Environmental Audit Report
(2023-2024)

TRIPURA UNIVERSITY
(A Central University)
SURYAMANINAGAR – 799022, TRIPURA, INDIA

प्रो. गंगा प्रसाद प्रसाईं
कुलपति

Prof. Ganga Prasad Prasain
Vice-Chancellor

त्रिपुरा विश्वविद्यालय
(केन्द्रीय विश्वविद्यालय)
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Suryamaninagar-799022, Tripura, India

No.F.TU/VCS/MISC/01/2022

Foreword from Vice Chancellor

It is with immense pride and responsibility that I introduce the Green/Energy/Environmental Audit Report 2023-24, which mark a transformative step in our institution's commitment to sustainability. This reports represent a comprehensive evaluation of our practices, reflecting our dedication to fostering an environmentally conscious campus and paving the way for a more sustainable future.

In today's world, where global challenges demand collective action, the report embody our commitment to transparency, accountability, and innovation. It serve as a testament to our institution's unwavering efforts to align with sustainability principles, emphasizing the critical role of awareness, knowledge, and collective responsibility in driving meaningful change.

The Green/Energy/Environmental Audit Report 2023-24 is the result of the meticulous efforts of our audit committees, which comprises of researchers/sustainability experts, and campus managers. Through their diligent assessments, this report provides a holistic view of our ecological footprint, evaluating our energy efficiency, waste management, water usage, and overall environmental impact. The report highlight our strengths while identifying opportunities for improvement, enabling us to take informed and impactful steps forward.

As we present this report to our stakeholders, it is with a renewed sense of optimism and determination. We recognize that the choices we make today are vital for securing a sustainable future for the generations to come. The findings outlined in this report challenge us to rethink traditional practices, adopt innovative solutions, and integrate eco-consciousness into every facet of our institution's operations.

I extend my heartfelt gratitude to every individual who has contributed to this audit report. Your dedication to advancing sustainability reflects the collaborative spirit and shared purpose that define our institution.

May this report serve as a compass, guiding us toward more sustainable practices, fostering a culture of environmental awareness, and inspiring collective action. Let us seize this opportunity to champion sustainability, confident that every step we take today will reverberate positively in the years to come.

Together, we embark on this journey toward a greener, cleaner, and more sustainable future, driven by the profound understanding that nurturing our environment is integral to nurturing ourselves.

With gratitude and determination,

(Prof. Ganga Prasad Prasain)

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that the Environmental Audit Report 2023-24 of Tripura University is an original internal audit work conducted by the Environmental Audit Committee to monitor the environmental management practices adopted in the University which is in line with the terms of the International Standards of Internal Auditing.

After going through the report, it is obvious that adequate and appropriate audit procedures were followed for the Environmental Quality Audit, Water Audit, and Waste Disposal Audit, and the gathered evidence supports the conclusions reached and contained in this report.

The suggestions and recommendations prescribed and the conclusions derived are quite genuine and within the achievable limits, and I understand that Tripura University is competent to fulfill those to meet the Sustainable Development Goals.

I recommend and firmly believe that this report meets the requirements prescribed for the development of a Green Campus.

22/1/25

Prof. Nalin B. Dev Choudhury
Dean (Research & Consultancy)
Professor, Electrical Engineering Department
NIT Silchar, Assam 788010

Acknowledgement

In keeping with our unwavering commitment to environmental stewardship and sustainability, Tripura University continues to spearhead impactful initiatives, including environmental campaigns, workshops, and extension programs, aimed at fostering societal transformation at both national and global levels. Our primary objective is to ensure a sustainable future for our institution while safeguarding the pristine ecosystem of our campus. This commitment reflects our vision of leaving a lasting legacy for future generations of students and residents.

This comprehensive report, covering the academic year 2023-24, marks the fifth formal effort to systematically document the results of our investigations and to provide a thorough analysis of all relevant aspects of the Environmental Audit process. In alignment with the climate neutrality objectives set forth by the Government of India, Tripura University aims to serve as a catalyst in mitigating the global ecological crisis. To this end, we have adopted a holistic approach that includes forming an Environmental Audit Committee comprising faculty members with specialized expertise in environmental sustainability. The committee has diligently gathered essential environmental data and implemented on-site solutions to address pressing environmental challenges on campus.

The primary mission of the Environmental Audit Committee is to identify existing and emerging environmental issues by conducting a meticulous evaluation of the University's environmental management practices and their impacts. This report is the result of a collaborative effort by the dedicated members of the Tripura University Environmental Audit Committee and its stakeholders. Through rigorous assessments of key environmental parameters, complemented by comprehensive data collection and analysis, the committee has pinpointed immediate threats to the campus environment. The recommendations and suggestions outlined in this report are aimed at laying a solid foundation for the ongoing improvement of our environmental standards.

This report also emphasizes the vital importance of stakeholder engagement. By fostering a bottom-up approach, we aim to unite the University community in addressing environmental challenges. This collaborative effort will drive meaningful action and nurture a lasting culture of environmental responsibility.

We extend our profound gratitude to Prof. Ganga Prasad Prasain, Hon'ble Vice Chancellor of Tripura University, for his visionary leadership and unwavering support throughout the course of this study. His encouragement and administrative backing have been a guiding light in this endeavor. We also express our appreciation to the teaching and non-teaching staff, Deans, and Heads of Departments, whose invaluable cooperation has been integral in collecting data for this report.

Special acknowledgment is due to the Tripura State Pollution Control Board (TSPCB) for their technical expertise and assistance in providing critical campus data.

We are deeply grateful to Prof. Nalin Behari Dev Choudhury from the Department of Electrical Engineering at NIT Silchar, who served as the External Expert for the Environmental Audit 2023-24. His expertise, insights, and dedication have significantly enriched the findings and quality of this report.

Our heartfelt thanks are extended to all members of the Environmental Audit Committee, whose tireless efforts and commitment have been instrumental in compiling this report. In particular, we commend Dr. Thiru Selvan, Convener of the Environmental Audit Committee, for his exceptional leadership and dedication to this initiative. Thanks are also due to the contribution of Ms. Lumgailu Panmei, Ph. D Scholar, Department of Forestry and Biodiversity in compiling the results of the Questionnaire Survey.

We firmly believe that the collective efforts outlined in this report will greatly benefit Tripura University. It is our earnest hope that the management plan and recommendations will be embraced by all stakeholders, fostering a sense of shared responsibility in reducing the environmental footprint of our university. Together, we can create a more sustainable and environmentally conscious future for Tripura University in the academic year 2023-24 and beyond.

Prof. Badal K Datta
Chairman

Tripura University Environment Audit Committee
2023-2024

Chairman

Prof. B. K. Datta, Dean, Faculty of Science, Tripura University

Members

Dr. S.S. Singh, Dept. of Zoology, Tripura University
Mr. N. Tripura, Electrical Engineer, Tripura University
Mr. Rajesh Banik, Civil Engineer, Tripura University
Mr. Krishna Das, Executive Engineer, Tripura University

External Expert

Prof. Nalin Behari Dev Choudhury, Department of Electrical Engineering, NIT, Silchar.

Convener

Dr. Thiru Selvan, Dept. Forestry and Biodiversity, Tripura University

CONTENT

Introduction

The growing urgency of environmental challenges and the increasing need for sustainable practices have made the conduct of environmental audits more crucial than ever. This Environmental Audit Report for the academic year 2023-24 provides a comprehensive evaluation of the environmental dimensions, operational methodologies, and potential avenues for improvement at Tripura University. With a primary focus on enhancing environmental efficiency, reducing operational costs, and minimizing the university's ecological footprint, this report represents a detailed scrutiny of the university's current environmental practices.

As the world accelerates toward sustainability, institutions are increasingly recognizing the integral role of environmental responsibility in achieving both economic and ecological objectives. This Environmental Audit Report serves as an essential tool in identifying conservation opportunities, prioritizing corrective actions, and crafting a strategic framework for implementing eco-friendly practices at Tripura University. By providing an in-depth overview of the existing environmental landscape and operational practices, the report equips the university with actionable insights to make informed, effective decisions for long-term sustainability.

The analysis contained within this report is the result of a collective effort between the university's Environmental Audit Committee and various campus departments. Their invaluable contributions, along with access to key data, were instrumental in conducting a thorough assessment. The audit involved a combination of on-site evaluations and data collection, enabling a comprehensive understanding of resource usage and areas where improvements can be made.

The report is structured to provide a clear depiction of the university's current environmental scenario, followed by a detailed exploration of potential conservation measures tailored to the specific needs and goals of Tripura University. These insights are designed to guide Tripura University in making sustainable decisions that align with its operational goals, thereby improving its environmental performance.

The insights offered in this report pave the way for a future defined by sustainability and ecological efficiency. By embracing these recommendations, Tripura University can take significant steps toward reducing resource waste, optimizing resource allocation, and contributing to a greener and more prosperous future. The report serves as a guide for achieving measurable improvements in the university's environmental impact, supporting both economic viability and environmental stewardship.

In addition to the direct environmental benefits, it is important to highlight that environmental auditing is aligned with Criterion 7 of the NAAC (National Assessment and Accreditation Council) accreditation process. This criterion focuses on environmental sustainability and operational efficiency, underscoring the university's commitment to holistic excellence. By conducting this environmental audit, Tripura University demonstrates its dedication to integrating environmental responsibility into its academic and operational strategies, which plays a key role in enhancing its NAAC accreditation standing.

The Environmental Audit Report for 2023-24 is a vital step in Tripura University's ongoing journey toward sustainability and operational excellence. Through careful assessment and strategic planning, the university can continue to refine its environmental practices, reduce its

ecological footprint, and promote a sustainable future. This audit serves not only as an important document for internal improvement but also as a testament to the university's commitment to environmental responsibility and global sustainability.

About Tripura University

Tripura University (a central university), established as a State University on October 2nd, 1987, with the enactment of the Tripura University Act in the Tripura Assembly, in deference to the long-cherished aspirations of the people of the state emerged from the renowned Calcutta University starting from the Starting from a modest P.G. Centre of Calcutta University (CUPGC) in 1976. Situated in the North Eastern region of India, the university has been committed to achieving academic excellence by offering quality teaching, learning and cutting-edge research experiences in different disciplines of Arts, Commerce, Humanities, Management, Science and Technology. The campus is nestled in a lush, semi-urban expanse of 75 acres along the National Highway at Suryamaninagar (23°45′40″N; 91°15′58″E), approximately 9 kilometers south of Agartala, the capital city.

Designated as one of the 56 Central Universities in India, Tripura University was founded on July 2nd, 2007, through a parliamentary act with the purpose of establishing a teaching and affiliating institution in the state. With Memorandum of Understandings with several National and International Institutions and numerous patents to its credit, this University, notwithstanding its geographical remoteness and other communicational disadvantages in the past, has always tried to compete with other universities of the country in terms of academic accomplishments, research breakthroughs, innovation and placement records, which have been aptly reflected in its NAAC Assessments and NIRF rankings. Notably, the university has made significant strides, enhancing its infrastructure and academic landscape.

Presently, the university offers diverse programs through its Science, Literature, Social Sciences, Commerce, Law, Management and Information Science Faculty. Its academic portfolio comprises a total of 65 programs, encompassing Undergraduate, Postgraduate, Doctoral, and other Postgraduate Programs. Additionally, the university provides Ph.D. programs in 41 subjects. With an annual enrollment exceeding about 1500 students, the campus serves as a hub of education and exploration. Moreover, Tripura University fosters pioneering research initiatives spanning various fields.

The university boasts 44 well-equipped departments, seven centres and one school, each furnished with state-of-the-art classrooms, laboratories, continuous internet access, a computer center, library, free Wi-Fi campus-wide, sports facilities, an open-air theater, health services, banking amenities, a cafeteria, post office, food court, hostels, and a guest house. Its esteemed faculty is not only dynamic but also compassionate and approachable. Alongside regular academic sessions, the university promotes a variety of sports and socio-cultural activities, including film screenings, musical performances, art festivals, debates, university fairs, sports tournaments, and wellness walks.

Set against a backdrop of scenic beauty, the campus encompasses lakes, woodlands, hills, flower gardens, and fruit orchards, creating a tranquil environment. The abundance of trees, the fragrance of flora, the chorus of birds, fluttering butterflies, and local wildlife collectively provide a refreshing contrast to academic demands, nurturing and rejuvenating the minds of its student community.

Environmental Audit at Tripura University

In line with the global emphasis on sustainable development and responsible economic growth, Tripura University is deeply committed to enhancing both academic and environmental outcomes. Recognizing the importance of human capital in driving national prosperity, the university aligns its educational mission with India's broader economic goals, while also addressing the environmental challenges that accompany growth. As we continue to grow and expand our academic and research endeavours, we are increasingly mindful of our ecological footprint and the need for sustainable practices across campus.

As Tripura University advances in its research and educational pursuits, energy consumption and environmental impact are becoming more prominent considerations. The university is keenly aware of the need to balance growth with sustainable resource management. Guided by the vision of the Government of India and the direction set by the Honourable Prime Minister, Shri Narendra Modi, Tripura University strives to integrate sustainability into every aspect of its operations. This commitment is further reinforced by the University Grants Commission's (UGC) Criterion VII, which mandates environmental consciousness as a key metric for assessing educational institutions.

Tripura University has made significant strides in fostering environmental responsibility, and environmental auditing plays a critical role in this journey. Environmental audits are a vital tool for identifying inefficiencies, tracking resource consumption patterns, and uncovering opportunities for sustainable practices. This ongoing process helps the university improve its operational efficiency, reduce waste, and ensure that the impact of its activities on the environment is minimized.

In line with national policies on sustainability, Tripura University is committed to ensuring that its academic, research, and campus operations adhere to eco-friendly practices. The Environmental Audit Committee is central to this effort, overseeing the evaluation of all practices related to resource utilization, waste management, energy consumption, and environmental conservation. By adopting and promoting sustainable practices, the university aims to reduce its carbon footprint and set a positive example for other educational institutions.

