# SMOKING TILE LINES: A DEMONSTRATION OF SOIL STRUTURE

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## Introduction

Soil structure is a key component to soil quality. Substitution of conservation tillage and no-till for conventional tillage practices greatly affects soil structure and decrease runoff and losses of soil, nutrients, and agrochemicals in overland flow. However, enhanced infiltration increases the potential for sub surface flow, especially in tile lines. Earthworm burrows, root holes, cracks and structural porosity in the soil surface can allow for rapid transport of nutrients and chemicals to tile lines.

Liquid manure has become the norm on many livestock operations. These liquid wastes are applied by surface application or incorporated with tillage or by direct injection. Because of concerns with odor and surface runoff, subsurface injection is becoming more widely used by livestock operations. The issue of liquid manure entering subsurface drainage systems is being increasingly recognized as an important environmental issue throughout drained areas in the U.S. Midwest. The combination of increased conservation tillage, increasing use of liquid manure, and deeper incorporation of liquid manure, transport of manure through soil to tile lines has become an issue.

## Transport to Tile Lines

Field research indicates that the amount of rainfall transmitted by earthworm burrows increases with storm intensity and is as much as 10% of total rainfall. Laboratory studies indicate that if a heavy, intense storm occurs shortly after surface application of liquid manure or chemicals, the water transmitted to the subsoil by earthworm burrows may contain significant amounts of that which was applied, up to a few percent. Transport of nutrients can be reduced with the passage of time or if light rainstorms precede the first major leaching event. In the case of fields with subsurface drainage, however, close association of earthworm burrows to tile drains may substantially increase the risk of surface water contamination by surface-applied agrochemicals and injected animal wastes. Likewise, earthworm burrows may connect to subsoil fractures and contribute to rapid water and chemical movement to drains and ground water.

The residue cover on no-till soil significantly reduces the effects of raindrop impact and the propensity for the soil to crust. The residue also produces a more favorable environment for earthworms by keeping the soil cool and moist and providing a continuous supply of food for surface-feeding earthworms. Since they can ingest and process a large amount of soil and residue on a yearly basis, earthworms have the potential to greatly affect how water moves through the soil.

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## Ohio Study Determines Transport to Tile Lines

In a study to determine the effect of earthworm burrows to tile line, Frank Gibbs, NRCS Ohio, and Martin Shipitalo, USDA-ARS, used dyed water to measure the infiltration in individual burrows. The infiltration rates in burrows that did not emit smoke were also measured using water dyed a different color. The dyed water quickly entered the burrows where smoke was observed and appeared in the outlet more than 12 m downstream from the nearest burrow only 14 minutes after infiltration measurements were begun and after only a total of only 9.3 L of water had been added to the burrows, even though the drain was not flowing at the time the experiment was begun. The dyed water added to the burrows that did not emit smoke was never observed in the drain. In this study, smoke was observed up to 7 m away from the tile line. Earthworm burrows are not solely responsible for this as burrows tend to be vertical. Burrows connected to cracks, root holes, and soil structure was other probable causes. Using melted plastic to mold earthworm burrows, it was determined that some burrows approach within a few cm of tile line but never entering it (Shipitalo and Gibbs, 2000).

## Tile Line Smoking Demonstration

In 2005, the UW-Extension Nutrient Management Team and Grains Team collaborated to host Soil Quality Field Days at four locations across Wisconsin. Field days were held in Fond du Lac, Chippewa, Adams, and Columbia counties. The tile line smoking demonstration was included at the Fond du Lac County site. This demonstration was designed to show how soil structure and specifically, earthworm burrows can affect water and liquid manure movement.

At the field day, Frank Gibbs, USDA-NRCS, Ohio presented information on earthworm burrows and how the tile line smoking demonstration is set up. A pit was opened to expose a short segment of the tile line and the line was temporarily severed. The 200-foot tile line was hooked up to a gasoline powered turbine blower. Once the blower was started, an ignited smoke cartridge was placed on the intake portion of the blower. Within seconds of smoke intake, smoke could be seen escaping through earthworm middens. In most cases, middens emitting smoke were in line with the tile line but there were cases where emission points were 18 to 24 inches outside of the tile line. Eventually, all portions of the tile line were emitting smoke.

A surface application of water was applied to a section of soil above the tile line two hours before the demonstration. The area that was watered had increased earthworm activity and was emitting an increase of smoke compared to the non-watered section.

## Control Measures

With the potential for liquid animal wastes to adversely affect water quality when applied to land that has subsurface drainage, both immediately after application and when mobilized by subsequent rainfalls, control measures exist that might reduce these concerns. If tillage is necessary, tilling as high above the tile line as possible will disrupt burrows and leave more area for liquid dispersion in the sub soil. Using precision farming technology to apply liquid manure away from drains may avoid drainage to tile lines. In many instances, however, this will be impractical because of uncertainty in locating the drains, the random nature of the drainage network, and the size of the area that needs to be avoided or tilled.

Inflatable plugs or shut-off valves might be used to block the drains when liquid animal wastes are being applied, thereby allowing any wastes that enter the drain time to reenter the soil. These may not work because of their in ability to withstand pressure heads. Use of shut off valves and catch basins can reduce the failure rate encounter with plugs and valves alone, but still does not

address the issue of rainfall-mobilized wastes. The use of application equipment that disrupts the continuity of macropores to the drains can promote diffusion of liquid animal wastes into the soil matrix and thereby reduce both immediate movement to the drains and rainfall-mobilized movement, but probably will not eliminate these losses. Likewise, tillage will probably reduce losses by disrupting macropores and promoting diffusion, but has undesirable consequences of negating the beneficial soil and water quality aspects of conservation tillage. (Shipitalo and Gibbs, 2005).

Gibbs indicated at the field day that liquid manure with more than 5% solids does not enter tile line as readily as manure with less than 5% solids. Agitation of manure storage units and bedding materials can greatly effect liquid manure composition. Managing agitation and bedding are ways to control liquid manure reaching tile lines.

## Future Demonstrations

Tile line smoking demonstrations are planned for Wisconsin and northern Illinois in June 2006. Contact the authors below for more information.

## References

Shipitalo, M.J., and F. Gibbs. 2000. Potential of earthworm burrows to transmit injected animal wastes to tile drains. Soil Sci. Soc. Am. J. 64:2103-2109.

Shipitalo, M.J., and F. Gibbs. 2005. Preferential flow of liquid manure in macropores and cracks. Paper for 2005 ASAE Annual International Meeting. Tampa, Florida.