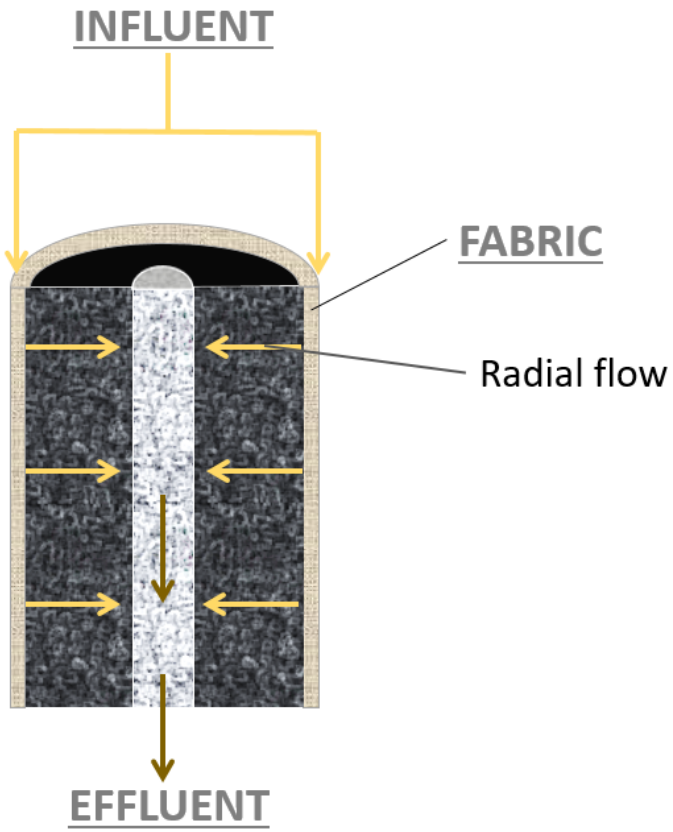
Observations about Water Quality Coming from Activated Carbon Block (ACB) Point-of-Use (PoU) "Lead Filters": An Emphasis on Bacterial Colonization



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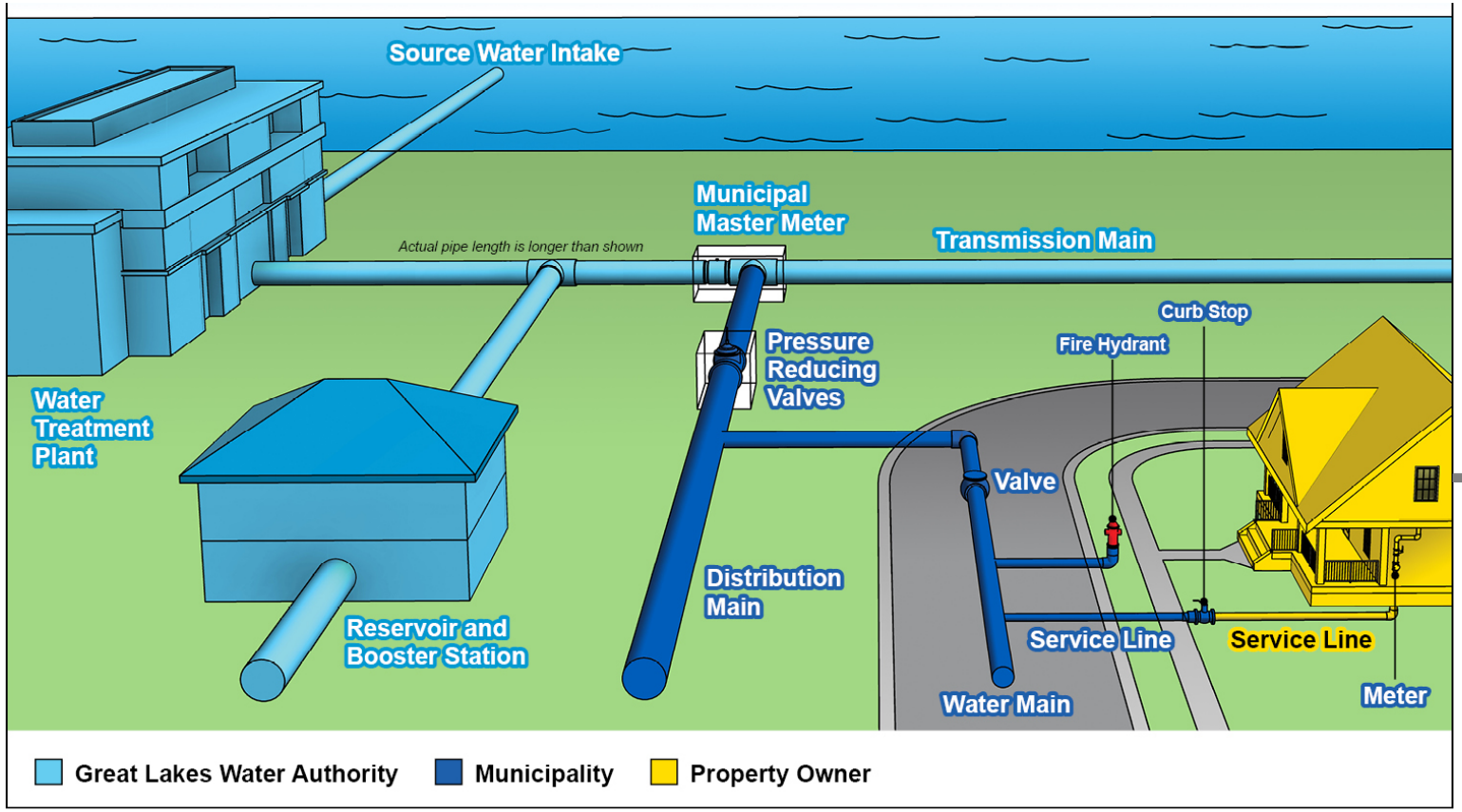
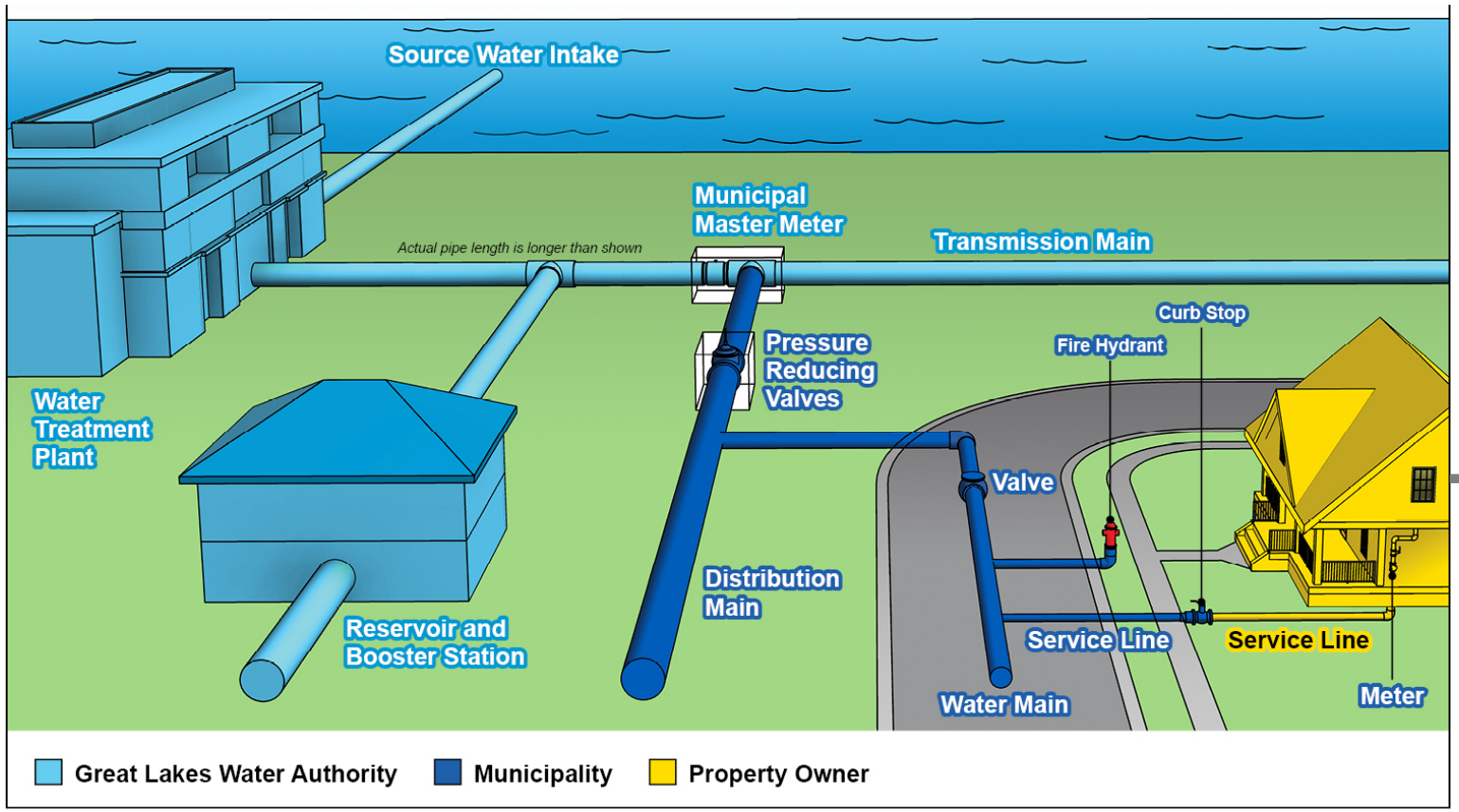
UNIVERSITY OF MICHIGAN

