Hard Disk 4 TB AV Segate	Nos	1	5000	8471			5000.00	0	0	0	0	18	900.00
6	CONVERTER LAN TO HDMI	Nos	2	2750	8536			5500.00	0	0	0	0	18	990.00
7	PVC PROTECTION BOX IT	Nos	1	900	8536			900.00	0	0	0	0	18	162.00
8	FIBER PATCH CARD	Nos	2	1400	8536			2800.00	0	0	0	0	18	504.00
9	D LINK PATCH CARD	Nos	2	170	8536			340.00	0	0	0	0	18	61.20
10	Installation & Commissioning Charges Material Required urgently for NGT Compliance Going Single Vendor	LOT	1	3500	9984			3500.00	0	0	0	0	18	630.00
Total										0		0		21283.20

	Transaction Value	118,240
	Less: Discount @ 0 %	0
	Other Charges	0
	Add : SGST	0
	Add: CGST	0
	Add: IGST	21283.20
	Total Amount :GST	21283.2
	Grand Total :	139523.20

Payment Terms	:IMMEDIATE
Delivery	:As per Schedule
Freight	:F.O.R.
Delivery Through	:BY ROAD
Special Instruction	:(Invoice,Transporter copy & Eway bill should be as per our PO Address)

Account Statement for Account Number 2912002100015175

Branch Details

Branch Name: PARWANOO
 Bank Address: BANK SQUARE
 SECTOR-I,PARWANOO
 City:
 Pin : 173220
 IFSC Code: PUNB0291200

Customer Details

Customer Name.: MOREPEN LABORATORIES LTD
 Customer Address: VILLAGE AND POST OFFICE MASULKHANNA
 TEHSIL KASALI DISTT SOLAN HP
 City:
 Pin : 173220

Nominee :

Statement Period : 09-07-2024 to 08-08-2024

Txn No.	Txn Date	Description	Branch Name	Cheque No.	Dr Amount	Cr Amount	Balance	KIMS Remarks
S52169756	08-08-2024	NEFT_OUT:PUNBS2 4221235077/ROCKW ELL AUTOMATION INDIA PV/BOFA0ND6216/2 4580010			59,000.00		0.00 Cr.	

Unless constituent notifies the bank immediately of any discrepancy found by him in his statement of Account, it will be taken that he has found the account correct.

*COMPUTER GENERATED ENTERIES SHOWN IN THE STATEMENT OF ACCOUNT DO NOT REQUIRE ANY AUTHENTICATION / INITIAL FROM THE BANK OFFICIAL.PLEASE DO NOT ACCEPT ANY MANUAL ENTRY IN YOUR COMPUTER GENERATED STATEMENT OF ACCOUNT

* PLEASE ENSURE THAT ALL THE CHEQUE LEAVES IN YOUR CUSTODY ARE DULY BRANDED WITH YOUR 16 DIGITS ACCOUNT NUMBER

* CUSTOMERS ARE REQUESTED IN THEIR OWN INTEREST NOT TO ISSUE CHEQUES WITHOUT ADEQUATE CLEAR FUNDS /ARRANGEMENTS. SUCH CHEQUES CAN BE RETURNED WITHOUT MAKING ANY FURTHER REFERENCE TO THEM.

* PLEASE MAINTAIN MINIMUM AVERAGE BALANCE,TO AVOID LEVY OF CHARGES.

*Pls note Penal interest may be charged in loan accounts due to financial reasons such as over drawings, non receipt of install on the rates prescribed by bank from time to time and for non financial reasons like non submission of , QMS forms, non adherence to terms and conditions etc.

