FRENCH VERTICAL FLOW WETLAND

AUTHORS

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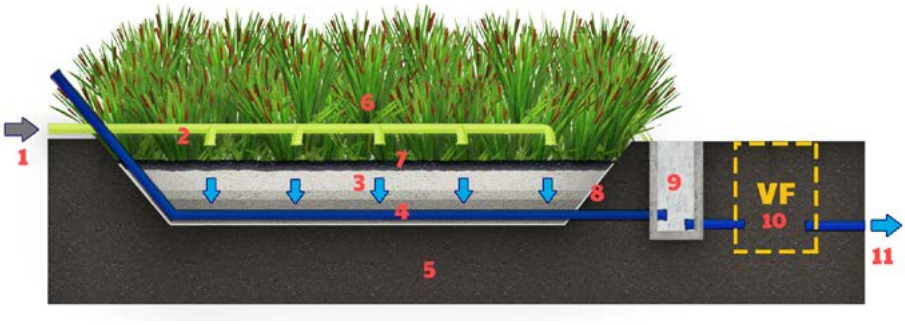

1 - Inlet
2 - Feeding system
3 - Porous media
4 - Drainage system
5 - Original soil
6 - Plants
7 - Sludge layer
8 - Waterproof liner
9 - Regulation manhole
10 - Vertical flow second stage
11 - Outlet

Description

The French vertical flow wetland is a specific configuration of the vertical flow (VF) wetland, consisting of two subsequent vertical stages with different filter media. The specific design and operation scheme for temperate climates – alternating feeding of three first and two second stage beds – allows a treatment of raw wastewater after passing a simple screen. In particular, the first stage for raw wastewater is often referred also as a French reed bed (FRB). Sludge accumulates and mineralizes at the surface; the FRB freeboard allows an operation without removing the deposit layer (20 cm maximum) between 10 and 15 years. The second stage is usually a classical VF, as seen in France, but it can be substituted by other wetland stages to respect context-specific water quality regulations (e.g., horizontal flow (HF) for denitrification). In recent years, an optimized design for tropical regions has been developed.

Advantages

- Simple sludge management, feeding with raw wastewater (minimization of operation and maintenance costs)
- Operation in separate and combined sewer systems possible
- Stable against load variations
- No specific hazard of mosquito breeding, no odor
- Lower risk of clogging than HF
- Low energy usage possible (feeding by gravity)
- Reuse potential at building scale (toilet flushing, irrigation)
- Affordable and energy sufficient sludge treatment
- High-quality end-product with more options for reuse
- Possibilities of nutrient reuse

Disadvantages

- Feeding system needs either mechanical (siphons) or electromechanical (pumps) component

Co-benefits

High	Water reuse	Biosolids			
Medium	Biodiversity (fauna)	Biomass production			
Low	Biodiversity (flora)	Carbon sequestration	Aesthetic value	Recreation	Storm peak mitigation

Compatibilities with Other NBSs

Primary treatment that can be combined with any kind of treatment wetland system according to outlet quality targeted.

Case Studies

In publication

- French vertical flow wetland for treatment of wastewater, Ohrei Municipality, Moldova
- Challex treatment wetland: French system treatment wetlands for domestic wastewater and storm waters
- Taupinière treatment wetland: unsaturated/saturated French system treatment wetlands for domestic wastewater in a tropical area

Operation and Maintenance

Regular

- Twice a week: checking the batch feeding systems for proper operation and filter alternation
- Regular cleaning of coarse screening
- Once a month: weed control
- Once a year: checking the organic deposit height and harvesting the reeds
- Plant maintenance frequency in tropical climates can be higher

Extraordinary

- First growing season: weed harvesting
- Removal of deposit layer at least every 10 to 15 years

Troubleshooting

- First stage clogging: if continuous hydraulic overloads arrive on the filters

Literature

Dotro, G., Langergraber, G., Molle, P., Nivala, J., Puigagut, J., Stein, O.R., von Sperling, M. (2017). Treatment wetlands. Biological Wastewater Treatment Series, Volume 7, IWA Publishing, London, UK, 172 pp.

Molle, P., Lombard Latune, R., Riegel, C., Lacombe, G., Esser, D., Mangeot, L. (2015). French vertical-flow constructed wetland design: adaptations for tropical climates. Water Science & Technology, 71(10), 1516-1523.

Morvannou, A., Forquet, N., Michel, S., Troesch, S., Molle, P. (2015). Treatment performances of French constructed wetlands: results from a database collected over the last 30 years. Water Science & Technology, 71(9), 1333-1339.

NBS Technical Details

Type of influent

- Raw domestic wastewater

Treatment efficiency

• COD	>90%
• BOD_5	~93%
• TN	20–60%
• NH_4-N	60–90%
• TP	10–22%
• TSS	>90%

Requirements

- Net area requirements: 2 m^2 per capita
- Electricity needs: can be operated by gravity flow, otherwise energy for pumps required
- Other:
  - For temperate climates: intermittent feeding of three first stage beds (3.5 days feeding, 7 days resting) and two second stage beds (3.5 days feeding, 3.5 days resting)
  - For tropical climates, only two beds in first stage required (3.5 days feeding, 3.5 days resting)

Design criteria

- First stage – FRB: ≥30 cm filter layer (gravel, 2–6 mm), 10–20 cm transition layer of (gravel, 5–15 mm), 20–30 cm drainage layer (gravel, 20–60 mm)
- Second stage–VF: ≥30 cm filter layer (sand, 0–4 mm), 10–20 cm transition layer of (gravel, 4–10 mm), 20–30 cm drainage layer (gravel, 20–60 mm)
- HLR: up to 1.8 $m^3/m^2/day$ with stormwater (dry weather HLR 0.37 $m^3/m^2/day$ – per square meter of bed in operation
- OLR: 350 g $COD/m^2/day$ – per square meter of bed in operation – first stage
- TSS: 150 $g/m^2/day$ – per square meter of bed in operation – first stage

Literature

Paing, J., Guilbert, A., Gagnon, V., Chazarenc, F. (2015). Effect of climate, wastewater composition, loading rates, system age and design on performances of French vertical flow constructed wetlands: a survey based on 169 full scale systems. Ecological Engineering, 80, 46-52.

Rizzo, A., Bresciani, R., Martinuzzi, N., Masi, F., (2018). French reed bed as a solution to minimize the operational and maintenance costs of wastewater treatment from a small settlement: an Italian example. Water, 10(2), 156.

NBS Technical Details

Commonly implemented configurations

- FRB – VF (French scheme – two stages)
- FRB – HF
- FRB – HF – FWS

Climatic conditions

- Configurations optimized for temperate as well as for tropical climates