

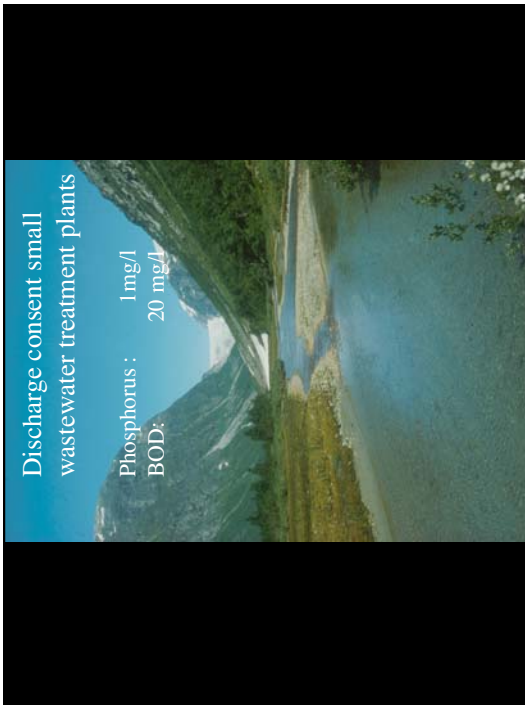
High Performance Constructed Wetlands for Cold Climates

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Presentation overview

- About Norway and climate
- Development of design for cold climate – insulation needs and pretreatment
- Removal results and mechanisms
- Reuse of wetland substrate saturated with phosphorus



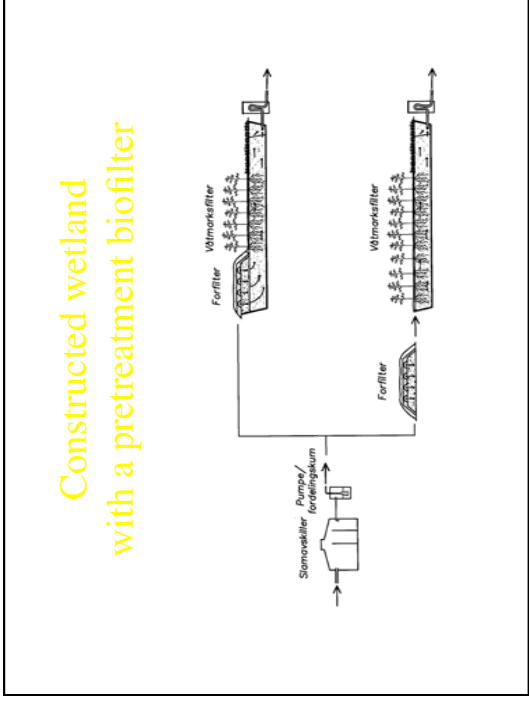
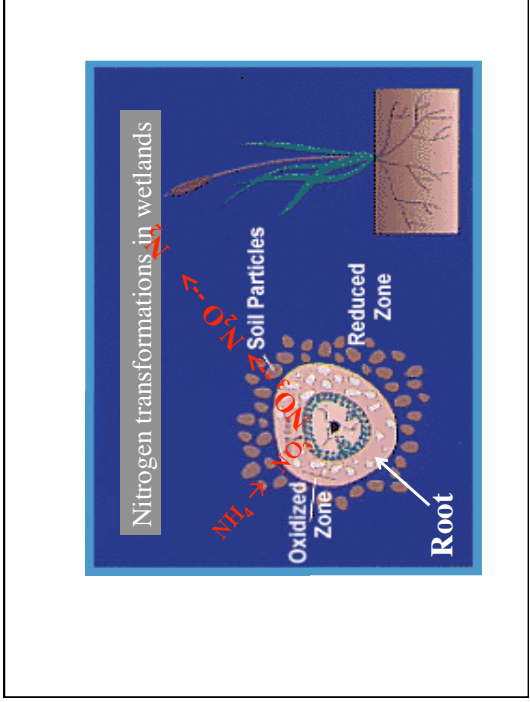
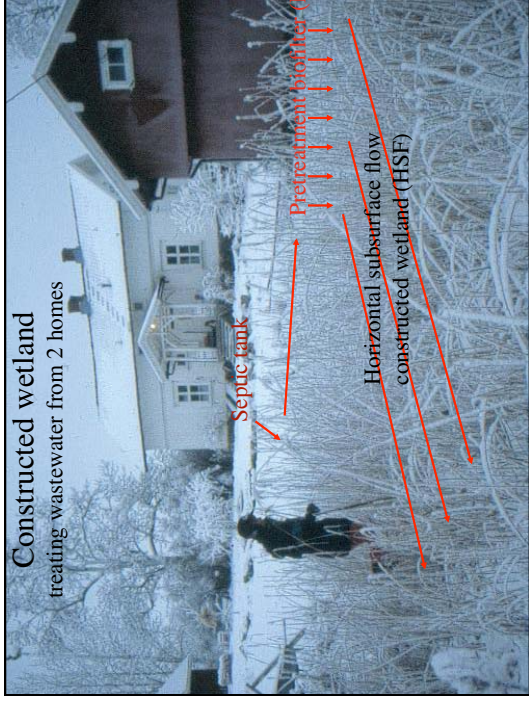
Frost mitigation

