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(Germany)

Reduction of Microorganisms in Municipal Sewage by Means of Planted and Unplanted Soil Filters

Project partners

- UFZ- Centre for Environmental Research
- Martin-Luther-University Halle-Wittenberg

Centre for Environmental Research Leipzig-Halle

Objective:

CW´s for supply of irrigation waters

⇒ Test and optimization of soil filters regarding the elimination of bacteria and parasites

- different design (vertical, horizontal, combination)
- different filtration substrates (sand, exclay)
- planted and unplanted filters
- variations in hydraulic surface loads

⇒ Adaptation of the design, comparison of the performance, and dimension for an advanced reduction of faecal indicator organisms

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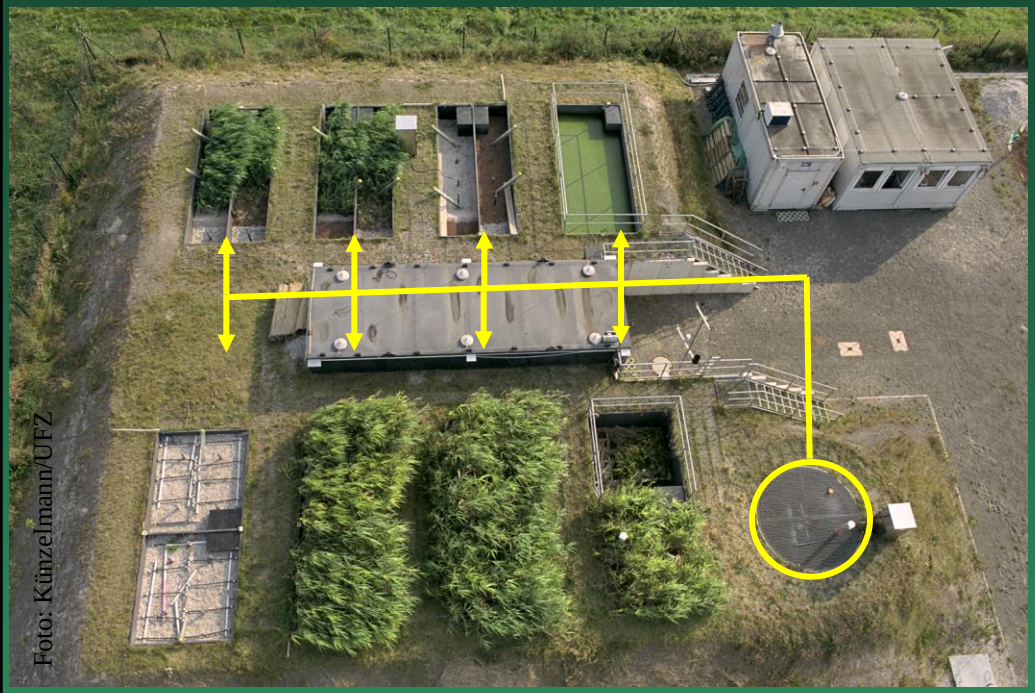
Pilot system Langenreichenbach

Operator:
Center for Environmental Research Leipzig-Halle GmbH

Site:	Village Langenreichenbach, Saxonia (Germany)
Capacity:	35 p. e.
Waste water:	municipal, from an influent of a municipal sewage plant
Design:	8 vertical-, 6 horizontal beds and 1 pond
Plant age:	4 years

Pilot system Langenreichenbach

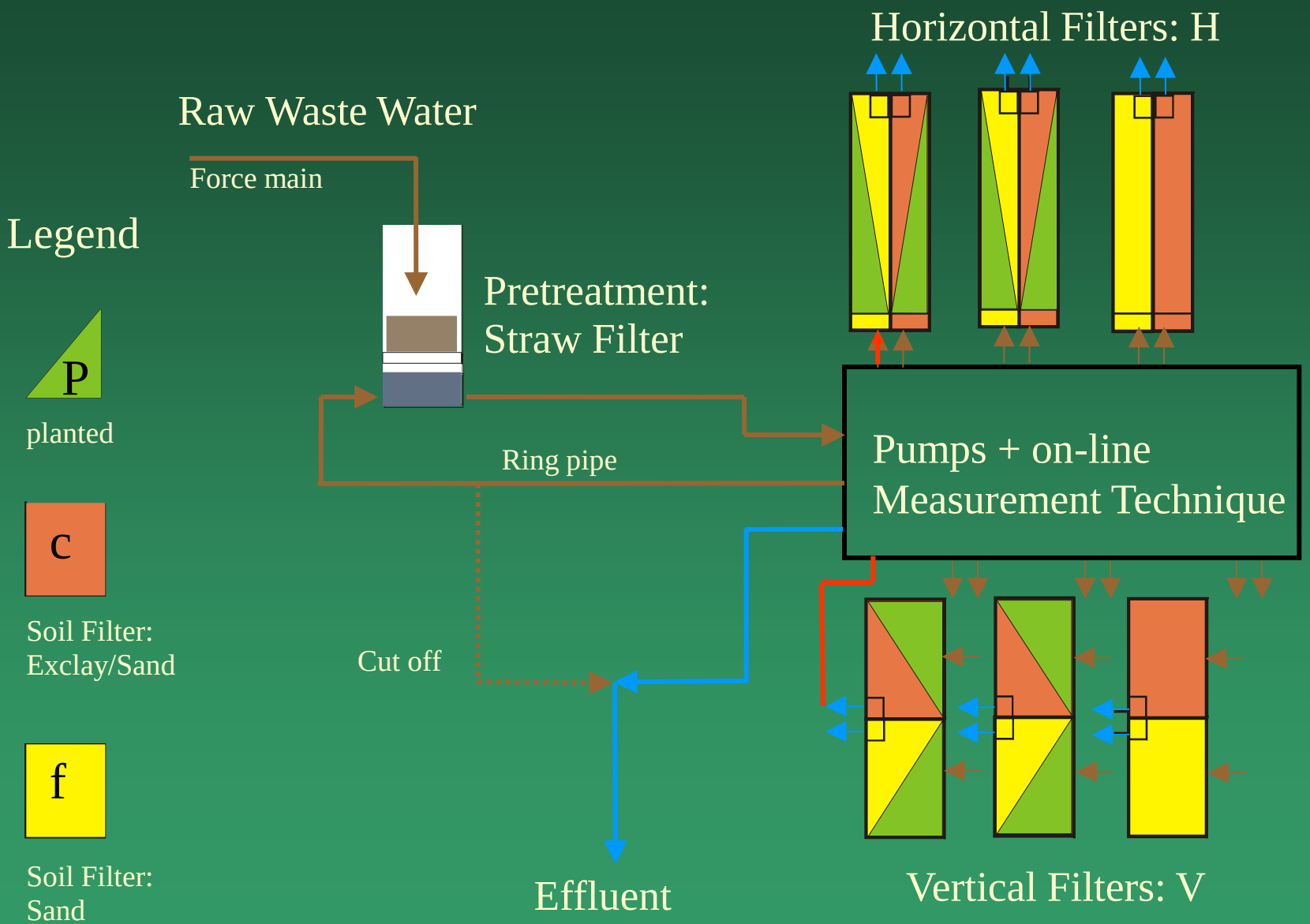
Quality of settled water



Operator:
Center for Environmental Research Leipzig-Halle GmbH

	C_S	C_{COD}	C_{BOD5}	S_{NH4-N}	S_{NO3-N}	C_{Nt}	*E. coli*
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lg(MPN/100 ml)
Median	**75**	**490**	**222**	**65,4**	**0,8**	**76**	**6,9**

