

Removing **toxic chemicals** from **drinking water** using *biochar*

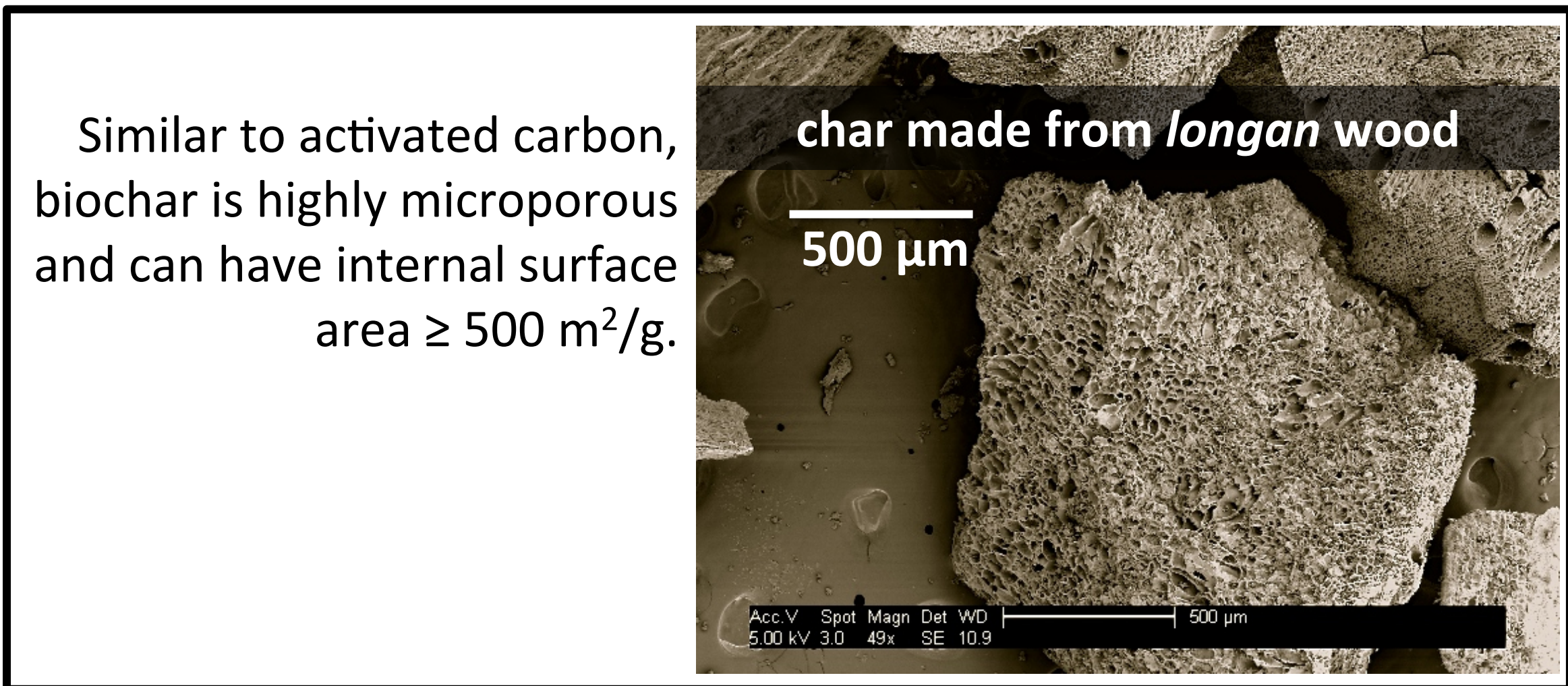
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While microbial pathogens typically represent the most immediate threat to human health, a wide variety of **toxic organic chemicals** – such as pesticides, pharmaceutical residues, industrial wastes, manufacturing additives, fuel compounds, and disinfection by-products – threaten the safety of drinking water in developing communities worldwide.

Long-term exposure to trace quantities (ppt to ppb) of these toxins can lead to **cancer, birth defects, reproductive disorders, developmental impairment, endocrine disruption, neurological dysfunction, damage to internal organs, and other health problems.**

Our lab and field research advances the application of **adsorbent biochar** as an effective, affordable, accessible, and sustainable means for controlling organic chemical contaminants and providing safe drinking to households and communities in impoverished regions of the world.

