Manipal University Jaipur Hazardous Waste Disposal Policy

1. Introduction

Manipal University Jaipur is dedicated to the safe and responsible management of hazardous materials generated on campus. This policy outlines our commitment to handling hazardous waste in compliance with local, state, and federal regulations and establishes procedures to safeguard the environment and the health and safety of our university community.

2. Purpose

- The objectives of this policy are to:
- Ensure the proper identification, handling, and disposal of hazardous waste.
- Comply with all relevant laws and regulations regarding hazardous waste management.
- Foster a culture of environmental responsibility and safety among university staff, faculty, students, and contractors.
- Raise awareness about waste disposal amongst stakeholders.

3. Policy Statements

Hazardous Waste Identification

- All university personnel are accountable for identifying materials classified as hazardous waste in alignment with regulatory guidelines.

- The Directorate of General Services & Administration will provide guidance and training to assist in the identification of hazardous materials.

Hazardous Waste Handling and Storage

- Hazardous materials must be stored in containers that are appropriately labeled with hazard information and disposal instructions.

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- Hazardous waste should be kept in designated, well-ventilated, and secure areas that are accessible only to authorized personnel.

- The university will maintain an inventory of hazardous materials and waste stored on campus.

Hazardous Waste Minimization

- Manipal University Jaipur is committed to reducing the generation of hazardous waste by promoting the use of less hazardous materials and processes whenever feasible.

- Faculty and staff are encouraged to explore sustainable alternatives and participate in waste minimization training.

Hazardous Waste Disposal

- Only authorized personnel trained in hazardous waste handling and disposal are permitted to transport and dispose of hazardous materials.

- Hazardous waste will be managed through licensed and authorized waste disposal facilities in full compliance with applicable regulations.

- University departments and laboratories are responsible for maintaining records of hazardous waste disposal activities.

Emergency Response

- The university will have established procedures and resources for responding to accidental releases or spills of hazardous materials to reduce potential risks to health and the environment.

- All personnel will receive training in emergency response procedures and be informed of the location of emergency equipment, including spill kits and eyewash stations.

4. Implementation

4.1. Responsibility

- The Directorate of General Services & Administration will oversee the implementation and enforcement of this policy.

- Each department and laboratory on campus is responsible for complying with this policy and ensuring proper hazardous waste management.

4.2. Compliance

- Non-compliance with this policy, as well as local, state, and federal regulations, may result in disciplinary actions, fines, or legal consequences as per university policies and applicable laws.

5. Training and Education

- The university will provide ongoing training and education to ensure that all personnel understand and adhere to hazardous waste disposal protocols.
- Regular drills and exercises related to emergency response will be conducted to maintain preparedness.

6. Reporting and Documentation

- All incidents involving hazardous materials must be promptly reported to the Directorate of General Services & Administration.
- Comprehensive records of hazardous waste generation, handling, and disposal will be maintained in accordance with regulatory requirements.

7. Review and Revision

This policy will be reviewed annually to ensure its continued effectiveness and compliance with evolving hazardous waste regulations and best practices.

8. Conclusion

Manipal University Jaipur is dedicated to the safe and responsible management of hazardous waste on campus. Through diligent adherence to this policy, we aim to protect the

environment, ensure the health and safety of our community, and maintain our commitment to regulatory compliance.

Version History

Number	Year	Major Revision
Version 4.0	2023	Focus on awareness
Version 3.0	2022	Updated Regulations in accordance with CPCB
Version 2.0	2021	COVID 19 Regulations
Version 1.0	2020	Initial policy

Approval

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Project Completion Report

Project Type: Research Fund Grant/ R21-1877916181

Project title: Harnessing the potential of Polyhydroxyalkanoates (PHA) from *Rhodopseudomonas palustris* as sustainable resource for production of bioplastics

Introduction: Plastics are widely utilized due to their durability and low cost, however, they are mostly generated from non-renewable resources such as natural gas, petroleum, or coal and contain additives such as stabilizers and plasticizers (Filho *et al.*, 2022). These chemicals, which are commonly present in plastics like polyvinyl chloride (PVC), polypropylene (PP), and polyethylene terephthalate (PET), can be toxic, functioning as endocrine disruptors or carcinogens. They can enter the body by skin contact, ingestion, or inhalation, particularly when used in food packaging (Adeniran and Shakantu, 2022; Gaston and Tulve, 2019; Hahladakis et al., 2018; Filho *et al.*, 2021). About 76% of plastic produced globally becomes waste, with 9% recycled, 12% incinerated, and 79% landfilled or released into the environment. This improper disposal harms ecosystems and poses health risks (Geyer, Jambeck and Law, 2017; Sameh S. Ali *et al.*, 2021a; Sameh Samir Ali *et al.*, 2021b). Environmental concerns about plastic waste have driven the shift from petrochemical-based plastics to biobased, biodegradable alternatives, called bioplastics (Reddy, Reddy and Gupta, 2013). Despite their introduction in the 2000s, bioplastics still represent only about 0.5% of the over 400 million tonnes of plastic produced annually (Folino *et al.*, 2020; European Bioplastics, 2023). By 2023, production had reached 2.18 million tonnes, with biodegradable plastics making up roughly 55%. This is expected to rise to 7.43 million tonnes by 2028, driven by increasing demand and advancements in technology (European Bioplastics, 2023). Various types of biobased plastics differ in their raw materials, chemical structures, production methods, and applications, but they offer similar material properties to conventional plastics. One of the most common examples is Polyhydroxyalkanoates (PHA). PHAs are biobased polyesters that are produced as carbon/energy storage materials in microbial cells under stress. These accumulate as intracellular granules without harming the host cell. Their biodegradability and good physical and mechanical qualities make them a viable substitute for conventional petroleum-based plastics (Rajvanshi *et al.*, 2023).

PHAs are produced by various microbial species including *Rhodopseudomonas palustris* (*R. palustris*). *R. palustris* is a versatile purple non-sulfur photosynthetic bacterium popular for its ability to produce bioplastics such as PHAs from diverse carbon and nitrogen sources. It possesses the ability to switch among four metabolic modes, indicating its adaptability to various environments, such as marine sediments and waste lagoons. Along with other bacteria such as *Rhodobacter* and *Rhodospirillum*, it is capable of utilizing various carbon sources for the production of polymers. Other than this, this species possesses potential applications in biotechnology, specifically in hydrogen production, electricity generation, and bioremediation (Brown, Wilkins and Saha, 2022)**.** Despite various attempts to generate industrial PHAs utilizing microorganisms, the costs remain a significant challenge. The high cost of microbial bioplastic synthesis remains a substantial impediment to industry growth. Large-scale PHA manufacturing usually utilizes pure microbial cultures that rely on expensive sugar-based substrates, which raises overall production costs. Furthermore, the process consumes a huge amount of freshwater, reducing availability and increasing expenses (Rajvanshi *et al.*, 2023). Addressing these challenges, the present study has explored the ability of *R. palustris* to use a wide range of substrates in varied conditions for cost-effective PHA production, along with using domestic reverse osmosis (RO) reject water as the major contributor in the production process, hence reducing unsustainable freshwater use. RO reject water is rich in nutrients and free from pathogens, making it an ideal nutrient source for microbial cultivation with minimal alterations. Using this water stream can significantly reduce the costs of expensive nutrient growth media and lessen the reliance on freshwater in cultivation systems (Bhandari and Prajapati, 2022a). This approach enables more cost-effective and large-scale biomass production. This is further helping in repurposing an unmanaged waste stream of RO reject water into a useful and environmentally sustainable process of PHA production.

2. Review of literature:

Based on the literature review, Table 1 summarizes the significance of bioplastic production, highlighting the numerous industries from which waste materials can be derived as substrates. These waste substrates, including agricultural waste, food waste, and industrial byproducts, play an important role in sustainable bioplastic production by lowering dependency on fossil fuels and strengthening waste valorization.

Table 1. List of waste resources used as substrates for cost-effective bioplastic production

S. No.	Waste carbon source	Microorganisms	Cultivation technique	Maximum biomass production	Biobased plastic produced	Maximum production	References
1	Mixture of crude and saponified SCG oil	*Cupriavidus necator* DSM 545	Shake flask technique	8.5 g/L	Polyhydroxyalkanoate (PHA)	84.4% (w/w)	(Ingram, Martin and Winterburn, 2022)
2	Nitrogen-deficient cheese whey mother liquor	*Paracoccus homiensis*	Shake flask technique	3.3 g/L	Poly (3-hydroxybutyrate-co-3-hydroxyvalerate) P(3HB-co-3HV)	1.1 g/ L	(Mozejko-Ciesielska *et al.*, 2022)
3	Fermented concentrated cheese whey permeates	Mixed microbial culture (MMC)	Sequencing batch reactor	-	PHA	62% g PHA/ g VSS	(Colombo *et al.*, 2019)
4	Fermented secondary cheese whey			-		55.1% g PHA/ g VSS	
5	Digestate of chicken manure with sunflower frying oil	*Cupriavidus necator* H16	Shake flask technique	75.1 % cell dry mass	PHA	4.6 g/ L	(Altun, 2019)
6	Waste frying oil with 40 g/ L NaCl	*Halomonas hydrothermalis*	Shake flask technique	3.64 g/ L	Polyhydroxybutyrate (PHB)	2.26 g/ L	(Pernicova *et al.*, 2019)
7	Onion peel	*Bacillus siamensis* PD-A10	Shake flask technique	90.86 g/ L	PHA	67.56 g/L	(Vijay and Tarika, 2019)
8	Paper industry effluent	*Ancylobacter aquaticus*	Shake flask technique	-	PHA	41.7% w/w	(Tyagi and Sharma, 2021)
9	Beer brewery wastewater	*Cupriavidus necator*	Batch system	7.90 g/ L	PHB	3 g/ L	(Amini *et al.*, 2020)
10	Candy industry wastewater	*Cupriavidus necator* H16	Flask culture	1.11 g/ L	PHB/ Polylactic acid (PLA)	65% (w/w)	(Hernández-Herreros *et al.*, 2024)
11	Digested sludge	*Rhodopseudomonas* sp. S16-VOGS3	Photobioreactor	0.37 g/ L	PHB	18.5 mg/ L	(Touloupakis *et al.*, 2023)
12	Olive mill wastewater	*Rhodopseudomonas* sp. S16-FVPT5	Tube culture	0.13 g/ L	PHB	101 mg/ L	(Carlozzi *et al.*, 2019)

3. Objectives

- Design a novel cost-effective artificial media mimicking seawater and optimize the parameters for the growth of *R. palustris.*
- Optimize culture conditions for high PHA production under different sets of nutrients limiting and stress conditions.
- Screen and qualitatively characterize the PHA granules via staining and microscopy and quantify the percentage of PHA accumulation.
- Augment the extraction of PHA from cell biomass and analyse its molecular structure.

