NATURAL RESOURCES CONSERVATION SERVICE
INTERIM CONSERVATION PRACTICE STANDARD

DENITRIFYING BIOREACTOR

(Ac.)
CODE 747

DEFINITION

A structure containing a carbon source installed to intercept subsurface drain (tile) flow or ground water, and reduce the concentration of nitrate-nitrogen.

PURPOSES

To improve water quality by reducing the nitrate-nitrogen content of:

- subsurface drain flow.
- ground water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sites where there is a need to reduce the concentration of nitrate-nitrogen of subsurface drain flow or groundwater.

CRITERIA

General Criteria Applicable to All Purposes

Design the bioreactor to achieve a reduction inthe nitrate-nitrogen concentration of the water flowing through the bioreactor.

Provide a hydraulic retention time through the bioreactor sufficient to achieve the planned reduction in nitrate-nitrogen concentration at the design flow rate.

Determine the bioreactor size and configuration using design procedures based on the design flow rate, permeability of the carbon source, and the desired hydraulic retention time.

Design the bioreactor for an expected life of at least 10 years unless provisions are made for periodic renewal.

Use a medium for the carbon source that is reasonably free from dirt, fines, and other contaminants. This does not preclude the planned addition of inoculants to improve the function of the bioreactor. Inert materials such as gravel may be mixed with the carbon source to provide the required bioreactor volume and flow rate along with the required amount of reactive carbon.

Do not subject the bioreactor to pressure greater than needed to provide gravity flow through the system.

Use geotextile lining for the bottom, sides, and top of the bioreactor as needed to prevent the migration of soil particles into the bioreactor, based on the soils and geology of the site.

Where practicable, make provisions to lower the water level briefly for maintenance or to flush the system.

Design water control structures to maintain the water level in the bioreactor at desired elevations. Refer to NRCS Conservation Practice Standard, Structure for Water Control (587), for criteria to design water control structures.

Construct the surface of the bioreactor to shed water from the top of the bioreactor and to allow for settlement. Excess soil removed during the installation of the bioreactor shall be disposed of by blending with the adjacent landscape or hauling away.

For safety and to prevent compaction of the bioreactor, identify the bioreactor location with appropriate signage or fence the site to avoid equipment travel over the bioreactor.

Protect all disturbed areas from erosion within 14 days of construction by seeding or mulching. Refer to NRCS Conservation Practice Standard, Critical Area Planting (342),

for criteria on seed selection, seedbed preparation, fertilizing, and seeding.

Additional Criteria for Treating Subsurface Drain Flow

Design the capacity of the bioreactor to treat the base flow using either a minimum drainage coefficient of 0.125 inches from the serviced area, or a minimum of 20 percent of the calculated peak subsurface drain flow. Flow from surface inlets may be disregarded when calculating peak subsurface drain flow.

Estimate the serviced area or peak subsurface drain flow of the subsurface drainage system from installation records, subsurface drain maps, size and capacity of the drainage main providing the flow being treated, monitoring the drainage main, research findings, etc.

Design control structures to maintain the water level at the upstream end of the bioreactor as high as practical while meeting the drainage needs in the area served by the system.

Protect the bioreactor from intermittent storms flows that could result in flushing or blow out of the established biofilm.

CONSIDERATIONS

Other practices and management systems can achieve a reduction of nitrate-nitrogen levels separately or in conjunction with this practice. Examples include NRCS Conservation Practice Standards, Nutrient Management (590), Cover Crop (340), Structure for Water Control (587), and Drainage Water Management (554).

Avoid a continually saturated zone with low or zero flow rate (stagnant zone) that may lead to production of contaminants such as methyl mercury.

Be aware of the effects on downstream flows or aquifers that would affect other water uses or users. For example, the initial flow from the bioreactor at start up may contain undesired contaminants.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for the Denitrifying Bioreactor that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications shall include:

- A plan view of the layout of the Denitrifying Bioreactor and associated components.
- Typical cross sections of the bioreactor(s).
- Profile(s) of the bioreactor(s) including inlet(s) and outlet(s).
- Details of required structures for water level control.
- Seeding requirements, if needed.
- Construction specifications that describe in writing site specific installation requirements of the Denitrifying Bioreactor and associated components.

The following list of Construction Specifications is intended as a guide to selecting the appropriate specifications for each specific project. The list includes most but may not contain all of the specifications that are needed for a specific project:

- MN-2 Clearing and Grubbing
- MN-5 Pollution Control
- MN-6 Seeding, Sprigging, and Mulching
- MN-21 Excavation
- MN-45 Plastic Pipe
- MN-46 Tile Drains
- MN-95 Geotextile

OPERATION AND MAINTENANCE

An operation and management plan shall be provided to and reviewed with the land manager. Specified actions shall include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance). The plan shall be site specific and include but not be limited to a description of the following:

- Anticipated flow rates, nitrate-nitrogen concentrations, reduction targets, etc.
- Planned water level management and timing.
- Inspection and maintenance requirements of the bioreactor and contributing drainage system, especially upstream surface inlets.

- Monitoring and reporting designed to demonstrate system performance and provide information to improve the design and management of this practice. Monitoring shall include water testing for nitrate-nitrogen (NO_3-N) in milligrams per liter, at the bioreactor inlet and outlet, at certain frequencies or specific dates, with a corresponding record of water level elevations.

REFERENCES

Christianson, L. E., A. Bhandari, M.H. Helmers, and M. St. Clair. 2009. Denitrifying bioreactors for treatment of tile drainage. *In*: Proceedings of World Environmental and Water Resources Congress, May 17-21, 2009, Kansas City, MO.

Verma, S, R. Bhattarai, G. Goodwin, R. Cooke, J.A. Chun. 2010. Evaluation of Conservation Drainage Systems in Illinois – Bioreactors. ASABE Paper 1009894 St. Joseph, MI: ASABE.