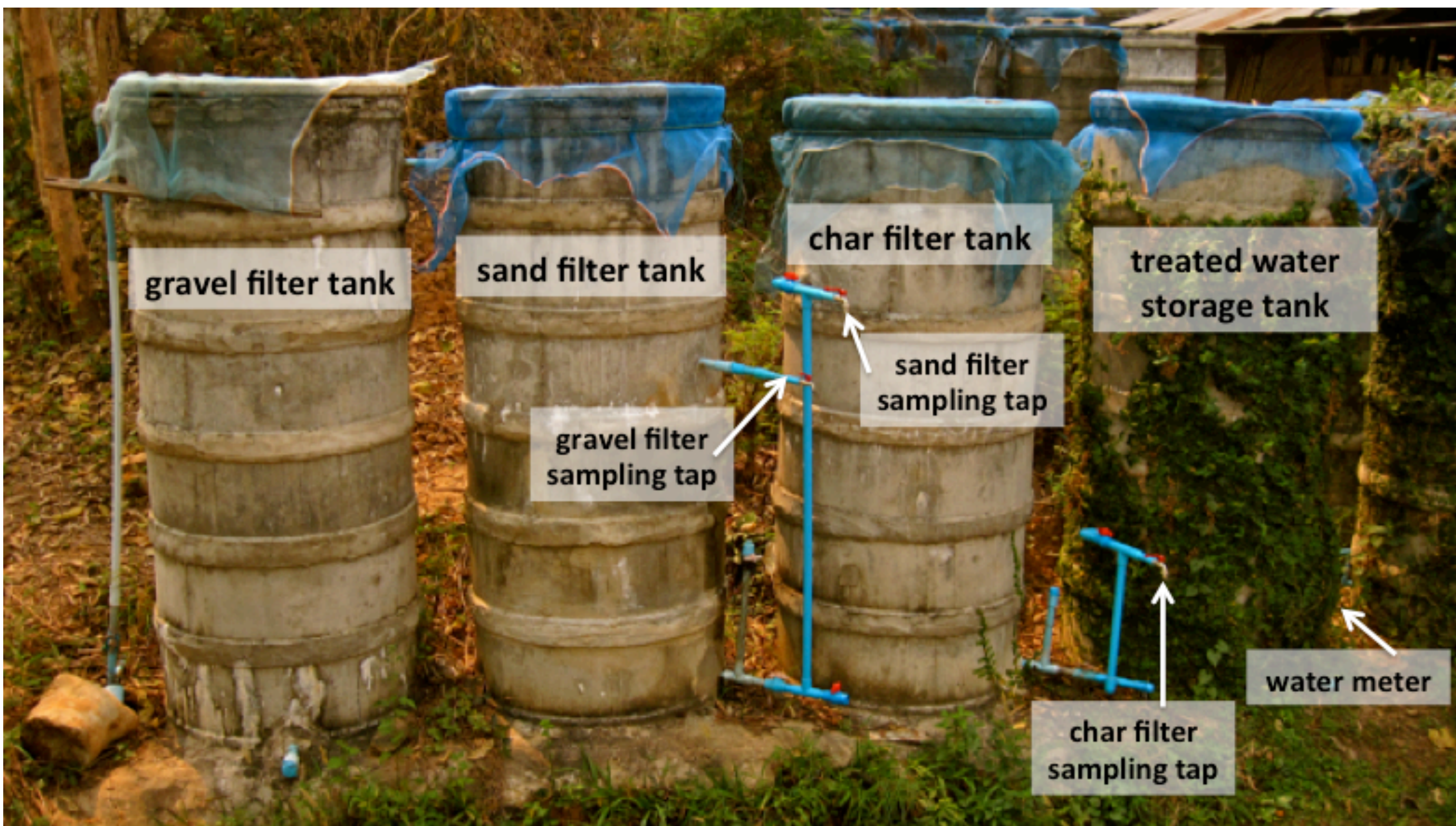