4. Methodology:

The *Rhodopseudomonas palustris* MDOC01 strain, isolated in our lab from dairy waste, was cultured in a synthetic medium called Designed Synthetic Water Medium (DSWM) containing minerals along with glycerol and monosodium glutamate as carbon and nitrogen sources. The cells were grown in 500 ml glass bottles with Q series GL45 caps for sampling and argon gas purging to maintain an anoxic environment. The cultures were kept at 30-35°C with continuous stirring at 500 rpm and 4000 lux light from 60 W incandescent bulbs (Syed, Sogani, Kumar, *et al.*, 2022). Figure 1 describes the detailed methodology followed during the work

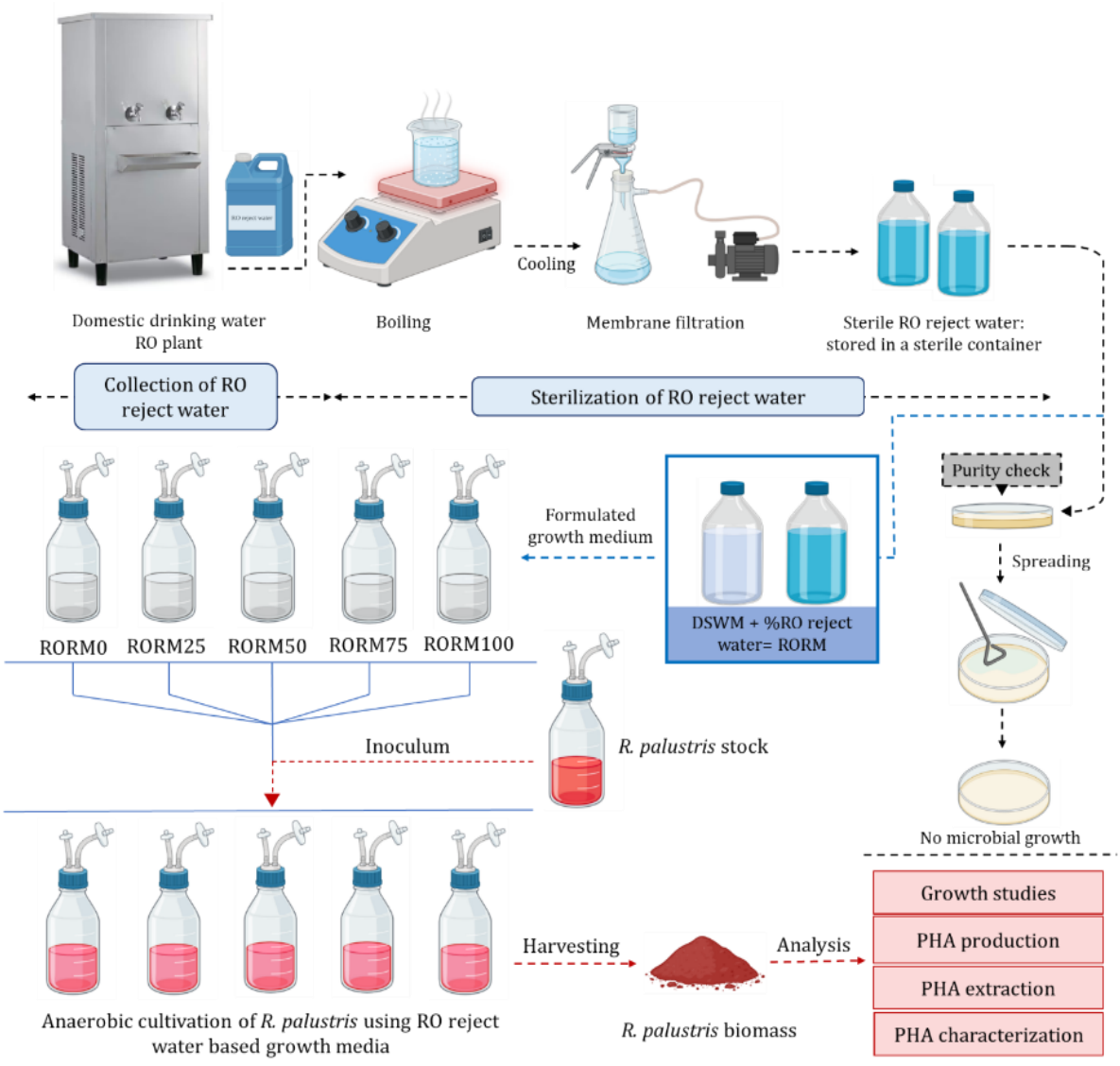

Figure 1. Detailed methodology of the research work

5. Results and discussion:

OBJECTIVE 1

Collection of RO reject water: The reject water coming from a domestic drinking water RO plant has a consistent nutrient and pathogen-free composition (Bhandari and Prajapati, 2022b). RO reject water, collected from a drinking water RO plant, located at Bagru, Rajasthan, was used to develop a novel cost-effective growth media for *R. palustris* culturing. Initially, the water was subjected to physicochemical analysis to determine its composition and suitability as a growth medium. Table 2 reveals that upon comparison with DSWM, the RO reject water was found to be very similar in the ionic and mineral composition to the DSWM. This, in addition to the metabolic adaptability of *R. palustris,* supports RO reject water as a cost-effective growth medium.

Table 2. Physicochemical analysis of the RO reject water

Parameters	**Results**
pH	7.9
TDS (ppm)	1318
Electrical conductivity (µS cm^{-1})	2636
Salinity (PSU)	1.34
Alkalinity (mg L^{-1})	258.5
Total hardness (mg L^{-1} as $CaCO_3$)	82.9
Chloride (mg L^{-1})	409
Sodium (mg L^{-1})	265.75
Potassium (mg L^{-1})	6.32
Nitrate nitrogen (ppm)	16.6
Nitrite (ppb)	2.0
Calcium (ppm)	200
Magnesium (ppm)	1000
Ammonical nitrogen (mg L^{-1})	<2.0
Ammonia (ppm)	0.06
Phosphate (ppm)	0.90
Phosphorus (mg L^{-1})	<0.50
Sulphate (mg L^{-1})	54.8
Fluoride (mg L^{-1})	<0.05
Iron (mg L^{-1})	<0.1

As the work was on pure microbial strain, the RO reject water was first subjected to sterilization via boiling followed by filtration. The sterility was confirmed by the spread plate technique and no microbial growth was observed within 24-48 hours of incubation. Further, the RO reject water was provided with glycerol and sodium glutamate as carbon and nitrogen sources, forming RO Reject water Medium (RORM). This, in addition to the metabolic adaptability of *R. palustris,* supports RO reject water as a cost-effective growth medium.

Suitability of RORM as a growth medium for *R. palustris* in terms of biomass and bacteriochlorophyll *a* (Bchl *a*) yields (Syed, Sogani, Sharma, *et al.*, 2022)**:** For this, the sterile RO reject water was mixed with different concentrations of DSWM (RORM0 (Positive control), RORM25, RORM50, RORM75, RORM100) and the N: C ratio of 5.4 mM: 10 mM was made consistent in all media sets (Sogani *et al.*, 2020). During 10 days of growth, RORM75 showed good biomass and Bchl *a* concentration and productivity (Biomass: 1.75 g L^{-1}; 92.44 mg L^{-1} d^{-1}; Bchl *a*: 15.10 mg L^{-1}; 1.223 mg L^{-1} d^{-1}), comparable to the control (RORM0; 2.0 g L^{-1}, 148.8 mg L^{-1} d^{-1}).

Microscopic analysis of *R. palustris* in RORM75: Scanning Electron Microscopy (SEM) was used to observe the morphology of *R. palustris*. As illustrated in Figure 2, no significant morphological differences were observed between the cells grown in RORM75 and DSWM (control). This finding suggests that RORM75 does not substantially alter the cell morphology, which is a positive indication regarding its impact on *R. palustris*.

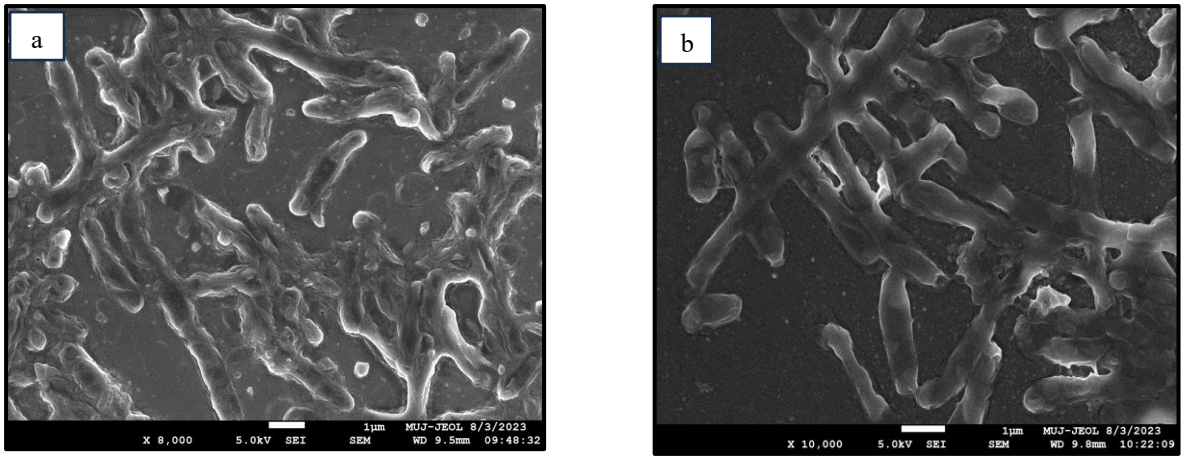

Figure 2. SEM images of *R. palustris* cells grown in (a) DSWM and (b) RORM75

Deliverables:

- RO reject water stream, otherwise discarded and not managed properly, can be repurposed for microbial cultivation for high biomass yield, hence suggesting an environmentally sustainable approach for RO reject water recycling.
- With appropriate adjustments, RORM75 offers both environmental and economic advantages for *R. palustris* cultivation, by replacing expensive nutrients present in the conventional growth media.