As Tripura University continues to grow, our focus remains on responsible resource management and sustainable development. Through environmental audits, continuous improvements, and a commitment to green practices, the university is contributing to India's broader goals of ecological sustainability and long-term prosperity. This approach not only enhances the university's environmental efficiency but also helps ensure that future generations benefit from a greener, more sustainable campus.

Objectives of the Tripura University Environmental Audit

As part of its ongoing commitment to sustainability, Tripura University aims to conduct a thorough environmental audit that evaluates the university's sustainable practices across administrative, academic, and research domains. This audit will highlight areas of strength while identifying opportunities for improvement through a detailed gap analysis. Based on these findings, actionable strategies will be developed to further enhance the university's sustainability goals and ensure the effective use of resources across campus.

Fostering Environmental Awareness: At Tripura University, we are dedicated to

cultivating a culture of environmental awareness throughout our community. We actively engage all stakeholders—students, faculty, staff, and administration—in fostering responsible and efficient resource utilization. By promoting sustainable practices and conscious consumption, we aim to minimize the campus's ecological footprint, ensuring that environmental consciousness becomes embedded in our daily operations and academic life.

Proactive Environmental Governance: Our environmental audit policy emphasizes the importance of proactive governance in environmental management. By gathering foundational data on key environmental parameters, the university aims to detect potential environmental concerns early and address them before they escalate. This forward-thinking approach will help maintain a balanced, sustainable, and ecologically harmonious campus environment, ensuring that we remain aligned with global sustainability efforts.

Commitment to Sustainable Practices: Through these objectives, Tripura University reinforces its commitment to responsible resource utilization, environmental awareness, and proactive environmental governance. The university is fully dedicated to using environmental audits as a tool to continually improve sustainability and reduce its environmental impact.

Role of the Environmental Audit Committee

To fulfill these objectives, the Environmental Audit Committee at Tripura University will focus on the following key tasks:

- Identifying both existing and emerging environmental concerns that could affect campus sustainability
- Monitoring and enhancing environmental management practices across academic, administrative, and research sectors
- Evaluating current resource consumption and identifying practices for improvement
- Promoting awareness and educational initiatives on sustainability within the university community
- Preparing a comprehensive Environmental Audit Report documenting the eco-friendly practices implemented by various departments and support services

Through these initiatives, Tripura University is taking significant steps toward creating a greener, more sustainable campus environment. This policy ensures that the university is aligned with the global call for responsible environmental stewardship, while also providing a roadmap for continued progress in the 2023-24 academic year.

Environmental Audit Methodology

The Environmental Audit at Tripura University for the academic year 2023-24 was carried out through a carefully designed methodology to assess and improve the university's environmental practices, resource utilization, and overall sustainability. This comprehensive approach encompassed the following key elements:

Preliminary Assessment

- **Gathering Pertinent Information:** The process began with the collection of critical data regarding current environmental practices, trends in resource consumption, and campus-specific environmental factors.

- **Identifying Key Impact Areas:** The audit team identified key areas with substantial environmental impact, such as waste management, water usage, energy consumption, emissions, and biodiversity. This early stage laid the foundation for targeted and in-depth assessments.

Data Collection

- **Site Visits:** Environmental auditors conducted on-site visits to various university buildings and facilities to observe firsthand environmental practices and resource usage. These visits ensured a real-time assessment of operational practices.
- **Water Quality Analysis:** Water quality was analyzed using standard protocols to assess critical water-related environmental parameters, such as pH, turbidity, and microbial contamination.
- **Air Quality Analysis:** Air quality measurements were conducted in key areas of the campus to assess air pollution levels and identify possible sources. The findings helped gauge the campus's overall environmental health.
- **Noise Level Measurements:** Specialized equipment was used to measure noise pollution at various points across the campus, both during the day and night, to understand the extent of noise pollution and its potential impacts on campus life.
- **Comprehensive Data Collection:** Detailed data was gathered regarding resource specifications, operational routines, consumption patterns, and the efficiency of existing systems throughout the campus.

Enquiries and Stakeholder Interviews

- **Engaging with Stakeholders:** Interviews and discussions were held with key stakeholders, including faculty members, students, facility managers, maintenance staff, and other campus occupants. These interactions provided critical insights into operational practices, waste management systems, and resource conservation opportunities.
- **Insights and Perspectives:** The stakeholder input allowed the audit team to identify challenges and opportunities from those directly involved in campus operations, which were instrumental in shaping the final audit report.

Resource Use Analysis

- **Data Analysis:** The collected data was analyzed rigorously to assess resource consumption patterns across different campus sectors, such as energy, water, and materials.
- **Identifying Trends:** The analysis aimed to identify any trends, irregularities, or areas of inefficiency in resource usage. This helped pinpoint areas where improvements could be made to reduce waste and optimize resources.

Waste Management Analysis

- **Evaluating Waste Practices:** The audit included a comprehensive evaluation of waste management practices across the campus, including waste segregation, recycling efforts, and disposal methods.
- **Proposing Strategies:** Based on the waste management analysis, actionable recommendations were developed to enhance recycling initiatives, reduce waste

generation, and improve overall waste management, thus lowering the university's environmental footprint.

Report Compilation

- The final stage of the audit involved compiling the findings, analyses, and recommendations into a detailed Environmental Audit Report. This report serves as a comprehensive guide for the university's sustainability efforts moving forward.

Through the implementation of this systematic and holistic environmental audit methodology, Tripura University gained a deeper understanding of its environmental practices and their impacts. The audit identified key opportunities for resource conservation and sustainable development, helping to lay the groundwork for a greener, more environmentally responsible campus. The outcomes of this audit underscore Tripura University's commitment to sustainability and the broader ecological objectives of responsible resource management, making substantial strides toward creating a more sustainable future for the university and its community.

AUDIT STAGE

The Environmental Audit at Tripura University for the academic year 2023-24 was initiated through a methodical and systematic approach, ensuring a comprehensive evaluation of key environmental aspects. The process was designed to provide a thorough understanding of the university's environmental impact and resource utilization. Below is an outline of the critical components involved in the audit.

Land Use and Land Cover (LULC) Assessment

The audit began with a detailed assessment of the university's land use and land cover (LULC). This analysis aimed to identify areas designated for specific uses (e.g., academic buildings, green spaces, and recreational areas) and evaluate how land resources were allocated and utilized. The insights gained from this assessment allowed for a better understanding of campus resource management.

Water Usage and Management

Comprehensive data regarding water availability, consumption patterns, and management practices were gathered. This included identifying water sources, monitoring consumption across various facilities, and evaluating water conservation measures. The audit team assessed the efficiency of water usage and the sustainability of existing water management practices on campus.

Waste Generation and Management Practices

An extensive evaluation of waste generation and management practices was conducted. This encompassed various waste types (e.g., solid waste, e-waste, and hazardous waste), disposal methods, recycling efforts, and the overall waste management strategies implemented by the university. The audit aimed to identify areas for improvement in waste reduction and recycling initiatives.

Environmental Parameters Assessment

To understand the broader environmental impact of the university, critical environmental parameters were recorded. These parameters included air quality, noise levels, and other ecosystem-related factors. The data helped assess the health of the campus environment and identify potential areas of concern for mitigation.

Facilities and Infrastructure Evaluation

The audit team conducted a detailed assessment of the university's infrastructure and facilities, focusing on their environmental impacts and resource consumption. This evaluation helped to identify areas where improvements could be made to reduce energy use, water consumption, and overall environmental footprints.

Stakeholder Engagement and Questionnaire Surveys

To gain insights into resource usage and environmental practices, the audit team distributed structured questionnaires to students, faculty, staff, and other stakeholders. These surveys sought information regarding appliance usage, frequency of usage, and general consumption patterns. The data collected from these questionnaires provided valuable insights into day-to-day practices across the university. The questionnaire set and the data collected are attached in **Appendix-I** and **Appendix-II**.

On-Site Data Collection and Surveys

Data collection was conducted through a combination of on-site visits and questionnaire-based surveys. Various sectors, including water, energy, and waste, were examined through this approach. The audit team conducted site visits to assess real-time environmental practices and resource usage, ensuring accurate and reliable data.

Ambient Quality Assessments

To evaluate the environmental health of the campus, ambient quality assessments were carried out. Standardized protocols were used to monitor air quality, noise levels, and other environmental parameters. These assessments helped gauge the university's overall environmental conditions and identify areas where improvements were necessary.

Data Collation and Analysis

The data collected from diverse sources were systematically compiled and analyzed. This rigorous analysis helped identify trends, patterns, and inefficiencies in resource usage across the campus. The aim was to pinpoint areas that required attention or improvement to enhance sustainability and environmental stewardship.

Environmental Audit Report

The culmination of the audit process resulted in the Environmental Audit Report of Tripura University. This comprehensive document encapsulates the findings, analyses, and recommendations derived from the audit. It provides a holistic view of the university's

environmental practices and their impact, offering actionable insights for future sustainability efforts.

Through this thorough audit process, Tripura University has reaffirmed its commitment to responsible resource management and environmental stewardship. The Environmental Audit Report serves as a valuable tool for informed decision-making and resource conservation, guiding the university towards a more sustainable and environmentally responsible future. The recommendations within the report are designed to support the university's ongoing efforts to foster a greener campus and contribute to broader ecological goals.

POST AUDIT STAGE

The completion of the Environmental Audit at Tripura University for the academic year 2023-24 marks a pivotal turning point—the beginning of the Post-Audit Phase. This phase holds immense significance as it transforms the valuable insights gained from the audit into actionable steps that will propel the university toward a more sustainable future. It serves as the catalyst for the implementation of eco-friendly practices, integrating sustainability into the university's long-term vision.

The Post-Audit Phase represents Tripura University's dedication to moving from assessment to action. By fully embracing the recommendations and findings of the audit, the university embarks on a path where campus development aligns with ecological awareness and responsible resource use. This transformative phase ensures that the environmental insights gained during the audit lead to tangible changes, fostering a balance between growth and sustainability.

Land Use and Ecological Impact

A key component of the Post-Audit Phase is the focus on land use and land cover practices. The insights gathered regarding how land resources are utilized across the campus will guide the university in making informed decisions that minimize environmental impact. This stage is crucial for refining how space is used, promoting sustainable land management practices, and ensuring that campus expansion does not compromise the environment.

Innovation, Collaboration, and Collective Action

During this phase, innovation becomes a key driver for positive change. It is a time for collaboration among faculty, staff, students, and administrators, all of whom play a vital role in turning the sustainability vision into reality. The university community is empowered to take part in the implementation of initiatives that will enhance resource efficiency, reduce waste, and minimize energy consumption. Together, they will address environmental challenges through collective action, establishing a model of sustainability that other institutions can follow.

Practical Action and Long-Term Change

The Post-Audit Phase is characterized by a focus on practical, measurable actions that will lead to long-term improvements. Tripura University is committed to making these changes not only within the campus boundaries but also beyond them, by setting an example of responsible environmental management. The successful implementation of the audit's

recommendations will be a testament to the university's dedication to sustainability and its role as a leader in ecological stewardship.

Sustainable Vision for the Future

As Tripura University steps into the Post-Audit Phase, the commitment to a sustainable and eco-conscious campus is at the forefront. This is where the vision of a greener campus becomes a reality, and the journey toward heightened sustainability begins in earnest. The university's ongoing commitment to reducing its ecological footprint, enhancing resource efficiency, and promoting environmental awareness will continue to guide its actions throughout the academic year and beyond.

The Post-Audit Phase is a call to action, signalling the university's unwavering commitment to evolving and adapting its practices in the pursuit of a more sustainable tomorrow. It represents Tripura University's leadership in integrating environmental responsibility into both academic goals and day-to-day operations. As the university embarks on this new phase, it carries the promise of a brighter, greener, and more environmentally conscious future for generations to come.

Land use and land cover

Nestled against a scenic, undulating landscape, the Tripura University campus boasts a serene wetland at its core, gracefully extending toward the southeastern edge. This wetland, nourished by rainwater, remains vibrant throughout the year, supporting a rich ecosystem of aquatic flora and fauna. Scattered trees across the campus create a lively mosaic of biodiversity, while the thoughtful integration of academic departments, residential quarters, and hostels reflects a harmonious balance between infrastructure and nature.

Recent studies reveal that the campus spans an impressive 97 acres, with the main campus covering 75 acres and an additional 22 acres acquired since 2015. Of this, approximately 36.67 acres (37.80%) are dedicated to orchards, wetlands, the Botanical Garden and Forest Park, Jungle area and playgrounds. Strategically planned plantations line internal roads, guesthouses, hostels, residential quarters, and green zones. However, challenges have emerged, including the silting of wetlands and the growth of dense grasses and aquatic weeds in certain areas.

Built-up areas occupy approximately 38.74 acres (~39.94% of the total campus), encompassing academic and administrative buildings, hostels, and residential quarters. Due to limited elevated land, new construction projects have gradually encroached upon the wetland, prompting a shift toward vertical expansion with multistoried structures. Roads connecting these facilities cover approximately 2.82 acres, while playgrounds span nearly 6.43 acres. Features of LULC are provided in Table 1 and Fig. 1, 2 and 3.

Observations

- A noticeable decline in vegetated areas has accompanied the construction of new buildings.
- Post-rainfall, dense weed growth occurs, necessitating annual cleanup efforts to maintain the campus's aesthetic appeal.
- There is a lack of systematic management of roadside avenue trees and other campus

flora.

- ❖ Controlled burning practices for quick bush clearance are observed and require immediate cessation.
- ❖ The campus lacks a comprehensive drainage network, contributing to water management challenges.

Suggestions and Recommendations

- ✓ **Sustainable Development Practices:** Future construction should prioritize seamless integration with the campus's natural aesthetics and minimize ecological disruption.
- ✓ **Preservation of Green Zones:** Protect and enhance the Botanical Garden, Forest Park, wetland, orchards, and jungle areas as vital carbon sinks and biodiversity hotspots.
- ✓ **Tree Management:** Implement rigorous management programmes to ensure the health and longevity of planted trees across the campus.
- ✓ **End Controlled Burning**: Cease all controlled burning practices to promote eco-conscious land maintenance.
- ✓ **Drainage Network:** Develop a comprehensive drainage system to effectively address waterlogging and enhance water management.