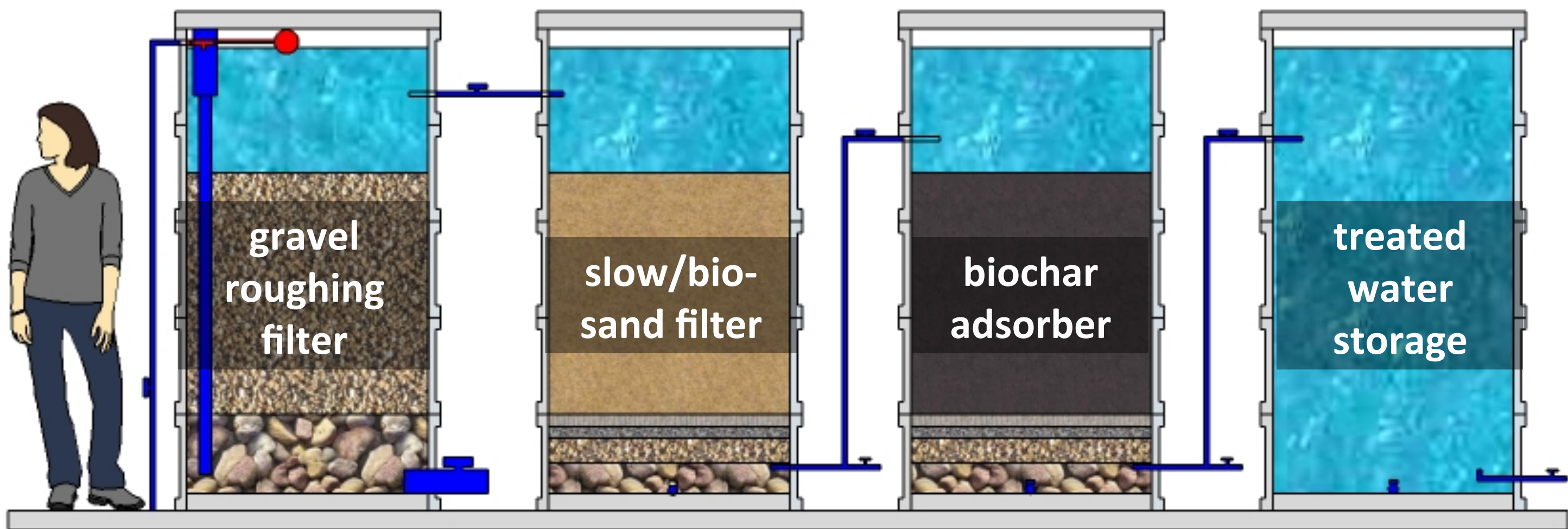


