



Performance and dimensioning of actively aerated treatment wetland systems

J. Nivala, T. Aubron, K. Bernhard, P. Mosig, M. van Afferden,
S. Wallace, R. Müller

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Contents of presentation

- Technology development of aerated wetlands
- Overview of the Ecotechnology Research Facility Langenreichenbach
- Details of aerated treatment wetland design
- Treatment performance
- Comparison to German standards for small and decentralized wastewater treatment plants

Technology development



1997



6,000 m³/d

2003



2006



2011

2001

(11) United States Patent
Wallace

(16) Patent No.: US 6,200,469 B1
(17) Date of Patent: *Mar. 13, 2001

(4) SYSTEM FOR REMOVING POLLUTANTS FROM WATER

(75) Inventor: Scott B. Wallace, St. Paul, MN (US)

(73) Assignee: North American Method Engineering, Forest Lake, MN (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.536, and is subject to the priority provisions of 37 U.S.C. 119(a)(2).

Subject to any disclaimer, the term of this patent in the United States of America shall be: 20 years.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: 09/100,000

(22) Filed: Jan. 10, 2001

(86) International No.: 01/000,000

(51) Int. Cl.:

(52) U.S. Cl.:

(58) Field of Search:

(94) U.S. Pat. No.:

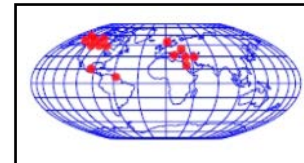
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6,104,000	11/007
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6,112,000	11/007



2010



2014



Advantages of aerated wetland technology

- Optimized biological degradation of carbonaceous compounds
- Aerobic removal rates up to 1,000 times higher than conventional treatment wetland designs
- Reduced footprint requirement
- Exceptional treatment performance (especially for nitrification) even in cold weather

Research Facility Langenreichenbach

- 50 km northeast from Leipzig
- Real wastewater from nearby village
- Common pre-treatment
- Design flows from 100 – 2000 L/d
- Each system is between 5 and 6 m²

Parameter	After pre-treatment (DWA, 2006) g/(PE-d)	After pre-treatment (Langenreichenbach) g/(PE-d)
BSB ₅	40	44.0
CSB	80	–
TOC	–	24.2
TS	25	23.4
TKN	10	13.5
P	1.6	–

Horizontal

25 cm depth
50 cm depth



Vertical

Sand (1 – 3 mm)
Gravel (4 – 8 mm)