Kettering UNIVERSITY
Colorado State University
MICHIGAN STATE UNIVERSITY
Henry Ford HEALTH SYSTEM
WAYNE STATE



Examples:
Point-of-Use Treatment

https://outreach.glwater.org/Home/News/OCW_Safeguarding_Our_Water_1/tabid/241/Default.aspx



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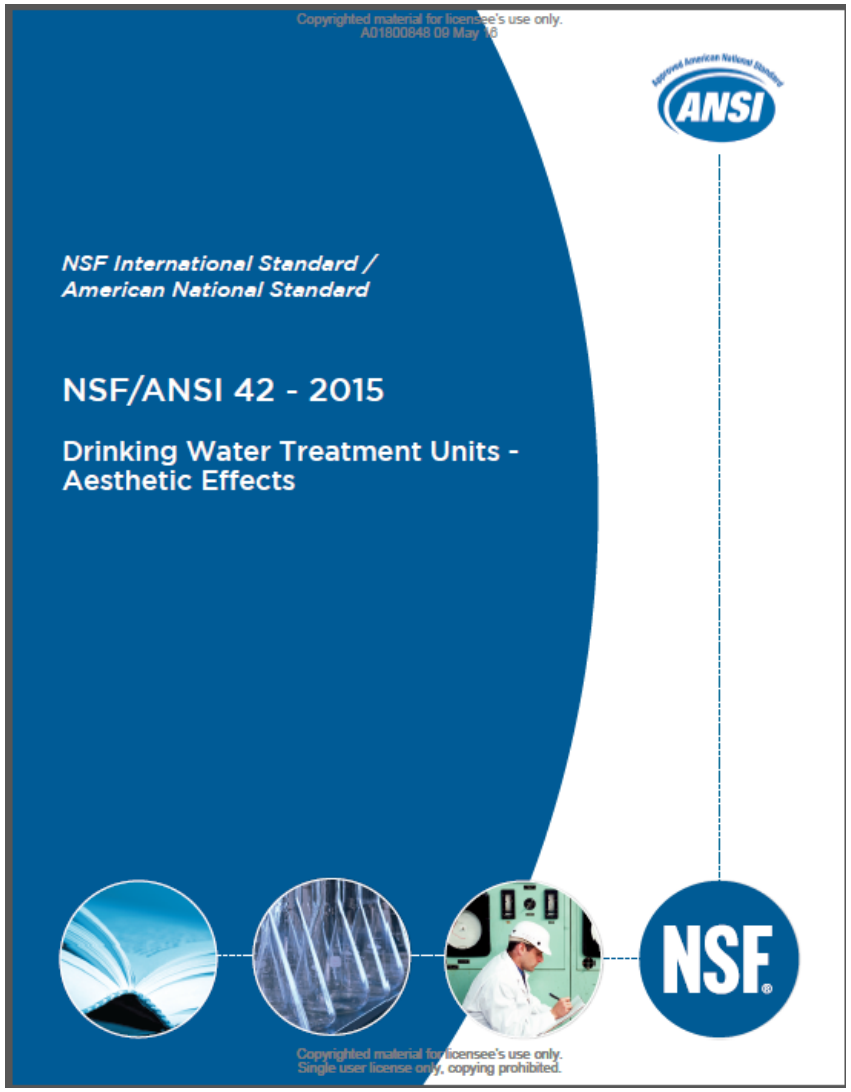
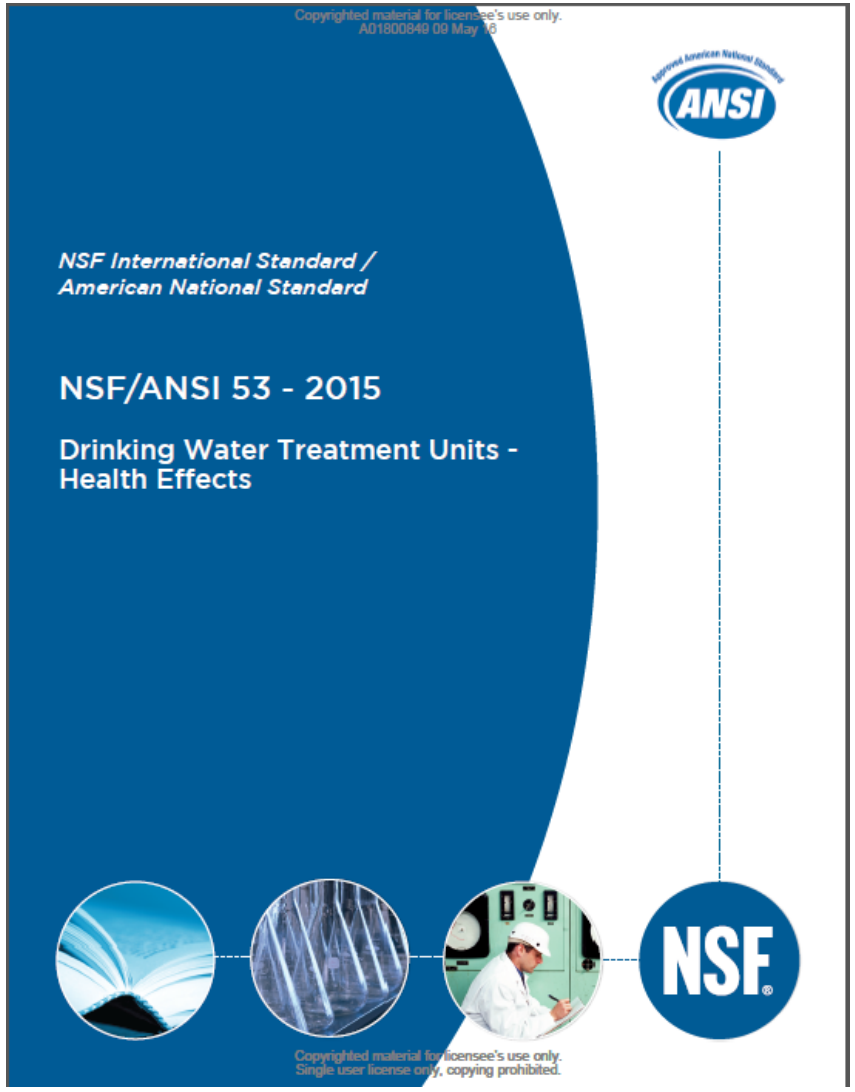
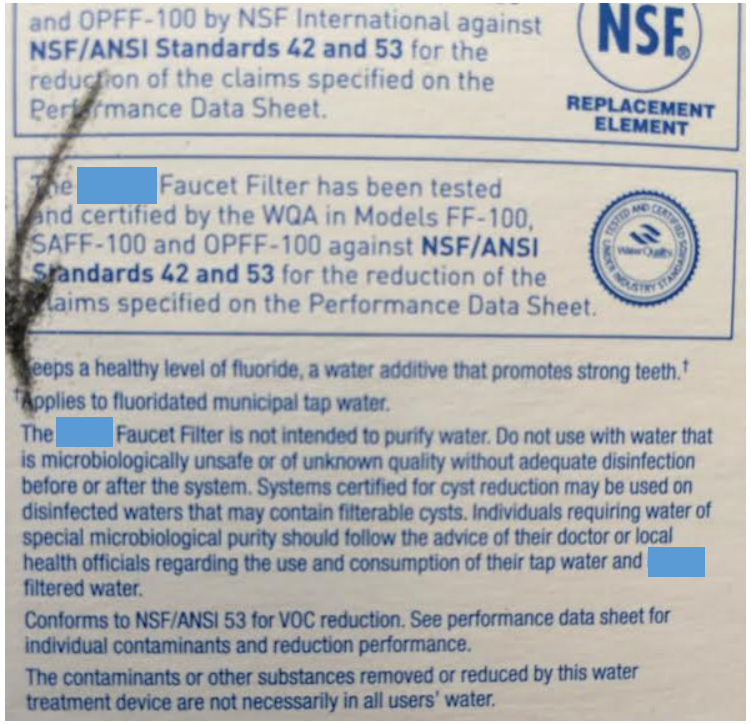