Abbreviations are as under:

BR: Branch Name , Csh: Cash , Clg: Clearing , ISO: Inter Sol(##)

QAB:Quarterly Average Balances , LF Chg: Ledger Folio Charges , Intt: Interest , Chrg: Charges

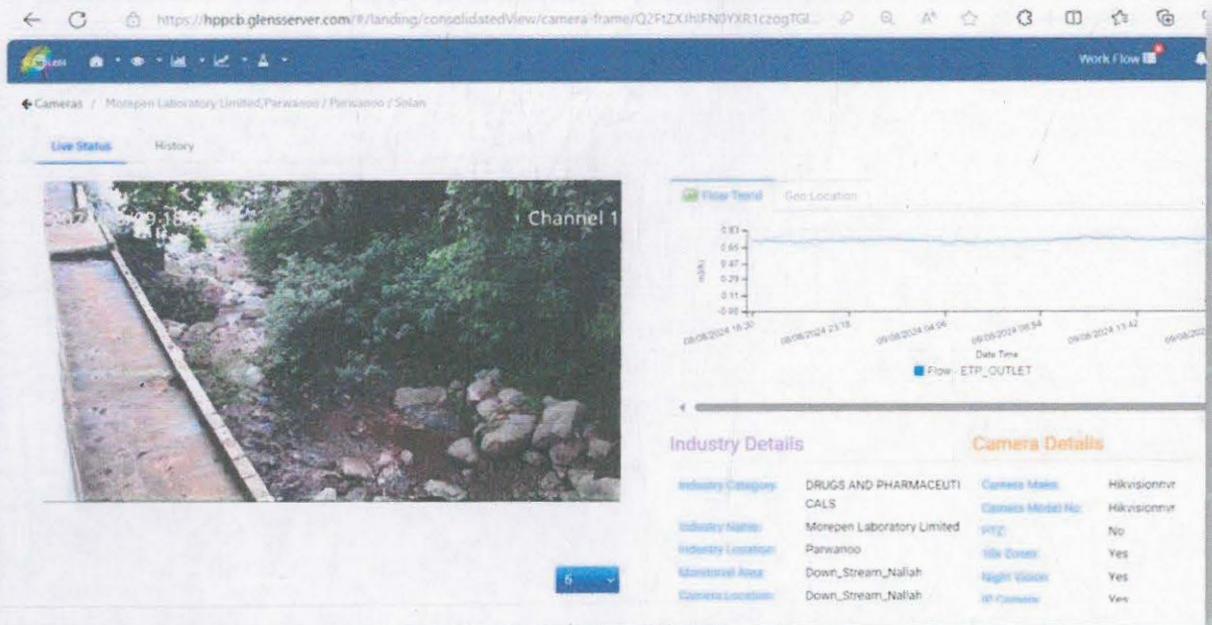
Ret:Returning , Chq: Cheque , SI: Standing Instruction , Stk Stmt: Stock Statement , Trf: Transfer , POSP:POINT OF SALE

Dear Devender Ji,

I am pleased to inform you that we have successfully completed all the activities related to PO Number 5001/2024-25.

As a token of completion, could you please review and provide your sign-off on the attached work completion certificate?

Thank you for your support and cooperation.



Bhushan Jadhav
 Rockwell Automation Bangalore
 P +91 9021726915



Date :- 09th Aug 2024

WORK COMPLETION CERTIFICATE

This is to certify that the camera connectivity associated with PO Number: 5001 / 2024-25, has been completed for Morepen Laboratories Limited, Parwanoo

Scope of Work

Project Milestones

1. Knowledge lens team has successfully completed - IP Camera Data Transmission – to CPCB & HPPCB
2. IP Camera Remote configuration is completed successfully
3. Below are the login credentials:-