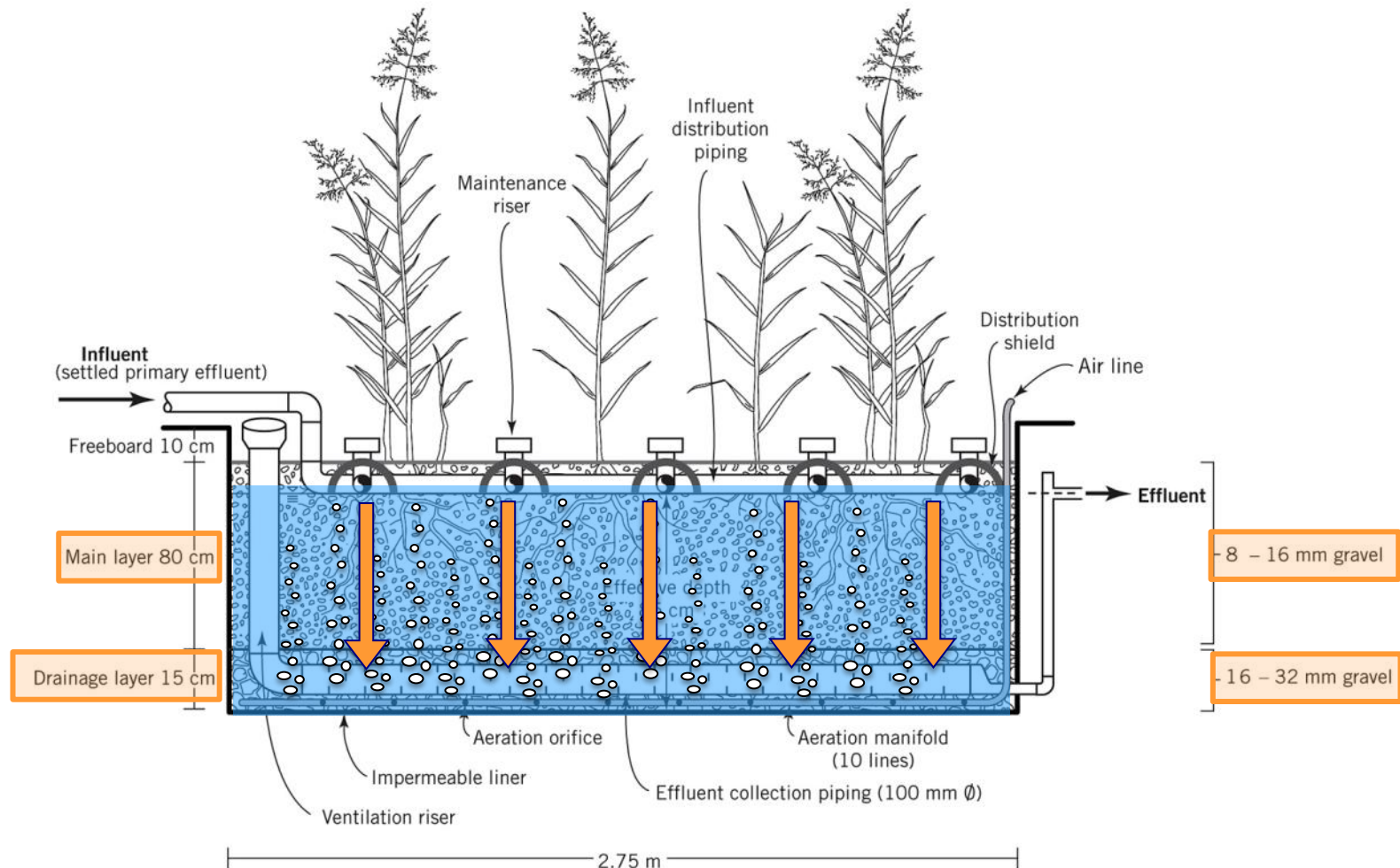
Intensified

Horizontal + aeration
Vertical + aeration



Vertical flow wetland + Aeration

VAp

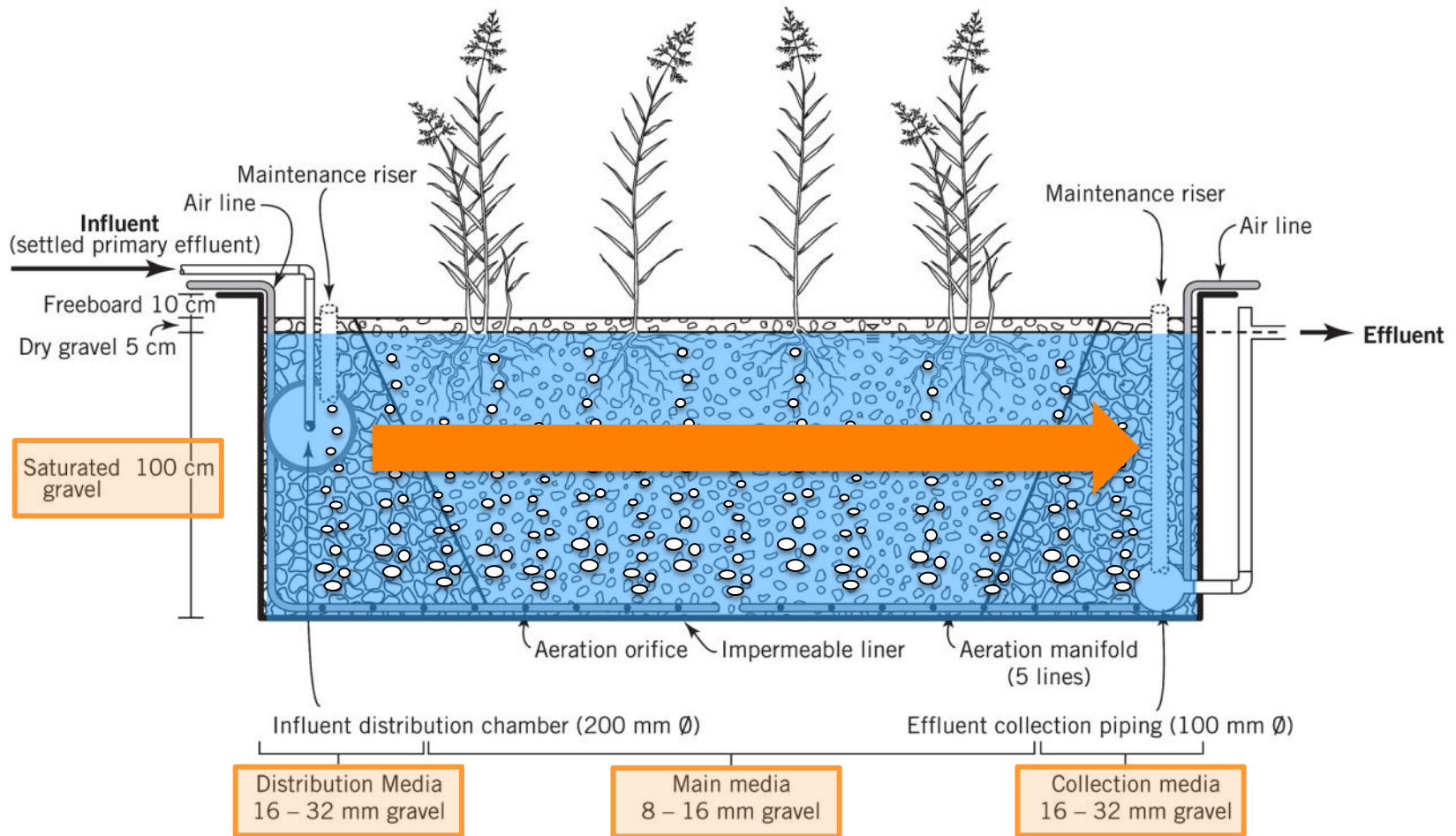


Integrated aeration system enables even distribution of air along the bottom of the wetland

$A = 6.2 \text{ m}^2$
 $Q = 590 \text{ L/d}$
Gravel (8 – 16 mm)