Design of the pilot system



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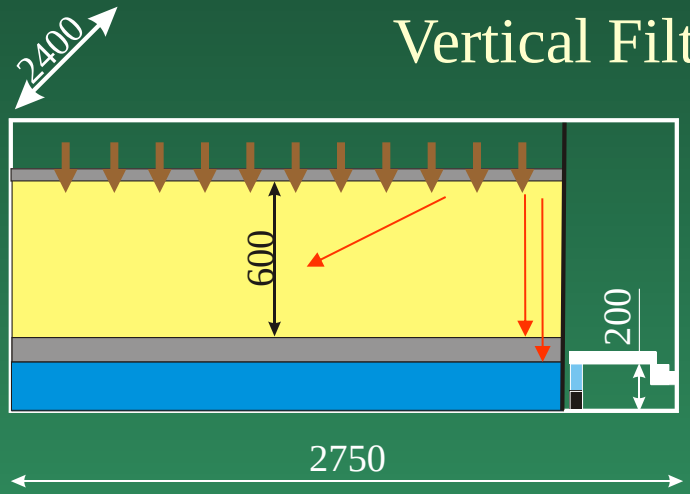
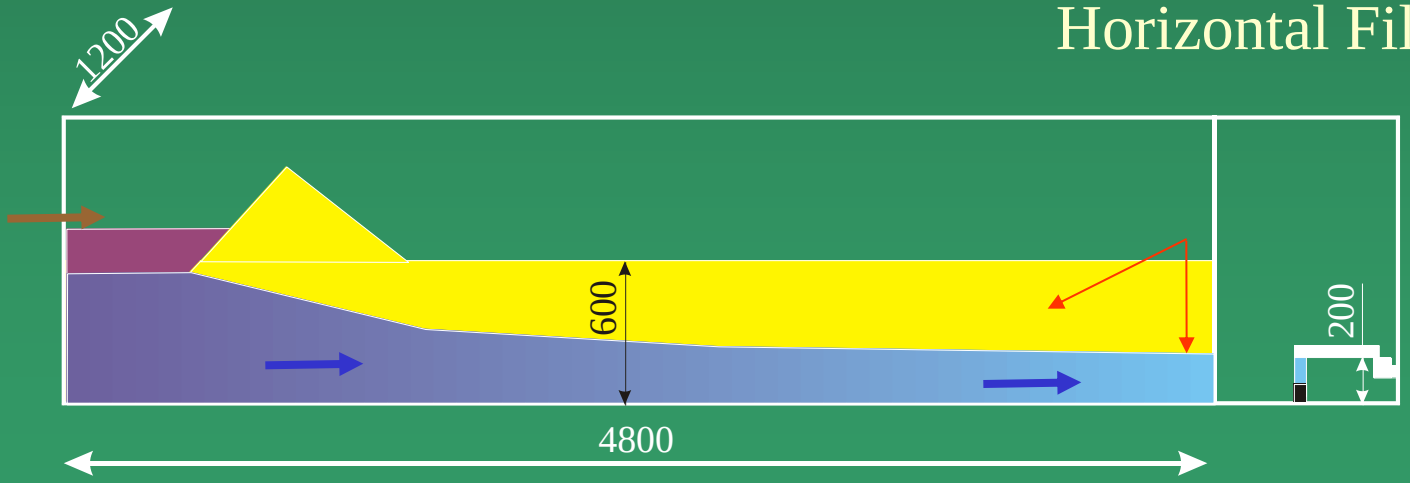
Filter Design

Vertical Filter



$A = 6\ m^2$

Horizontal Filter



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Waste water analysis

Microbiological/Parasitological Parameters	Physicochemical Parameters
total bacterial number (CFU) at 22°C and 36°C	chemical oxygen demand COD
thermotolerant coliform bacteria	biological oxygen demand BOD_5
Escherichia coli	ammonia- nitrogen
Enterococci	nitrate- nitrogen
Salmonella	total nitrogen
Clostridia	ortho-phosphate
Cryptosporidium oocysts	water balance
Giardia cysts	bromide (tracer tests)

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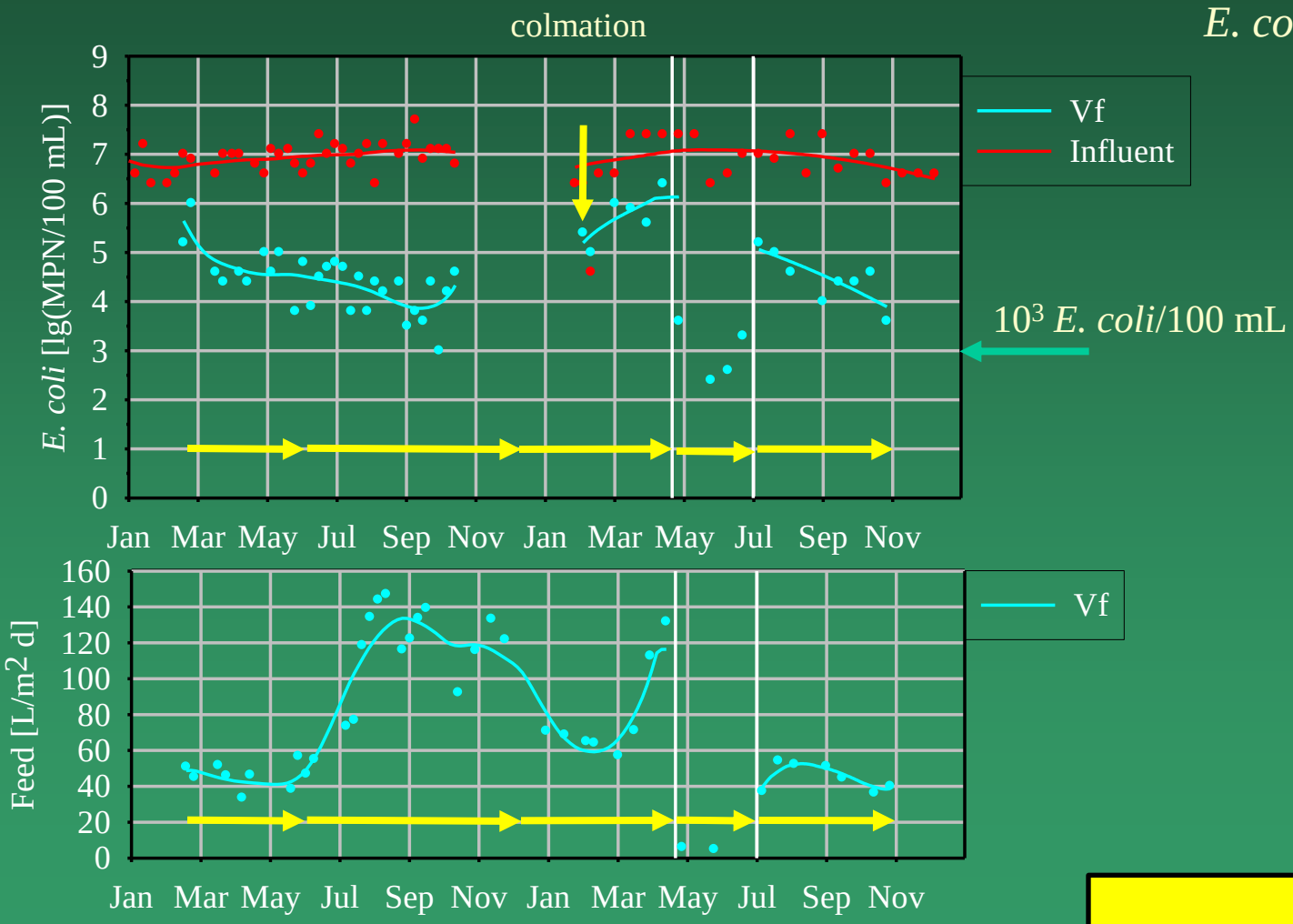
Reduction of *E. coli* by means of individual filters

