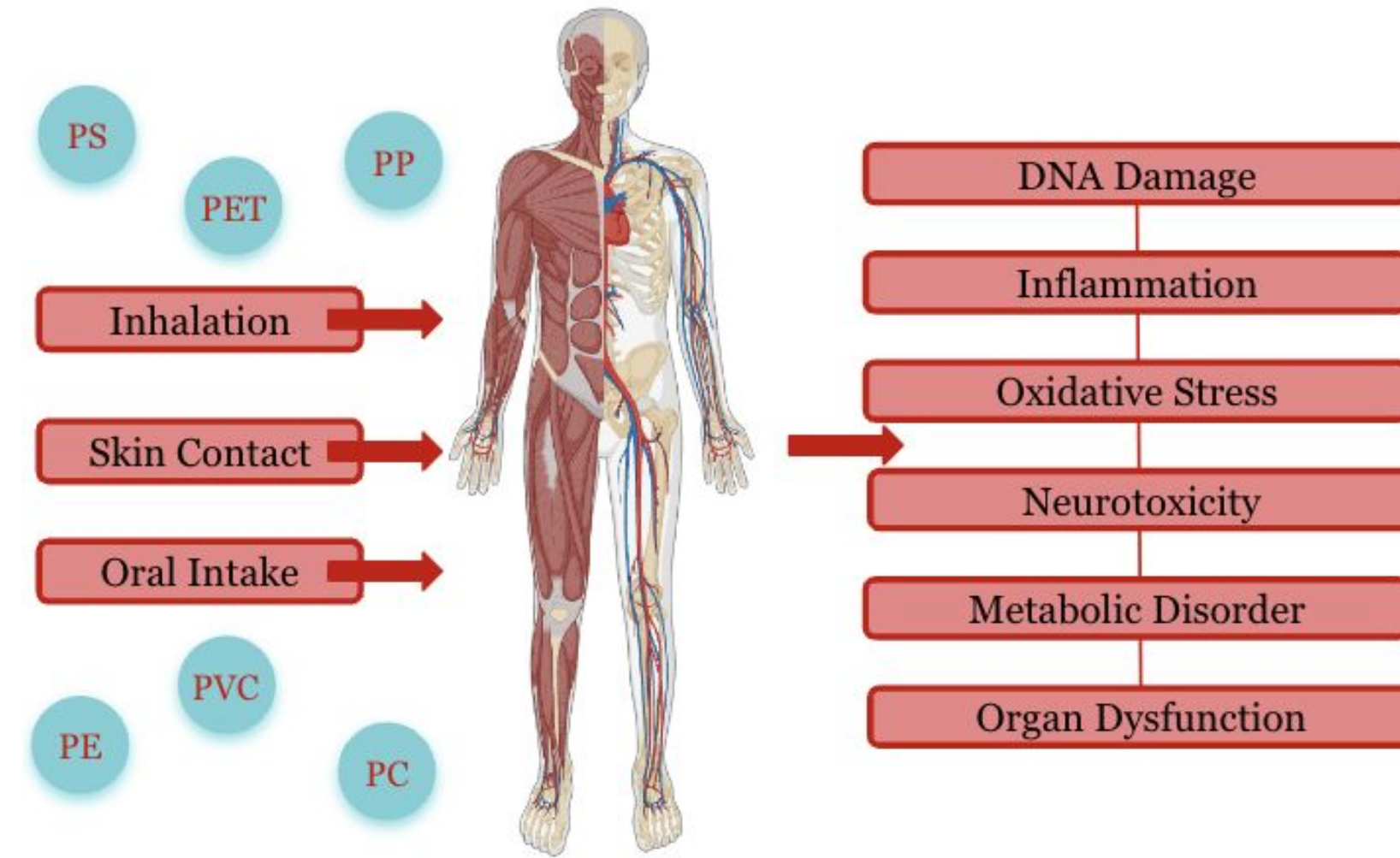


## 1. Motivation

To develop a cost effective and efficient process to remove microplastics (<100  $\mu\text{m}$ ) from wastewater that can be integrated into existing wastewater treatment plants.