Horizontal flow wetland + Aeration

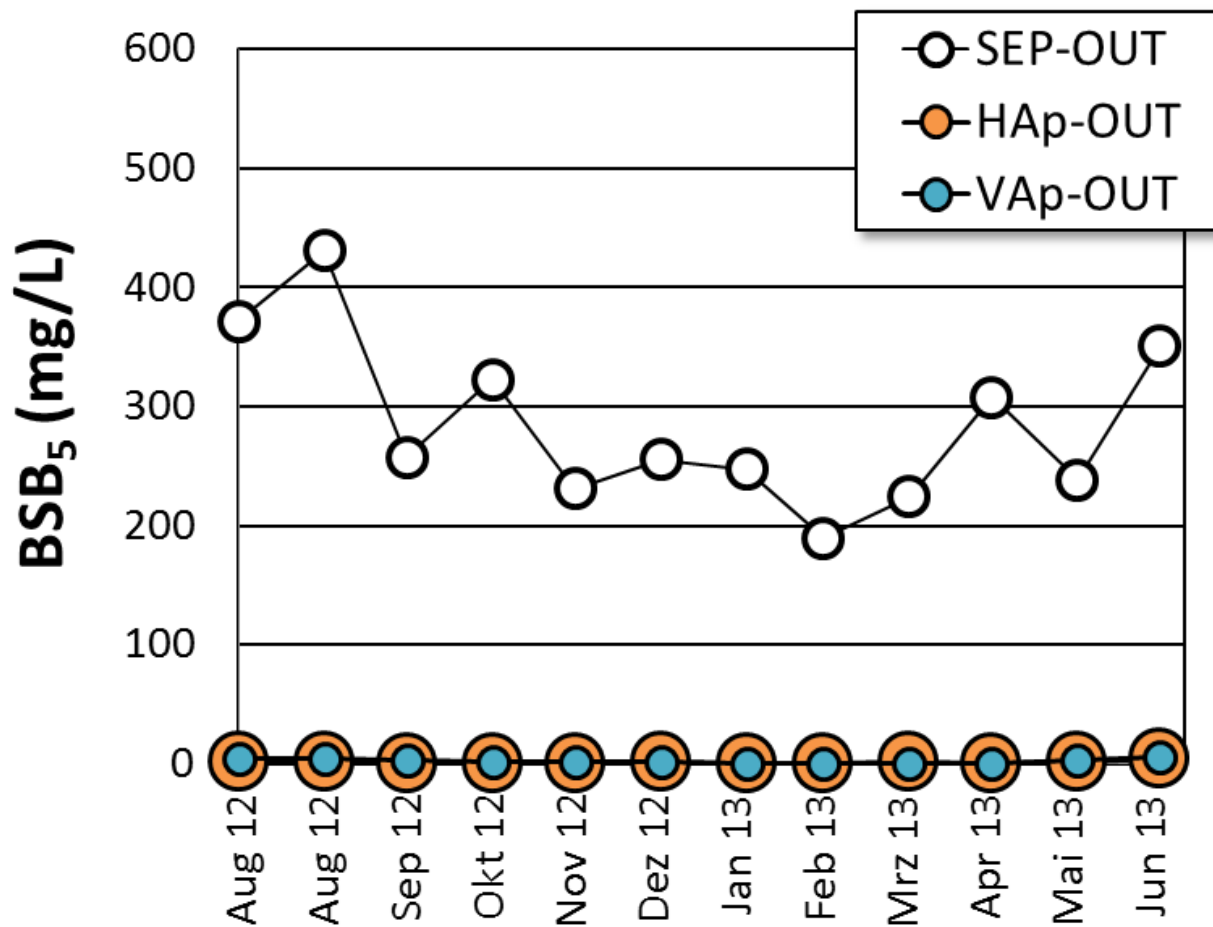
HAp



Integrated aeration system enables even distribution of air along the bottom of the wetland

$A = 5.6 \text{ m}^2$
 $Q = 730 \text{ L/d}$
Gravel (8 – 16 mm)

BOD₅



12-Month

Average (n = 39)

