NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

DENITRIFYING BIOREACTOR

(Ac.)

INTERIM CODE 747

DEFINITION

A structure containing a carbon source, installed to reduce the concentration of nitrate nitrogen in subsurface agricultural drainage flow via enhanced denitrification.

PURPOSE

To improve water quality by reducing the nitrate-nitrogen content of subsurface agricultural drainage flow.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sites where there is a need to reduce nitrate nitrogen concentration in subsurface drainage flow.

This practice does not apply to underground outlets from practices such as terraces where the drainage source is primarily from surface inlets.

CRITERIA

Performance and Capacity

For bioreactors that treat subsurface tile drain flow, design the capacity of the bioreactor based on one of the following:

- Design for the bioreactor chamber to treat peak flow from a 10-year, 24-hour drain flow event.
- Design for the bioreactor chamber to treat at least 15% of the peak flow from the drainage system.
- Design for the bioreactor chamber to treat at least 10% of the peak flow from the drainage system if systematic monitoring will be taking place according to NRCS Conservation Activity 201 – Edge of Field Water Quality Monitoring and Evaluation.
- Design using locally proven criteria (e.g., drainage coefficient) that will result in the treatment of at least 60% of the long-term average annual flow from the drainage system.

Flow from surface inlets may be disregarded when calculating design subsurface drain flow.

Design the bioreactor to achieve at least a 30% annual reduction in the nitrate-nitrogen concentration of the water flowing through the bioreactor, taking into account the hydraulic retention time of the bioreactor.

Unless additional provisions are made to prevent extremely reducing conditions that may result in the production of methyl mercury, limit the planned nitrate-nitrogen reduction performance to 85% maximum and ensure that stagnant conditions do not develop in the media chamber.

Media Chamber

Use a medium for the carbon source that is reasonably free from dirt, fines, and other contaminants. Distribute the media within the bioreactor to achieve a uniform flow path.

Use geotextile or plastic lining for the bottom, sides, and top of the bioreactor as needed based on site soils and geology to prevent migration of soil particles into the bioreactor and minimize bypass of treatment flow via leaching from the media chamber.

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

Water Control Structures

Design water control structures to provide the required capacity and hydraulic retention time. See Conservation Practice Standard Structure for Water Control (587) for criteria to design water control structures.

Manage water levels at the upstream end of the bioreactor according to criteria in Conservation Practice Standard 554 – Drainage Water Management if site topography is such that the planned elevated water table upstream of the bioreactor might negatively affect crop performance.

Provide a means to evenly distribute and collect water in the upstream and downstream ends of the media chamber.

Provide a means to completely drain the media chamber to facilitate bioreactor management and maintenance.

Protection

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

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 should be disposed of by blending with the adjacent landscape or hauling away.

For safety and to prevent compaction of the bioreactor media, identify the bioreactor location with appropriate signage or fence the site to avoid equipment travel over the bioreactor. Alternatively, if the bioreactor is expected to be subject to equipment traffic for mowing or other purposes, ensure that the design provides adequate cover to prevent damage to the bioreactor, based on soil bearing strength.

When tile drainage water is released from the water control structures, drainage water flow velocity in the tile lines must not exceed velocity prescribed by Conservation Practice Standard 606 - Subsurface Drain.

Protect all disturbed non-crop construction areas by seeding or mulching within 14 days of construction. See Conservation Practice Standards Critical Area Planting (342) for criteria on seed selection, seedbed preparation, fertilizing, and seeding, and Mulching (484) for criteria on mulching.

CONSIDERATIONS

Other practices and management systems can achieve a reduction of nitrate-nitrogen levels separately or in conjunction with the denitrifying bioreactor. Examples include Conservation Practice Standards Nutrient Management (590), Cover Crop (340), and Drainage Water Management (554).

Determining the normal nitrate levels expected in the water being treated prior to design work will aid in establishing design parameters.

Inoculants may be added 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.

Situating the bioreactor on a low bench will minimize interference with the drainage needs of the area served during the growing season.

Exclude surface water from the bioreactor as much as possible, by selecting a location away from areas that will pond surface water during storm events.

When designing the bioreactor using methods based on a percentage of the peak flow from the drainage system, target 15-20% of peak flow for best performance.

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

Plans and specifications for denitrifying bioreactor shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

As a minimum, the plans and specifications must include:

- A plan view of the layout of the denitrifying bioreactor and associated components
- Typical cross section(s) of the bioreactor
- Profile(s) of the bioreactor including inlet(s) and outlet(s)
- Details of required structures for water level control

- Material specifications for the bioreactor media
- Seeding requirements, if needed
- Construction specifications that describe site specific installation requirements of the bioreactor and associated components.

OPERATION AND MAINTENANCE

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

- Planned water level management and timing.
- Inspection and maintenance requirements of the bioreactor and contributing drainage system, especially upstream surface inlets.
- Requirements for monitoring the status of the bioreactor media and replacement/ replenishment of media as needed.
- Monitoring and reporting designed to demonstrate system performance and provide information to improve the design and management of this practice, if available.

REFERENCES

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