Common claims of filter reduction: **chlorine** (taste and odor), **chloramines**, **iron**, **manganese**, **hydrogen sulfide**, **pH neutralization** and **zinc**.



Common claims of filter reduction: **heavy metals** (arsenic, cadmium, chromium, copper, lead, mercury and selenium), **inorganics** (fluoride, nitrate, nitrite) and **VOCs** including DBPs.


and OPFF-100 by NSF International against **NSF/ANSI Standards 42 and 53** for the reduction of the claims specified on the Performance Data Sheet.

NSF

REPLACEMENT ELEMENT

The [redacted] Faucet Filter has been tested and certified by the WQA in Models FF-100, SAFF-100 and OPFF-100 against **NSF/ANSI Standards 42 and 53** for the reduction of the claims specified on the Performance Data Sheet.

eeps a healthy level of fluoride, a water additive that promotes strong teeth.†

†Applies to fluoridated municipal tap water.

The [redacted] Faucet Filter is not intended to purify water. Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system. Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts. Individuals requiring water of special microbiological purity should follow the advice of their doctor or local health officials regarding the use and consumption of their tap water and [redacted] filtered water.

Conforms to NSF/ANSI 53 for VOC reduction. See performance data sheet for individual contaminants and reduction performance.

The contaminants or other substances removed or reduced by this water treatment device are not necessarily in all users' water.

Courtesy: Dr. Laura Sullivan

"The XXXX Faucet Filter is not intended to purify water. Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system. Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts. Individuals requiring water of special microbiological purity should follow the advice of their doctor or local health officials regarding the use and consumption of their tap water and XXX filtered water."

Recommendations to use Point-of-Use filters must consider the overall status of the drinking water system supplying water to the filter.

This includes being aware of the system's *water age*.

Higher water age = higher water storage in the system and the potential for reduced disinfectant residual.


Garland St
Martin Luther King Ave
11th Ave
Lyon St
Ave C
Ave B
Ave A
Root St
Mason St
W Wood St
N Grand Traverse St
Tenth Ave
Health Awareness Center
Williams St
MLK Market
9th Ave
Eighth Ave
7th Ave
New Paths, Inc
Louisa St


Lyon St
Tenth Ave

Water quality deteriorates with water age or storage

Chemical Issues

Disinfection byproduct formation
Disinfectant decay
Corrosion control effectiveness
Taste and odor

Biological Issues

Disinfection byproduct degradation
Nitrification
Microbial regrowth/recovery
Taste and odor

Physical Issues

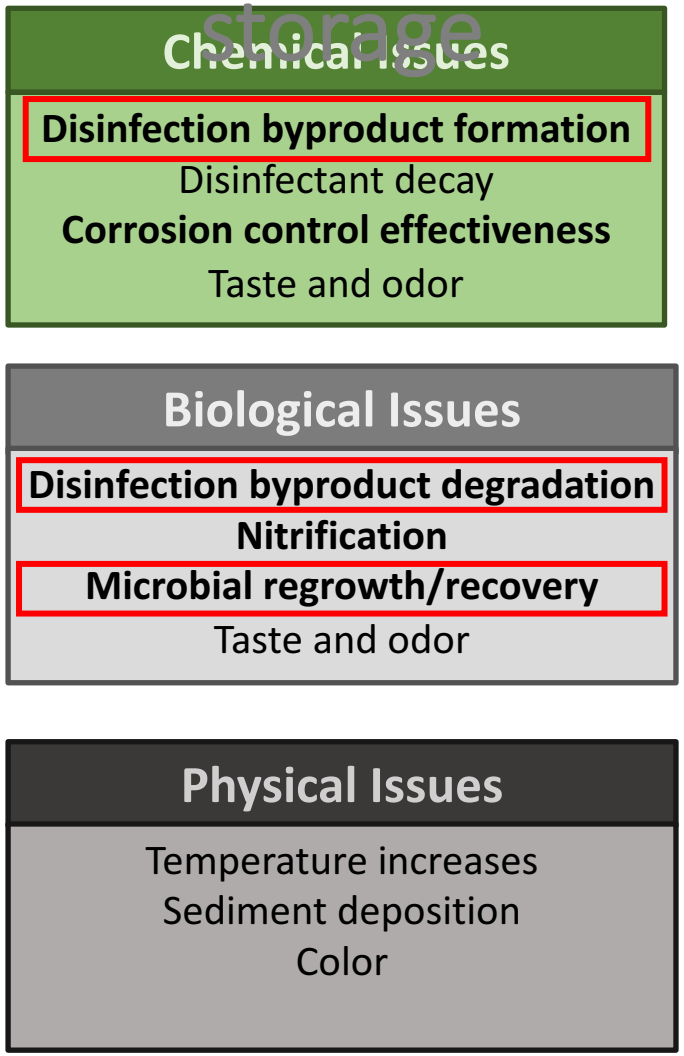
Temperature increases
Sediment deposition
Color