OBJECTIVE 2:

Production of PHA under PHA-producing culture conditions: As reported earlier, PHAs are produced by microbial cells under stress conditions (e.g. Nutrient limitation) and high carbon concentration in the form of energy and carbon storage granules (Mannina *et al.*, 2020)**.** The present work used the concept of feast and famine conditions for microbial PHA production. In the feast phase, *R. palustris* was provided with abundant nutrients for maximum growth and then subjected to the famine phase with limited nutrients for PHA production. As RORM75 showed the maximum biomass, it was taken further for PHA production along with RORM0 and RORM100. Figure 3 shows the culture conditions for PHA production from *R. palustris.*

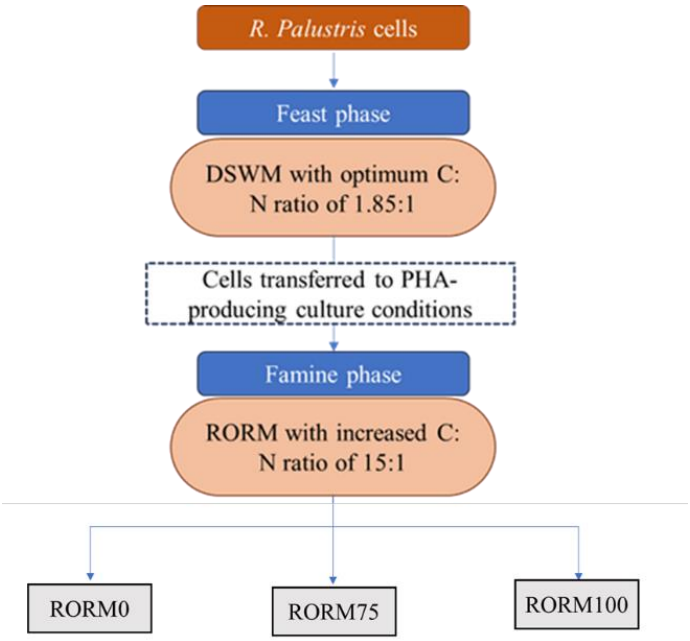

Figure 3. Various culture conditions for PHA production from *R. palustris*

After 7 days of the famine phase, PHA was extracted using the hypochlorite method, and the percent PHA of cell dry weight (CDW) was calculated in each condition (Marudkla *et al.*, 2018). Figure 4 depicts the white-colored PHA extracted from *R. palustris* from RORM75 with a C: N ratio of 15:1 and Table 3 shows the PHA yield

obtained in each culture condition and it can be concluded that RORM75 with a C: N ratio of 15:1 yielded the maximum PHA of 130 % CDW.

Figure 4. PHA extracted from *R. palustris* cultured in RORM75 with C: N= 15:1

Table 3. Amount of PHA obtained from *R. palustris* in various culture conditions

S. No	Culture conditions with C: N= 15:1	Amount (mg)	% PHA of CDW
1	RORM0	196	10.6
2	RORM75	1336	130
3	RORM100	27	2.4

Deliverables:

- The most suitable combination of feast and famine phases for high PHA production from *R. palustris* is DSWM with an optimum C: N ratio as the feast phase and RORM75 with a high C: N ratio of 15:1 as the famine phase.

OBJECTIVE 3 and OBJECTIVE 4

Characterization of the extracted PHA: The extracted PHA was subjected to Fourier Transform Infrared Spectroscopy (FTIR) and Proton Nuclear Magnetic Resonance (^{1}HNMR) analysis for its chemical and molecular characterization (El-Kadi *et al.*, 2021). Figures 5 and 6 show the FTIR and ^{1}HNMR spectra of PHA extracted from RORM75 and the standard PHA obtained from Sigma Aldrich.

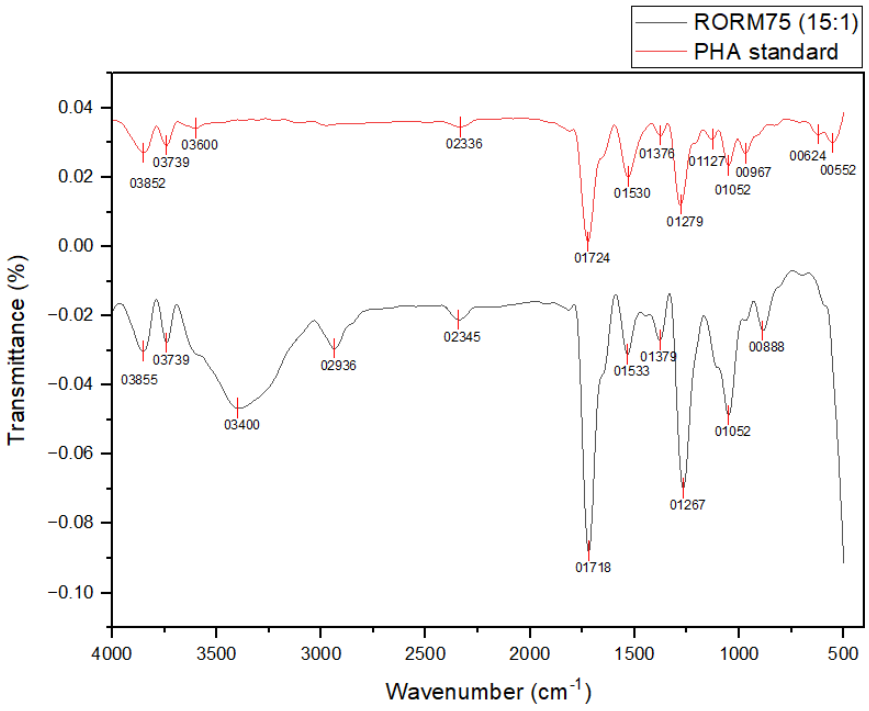

Figure 5. FTIR spectra of PHA extracted from RORM75 and the standard PHA obtained from Sigma Aldrich

PHA was characterized in the range of 500–4000 cm^{-1}. A broad and weak band around 3600 cm^{-1} in the standard indicates O-H stretching, showing the presence of hydroxyl groups like alcohols or carboxylic groups. A similar but less prominent band is seen around 3700–3600 cm^{-1} in the case of PHA extracted from RORM75 (15:1), The O-H or N-H stretching is seen in both the cases but the intensity in PHA extracted from RORM75 (15:1) is weaker, possibly due to lower concentration or interaction of the hydroxyl groups. A sharp and intense peak at 1724 cm^{-1} in standard PHA might indicate strong C=O stretching, which is typical for esters or carboxylic acids. This is a defining feature of PHA, which contains ester bonds. PHA from RORM75 (15:1) also has strong C=O peaks, but it is slightly shifted (1718 cm^{-1}) which may reflect different carbonyl environments or interactions with other groups. Peaks at 1376 cm^{-1} and 1279 cm^{-1}, correspond to C-H bending and C-O stretching in esters in the standard. Similar peaks are present but with some shifts in the PHA extracted from RORM75 (15:1), such as peaks at 1379 cm^{-1} and 1267 cm^{-1}. This region may also show contributions from other functional groups. The fingerprint region which is unique to each compound, shows that PHA extracted from RORM75 (15:1) has structural differences compared to the PHA standard, likely due to differences in its polymeric structure or side chain composition.

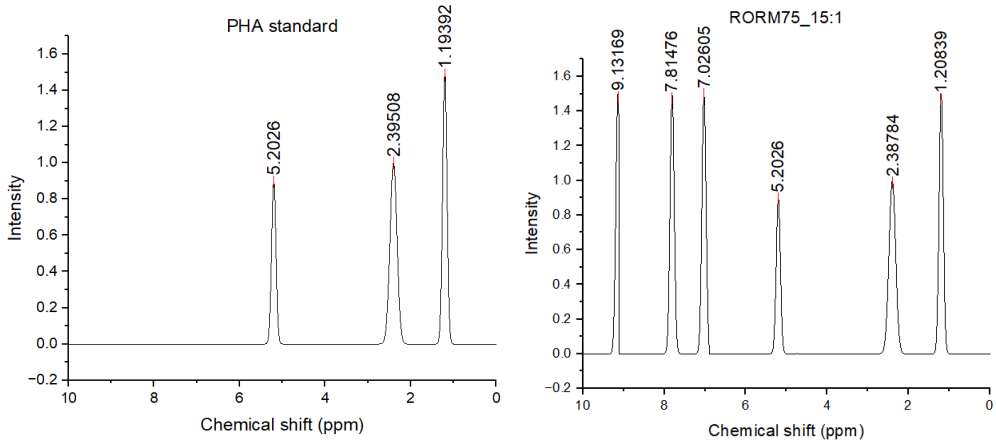

Figure 6: ^{1}HNMR spectra of PHA extracted from RORM75 (15:1) and the standard PHA obtained from Sigma Aldrich

The key observations from the spectra of standard PHA include a peak at 5.20 ppm showing the methine proton (-CH), attached to the carbonyl group in the polymer backbone, typical of PHA. This indicates an ester linkage where a proton is adjacent to a carbonyl group. Another peak at 2.39 ppm corresponds to methylene protons (-CH_2) adjacent to the carbonyl group in the PHA structure, again indicating ester functionality. Lastly, a peak at 1.19 ppm represents a methyl group (-CH_3) at the end of the alkyl chain, commonly found in PHAs where the chain ends with methyl groups. Comparing both spectrums, additional peaks at 9.13 ppm, 7.81 ppm, 7.02 ppm are unique to PHA extracted from RORM75 and absent in the PHA standard, suggesting the presence of aromatic groups, but the common peaks at 5.20 ppm, 2.38 ppm, and 1.20 ppm, in the spectrum of PHA obtained from RORM75 (15:1) are comparable to the standard and indicates that both materials contain ester groups (C=O) and aliphatic chains.