Traditional and modern low-cost biochar production systems



Gasifier cookstoves and drum ovens (1) are clean burning, (2) utilize a wide variety of bio-waste feedstocks, (3) are constructed from scrap metal and surplus drums/canisters using simple hand-tools (no need for electricity or power tools), and (4) produce consistent, high-adsorbing biochar!

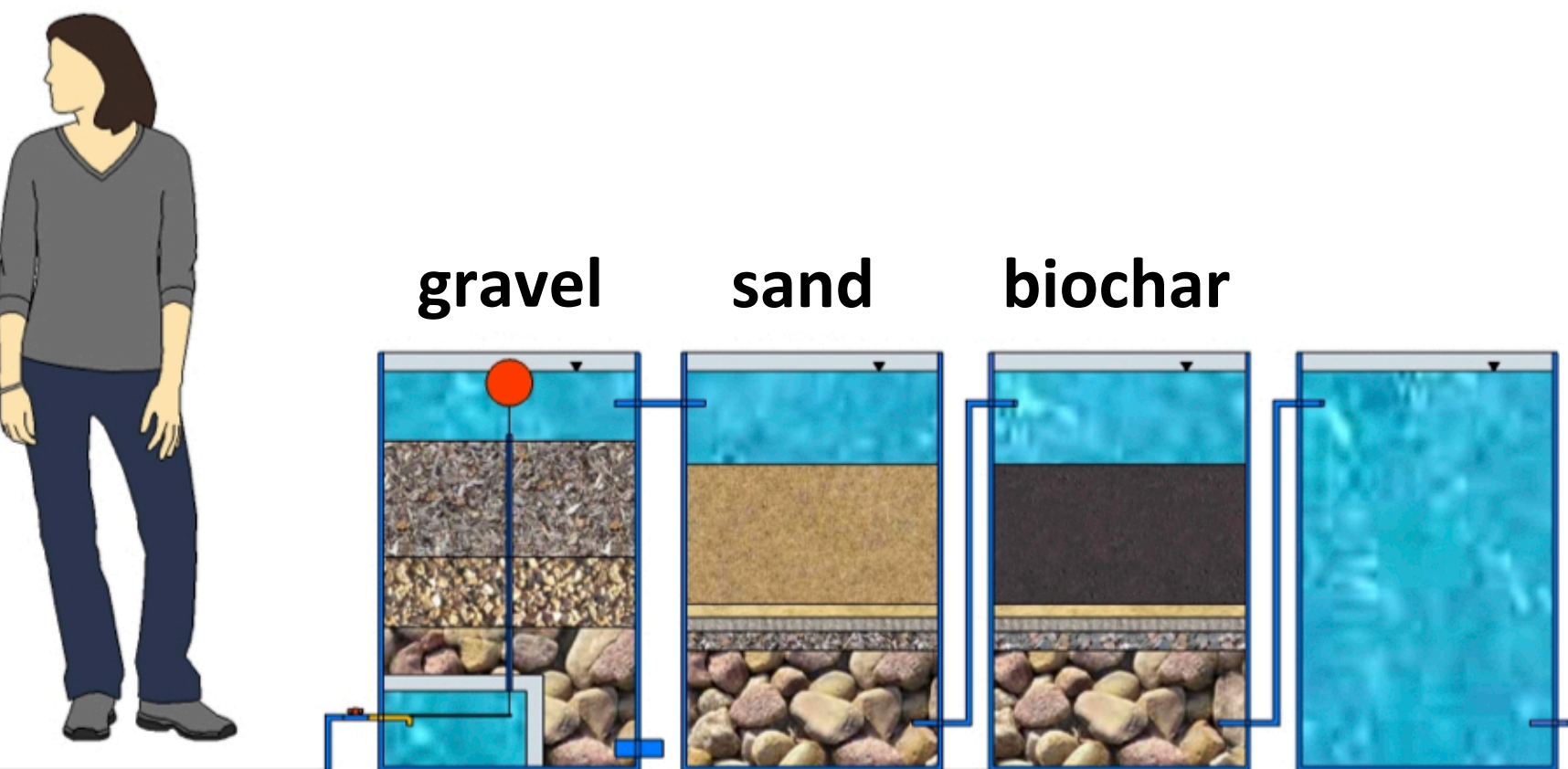
Putting biochar adsorption into practice!



“Micro” Multi-Barrier Water Treatment Plant

2,000-3,000 L/day cost: US\$ 400 local materials

The system above is located in a farm community in northern Thailand and has been in continuous service since February 2008, and to-date* has produced over 2.5 million liters.
* As of March, 2015.



“Nano” Portable/Emergency Water Treatment Plant

300-500 L/day cost: US\$ 125 local materials



Since March 2012 around 40 of these systems have been installed,* mainly in SE Asia.

Made from surplus HDPE drums and a few PVC fittings, these systems can be transported over rugged terrain on foot and installed using filter media acquired/generated on-site.

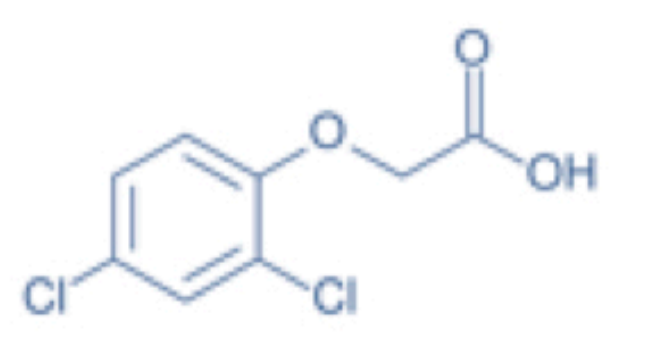
No electricity or power tools required!

