Granular Activated Carbon and Biological Activated Carbon technologies for Removing DBP Precursors and Controlling Taste and Odor Compounds

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OUR AGENDA

01. Definitions

02. Benefits

03. Technology Applications

01. 02. 03.

Definitions

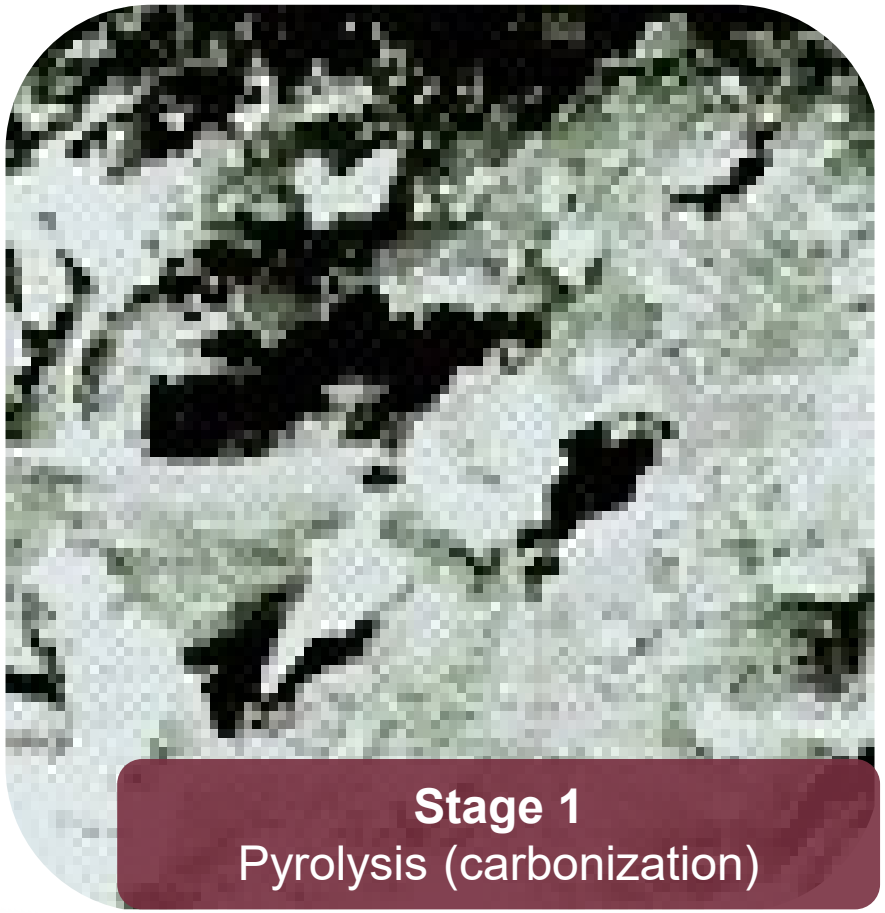
Activated carbon is made from various natural raw materials

Coal

Wood

Coconut Shell

After the activation process the source material is converted to GAC which has a highly porous structure



Stage 1
Pyrolysis (carbonization)

Stage 2
Activation

Activated carbon is categorized according to various identifiers

Source Material

- Coal – Lignite, Bituminous
- Coconut Shell
- Dehydrated Wood

Manufacturing Process

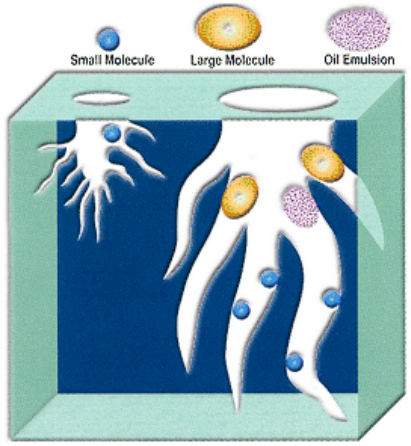
- Direct Activated (Import)
- Re-agglomerated GAC (Domestic)