Deliverables:

- FTIR: PHA extracted from RORM75 (15:1) appears to share a similar backbone to PHA but with structural variations, possibly due to the presence of different side groups, chain lengths, or copolymer compositions.
- ^{1}HNMR: The PHA produced by *R. palustris* in RORM75 (15:1) is a modified version of the PHA, containing the same core ester and aliphatic groups as the PHA standard, but with significant modifications involving the addition of aromatic components.

6. Conclusion:

RO reject water can be used as a growth medium for cost-effective culturing and high biomass production of *R. palustris*.This concept not only makes the process of microbial cultivation economical but also provides an environmentally sustainable and safe approach for RO reject water management, thus avoiding environmental issues like groundwater and soil contamination caused by its current improper management strategies. Further, in the study, *R. palustris* stands out as an efficient microbial system for high PHA production, using RO reject water for the famine phase, thus also suggesting an approach for large-scale cost-effective production of PHA from *R. palustris*. The present study addresses various environmental issues, including improper RO reject water management, huge freshwater and expensive nutrient demand for high microbial biomass production, and plastic

pollution caused by the increased use of petro-based plastic materials. Moreover, a switch from using nonrenewable resources to renewable ones for developing materials like plastics would also help in dealing with climate change mitigation. Overall, the study focuses on exploiting the possible benefits of versatile microbes like *R. palustris* in maintaining the quality, health, and sustainability of the environment.

Outcomes:

Journal publications

- Rajvanshi, J., **Sogani, M.**, Kumar, A., Arora, S., Syed, Z., Sonu, K., Gupta, N.S. and Kalra, A., 2023. Perceiving biobased plastics as an alternative and innovative solution to combat plastic pollution for a circular economy. *Science of The Total Environment*, *874*, p.162441; (Q1, Impact factor: 8.2)
- Rajvanshi, J., **Sogani, M.**, Tziouvaras, G., Kumar, A., Syed, Z., Sonu, K., Gupta, N.S. and Sen, H., 2024. An analytical review on revamping plastic waste management: exploring recycling, biodegradation, and the growing role of biobased plastics. *Environmental Science and Pollution Research*, pp.1-19; (Q1, Impact factor: 5.8)
- Rajvanshi, J., **Sogani, M.**, Kumar, A. and Arora, S., 2023. Biomaterials: A Sustainable Solution for a Circular Economy. *Engineering Proceedings*, *59*(1), p.133; (SCOPUS Indexed conference proceeding).

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Manipal University Jaipur

Note Sheet

Manipal University Jaipur
Registrar Office
Recd on 31/8/23 Sr.No 2464
Signature

Date: 31.07.2023

It is informed you that the consultancy proposal was discussed and finalised during the time of Australia. Therefore, the agreed amount is in USD. However, UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION is also operating from India, and they have agreed for the transfer of the money in INR in the MUJ Account. The total amount of the consultancy is INR 1591619 including GST.

The based on the attached agreement the following will be the payment plan under this consultancy:

- 20% up receipt of the duly countersigned contract - INR 318324
- 20% upon completion of Deliverable - 1 and acceptance of the corresponding report by UNIDO- INR 318324
- 50% upon submission of Deliverable -2 and acceptance of the corresponding report by UNIDO - INR 795809
- 10% upon acceptance of the Final report by UNIDO - INR 159162

This consultancy belongs to the Department of Chemical and Biotechnology with association of Department of Mechanical Engineering.

The detail of the proposal is attached in the separate format "Request for proposal".

The proposal is submitted for the approval and booking of the consultancy amount as per the MUJ rules.

Abhishek Sharma | Anand G. Chakinala | Rahul Goyal | Dharmesh Yadav

Name and Sign of PI and Co-PIs

HoD :
Director : 31/07/23

DOR

21/8/23

Recommended and forwarded to Director (Research)

28.8.23

Registrar

04/08/2023

MANIPAL UNIVERSITY
JAIPUR

Directorate of Research

Proposal for Consultancy

Date: 31.07.2023

To

The Registrar

Manipal University Jaipur

Subject: Approval of Proposal for Consultancy Project

The Following details are submitted for your kind pursual and approval of the same.

1.	Title of the Consultancy Proposal	BENCH-SCALE EXPERIMENTATION RELATED TO THERMOCHEMICAL CONVERSION (THROUGH PYROLYSIS) OF PLASTIC WASTES GENERATED FROM RECYCLED-FIBRE BASED PAPER MILLS
2.	Consultancy Type (Research Based/Non-Research based)	Research based
2.	Name of the Principal Investigator (Department/School/Phone/E-mail)	Dr. Abhishek Sharma Professor, Department of Biotechnology and Chemical Engineering
3.	Name of the Co-Principal Investigator (Department/School/Phone/E-mail)	Dr. Anand Chakinala (Biotechnology and Chemical Engineering) Dr. Rahul Goyal (Mechanical Engineering) Mr. Dharmesh Yadav (Mechanical Engineering)
4.	Name of the Institution with Full Address	Manipal University Jaipur
5.	Proposed duration of Consultancy Project	6 months
6.	Name of Consultant Partner	United Nations Industrial Development Organization
7.	Address and Contact Details of Consultation Partner	Wagramer Strasse 5, A-1220 Vienna, Austria
8.	Consultancy Amount requested as per Estimated Budget (in Rs.)	INR 1591619 (including GST)
9.	Bank Account Details for Fund Transfer (Kindly Endorse by MUJ Finance)	**Name: MANIPAL UNIVERSITY JAIPUR** **Account No. 41058604477** **Account Type: Savings** **Branch Name and Code: SBI Bhankrota, Jaipur (11396)** **IFSC Code: SBIN0011396**

MANIPAL UNIVERSITY
JAIPUR

Technical Details of the Consultancy Proposal

1.	Title of the Consultancy Proposal	BENCH-SCALE EXPERIMENTATION RELATED TO THERMOCHEMICAL CONVERSION (THROUGH PYROLYSIS) OF PLASTIC WASTES GENERATED FROM RECYCLED-FIBRE BASED PAPER MILLS
2.	Summary of the proposed consultancy project .	The novel thermo-chemical conversion of waste plastic and paper mixture has a great potential for the recovery of value-added products such as diesel grade fuel, adsorbents, catalysts, fillers, and raw materials for graphene and activated carbon fabrication. Further research is required in this direction for establishing overall sustainability in circular economy framework.
3.	Objectives	For improving the overall process design and conducting application-based studies, specific activities are proposed in this project. The applications focused under this project are extensive diesel engine performance testing and rubber compounding, with process optimization and high-level techno-economic analysis.
4.	Approach	1. Feed characterization will be carried out with thermo-chemical upgradation in a semi-continuous unit at varying operating conditions (temperature between 500 to 700°C and residence time between 60 to 120 mins). Product yield and quality will also be studied. This will be completed in first and second month. 2. Diesel engine studies will be conducted for improving the overall performance with emission characteristics analysis at four different blending ratios (5-20) and six engine loading (2-12 kg) at fixed compression ratio and engine speed. The optimal blend fuel will be selected based on considerable enhancement in brake thermal efficiency and maximum reduction in emissions. This will be completed in second and third month. 3. Investigate long-term effect of plastic oil in diesel engines to identify operational problems related to wear and maintenance such as engine deposits, piston ring sticking, injector choking, gum formation, and lubricating oil thickening. Experimental study will be conducted on diesel engine for 512 h with optimum blend fuel. This test will complete in 32 days (32 cycles). This will be completed in third and fourth month. 4. Rubber compounding studies using char will be performed at site of Indian Rubber Manufacturer Research Association (IRMRA) in Mumbai. Details of this activity with budget will be shared by IRMRA team. This will be completed in second and third month. 5. High level techno-economics for process scale up and project reporting with stakeholder engagement. This will

		be completed in fifth and sixth month.	
5.	Available Institutional facilities	Semi pilot pyrolysis unit Research engine test rig Distillation setup Analytical Facilities	
6.	Consultancy Amount	Consultancy Charges	1348829
		GST (18% of Consultancy Charges)	242789
		Total Amount	1591619

Please enclose the sanction letter of the consultancy partner.

Abhishek Sharma Anand G. Chakinala Rahul Goyal Dharmesh Yadav

Name and sign of the PI Name and Sign of the Co-PI

HOD 31/07/2023

Director (School) Forwarded

Directorate of Research

CONTRACT NO. 3000116873

between the

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

(UNIDO)

and

MANIPAL UNIVERSITY JAIPUR

(MUJ)

FOR THE PROVISION OF SERVICES RELATED TO BENCH-SCALE EXPERIMENTATION RELATED TO THERMOCHEMICAL CONVERSION (THROUGH PYROLYSIS) OF PLASTIC WASTES GENERATED FROM RECYCLED-FIBRE BASED PAPER MILLS

UNIDO Project No.: 180200

This Contract comprises this cover page, a table of contents and 6 pages of text and 9 pages of Annexes (Annex A through B).

UNIDO
COR/PRO

TABLE OF CONTENTS

CONTRACT

between the

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

(UNIDO)

and

MANIPAL UNIVERSITY JAIPUR

(MUJ)

FOR THE PROVISION OF

SERVICES RELATED TO BENCH-SCALE EXPERIMENTATION RELATED TO THERMOCHEMICAL CONVERSION (THROUGH PYROLYSIS) OF PLASTIC WASTES GENERATED FROM RECYCLED-FIBRE BASED PAPER MILLS

THIS CONTRACT is entered into between the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION, a Specialized Agency of the United Nations, having its headquarters located at Wagramer Strasse 5, A-1220 Vienna, Austria (hereinafter referred to as "UNIDO"), and **MANIPAL UNIVERSITY JAIPUR**, having its principal office located at Dehmi Kalan, Off Jaipur-Ajmer Expressway, Jaipur - 303007, Rajasthan, India, (hereinafter referred to as the "Contractor"). UNIDO and the Contractor are collectively referred to herein as the "Parties" and each individually as a "Party".

