Denitrifying Bioreactor Fact Sheet

USDA Natural Resources Conservation Service – Iowa January 2015

Definition and Purpose – A denitrifying bioreactor is a structure containing a carbon source installed to reduce the nitrate concentration in subsurface drain (tile) discharge (Fig. 1). In Iowa, this practice is being investigated as a way to reduce nitrate loading to surface waters. The Iowa Nutrient Reduction Strategy has a goal to reduce non-point source nitrate loads by 41%. Achieving this goal will require some sort of nitrate reduction treatment for nearly all of Iowa's drained land. The denitrifying bioreactor is one of several practices that may be used for this purpose.

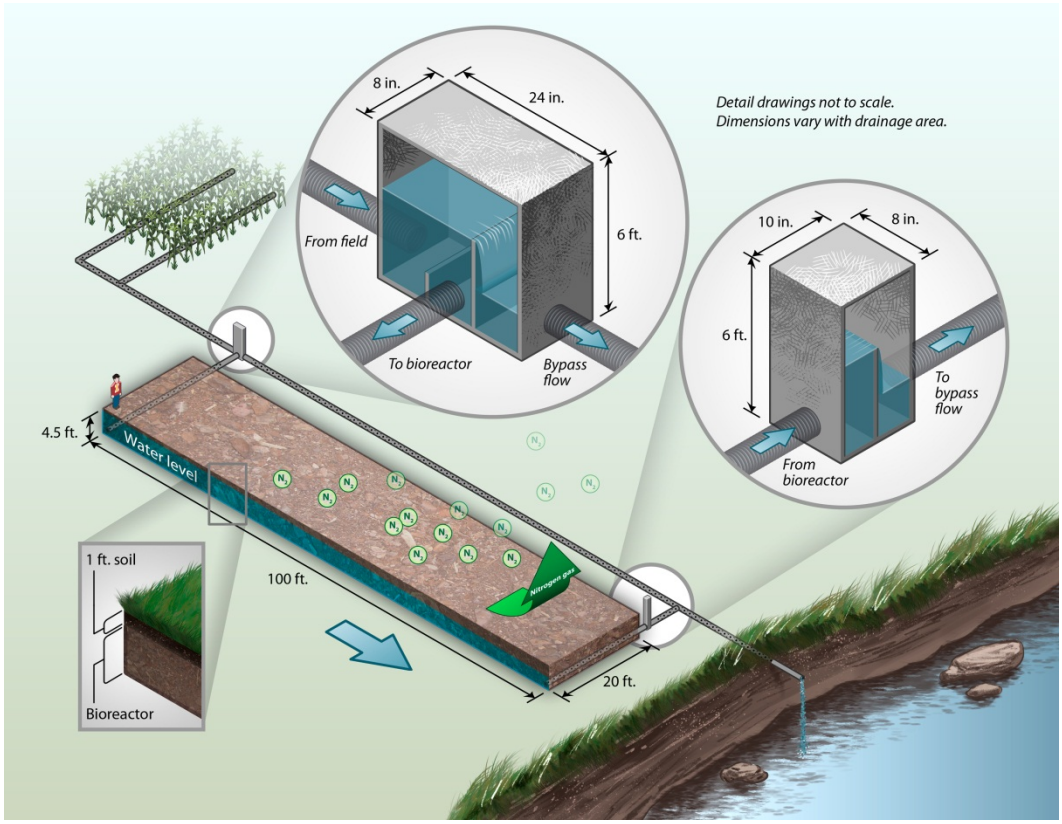

Figure 1. Schematic of a denitrifying bioreactor for agricultural drainage (From Christianson and Helmers, 2011)

Conservation Practice Standard - Interim Conservation Practice Standard (Code 747), "Denitrifying Bioreactor" was approved for use in September 2009 for a period of three years in order to evaluate the denitrifying bioreactor as a nitrate reduction practice. The final report was submitted to Wayne Bogovich, Chair, National Conservation Practice Standards Subcommittee, on April 4, 2013. The final report recommended the interim standard be converted to a national standard. The conversion process is underway and approval is expected by late 2015. Iowa NRCS continues to use the interim standard since a national standard has not been approved as of January 2015.

Research and demonstration sites – Researchers at Iowa State University have researched bioreactors since 2004. From August 2008 to December 2011, seven denitrifying bioreactors were installed in north-central Iowa by the Iowa Soybean Association in association with USDA-NRCS, Agriculture's Clean Water Alliance, the Walton Family Foundation, and the Sand County Foundation. The Iowa Soybean

Association has been monitoring these installations by collecting grab samples of the inflow and outflow. The samples are analyzed for nitrate-nitrogen concentration and other constituents.

Results – Laura Christianson (ISU) and other researchers reviewed the performance of four Iowa bioreactors and reported bioreactor and total load reductions of 45% and 32%, respectively, averaged over all years. Temperature and influent nitrate concentration were the most important factors for percent bioreactor N load reduction and N removal rate, respectively. It is important to avoid stagnant conditions in the bioreactor in order to limit production of methyl mercury. Production of nitrous oxide (N_20) has not been shown to be a problem.

Figure 2 shows the performance of three denitrifying bioreactors installed in the Boone River watershed in Iowa. The spring of 2013 was very wet, producing high flow rates which often exceeded the capacity of the bioreactors. This may have contributed to the lower than expected fraction of the drain discharge treated by the bioreactor.

ite	Area (ac)	Total Drain Discharge (in)	Drain Discharge Treated (%)	Potential Nitrate Load lb/ac	Nitrate Load Reduction (%)
UWFC	25	9.33	34	19.1	14
LWFC	44	6.93	38	21.2	20
LEC 2	39	16.11	19	12.9	14

Figure 2. Performance of three bioreactors in the Boone River Watershed in 2013. Note variability in total drain discharge, drain discharge treated, and potential nitrate load

Financial and Technical Assistance – Technical assistance with the planning and design of denitrifying bioreactors is available through normal NRCS procedures using the interim standard. A spreadsheet is used for the design. As with all interim standards, design approval remains with the State Conservation Engineer.

Financial assistance is available through EQIP. The payment rate is based on the cubic yards of woodchips used and includes excavation, wood chips, two water control structures, and connecting pipes.

A denitrifying bioreactor cannot be placed in a Conservation Reserve Program (CRP) buffer. After a national standard is approved, the USDA Farm Service Agency may provide financial assistance to install a denitrifying bioreactor as a CRP practice in the future.