Design, construction and operation principles of constructed wetlands Examples from Europe

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Sewage enginering - sewerage and drainage, sewage treatment plants, plant operation, landfill leachate
International transfer of knowledge
Environmental technology for medium-sized companies and industry
Building technology - ecological designs, solar technology, grey- and rainwater utilisation, plant water utilisation

Biogas and district heating systems

Speaker of the DWA specialist group wastewater treatment in Constructed Wetlands

Speaker of the DWA specialist group wastewater treatment in rural aereas

Background

centralized wastewater treatment plants for most urbanized areas are realised/ in construction / in planning

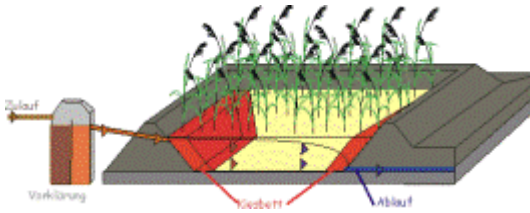
in **less populated areas** with communities < 2000 p.e. also wastewater treatment is necessary

for this field of application "**constructed wetlands**" as **cost effective** solution → **but not a "simple" technology!**

demand on knowledge about calculation, construction, operation and maintenance of such wastewater treatment plants

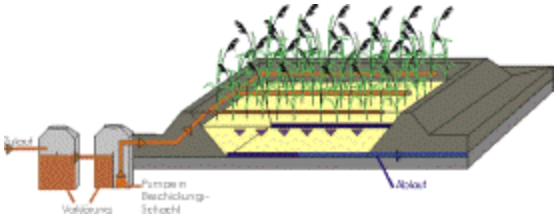
Constructed Wetlands (CWs)

- Surface flow
- Subsurface flow (SSF)
  - Emergent plants
  - Free floating plants
  - Floating-leaved plants
  - Horizontal (HFB)
  - Vertical (VFB)
    - Downflow
    - (Upflow)
    - (Tidal)
- Hybrid systems



lower demand on area

stable cleaning performance



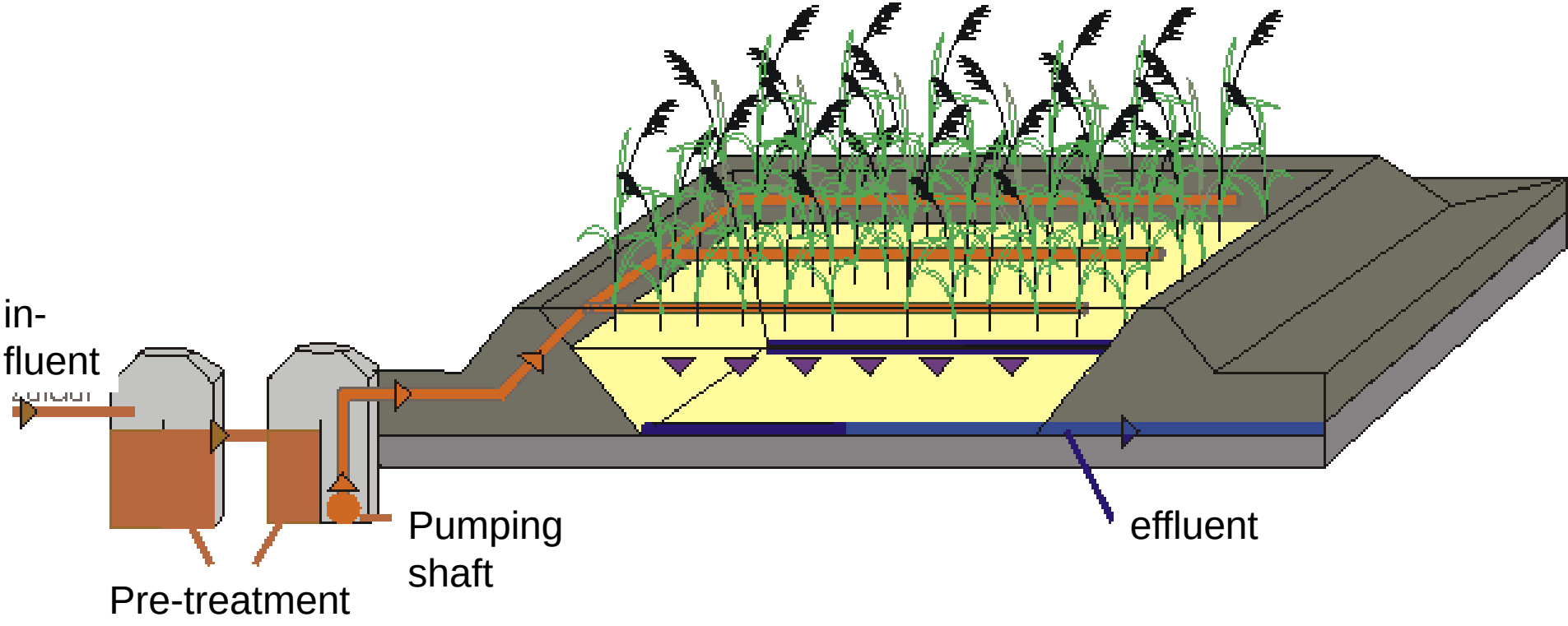
Classification of constructed wetlands for wastewater treatment

Experiences from over 60 years with constructed wetlands in Germany - several hundred small plants and thousands on-site plants

priority task ➡ avoidance of soil clogging by:

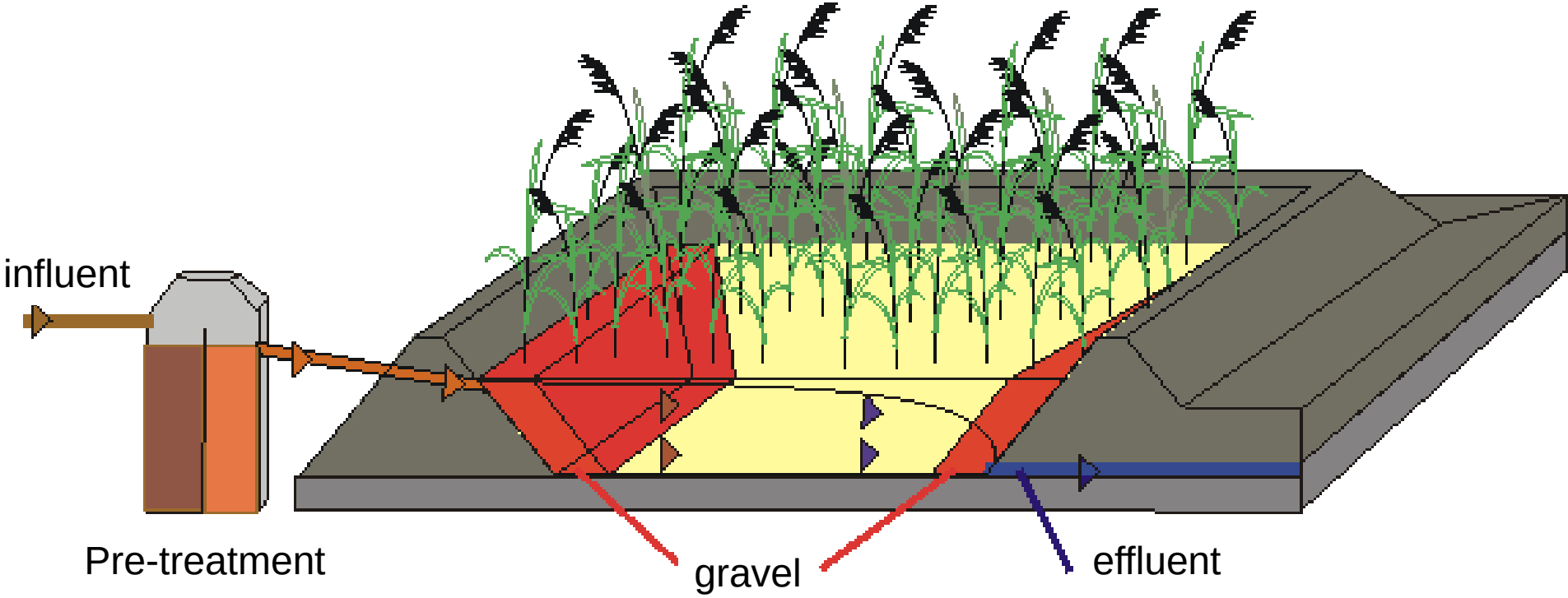
- Adequate design of pre-treatment
- Selection of suitable filter substrates
- Sufficient filter area
- Adequate distribution of wastewater on the whole filter area
- Intermittent feeding and by a hydraulic bore
- Regular resting phases without feeding

Vertical flow soil filter



(source www.bodenfilter.de)

Horizontal flow soil filter



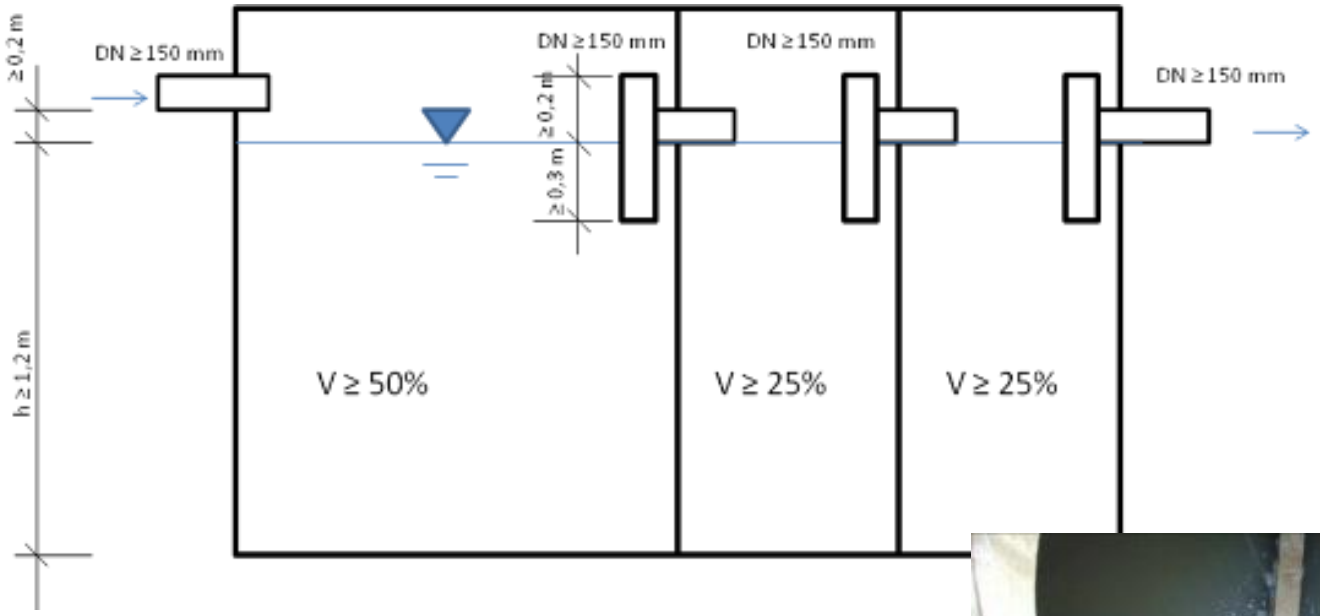
(source www.bodenfilter.de)

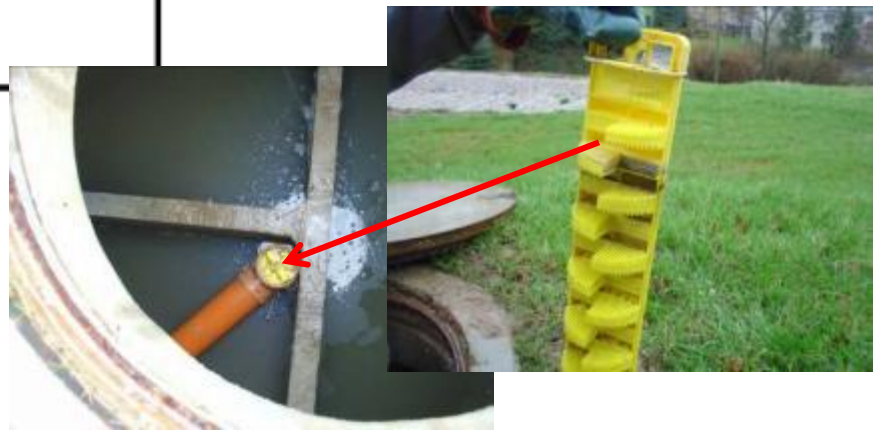
Pre-treatment

Pre-treatment pond
1,5 m²/p.e.