Li et. Al, Environment & Health, (2023)

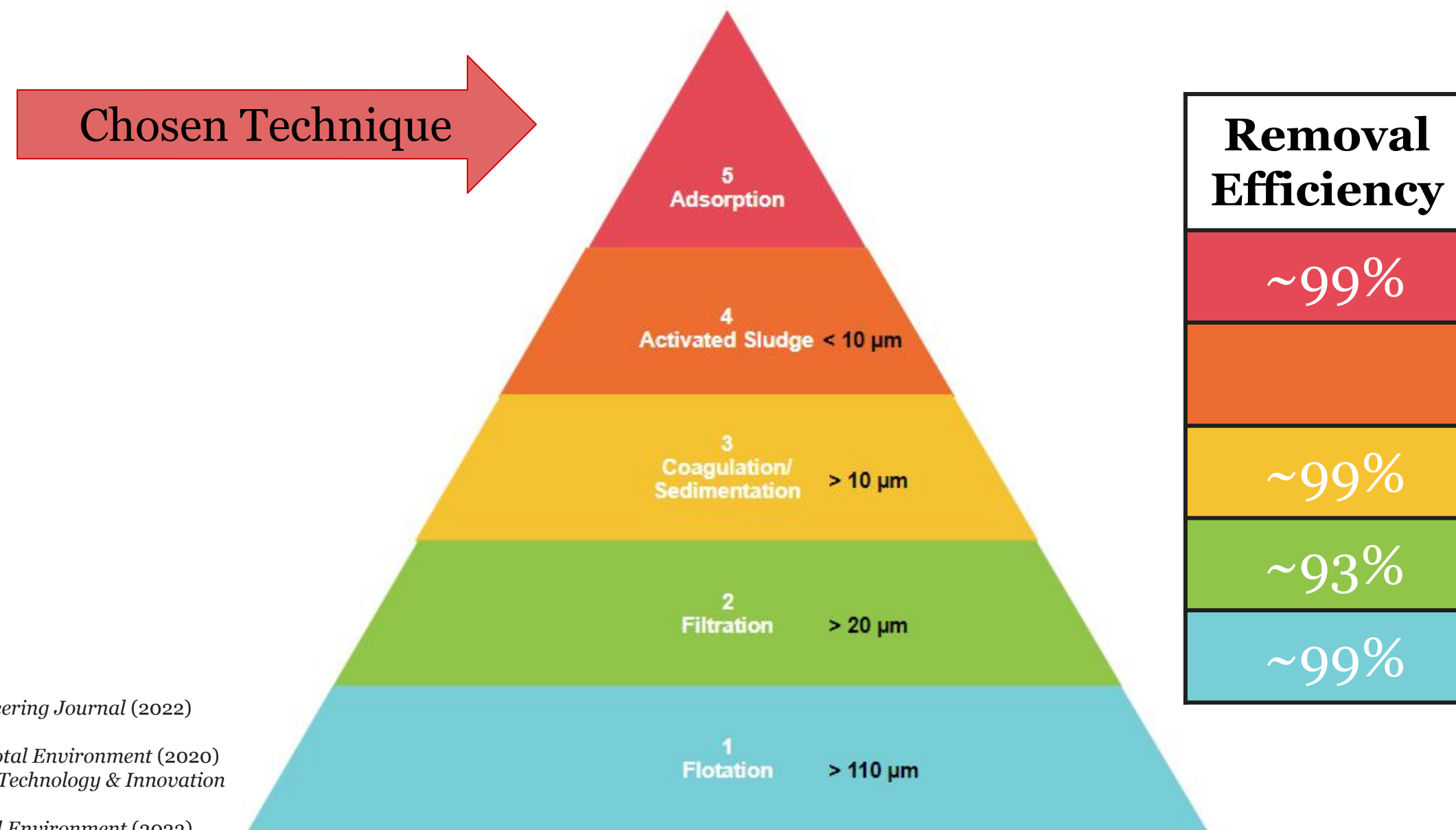
## 2. Background

- Microplastics: polymeric fibers, films, fragments, and pellets < 5 mm
- **No EPA regulations** on microplastic removal
- Microplastic Quantification & Identification: **FTIR & Raman**
  - Measures vibrational modes to identify inorganic compounds
  - FTIR: > 10  $\mu\text{m}$
  - Raman: > 1  $\mu\text{m}$
- Dempsey E. Benton Wastewater Treatment Plant, Garner, NC
  - **Dissolved Air Flotation (DAF)**
  - Particle counter detects 2-5  $\mu\text{m}$
  - No microplastic tests conducted