WHEREAS, UNIDO, in response to a request from the Government of India (hereinafter referred to as the "Government"), has agreed to provide assistance to the Government in carrying out the project entitled "Firm-level demonstration of technologies and productivity enhancement for the pulp and paper industry (hereinafter referred to as the "Project") in India (hereinafter referred to as the "Project Area");

WHEREAS, in this connection, UNIDO, acting in agreement with the Government, desires to engage a contractor to provide the services and perform the work hereinafter set forth;

WHEREAS, UNIDO intends to procure services required to implement manufacturing excellence /lean manufacturing tools in selected pulp and paper mills in the Project Area; and

WHEREAS, the Contractor represents that it possesses the requisite knowledge, skill, personnel, resources and experience and that it is fully qualified, ready, willing, and able to provide such services (as defined below) and perform such work in accordance with the terms and conditions set forth in this Contract;

NOW, **THEREFORE**, the Parties hereto mutually agree as follows:

ARTICLE 1

SCOPE OF THE CONTRACT

In accordance with the terms and conditions stated herein and in the Annexes hereto, the Contractor shall provide all the services (hereinafter referred to as the "Services") as described in detail in the terms of reference dated 02 June, 2023, as subsequently clarified and/or amended in writing by UNIDO, (hereinafter collectively referred to as the "Terms of Reference") and the Contractor's proposal dated 09 June, 2023, which the Contractor submitted to UNIDO in response to UNIDO's Request for Proposal No. 7000006278 dated 02 June, 2023 and clarified by e-mails dated 29 June, 2023 and 05 & 06 July, 2023 (hereinafter collectively referred to as the "Proposal"). The Contractor's said Proposal although not attached hereto, is made a part hereof by way of reference.

ARTICLE 2

CONTRACT DOCUMENTS

This document, together with the Annexes attached hereto and referred to below, all of which are incorporated herein and made part hereof, constitute the entire contract between UNIDO and the Contractor for the provision of the Services (hereinafter referred to as the "Contract"). The Contract supersedes all prior representations, agreements, contracts and proposals, whether written or oral, by and between the Parties with regard to the subject matter. The documents comprising the Contract are complementary to one another, but in case of ambiguities, discrepancies or inconsistencies between or among them, the following order of priority for purposes of application and interpretations shall apply:

i. This document;

ii. General Conditions of Contract (hereinafter referred to as "GCC") (Annex A);

iii. Terms of Reference (Annex B);

iv. Proposal.

ARTICLE 3

ENTRY INTO FORCE AND DURATION

The Contract shall enter into force upon the date of the last signature by the duly authorized representatives of the Parties, and shall remain in force until satisfactory fulfillment of all contractual terms and conditions unless terminated earlier pursuant to the terms of the Contract.

ARTICLE 4

DELIVERABLES

The Contractor shall submit to UNIDO in English in one electronic copy of editable format the following deliverables:

Deliverable 1: Conduct of experiments for feed characterization and pre-treatment of plastic waste and corresponding report as specified in section "scope of the proposed contracted services" at Section 3 at Sl # 3 a and c) of this Terms of Reference **within 2 months from the date of issuance of contract.**

Deliverable 2: Experiments for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas), process optimization and corresponding report on "technical process and findings of experiments conducted for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization"; as specified in section "scope of the proposed contracted services" at Section 3 at Sl # 3 b and c) of this Terms of Reference **within 5 months from the date of issuance of contract.**

Deliverable 3: Final Report on "experiments and studies conducted covering background of the thermochemical conversion process, assessment of this pyrolytic conversion vis-à-vis comparable treatment/technology options; strategy adopted and rationale for choice of optimal process parameters; results of experiments conducted; and estimated technoeconomic parameters for scaling up adoption of pyrolytic conversion of plastic wastes from RCF-based paper mills"; as specified in section "scope of the proposed contracted services" at Section 3 at Sl # 3 c) of this Terms of Reference **within 6 months from the date of issuance of contrac**t.

ARTICLE 5

PERSONNEL

For the performance of its obligations under the Contract, the Contractor shall make available in line with the Contractor's Proposal.

The Key Personnel to be provided by the Contractor, their project function and the duration of their assignments shall be as follows:

Name	Project Function
Dr. Abhishek Sharma	Project Leader
Dr. Rahul Goyal	Project Team member
Dr. Anand Gupta Chakinala	Project Team member
Dr. Dharmesh Yadav	Project Team member

The Contractor's Team Leader shall be: Dr. Abhishek Sharma

ARTICLE 6

CONTRACT PRICE

UNIDO shall pay the Contractor for the full and proper performance of its obligations under the Contract the sum of USD 19,347 (including GST *); hereinafter referred to as the "Contract Price".

Progress payments on account of the Contract Price shall be made in the currency and in the pro-rated amounts, against receipt and acceptance of the Contractor's invoices, as follows:

[USD]

i. 20% upon UNIDO's receipt of the duly countersigned contract - USD 3,869.40
ii. 20% upon completion of Deliverable - 1 and acceptance of the corresponding report by UNIDO- USD 3,869.40
iii. 50% upon submission of Deliverable -2 and acceptance of the corresponding report by UNIDO - USD 9,673.50
iv. 10% upon acceptance of the Final report by UNIDO - USD 1,934.70

Grand Total: USD 19, 347 (inclusive of GST)

No payment shall be released until receipt by UNIDO, along with the countersigned Contract, of the Bank Information Form, which shall be completed, signed and stamped by the Contractor.

* GST to be claimed separately

ARTICLE 7

COMMUNICATIONS

Official communications in relation to the Contract shall be in English and shall be made to the following contact persons:

UNIDO:

For contractual matters:

Mr. Farrukh Alimdjanov
Project Manager
Industrial Development Officer, TCS/DAS
UNIDO
Wagramer Strasse 5
A-1220 Vienna
Austria
Tel.: +43 1 26026 Ext. [5090]
Email: F.ALIMDJANOV@UNIDO.ORG

Contractor:

Dr. Abhishek Sharma
Professor of Chemical Engineering, Faculty of Engineering
MANIPAL UNIVERSITY JAIPUR (MUJ)
Dehmi Kalan, Off Jaipur-Ajmer Expressway
Jaipur – 303007
State-Rajasthan-India
Tel.: +91- 7073024573
Email: abhishek.sharma@jaipur.manipal.edu

IN WITNESS WHEREOF, the Parties hereto have executed this Contract.

For and on behalf of **UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION** By..... Mr. Farrukh Alimdjanov Project Manager Industrial Development Officer, TCS/DAS UNIDO Wagramer Strasse 5, A-1220 Vienna Austria Date.....	For and on behalf of **Manipal University Jaipur** By..... Dr. Abhishek Sharma Professor of Chemical Engineering Faculty of Engineering MANIPAL UNIVERSITY JAIPUR Dehmi Kalan, Off Jaipur-Ajmer Expressway Jaipur – 303007, Rajasthan India Date.....

****

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

TERMS OF REFERENCE

For services related to "bench-scale experimentation related to thermochemical conversion (through pyrolysis) of plastic wastes generated from recycled-fibre based paper mills."
Project ID 180200

1. GENERAL BACKGROUND INFORMATION

The United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. UNIDO supports countries to industrialize in ways that foster digital and green transitions and accelerate progress with the Sustainable Development Goals. UNIDO provides support to its 171 Member States through four mandated functions: technical cooperation; action-oriented research and policy-advisory services; normative standards-related activities; and fostering partnerships for knowledge and technology transfer. The Directorate of Technical Cooperation and Sustainable Industrial Development (TCS), headed by a Managing Director, oversees the Organization's development of capacities for industrial development as well as industrial policy advice, statistics and research activities and the Organization's normative contribution to Member States and global development community in achieving the SDGs. The Directorate also ensures the application of strategies and interventions for sustainable industrial development related to Environment, Energy, SMEs, Competitiveness and Job creation, as well as Digitalization and Artificial Intelligence.

One of the projects implemented by UNIDO is a project in India ''Firm-level demonstration of technologies and productivity enhancement for the pulp and paper industry" funded by the Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry, Government of India. The objective of the project is to enhance the productivity and competitiveness of the Indian pulp and paper industry. This project aims to demonstrate process improvement interventions as well as the applicability of two innovative technologies in Indian paper mills.

2. AIM OF THE PROJECT

The objective of the current project is to contribute to enhancing the productivity and competitiveness of the Indian pulp and paper industry. The project aims to achieve this objective through two types of interventions at the firm level: (i) demonstration of process optimization and productivity enhancement measures and (ii) demonstration of innovative technologies (Membrane filtration technology, black liquor heat treatment technology and application of Chlorine dioxide).

Under this project, it is aimed to explore and demonstrate a potential option for the utilization of plastic wastes generated in recycled fibre (RCF)-based paper mills. India produces approximately 22 million tonnes of paper per annum (including paper, paperboard, and newsprint). About ~73% of this production comes from mills using recycled fibre (or wastepaper) as the primary fibre source for the production of paper, paperboard, and newsprint. RCF-based mills generate over 0.5 million tonnes of plastic wastes per

annum, disposal of which is a major challenge for the paper industry, from an environmental point of view. Disposal also represents a productivity loss and waste of resources with potential alternative, albeit unexplored, applications.

It is envisaged to facilitate bench-scale experimentation to explore the feasibility of (i) thermochemical conversion of plastic waste generated in paper mills into pyrolysis oil, char and syn gases through pyrolysis; (ii) utilization of the resultant oil as a boiler fuel or for blending applications along with diesel fuel in paper mills; and (iii) utilization of resultant syn gaseous fractions for heating of pyrolysis reactor for sustaining the energy requirement of the process.

In this context, UNIDO is looking to identify a suitable technical institution to conduct bench-scale experiments at their facilities, as per the details provided in the following sections.