Pre-treatment

Multicompartment septic tank

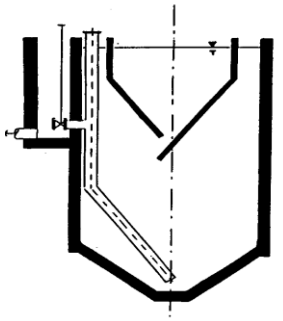


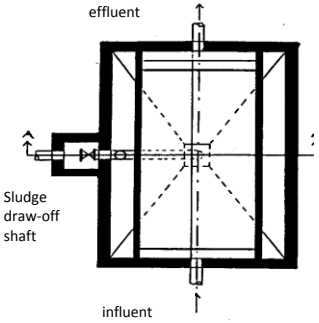


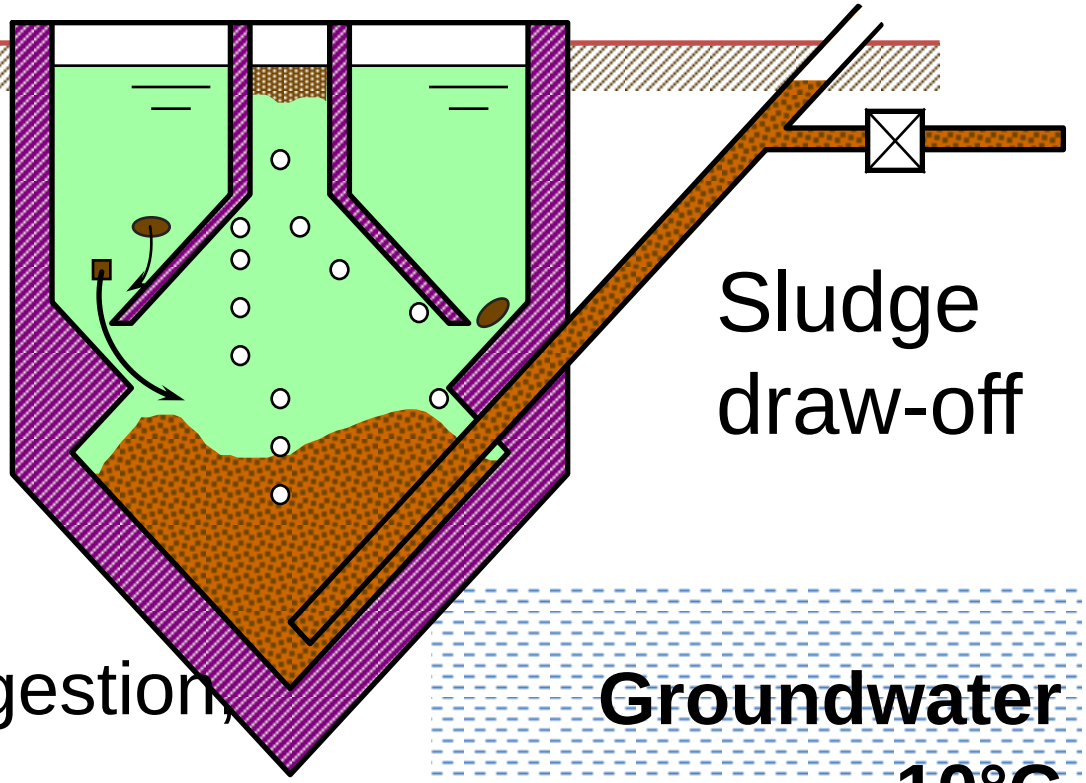
SS-filter in effluent T-fitting of a multicompartment septic tank, annual cleaning required

Pre-treatment

Imhoff tank:







Sludge draw-off

Sludge digestion, cold

Groundwater 10°C

Field of usage		**Main biological stage**	**Biological stage for post-treatment**
Specific filter area	[m²/p.e.]	≥ 4*)	≥ 4*)
or COD-area loading rate of entire area	[g/(m²·d)]	≤ 20	≤ 20
and/or COD-area loading rate of area in operation	[g/(m²·d)]	≤ 27	≤ 27
Hydraulic surface flow rate	< 12 °C [l/(m²·d)]	≤ 80	≤ 80
	≥ 12 °C		≤ 120
Resting time between loadings [hours]	< 12 °C	≥ 6	≥ 6
	≥ 12 °C	≥ 6	≥ 3
Loading rate	[l/(m²·min)]	≥ 6	≥ 6
Loading amount	[l/m²]	≥ 20	≥ 20

Example Albania: two types of regions with very different climate

Lowland/ coastal area

Month	max. Temp °C	min. Temp °C	Sun hours	Rain days	humidity %
January	11.9	2.1	4.1	12	67
February	13.2	2.7	4.4	10	66
March	15.1	5.1	5.1	11	65
April	20.1	8.7	6.8	11	64
May	24.3	12.6	8.6	10	66
June	28.5	15.8	9.9	6	59
July	31.9	17.8	11.4	4	54
August	31.6	17.9	10.6	4	52
September	28.2	15.2	8.8	6	59
October	22.6	11.5	7.0	11	62
November	17.4	7.9	4.2	13	71
December	13.1	4.3	2.8	12	69