Influence of hydraulic load



Vf
vertical sand filter, unplanted

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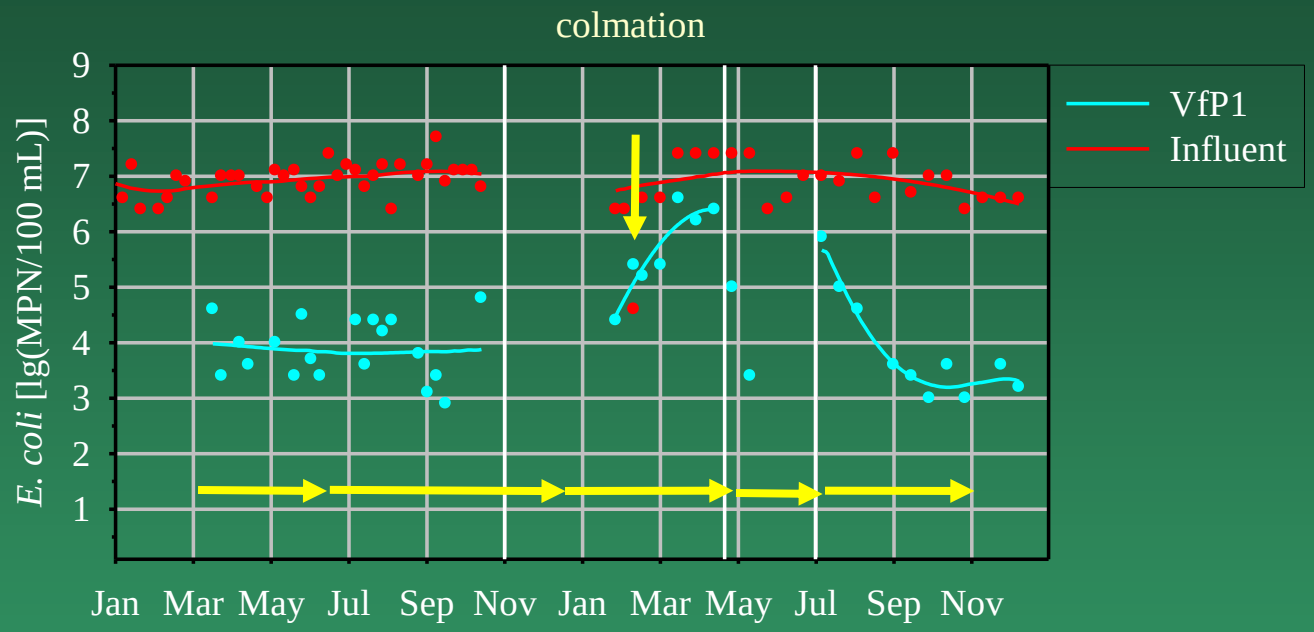
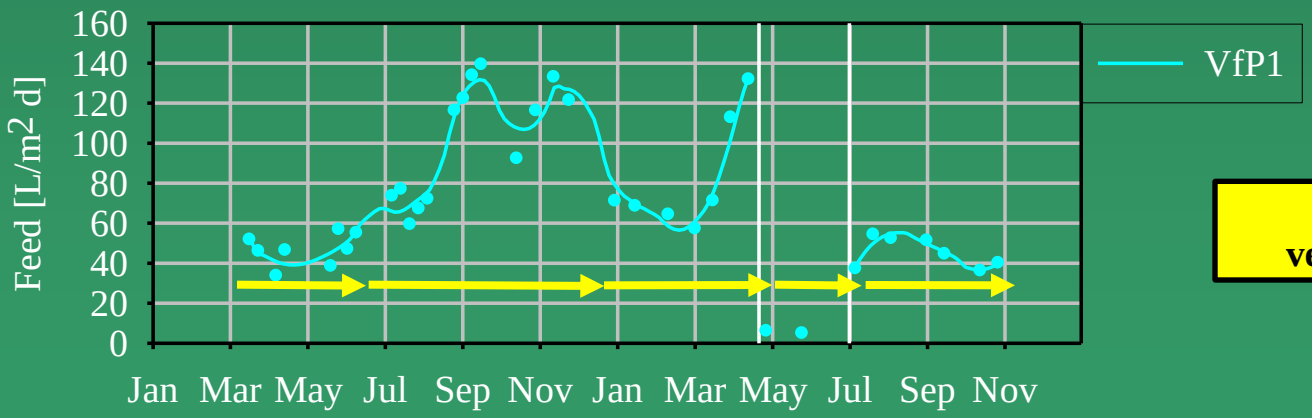
Reduction of *E. coli* by means of combined filters

