Evaluating the Impacts of Subsurface Agricultural Tile Drainage Systems to Water Quality in Vermont

STONE ENVIRONMENTAL

Services / Expertise
Agricultural Conservation Practice and Design
Water Quality & Flow Monitoring
Edge-of-Field & Conservation Practice Monitoring
Subsurface Tile Drain Systems
Required Agricultural Practices
TMDL Implementation Support
Literature Review

Markets
State Government
Municipal & RPCs
Site Owners
Watershed Protection Organizations

Project Locations
Jewett Brook Watershed
St. Albans, Vermont

Dates
2015–Present

Project Owner
The Lake Champlain Basin

External Link:
Tile Drainage Literature Review
Stone's deliverable for the Lake Champlain Basin Program's project.
http://www.lcbp.org/2017/01/lcbp-technical-report-tile-drainage-literature-review/

One of the solar-powered monitoring stations Stone designed and installed at tile drain outlets located on farms within in the Jewett Brook Watershed.

LAKE CHAMPLAIN (Vermont – New York – Quebec) continues to suffer from the effects of excessive phosphorus (P) loading from sources in the Lake Champlain Basin. Nonpoint source P derived from agricultural land is a substantial component of the lake's annual P load. Vermont farmers have shown strong interest in implementing best management practices (BMPs), such as conservation tillage, manure and nutrient management, and cover cropping in recent decades to address losses of P, sediment, and other pollutants to surface waters. However, despite unprecedented investments by farmers and federal and state programs, these efforts have not yet yielded the desired water quality results.

One factor that may contribute to the slow pace of progress in attaining these water quality goals is the loss of P via agricultural tile drainage systems. For many years, relatively scant attention was given to potential tile drainage contributions of P to local receiving waters due to the prevailing view that, because soils have an affinity for P, losses of P via subsurface drainage should be minimal. However, recent research has revealed that tile drainage systems in agricultural fields can discharge significant quantities of P under a wide range of soil characteristics and management practices. Several studies have demonstrated that a considerable amount of P can be transported beneath the surface in tile-drained fields.

In Vermont, as in much of the nation, the pace of tile drain installation has accelerated in recent years. As the area of tile drained cropland rises, concern regarding nutrient losses and other water quality impacts related to tile drainage has

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increased. The USDA Natural Resources Conservation Service (NRCS) has a long list of conservation practice standards concerning everything from manure and silage leachate management in barnyards to erosion prevention and sediment and nutrient control on cropland. Practices targeting surface runoff, however, may not be sufficient to meet water quality targets if a substantial portion of the P loading from tile-drained agricultural land is delivered through subsurface drainage. To our knowledge, Vermont is the only state with a relevant standard, an interim conservation practice standard (Phosphorus Removal System, Code 782) adopted by Vermont NRCS in 2013.

In late 2016, Stone began working with Lake Champlain Basin Program (LCBP) to assess the P contributions from tile drainage systems in Jewett Brook—a small agricultural watershed that has the highest median P concentrations of any Lake Champlain tributary—prior to discharge to St. Albans Bay. This is the first intensive study in Vermont aimed at increasing our knowledge and understanding of the impacts of tile drainage systems on water quality. At the outset of the study, a comprehensive literature review was prepared, which became the basis of the Vermont Agency of Agriculture, Food and Markets' and the Vermont Agency of Natural Resources' joint *Subsurface Agricultural Tile Drainage Report* to the Vermont legislature in January 2017.

Based on key findings from the literature review, Stone established site selection criteria and ultimately selected twelve tile drainage systems across the Jewett Brook watershed that represented an appropriate range of field conditions for monitoring. A solar-powered monitoring station was installed at each site, which included a manhole designed to intercept the tile lines and collect data using an electromagnetic flowmeter and an instrument shelter with autosamplers, dataloggers, and modems. Stone commenced monitoring activities in April 2017 at twelve tile drain outlets, continuously monitoring flow rates, collecting flow-paced composite samples, and calculating P concentrations and loading. Following a year of data collection, the results showed extremely high variability in phosphorus concentrations among the 12 sites and with time. Total phosphorus concentrations have ranged from 11 to greater than 4,000 μg/L. Phosphorus concentrations in tile drain flow clearly reflect both soil phosphorus concentrations and the effects of recent nutrient additions.

In 2018, the LCBP provided funding to extend monitoring of five of the twelve tile drain stations in the Jewett Brook watershed to collect sufficient data to characterize how export of nutrients in tile drainage water responds to agronomic management practices. In addition, monitoring was expanded to five new tile drainage systems in Addison County to represent field conditions in the southern Lake Champlain Basin and address concerns that the tile drain monitoring results in the Jewett Brook watershed may not be representative of conditions elsewhere in the Lake Champlain Basin. At the Jewett Brook Watershed sites, flow monitoring and sample collection continued from May 2018 through August 2019. Monitoring of the Addison County tile drain sites was initiated in November 2018 and continued through November 2019.

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Lake Champlain Basin Program

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