Mountain region

Month	max. Temp °C	min. Temp °C	Sun hours	Rain days	humidity %
January	4.3	-3.5	3.2	10	78
February	6.0	-2.3	4.0	8	76
March	9.7	2.3	4.8	10	73
April	14.4	4.2	6.7	10	66
May	19.6	8.3	7.8	11	67
June	23.5	11.3	8.9	7	63
July	26.5	13.3	10.7	4	55
August	26.4	13.3	9.9	4	52
September	22.7	10.3	8.1	6	64
October	16.7	6.0	6.2	9	70
November	11.1	2.0	4.1	10	78
December	6.0	-1.7	2.5	10	80

different design criterias/norms for different regions

Constructed Wetland for 220 p.e. in SOS children´s village in Tirana/Albania

Distribution systems for vertical flow filters

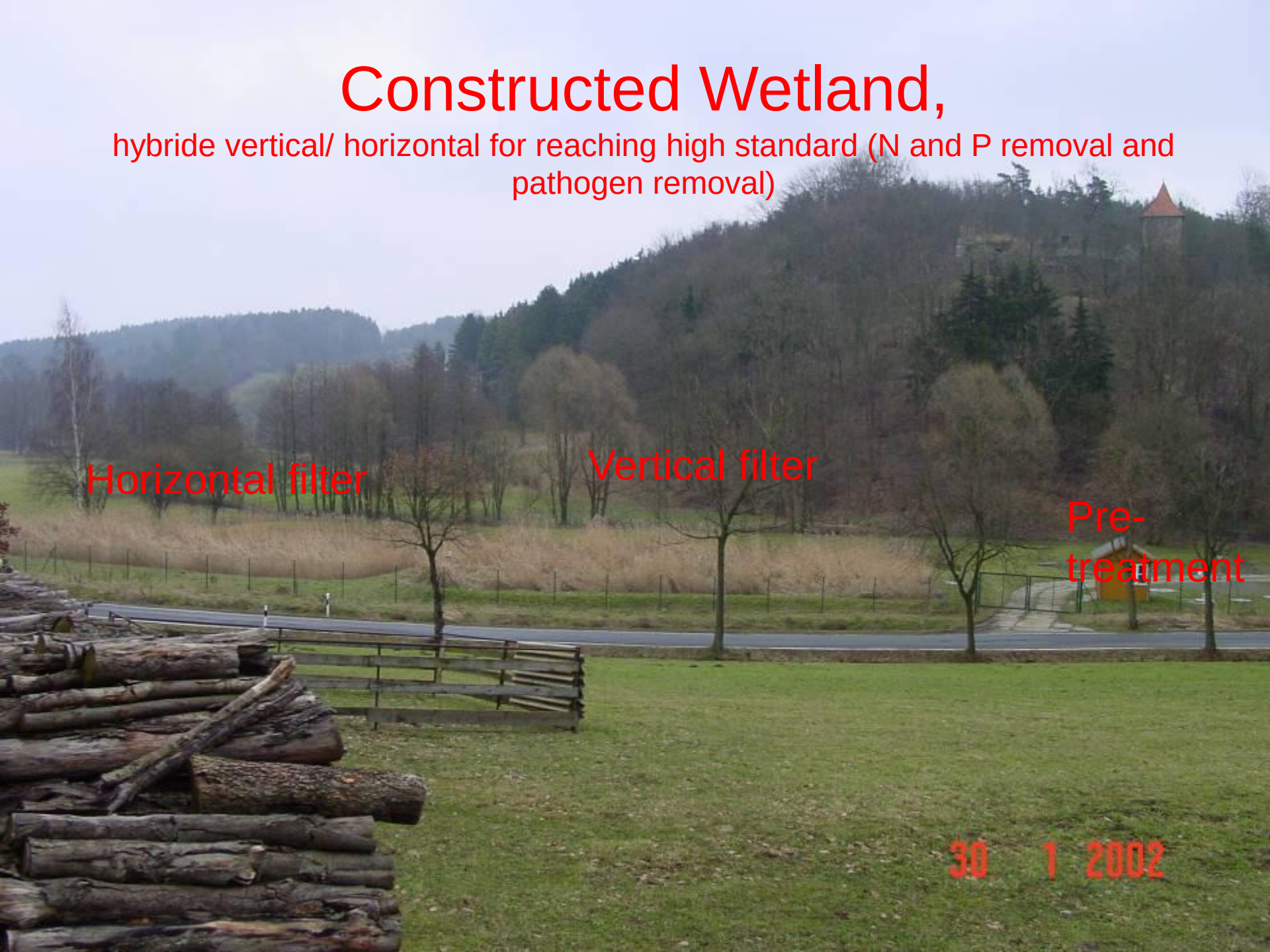
Germany 1000 pe

Germany 4 pe

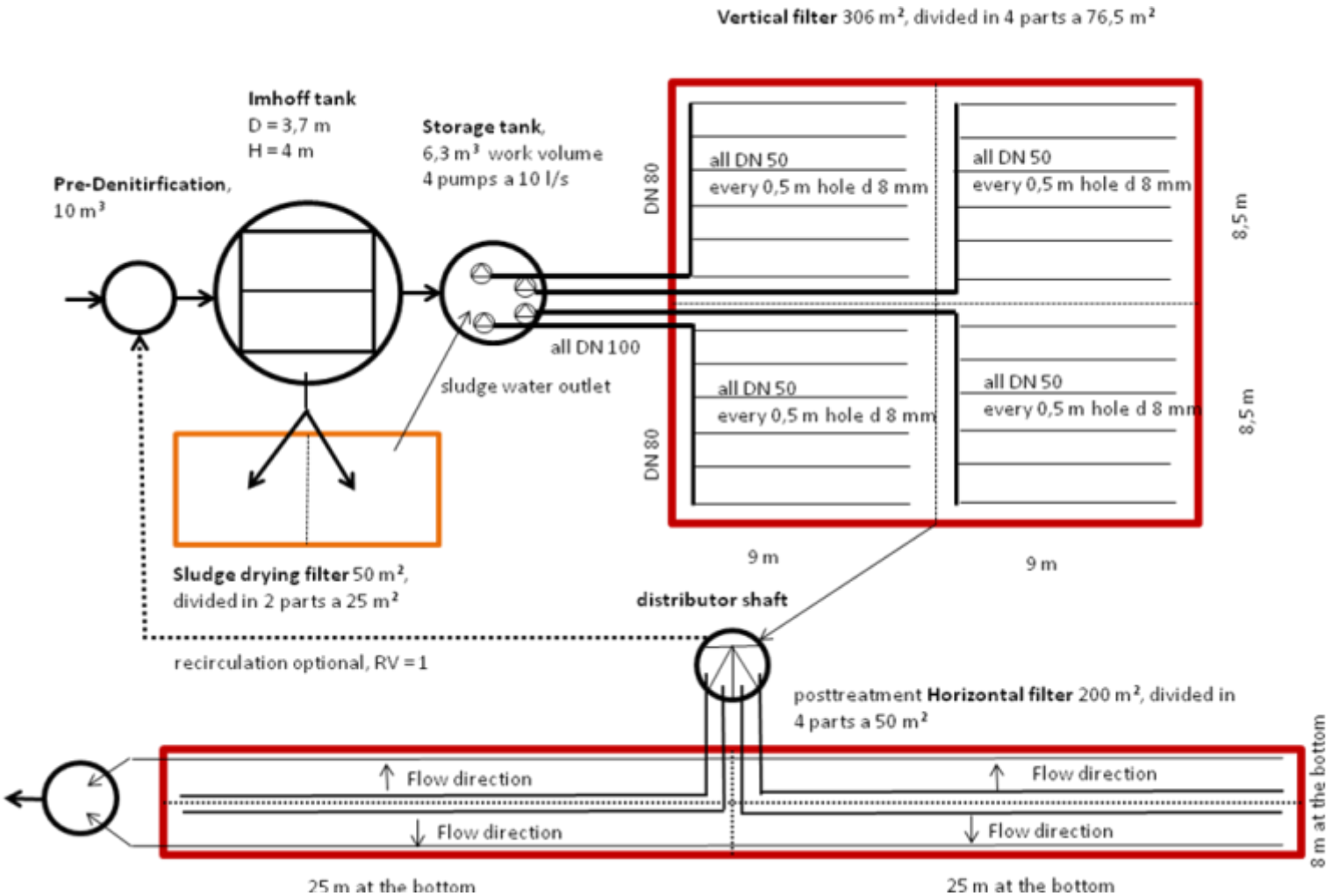

Access for cleaning the drainage
Inlet distribution pipe, under filter top level

Constructed Wetland,

hybride vertical/ horizontal for reaching high standard (N and P removal and pathogen removal)



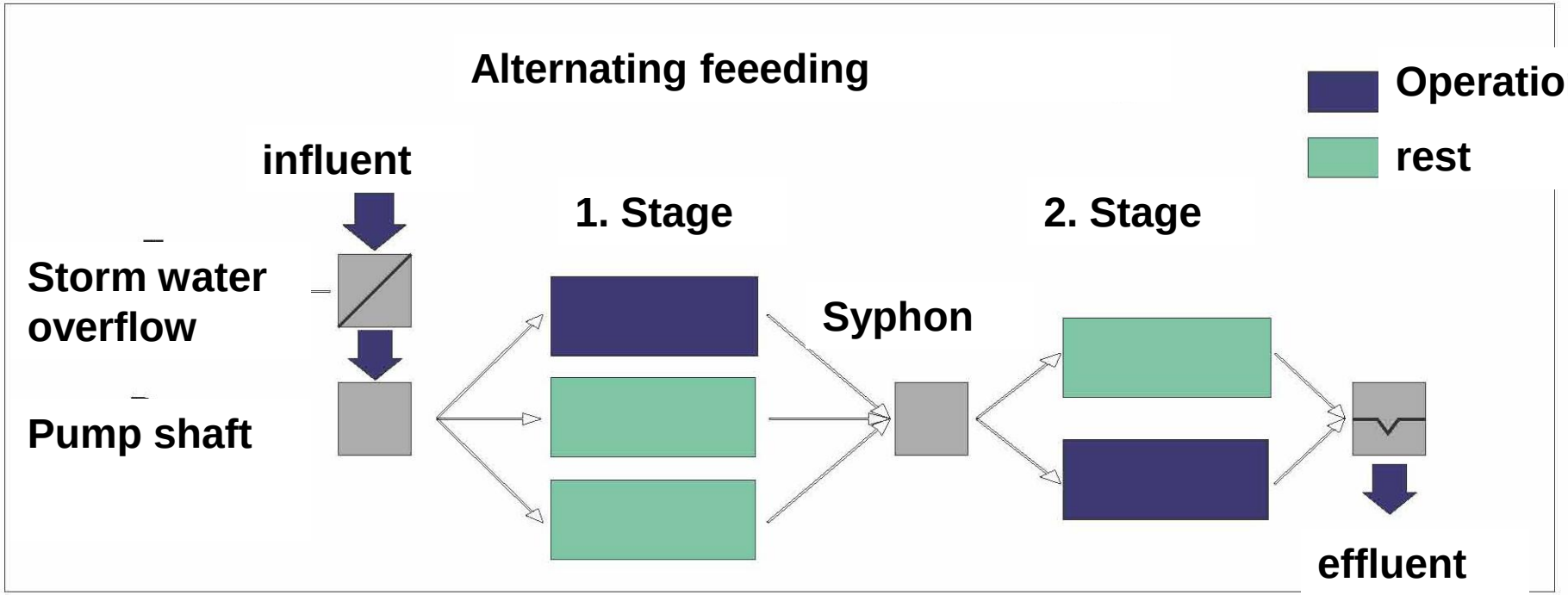
Schematic depiction of results of sample calculation for constructed wetland for 200 p.e. and reaching high standard on effluent quality in lowland



