Bioreactor: A bioreactor is an edge-of-field treatment process which allows the producer to reduce the amount of nitrogen leaving the field from a tile line, improving water quality of the receiving stream. It consists of a buried pit filled with a carbon source, commonly wood chips, through which tile water is diverted. The carbon provides material which serves as a food source for microorganisms. In the low oxygen environment the microbes use the nitrate to metabolize the carbon, converting the nitrate to harmless atmospheric nitrogen (N₂) gas.

**Function:**
Two control structures are used to divert tile water into the bio-reactor and to control retention time. Both structures use a stop log system to manipulate the flow. The control structure at the upper end of the bioreactor determines the amount of water diverted. The structure essentially “T’s” into the existing field tile. When flow exceeds the bioreactor’s capacity, excess water bypasses the system and flows down the existing tile line, preventing backup into the field. The lower control structure determines the depth of flow within the bioreactor. By raising the water level in the lower control structure, the flow rate within the bioreactor is reduced, increasing retention time.

**Location**
- 40-80 acre drainage areas
- Typically requires < 0.05 acres
- Works well in existing filter strips

**Installation**
1. Place control structures (Fig. 2).
2. Excavate pit (Fig. 3).
3. Fill with wood chips, 100 cubic yards/semi-load and minimum depth of 2.5 ft. (Fig. 4).
4. Roll geo-fabric over wood chips (Fig. 5).
5. Cover pit with soil, minimum 18-24 inches (Fig. 6).
6. Reseed area (Fig. 7).

**Design**
- Based upon size and slope of tile
- 20% of peak flow
- Targeted retention time of 4-8 hours
- Carbon source (wood chips) estimated life span, 10-15 years
- $8,000 average installation costs
  - EQIP fundable at least 50%, depending on location and special program funding
  - Other funding opportunities available
Results

- 48% average reduction in nitrate concentration
- Median nitrate concentration of influent is 10.52 mg/l
- Median nitrate concentration of effluent is 5.28 mg/l
- Rate of reduction increases with temperature.
- Reduction increases with retention time.

In 2009 the Greene County bioreactor reduced the load of nitrate from the field tile by 38 percent. Without the bioreactor, 585 kg (1290 lbs.) of nitrate would have reached the stream, but the bioreactor removed 221 kg (487 lbs.) of nitrate, which means only 364 kg (802 lbs) of nitrate reached the stream. Research indicates bioreactors can remove closer to 50 percent of the nitrate with improved stop log management and sizing methods.

Management

Figure 10 looks down into an upper control structure. The flow of water from the tile line is illustrated by the red arrows, moving from right to left in the picture. The first set of stop logs can be used for water table management. The second set of stop logs determines the amount of water diverted into the bioreactor. The depth of stop logs in the upper control structure should be reduced a few weeks prior to spring field operations, and should be reset once initial operations are completed. The lower control structure has only one set of stop logs, used to control flow rate within the bioreactor. Two to three stop logs should be set during the winter and early spring to slow the flow when water temperatures are low. These stop logs should be removed in May when temperatures and tile flow rates increase.

FAQ’s

- **How effective is a bioreactor?**
  Bioreactors can be expected to remove 35-50% of nitrate from tile water.

- **What is the life expectancy?**
  The wood chips will need to be replaced after 10-15 years.

- **Is there a certain species of wood chips needed?**
  Currently, there are no preferred species; both hardwoods and softwoods are used.

- **What maintenance is involved?**
  No maintenance is normally required, other than changing stop log levels a few times a year.

- **How much do bioreactors cost?**
  Installations vary, but on average they cost $8,000, and EQIP may fund at least 50% of the cost.

Additional Information

http://www.iasoybeans.com/environment/bioreactorbasics.html
http://www.acwa-rrws.org/bioreactordemo.html

Contact ISA’s Environmental Programs.
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The information in this fact sheet is a result of Agriculture’s Clean Water Alliance (ACWA) and the Sand County Foundation’s Bioreactor Demonstration Project and was prepared by Keegan Kult.