Wastewater Digest, (2011)  
Braun et. Al, Agilent (2020)  
Verma et. Al, Chemosphere 352, (2024)  
Koelmans et. Al, Marine Anthropogenic Review (2015)

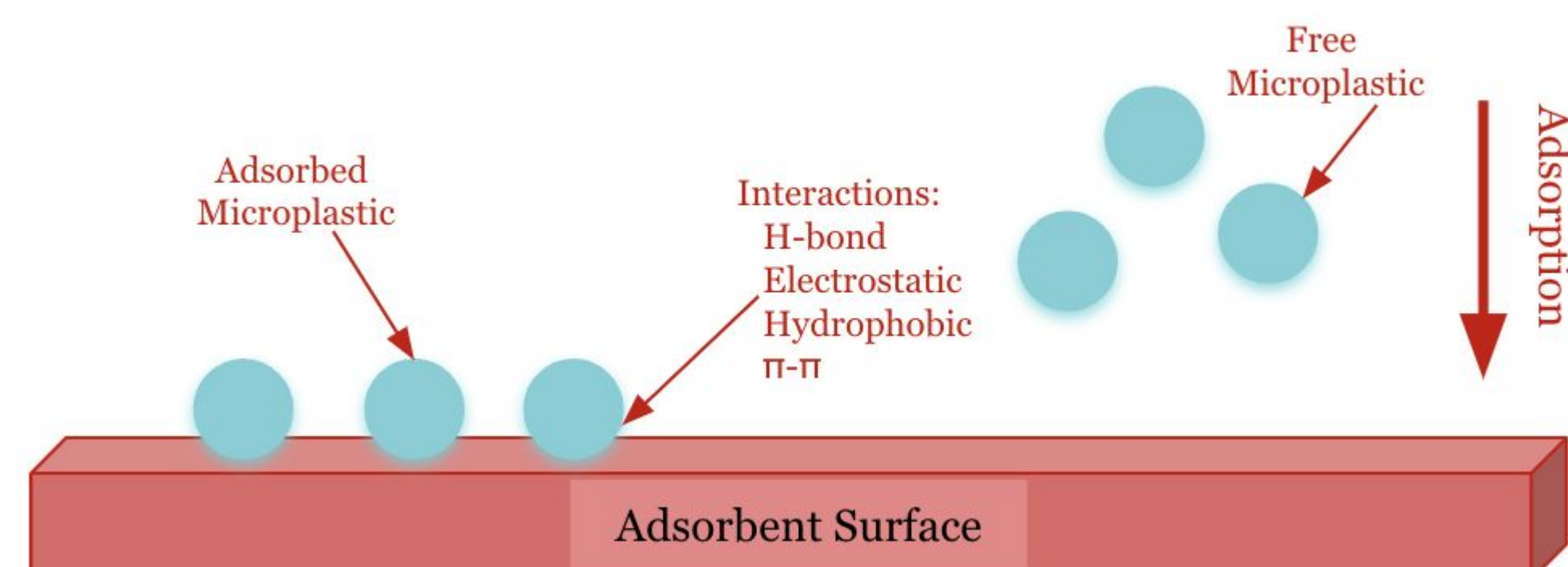
## 3. Current Technologies



B. Swart et. al, Chemical Engineering Journal (2022)  
S. Wolff et. al, Water (2021)  
Z. Wang et. al, Science of The Total Environment (2020)  
A. Reddy et. al, Environmental Technology & Innovation (2022)  
L. Jia et. al, Science of The Total Environment (2023)