Sizes

- 8x16, 8x20, 8x30, 12X30, 12X40

Properties

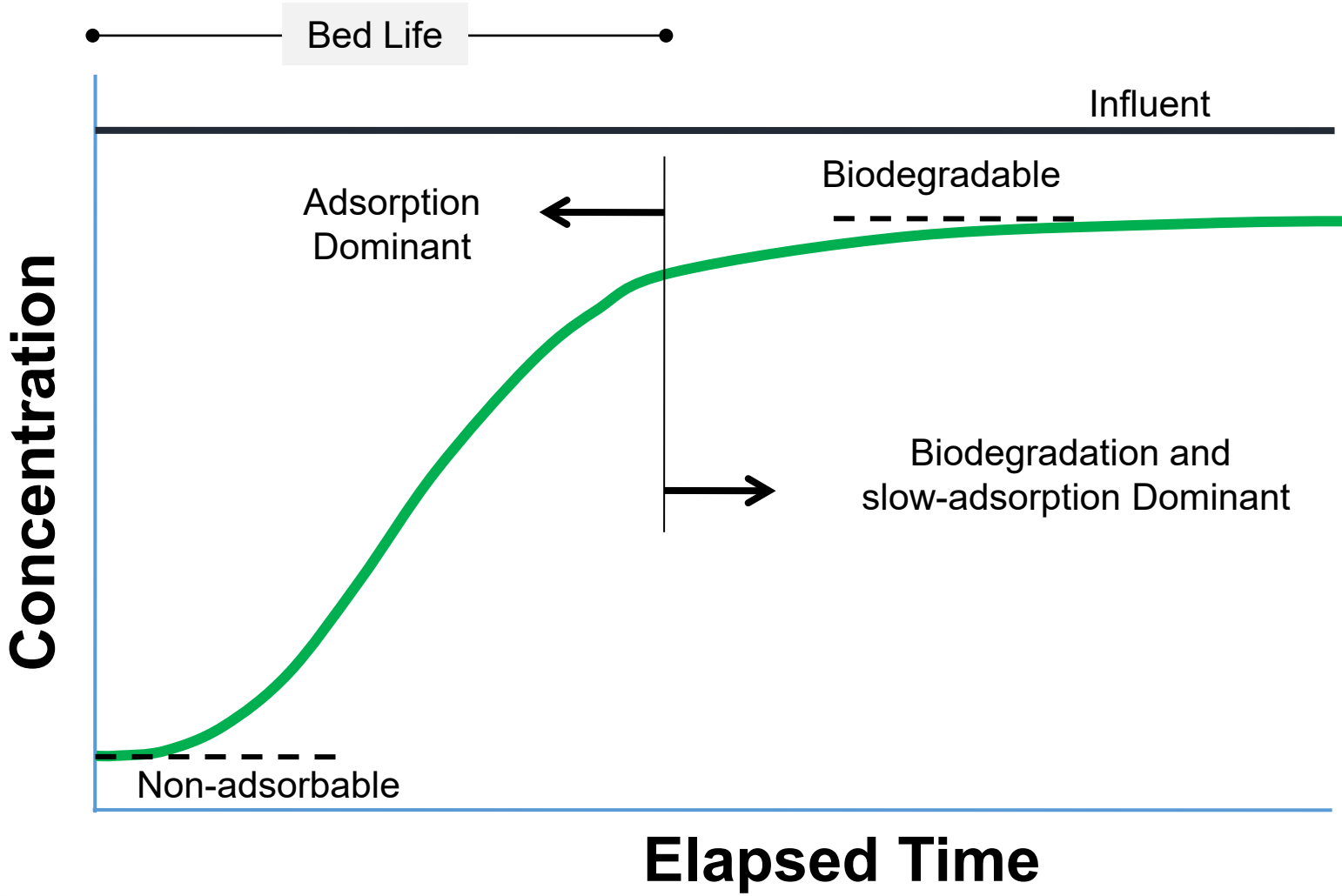
- Pore-size Distribution
- Density



What is Granular Activated Carbon (GAC) and Biological Filtration (BAF/BAC)?

- **Adsorption on GAC is a dynamic process in which contaminants are removed by attaching them to the media surface**
- **Biological filtration is a steady-state process in which contaminants are removed by biologically degrading them on the media surface**

A breakthrough curve informs us about the treatment performance



Empty bed contact time and carbon usage rate defines a GAC contactor

EBCT in minutes represents the amount of time water spends in the GAC contactor while the water is flowing through the contactor at the design flow rate

$$EBCT = \frac{\text{Volume}}{\text{Flow Rate}}$$

CUR in lbs/MG represent the amount of carbon needed to treat a million gallon of water to the treatment target

Breakthrough time is often reported in bed volumes which is the actual time passed till breakthrough divided by EBCT

$$BV = \frac{\text{Time to breakthrough}}{EBCT}$$

GAC is Considered Best Available Technology (BAT) for DBP Rule Compliance

Enhanced Coagulation plus GAC 10:

- 10 minutes EBCT
- Replacement frequency up to 360 days
- Free chlorine as residual disinfectant

GAC20:

- 20 minutes EBCT
- Replacement frequency of up to 240 days
- Free chlorine as residual disinfectant

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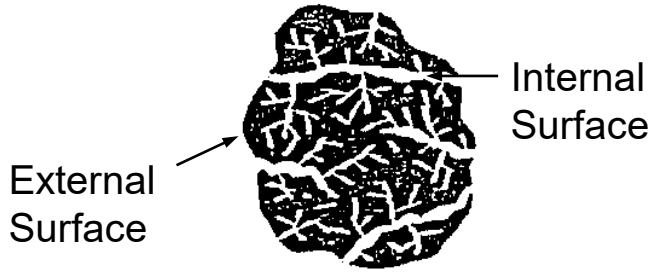
Benefits