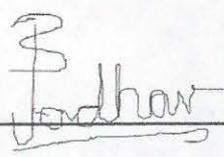
HPPCB

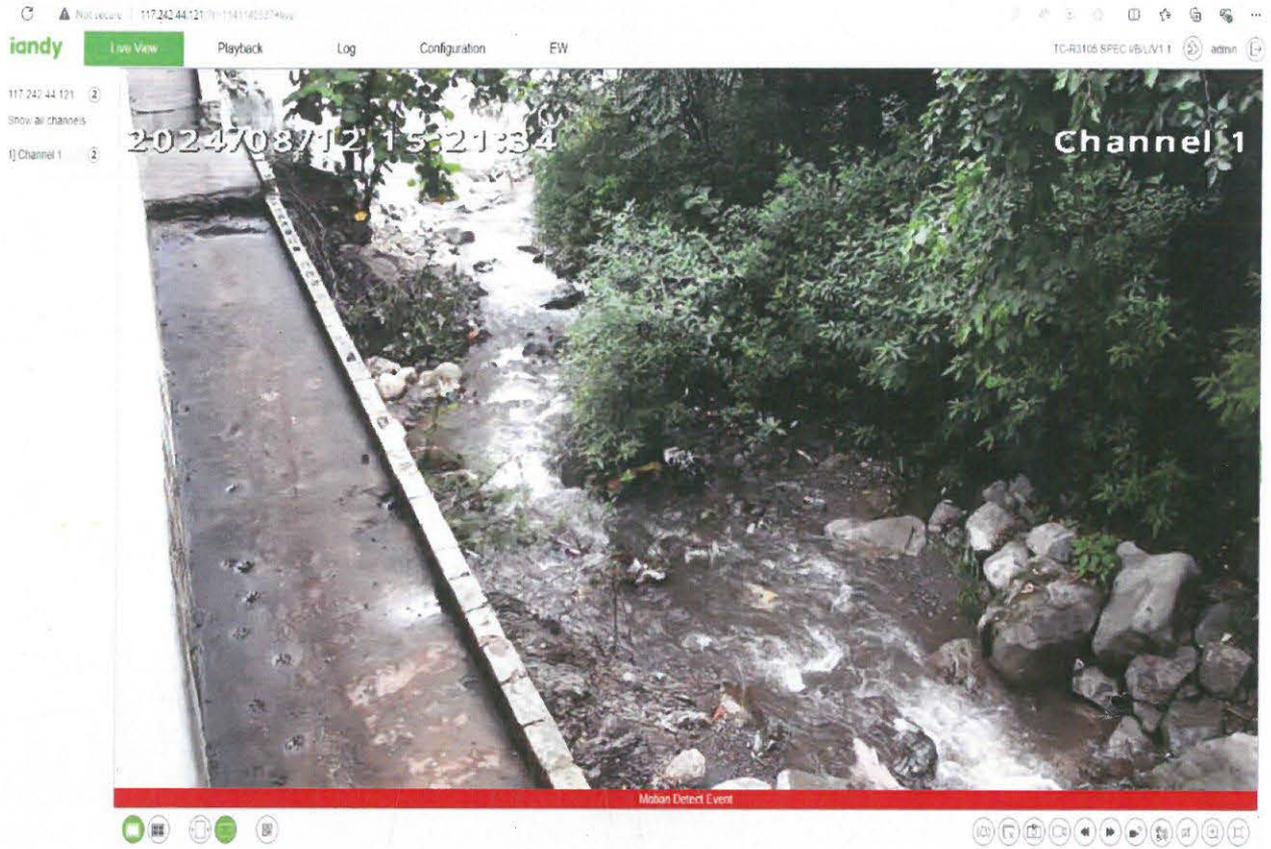
URL	Username	Password
hppcb.glensserver.com	MLLD	Mlld@123

TRIAL:

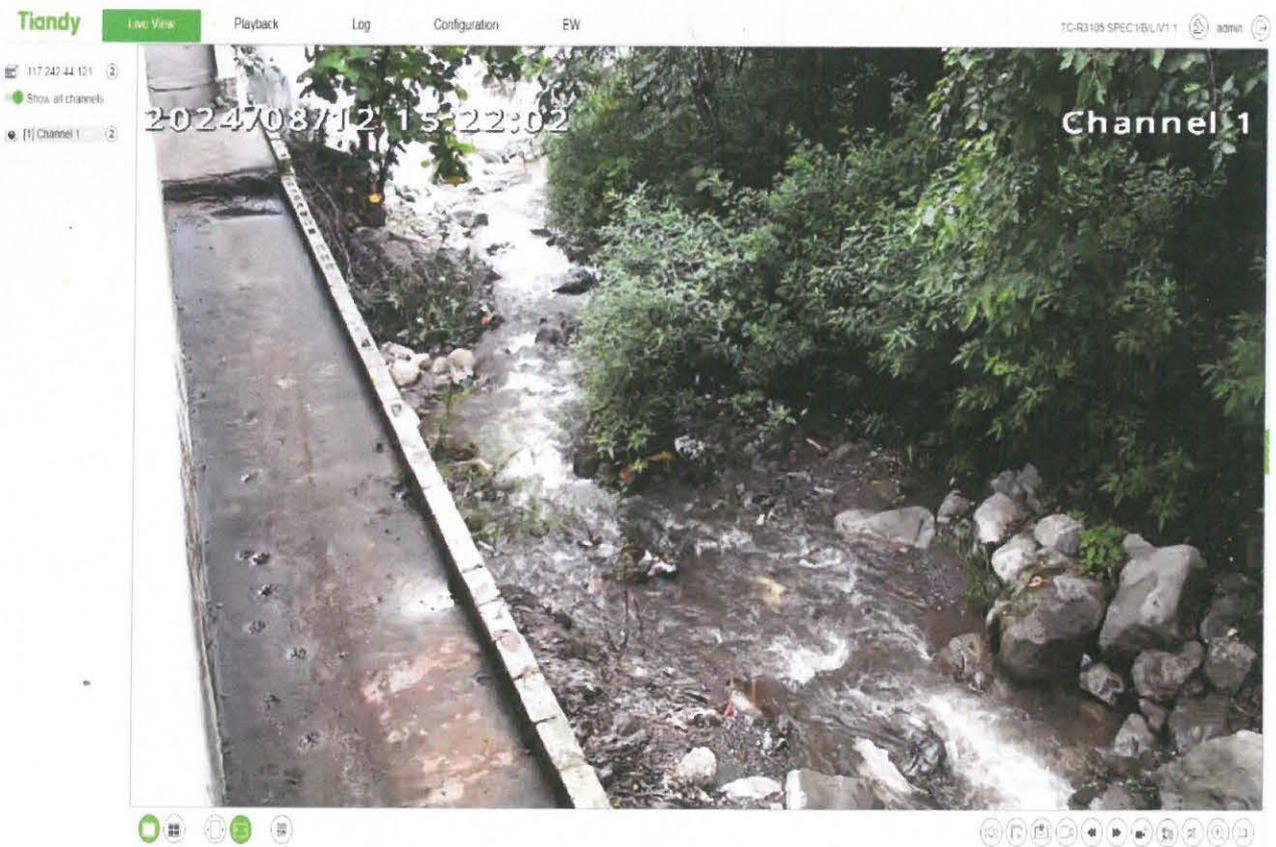
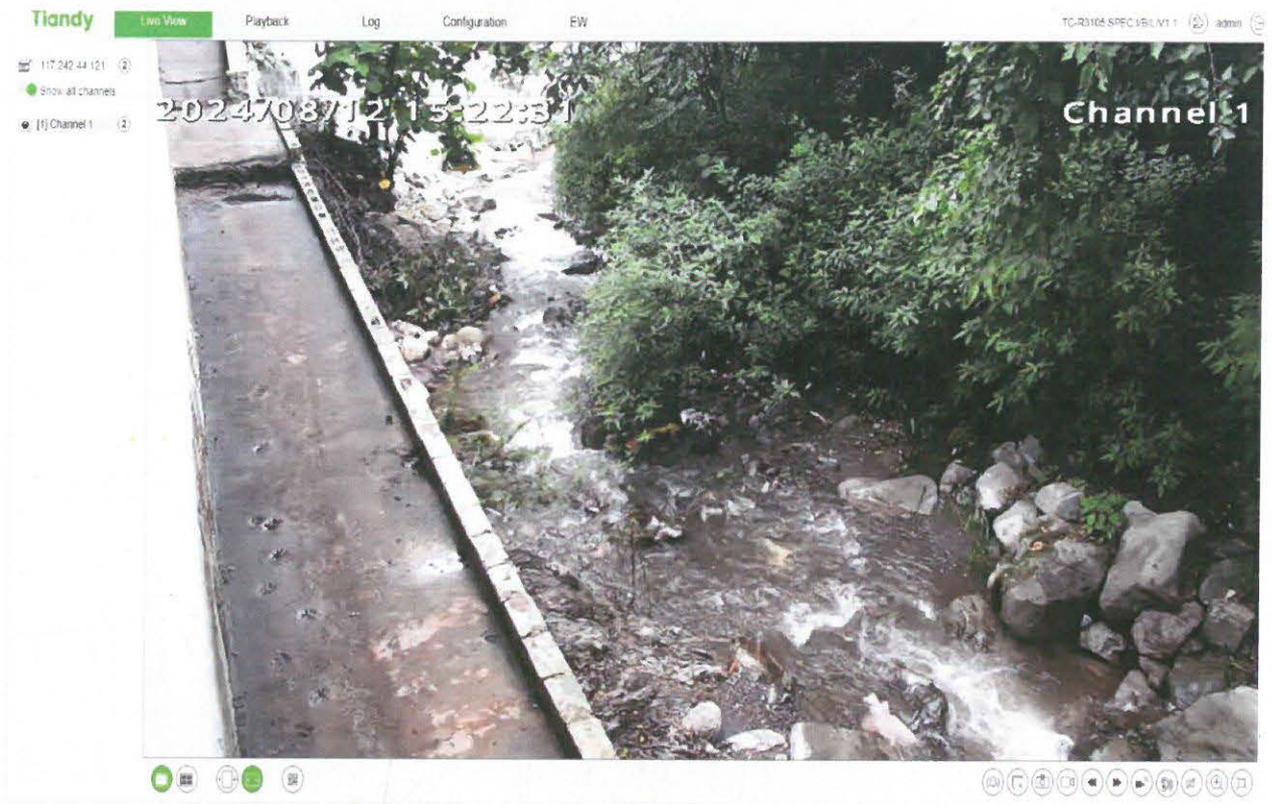
URL	Username	Password
trial.glensserver.com	MOLL	Moll@32