Bold denotes water quality problem with direct potential public health impact

Design guidelines for water age: preferably <72 hours

After: USEPA. 2002. Effects of Water Age on Distribution System Water Quality; The Water Industry Database, AWWA and AwwaRF, 1992.

Water quality deteriorates with water age or storage



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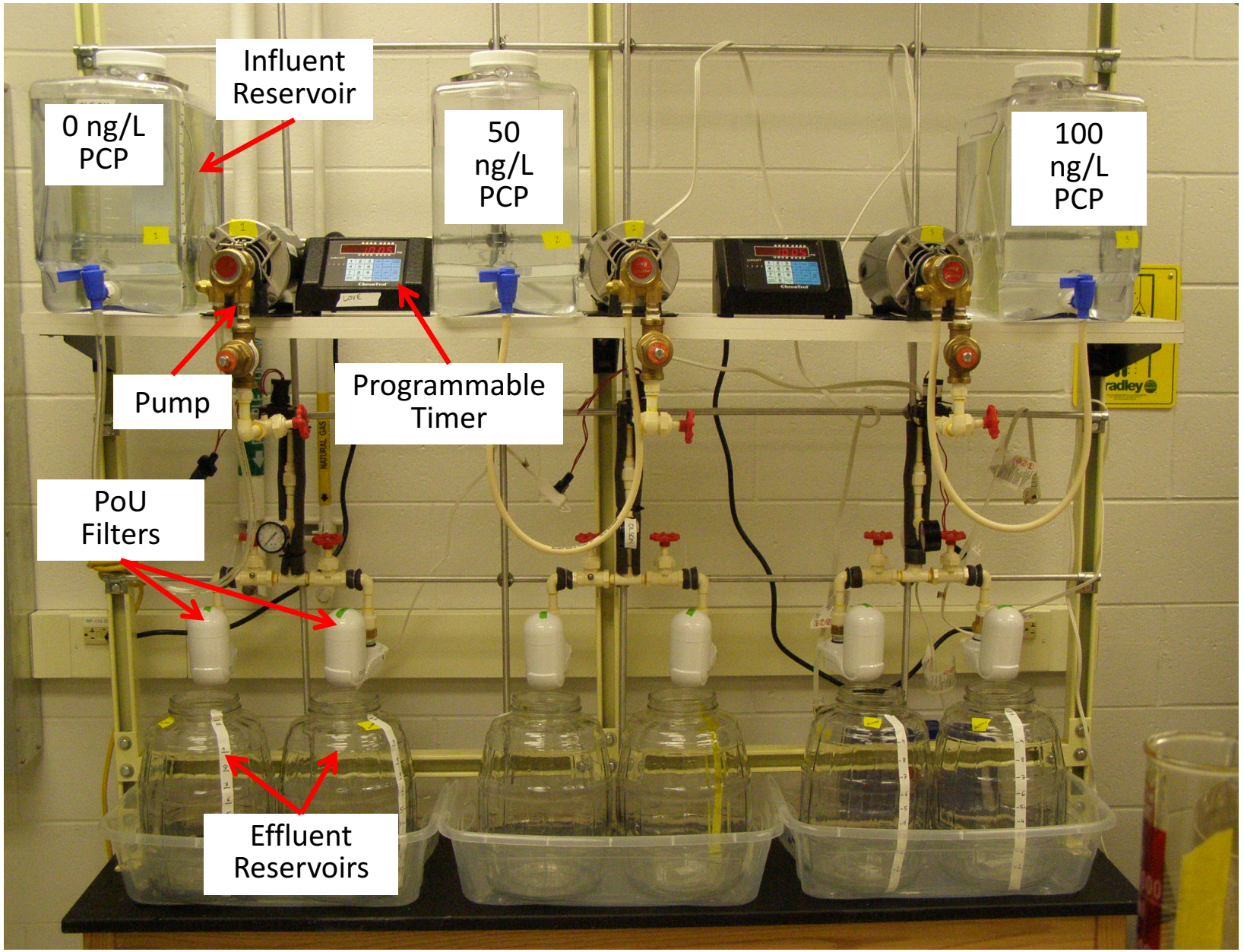
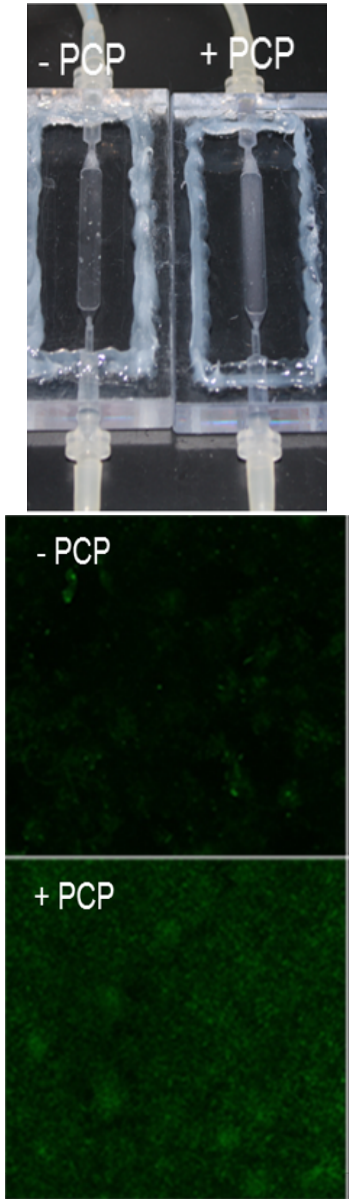




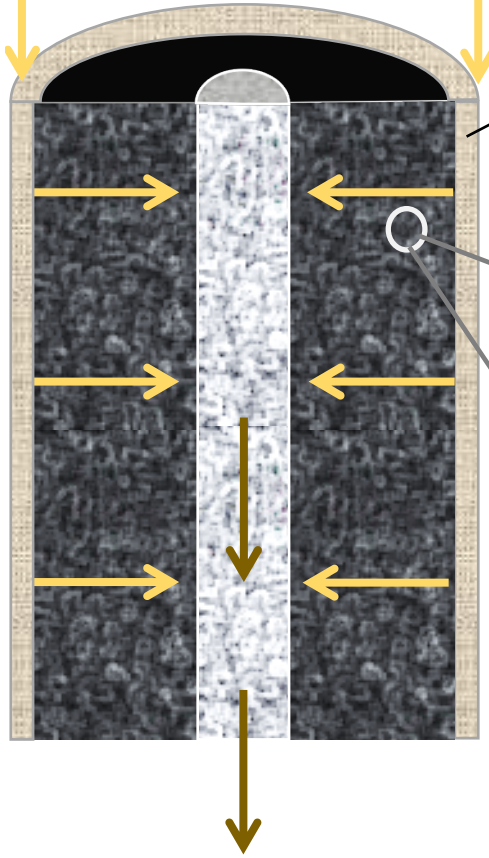
Ghosh, Cremers, Jakob and Love, 2011, Chlorinated phenols control the expression of the multi-drug resistance efflux pump MexAB-OprM in *Pseudomonas aeruginosa* by activating NalC. *Mol Micro*, 79(6):1547-1556.