HAp-OUT 2.9 mg/L

VAp-OUT 2.7 mg/L

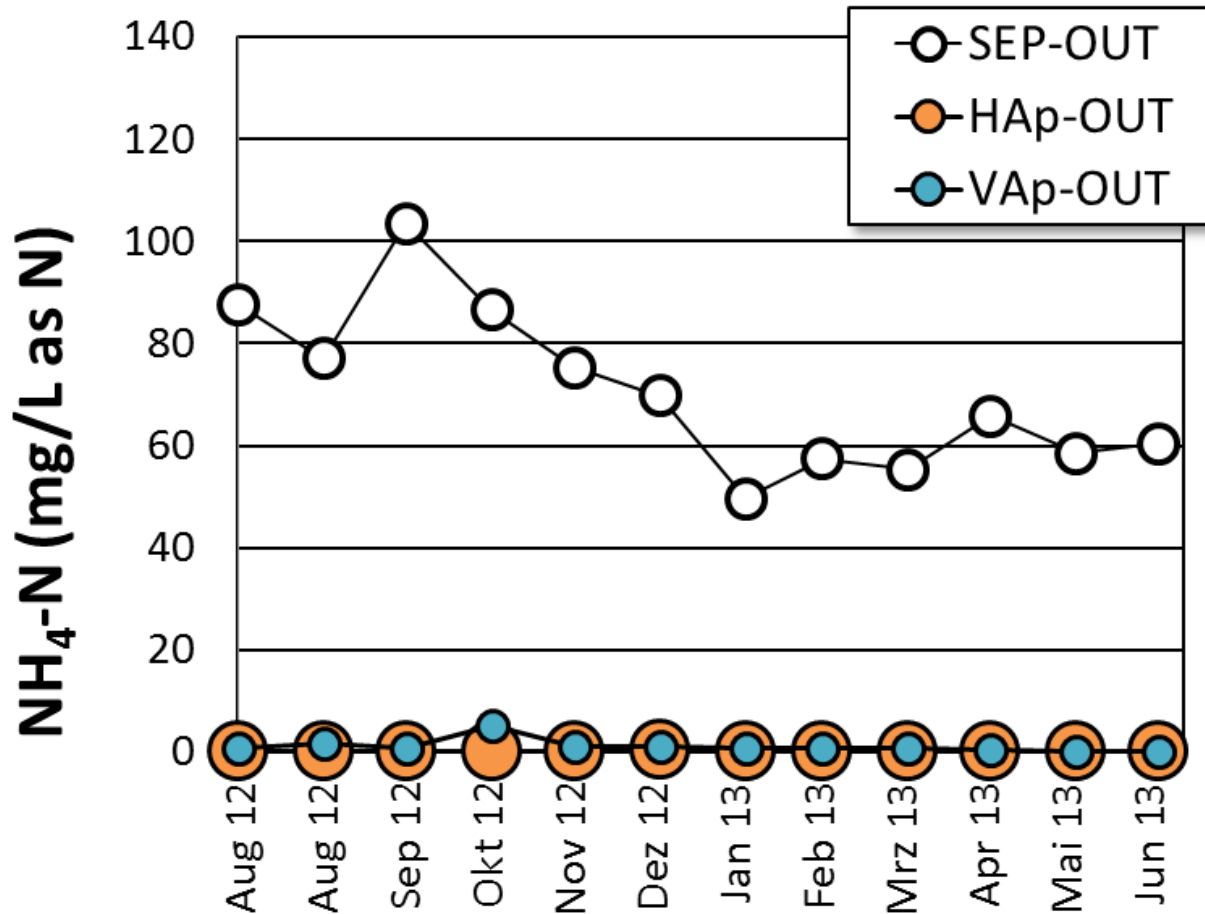
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Bautechnik