Activated carbon offers many benefits in water treatment



Large internal surface area (500-2500 m^2/g)

Wide range of pore sizes

- Micropores (<2 nm)
- Mesopores (2-50 nm)
- Macropores (>50 nm)

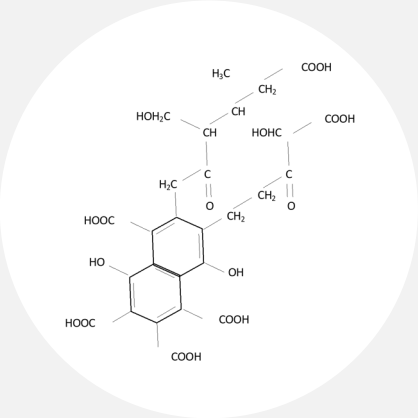
Considerable adsorptive capacity for most organic compounds

- Adsorption capacity varies depending on carbon properties (surface area, pore sizes, etc.) and contaminant properties (hydrophobicity)

Modifications of GAC for specific purposes are also possible

- Tailored GAC can be more effective for some inorganic (e.g. perchlorate) removal

GAC is an effective process for removal of natural and synthetic organic matter



Natural Organic Matter (NOM)

Precursors to DBPs

Trace Organic Contaminants (TOrCs)

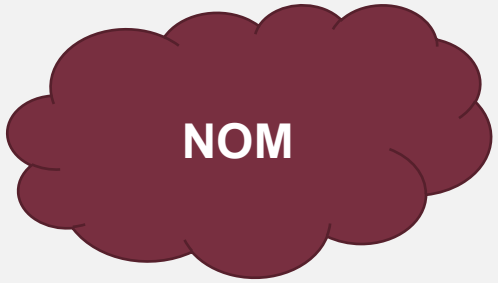
T&O compounds	Algal toxins	Allochthonous Compounds