Fig. 1: LULC Map of Tripura University campus

Fig. 2: Hostels and Academic Building 12 near the lake and plantation area

Fig 3: Sports field near students and scholars' hostel

Table 1: Land use categories in Tripura University Campus

Sl. No.	**Land Use Category**	**Area (in approx. Acres)**
1	Botanical Garden and Forest Park	3.75
2	Wetland (Lake area)	10.4
3	Play ground	6.43
4	Orchards	10.94
5	Road	2.82
6	Foot Path	0.21
7	Pump Station	0.20
8	Protection Wall	0.02
9	Drain	0.46
10	Retaining Wall	0.02
11	Culvert	0.02
12	Building Under Construction	2.17
13	Overhead Tank	0.009
14	Car Parking	1.48
15	Garage	0.15

16	Building	29.17
17	Transformer	0.104
18	Generator	0.05
19	Security House	0.012
20	Water Pump	0.04
21	Septic Tank	0.88
22	Jungle Area	5.51
23	Tin Shed	0.06
24	Power Sub Station	0.25
25	Toilet	0.49
26	Garden	0.25
27	Statue	0.001

WATER AUDIT

Water, the essence of life, remains one of the most vital natural resources supporting the survival of all living beings. Its availability is deeply influenced by climatic conditions and geographical features. While water is abundant in nature, the accessibility of clean and potable water remains a privilege not universally available. Over time, thoughtful conservation practices have emerged to address this challenge, yet unsustainable consumption and overexploitation of water resources continue to threaten their availability. Groundwater, along with water in lakes, ponds, and streams, faces significant risks of contamination and depletion due to increasing human-induced pressures.

The growing threats to water resources emphasize the critical need for their conservation, protection, and sustainable management. In this context, ensuring the efficient utilization and preservation of water within the Tripura University campus has become a key priority for the academic year 2023-24. A strategic and holistic approach to water management is necessary to prevent further degradation and ensure long-term resource sustainability.

Water auditing serves as an essential tool for evaluating the quality, availability, and utilization of water resources. Its scope extends beyond mere assessment to include an analysis of existing facilities, practices, and methodologies aimed at replenishing and efficiently managing water. By systematically examining water usage, the audit seeks to maintain the integrity of these resources, prevent degradation, and ensure their continued sustainability.

As Tripura University undertakes Water Audit, it reaffirms its commitment to responsible water management. This initiative symbolizes the university's dedication to safeguarding and enhancing its water resources, ensuring their availability for future generations. The Water Audit not only highlights the institution's ecological consciousness but also sets a precedent for sustainable practices that contribute to a greener and more resilient future.

Water Usage and Management

Water Consumption:

On the dynamic campus of Tripura University, water serves as a critical resource, meeting the daily needs of its diverse community. An impressive 431,000 L of water are drawn daily,

treated, and distributed (Fig. 4, 5) to support the requirements of residential quarters, academic departments, and administrative offices (refer to Table 2). This considerable consumption underscores the imperative of efficient and sustainable water management practices.

Reuse and Recycle: Sustainable approach

In alignment with sustainable development goals, Tripura University's residential stakeholders demonstrate commendable practices by reusing greywater—water generated from household activities—for irrigation purposes. This reused greywater nurtures gardens and cultivates vegetable fields, promoting sustainable food practices within the campus. Additionally, water recycling initiatives, activated under proper oversight, further strengthen the university's commitment to minimizing water wastage and conserving resources in adherence to its green policies.

Rainwater Harvesting

The campus boasts a natural marvel in the form of a substantial 10.4 acres lake, locally known as "Lunga land." This water body serves as the centerpiece for the university's rainwater harvesting system. During the monsoon season, rooftop rainwater is efficiently funneled into the lake via an elaborate network of rainwater outlets and reinforced concrete drains. This system not only replenishes groundwater levels but also ensures a steady year-round supply of water for campus use.

To maintain a consistent water level, a sluice gate (Fig. 6) and a semi-permanent structure have been installed. These measures regulate the lake's capacity, ensuring it remains a reliable source for recharging groundwater. Beyond this, the lake supports fish farming and irrigates orchards growing sweet lemon, banana, guava, and other fruits during the pre-monsoon period. The lake also aids the surrounding local community by providing irrigation support for agricultural fields.

Water Conservation facility

The 10.4 acres natural lake within the university premises is central to the institution's water conservation strategy. Not only does it collect rainwater and recharge the groundwater table, but it also facilitates sustainable activities like fish farming and supports orchard irrigation. This holistic utilization ensures that the lake functions as a reservoir, contributing significantly to both ecological balance and resource availability.

Table 2: Source and uses of water in the TU campus

Source of water		
	Parameters	**Information**
1	No of Wells	2
2	No of the motors used	2
3	Horsepower- motor	20 HP x 2
4	Depth of well- Total	76 m x 2
5	Capacity of Tank-Total	150000 L
6	Iron Removal Plant	02x 10000; 02x5000; 02x2500; 01x3500

Quantity of water used in different sections of the Campus

	Sections	Water use (L/ day)
7	Hostel	135000
8	Resident quarter	54000
9	Administrative block	8000
10	Construction work	Self-Arrangement
11	Canteen	4000
12	Urinals and Toilets	80000
13	Departments	63000
14	Gardens	50000
15	Laboratories	20000
16	Drinking	12000
17	Leakage	5000
18	Main purposes of water use in the campus	Drinking and cooking purpose Toilets and wash areas, Laboratory use, Gardening, Construction
19	Nos. of water tap excluding households/ residential quarters)	1250 Nos
20	Water cooler and drinking water filtration facility (excluding households/ residential quarters)	68 Nos
21	Nos. of urinal and toilets (excluding households/ residential qtrs.)	113
22	Nos. of waterless /bio-toilets	Nil
23	Any water wastage/why?	Yes, leakage from pipes and tanks, taps
24	Water usage for gardening	50000 L
25	Wastewater sources	Leakage from pipes and tanks, Overflowing tanks from residential qtrs., Toilets, labs., hostels
26	Use of wastewater	Nil
27	The fate of wastewater from labs	Discharged into soak pit in case of contamination and natural discharge
28	Any wastewater treatment for lab water	No
29	Whether any green chemistry method practiced in Labs	No
30	Rainwater harvesting	Rain water harvesting is maintained by the water body within the premises which also helps in maintaining the ground water level and there is no reusable rain water which is harvested

Fig. 4: Water treatment facility

Fig. 5 Water storage unit

Fig. 6: Sluice gate for sustaining and controlling flow/water level of the TU Lake

Groundwater Management

Groundwater management at Tripura University reflects the institution's unwavering commitment to sustainable environmental practices, a cornerstone of its ongoing efforts in environmental stewardship. Recognizing the critical role groundwater plays in supporting ecological stability, the university has taken deliberate steps to optimize its usage and preserve this vital resource as part of its comprehensive environmental initiatives for the academic year 2023-24.

Rainwater Harvesting Systems

A primary strategy employed by the university is the installation of rainwater harvesting systems throughout the campus. These systems efficiently capture and channel rainfall into recharge structures, helping replenish the groundwater table. By collecting rainwater during the monsoon season, Tripura University ensures that the natural aquifer is replenished, mitigating the risk of groundwater depletion during drier months.

Permeable Pavements for Aquifer Recharge

The university has also invested in the use of permeable pavements across various campus areas. These pavements allow rainwater to naturally infiltrate the soil, supporting groundwater recharge and reducing surface runoff. This initiative aligns with the university's broader goals of enhancing its ecological footprint while addressing water management challenges.

Efficient Irrigation Practices

Efficient irrigation techniques have been adopted, particularly in the landscaping and agricultural areas of the campus. These methods not only optimize water usage but also minimize the strain on groundwater resources. By utilizing modern irrigation systems, the university has been able to maintain lush green spaces while ensuring that groundwater reserves are conserved.

Regular Groundwater Monitoring

To assess the impact of campus activities on the aquifer, Tripura University conducts regular groundwater monitoring. This process helps track changes in groundwater levels, ensuring that conservation efforts are both effective and sustainable over time. By closely monitoring groundwater health, the university can implement necessary adjustments and address any emerging concerns promptly.

Native Vegetation for Reduced Water Demand

In line with its sustainable landscaping efforts, Tripura University has embraced the use of native vegetation throughout the campus. Native plants are more adapted to local climate conditions and require less water for maintenance. By reducing overall water demand, this strategy further supports the natural recharge of groundwater.

Through these concerted and proactive measures, Tripura University is actively safeguarding its groundwater resources. By balancing ecological needs with sustainable water management practices, the university is ensuring a resilient and efficient water management system that benefits both the campus and the broader environment for years to come.

Tripura University, through sustainable practices such as rainwater harvesting, grey water reuse, and rigorous water quality assessments, exemplifies its commitment to responsible environmental stewardship. By integrating innovative water management systems and conservation strategies, the university is setting a benchmark for ecological sustainability while ensuring the health and well-being of its community.

Observations

A thorough evaluation of water management practices at Tripura University has highlighted areas requiring immediate attention:

- **Absence of Reusable Water Treatment Facilities:** The lack of a dedicated wastewater treatment facility for residential, academic, and administrative buildings impedes efficient recycling and reuse of water.
- **Overflowing Overhead Water Tanks:** Frequent instances of tank overflow indicate water wastage and insufficient monitoring mechanisms.
- **Inadequate Monitoring of Water Consumption:** The absence of systematic water usage records hampers the development of targeted conservation strategies.
- **Sediment Accumulation in the Lake:** Sediment buildup, exacerbated by rainfall, threatens the lake's water quality and ecological balance.
- **Uncontrolled Water Discharge:** Untreated water discharged from buildings into the lake poses risks to the ecosystem, contributing to pollution and imbalance.

Suggestions and Recommendations

To address these challenges, Tripura University aims to implement innovative and sustainable water management solutions:

- ✓ **Enhancing Rainwater Harvesting Systems:** Equip all buildings with advanced rainwater harvesting mechanisms to maximize water reuse and replenishment.
- ✓ **Launching Campus-Wide Water Conservation Drives:** Promote awareness campaigns and engage stakeholders to adopt water-saving practices, fostering a culture of conservation.
- ✓ **Implementing Automated Overflow Prevention Systems:** Install automated sensors in water tanks to prevent overflow, reduce wastage, and streamline water distribution.
- ✓ **Adopting Automated Taps:** Introduce sensor-operated taps across campus to regulate water flow and minimize unnecessary usage.
- ✓ **Establishing a Sewage Treatment Plant (STP):** Develop a robust STP to treat wastewater effectively. Treated water can be reused for toilet flushing, irrigation, and other non-potable applications.

Tripura University's dedication to preserving its natural resources and enhancing sustainability is evident through its meticulous water quality assessments and actionable recommendations. By addressing critical challenges such as sediment accumulation, water wastage, and pollution, the institution reaffirms its commitment to a greener future. These initiatives will not only enrich the campus ecosystem but also set a benchmark for environmental stewardship in higher education.

SOIL CONSERVATION

Soil conservation initiatives at Tripura University continue to demonstrate the institution's dedication to sustainable environmental practices, a critical component of its environmental strategy. Acknowledging the vital role of soil health in maintaining ecological balance, the university has implemented a multi-pronged approach to soil conservation, seamlessly integrating these efforts into its broader environmental audit objectives.

Agroforestry Practices

Agroforestry remains a cornerstone of the university's soil conservation strategy. By incorporating trees and shrubs into agricultural areas, Tripura University prevents soil erosion, promotes biodiversity, and enhances soil fertility through natural nutrient cycling. This practice also contributes to carbon sequestration, further supporting the institution's sustainability goals.

Contour Planting

The adoption of contour planting across undulating terrain has proven effective in reducing surface runoff and preventing soil erosion. By planting along natural land contours, the

university minimizes soil disturbance and retains the integrity of the topsoil, ensuring better water retention and reduced nutrient loss.

Cover Cropping

Tripura University has implemented cover cropping techniques during non-cultivation periods to combat soil erosion. Cover crops act as a protective layer, preventing runoff, improving soil structure, and enhancing water infiltration. These efforts significantly contribute to maintaining soil moisture levels and reducing degradation.

Organic Farming Practices

Prioritizing sustainable agriculture, the university promotes organic farming practices. The use of organic manures, compost, and biofertilizers enriches the soil with essential nutrients while improving its structure and fertility. These practices not only reduce dependency on chemical inputs but also enhance long-term soil health.

Mulching for Soil Protection

In addition to other methods, the university has introduced mulching as a conservation strategy. Mulching involves applying organic or inorganic materials over the soil surface to prevent erosion, conserve moisture, and regulate soil temperature, further ensuring optimal growing conditions.

Sustainable Ecosystem

These soil conservation efforts are seamlessly aligned with Tripura University's commitment to fostering a sustainable and resilient campus ecosystem. By preserving soil health, the university not only ensures the productivity of its land but also contributes to environmental sustainability, setting a benchmark for eco-conscious practices in higher education.

Through its continued focus on soil conservation, Tripura University reinforces its role as an environmental steward, championing sustainable practices that benefit both the campus community and the broader environment.

WASTE DISPOSAL AUDIT

The waste disposal audit at Tripura University highlights the intricate dynamics of waste management on campus, aiming to reduce ecological and health risks associated with improper waste handling. The audit underscores the university's dedication to promoting sustainable practices and environmental stewardship.

Types of Solid Waste Generated

Biodegradable Waste: Includes organic materials like food waste, canteen disposables, and toilet waste, which can be composted or converted into organic fertilizers.

Non-Biodegradable Waste: Comprises plastics, tins, and glass bottles, which require recycling or reuse to minimize environmental harm.