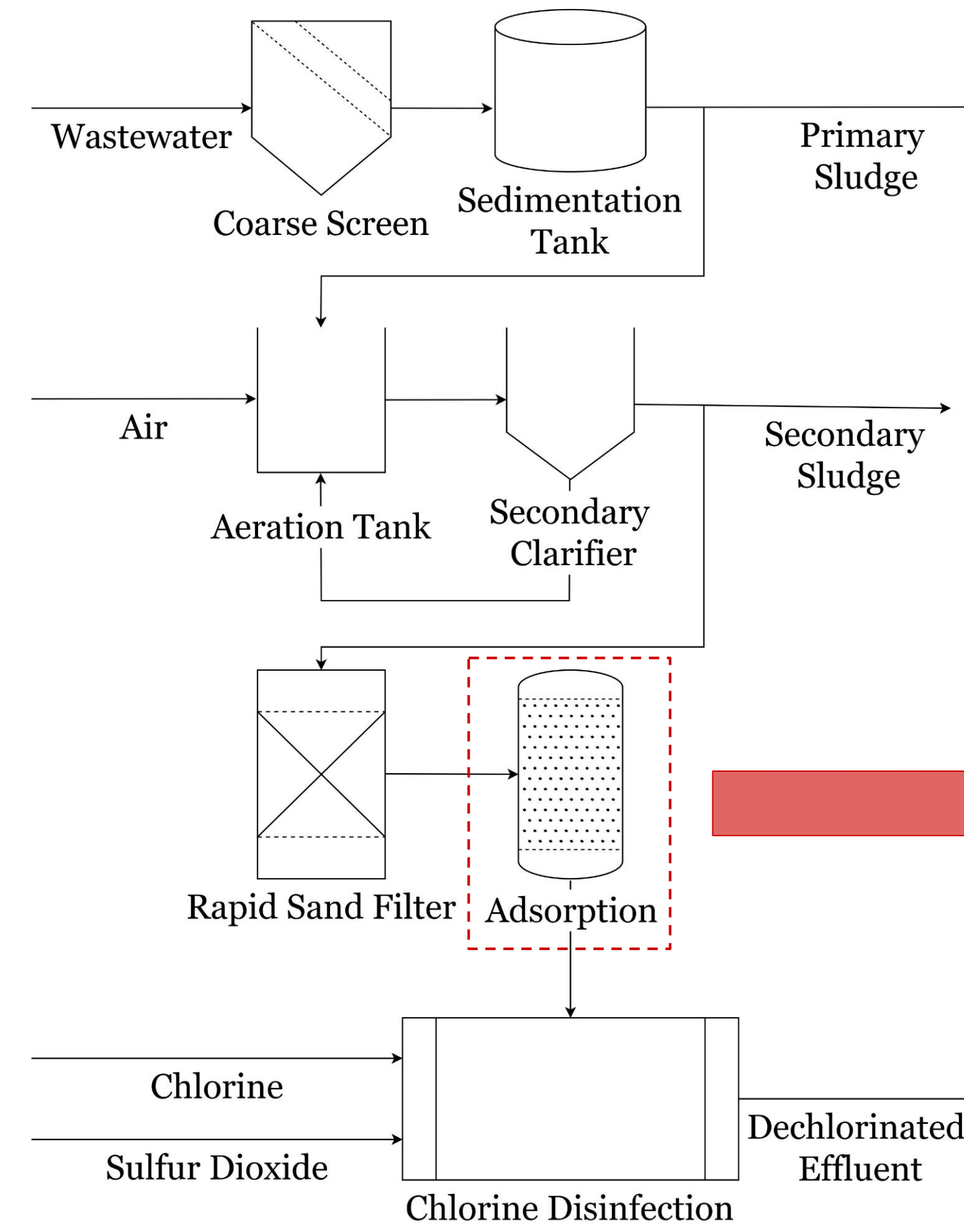
## 4. Adsorption

- Largest removal efficiency for smallest microplastic
- Removal Efficiency: PE > PET > PA
- Microplastics Removed: PE, PS, PET, PVC, PP