Removing NOM before disinfection reduces DBP formation

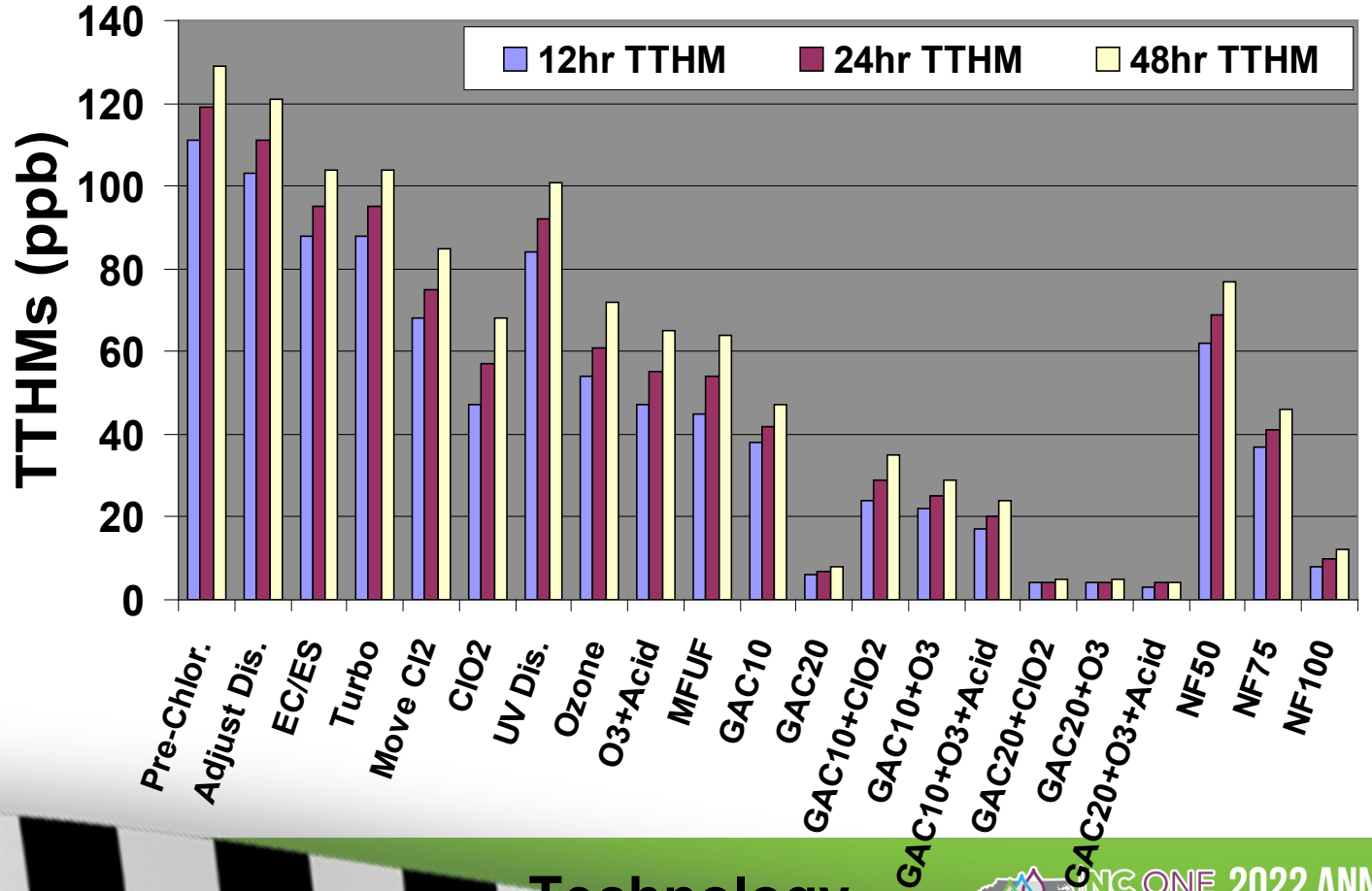
Halogenated DBPs

- Trihalomethanes (THMs)
- Haloacetic Acids (HAA)
- Brominated and Iodinated DBPs

- Regulation may expand beyond THM4 and HAA5



DBP levels could be controlled to very low levels by adding GAC adsorbers to existing WTPs