Hazardous Waste: Includes materials like corrosive chemicals, acids, and flammable substances, which pose significant health and environmental risks if not managed properly.

Environmental and Health Implications

Improper waste disposal leads to environmental degradation, such as litter accumulation, soil and water contamination, and the release of harmful greenhouse gases. These practices pose serious risks to public health and contribute to climate change. The audit emphasizes the need for systematic waste management (see Fig. 7 and 8) to mitigate these impacts.

Current Waste Management Practices

Waste Collection Process:

- Waste is generated across academic departments, administrative offices, hostels, and residences.
- Small waste bins in each department are emptied by housekeeping staff into larger bins.
- Waste is collected bi-daily by the Agartala Municipal Corporation (AMC) for segregation, landfilling, and composting.

Table 3: Solid waste generated on the campus per week

Stakeholders	Types of solid waste	Average waste generated / Week (Kg)	% of waste
Academic Department	Paper waste	82.5	59.57
	Plastic waste	06.0	4.33
	Organic Waste	48.0	34.66
	E-waste	02.0	1.44
Administrative Office	Paper waste	42.0	70.00
	Plastic waste	02.0	3.33
	Organic Waste	15.0	25.00
	E-waste	01.0	1.67
Residential Quarter/Hostels/ GuestHouse	Paper waste	35.0	11.51
	Plastic waste	17.0	5.59
	Organic Waste	250.0	82.24
	E-waste	02.0	0.66
Canteens	Paper waste	15.0	36.14
	Plastic waste	01.5	3.61
	Organic Waste	25.0	60.24
	E-waste	0.00	0.00
	TOTAL	544.00 Kg /week	

Stakeholder Contributions:

- Hostels and faculty accommodations contribute significantly to waste generation, producing an average of 428 kg (Table 3) of solid waste weekly.
- 40% of academic departments and 50% of residential quarters practice separate disposal systems for dry and wet waste.

- Biodegradable waste segregation is partially implemented in teachers' quarters, guest houses, and 20% of academic departments.

Fig. 7: Waste collection points within campus and collection by AMC truck and personnel

Fig. 8: Assorted bins for waste segregation at some locations in the campus

Innovative Practices in Waste Management

Vermicomposting:

The university have a dedicated vermicomposting unit (Fig. 9) using *Perionyx excavatus* earthworms. Organic waste such as leaves, weeds, and kitchen scraps are converted into nutrient-rich vermicompost in 45 days (see Table 4 and 5). This vermicompost is used in flower gardens and orchards on campus, promoting sustainable agriculture.

Fig. 9: Vermicomposting unit

Table 3: Nutrient characteristics of different organic wastes

Parameters	C	BC	AC	MC	KW
pH	7.42	6.75	6.3	7.63	10.0
Electrical conductivity (µMho cm^{-1})	580.66	720.00	570.00	990.00	-
Organic Carbon (%)	17.14	19.52	19.83	20.37	36.8
Total Nitrogen (%)	1.26	1.52	1.82	3.08	3.49
Av. Phosphorus (mg $100g^{-1}$)	147.39	48.97	26.15	163.71	0.89 % (Total P)
Av. Potassium (mg $100g^{-1}$)	1000.00	937.33	1087.00	5962.00	2.18 % (Total K)

*C = Cow dung, BC = Bamboo - cow dung, AC = *Acacia* - cow dung, MC = *Mikania* - cowdung, KW = Kitchen waste

Table 4 : Plant nutrients in vermicompost (after 45 days)

Parameters	C	BC	AC	MC	KW
pH	6.85	7.06	6.9	6.71	7.59
Electrical conductivity (µMho cm^{-1})	594.33	870.00	680.66	1387.00	-
Organic Carbon (%)	11.20	17.90	14.92	17.49	10.48
Total Nitrogen (%)	1.96	2.23	2.16	3.83	1.67
Av. Phosphorus (mg $100g^{-1}$)	275.04	130.96	86.88	300.96	1.09% (Total P)
Av. Potassium (mg $100g^{-1}$)	1175.00	1420.00	1589.00	7321.33	0.85% (Total K)

*C = Cow dung, BC = Bamboo - cow dung, AC = *Acacia* - cow dung, MC = *Mikania* - cowdung, KW = Kitchen waste

Collaboration with AMC:

- ❖ AMC collects 90% of the solid waste generated on campus, ensuring effective disposal through composting and landfilling.

Challenges in Waste Management

- ❖ **Absence of a Dedicated Waste Treatment Facility:** Lack of centralized systems for treating wastewater from academic buildings, hostels, and residences.
- ❖ **Overflowing Water Tanks:** Instances of water wastage due to inadequate monitoring systems.
- ❖ **Inadequate Waste Segregation:** Limited implementation of systematic segregation of biodegradable and non-biodegradable waste.
- ❖ **Sediment Accumulation in the Lake:** Impacts water quality and ecological balance.
- ❖ **Untapped Recycling Potential:** Recycling remains underutilized on campus, despite its potential to reduce waste.

Recommendations for Improved Waste Management

Enhancing Waste Segregation Systems:

- ✓ Implement separate bins for dry and wet waste across all departments, hostels, and residences.
- ✓ Provide training sessions for stakeholders on proper segregation practices.

Establishing a Sewage Treatment Plant (STP):

- ✓ Introduce an STP to treat wastewater for reuse in irrigation and toilet flushing.

Introducing Automated Waste Management Systems:

- ✓ Use automated sensors to monitor water tanks and prevent overflow.
- ✓ Adopt automated taps to reduce water wastage.

Promoting Awareness Campaigns:

- ✓ Organize workshops and drives to educate the university community about sustainable waste management.

Activating Recycling Initiatives:

- ✓ Set up recycling units on campus to repurpose non-biodegradable waste.
- ✓ Partner with local organizations for effective recycling practices.

Tripura University's waste disposal audit reflects a proactive approach to sustainable practices, fostering environmental stewardship. By integrating innovative solutions like vermicomposting, enhancing stakeholder awareness, and implementing systematic waste segregation, the university paves the way for a greener and more sustainable future. Through these efforts, Tripura University exemplifies its commitment to harmonizing academia with ecological responsibility, creating a legacy of environmental consciousness.

LIQUID WASTE MANAGEMENT

In the symphony of sustainability, liquid waste management stands as a crucial component of Tripura University's green audit initiatives. As the campus continues to thrive as a hub of scientific discovery, academic pursuits, and residential activity, the management of liquid waste emerges as a key area of focus to preserve ecological harmony.

Sources of Liquid Waste

The diverse origins of liquid waste reflecting the multifaceted activities that characterize campus life forms a complex liquid waste system, demanding a responsible and sustainable approach to disposal:

- ❖ **Science Laboratories:** Chemical and experimental residues generated during research and academic activities.
- ❖ **Hostels and Residential Quarters:** Effluents from daily washing, cooking, and cleaning.
- ❖ **Canteen Operations:** Wastewater from food preparation and cleaning processes.

Categories of Liquid Waste

Liquid waste on campus is classified into two main categories, each requiring tailored management strategies:

Sewage Waste: Comprising domestic waste from hostels, residences, and canteen facilities. This waste represents the residues of daily life, necessitating systematic containment and treatment.
Effluents from Laboratories, Washing, and Canteen: Laboratory waste includes chemical residues from experiments. Effluents from residential washing and canteen discharges contribute to the liquid waste matrix. These streams highlight the intersection of academic, residential, and operational activities on campus.

Current Liquid Waste Management Practices

The university has adopted interim methods to manage liquid waste responsibly while striving for more comprehensive solutions:

- ✓ **Soak Pits for Laboratory Waste:** Liquid waste from laboratories is directed into soak pits, which prevent contamination of the soil and water table. This practice reflects an eco-conscious approach to chemical waste disposal.

- ✓ **Drainage Channels for Effluents:** Other liquid waste, including washing and canteen effluents, flows through drainage channels to support groundwater recharge. This system aids in maintaining water balance on the campus.

Challenges and Opportunities

Despite these efforts, the absence of a dedicated Sewage Treatment Plant (STP) is a significant gap in the campus's liquid waste management infrastructure. Without an STP, untreated sewage and effluents could pose risks to both public health and the environment.

Proposed Measures for 2023-24

The university has identified key areas for improvement and envisions a future built on sustainable liquid waste management:

- ✓ **Establishment of a Sewage Treatment Plant (STP):** A state-of-the-art STP will enable the treatment of sewage and effluents, reducing environmental impact. Treated water can be reused for irrigation, flushing systems, and maintaining campus greenery.

- ✓ **Chemical Waste Treatment System:** Laboratories require dedicated mechanisms for safe disposal of chemical residues, such as neutralization pits and specialized waste containment systems.

- ✓ **Awareness and Training Programmes:** Conduct workshops and training for students and staff to promote awareness about responsible liquid waste disposal.

- ✓ **Regular Monitoring and Compliance to Regulations:** Install monitoring systems to track liquid waste quality and disposal efficiency to ensure compliance with environmental regulations.

Vision for a Greener Future

Tripura University's commitment to sustainable liquid waste management is unwavering. The institution strives to create a comprehensive framework that aligns with global best practices in waste management, ensuring the preservation of natural resources while fostering a healthier campus environment.

By embracing innovative solutions, promoting stakeholder involvement, and prioritizing sustainability, the university continues its journey towards harmonizing academic excellence with environmental stewardship. In doing so, it envisions a campus where liquid waste management contributes significantly to ecological balance and a greener, more sustainable future.

BIOMEDICAL WASTE MANAGEMENT

In the grand narrative of sustainability, biomedical waste management emerges as a critical strand in Tripura University's green audit framework. As the university continues to engage in advanced research activities, particularly those involving animal studies, the conscientious handling of biomedical waste underscores its commitment to eco-conscious and ethical practices.

Sources of Biomedical Waste

Certain faculties within the university engage in research involving animals, albeit on a limited scale. These activities generate a small but significant amount of biomedical waste, which includes:

- ❖ **Research Animal Carcasses:** A byproduct of scientific exploration that requires special attention and handling.
- ❖ **Other Biomedical Residues:** Minor waste associated with laboratory activities involving biological materials.

Although the volume of waste is minimal, its proper management reflects the university's adherence to ethical research standards.

Storage and Ethical Handling

Tripura University prioritizes ethical stewardship in the management of biomedical waste:

Temporary Storage at -20°C: Animal carcasses are stored in designated freezers (Fig. 10) at -20°C, ensuring safe containment and preventing decomposition. This step demonstrates respect for the research process and aligns with global best practices in biomedical waste management.

Fig. 10: Biomedical waste storage

Disposal Practices

When the accumulated biomedical waste reaches a manageable volume, the university ensures its responsible disposal through collaboration with external agencies:

Partnership with Agartala Municipal Corporation (AMC): The university hands over biomedical waste to the AMC, which is equipped to handle such waste following municipal and environmental regulations.

Compliance with Regulatory Standards: The disposal process adheres to established biomedical waste management guidelines, ensuring minimal impact on the environment. This seamless transition highlights the university's proactive engagement with the broader civic ecosystem in managing specialized waste.

Commitment to Ethical Research and Sustainability

While the generation of biomedical waste is limited, Tripura University's approach reflects its dedication to maintaining high ethical and environmental standards. By integrating responsible biomedical waste management into its green audit initiatives, the university:

- ✓ Reinforces its commitment to sustainable research practices.
- ✓ Ensures the dignity and proper disposal of research byproducts.
- ✓ Collaborates effectively with community stakeholders for sustainable outcomes.

In the academic year 2023-24, Tripura University continues to showcase its unwavering commitment to sustainability. The meticulous handling of biomedical waste may seem like a minor detail, but it serves as a testament to the institution's broader ethos—one of ethical research, environmental consciousness, and community collaboration.

As the university charts its path toward academic excellence and environmental stewardship, the careful management of biomedical waste becomes a symbol of its dedication to a sustainable and ethical future.

E-WASTE MANAGEMENT

Within the vibrant ecosystem of Tripura University, where technology underpins innovation and learning, the institution remains acutely aware of its responsibility toward e-waste management. The campus harmonizes technological advancement with sustainability, ensuring that the remnants of progress—electronic waste—are responsibly managed.

Sources of E-Waste:

The digital infrastructure of Tripura University, encompassing various academic and administrative domains, generates e-waste from the following sources:

Laboratories: Computer labs, electronic labs, Physics labs, Chemistry labs, and Biotech labs contribute significant electronic waste.

Offices: Academic and administrative offices discard outdated equipment and electronic accessories.
This extensive network of e-waste mirrors the dynamic growth of the university's technological landscape, highlighting the need for effective waste management practices.

The Composition of E-Waste

E-waste at Tripura University includes:

- **Outdated and Non-functional Equipment:** Computers, laptops, printers, scanners, and projectors.
- **Accessories and Consumables:** Cables, cartridges, and batteries.
- **Laboratory Instruments:** Obsolete equipment and circuitry used in scientific research and experiments.

These discarded items (Fig. 11 and 12), which have reached the end of their functional life, form the backbone of the university's e-waste stream.

From L to R:
Fig. 11: Spent batteries
Fig. 12: Spent cartridges, fragments of damaged laboratory instruments

Strategies for E-Waste Management

Tripura University adopts a systematic approach to e-waste management, grounded in sustainability and responsibility. Key practices include:

Reuse and Refurbishment:

Functional but outdated equipment is refurbished and reused within the campus, extending its lifecycle.

Recycling: Items beyond repair are handed over to authorized vendors for recycling. This ensures that valuable components are extracted and reused while minimizing environmental harm.

Responsible Disposal: E-waste unsuitable for reuse or recycling is disposed of through certified channels, adhering to environmental standards and guidelines.

Balancing Innovation and Sustainability

As technology evolves rapidly, Tripura University faces a crucial choice between acquiring new equipment and opting for buy-back programs that promote sustainability. The campus increasingly embraces the buy-back option, trading outdated devices for newer ones while ensuring the ethical disposal of the older equipment.