3. THE SCOPE OF THE PROPOSED CONTRACTED SERVICES

The scope of the Terms of Reference (ToR) includes activities related to conducting bench-scale experimentation related to thermochemical conversion (through pyrolysis) of paper wastes generated from recycled-fibre based paper mills. In context of the aforementioned, UNIDO would like to receive a technical offer (inclusive of tentative implementation schedule) and a respective cost estimate in the form of a proforma invoice for the activities defined and listed below:

a) Experiments for feed characterization and pre-treatment:
   - Conduct bench-scale experiments and trials for characterization and pre-treatment for feed plastic waste, prior to experiments for thermochemical conversion through pyrolysis.

b) Experiments for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization:
   - Conduct bench-scale experiments using a pyrolysis reactor[1] to determine optimal process conditions of the pyrolytic process that would convert plastic wastes (emerging from RCF-based paper mills) into oil, char and syn/fuel gases. Process optimization and related adjustments would be done with a view to understand the conversion behavior and product generation via thermochemical treatment process, and would aim to maximize oil yields and enhance quality of oil generated (which would involving upgrading or separation of oil fractions including yield estimation of liquid, solid and gaseous products in different operating conditions).
   - Conduct studies on oil generated through pyrolysis of the plastic waste to explore the feasibility of its use as a boiler fuel or feasibility of blending this oil with diesel fuel in paper mills.
   - Conduct studies to assess the generated syngas in terms of composition and calorific value to determine its usage for heating the pyrolysis reactor and other thermal requirements of the thermochemical conversion process.

c) Preparation of three reports on:
   - Findings of feed characterization and pre-treatment experiments/studies;
   - Technical process and findings of experiments conducted for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization;

[1] It is expected that potential bidders would already be in possession of a pyrolysis reactor for the intended experiments. Purchase of additional equipment is not within the scope of this contract.

- Final report on experiments and studies conducted covering background of the thermochemical conversion process, assessment of this pyrolytic conversion vis-à-vis comparable treatment/technology options; strategy adopted and rationale for choice of optimal process parameters; results of experiments conducted; and estimated technoeconomic parameters for scaling up adoption of pyrolytic conversion of plastic wastes from RCF-based paper mills.

4. LOCATION

The services as defined in the scope of this ToR are required to be carried out in the Republic of India.

5. GENERAL TIME SCHEDULE

The scope of services, as defined in section 3 are to be completed in no more than **six months from the date of issuance of contract.** Interim deadlines for different activities are indicated below:

S.No.	Milestones	Month
1	Experiments for feed characterization and pre-treatment of plastic waste and report	Within 2 months from issuance of contract
2	Experiments for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization and report	Within 5 months from issuance of contract
5	Final report	Within 6 months from issuance of contract

6. PERSONNEL REQUIREMENTS

Technical and Functional Experience

a) The bidding institution should demonstrate at least 10 years' experience in providing research and testing-related services related to chemical engineering or related areas.
b) The experts undertaking the assignment from the bidding institutions should have a minimum of a post-graduate degree in chemical engineering or related areas.
c) The experts undertaking the assignment from the bidding institutions should have a minimum of 8 years' work experience in providing research or testing-related services.
d) CVs of the expert(s) should be submitted in order to demonstrate respective backgrounds (1 electronic copy each, to be included in the offer).
e) Fluency in written and spoken English is required.

7. LANGUAGE REQUIREMENTS

All written material submitted to UNIDO should be in English and of such quality that no additional technical editing is required.

8. DELIVERABLES

Conclusion of contract implies delivery of:

a) Conduct of experiments for feed characterization and pre-treatment of plastic waste;
b) Report on experiments for feed characterization and pre-treatment of plastic waste;

c) Conduct of experiments for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization;

d) Report on experiments for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization;

e) Final report.

9. QUALIFICATION REQUIREMENTS

Following are qualification requirements for bidders' offer to be considered:

a) Corporate registration: The bidder should provide a certified copy of their Certificate of Incorporation or other documents setting forth the legal basis of the company/organization and therefore proving a legal capacity to enter into a contract.

b) **Authorization:** The bidder should provide a copy of relevant licenses and/or authorizations enabling the company to perform the services required under the RFP.

c) Internationally recognized quality standards: The bidder should provide evidence of relevant accreditation and/or relevant international quality standards.

d) **Years in business:** The bidder should be able to evidence existence of operations for at least ten (10) years.

e) **Required financial information:** The bidder shall provide a certified copy of its Financial Statements for the last 3 years of business (if the bidder has not been in business for 3 years Certified Financial Statements for the period that they have been in business should be provided).

f) Failure by the bidder to meet mandatory qualification requirements will exclude the bidder from further consideration in the procurement process.

10. EVALUATION CRITERIA

COMMERCIAL

a) Total price/cost: The total cost of the services to be delivered as per the details provided in the Terms of Reference. Financial proposal to be included as per format attached in Annex I.

b) Payment Schedule: The bidders comply with the following payment schedule:

Deliverable	**Instalment against deliverable**
Signing of contract	20%
Experiments for feed characterization and pre-treatment of plastic waste and report	20%
Experiments for thermochemical conversion of plastic waste through pyrolysis (for conversion into oil, char and syn gas) and process optimization and report	50%
Final report	10%

CONTRACTUAL

a) **Agreement to the UNIDO contractual terms and conditions:** The bidder should confirm the acceptance of UNIDO contractual terms and conditions.

b) **Scope**: The bidder should confirm agreement to deliver scope of services as outlined in section 3 of the Terms of Reference.

TECHNICAL

a) Compliance with requirements of the Terms of Reference:

- The bidder should submit a technical proposal in compliance with the Terms of Reference, as well as detailed descriptions of sub-activities.
- The proposer should submit a narrative description of implementation plan to be used for the delivery of requested services, including an explanation of understanding of the work to be performed and the services to be provided and the overall operational plan for the execution of the work.
- Workplan for delivery of requested services should include proposed timeline/delivery schedule with clear milestones.

b) Management:

- The bidder should indicate facilities (in terms of testing laboratory, equipment and other resources) available in line with scope of services specified in the Terms of Reference.
- The bidder should indicate experience of fulfilling contracts of a similar nature to the scope of services specified in this Terms of Reference.

c) Personnel qualifications:

Technical qualifications and experience of the proposed principal personnel must meet the requirements specified in this Terms of Reference.

11. SUBMISSION OF OFFERS

a) The terms set forth in this ToR and in UNIDO General Conditions of Contract, will form a part of any contract should UNIDO accept bidder´s offer.

b) The bidder´s offer must be signed by an official legally authorized to enter into contracts on behalf of the bidder.

c) Together with an offer, following statements must be submitted by the bidder:

i) A statement that bidder has carefully reviewed the Contract/Purchase Order Form and UNIDO General Conditions and is in agreement with its terms and conditions.

ii) A statement that bidder's quotation is valid for a minimum period of 60 days from the date of the quotation. Once the offer is accepted during this period, the price quoted must remain unchanged for the entire period of the resulting contract.

iii) The bidder should also commit in writing, on company paper signed by the official signatory of the company, to following:

- company pursues a zero tolerance towards fraud and corruption;
- company confirms that not of its managers/administrators /owners has been convicted of any crime
- company confirms absence of conflict of interest of its employees, managers / administrators or owners in relation to this tender;
- company confirms that it is not and has not been suspended /barred from doing business with any UN or other public organization.

12. AWARD CONDITION

UNIDO reserves the right to split an award between any suppliers in any combination, as it may deem appropriate. If the quotation is submitted on an "all or none" basis, it should be clearly stated as such in your response to this RFP.

ANNEX I: FINANCIAL PROPOSAL FORMAT

Financial proposal format

- **A.** This form is a standardized document, which the bidder must submit to UNIDO in connection with this contract for delivery of technical/expert services.
- **B.** Where a particular cost element is not appropriate for the proposed contract, please indicate "Not applicable" or "NA" on the form.
- **C.** In addition to the cost breakdown on this form, the bidder, in good faith, should submit with this form any additional data, supporting schedules and substantiation, which are reasonably necessary for the conduct of an appropriate review of the proposed contract costs. Failure to furnish the information requested on this form may render his proposal non-responsive.
- **D.** If a cost is included in a particular item, do not duplicate the cost or any portion thereof in another item on the form.
- **E.** Unless otherwise advised, all costs on the form should be stated in Indian Rupees (INR) equivalent United States dollars.

Grand Total and Sub-totals

UNIDO RFP reference No.
Specification of Supply

UNIDO REQUIREMENTS		**TO BE COMPLETED BY THE INVITEE**				
Item	**Name and required parameters**	**Qty**	**Unit price Currency**	**Total price Currency**	**Compliance Yes/no *)**	**Remarks**
	I. Technical Services, incl.					
1						
2						
…						
	Sub-total:					
	II. Equipment, parts, supplies					
1						
2						
…						
	Sub-total:					
	III. Installation, commissioning					
	IV. Cost of transportation & insurance					
	V. Taxes, as applicable					
	Total price:					

*****

Annex A

UNIDO GENERAL TERMS AND CONDITIONS

1.Confidential Nature of Documents

All maps, drawings, photographs, mosaics, plans, reports, recommendations, estimates, documents and all other data compiled by or received by the Contractor under this Contract shall be the property of UNIDO, shall be treated as confidential and shall be delivered only to UNIDO's authorized officials on completion of the work under this Contract; their contents shall not be made known by the Contractor, without the written consent of UNIDO, to any person other than the personnel of the Contractor performing services under this Contract. The obligations of this paragraph do not lapse upon satisfactory completion of the work under this Contract or termination of this Contract, including termination by UNIDO.

2.Independent Contractor.

The Contractor shall have the legal status of an independent contractor. Any person assigned by the Contractor to perform services under this Contract shall remain in the employment of the Contractor. The Contractor's personnel and sub-contractors shall not be considered in any respect as being the employees or agents of UNIDO or the United Nations. Without restricting the generality of the foregoing, UNIDO shall not be liable for any claims and demands, loss, costs, damages, actions, suit or other proceedings, brought or prosecuted, in any manner based upon, occasioned by or attributable to the employment relationship between any person assigned by the Contractor to perform services under this Contract and the Contractor. Unless otherwise provided for in this Contract, UNIDO shall not be liable for claims of any kind in connexion with the performance of such services. The Contractor and his employees shall conform to all applicable laws, regulations and ordinances promulgated by legally constituted authorities of the Government.