DIBt

DIN EN 12566-3

Class C

Nitrification



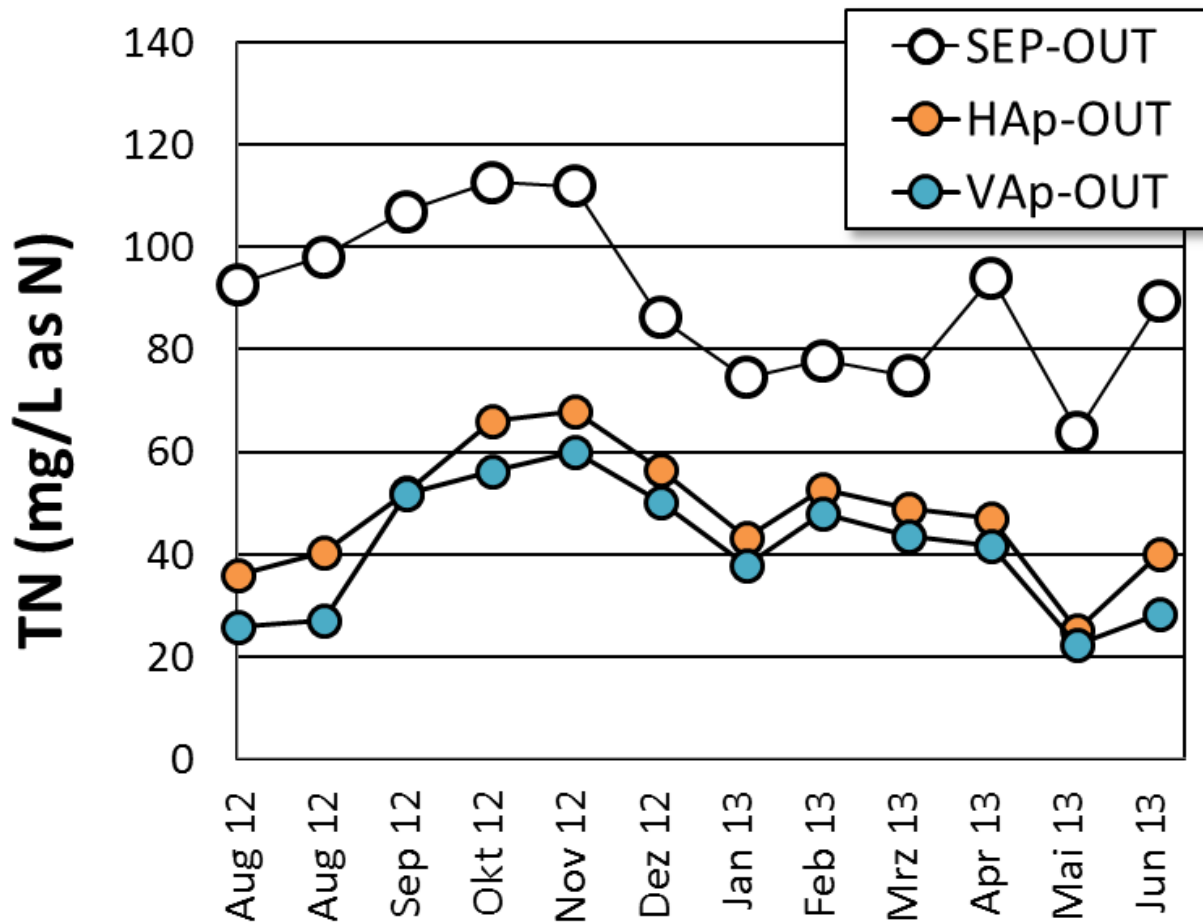
**12-Month
Average (n = 38)**
HAp-OUT 0.1 mg/L
VAp-OUT 1.2 mg/L