Commitment to Environmental Responsibility

Tripura University recognizes that its technological footprint extends beyond laboratories and offices. The university's e-waste management practices exemplify its commitment to:

- ✓ Reducing the environmental impact of discarded electronics.
- ✓ Preserving resources through recycling and reuse.
- ✓ Promoting sustainability in all aspects of campus life.

In the rhythm of technological advancement, Tripura University conducts a symphony of responsibility and progress. Through its structured approach to e-waste management, the institution not only addresses the challenges of electronic waste but also contributes to the global call for sustainability. As the academic year 2023-24 unfolds, the university's efforts in e-waste management echo its dedication to harmonizing progress with environmental stewardship.

HAZARDOUS WASTE

Hazardous waste management forms an essential component of Tripura University's sustainability journey. Recognizing the risks associated with hazardous materials, the University has implemented measures to ensure their responsible handling, transportation, and disposal, aligning with regulatory frameworks and best practices.

Regulatory Framework: Guiding Principles

Tripura University's hazardous waste management practices are shaped by the Hazardous Waste (Management, Handling, and Transboundary Movement) Rules, 2008, established by the Ministry of Environment, Forest and Climate Change, Government of India. These regulations provide the foundation for responsible waste handling across the University.

Sources and Types of Hazardous Waste

Hazardous waste on campus originates from diverse sources:

- **Laboratories:** Academic and research activities generate chemical residues, solvents, and reactive substances.
- **Administrative and Residential Areas:** Batteries, pesticides, and cleaning agents contribute to hazardous waste streams.
- **Workshops and Maintenance Units:** Materials like paints, adhesives, and preservatives add to the waste matrix.

Challenges in Hazardous Waste Management

Limited Awareness: Despite the university's efforts, not all stakeholders fully grasp the regulations and obligations related to hazardous waste.
Disposal Uncertainty: Surveys by the Green Audit Committee revealed a knowledge gap among stakeholders regarding proper disposal pathways.
Varied and Small Quantities: Many hazardous waste types are generated in minimal amounts, complicating centralized management efforts.

Observations

The Audit conducted during 2023-24 has shed light on critical areas for improvement:

- **Biomedical Waste Disposal:** Laboratories require a more streamlined and effective biomedical waste disposal system.
- **Liquid Hazardous Waste:** A sustainable disposal pathway for liquid hazardous waste is needed to prevent environmental contamination.
- **Plastic Waste Reduction:** Despite progress, achieving a plastic-free campus requires more collective effort.
- **Vermi-Composting:** Current vermicomposting efforts need enhancement to fully realize their potential.

Recommendations for Improvement

From the observations, the following recommendations are proposed to enhance hazardous waste management:

1. **Enhancing Awareness and Training:** Conduct workshops and training sessions to educate stakeholders about hazardous materials and their disposal regulations.
2. **Improving Disposal Pathways:** Partner with authorized treatment facilities for safe transportation and disposal of liquid and solid hazardous waste.

Establish clear guidelines for separating and storing hazardous materials on-site before disposal.
3. **Plastic-Free Campus Initiatives:** Promote biodegradable alternatives to single-use plastics across campus. Increase awareness campaigns to encourage responsible behavior among students and staff.
4. **Strengthening Vermi-Composting:** Allocate resources to scale up vermicomposting initiatives, ensuring sufficient organic waste processing capacity.
5. **Centralized Paper Recycling:** Implement a centralized system for paper recycling to minimize waste and extend paper's lifecycle.
6. **Installing an Incinerator:** Set up an incinerator for proper disposal of specific hazardous materials, such as contaminated lab waste, while adhering to environmental safety standards.

Tripura University envisions a future where hazardous waste management seamlessly integrates with its academic and research ethos. Through sustained efforts in education, collaboration, and infrastructure development, the University aims to create a model of responsible waste stewardship.

In the symphony of sustainability, hazardous waste management emerges as a key movement, harmonizing knowledge with action. Guided by the observations and recommendations of the Green Audit, Tripura University steps confidently into a future where progress and environmental consciousness coexist.

ENVIRONMENTAL QUALITY AUDIT

Evaluating Water Quality

Water Source and Treatment

Tripura University fulfills its water demands primarily through two underground tube wells. The water extracted is subjected to an extensive purification process in an iron removal plant, which integrates oxidation and mixing chambers to ensure its suitability for consumption. This advanced system transforms untreated water—initially rich in sediments and unsuitable for direct use—into potable water.

Quality Analysis

Water samples are periodically drawn from various campus sources for thorough analysis to ensure the highest quality standards. These tests evaluate a range of parameters to confirm water safety and suitability for drinking and other uses. To assess the university's drinking water quality, a sample was collected in a pre-cleaned one-litre polythene bottle for the analysis of different physical & chemical parameters. The analysis was conducted in the Tripura State Pollution Control Board laboratory using the standard methods given in APHA (American Public Health Association), 2012. The analytical results of the collected water samples are shown in Table 6.

Table: 6: Analytical Result of Drinking Water Sample Collected from Tripura University.

Parameter	Sample data	Standard (BIS, 2012)		Method of measurement
pH	6.68	6.5-8.5	6.5-8.5	pH Meter
Conductivity (µS/cm)	107			Conductivity Meter
TDS (mg/L)	54	500	2000	Gravimetric
Turbidity (NTU)	2.84	5	1	Turbidity Meter

Chlorine (mg/L)	11.4	250	1000	Argentometric
Total Hardness (mg/L)	80.2	200	600	EDTA- Titrimetric
Iron (mg/L)	0.08	0.3	0.3	Spectrophotometric
Magnesium (mg/L)	7.2	30	100	Calculation
Calcium (mg/L)	11.8	75	200	EDTA- Titrimetric
Arsenic (mg/L)	BDL	0.01	0.05	Spéarophiolometric

*BDL= below detectable limit

To ensure the adherence of the water to stringent quality standards, a comprehensive assessment of its parameters is imperative. Water samples drawn from various sources within the campus were subjected to thorough analysis. The resultant data, encapsulating quality parameters, findings, and insights, have been briefly summarized in Table 7. This analytical endeavour accurately represents the water's quality, thereby ensuring its fitness for consumption and diverse uses.

Tripura University's commitment to ensuring the purity of its water resources is vividly reflected in this stringent quality assessment. By subjecting its water to rigorous scrutiny, the institution safeguards the health and well-being of its occupants while upholding the tenets of responsible environmental management.

Table 7: Water quality analysis report of the water samples obtained from different sources within TU campus

Type of Sample	Water Source/ point of use/ purifier used	TDS (ppm)	pH Range	Turbidity (NTU)	Calcium (ppm)	Magnesium (ppm)
Raw Water	Tap water	102.0	6.82	50	11.11	1.77
Drinking water	Resin cum RO-UV purifier (Model Kent Mineral RO)	88	6.78	<1	13.49	2.22

Ref.No. EQNX:005: LAB: W:24:05:00024-R ULR-TC1223724000000273F,
EQNX:005: LAB: W: 24:05:00023-R ULR-TC1223724000000272F
Note: As per IS: 15185: 2016 methods, Coliform and *E.coli* was not detected in both type of sample

Assessing Lake Water Quality

Tripura University remains steadfast in its commitment to ecological preservation, as reflected in its comprehensive evaluation of the lake's water quality. This seasonal assessment highlights the institution's dedication to understanding and safeguarding its natural resources.

To evaluate the lake's water quality, a meticulous comparison was conducted, aligning its physico-chemical parameters with benchmarks set by the Bureau of Indian Standards (BIS), the World Health Organization (WHO) for drinking water, and the pisciculture standards defined by ICAR-RC-NEH. The findings, detailed in Table 8, revealed the following:

Table 8: Seasonal Water Quality of Tripura University Lake

	Parameters	Seasons			Drinking		Fish
		Monsoon Mean ± SE	Winter Mean ± SE	Summer Mean ± SE	BIS	WHO	ICAR
1	Temp ^{0}C	31.45 ± 0.11	19.05 ± 0.45	33.4 ± 0.21	-	-	-
2	EC (mhos/cm)	1.62 ± 0.02	1.42 ± 0.01	1.16 ± 0.02	-	-	-
3	Total suspended solid	20.38 ± 1.07	27.63 ± 1.80	29.25 ± 1.66	75	≤ 30	-

4	Total Dissolved Solids	215.75 ± 1.33	304.12 ± 1.76	319.13 ± 2.43	500	500	-
5	pH	7.58 ± 0.04	7.78 ± 0.06	6.91 ± 0.01	6.5-9.2	6.5-8.5	6.7-9.5
6	Total Alkalinity (mg/l)	148.43 ± 2.50	101.67 ± 2.34	167.57 ± 3.05	200	120	50-300
7	Chloride	56.80 ± 2.37	88.75 ± 2.17	128.98 ± 2.97	250	250	-
8	Free CO_2	5.68 ± 0.41	5.5 ± 0.72	7.7 ± 0.57	-	-	5
9	Total CO_2	112.31 ± 0.55	218.10 ± 2.24	136.30 ± 2.35			
10	Dissolved Oxygen	5.02 ± 0.58	5.22 ± 0.84	5.12 ± 0.54	6.0	4.0-6.0	4
11	BOD	1.63 ± 0.18	1.83 ± 0.41	1.08 ± 0.39	-	20-30	<10
12	Total hardness (mg/l)	162.5 ± 2.5	165.25 ± 1.81	177 ± 1.69	300	500	30-180
13	Ca^{2+}hardness	89.75 ± 2.01	104.5 ± 2.69	116.25 ± 2.51	75	75	75-150
14	Mg^{2+}hardness	72.75 ± 2.41	60.75 ± 2.78	72.5 ± 2.87	30	150	-
15	Ammonia	0.98 ± 0.14	0.91 ± 0.10	1.05 ± 0.22	0.5	1.5	0.1

Note: - BIS: Bureau of Indian Standards, WHO: World Health Organization, Reference: IS 10500: 2012, WHO 2004, ICAR-RC-NEH

Most parameters adhered to established drinking water quality standards. However, Dissolved Oxygen (DO) levels and Calcium hardness exceeded desirable limits, necessitating closer monitoring. For pisciculture, parameters such as free carbon dioxide, DO, Total Hardness (TH), and ammonia surpassed optimal levels, raising concerns over potential fish mortality risks.

Indices of Water Quality

The analysis revealed key insights into the lake's ecosystem:

- The Water Quality Index (WQI) was determined to be 79.95, placing it within the "good quality" range (50–100).
- The Palmer's Algal Pollution Index recorded a value of 12, signifying moderate pollution primarily caused by sediment accumulation during rainfall.
- These indices underscore the university's dual focus on academic inquiry and ecological stewardship, balancing the need for detailed analysis with actionable insights to preserve its natural assets.

Air quality assessment

PM_{10} refers to airborne particles with diameters of 10 micrometres or less, encompassing elements such as dust, soot, and metal particles, often originating from vehicular emissions, construction activities, and other human-induced sources. $PM_{2.5}$ includes even finer particles that pose a greater risk to human health.

SO_2 (Sulphur dioxide) serves as an indicator for gaseous sulphur oxides (SOx) and is a by-product of burning fossil fuels. Vegetation on campus helps absorb SO2, mitigating its concentration in the air. Meanwhile, **NO_2** (Nitrogen dioxide) is a prominent nitrogen oxide (NOx) that originates from combustion processes, contributing to air pollution, ozone formation, and acid rain

An air quality monitoring station was established atop the Laboratory of Chemistry building, chosen for its secure location, reliable power supply, and accessibility, in collaboration with the Tripura State Pollution Control Board (TSPCB). Continuous monitoring was conducted in three eight-hour shifts using internationally recognized equipment, including the Respirable Dust Sampler (RDS) with gaseous sampling attachments and $PM_{2.5}$ sampler (M/s Envirotech Instruments Pvt. Ltd., New Delhi).

The results (Table 9) confirm that levels of PM_{10}, $PM_{2.5}$, SO_2, and NO_2 on the Tripura University campus remain well within the permissible limits set by the CPCB. These findings underscore the university's proactive approach to environmental monitoring and management, contributing to a clean and sustainable campus environment.

By maintaining a focus on responsible air quality management, Tripura University reaffirms its dedication to the well-being of its community while setting a benchmark for eco-conscious practices in higher education institutions. This ongoing effort to monitor and improve air quality not only promotes health and sustainability on campus but also supports broader environmental goals.

Table 9: Status of ambient air quality on the campus of Tripura University

Pollutants	Time weighted Average	S-1	S-2*	Standards (CPCB, 2009)	Method Used
Particulate matter (PM_{10}) µg/m^3	24 Hours	63.2	66.2	100	Gravimetric
Particulate Matter ($PM_{2.5}$) µg/m^3	24 Hours	44.80	31.2	60	Gravimetric
Sulphur Dioxide (SO_2) µg/m^3	24 Hours	4.39	15.8	80	Improved West and Geake
Nitrogen Dioxide (NO_2) µg/m^3	24 Hours	15.8	18.3	80	Jacob & Hochheiser

*Based on information provided by IQ Air App which uses real time air monitoring

VEHICULAR MOVEMENTS

As part of the environmental audit conducted during the academic year 2023-24, an in-depth analysis of vehicular movements at Tripura University was undertaken. The objective was to assess their environmental impact and propose actionable recommendations to transition toward sustainable transportation practices. The following sections present the findings, implications, and proposed solutions.

Analysis of Vehicular Movements

- **Traffic Volume**: On average, approximately 250 two-wheelers and 300 four-wheelers, including vehicles visiting the campus's bank and post office, frequented the Tripura University campus daily. This analysis excluded vehicles owned by campus residents to focus on external traffic.
- **Parking Facilities**: Two designated parking areas accommodate these vehicles. However, it was noted that about 30% of the vehicles were short-term visitors, highlighting the need for optimized parking and reduced emissions from idling vehicles.