- Increase the depth
- Keep the water level at least 10 cm below the surface of the wetland (insulate with straw (new systems))
- Freeze an ice cap



Inlet Outlet

Depth 1.0 m



Constructed wetland

Wetland plants

Grass

Constructed wetland at Dal primary school

Built: april 2000
 100 pupils, 30 PE
 Total area: 250 m²
 Area/PE: 8,3 m²
 Depth HSF: 1,0m

Pretreatment brofilter (PBF)

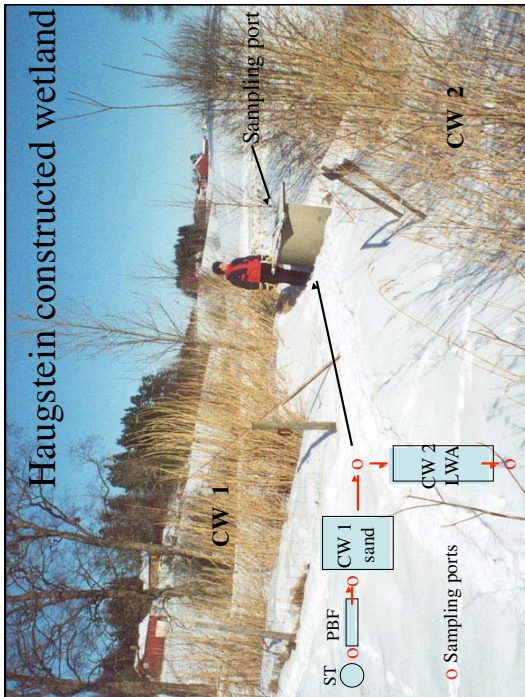
Horizontal subsurface flow section (HSF)

Photo: J. Nybø Jensen

Constructed wetland at Dal primary school

Haugstein constructed wetland

Built: 1991
 Serving: 8 persons
 Total area: 100 m²
 Area/p: 12,5 m²
 Depth HSF: 0,50m



Haugstein constructed wetland

Average influent (STE) and effluent concentrations (mg/l)