Wu, C.-C., S. Ghosh, K. J. Martin, A. J. Pinto, V. J. Denef, T. M. Olson, N. G. Love*. 2017. The microbial colonization of activated carbon block point-of-use (PoU) filters with and without chlorinated phenol disinfection byproducts. *Environmental Science: Water Research & Technology*, 2017, DOI: 10.1039/C7EW00134G

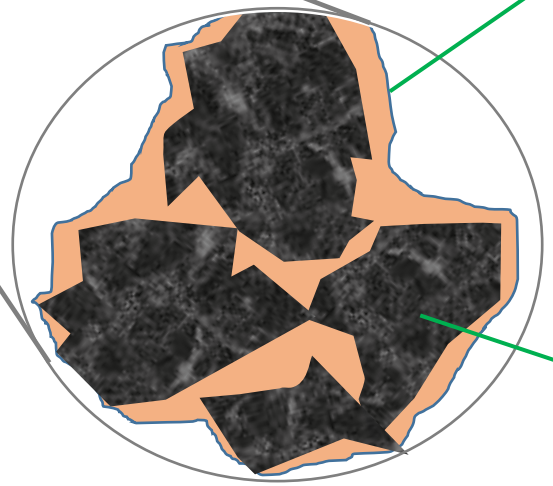
The anatomy of a point-of-use filter

INFLUENT *planktonic*

FABRIC *Attached growth*



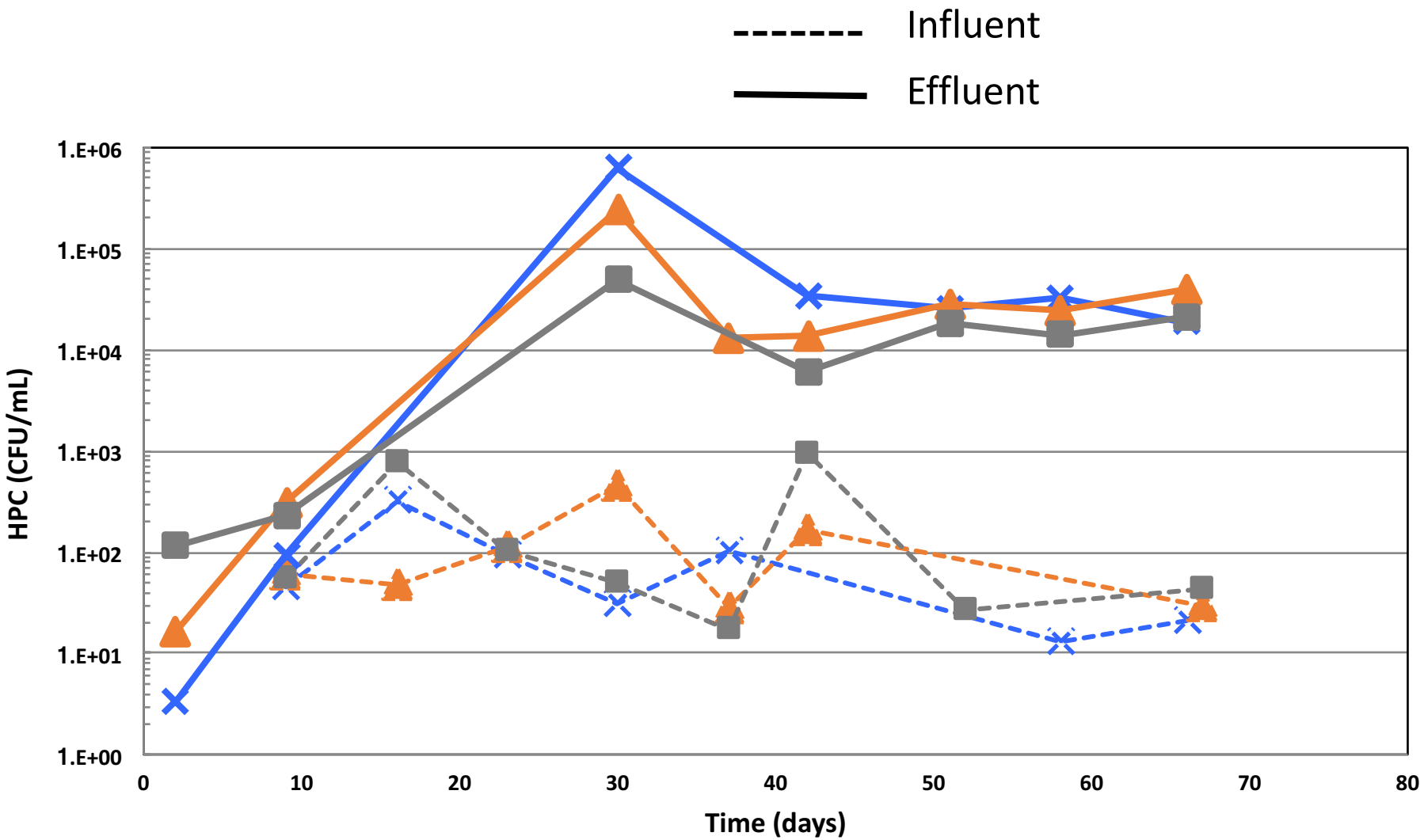
EFFLUENT *planktonic*



Polymer binder

PAC

Ann Arbor Study: Heterotrophic plate counts show enhanced growth in the effluent within one month of operation.