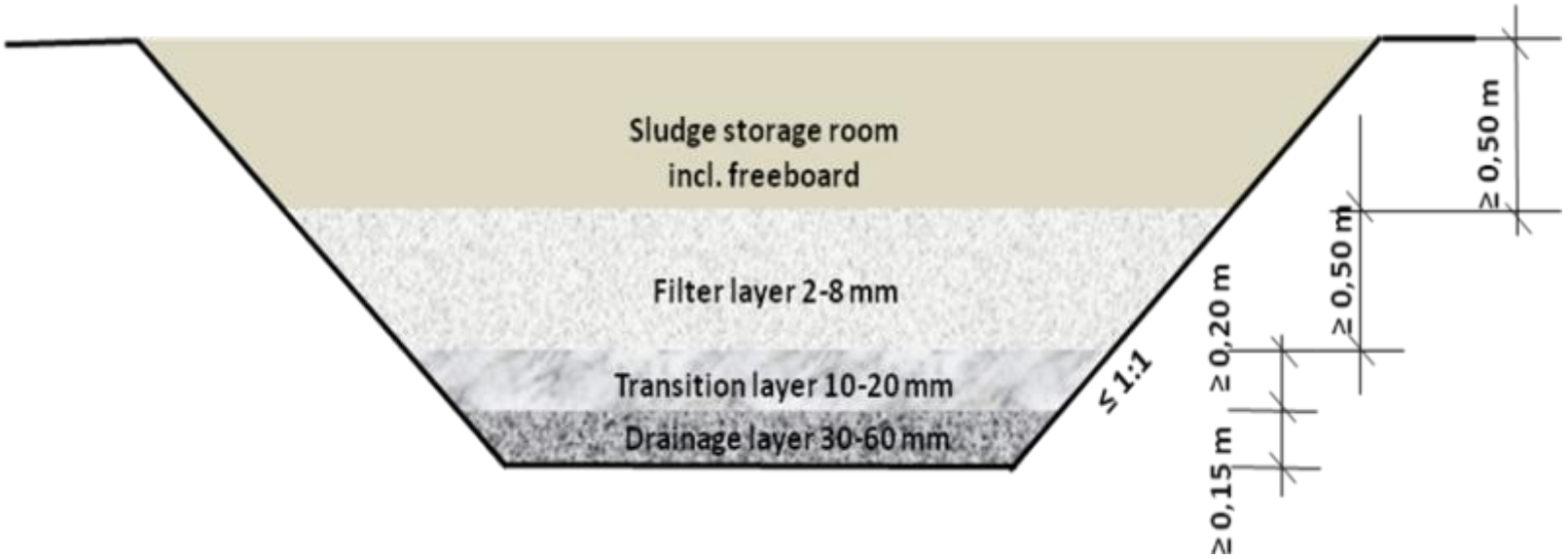
Constructed wetlands with raw waste water filter

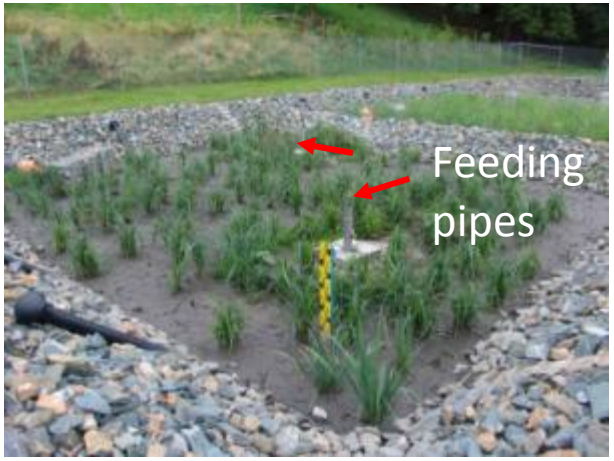
„french system“ (System Phragmifiltre®)

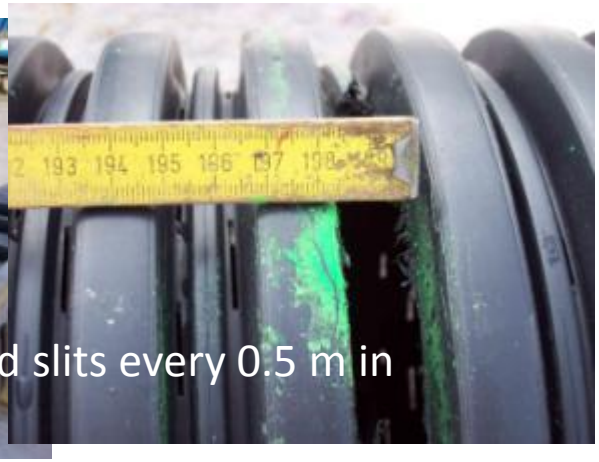
1. Stage 1,2 m²/E, 2. Stage 0,8 m²/E



Constructed wetlands with raw waste water filter first stage:

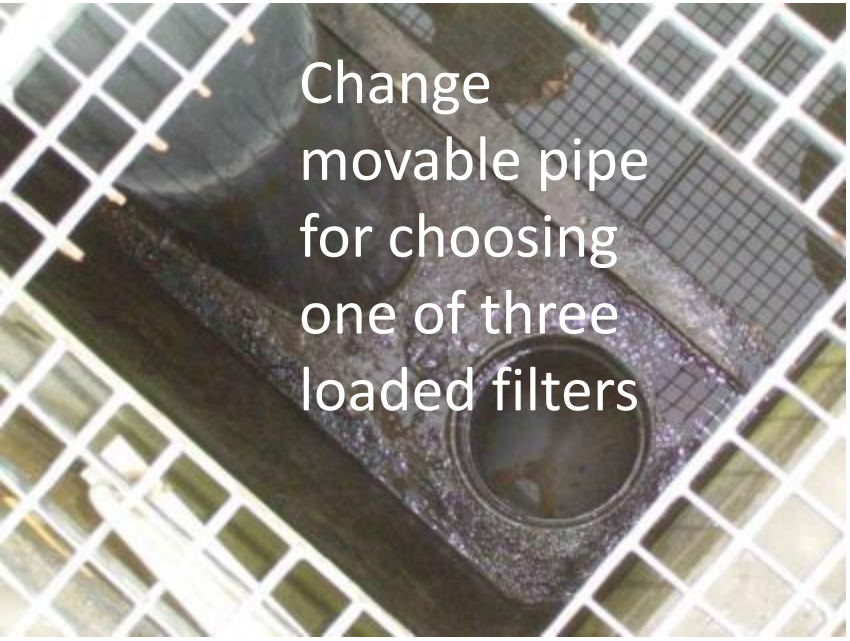






Float-siphon for raw wastewater

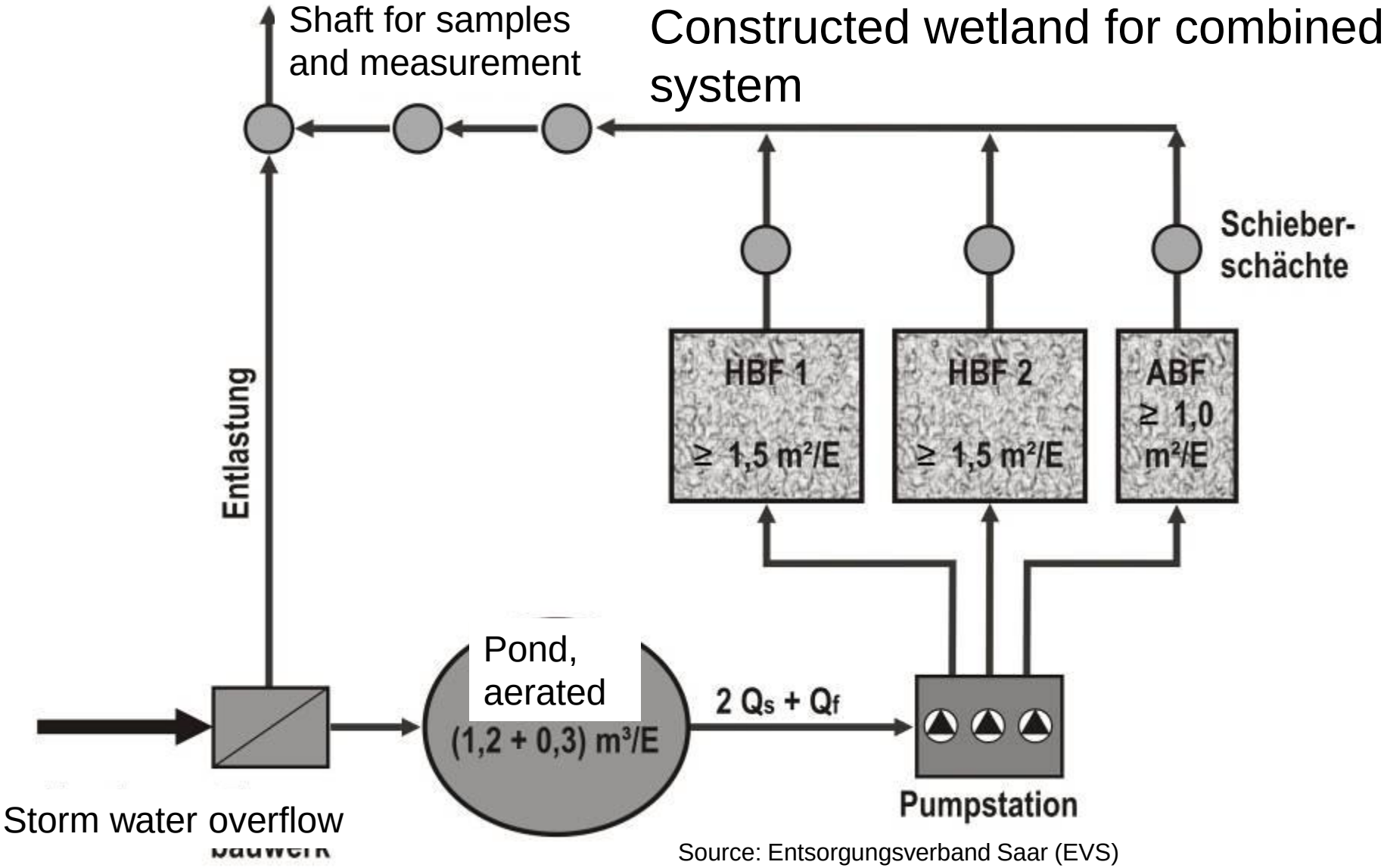
Without electrical energy



Secondary filter layer on 1. stage

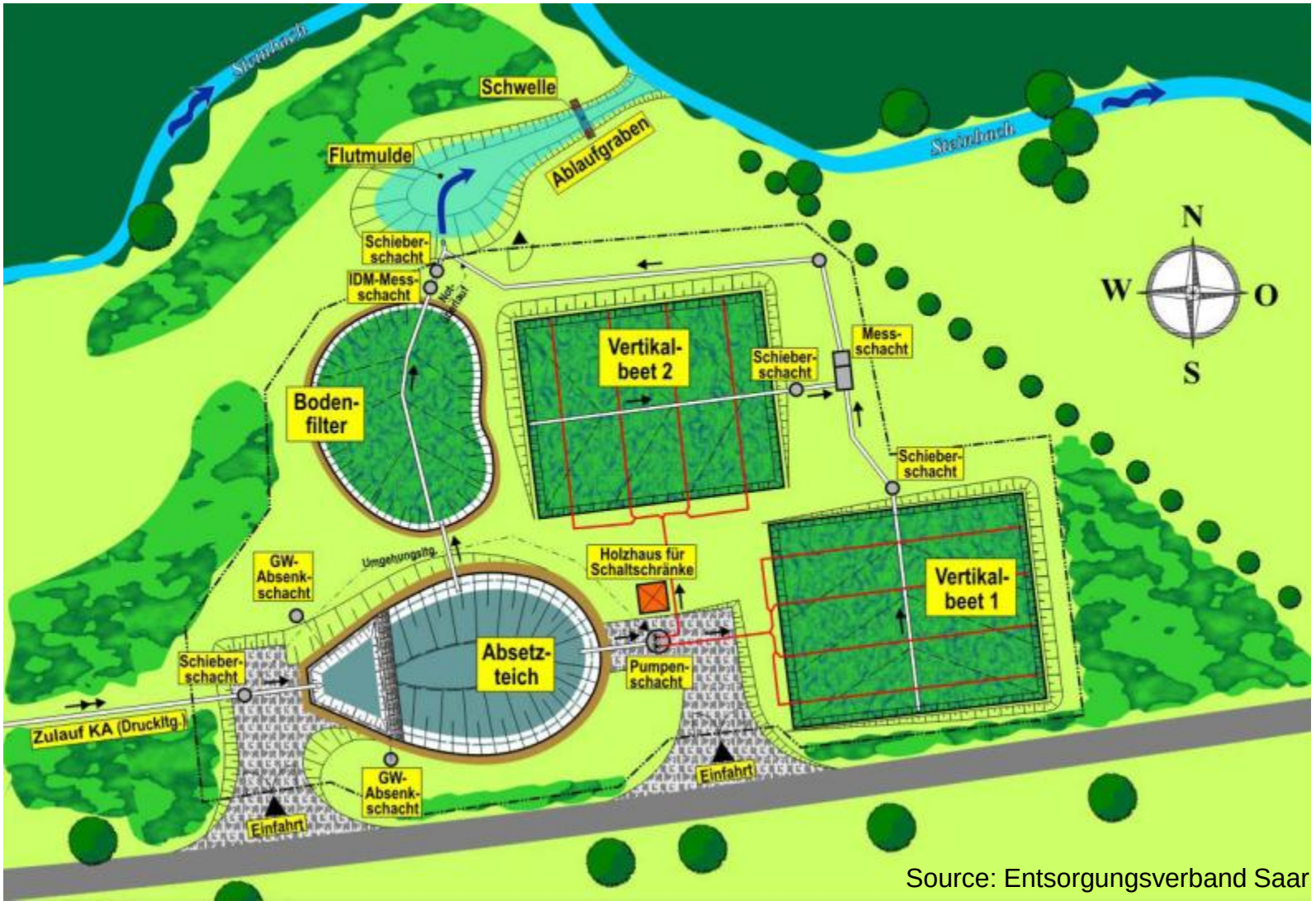
France

Constructed wetland for combined system



Source: Entsorgungsverband Saar (EVS)

Constructed wetland for combined system (Germany)



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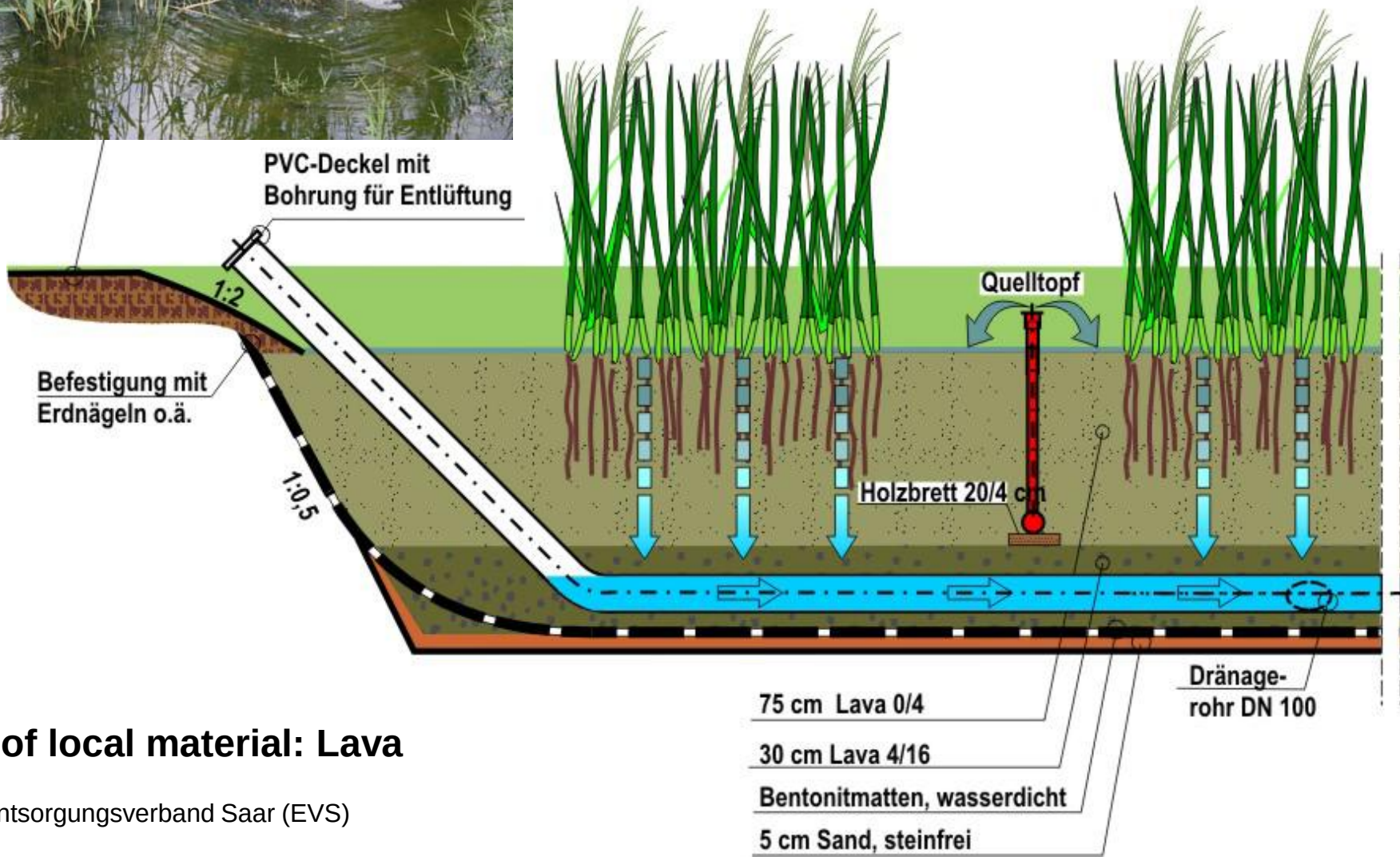

Use of local material: Lava

Source: Entsorgungsverband Saar (EVS)

Further reading

Albanian guidelines for the design and implementation of wastewater treatment plants using constructed wetlands
Also in English available
→ Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH

GIZ-Paper 'Technology review of constructed wetlands. Subsurface flow constructed wetlands for greywater and domestic wastewater treatment' from 2011
http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=930

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