DIN EN 12566-3

Class C/N

Total Nitrogen



**12-Month
Average (n = 38)**
HAp-OUT 47 mg/L
VAp-OUT 40 mg/L

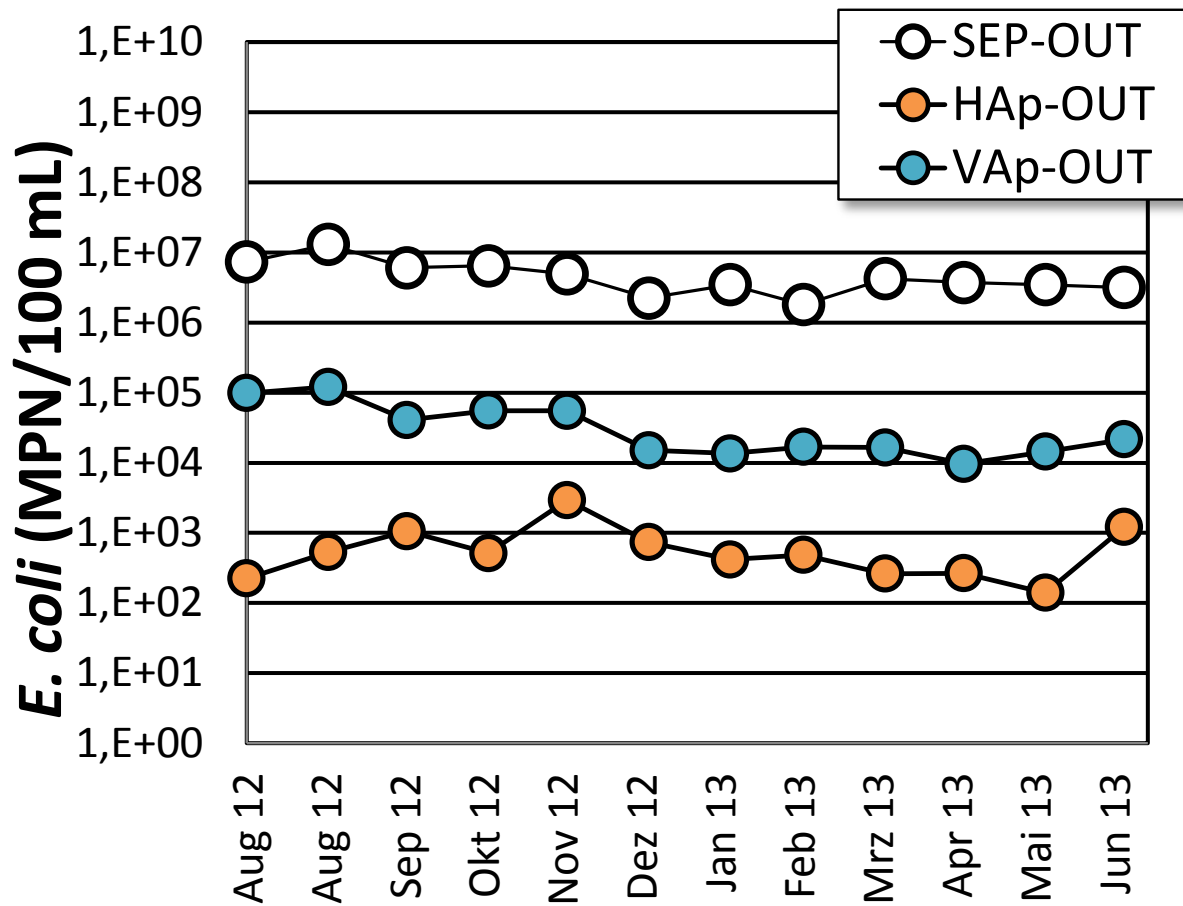


DIN EN 12566-3

~~Class C/N/D~~

≈ 50%

E. coli



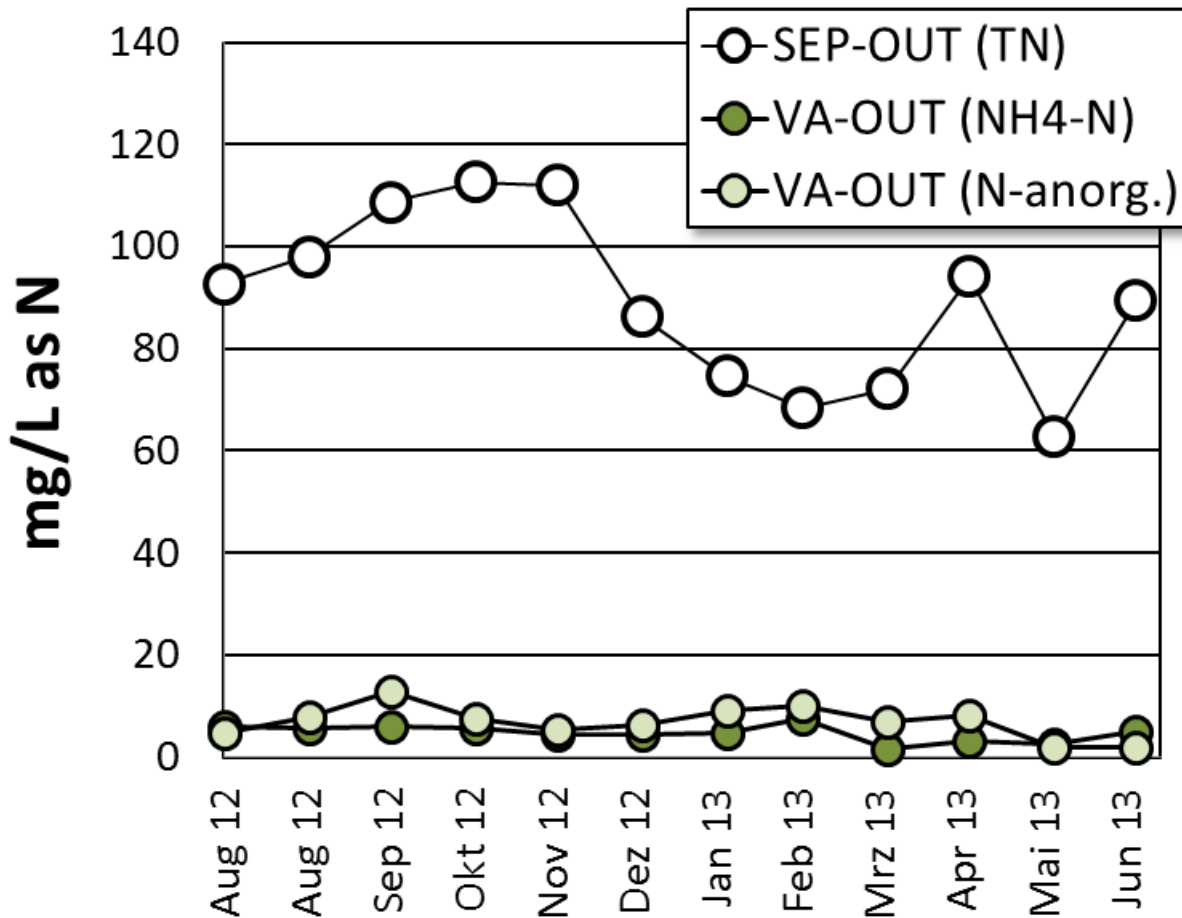
**12-Monate
Geomean (n = 38)**
HAp 480 CFU/100mL
VAp 30,600 CFU/100mL