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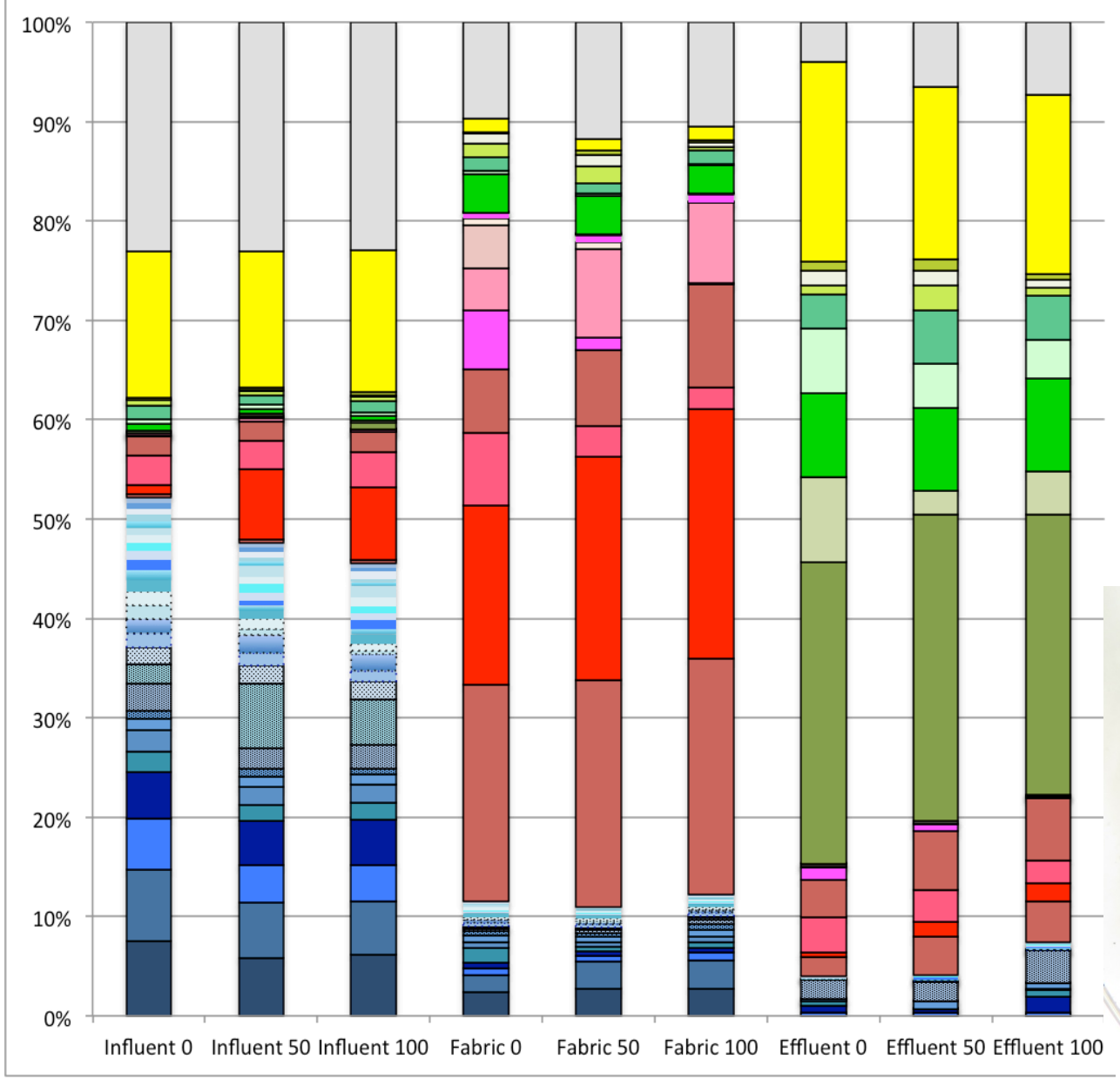