Influence of hydraulic load

E. coli concentration



surface load



VfP1
vertical sand filter, planted

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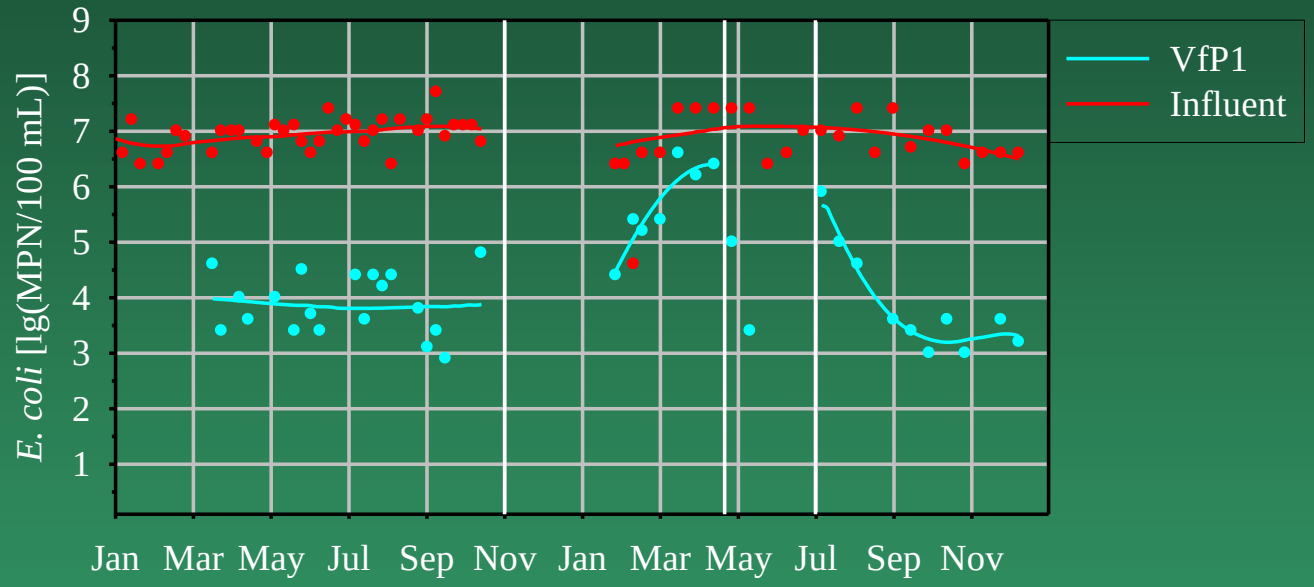
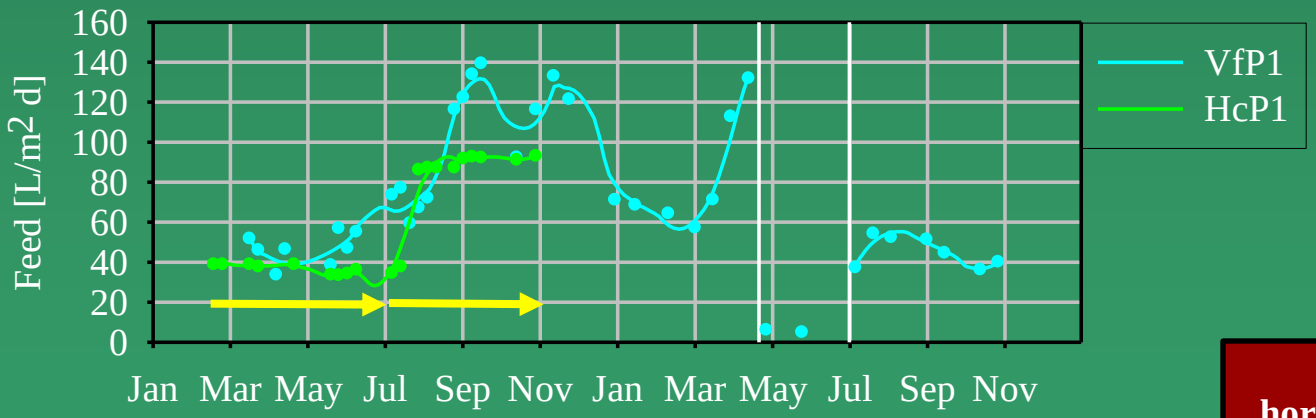
Reduction of *E. coli* by means of combined filters

Influence of hydraulic load

E. coli concentration



surface load



HcP1
horizontal exclay filter, planted

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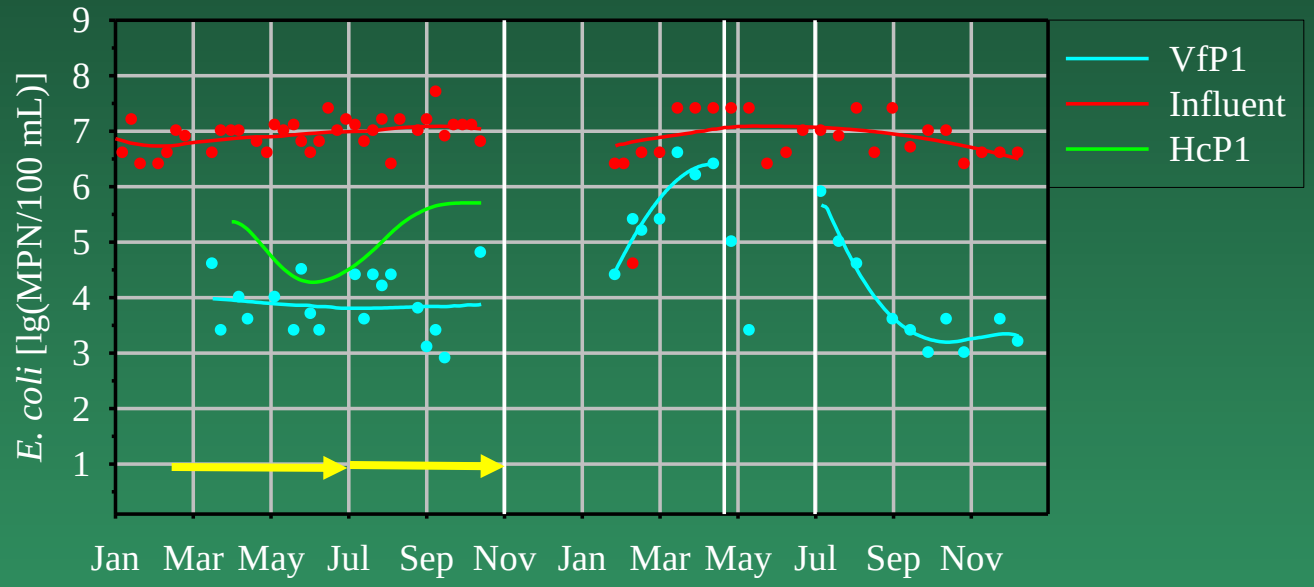
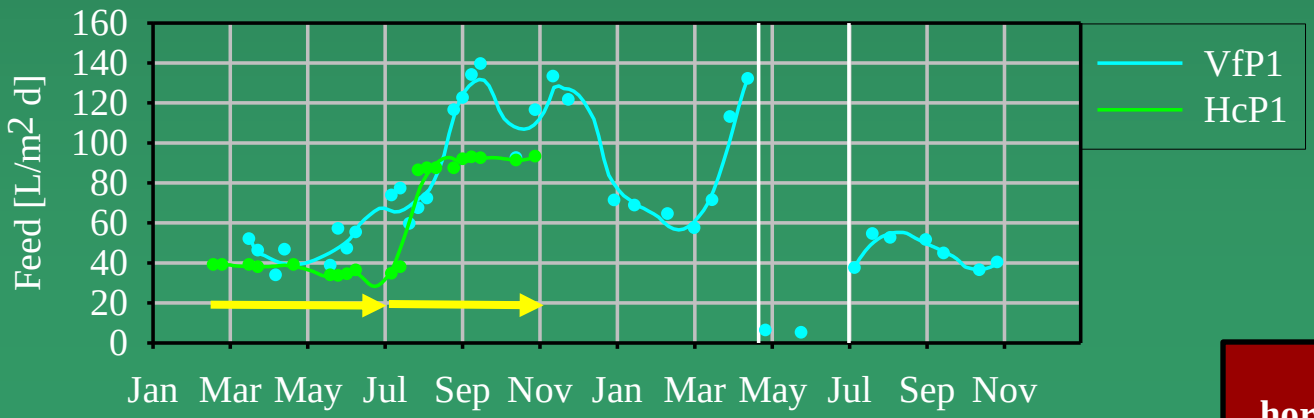
Reduction of *E. coli* by means of combined filters