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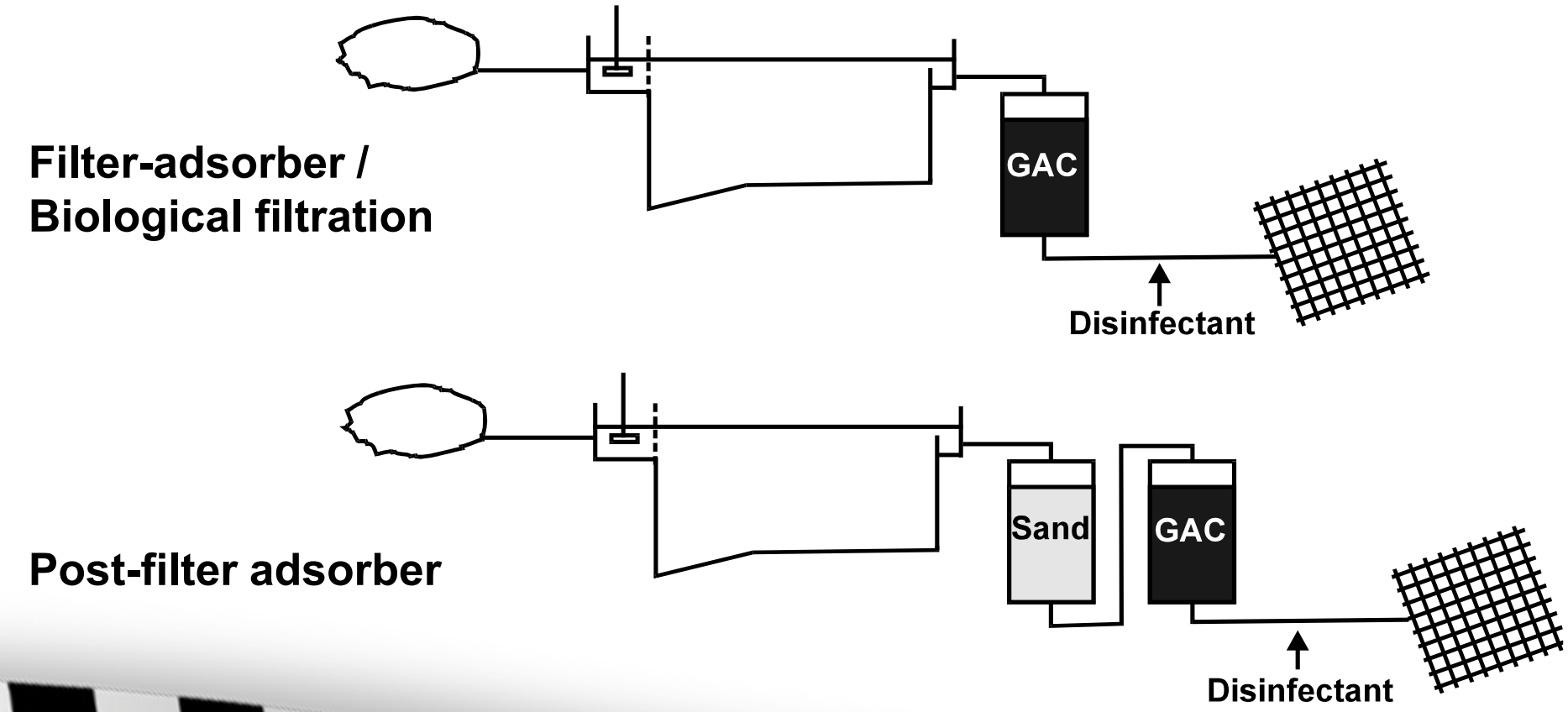
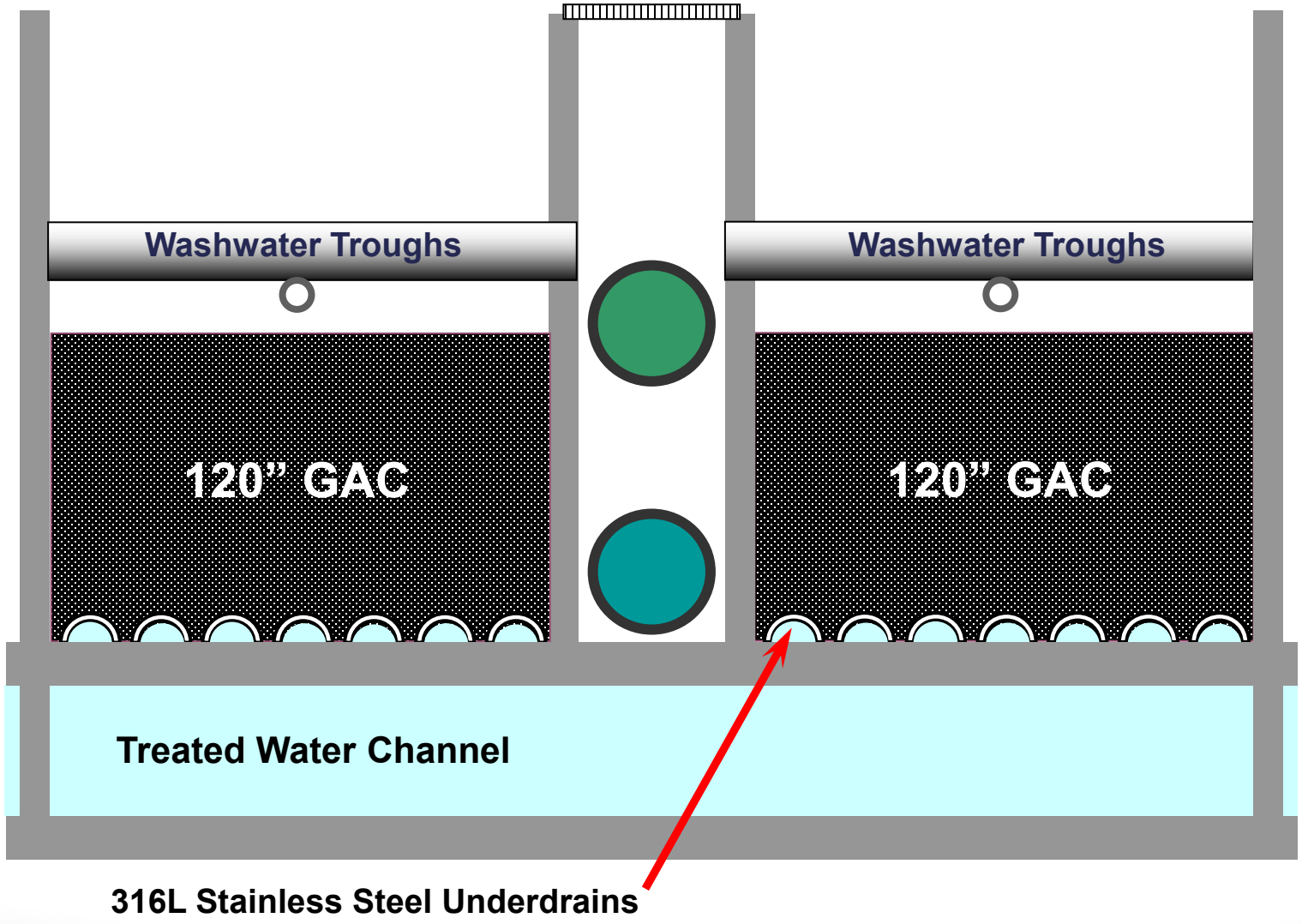
Technology Applications