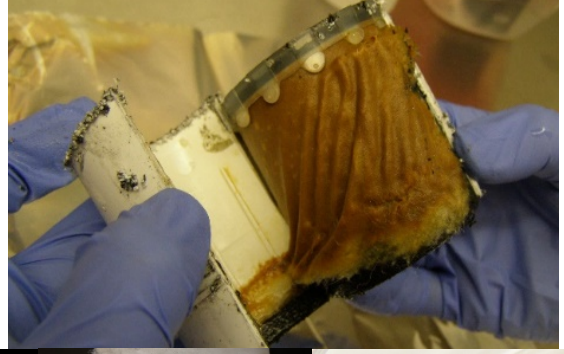

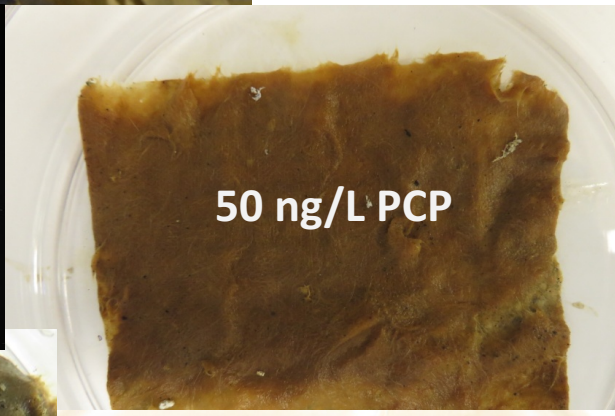

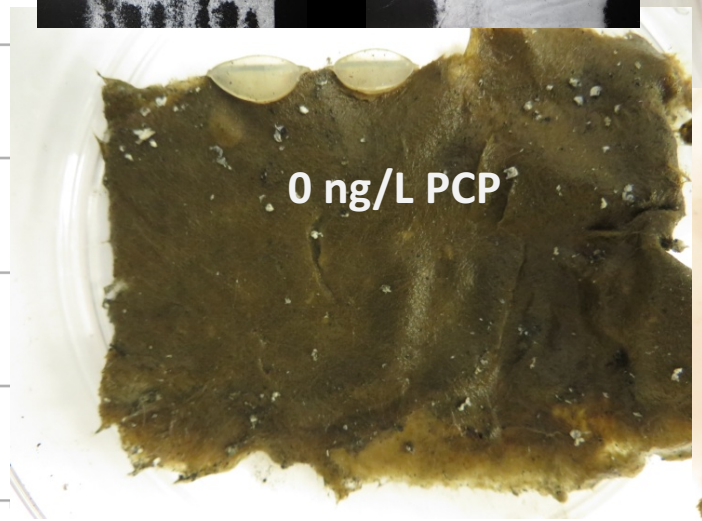

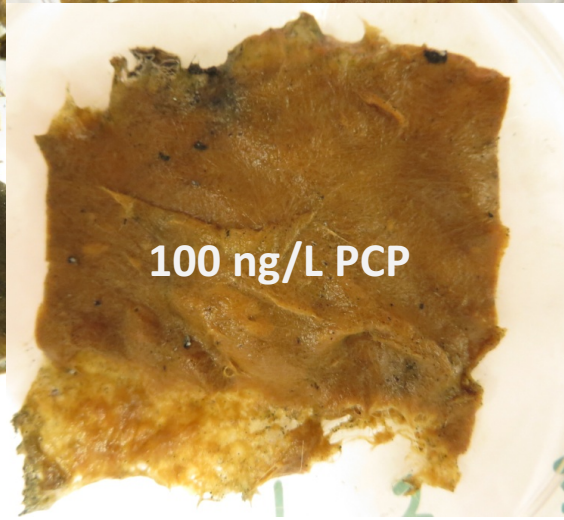

Filtered OTUs **Attached OTUs** **Unfiltered OTUs**

Dominant OTUs with relative abundance >1%

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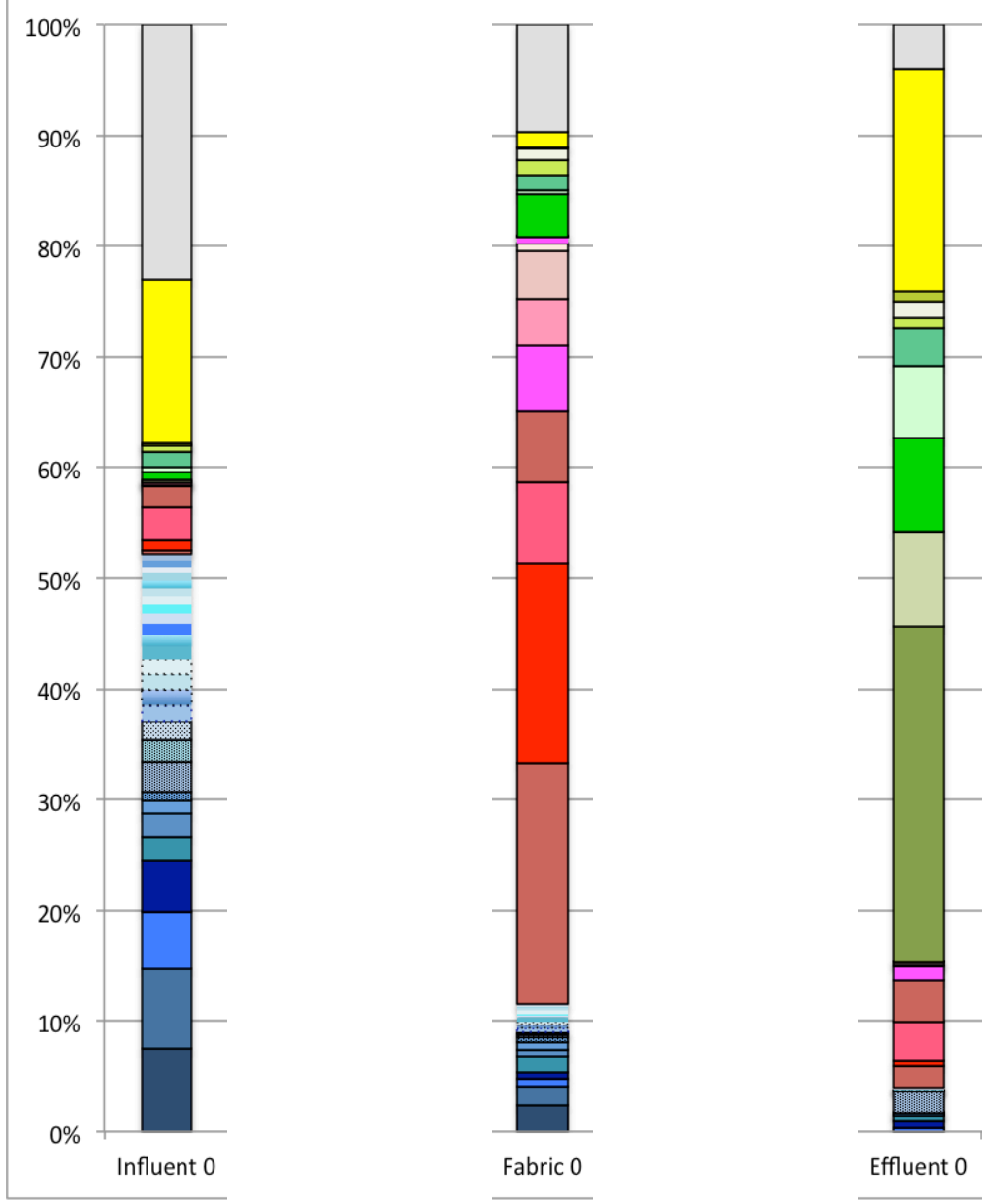

16S rRNA gene Illumina sequence analysis

***Ann Arbor Study:* Point-of-use filters change the composition and abundance of microorganisms consumers are exposed to.**

Dominant OTUs with relative abundance >1%

Filtered OTUs **Attached OTUs** **Unfiltered OTUs**

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Ann Arbor Study: PoU filters increased the absolute abundance of selected taxa across filters, including the Mycobacterium genus that includes NTM

	0 ng/L PCP		50 ng/L PCP		100 ng/L PCP	
Highly Dominant Taxa (OTU#)	Influent	Effluent	Influent	Effluent	Influent	Effluent
Hydrogenophaga (4)	6E+04	**1E+05**	5E+02	**2E+05**	1E+03	**2E+05**
Unclassified Bacteroidetes (19)	3E+04	0E+00	2E+02	0E+00	6E+02	2E+01
Unclassified Bacteriodetes (12)	3E+04	1E+02	2E+02	1E+02	5E+02	1E+02
Brevundimonas (30)	2E+04	2E+03	1E+02	**4E+03**	4E+02	**3E+03**
Unclassified Betaproteobacteria (10)	2E+04	5E+03	2E+02	**3E+03**	5E+02	**1E+04**
Sphingopyxis (1)	2E+03	**1E+04**	1E+01	**4E+04**	4E+01	**4E+04**
***Mycobacterium* (3)**	4E+03	2E+03	3E+02	**2E+04**	7E+02	**2E+04**
Aquabacterium (5)	1E+04	**2E+04**	1E+02	**4E+04**	4E+02	**2E+04**
Acidovorax (2)	8E+03	**3E+04**	8E+01	**6E+04**	2E+02	**6E+04**
Unclassified Sphingomonadaceae (14)	6E+02	**8E+03**	0E+00	**8E+03**	6E+00	**5E+02**
Unclassified Proteobacteria (7)	3E+02	**2E+05**	2E+00	**3E+05**	1E+01	**3E+05**
Unclassified Betaproteobacteria (15)	7E+02	**6E+04**	7E+00	**3E+04**	2E+01	**4E+04**
Unclassified Bacteria (9)	3E+03	**6E+04**	2E+01	**9E+04**	5E+01	**9E+04**
Nitrospira (20)	2E+03	**4E+04**	2E+01	**5E+04**	3E+01	**4E+04**