Signature

Morepen Laboratories Limited, Parwanoo		Knowledge Lens Private Limited Rockwell Automation	
Name	Signature	Name	Signature
		Bhushan Jadhav	



Live CCTV footages of 360° night vision camera at Masulkhana Plant:

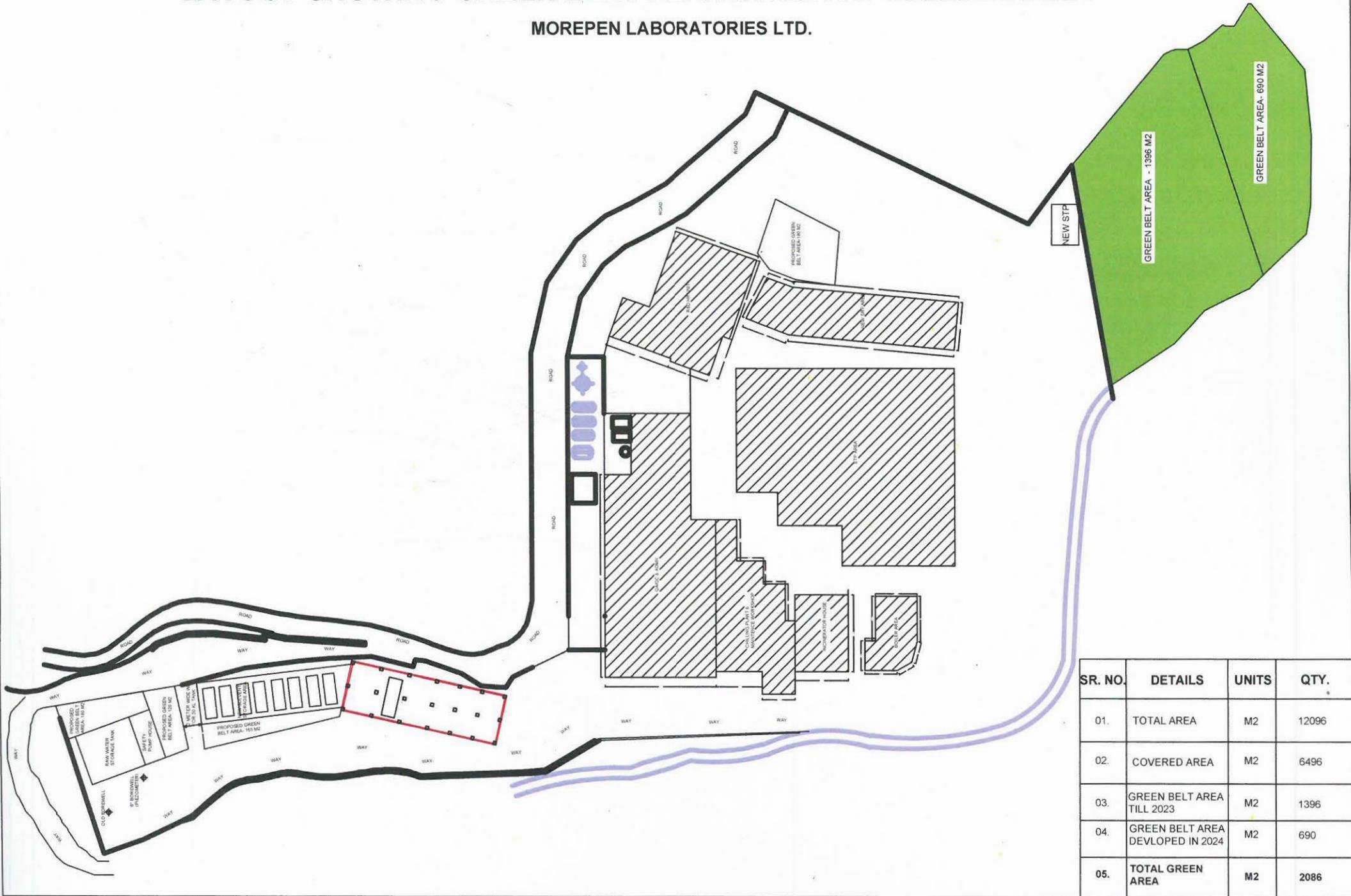


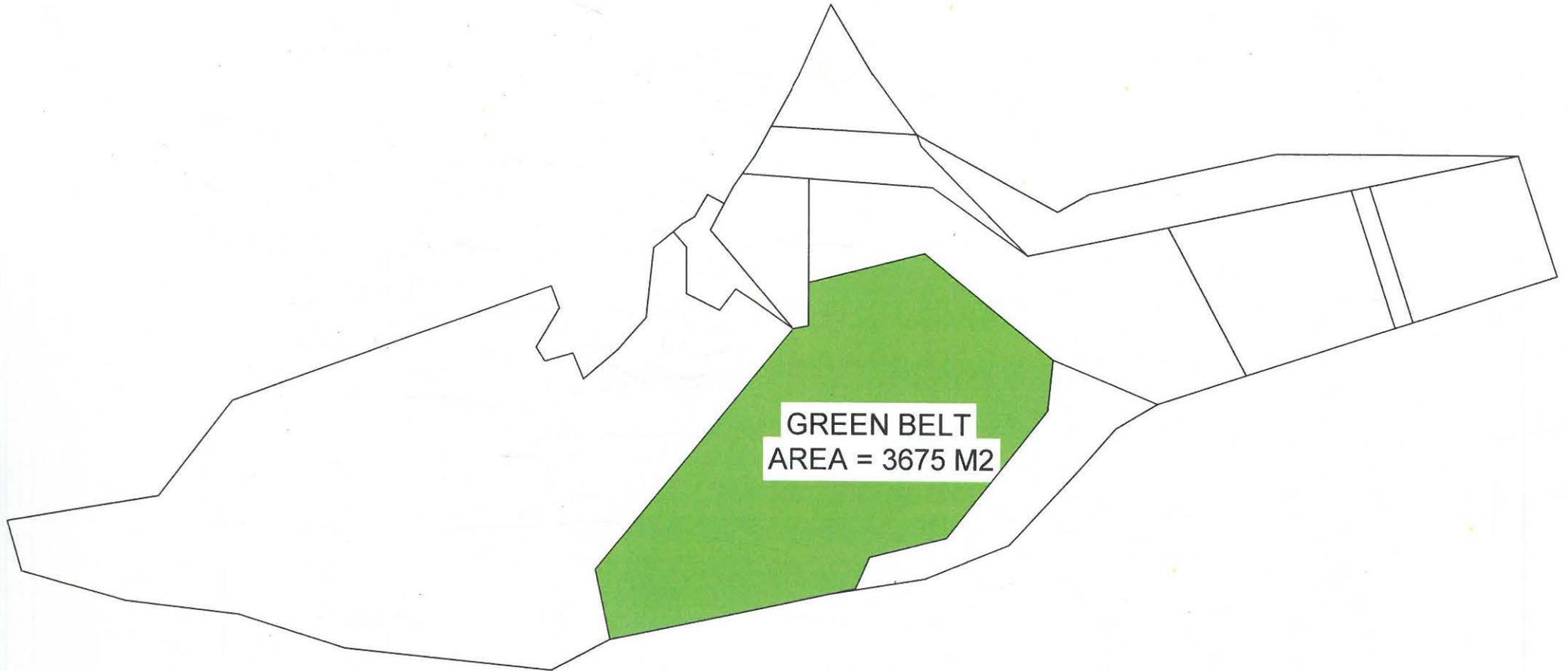
1738

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LAYOUT SHOWING GREEN BELT PLANTATION AT MASULKHANA

MOREPEN LABORATORIES LTD.



GREEN BELT PLANTATION AT NARYAL

**MOREPEN LABORATORIES LIMITED
VILLAGE & V.P.O. MASULKHANA,
PARWANOO, DISTT. SOLAN(H.P.)
INDIA 173220**

1740

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MOREPEN LABORATORIES LIMITED

Village & PO Masulkhana, Parwanoo, Distt. Solan
Himachal Pradesh, 173220, Contact No. : 01792-233283-88
DL No.: MB/93/6, MB/93/6

GSTIN No.: 02AABCM1083B1ZA

PAN No.: AABCM1083B

PURCHASE ORDER

Department : Consumables Stores

Vendor Detail		Billing Address	
Name :	HIMACHAL NURSERY	PO No :	MSL/2024-25/5615
Address :	Opposite Indage Rubber, Village Jhiriwala PO. Reru, Teh. Nalagarh Distt. Solan HP-174101, NALAGARH	PO Date :	25-07-24
State :	Himachal Pradesh	Billing Add:	MOREPEN LABORATORIES LIMITED, Village & PO Masulkhana, Parwanoo,, Distt. Solan, Himachal Pradesh - 173220
Country :	INDIA	Contact No. :	01792-233283-88
Contact :	, 9816409045, 7018140714		
GSTIN :	02AEZPV1585L2ZL		
PAN No. :	AEZPV1585L		
Email :		State Code :	02