3.The Contractor's Responsibility for Employees

The Contractor shall supervise and be fully responsible for the work performed by and the professional and technical competence of his employees and shall select, for work under this Contract, reliable individuals who will perform effectively in the implementation of the Contract, comply with the laws of the Government, respect the local customs and conform to a high standard of moral and ethical conduct.

4.Assignment of Personnel

The Contractor shall not assign any personnel other than those referred to in this Contract for the performance of work in the field without the prior written approval of UNIDO. Prior to assigning any other personnel for the performance of work in the field, the Contractor shall submit to UNIDO for its consideration, the curriculum vitae of any person the Contractor proposes to assign for such service.

5.Removal of Personnel

Upon written request by UNIDO, the Contractor shall withdraw from the field any personnel provided under this Contract and shall replace such personnel by other acceptable to UNIDO, if UNIDO so requests. All costs and additional expenses resulting from the replacement, for whatever reason, of any of the Contractor's personnel shall be for the account of the Contractor. Such withdrawal shall not be considered as termination in part or in total of this Contract under the provisions of paragraph 12 "Termination" hereafter.

6.Assignment

The Contractor shall not assign, transfer, pledge or make other disposition of this Contract or any part thereof or of any of the Contractor's rights, claims or obligations under this Contract except with the prior written consent of UNIDO.

7.Sub-Contracting

In the event the Contractor requires the services of sub-contractors, the Contractor shall obtain the prior written approval and clearance of UNIDO for all sub-contractors. UNIDO's approval of a sub-contractor shall not relieve the Contractor of any of his obligations under this Contract, and the terms of any sub-contract shall be subject to and in conformity with the provisions of this Contract.

8.UNIDO Privileges and Immunities

Nothing in or relating to this Contract shall be deemed a waiver of any of the privileges and immunities of UNIDO**.**

9.Non-employment of UNIDO Staff Members

The Contractor shall not, while this Contract is in effect, employ or consider the employment of UNIDO staff members without the prior written approval of UNIDO.

10.Language, Weights and Measures

Unless otherwise specified in the Contract, the English language shall be used by the Contractor in all written communications to UNIDO with respect to the services to be rendered and all documents procures or prepared by the Contractor pertaining to the work. The Contractor shall use the metric system of weights and measures and estimates of quantities involved shall be made and recorded in metric units, except when otherwise specified in the Contract.

11.Force Majeure

Force Majeure as used herein shall mean acts of God, laws or regulations, industrial disturbances, acts of the public enemy, civil disturbances, explosions and any other similar event of equivalent force not caused by nor within the control of either party and which neither party is able to overcome. As soon as possible after the occurrence of any event constituting Force Majeure, and if the Contractor is thereby rendered unable, wholly or in part, to perform its obligations and meet its responsibilities under this Contract, the Contractor shall give notice and full particulars thereof in writing to UNIDO. In this event, the following provisions shall apply:

(a) The obligations and responsibilities of the Contractor under this Contract shall be suspended to the extent of its inability to perform them and for as long as such inability continues. During such suspension and in respect of work suspended, the Contractor shall be entitled only to reimbursement by UNIDO, against appropriate vouchers, of the essential costs of maintenance of any of the Contractor's equipment and of per diem of the Contractor's personnel rendered idle by such suspension.

(b) The Contractor shall, within fifteen (15) days of the occurrence of the Force Majeure, submit a statement to UNIDO of estimated expenditures for the duration of the period of suspension.

(c) The term of this Contract shall be extended for a period equal to the period of suspension taking, however, into account any special conditions which may cause the time for completion of the work to be different from the period of suspension.

(d) If the Contractor is rendered permanently unable, wholly or in part, by reason of Force Majeure, to perform its obligations and meet its responsibilities under this Contract, UNIDO shall have the right to terminate this Contract on the same terms and conditions as are provided for in paragraph 12, "Termination" except that the period of notice may be seven (7) days instead of thirty (30) days.

(e) For the purpose of the preceding sub-paragraph (d), UNIDO may consider the Contractor permanently unable to perform in case of any period of suspension in excess of ninety (90) days. Any such period of ninety (90) days or less shall be deemed temporary inability to perform.

…/…

12.Termination

UNIDO may terminate this Contract in whole or in part and at any time, upon thirty (30) days' notice of termination to the Contractor. The initiation of arbitral proceedings in accordance with paragraph 16, "Arbitration", below shall not be deemed a termination of this Contract. In the event such termination is not caused by the Contractor's negligence or fault, UNIDO shall be liable to the Contractor for payment in respect of work already accomplished, for the cost of repatriation of the Contractor's personnel, for necessary terminal expenses of the Contractor, and for the cost of such urgent work as is essential and as the Contractor is asked by UNIDO to complete. The Contractor shall keep expenses at a minimum and shall not undertake any forward commitment from the date of receipt of UNIDO's notice of termination.

13.Bankruptcy

Should the Contractor be adjudged bankrupt or be liquidated or become insolvent, or should the Contractor make a general assignment for the benefit of its creditors, or should a receiver be appointed on account of the Contractor's insolvency, UNIDO may, without prejudice to any other right or remedy it may have under the terms of this Contract, terminate this Contract forthwith by giving the Contractor written notice of such termination. The Contractor shall immediately inform UNIDO of the occurrence of any of the above events.

14.Insurance and Liabilities to Third Parties

(a) The Contractor shall provide and thereafter maintain insurance against all risks in respect of its property and any equipment used for the execution of this Contract.

(b) The Contractor shall provide and thereafter maintain all appropriate workmen's compensation insurance, or its equivalent, with respect to its employees to cover claims for personal injury or death in connection with this Contract.

(c) The Contractor shall also provide and thereafter maintain liability insurance in an adequate amount to cover third party claims for death or bodily injury, or loss of or damage to property, arising from or in connection with the provision of services under this Contract or the operation of any vehicles, boats, airplanes or other equipment owned or leased by the Contractor or its agents, servants, employees or sub-contractors performing work or services in connection with this Contract.

(d) Except for the workmen's compensation insurance, the insurance policies under this Article shall:

(i) Name UNIDO as additional insured;

(ii) Include a waiver of subrogation of the Contractor's rights to the insurance carrier against UNIDO;

(iii) Provide that UNIDO shall receive thirty (30) days written notice from the insurers prior to any cancellation or change of coverage.

(e) The Contractor shall, upon request, provide UNIDO with satisfactory evidence of the insurance required under this Article.

(f) Any amounts not insured or not recovered from the insurers shall be borne by the Contractor.

If the Contractor fails to effect and keep in force any of the insurances required under the Contract, then and in any such case UNIDO may, at its option, hold the Contractor in default in accordance with the Contract, or effect and keep in force any such insurances and pay any premium as may be necessary for that purpose and from time to time deduct the amount so paid from any monies due to the Contractor, or recover the same as a debt due from the Contractor.

15.Indemnification

The Contractor shall indemnify, hold and save harmless and defend at its own expense UNIDO, its officers, agents, servants and employees from and against all suits, claims, demands and liability of any nature or kind, including costs and expenses, arising out of acts, omissions, negligence or misconduct of the Contractor or its officers, agents, servants, representatives, employees, or sub-contractors in the performance of this Contract. This requirement shall extend to claims or liabilities in the nature of workmen's compensation and to claims or liabilities arising out of the use of patented inventions or devices. The obligations under this paragraph do not lapse upon termination of this Contract.

16.Settlement of Disputes

(a) Amicable Settlement:

The Parties shall use their best efforts to settle amicably any dispute, controversy or claim arising out of, or relating to this Contract or the breach, termination or invalidity thereof. Where the parties wish to seek such an amicable settlement through conciliation, the conciliation shall take place in accordance with the UNCITRAL Conciliation Rules then obtaining, or according to such other procedure as may be agreed between the parties.

(b) Arbitration

Unless, any such dispute, controversy or claim between the Parties arising out of or relating to this Contract or the breach, termination or invalidity thereof is settled amicably under the preceding paragraph of this Article within sixty (60) days after receipt by one Party of the other Party's request for such amicable settlement, such dispute, controversy or claim shall be referred by either Party to arbitration in accordance with the UNCITRAL Arbitration Rules then obtaining, including its provisions on applicable law. The arbitral tribunal shall have no authority to award punitive damages. The parties shall be bound by any arbitration award rendered as a result of such arbitration as the final adjudication of any such dispute. It is understood, however, that the provisions of this paragraph shall not constitute nor imply the waiver by UNIDO of its privileges and immunities.

17.Conflict of Interest

No employee of the Contractor assigned to perform work under this Contract shall engage, directly or indirectly, either in his own name or through the agency of another person, in any business, profession or occupation in the country of the Government; nor shall he make loans to or investments in any business, profession, or occupation in the said country.

18.Obligations

In connexion with the performance of its services under this Contract, the Contractor shall neither seek nor accept instructions from any authority external to UNIDO. The Contractor shall refrain from any action which may adversely affect UNIDO and shall fulfill its commitments with full regard for the interests of UNIDO. Unless authorized in writing by UNIDO, the Contractor shall not advertise or otherwise make public the fact that it is performing or has performed services for UNIDO. Also, the Contractor shall not, in any manner whatsoever, use the name, emblem or official seal of the United Nations or of UNIDO or any abbreviation of the name of the United Nations in connexion with its business or otherwise. The Contractor is required to exercise utmost discretion in all matters relating to this Contract. Unless required in connexion with the performance of its work under this Contract or where specifically authorized by UNIDO, the Contractor shall not communicate at any time to any person, government or authority external to UNIDO any information which has not been made public and which is known to it by reason of its association with UNIDO. The Contractor shall not, at any time, use such information to private advantage. These obligations do not lapse upon satisfactory completion of the work under this Contract or termination of this Contract, including termination by UNIDO.