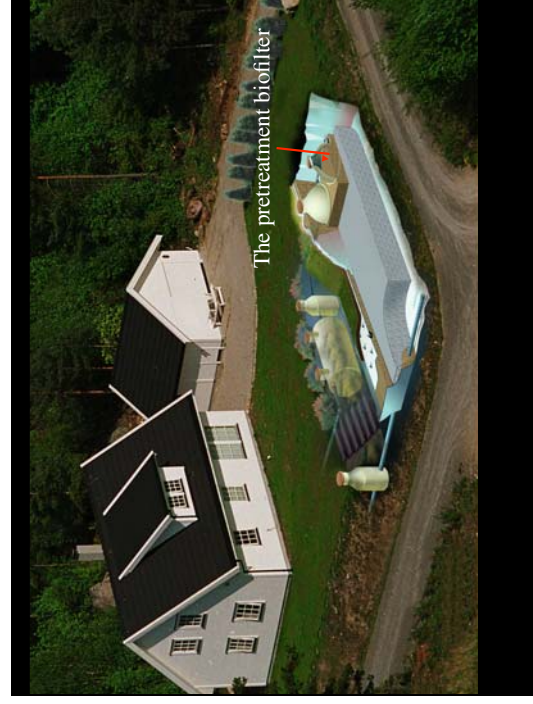
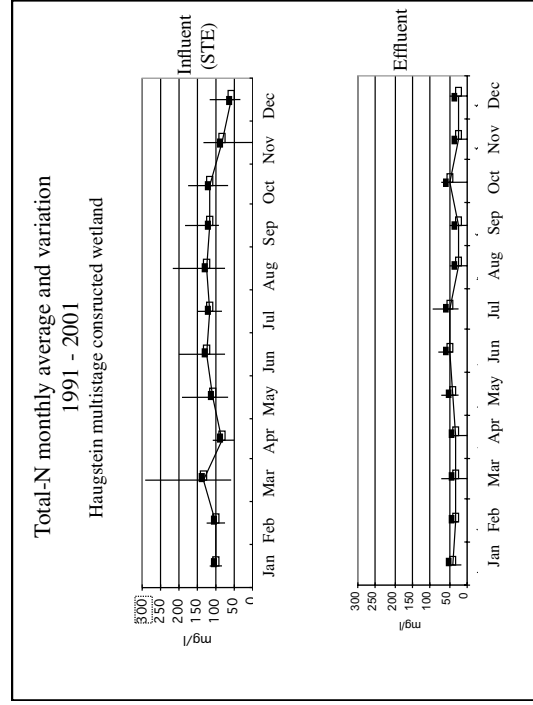
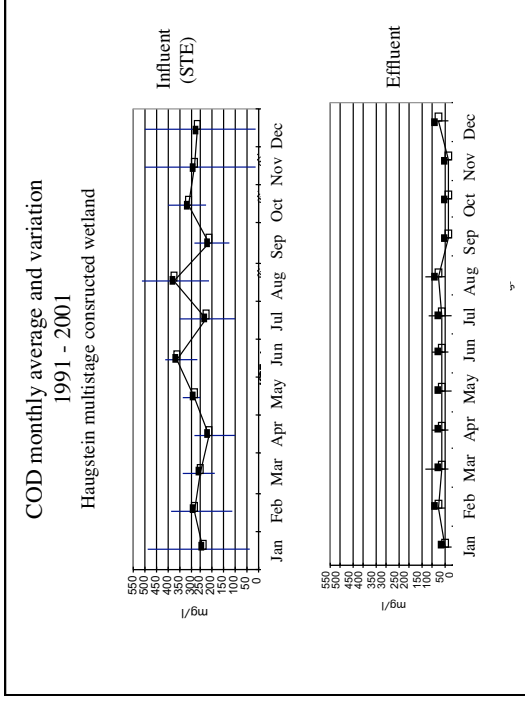
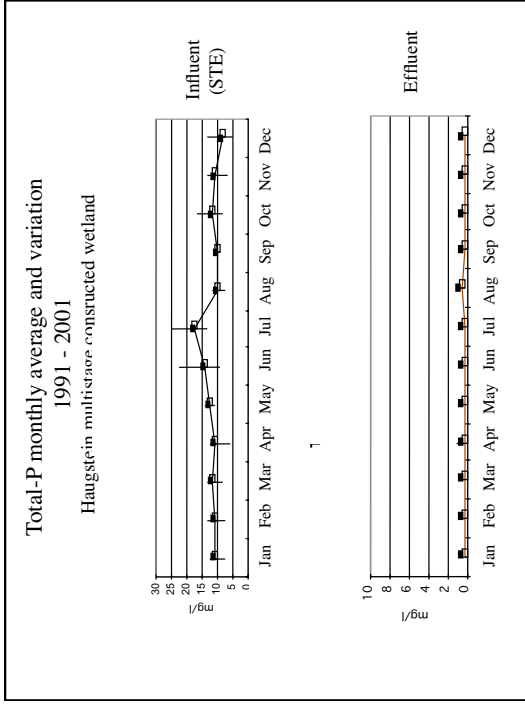
Parameter	Influent	Effluent
Total - P	10,0	0,3
Total - N	111	40
COD	240	52
SS		< 5
T. coli./100ml		< 100

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Typical treatment efficiency (%)

- Total - P > 90
- Total - N 40 - 60
- COD 60 - 80
- BOD 70 - 90
- SS (mg/l) < 10
- Termotolerant coli/100ml < 100