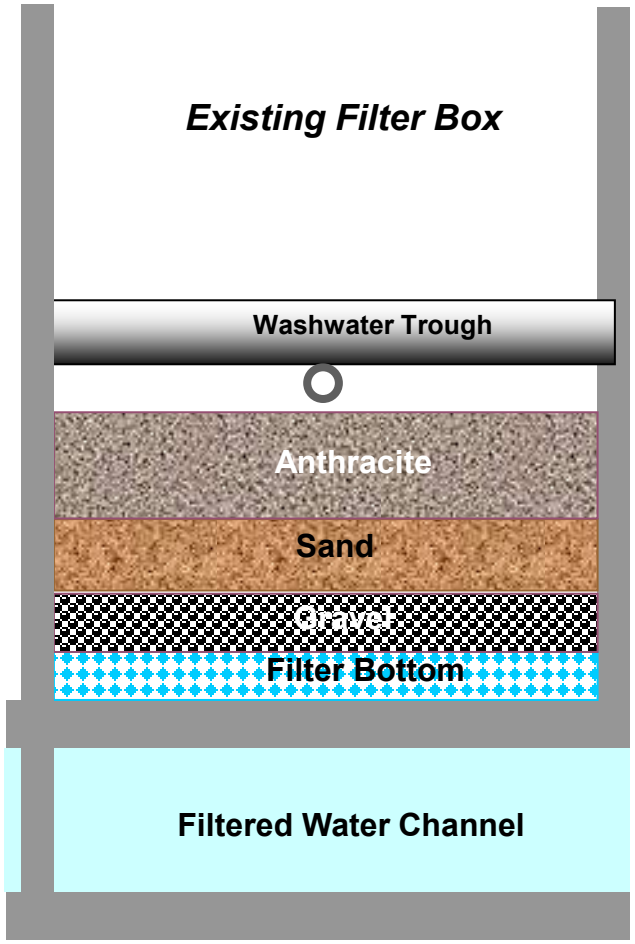
GAC adsorption can be accomplished in filters or post filters



