1.5.1. Phosphorus Removal System (surface and subsurface flows on farms)

Summary: This passive filtration system was developed in the United States and is an outcome of a decade (1999 – 2009) of research by Drizo and co-workers on the use of steel slag aggregates (SSA) for P removal from wastewaters. The system is accepted in five states in the USA as the first and only conservation practice especially developed to reduce the amount of P from subsurface drain (tile) flows and other subsurface and surface P containing runoff outflows. Sources of agricultural outflows may include agricultural tile drains, ditches and animal heavy use areas such as milk-house wastewater, feed bunks, and silage leachate runoff.

Operation and Maintenance: The system is installed to intercept subsurface (tile) flow, ground water or surface runoff flow, and reduce the concentration of P. It is a user friendly, passive treatment system which does not require any mechanical or moving parts, nor electrical components. Therefore it has minimal annual operational and maintenance (O & M) requirements for the owner. O&M consists of the visual inspection of filters for signs of scum formation or preferential flows, after major precipitation/snowmelt events.

Efficiency:
- Up to 95% Phosphorus removal
- Up to 90% Pathogens removal
- Up to 90% Solids removal

General Criteria Applicable to All Purposes

- Design the system to achieve a reduction in P concentration of the water flowing through the system (USDA NRCS, 2013; Drizo, 2019)
- Provide a hydraulic retention time (HRT) sufficient to achieve the planned reduction in P concentrations.
- Determine the system size and configuration using the design procedures based on the design flow rate, permeability of the media, P retention capacity of the media and the desired HRT.
- Use geotextile lining, sediment basin or a containment vessel to prevent the migration of soil particles into the system.
- Design water control structures' as needed, to maintain the water level in the system at desired elevations (USDA NRCS, 2010).
- Ensure that the media has a phosphorus retention capacity of at least 0.50 percent by weight of materials, or 4.5 kg P/ton of media.
- Ensure that the particle diameter of the media provides sufficient permeability for the flow.
- Use material that is recyclable and/or disposable when it has used up its P removal capacity.
- Restore the pH of the discharge water leaving the treatment to acceptable levels.
- Use media for restoring pH levels that is recyclable and disposable, according applicable permits, when it has used up its pH restoration capacity.

Ability for climate chance mitigation: P removal system media is porous and available in different sizes. Drizo is currently developing novel designs so that the system can also be used for water retention (and floods mitigation). Also vegetated with local grasses and shrubs, P removal system can contribute to both N2O and CO2 emissions mitigation. **Potential for nutrient recovery**: P sorbing material used in filters to reduce P from waste streams has potential to act as a slow release P fertilizer.

Landbúnaðarháskóli Íslands Agricultural University of Iceland
búnaðarstovan
SAVONIA UNIVERSITY OF APPLIED SCIENCES
LULEÅ UNIVERSITY OF TECHNOLOGY
afbi Agri-Food and Biosciences Institute
GTK
HERIOT WATT UNIVERSITY
Comhairle Contae Dhún na nGall Donegal County Council
LOUGH NEAGH PARTNERSHIP

Evidence of Success:

System installation at Ohio State University farm, May 2012

System installation at St Mary seminary, OH, May 2012

Pilot testing at Nordic Farms, Vermont, USA 2009-2010

General Design Criteria

- General design criteria developed by Dr. Drizo are provided at the USDA NRCS websites (e.g. https://efotg.sc.egov.usda.gov/references/public/VT/VT782_(1Col).pdf).
- WSSI (Dr Drizo) provides design services in the USA (and internationally) working with local engineers and contractors..
- Each project is site specific with system sizing and design being dependent on the maximum expected flows from the tile drains.

Table 1: Example of a pilot system performance during spring rain events in VT, USA

	Tile drain IN DRP Cumulative Mass Load	SSF OUT DRP Cumulative Mass Load
	g	g
20/4	1.5	0.1
21/4	2.4	0.2
26/4	2.6	0.3
27/4	2.9	0.4
28/4	7.3	1.4
29/4	7.7	1.6
3/5	8.2	1.8
4/5	8.7	2.0
17/5	8.8	2.2
TOTAL	9.0	2.6
Reduction (%)		71

Cost: The cost of filters depends on the volumes of wastewater that need to be treated, influent and effluent P concentrations and availability of the SSA filtration media. Majority of the cost is for media transportation (generally 40 euros/ton). The initial capital costs for larger filters (flows 60-150 m3/d) can be high. However, the filter has a life span of 30+ years and minimum maintenance fee.
In general for base flows of up to 20 m3/d systems design cost is 7,000 USD (6,200 euros), plus the cost of media and transportation and system construction. For greater flows (60-150 m3/d) filter media and transportation costs can reach 35,000 euro, and with the excavation, implementation costs can reach 70,000 euro. However such filter would be able to treat (remove and also provide possibility for recycling) 55,000 m3 of agricultural runoff per year containing 1-40 g P (after manure spreading).

References

Drizo, A. (2019). Phosphorus Pollution Mitigation Strategies for Eutrophication Prevention and Control, pp. 140. In Press. John Wiley and Sons, fall2019.
USDA NRCS Vermont (2013). Natural Resources Conservation Service Interim Conservation Practice Standard. Phosphorus Removal System (Number) Code 782. August 2013. url: https://efotg.sc.egov.usda.gov/references/public/VT/VT782_(1Col).pdf

MORE INFORMATION:
Dr. Aleksandra Drizo; Water and Soil Solutions International Ltd.; adrizo@phosphoreduc.com
www.phosphoreduc.com

Northern Periphery and Arctic Programme 2014–2020
EUROPEAN UNION
Investing in your future
European Regional Development Fund