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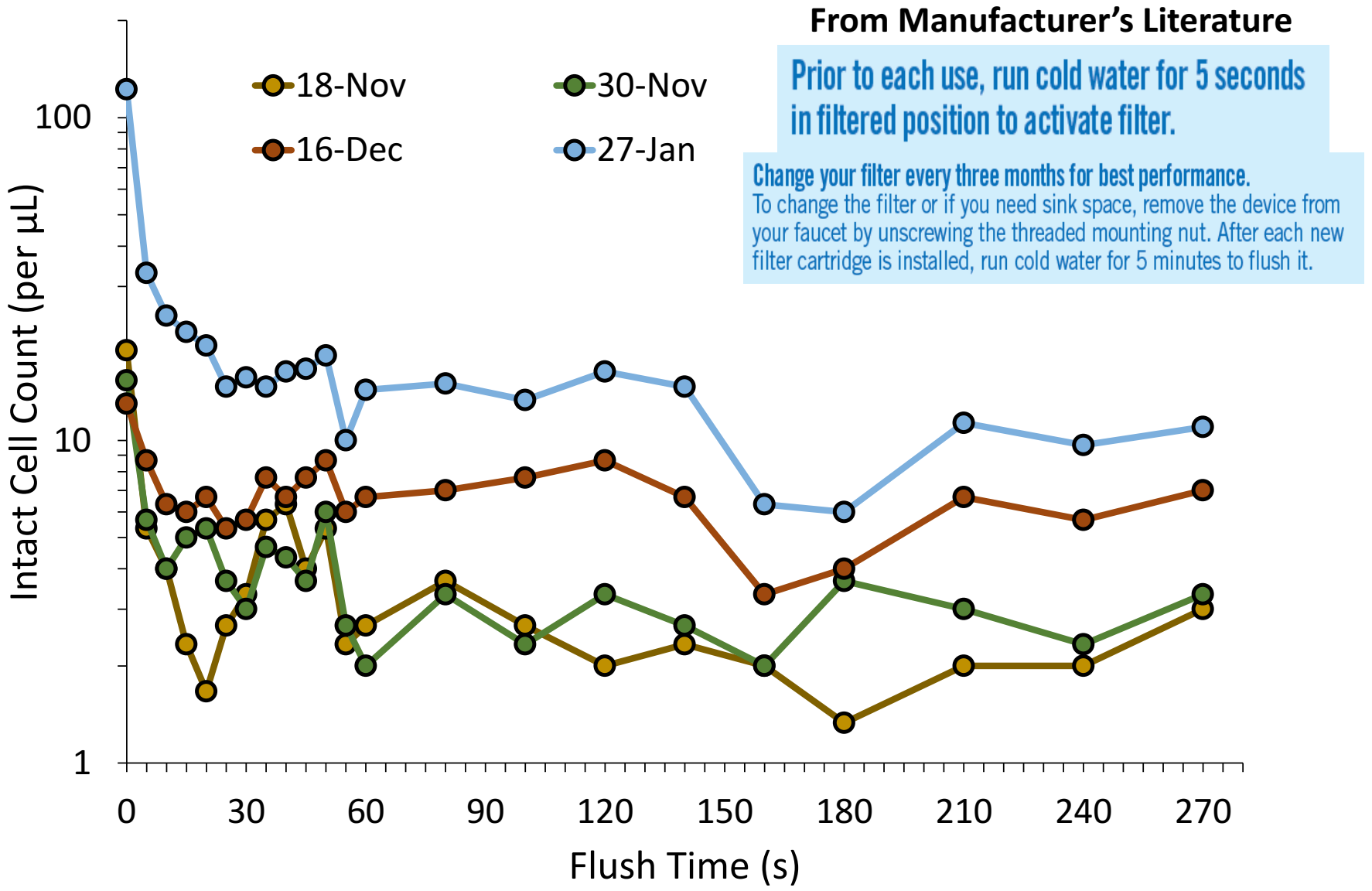
There is uncertainty around point-of-use filters, and this deserves more attention:

- We do not know how point-of-use filter performance in field trials changes with increasing water age and across different systems (different treatment processes, different infrastructure conditions).
- We do not know the relationship between microbial stability, chemical water quality, point-of-use filters, and opportunistic pathogens in field trials.
- We do not know the relationship between emerging opportunistic pathogens and point-of-use filters based on field trials.
- Coordinated water quality + epidemiological studies around point-of-use filters are quite limited.

Flushing education is important for PoU filter deployments



From Manufacturer's Literature

Prior to each use, run cold water for 5 seconds in filtered position to activate filter.

Change your filter every three months for best performance.
To change the filter or if you need sink space, remove the device from your faucet by unscrewing the threaded mounting nut. After each new filter cartridge is installed, run cold water for 5 minutes to flush it.

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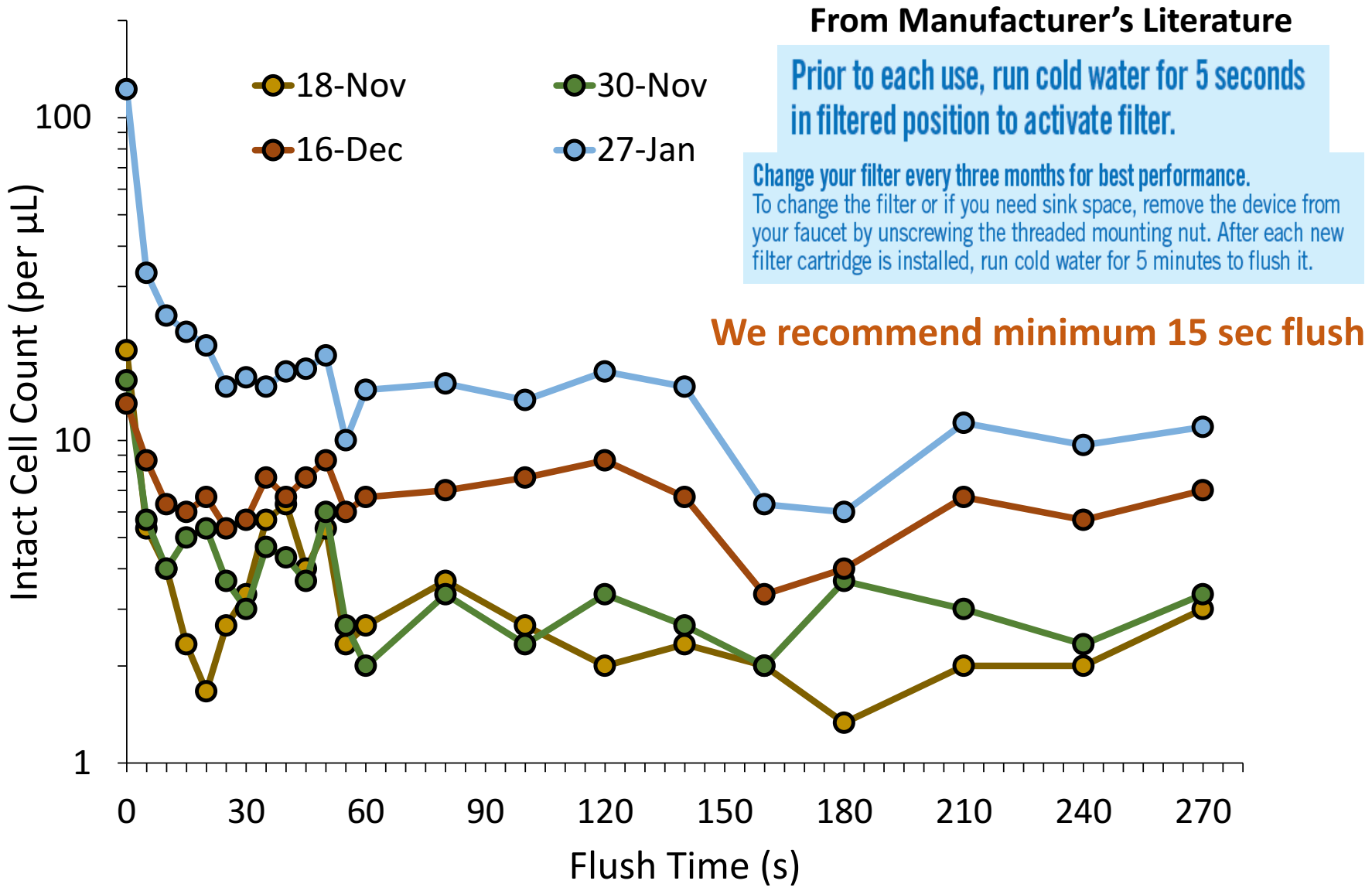

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We recommend minimum 15 sec flush

PoU Filter Train the Trainers Program

Greater than 8 hours of inactivity	• Flush water through bypass until cold or 1-2 minutes
Beginning of each use period *	• Flush water through filter cartridge for 15 seconds
Use filter	• Use filter only with cold water **

https://www.urbanlab.umich.edu/project/point-of-use-water-filters-a-grassroots-train-the-trainer-program/