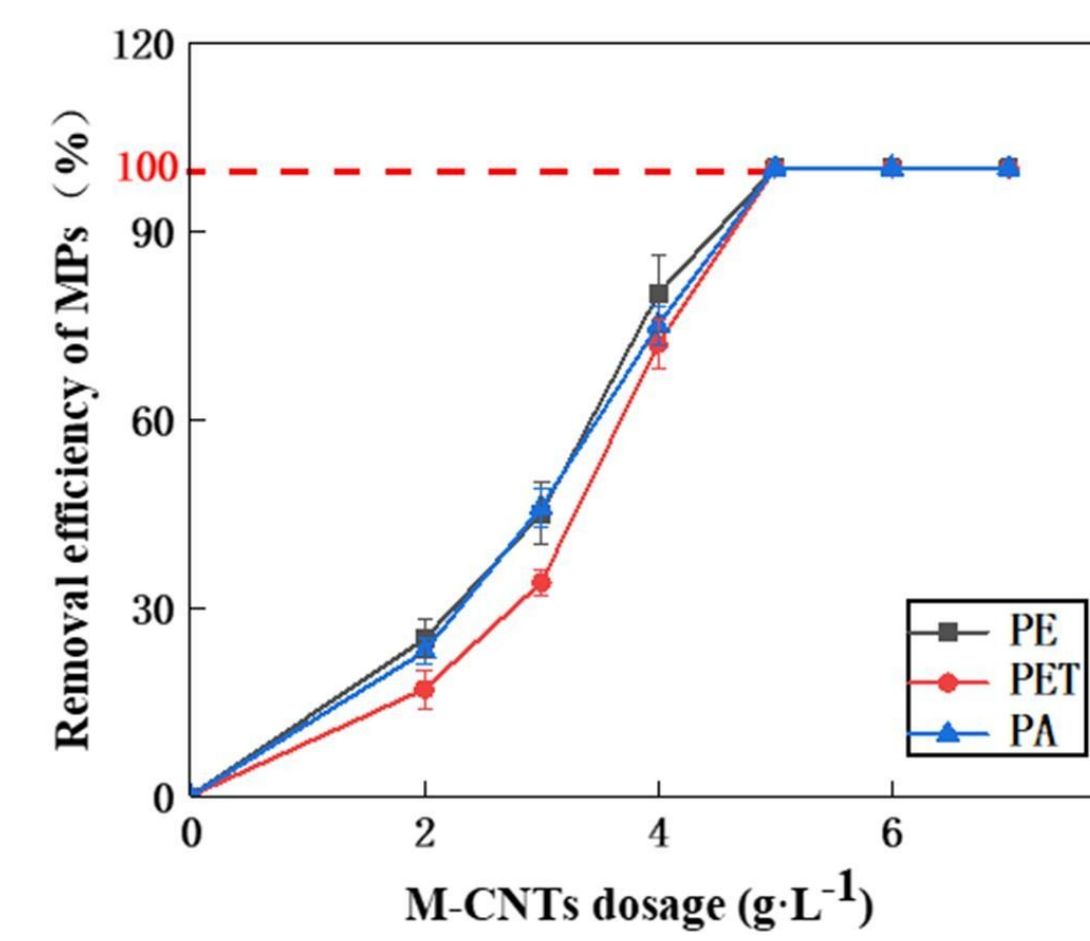


Verma et. Al, Chemosphere (2024)  
L. Jia et. Al, Science of The Total Environment (2023)