Environmental Implications

1. **Air Quality Degradation**:
   Emissions from the high volume of vehicles contribute to air pollution, adversely affecting the health and well-being of campus residents and surrounding communities.
2. **Traffic Congestion**:
   Increased vehicular movement causes congestion, leading to inefficient transportation and heightened greenhouse gas emissions.
3. **Noise Pollution**:
   Vehicular noise disrupts the campus environment, impacting students, faculty, and staff.
4. **Parking Challenges**:
   Inefficient utilization of parking spaces results in haphazard parking, diminishing campus aesthetics and creating safety risks.

Promoting Environment-Friendly Transportation

Tripura University has implemented several initiatives to foster sustainable and eco-friendly transportation within the campus:

1. **Cycling and Pedestrian Infrastructure**:

   - Dedicated, well-maintained cycling tracks and pedestrian pathways have been developed to reduce vehicular dependency.
   - Bicycle usage among students and staff is actively encouraged through campus-wide campaigns.

2. **Electric Vehicle (EV) Adoption**:

   - Promotion of EVs through awareness campaigns and designated charging stations.
   - Reserved parking areas for electric cars and scooters to incentivize their usage.

3. **Public Transport and Carpooling**:

   - Collaboration with local authorities to enhance public transportation options to and from the campus.
   - Designated carpooling zones to encourage shared commuting and reduce the number of vehicles on campus.

Recommendations for Sustainable Transportation

To address environmental concerns and enhance sustainability, the following measures are proposed:

1. Promoting Alternatives: Encourage walking, cycling, and carpooling as preferred modes of transportation for students, faculty, and staff.

2. **Public Transport Accessibility**: Work with local transit authorities to improve bus and shuttle services connecting the university to nearby towns and cities.

3. **Optimized Parking Policies**: Implement time-limited parking for visitors. Introduce parking fees to discourage extended stays and promote efficient utilization of parking spaces.

4. Incentives for Green Transportation: Provide benefits such as reduced parking fees for EV users. Expand EV charging infrastructure to support the transition to electric vehicles.

5. Awareness Campaigns: Conduct workshops, seminars, and awareness drives to educate the campus community about the environmental impact of vehicular emissions and the importance of sustainable commuting.

6. Monitoring and Reporting: Regularly monitor vehicular emissions, traffic patterns, and the adoption of sustainable practices. Publish periodic reports to track progress and ensure accountability.

The environmental audit findings emphasize the need for a holistic approach to managing vehicular movements at Tripura University. By implementing sustainable transportation practices, the university can significantly reduce its environmental footprint while fostering a greener, more eco-conscious campus environment. These initiatives align with Tripura University's commitment to environmental stewardship and serve as a model for responsible campus management.

AMBIENT NOISE LEVELS

Under the Air (Prevention and Control of Pollution) Act, 1981, noise is recognized as a pollutant. Noise pollution occurs predominantly in two contexts: community and industrial settings. Community noise, also referred to as environmental noise, is defined as noise generated from all sources excluding industrial activities.

The World Health Organization (WHO) guidelines recommend the following:

- Noise levels in bedrooms at night should remain below 30 dB(A) to ensure quality sleep.
- Noise levels in classrooms should be under 35 dB(A) to create an optimal teaching and learning environment.

Noise Measurement Parameters

1. Sound Pressure and Levels:

- The root mean square (rms) quantity of a sound wave measures the sound pressure, expressed as force per unit area in Newton per square meter (N/m^2) or Pascal (Pa).
- Sound Level (dB) is determined using the formula: Sound Level (dB) = $20 \times \log_{10}$ (weighted sound pressure/reference sound pressure).

2. A-Weighted Adjustments:

- Noise levels are adjusted using the A-weighted system, which accounts for the ear's varying sensitivity to frequencies.

3. Equivalent Noise Level (L_{eq}):

- L_{eq} represents the steady sound pressure level that accounts for fluctuating noise over a given time period. The formula for L_{eq} is:

$$L_{eq} = 10 \log \left(\sum_{i=1}^{n} f_i \, 10^{Li/10} \right)$$

f_i: Fraction of time the specific sound level persists.
L_i: Sound Intensity Level.
L_{min}: Minimum Noise Level.
L_{max}: Maximum Noise Level.

Noise Monitoring

The study assessed equivalent noise levels (L_{eq}) across the university campus during the day and night. Noise monitoring was conducted using Sound Level Meters (SLM) SL-4001, with observations made for at least 30 minutes at each location. The monitoring covered the following four locations:

1. Entrance Gate
2. Administrative Block
3. Library Building
4. Chemistry Department

Key Findings

Compliance with Standards: Noise levels at all four monitored locations were within the permissible limits set by the Central Pollution Control Board (CPCB):

- **Daytime**: Maximum permissible limit of 50 dB(A).
- **Nighttime**: Maximum permissible limit of 40 dB(A).

Slightly Elevated Noise Levels: Noise levels were marginally higher at the Entrance Gate and Administrative Block due to:

- Vehicular traffic along the National Highway adjacent to the campus.
- Increased activity during All India Examinations and Admission periods, resulting in large gatherings and vehicular congestion.

Classroom Noise Levels: While overall campus noise levels were below the maximum permissible limits, L_{eq} levels outside classrooms occasionally exceeded the WHO-recommended 35 dB(A), highlighting the need for additional noise mitigation strategies.

Community Noise: Reduced population density within the campus helped maintain low community noise levels in most areas.

Table 10: Noise Levels in dB (A) at different locations within T.U. Campus

Sl. No.	Location	Measured Noise Level at Day Time L_{eq} dB(A)	Measured Noise Level at Day Time L_{eq} dB(A)*	Standard at Day Time for Sensitive Zone L_{eq} dB(A)	Measured Noise level at Night Time L_{eq} dB(A)	Measured Noise level at Night Time L_{eq} dB(A)*	Standard at Night Time for Sensitive Zone L_{eq} dB(A)
1	Main Gate (Entrance)	48.6	49.5	50	39.8	39.9	40
2	Near Library Building	46.1	48.6	50	39.1	39.3	40
3	Near Administrative Building	48.1	49. 8	50	39.2	39.4	40
4	Near Chemistry Department	45.2	44.7	50	34.8	35.4	40

*Monitored real time using Sound meter App of CSIR-NEERI

Observations

- Over 60% of campus residents commute on foot, significantly reducing noise from vehicular traffic.
- Noise disturbances are most noticeable:
  - Along the National Highway bordering the campus.
  - During peak campus activity periods such as examinations and admissions.

Suggestions and Recommendations

1. **Promote Sustainable and Eco-Friendly Transportation**: Encourage using bicycles, walking, and carpooling among students, faculty, and staff. Offer incentives for eco-friendly vehicles, such as electric vehicles, within the campus.

2. **Enhance Public Transportation**: Collaborate with local authorities to improve public transport accessibility to the university.

3. **Noise Mitigation Measures**: Plant vegetation around campus buildings and along the highway to act as natural noise barriers. Install soundproofing materials near classrooms and offices located in high-noise zones.

4. **Regulate Vehicular Activity**: Maintain a comprehensive vehicle log for all campus residents and staff to minimize unnecessary vehicular movement.

5. **Compliance with Noise Regulations**: Request government authorities to enforce rules for loudspeakers and noise-emitting sources within a 100-meter radius of the campus.

6. **Awareness Programmes**: Conduct campaigns to educate the campus community about noise pollution and strategies to reduce it.

7. **Improved Classroom Environment**: Take measures to ensure noise levels outside classrooms remain below the WHO-recommended 35 dB(A) to support an effective learning atmosphere.

The noise monitoring data confirms that ambient noise levels at Tripura University are largely within permissible limits. However, targeted interventions, especially at high-activity zones such as the Entrance Gate and Administrative Block, are essential to address occasional noise spikes. Implementing the recommended measures will further enhance the campus's commitment to maintaining a peaceful, eco-friendly, and academically conducive environment for all stakeholders.

SUMMARY

Environmental auditing is the process of evaluating how well the practices of an institution align with eco-friendly and sustainable principles. In this context, Tripura University conducted its Environmental Audit for 2023-2024 to assess the institution's environmental initiatives and produce a comprehensive audit report.

The environmental audit began by examining waste management systems and water consumption patterns across the university. A systematic assessment was conducted, including:

- Measuring water usage and identifying consumption patterns.
- Gathering inputs from faculty, staff, and students via surveys and interviews.
- On-site visits and direct measurements of environmental parameters in areas such as water, waste, and air quality.
- Employing standard environmental monitoring protocols to evaluate the campus's environmental health.

Campus Area: Tripura University spans **97 acres**, of which **75 acres** form the main campus. An additional **22 acres** was added in 2015.

Water Usage: Daily water consumption during 2023-24 was approximately 4, 31,000 L. Potable water quality was within the prescribed standards of the Central Pollution Control Board (CPCB). Greywater from residential quarters is reused for gardening and vegetable farming, but a reusable wastewater treatment facility for academic and residential buildings is absent.

Rainwater Harvesting: The university's natural lake serves as a primary rainwater harvesting site. Improvements in rainwater harvesting systems are recommended, ensuring every building is equipped with facilities to reuse water.

Solid Waste Generation: The university generates approximately 428 kg of solid waste weekly. Indoor Dustbins: Across 44 academic departments, 180 dustbins are installed, averaging 5 per department. Residential quarters also maintain individual dustbins and organic waste pits.

Waste Disposal Systems: About 90% of solid waste is collected bi-weekly by the Agartala Municipal Corporation (AMC) for segregation and landfill disposal. Organic waste is composted, a practice that aligns with sustainable waste management.

E-Waste Management: E-waste is managed efficiently, with unusable equipment being disposed of through authorized vendors. A buy-back option is prioritized for technology upgrades to minimize new procurement.

Hazardous Waste: Minimal hazardous waste is generated (<100 grams per month), which requires proper transportation to approved treatment facilities. Laboratory liquid waste is directed to soak pits, with other liquid wastes contributing to groundwater replenishment. However, a sewage treatment plant is yet to be established.

Air Quality Monitoring: Air quality parameters (PM_{10}, $PM_{2.5}$, SO_2, NO_2) were found to be within CPCB standards:

- PM_{10}: 63.2 µg/m³ (limit: 100 µg/m³) $PM_{2.5}$: 44.8 µg/m³ (limit: 60 µg/m³)
- SO_2: 4.39 µg/m³ (limit: 80 µg/m³) NO_2: 15.8 µg/m³ (limit: 80 µg/m³)

Primary contributors to particulate matter include vehicular traffic, construction activities, and natural dust. The campus's lush vegetation aids in the absorption of pollutants like SO2.

Noise Levels: Noise monitoring was conducted in four key locations: Entrance Gate, Administrative Block, Library Building, and Chemistry Department. Noise levels were within permissible limits during both daytime and night time. Slightly elevated noise levels were observed near the Administrative Block and Entrance Gate, primarily due to vehicular movement and stakeholder activities.

Observations and Recommendations

Observations:

1. **Waste Management**:
   - Composting of organic waste is a well-established practice.
   - Separate waste disposal systems for dry and wet waste are adopted by 40% of academic departments and 50% of residential quarters.
2. **Water Management**:
   - The absence of a wastewater treatment facility is a critical gap.
   - Rainwater harvesting practices require expansion and modernization.
3. **Air and Noise Quality**:
   - The air and noise quality across the campus meet CPCB standards, indicating minimal pollution.
   - Vehicular traffic is a significant contributor to dust and noise pollution.
4. **Community Engagement**:
   - Over 90% of faculty and staff have a clear understanding of hazardous waste management.

Recommendations:

1. **Waste Management**:
   - Establish a **sewage treatment plant** to handle liquid waste efficiently.
   - Expand separate disposal systems for dry and wet waste to all departments and residential quarters.
2. **Water Conservation**:

- Develop a centralized water treatment and recycling facility for wastewater.
- Expand rainwater harvesting systems across all buildings.

3. **Eco-Friendly Practices**:

- Reduce vehicular traffic by promoting cycling, walking, and carpooling within the campus.
- Introduce electric or eco-friendly shuttle services for students and staff.

4. **Green Initiatives**:

- Plant additional vegetation along high-traffic areas to mitigate noise and air pollution.
- Expand composting initiatives to include all organic waste.

5. **Policy and Awareness**:

- Create university-wide policies to promote sustainable practices, including waste reduction, water conservation, and energy efficiency.
- Conduct awareness campaigns to educate stakeholders on eco-friendly practices.

CONCLUSION

The Environmental Audit Report for 2023-24 reflects that Tripura University is progressing steadily toward sustainability. While the environmental status of water, air, and noise on campus is satisfactory, there is room for improvement in waste and water management systems.

By implementing the suggested measures, Tripura University can strengthen its commitment to eco-friendly practices, contributing to sustainable development and setting an example for institutions globally. The audit report serves as a guide to achieving long-term environmental goals while fostering a green and sustainable campus.

Appendix-I

Green/Energy/Environmental Audit Questionnaire - Tripura University – 2023-2024

Instructions: Please provide accurate and detailed information to aid in the Green/Energy/Environmental Audit Report's data collection and analysis. Your responses are crucial in assessing the university's environmental practices and sustainability efforts.

Section 1: Stakeholder Survey

Please specify if you are a:

Teaching Staff	
Non-Teaching Staff	
Student	
Other (please specify)	

Section 2: General Awareness

a) Whether TU/ any department has conducted awareness/responsibility programme among the staff/student members:

Yes		No		Maybe	

b) Whether all the departments/teachers/non-teaching members/students are aware about the need of the environmental protection and audit:

Yes		No		Maybe	

c) Whether TU has involved the students as volunteers in green activities/ programme:

Yes		No	

d) Whether TU has conducted any workshop/seminar/lecture on environmental awareness programme inside and/or outside the campus:

Yes		No		Maybe	

Section 3: Water Consumption, Usage and Management

a) Whether TU has an efficient and hygiene water storage facility/ structure/ mechanism to minimize the loss of water during storage:

Yes		No	

b) Whether TU has installed/ is using water filter with RO, Aqua Guard and/or large water filter with cooler at strategic locations in the departments/ Central library/ other centres within the campus:

Yes		No	

c) Whether TU has its own mechanism and/ or technical personnel to repair water leakage/ carry out routine inspection:

Yes		No		Don’t know	

d) Whether rainwater harvesting units are installed in TU Campus:

Yes		No		Maybe		Don’t know	

e) Whether TU has developed/ is developing a system for reuse and recycle of water:

Yes		No		Don't know	

f) Whether there is any of necessity for assessing the Water Quality Index (parameters: pH, EC, TDS, Turbidity, metal contaminants- Iron, Arsenic, etc.) of water used in hostel, lab, office, canteen, tap water:

Yes		No		Maybe		Don't know	

g) Whether TU has adequate/ sufficient drainage system:

Yes		No	

h) Do you have any knowledge of the university's water availability and usage patterns?