Influence of hydraulic load

E. coli concentration



surface load



HcP1
horizontal exclay filter, planted

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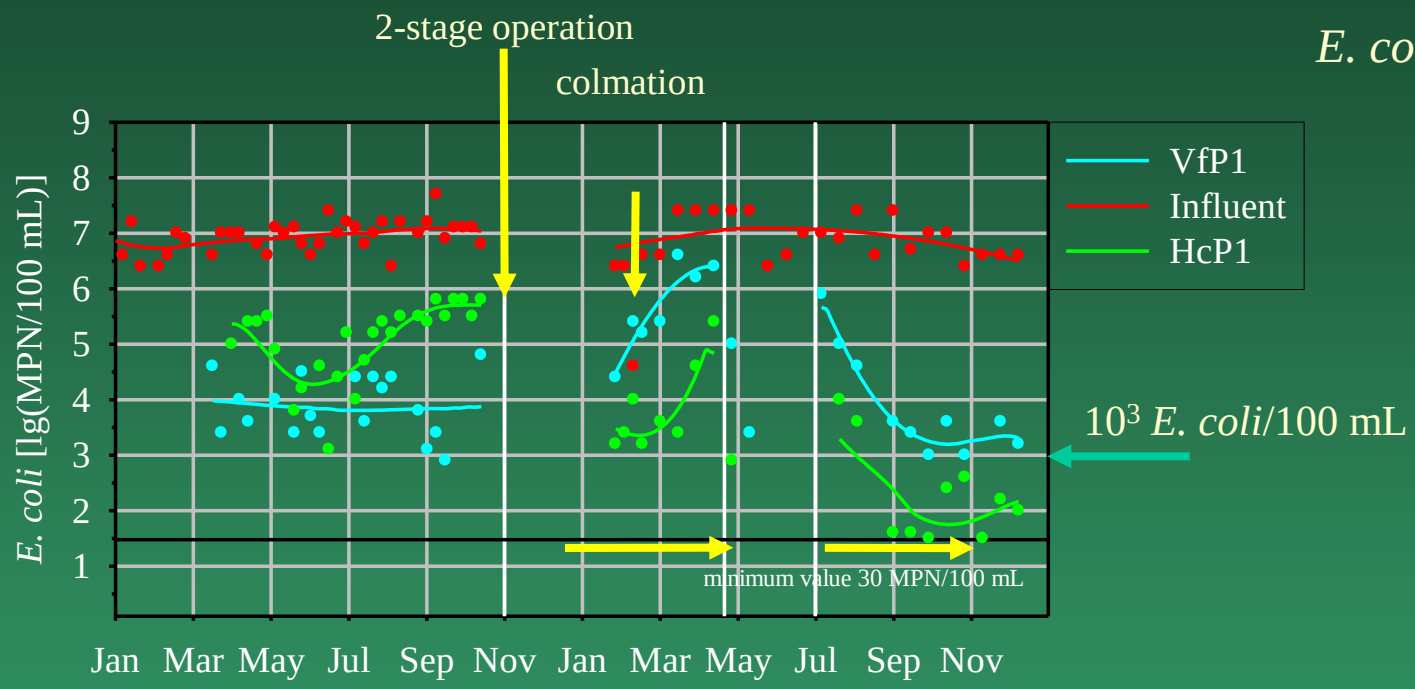
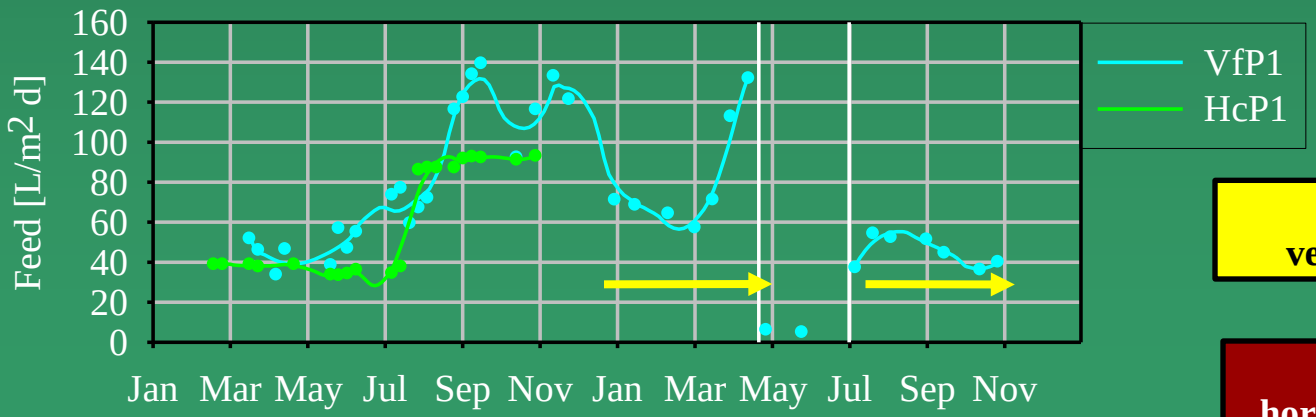
Reduction of *E. coli* by means of combined filters