DIN EN 12566-3
Class H (HAp only)

Total Nitrogen (nitrification and denitrification)

Intermittent aeration



12-Month

Average (n = 35)

NH₄-N 4.8 mg/L

NO_x-N 6.4 mg/L

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DIBt

DIN EN 12566-3

Class C/N/D

Dimensioning Comparison

Specific area

- HF (DWA) 5 m²/PE
- VF (DWA) 4 m²/PE
- HAp 1.1 m²/PE
- VAp 1.7 m²/PE

Organic loading rate

- HF (DWA) 16 g/m²-d (COD)
- VF (DWA) 20 g/m²-d (COD)
- HAp 38.7 g/m²-d (BOD₅)
- VAp 26.5 g/m²-d (BOD₅)

Hydraulic loading rate

- HF (DWA) 40 mm/d
- VF (DWA) 80 mm/d
- HAp 125 mm/d
- VAp 95 mm/d



Energy comparison (Kadlec & Wallace, 2009)

TABLE 1.1
Energy Requirements for Different Types of Wastewater Treatment Plants

System	Hydraulic Load (m ³ /d)	Energy Utilization (kW·h/m ³)	Reference
Surface Flow Wetlands	—	<0.1	Brix (1999)
Subsurface Flow Wetlands	—	<0.1	Brix (1999)
Facultative Lagoon + Rapid Infiltration	3,786	0.11	Campbell and Ogden (1999)
Facultative Lagoon + Overland Flow	3,786	0.16	Crites <i>et al.</i> (2006)
Aerated Subsurface Flow Wetlands	5,500	0.16	Wallace <i>et al.</i> (2006)
Tidal Flow (Fill-and-Drain) Wetlands	1,000	0.18	Maciolek and Austin (2006)
Carrousel Oxidation Ditch	3,786	0.51	U.S. EPA (1996)
Trickling Filter + Nitrogen Removal	3,786	0.61	Crites <i>et al.</i> (2006)
Activated Sludge + Nitrification	3,786	0.76	Campbell and Ogden (1999)
Extended Aeration Package Plant	3,786	1.06	U.S. EPA (1996)
Sequencing Batch Reactor	303	1.13	U.S. EPA (1996)
Living Machine	3,786	1.51	U.S. EPA (1996)



Summary: Aerated treatment wetlands

- have a reduced system area compared to traditional designs
- can handle higher organic loading rates
- have excellent treatment efficiency even in cold climates
- can be optimized to increase treatment performance
- are well adapted for use in developed and developing countries (e.g., solar powered aeration?)

Thank you for your attention