Typical post filter GAC adsorbers includes deep single media



Typical filter adsorbers or biological filters utilize shallower depth

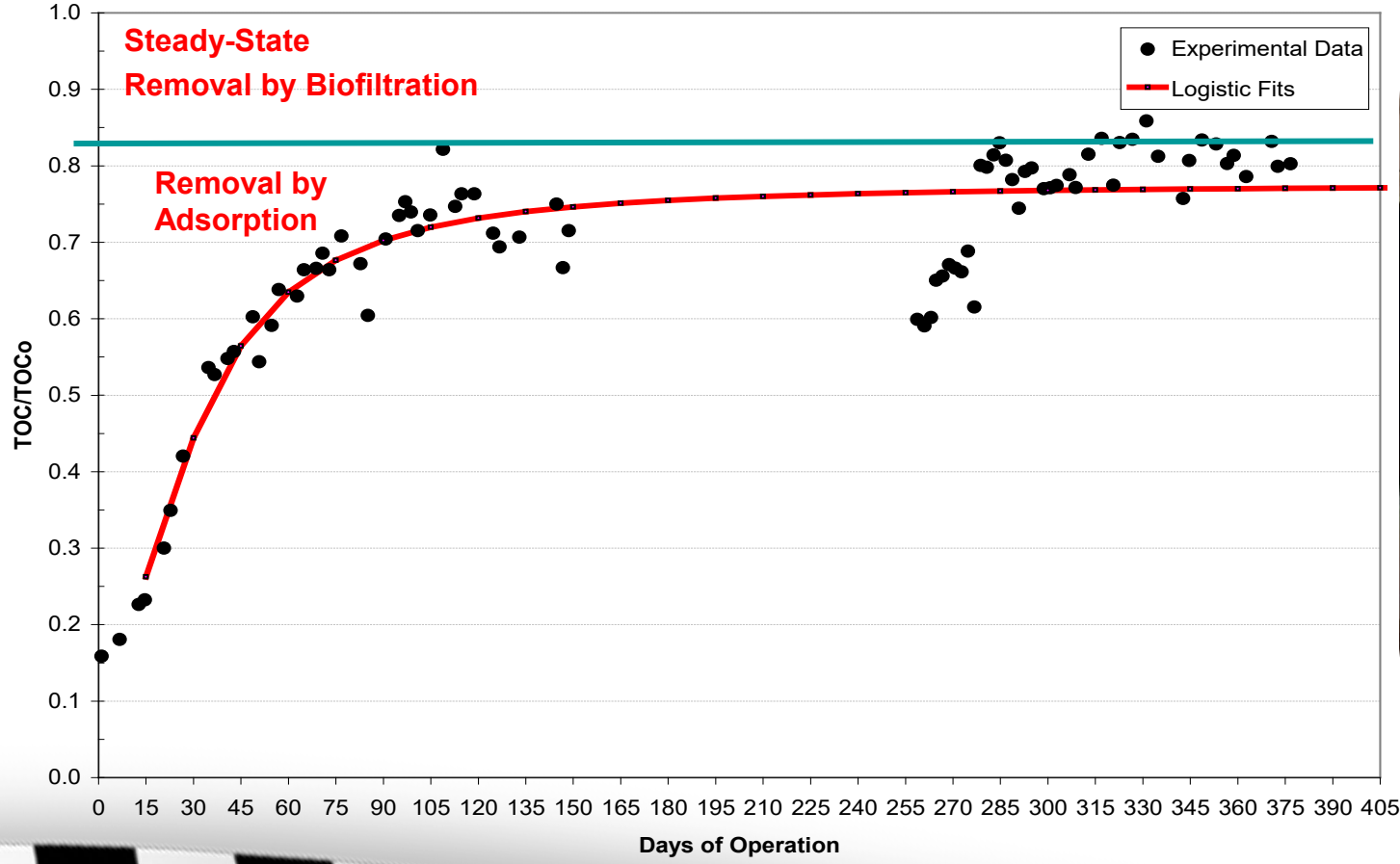


GAC adsorber

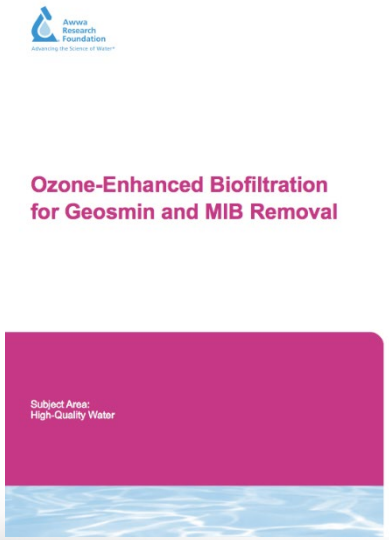
Typical design parameters

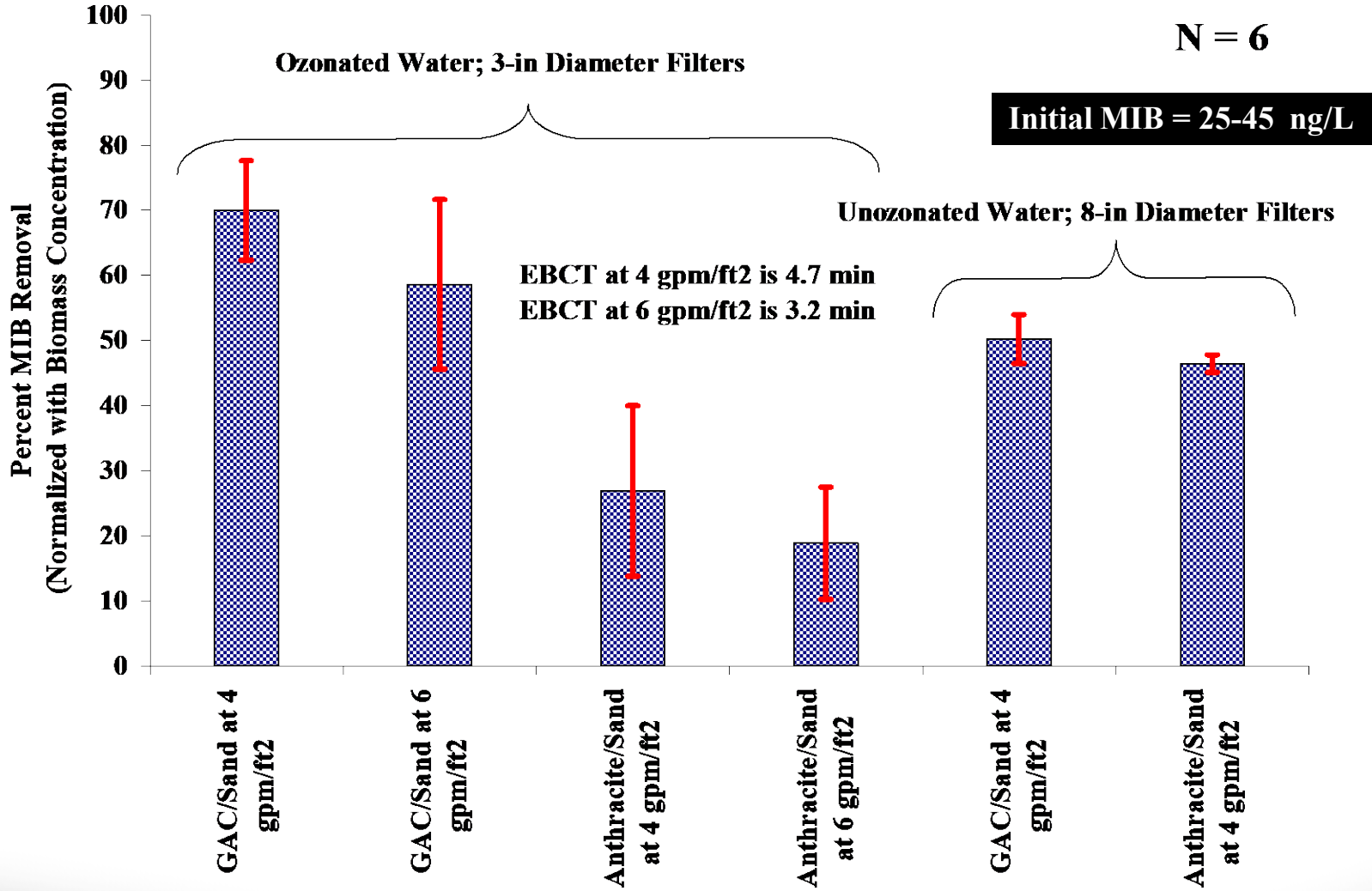
Parameter	Biological Filtration	GAC Adsorption
Empty-Bed Contact Time (EBCT), minutes	5-10	10-20
Loading Rate, gpm/ft^2	4-6	6-8
Media Depth, feet	4-5	7-12
Backwash Interval, days	1-2	14-21
Backwash	Air, Water	Water
GAC Mesh Sizes	8x16, 8x20, 8x30	12x30, 12x40