Influence of hydraulic load



E. coli concentration

10^3 *E. coli*/100 mL



surface load

VfP1
vertical sand filter, planted

HcP1
horizontal exclay filter, planted

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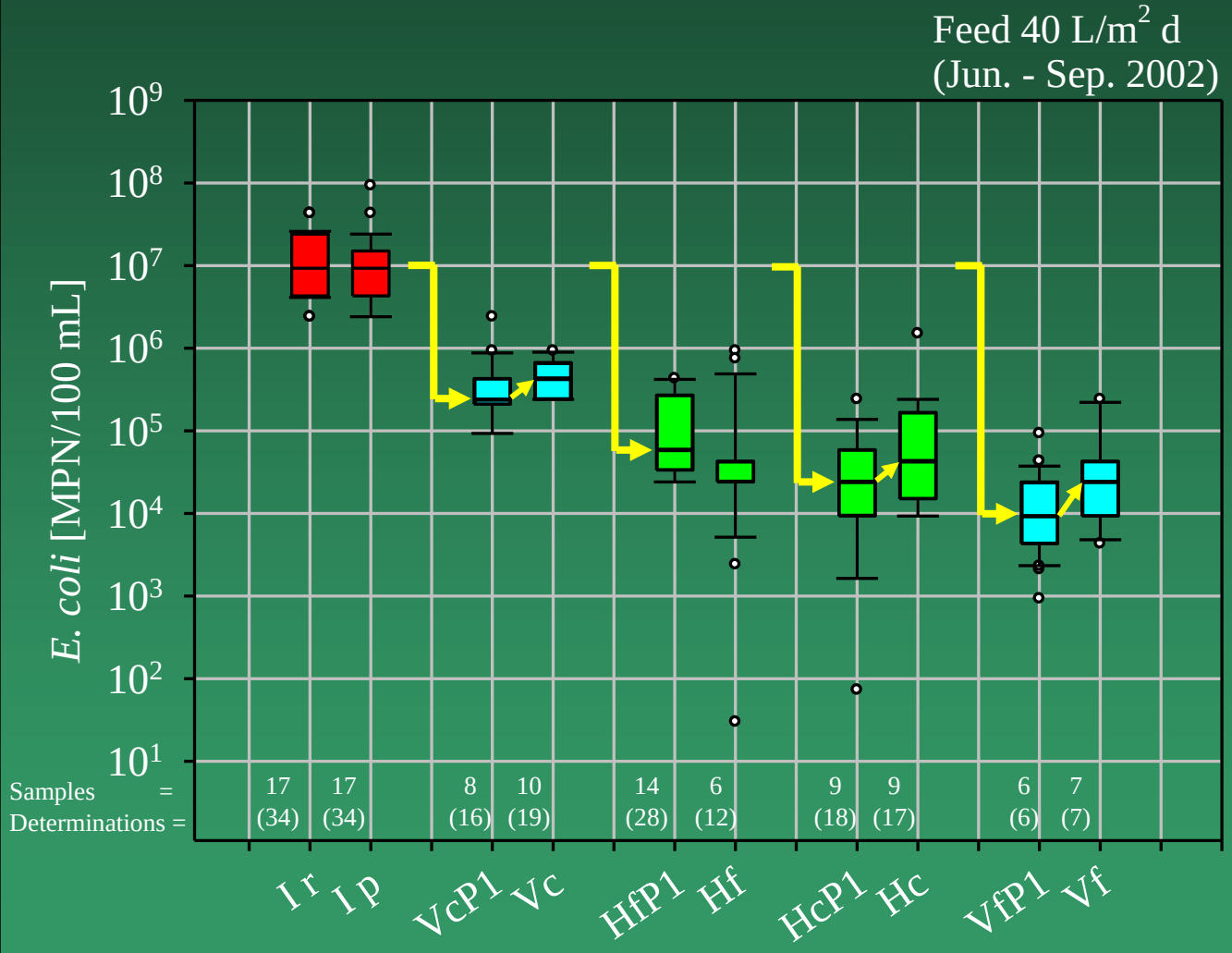
Reduction of *E. coli* by means of individual filters

Influence of the filter design



I influent
H horizontal filter
V vertical filter
r Raw water
p pretreated water
f fine material: sand
c coarse material: exclay
P1 planted, basin 1

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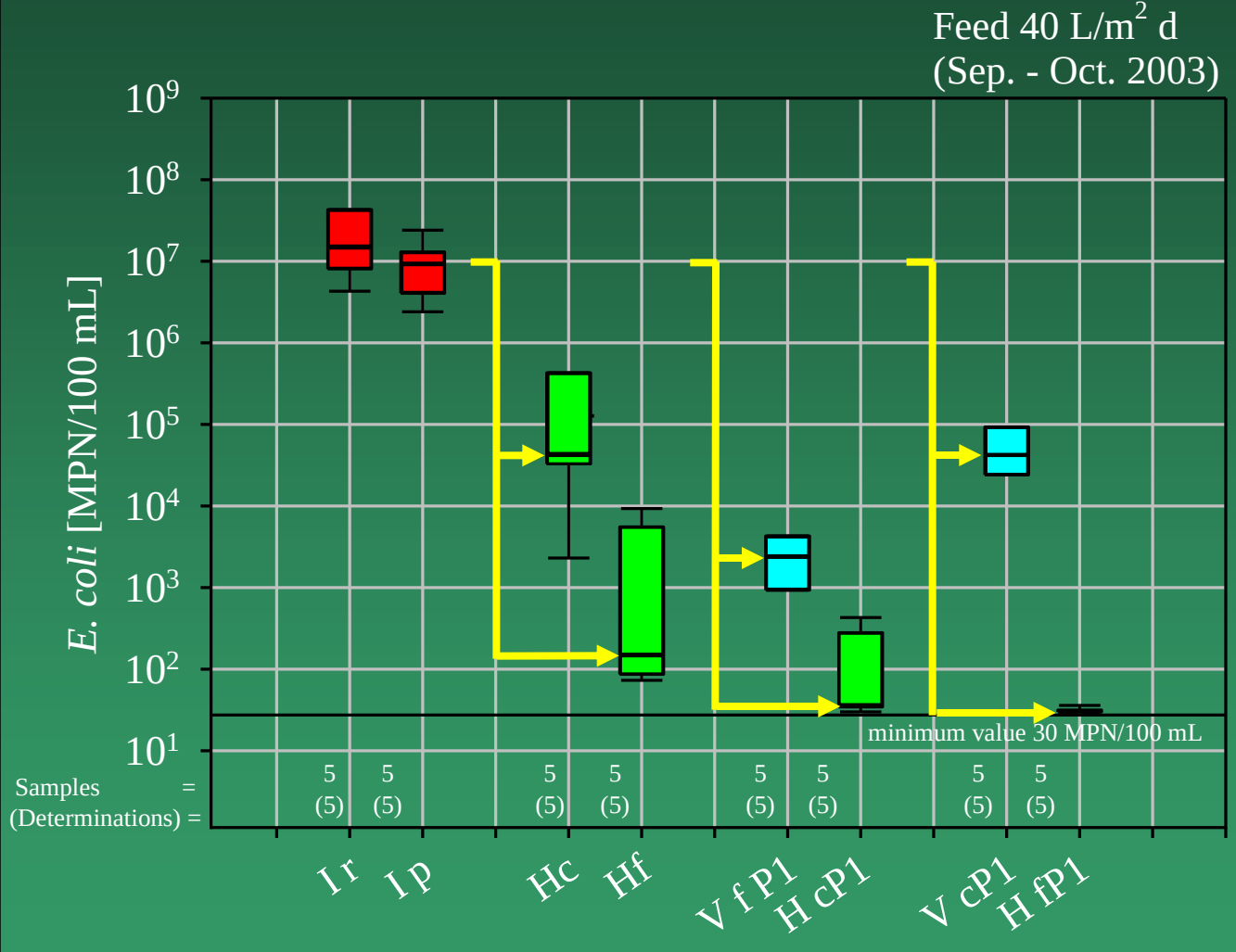
Reduction of *E. coli* by means of combined filters