Yes		No	

i) If your response to the above question is Yes, please provide any details you are aware of regarding water usage and conservation efforts: _____

Section 4: Energy Conservation Strategies and practices

a) Whether TU has any provision/choice of renewable and carbon-neutral electricity options:

Yes		No		Maybe	

b) Whether TU is planning / has installed solar panels for harnessing solar energy:

Yes		No		Maybe	

c) Whether TU has efficient water heating system:

Yes		No		Maybe		Don't know	

d) Whether you are concerned in turning off electrical appliances when not in use either in institutional and/ or commercial and/ or residential area:

Yes		No	

e) Whether there is monitoring system to switch off the power mains when not in use:

Yes		No		Don't know	

f) Whether the users follow the appropriate and measurable targets for a reduction of energy, such as, computer, printers, lab equipment when not in use

Yes		No		Maybe		Don't know	

g) Whether there any options for equipment's running on standby mode:

Yes		No		Maybe		Don't know	

h) Whether TU has taken initiative to purchase efficient and environmentally sound appliances in order to fulfill the green budget:

Yes		No		Maybe		Don't know	

i) Whether TU has its own mechanism in repairing of electrical fault:

Yes		No		Maybe		Don't know	

j) Whether the class rooms are with sufficient illumination in day time and ventilation

Yes		No	

k) How many (%) e-notice generated by the college for academic/administrative purposes in a month? _____

l) Whether TU has organized lectures on energy conservation in order to give awareness to the students:

Yes		No		Maybe	

m) How frequently do you use appliances/equipment within the university premises?

Daily		Rarely		Few times a week		Few times a month	

Other: _____

n) Can you provide general characteristics of the appliances/equipment you use regularly? (e.g., lighting, computers, printers, etc.) _____

o) Whether the architectural design for TU is based upon use of natural lighting & ventilation, to save extra power for bulbs and fans:

Yes		No	

p) Whether florescent bulbs are replaced with CFL bulbs/LEDs:

Yes		No		Don't know	

q) Are you aware of any conservation strategies or practices implemented within Tripura University?

Yes		No	

r) If your response to the above question is Yes, could you briefly describe these strategies or practices? _____

s) Whether TU has any common car sharing/car pool among the students and faculty:

Yes		No		Maybe		Don't know	

t) Mode of commute to TU:

Public		Private		Walking	

u) If you use private vehicle to commute please specify the type of vehicle:

4-Wheeler with CNG		4-Wheeler without CNG	

2 Wheeler		Bicycle	

Section 5: Waste Management and Sustainability

a) How familiar are you with the waste disposal practices followed within the university?

Very Familiar		Somewhat Familiar		Not Familiar	

b) Is there any method of segregation of waste materials?

Yes		No		Maybe		Don't know	

c) Have you observed any waste reduction or recycling initiatives on campus?

Yes		No	

d) Whether TU has arranged any workshop/seminar/conference for awareness of the students/staff for specific arrangements for recyclable wastes:

Yes		No		Maybe		Don't know	

e) Whether TU follow specific disposal method for solid or liquid waste in specific manner:

Yes		No		Maybe		Don't know	

f) Whether the recycling/collection facilities are provided by the Agartala Municipality Council and/or private suppliers (recyclables including glass, white plastic bottle, printer cartridges, cardboard, furniture, plastics, thermocol, waste papers, electrical goods & appliances, electronic gadgets, instruments, equipment, packing materials):

Yes		No		Maybe		Don't know	

g) Whether TU has any composting ground/ waste collection from every household or any collection unit, etc.:

Yes		No		Don't know	

h) Is there any mechanism of treatment/uses of domestic influent in the college campus (if so,

Yes		No		Don't know	

i) If the response to the above question is Yes, what is the capacity of treatment plant/composting etc.? _____

j) Is there any incidents of burning of plastics containing garbage within the campus for necessary reduction?

Yes		No		Maybe		Don't know	

k) Whether the cleaning products used by the TU staff are eco-friendly and under the COSHH (Control of Substances Hazard to Health) regulations:

Yes		No		Don't know	

l) Whether TU is using fertilizers, pesticides for any purposes

Yes		No		Don't know	

m) If your response to the above is Yes, please specify amount used per month and places of uses: _____

E-WASTE MANAGEMENT

n) Is there any means of disposal of unused computers, printers and electronic wastes through authorized agents?

Yes		No		Maybe		Don't know	

Section 6: Biodiversity and Land Use

a) Is there any garden inside/outside the campus under TU custody?

Yes		No	

b) Whether the garden is watered by using drip/sprinkler irrigation system:

Yes		No		Maybe		Don't know	

c) Have you come across migratory birds and wild animals in the TU campus?

Yes		No	

d) Have you come across stray animals (dogs, cats) in the TU campus?

Yes		No	

e) Have you noticed any efforts to preserve or enhance biodiversity within the university campus?

Yes		No		Maybe		Don't know	

f) If the response to the above question is Yes, please provide any information about those efforts?

_____

g) Is there any mechanism of review or periodical monitoring of tree species?

Yes		No		Don't know	

h) Whether TU has taken any programme for plantation of some fruit trees which can attract birds, bees etc.:

Yes		No		Don't know	

Section 7: Environmental Quality Assessment

a) Have you observed any changes in the ambient environmental quality within the university campus?

Yes		No	

b) If your response to the above question is 'Yes', please describe the changes you've observed: _____

Section 8: Conservation Strategies and Practices

a) Are you aware of any conservation strategies or practices implemented within Tripura University?

Yes		No	

b) If your response to the above question is 'Yes', please briefly describe these strategies or practices? _____

Thank you for taking the time to complete this questionnaire. Your input are invaluable in shaping the Green/ Energy/Environmental Audit Report and contributing to Tripura University's commitment to environmental sustainability

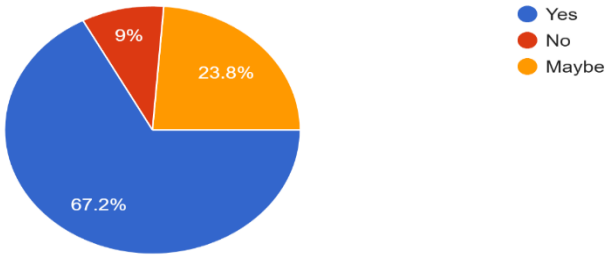
Appendix-II

This section contains responses obtained as a result of the questionnaire survey conducted on the stakeholders. Tripura University is at the forefront of developing into a model environmentally sustainable campus with efforts from relevant departments and also all the concerned stakeholders. Several sensitization programmes are conducted at the departmental and university level as well as outreach-outside campus programmes for general awareness. The university perseveres to promote judicious use of resources, proper disposal of residues and waste, maintaining the cleanliness of campus and making an environmental pollution free campus that can enhance the overall growth and development of the academic atmosphere of all the stakeholders. The questionnaire consists of several questions that seek to understand the impact of the efforts being felt by the stakeholders. The survey revealed that more ventures are needed for mass awareness, acceptance and participation to steer the paradigm shift towards an epitome of environmental stewardship among the universities in the country. The questionnaire is divided into sections and is presented as follows:

General Awareness

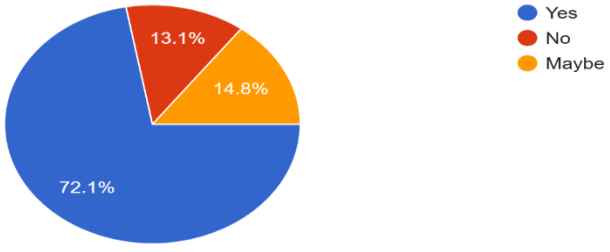
a) Whether TU/ department has conducted any awareness/ sensitization programme among the staff/ student members:

122 responses

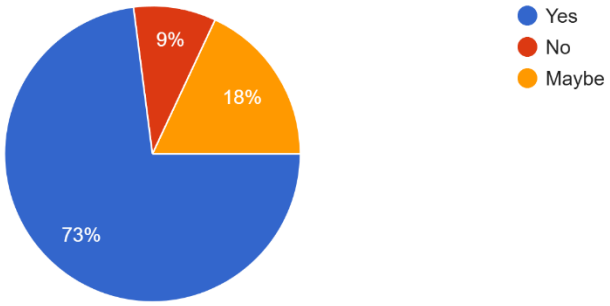


b) Whether all the departments/ teachers/ non-teaching members/ students are aware about the need of the environmental protection and audit:

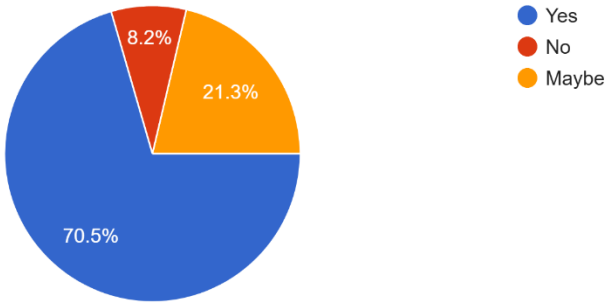
122 responses



c) Whether TU has involved the students as volunteers in green activities/ programmes:
122 responses

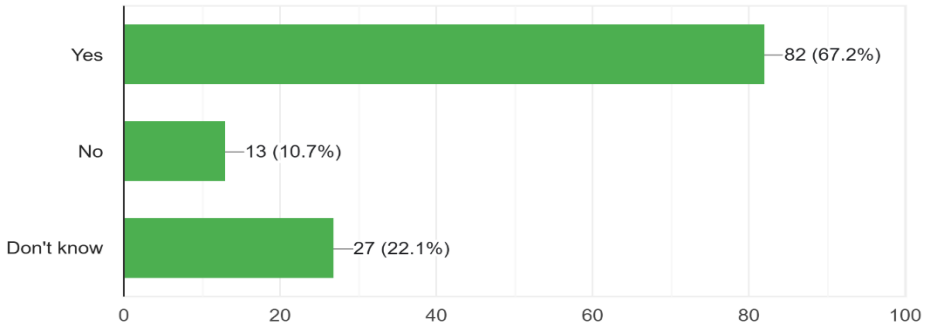


d) Whether TU has conducted any workshop/ seminar/ lecture on environmental awareness programme inside and/or outside the campus for society/ people outside the university:
122 responses



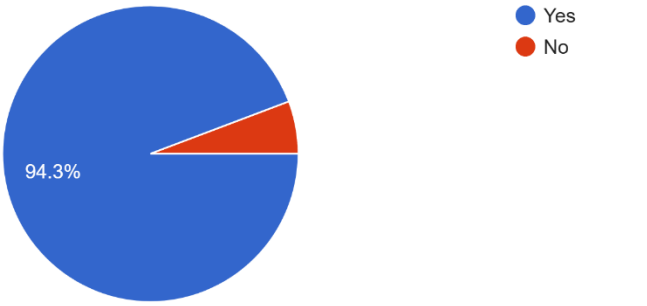
Water Consumption, Usage and Management

a) Whether TU has an efficient and hygienic water storage facility/ structure/ mechanism to minimize the loss of water during storage:
122 responses



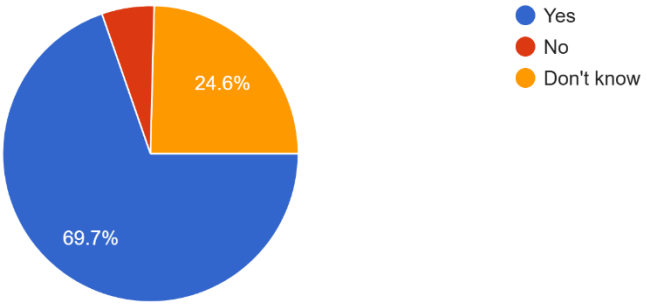
b) Whether TU has installed/ is using water filter with RO, Aqua Guard and/ or large water filter with cooler at strategic locations such as in the departm.../ Central library/ other centres within the campus:

122 responses



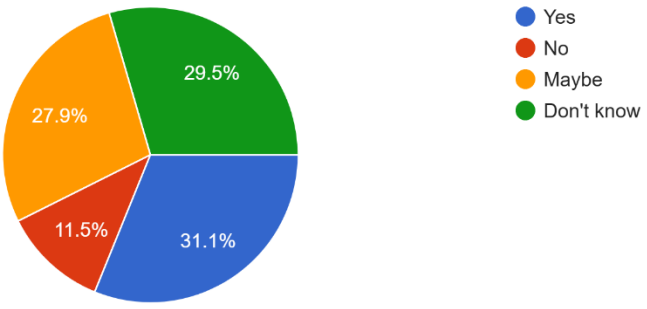
c) Whether TU has its own mechanism and/ or technical personnel to repair water leakage/ carry out routine inspection:

122 responses



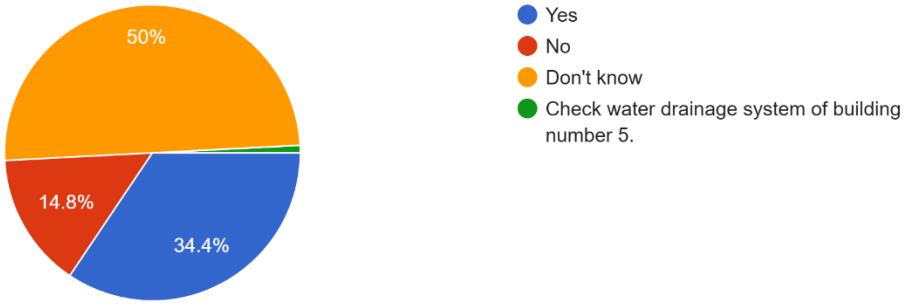
d) Whether rainwater harvesting units are installed in TU Campus:

122 responses



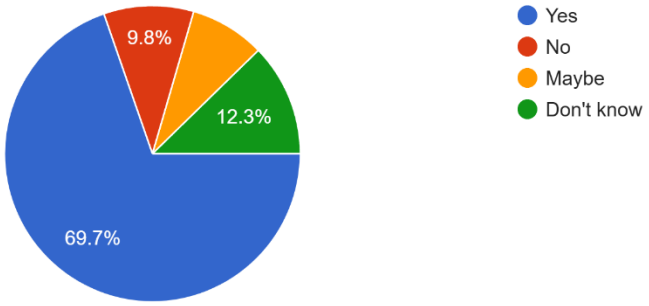
e) Whether TU has developed/ is developing a system for reuse and recycle of water:

122 responses



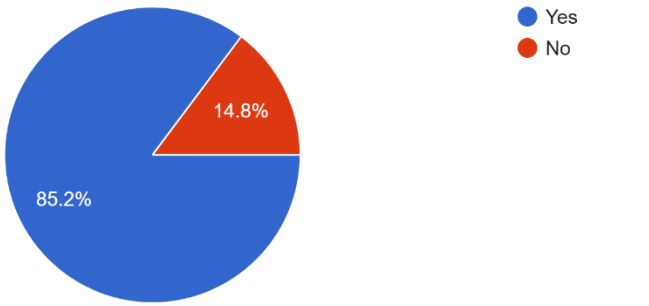
f) Whether there is any necessity for assessing the Water Quality Index (parameters: pH, EC, TDS, Turbidity, metal contaminants - Iron, Arsenic, etc.) o...at includes hostels, lab, office, canteen, tap water:

122 responses



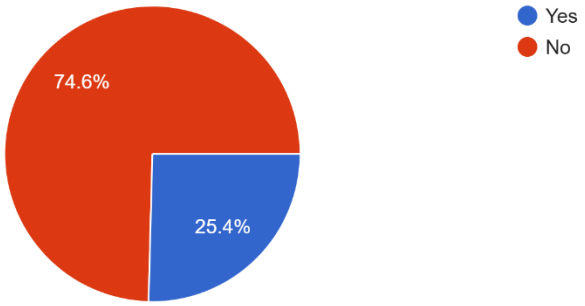
g) Whether TU has adequate/ sufficient drainage system:

122 responses



h) Do you have any knowledge of the university's water availability and usage patterns?

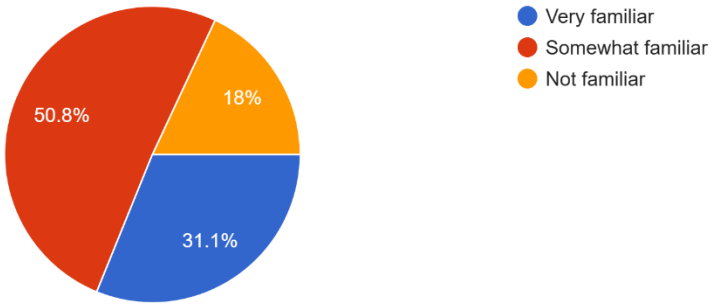
122 responses



Waste Management and Sustainability

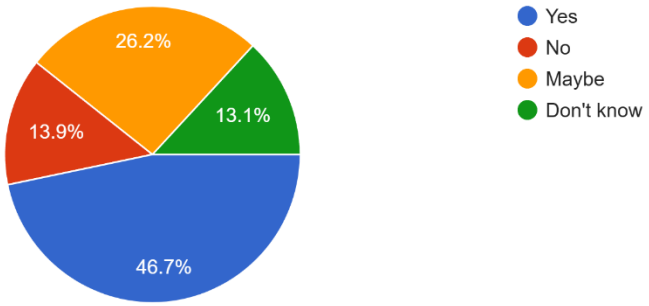
a) How familiar are you with the waste disposal practices followed within TU campus?

122 responses



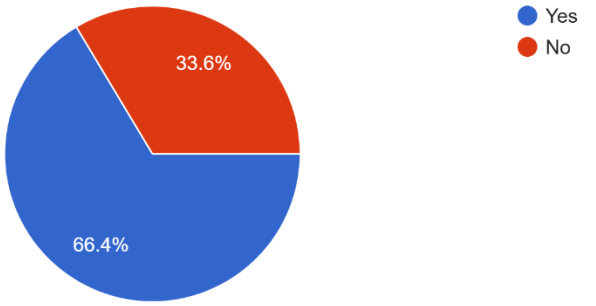
b) Is there any method of segregation of waste materials?

122 responses



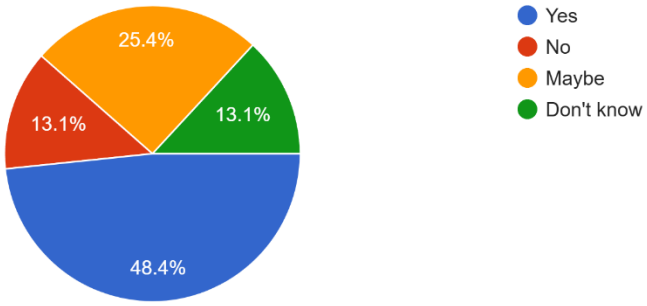
c) Have you observed any waste reduction or recycling initiatives on campus?

122 responses



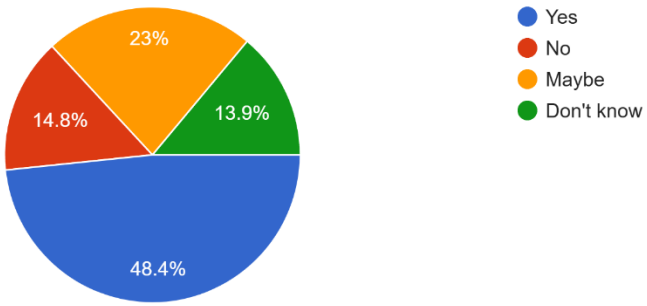
d) Whether TU has arranged any workshop/ seminar/ conference for awareness the students/ staff for specific arrangements for recyclable wastes:

122 responses

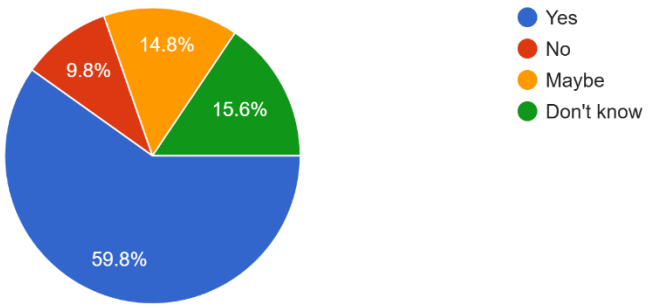


e) Whether TU follow specific disposal method for solid or liquid waste in specific manner:

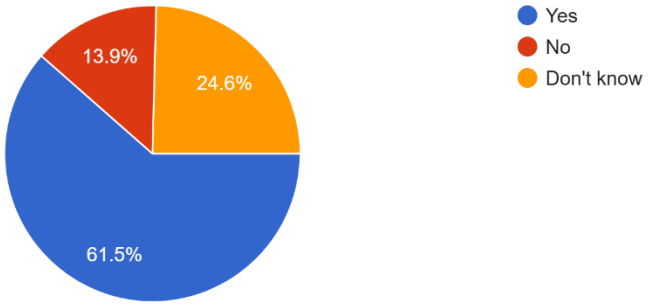
122 responses



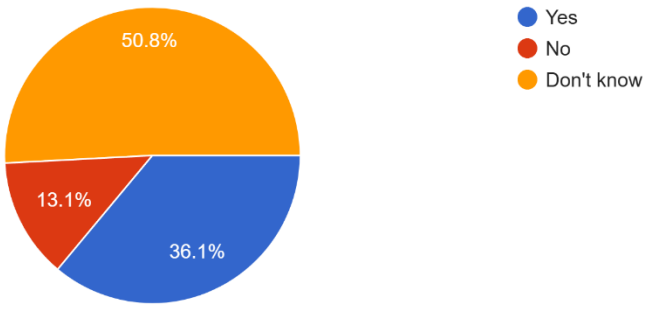
f) Whether the recycling/ collection facilities are provided by the Agartala Municipality Council and/or private individuals/ organizations (recyclab...dgets, instruments, equipment, packing materials):
122 responses



g) Whether TU has any composting ground/ waste collection from every household or any collection unit, etc.:
122 responses

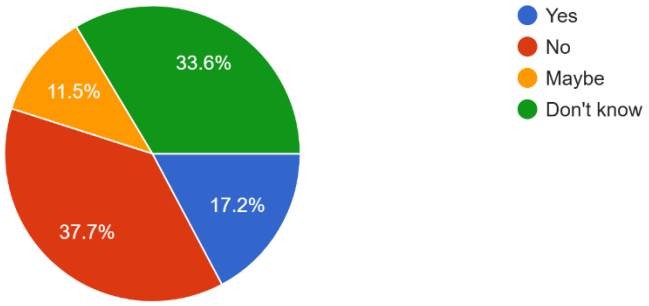


h) Is there any mechanism for treatment/ secondary uses of domestic effluent in the TU campus?
122 responses



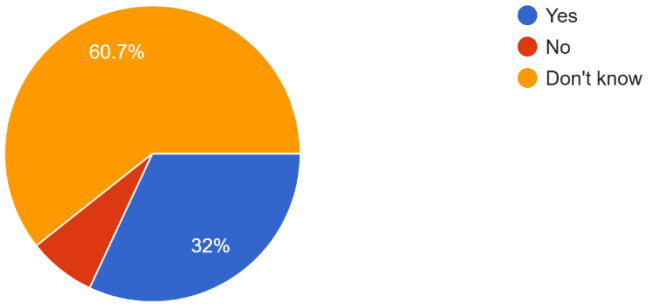
j) Is there any incidents of burning of plastics containing garbage within the campus for necessary reduction?

122 responses



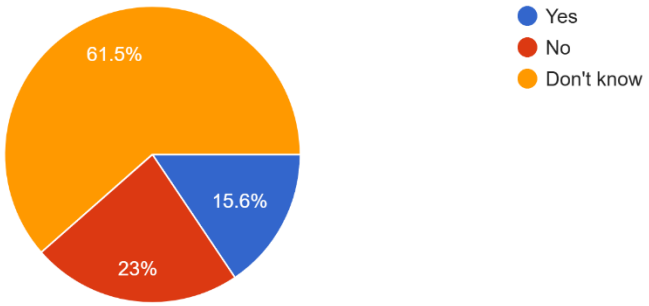
k) Whether the cleaning products used by the college staff are eco-friendly and under the COSHH (Control of Substances Hazard to Health) regulations:

122 responses



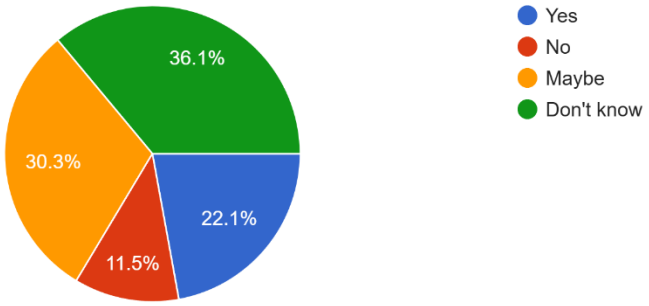
l) Whether TU is using fertilizers, pesticides for any purposes:

122 responses



E-waste Management n) Is there any means of disposal of unused computers, printers and electronic wastes through authorized agents?

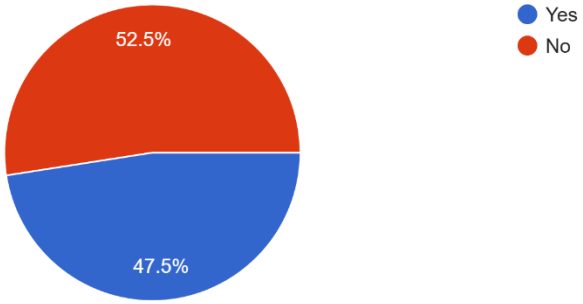
122 responses



Environmental Quality Assessment

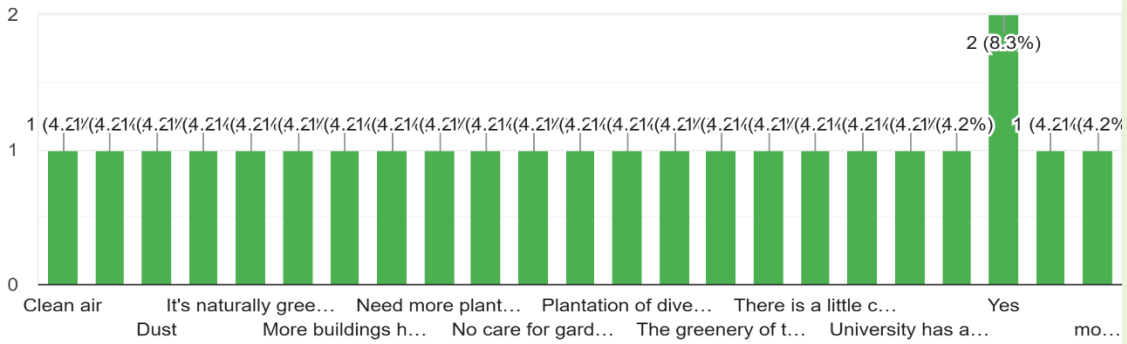
a) Have you observed any changes in the ambient environmental quality within the university campus?

122 responses



b) If your response to the above question is Yes, please describe changes that you have observed

24 responses



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