S- N o	Item Name	UOM	Qty	Price	HSN	Disco unt %	Discoun t Value	Taxable Value	SGST %	SGST Amt	CGST %	CGST Amt	IGST %	IGST Amt
1	PLANTS Mahogani 5-6 Feet	Nos	300	130	0602			39000.00	0	0	0	0	0	0
2	PLANTS Ficus 3-4 Feet HT.	Nos	100	80	0602			8000.00	0	0	0	0	0	0
3	PLANTS Kaner 2-3 Feet HT.	Nos	80	50	0602			4000.00	0	0	0	0	0	0
4	PLANTS Champa 3-4 Feet HT.	Nos	40	130	0602			5200.00	0	0	0	0	0	0
5	PLANTS Toon 4-5 Feet HT.	Nos	20	50	0602			1000.00	0	0	0	0	0	0
Total												0	0	0

											Transaction Value	57,200
											Less: Discount @ 0 %	0
											Other Charges	0
											Add : SGST	0
											Add: CGST	0
											Add: IGST	0
											Total Amount :GST	0
											Grand Total :	57200.00

Payment Terms : 30 DAYS

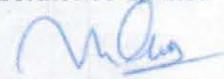
Delivery : As per Schedule

Freight : F.O.R.

Delivery Through : BY ROAD

Special Instruction : (Invoice, Transporter copy & Eway bill should be as per our PO Address)

Morepen Laboratories Limited


 Authorised Signatory

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MOREPEN LABORATORIES LIMITED

Village & PO Masulkhana, Parwanoo, Distt. Solan
Himachal Pradesh, 173220, Contact No. : 01792-233283-88
DL No.: MB/93/6, MB/93/6

GSTIN No.: 02AABCM1083B1ZA

PAN No.: AABCM1083B

PURCHASE ORDER		Department : Consumables Stores	
Vendor Detail		Billing Address	
Name :	HIMACHAL NURSERY	PO No :	MSL/2024-25/5615
Address :	Opposite Indage Rubber, Village Jhiriwala PO. Reru, Teh. Nalagarh Distt. Solan HP-174101, NALAGARH	PO Date :	25-07-24
State :	Himachal Pradesh	Billing Add:	MOREPEN LABORATORIES LIMITED, Village & PO Masulkhana, Parwanoo,, Distt. Solan, Himachal Pradesh - 173220
Country :	INDIA	Contact No. :	01792-233283-88
Contact :	9816409045,7018140714		
GSTIN :	02AEZPV1585L2ZL		
PAN No. :	AEZPV1585L		
Email :		State Code :	02

TERMS AND CONDITIONS OF PURCHASE

- ACCEPTANCE** : If no formal acceptance received within 10 days from date of order, the same shall be deemed accepted.
- SPECIFICATION** : Specifications stipulated must be adhered to otherwise we reserve the right to cancel whole/ part order.
- INSPECTION** : Company will not be liable for non performance, either in whole or in part of any contract, or any delay in performance there of, as a consequence of occurrences beyond the control of the company.
- VALIDITY** : Delivery must be as per given schedule. Failing which, we reserve the right to cancel order, whole/part. We shall be compensated for losses for non compliance of order. Our assessment of losses shall be final.
- INVOICE** : All invoices shall be made as per prevailing Central Excise rules so that MODVAT can be availed of.
- FORCE MAJURE** : Company will not be liable for non performance, either in whole or in part of any contract, or any delay in performance there of, as a consequence of occurrences beyond the control of the company.
- JURISDICTION** : All disputes arising out of this contract shall lie within the Solan Jurisdiction only.
- Do not charge TCS on your invoices, We will deduct TDS as per section 194 Q, if applicable on you

Images showing completion of Reservoir of 20KL capacity:



Aerial view of Reservoir-20KL Storage Capacity



Reservoir of 20KL Storage Capacity