Influence of the filter design



I influent
H horizontal filter
V vertical filter
r Raw water
p pretreated water
f fine material: sand
c coarse material: exclay
P1 planted, basin 1

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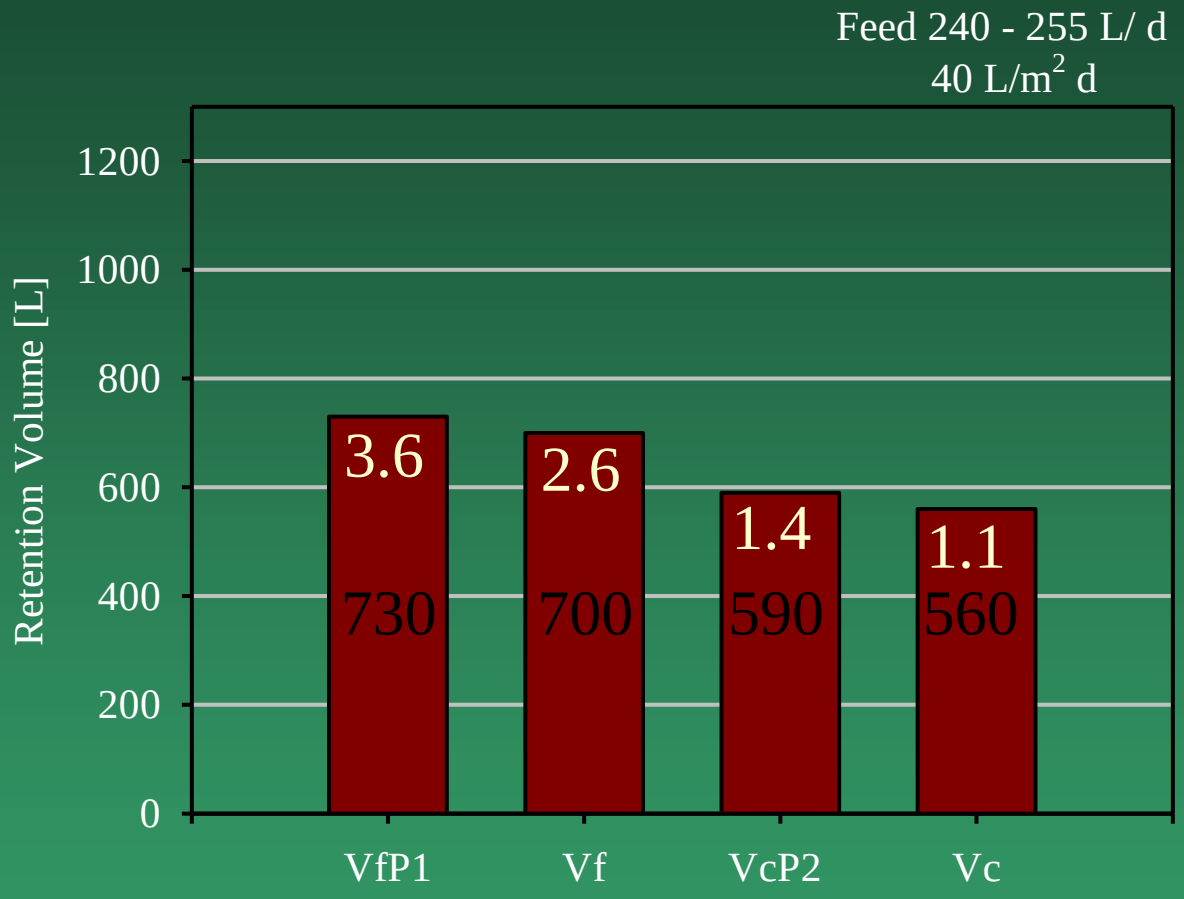
Retention volume and reduction efficiency

Individual operated vertical filters



$E_{E.coli} = \lg(C^{in}_{E.coli}) - \lg(C^{out}_{E.coli})$

$C^{in}_{E.coli}$ Median of the influent concentration [MPN/100 ml]

$C^{out}_{E.coli}$ Median of the effluent concentration [MPN/100 ml]

$E_{E.coli}$ (stage I)