The pretreatment biofilter

3. generations of distribution systems

BOD-removal vs. distribution system in full scale biofilters

Configuration	BOD-removal (%)
Configuration 1 (Green)	~85
Configuration 2 (Blue)	~75
Configuration 3 (Orange)	~65

The pretreatment biofilter

The pretreatment biofilter

Effective wetted area (EWA)

Pretreatment biofilter

Porous media

LWA
Diam: 2,5 mm

Surface area
> 5000m²/m³

Bacteria on
LWA
surface

BOD-removal in coarse sand as a function of wastewater distribution

predicted % removal

O₂ demand

Uniform distribution unclogged

Point loading unclogged

Uniform distribution clogged

Point loading clogged

Point loading unclogged

Uniform distribution unclogged

Ausland (1998)

Pretreatment biofilter

Porous media

2,0m

0,6m

Grain size:

- 2-4 (10) mm

Material:

- LWA
- Gravel
- Crushed rock
- Crushed brick
- Other

Pretreatment biofilter

Loading rate - commercial systems

2,0m

0,6m

Dom. wastew.

- 10 - 20 cm/d

Greywater

- 20 - 30 cm/d

Dosing

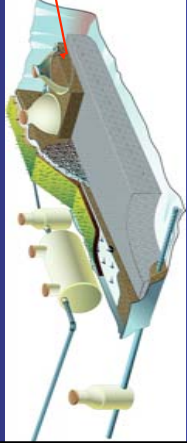
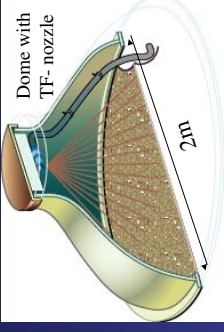
- 24 - 48/d
- minimum 8/d

Area/person

- 0,3 - 2,0 m²

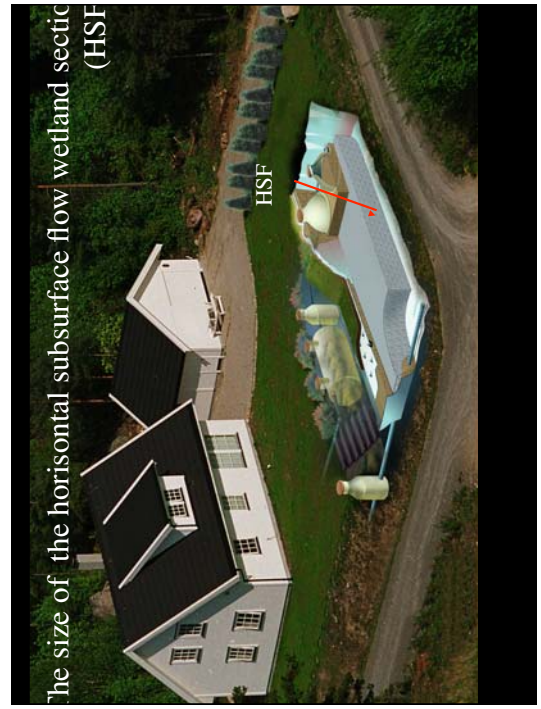
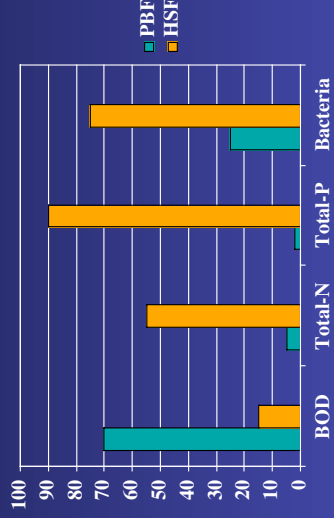
3rd. generation pretreatment biofilter

- BOD removal: 70 - 80%
- Complete nitrification
- Total-N removal 5-40%
- SS 60 - 70%
- Bacteria reduction: up to 5 logs



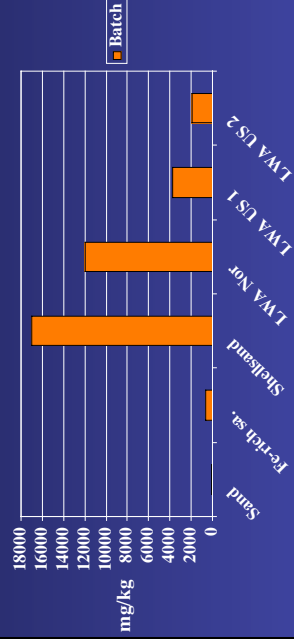
Grain size: 2 - 10 mm
 Depth: 50 - 60 cm
 Area: 0,3 - 2,0m²/person