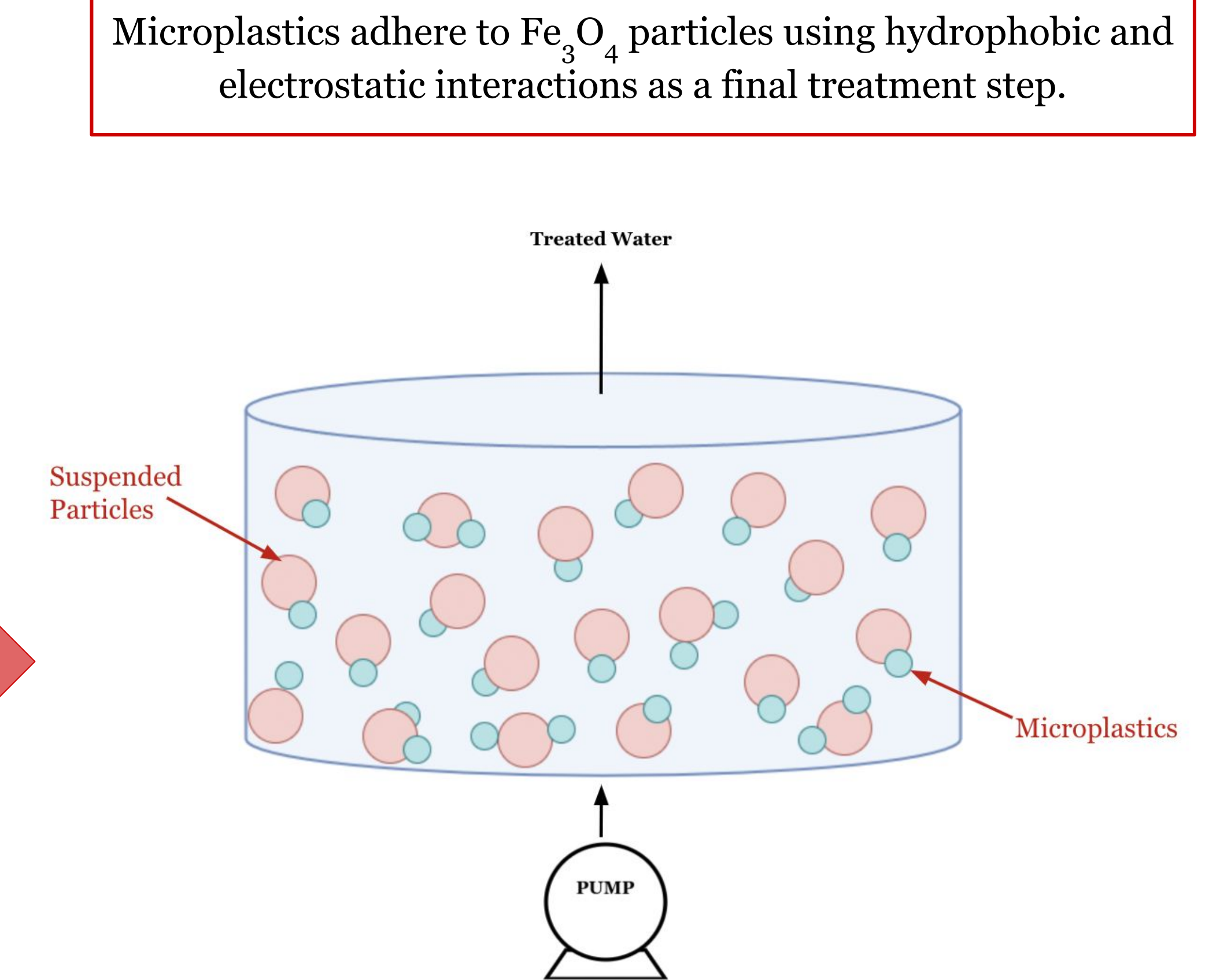
## 5. Treatment Process



Adsorption is placed after primary, secondary, and tertiary treatment to prevent fouling from occurring in the adsorbent membrane.



Magnetic carbon nanotubes significantly increase removal efficiency.