* As of March, 2015.

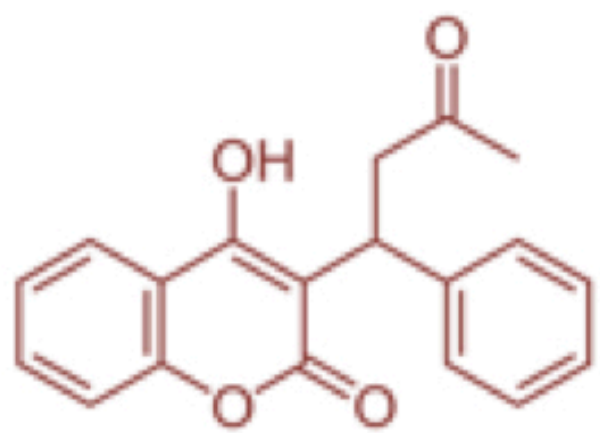
Adsorption equilibrium batch test data overview

Probe compound selection criteria from a water treatment perspective:

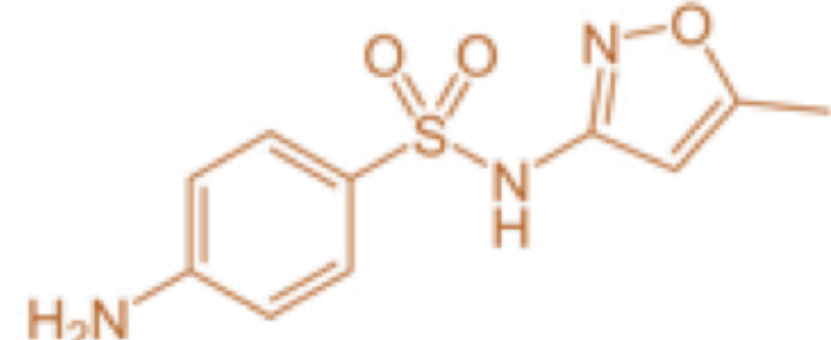
- environmental relevance - widely occurring
- negative human health impact
- impair water aesthetics
- difficult to remove



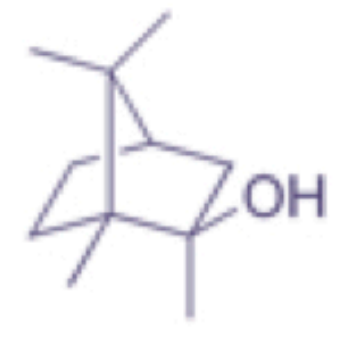
2,4-D
herbicide
possible carcinogen,
suspected endocrine
disruptor
USEPA MCL 70 µg/L
WHO Guideline 30 µg/L
pK_a 2.7



warfarin (WFN)
anticoagulant, rodenticide
pK_a 5.1



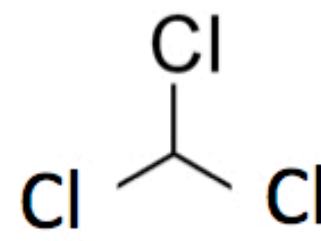
sulfamethoxazole (SMX)
antibiotic (humans and livestock)
pK_a 5.6



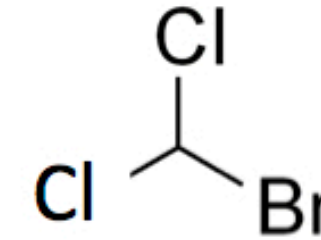
2-methyl isoborneol (MIB)
cyanobacteria metabolite
not a health concern
musty taste & odor at >10 ng/L

trihalomethanes (THMs)
disinfection by-products (DBPs)
USEPA MCL 80 µg/L total THMs (TTHMs)

