Our Water Keeping it Clean

North Dakota Department of Health Environmental Health Section

Tile Drainage the Effects on Water Quality

by Jim Collins, Jr., Environmental Scientist, North Dakota Department of Health

What is a Tile Drain System?

Tile drainage was first introduced to the United States in 1838 by farmer, John Johnston. Johnston brought the practice with him from Scotland to his farming operation in New York. In its infancy, tile drains were exactly what the name implied, clay tile, u-shaped in form and placed by hand into the soil. This evolved to clay pipe with inlet holes buried in the soil surrounded by gravel or timbers to promote water infiltration. Today we have perforated polyethylene pipe, sometimes wrapped with a filter material to prevent sediment from clogging the pipes. Mechanized large horsepower tile ploughs have replaced manpower, allowing several hundred feet of tile to be laid in one day.

Modern tiling ploughs can be self contained or an attachment—Courtesy Alfa img.

Why Install a Tile Drain System?

In North Dakota, tile drain systems are typically installed to increase in crop yields for the parcel of land being drained by one or more of the following:.

achieve one or all of three results:

1) remove excess surface water
2) remove excess subsoil moisture, lowering the water table
3) draw highly saline water down from the soil's surface to the tile system.

Tile Drain Discharge study.

From 2008 to 2013, the North Dakota Department of Health partnered with the NDSU Extension Ag and Biosystems Engineering programs to determine the water quality characteristics of discharges from tile drainage systems installed in saline soils. Samples were collected on a weekly basis at 18 sites in Phase I (2008) and eight sites in Phase II (2009-2013).

Study Results

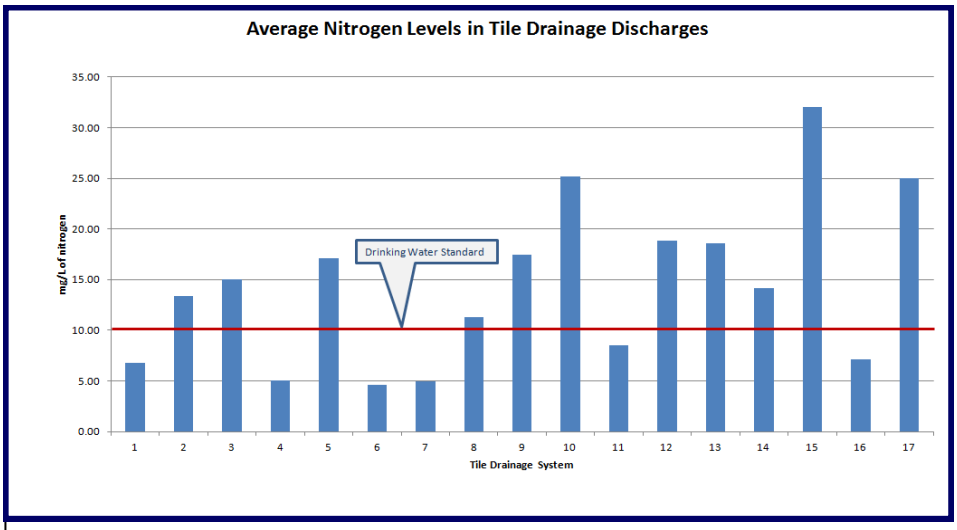
The final report concluded:

1) Flow does not begin until most of the frost is out of the ground.
2) Flow is affected by rainfall amounts.
3) Average total dissolved solids (TDS) ranged from 500—11,000 mg/L
4) The concentration of nitrogen in the discharge water is highly variable

Study Conclusions

1) In the spring, surface waters receive a majority of their flow from snowmelt runoff. If soil is unprotected, erosion can occur and excess nutrients are delivered to the waterbody. Also, infiltration will be minimal and the tile drain system will not be flowing. Once the frost line has disappeared and rainfall can reach the tile system, it will contribute between 11and 30 percent of the flow.
2) Nutrients and TDS will increase after rainfall events due to more water moving through the soil profile to the tile drains.
3) In most tile systems, TDS is highest when the system is first installed and decreases over time. The dominant mineral in discharges is sulfate (SO_4). Total loads to receiving streams for the Phase II four-year study period ranged from 65 to 1,375 tons of minerals.
4) One of the primary concerns with discharges from tile drainage systems are nutrient levels. Two main nutrients drive productivity in surface waters: phosphorus and

nitrogen. When phosphorus is applied to a field, it binds to soil particles and does not dissolve easily. Therefore, soil erosion is the predominant delivery method of phosphorus to surface waters. Conversely, nitrogen readily dissolves in water. This allows it to travel downward through the soil profile to the tile drainage system and discharged to a receiving water. The average annual amount of nitrogen in the drainage water varied from about 1 pound per acre to a maximum of about 10 pounds per acre. However, the 4-year total of nitrogen that flowed into the receiving water stream varied from a low of 719 pounds to 6,070 pounds. With large flow events, nitrogen losses can exceed 100 pounds per day from a 130 acre field.



Total nitrogen averages for tile drain discharges as compared to the Safe Drinking Water Standard, NDDoH 2016.

Effects on Receiving Waters

These nutrients, intended to grow better crops, will also increase plant life in streams, rivers and lakes. When the resulting plant life dies and decomposes, oxygen is used up and may result in adverse effects to aquatic life. Also, nutrients can affect human health. Currently, the standard for drinking water is 10 mg/L and the cumulative effects of tile drain discharge water may result in the need for treatment before consumption. The municipal treatment system that supplies Des Moines, Iowa, has filed a lawsuit seeking compensation for increased treatment costs due to uncontrolled tile drainage discharges.

What can we do?

Careful management is the key.

1) Managing inputs on fields so crop uptake equals the input. This can be achieved by precision application of fertilizers.
2) Managing soil health. Cover crops can take up excess nutrients and moisture, reducing and improving the quality of resulting discharge.
3) Managing discharges. Adjusting the timing of tile drain discharges can help lower peak flows in streams during and following rainfall events. This can help minimize stream bank erosion and sediment loads.

A pattern tile drainage system in a midwestern field.

There is no doubt that tile drainage may improve yields, however, proper management is needed to minimize impacts to North Dakota's surface waters.

For more information, contact the Watershed Management Program at 701.328.5210.

North Dakota Department of Health
Environmental Health Section
Gold Seal Center, 4th Floor
918 East Divide Ave.
Bismarck, N.D. 58501-1947
701.328.5150
www.ndhealth.gov