V vertical filter: stage I

f fine material: sand
c coarse material: exclay
P planted

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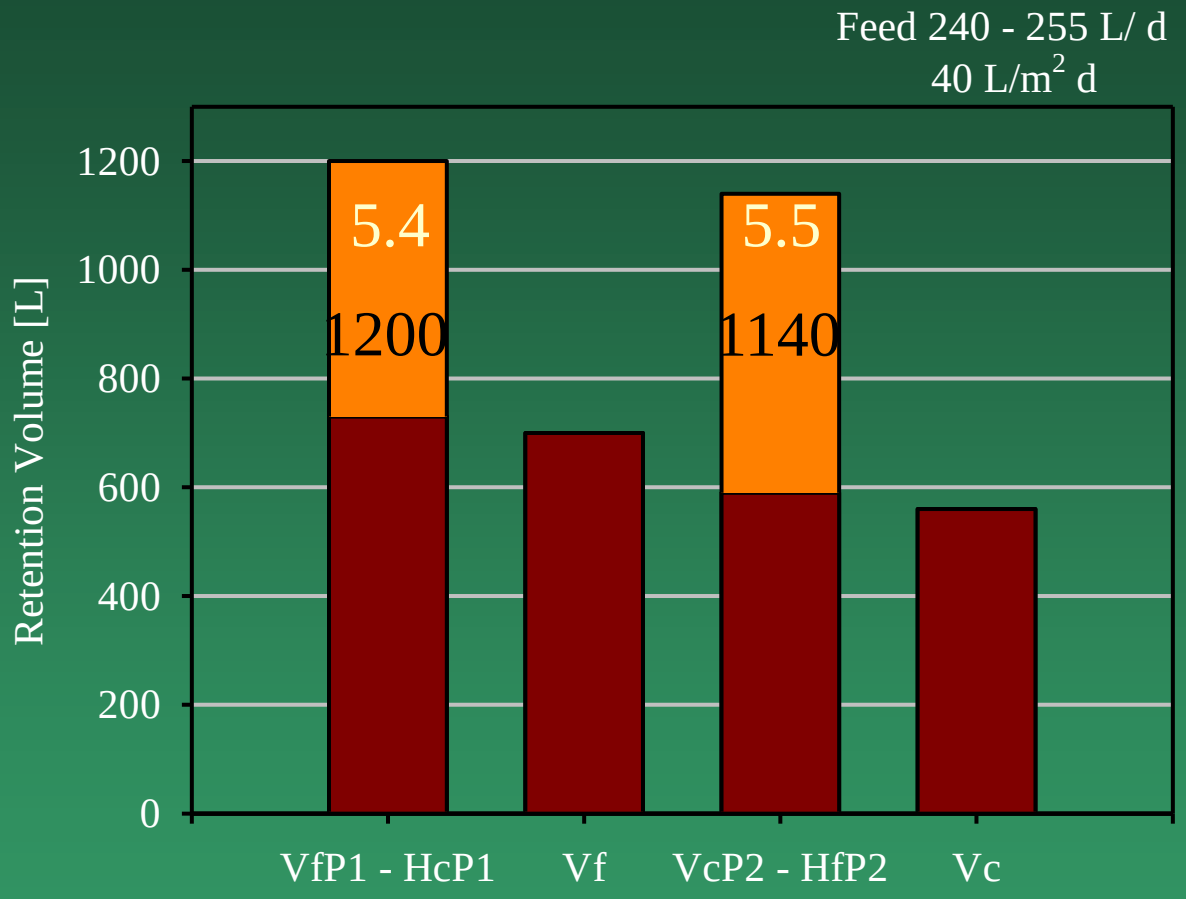
Retention volume and reduction efficiency

Combined operated filters



E *E. coli* (stage I +stage II)

$$E_{E.coli} = \lg(C^{in}_{E.coli}) - \lg(C^{out}_{E.coli})$$

$C^{in}_{E.coli}$ Median of the influent concentration [MPN/100 ml]

$C^{out}_{E.coli}$ Median of the effluent concentration [MPN/100 ml]

V vertical filter: stage I
H horizontal filter: stage II
f fine material: sand
c coarse material: exclay
P planted

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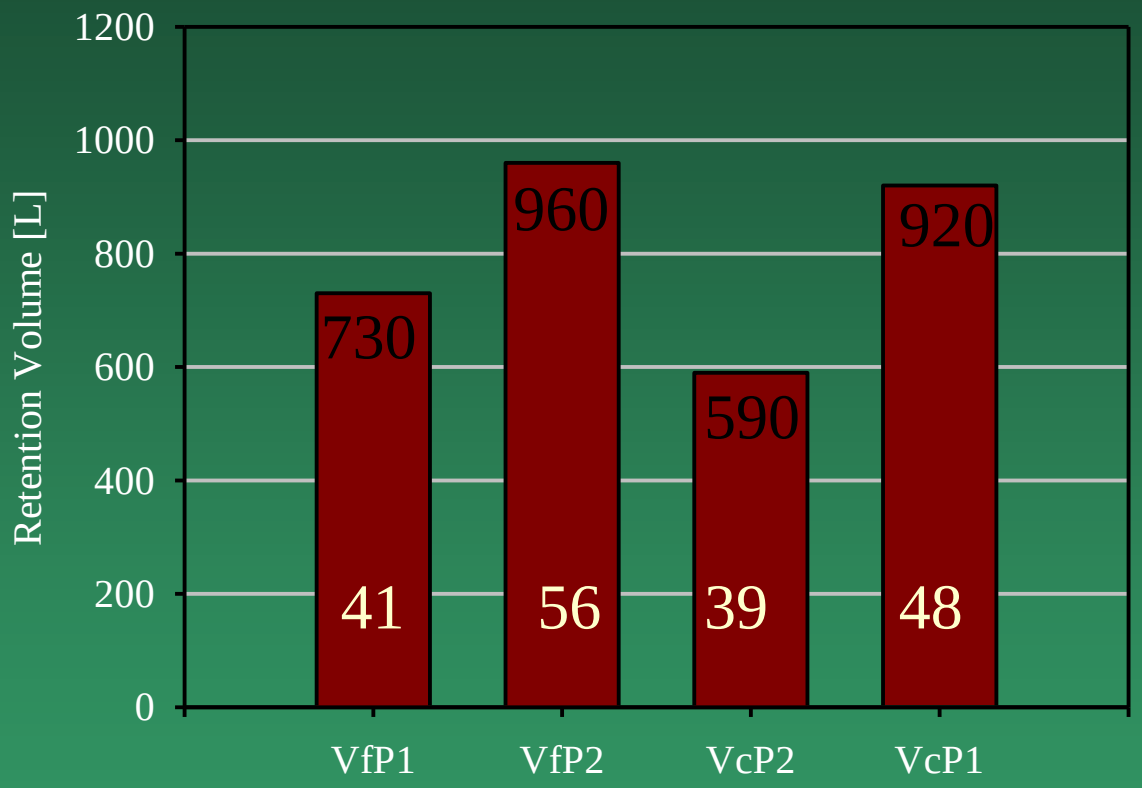
Retention volume

Influence of the hydraulic load in vertical systems



$V_{50\%}$

hydr. load [L/m² d]

V vertical filter
f fine material: sand
c coarse material: exclay
P planted

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Summary

***E. coli* reduction in pilot plant systems with different types of CW under identical conditions**

- Similar germ reduction potential of horizontal- and vertical systems
- Lower influence of hydraulic load on the reduction efficiency in vertical compared to horizontal systems
- During colmation phases strong decreasing efficiency of *E. coli* reduction
- Hydraulic efficiency as an important parameter dimensioning plants for an advanced germ reduction performance in similar types of CW

Unanswered questions/ Further research

- *Salmonellae spp.*: Strong fluctuations of removal rate
- *Clostridia* : Higher discharge values after at stage II as after the stage I
- Parasites: Low removal rate for in the german pilot plant (about 2 $\log_{10}$)
- Faecal indicator system: no direct correlation to pathogenic microorgansms (protozoa, und helminth, *Cryptosporidia*)

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bmb+f
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