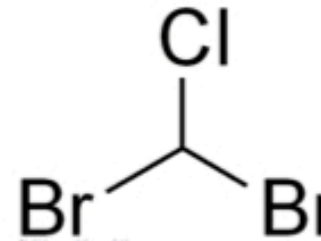
chloroform
probable carcinogen



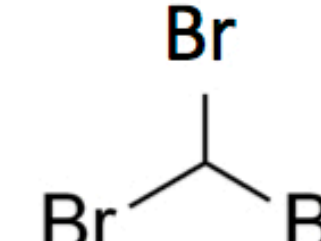
BDCM
probable carcinogen



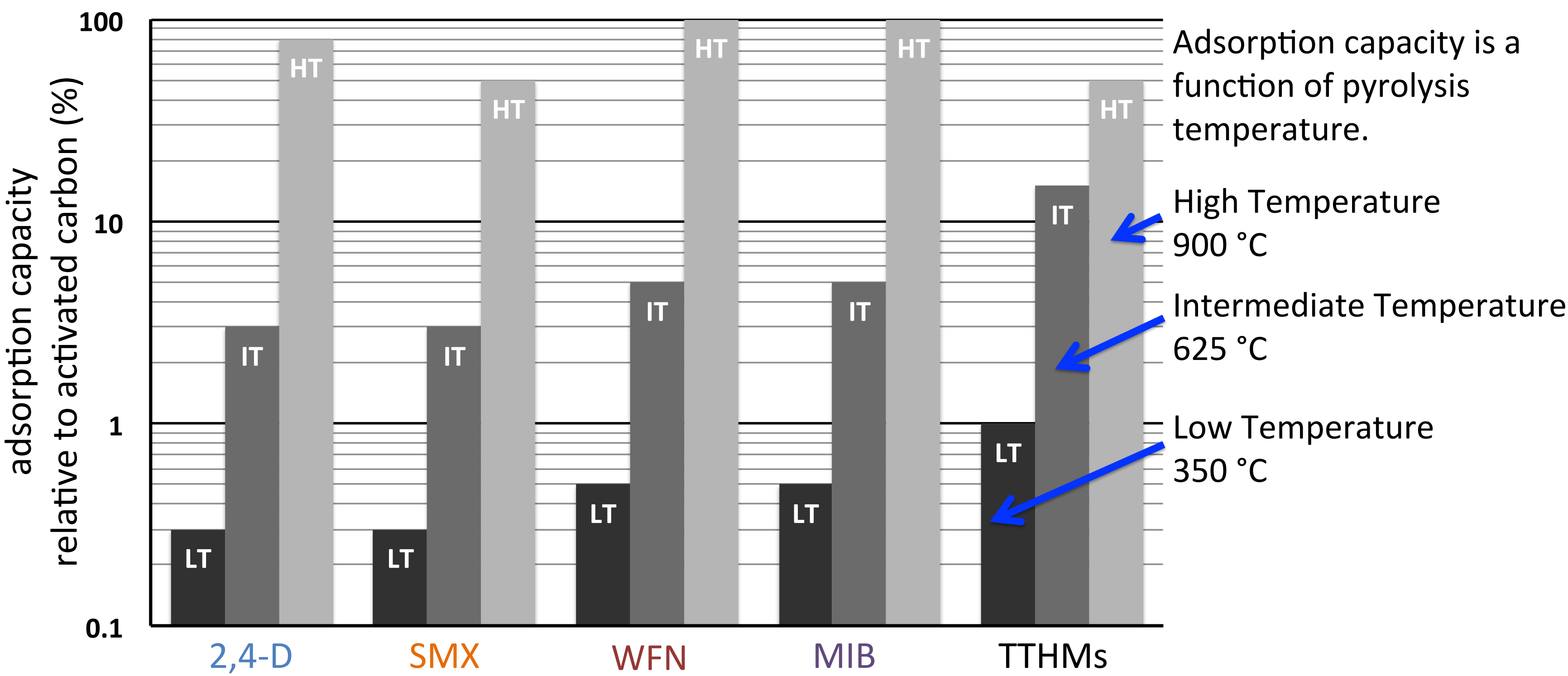
CDBM
possible carcinogen



bromoform
probable carcinogen



background matrices – surface water, wastewater, stormwater, 0-15 mg/L TOC

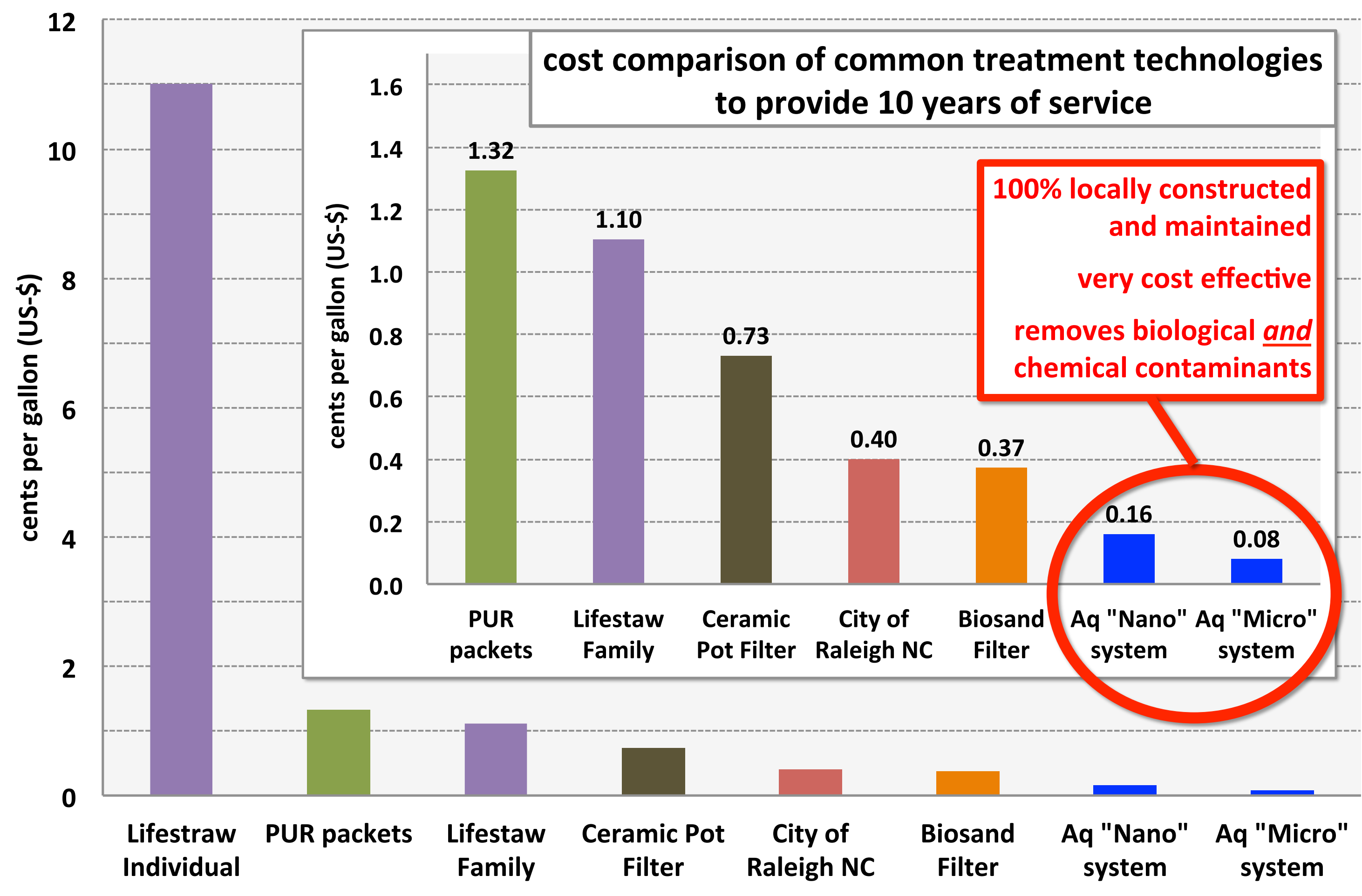


Adsorption capacity is a function of pyrolysis temperature.

High Temperature
900 °C

Intermediate Temperature
625 °C

Low Temperature
350 °C



cost comparison of common treatment technologies to provide 10 years of service

100% locally constructed and maintained
very cost effective
removes biological and chemical contaminants