Natural Organic Matter Removal

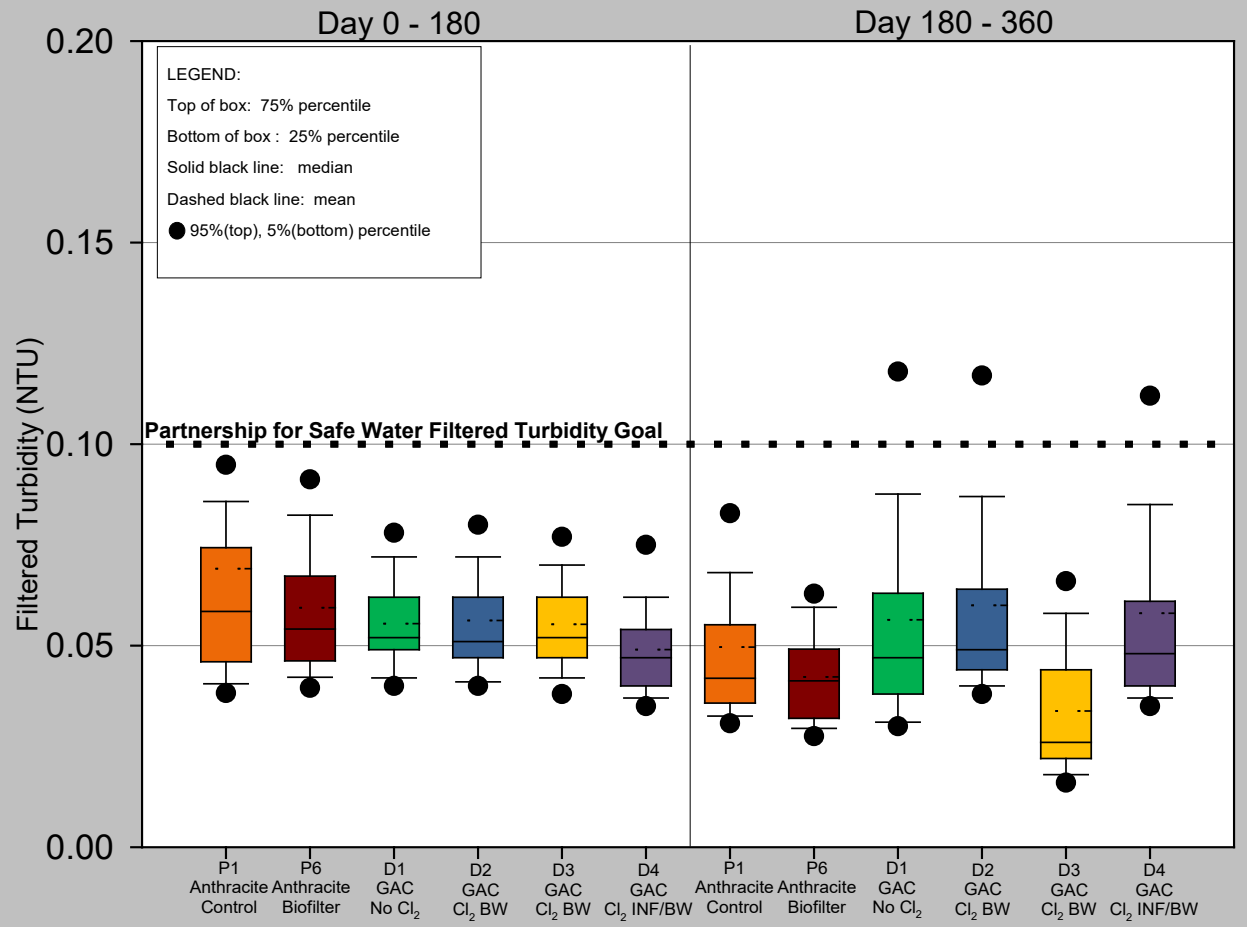


Taste and odor removal by biodegradation





Turbidity results



Summary: BAC

EBCT most important design parameter

Ozone dose and temperature also important

BAC more resilient at low temperatures

Secondary BAC benefits

- Improved T&O, algal toxins, and other trace organics

Particle and pathogen removal are not compromised

BAC more resilient at low temperatures

Summary:
GAC Adsorption

- EBCT most important design parameter
- Capital cost is a direct function of EBCT
- Adsorption capacity determines operational cost and replacement frequency
- One of the best barriers against organics, NOM, T&O compounds, Algal toxins, and TOrCs
- Offers secondary filtration benefits

Questions?

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