…/…

19.Title Rights

(a)The United Nations or UNIDO, as the case may be, shall be entitled to all property rights including but not limited to patents, copyrights and trademarks, with regard to material which bears a direct relation to, or results from the services provided to the United Nations or UNIDO by the Contractor under this Contract. At the request of UNIDO, the Contractor shall take all necessary steps, prepare and process all necessary documents and assist in securing such property rights and transferring them to the United Nations and UNIDO in compliance with the requirements of the applicable law.

(b)Title to any equipment and supplies which may be furnished by UNIDO shall rest with the United Nations or UNIDO as the case may be and any such equipment and supplies shall be returned to UNIDO at the conclusion of this Contract or when no longer needed by the Contractor. Such equipment and supplies, when returned to UNIDO, shall be in the same condition as when delivered by UNIDO to the Contractor, subject to normal wear and tear.

20.Facilities, Privileges and Immunities of Contractor and Contractor's Personnel

UNIDO agrees to use its best efforts to obtain for the Contractor and his personnel (except Government nationals employed locally), to the extent granted by the Government to UNIDO staff members, such facilities, privileges and immunities as the Government has agreed to grant to contractors and to their personnel performing services for the United Nations Development Programme within the country. Such facilities, privileges and immunities shall include exemption from or reimbursement of the cost of any taxes, duties, fees or levies which may be imposed in the country on salaries or wages earned by the Contractor's foreign personnel in connexion with the execution of the work under this Contract and on any equipment, materials and supplies which the Contractor may bring into the country in connection with the work under this Contract or which, after having been brought into the country, may be subsequently withdrawn there from. A copy of the relevant provisions concerning facilities, privileges and immunities that UNIDO shall seek to obtain, is attached to and made a part of this Contract (Annex B).

21.Waiver of Facilities, Privileges and Immunities

Any provision, whether in an Agreement, Plan of Operation or any other instrument, to which the recipient Government is a party and by which the recipient Government confers benefits upon the Contractor and his personnel in the form of facilities, privileges, immunities, or exemptions by reason of his performance of services for UNIDO under this Contract may be waived by the UNIDO where, in its opinion, the facility, privilege or immunity would impede the course of justice and can be waived without prejudice to the successful completion of the work under this Contract or to the interest of the United Nations Development Programme or UNIDO.

22.Encumbrances/liens

The Contractor shall not cause or permit any lien, attachment or other encumbrance by any person to be placed on file or to remain on file in any public office or on file with UNIDO against any monies due or to become due for any work done or materials furnished under this Contract, or by reason of any other claim or demand against the Contractor.

23.Tax Exemption

(a) In accordance with Section 7 of the Convention on the Privileges and Immunities of the United Nations and Section 9 of the Convention on the Privileges and Immunities of Specialized Agencies which are applicable to UNIDO by virtue of Article 21 of its Constitution, UNIDO is exempt from all direct taxes, except charges for public utility services, and is exempt from customs duties and charges of a similar nature in respect of articles imported or exported for its official use. In the event any governmental authority refuses.to recognize UNIDO's exemption from such taxes, duties or charges, the Contractor shall immediately consult with UNIDO to determine a mutually acceptable procedure.

(b) Accordingly, the Contractor authorizes UNIDO to deduct from the Contractor's invoice any amount representing such taxes, duties or charges, unless the Contractor has consulted with UNIDO before the payment thereof and UNIDO has, in each instance, specifically authorized the Contractor to pay such taxes, duties or charges under protest. In that event, the Contractor shall provide UNIDO with written evidence that payment of such taxes, duties or charges has been made and appropriately authorized.

24.Child labor

(a) The Contractor represents and warrants that neither him, nor any of his suppliers is engaged in any practice inconsistent with the rights set forth in the Convention on the Rights of the Child, including Article 32 thereof, which, inter alia, requires that a child shall be protected from performing any work that is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical mental, spiritual, moral or social development.

(b) Any breach of this representation and warranty shall entitle UNIDO to terminate this Contract immediately upon notice to the Contractor, without any liability for termination charges or any other liability of any kind of UNIDO.

25.Mines

(a) The Contractor represents and warrants that neither him, nor any of his suppliers is actively and directly engaged in patent activities, development, assembly, production, trade or manufacture of mines or in such activities in respect of components primarily utilized in the manufacture of Mines. The term "Mines" means those devices defined in Article 2, Paragraphs 1, 4 and 5 of Protocol II annexed to the Convention on Prohibitions and Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects of 1980.

(b) Any breach of this representation and warranty shall entitle UNIDO to terminate this Contract immediately upon notice to the Contractor, without any liability for termination charges or any other liability of any kind of UNIDO.

Waste Generation and Disposal Report

MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

SOLID WASTE MANAGEMENT- Segregation & Collection at Source

Solid waste Generation Data

MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

MEDICAL WASTE SEGREGATION MANAGEMENT

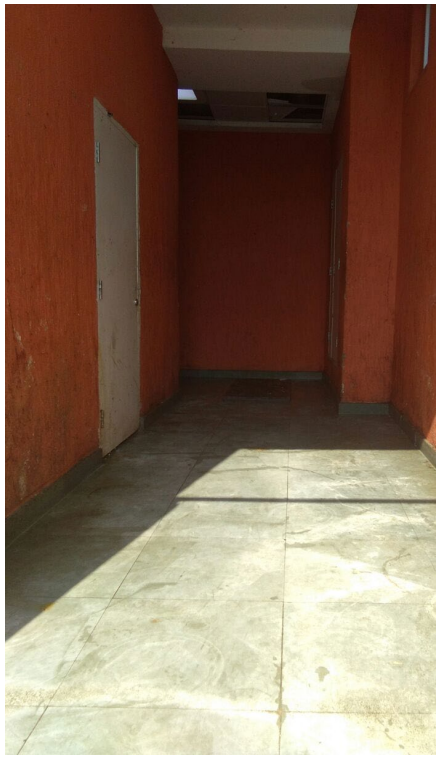
MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

SOLID KITCHEN WASTE MANAGEMENT

Sr.No.	Department/ Area of source of waste (Everypoint of waste generation within the campus should be identified and listed - cross	Types of waste generated in each of the point source (for each type of waste, use separate row)						Dry (in kgs/ day
		Food wastage	Paper/Card board	Plastic	Wood	Glass	Metal	
Mar-19	MUJ Academic Blocks		6790	65	60		120	7035
Mar-19	MUJ HOSTEL Blocks	4279						
Apr-19	MUJ Academic Blocks		92	33	44	0	20	189
Apr-19	MUJ HOSTEL Blocks	3689					940	940
May-19	MUJ Academic Blocks		73	28	31	2	17	151
May-19	MUJ HOSTEL Blocks	2452		591			860	1451
Jun-19	MUJ Academic Blocks		68	25	31	1	17	142
Jun-19	MUJ HOSTEL Blocks	1160					700	700
Jul-19	MUJ Academic Blocks		85	36	45	0	26	192
Jul-19	MUJ HOSTEL Blocks	4638					240	240
Aug-19	MUJ Academic Blocks		101	40	47	0	29	217
Aug-19	MUJ HOSTEL Blocks	4596		260			380	640
Sep-19	MUJ Academic Blocks		97	30	62	1	37	227
Sep-19	MUJ HOSTEL Blocks	2839						
Oct-19	MUJ Academic Blocks		170	95	92	0	82	357
Oct-19	MUJ HOSTEL Blocks	4799						
Nov-19	MUJ Academic Blocks		66	55	71	0	75	192
Nov-19	MUJ HOSTEL Blocks	4155						
Dec-19	MUJ Academic Blocks		81	58	48	0	45	187
Dec-19	MUJ HOSTEL Blocks	2033						
Jan-20	MUJ Academic Blocks		112	62	51	0	76	225
Jan-20	MUJ HOSTEL Blocks	6195						
Feb-20	MUJ Academic Blocks		73	70	51	8	82	202
Feb-20	MUJ HOSTEL Blocks	6178						
Mar-20	MUJ Academic Blocks		55	50	46	8	49	159
Mar-20	MUJ HOSTEL Blocks	5159						
Apr-20	MUJ Academic Blocks		23	17	26	2	17	68
Apr-20	MUJ HOSTEL Blocks	NIL						
May-20	MUJ Academic Blocks		40	46	35	5	41	126
Jun-20	MUJ Academic Blocks		38	35	24	3	42	100
Jul-20	MUJ Academic Blocks		43	33	33	6	59	115
Aug-20	MUJ Academic Blocks		20	21	31	3	26	75
Sep-20	MUJ Academic Blocks		27	16	22	6	41	71

Collection frequency & clearance: Twice a day

Time: 9:00 AM & 4:00 PM



MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

HUMAN RESOURCE FOR WASTE MANAGEMENT

HOUSEKEEPING and SUPPORT STAFF AT MUJ

MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

DISPOSAL OF SOLID WASTE - INHOUSE

Solid Waste Management

1. Organic waste from kitchen and horticulture used in **Biogas Plant** which supplies fuel to Food Court.
2. Recyclable solid waste **collected separately**
3. Pilot project with BEIL (Bharuch Enviro Infrastructure Ltd) for converting MSW to Fuel / Energy.
4. Bio Medical waste is collected separately and Disposed
5. Papers printed on one side are not discarded but reused.

➢ **Agreement for external agency for partial waste management (click here)**

Bio-Gas generation system
30kg of Gas per day with 500 kg of Kitchen waste

MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

LIQUID WASTE MANAGEMENT-INHOUSE- SEWAGE TREATMENT PLANT

MUJ is equipped with **4 STP** Plants with different capacity 1000 KLD, 350 KLD(two) and 150 KLD **IN TOTAL 1850 KLD**. Sewage treatment removes contaminants from wastewater, which includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safer treated water (it has been used for flushing and gardening). In normalcy are producing 1850KL treated water per day.

➢ **Production of recycle waste-water report (click here)**

MANIPAL UNIVERSITY
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LIQUID WASTE MANAGEMENT-INHOUSE- SEWAGE TREATMENT PLANT

MANIPAL UNIVERSITY
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(University under Section 2(f) of the UGC Act)

Waste Usage /COMPOSE PIT

1. Waste is collected from different corners of campus
2. After segregation, waste is put into compose pit
3. After a few weeks, earthworms and microorganisms in the soil convert the organic matter into useable compost.