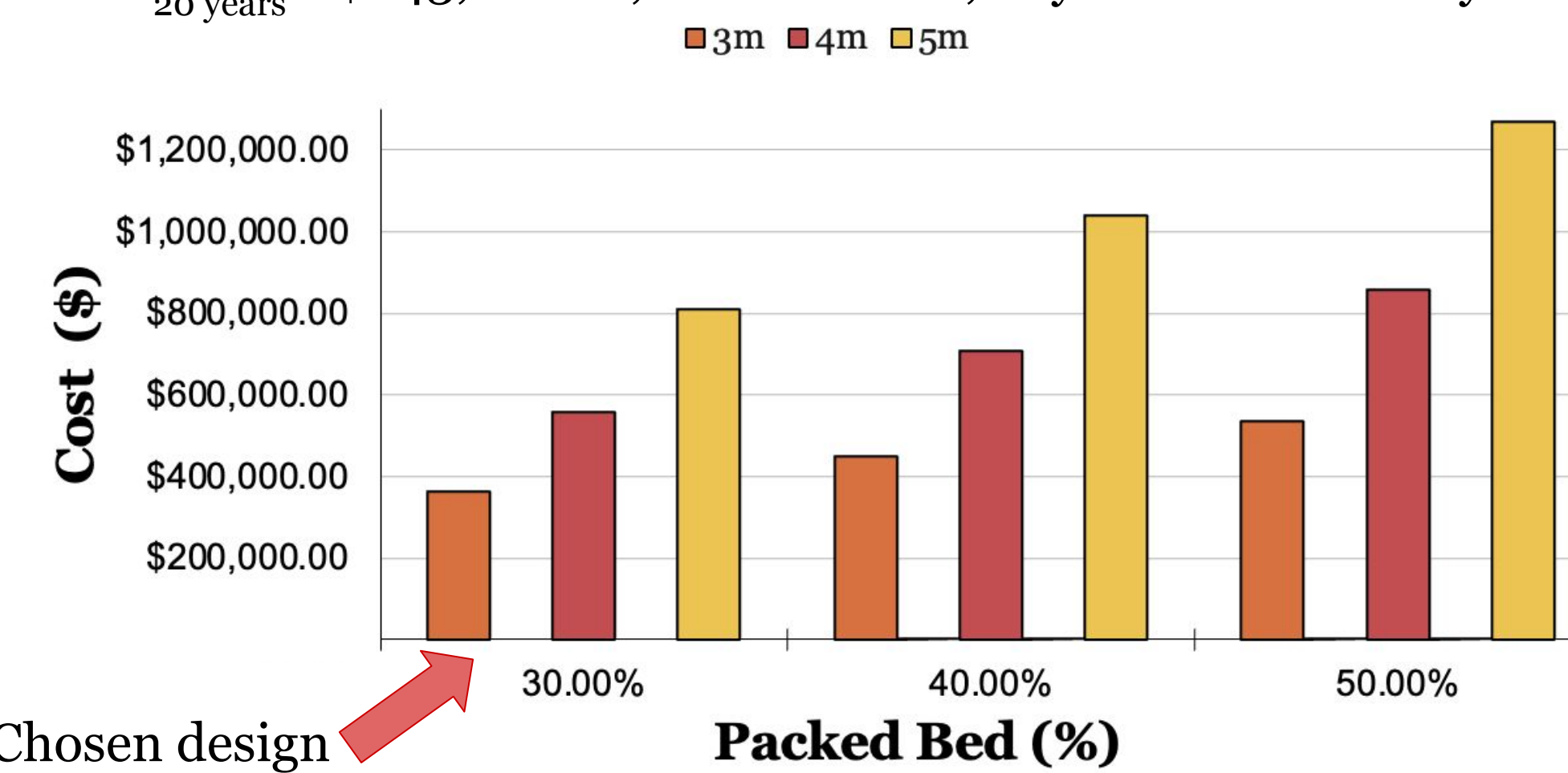
### Reactor Specifications

Suspended Particle Type	Magnetic Nanotubes ( $\text{Fe}_3\text{O}_4$ ) Silica ( $\text{SiO}_2$ )
Suspended Particle Ratio	95% $\text{Fe}_3\text{O}_4$ 5% $\text{SiO}_2$
Percent Packed By Volume	30%
Reactor Size	3m diameter 2m height
Flowrate Capacity	6,930 gallons/minute

Wastewater Digest, (2011)  
Verma et. Al, Chemosphere 352, (2024)  
Tang et. Al, Chemical Engineering Journal 406, (2021)

## 6. Economic Analysis

NPV<sub>20 years</sub> = \$243,201.22, MARR=10%, Payback Period=10 years



Chosen design  
**Cost of Bed Diameter Versus Packed Bed Material**

## 7. Conclusions

- Microplastics are harmful to human health
- Microplastic removal efficiency is affected by size and chemical composition
- Adsorption is the best removal technology to accommodate for microplastic <100  $\mu\text{m}$
- FTIR & Raman identification is most effective in analyzing microplastic
- Next Step: conduct experiments to confirm microplastic removal efficiency using the adsorption process

## 8. Acknowledgments

We would like to thank Dr. Efimenko, Dr. Genzer, and Dr. Johnson for their guidance and expertise throughout this project.