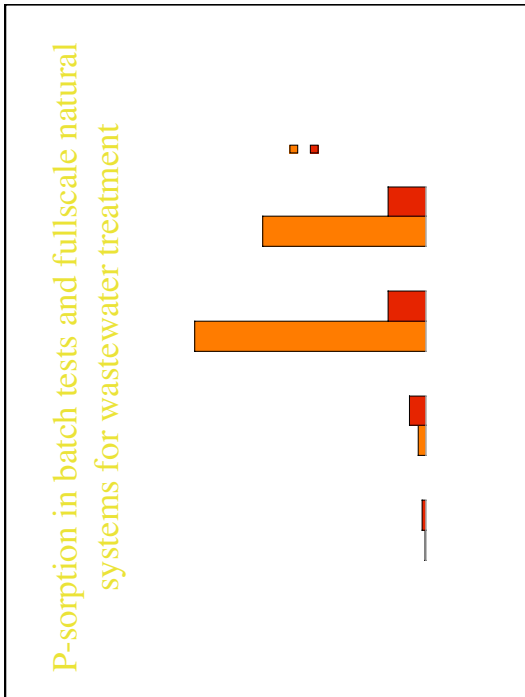
Removal efficiency Pretreatment biofilter (PBF) Horizontal subsurface flow constructed wetland (HSF)



The size of the horizontal subsurface flow wetland section (HSF)

P-sorption in batch experiments for some natural porous media and LWA





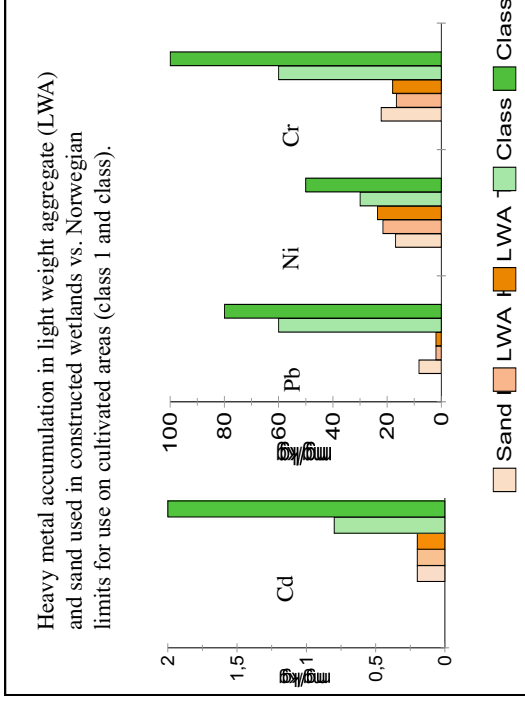
Volume needed to sorb P emitted from one person over 15 years

700	700	1,4
17 000	2 500	0,7
12 000	2 500	0,7



Heavy metal content (mg/kg) LWA filter material

	LWA used 8 years		LWA before use
	Inlet zone	Outlet zone	Background
Cd	<0.4	<0.4	<0.4
Pb	<4	<4	<4
Cu	18.0	20.3	23.4
Zn	22.9	26.8	19.1
Ni	28.0	19.1	17.6
Cr	17.8	18.2	15.3
Co	4.7	4.6	4.1
V	17.1	16.9	15.0



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Conclusions

- Constructed wetlands with pretreatment biofilters remove > 90% of P 40-60% of N, P, and bacteria to meet European standards for swimming water quality
- Constructed wetlands with pretreatment biofilters produce an effluent quality not affected by season
- Pretreatment biofilters that nitrify and reduce BOD are a necessary component of cold climate CW's

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Conclusions

- Better prediction of the long tm P-sorption and further optimizing of the PBF will yield more cost effective sytems
- Greywater treatment needs less area and open for decentralized treatment of greywater in urban areas

High Performance Constructed Wetlands for Cold Climates

Conclusions

- Low heavy metal accumulation - facilitates reuse of P-saturated filter material as fertilizer
- The fertilizer effect of P-saturated LWA is comparable to mineral fertilizer

