Friends of Northern Lake Champlain End of Tile Drain Treatment System
Summary of First Round of Sampling

Submitted for the Friends of Northern Lake Champlain
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Project Overview:

The Friends of Northern Lake Champlain, in association with the Natural Resources Conservation Service (NRCS), the VT Agency of Agriculture, Food, and Markets, and Stone Environmental, have installed an end of tile drain treatment system on a farm in Franklin. This work was funded through a Conservation Innovation Grant from the NRCS. This project is part of a study that is investigating the effectiveness of two different media in removing phosphorous from tile drain discharge water. In this study, filters were designed to remove dissolved phosphorus from tile drain water using sorptive media available locally or within the region at low cost. The two media being examined are: drinking water treatment residuals and a limestone bedding. Specific components of this study include: continuously monitoring inflows and outflows through the phosphorus treatment systems; quantifying phosphorus reductions in the treatment systems by comparing total phosphorus and total dissolved phosphorus concentrations and loads in inflow and outflows; and quantifying changes in nitrogen and total suspended solids concentrations and loads by comparing inflow and outflows.

Study area:

The phosphorus removal systems were constructed at the approximate location indicated in Figure 1. The systems were installed near the end of an existing tile line that drains approximately 35 acres of cropped land.

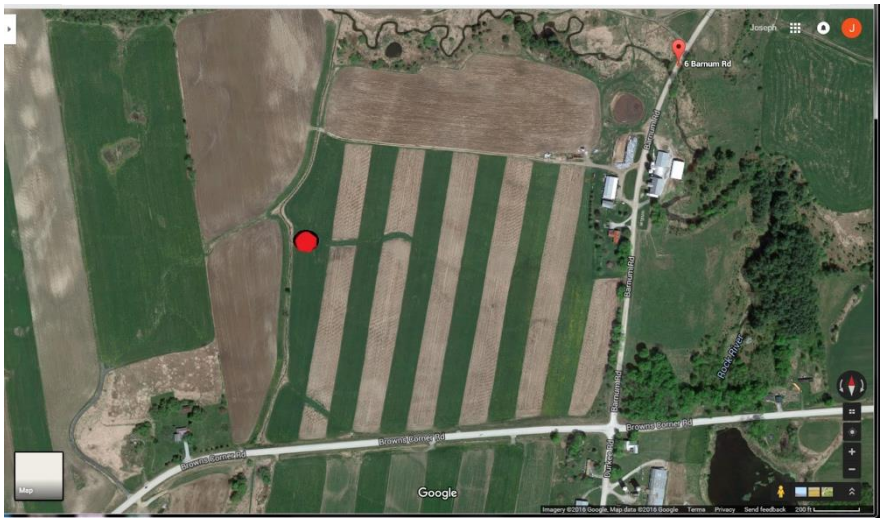

Figure 1. Approximate location of phosphorus removal system.

Monitoring design:

Collection of flow-proportional water samples were taken on: 11/19, 12/2, 12/10, and 12/6. Future sampling will occur once weather permits and will happen on a weekly basis and on the same day when possible. Monitoring will continue up to December 2016 (later if weather permits). The pollutants that are being monitored include: total phosphorus, dissolved phosphorus, total nitrogen, and total suspended solids. All samples were analyzed by the standard methods of the VT Department of Conservation Lab.

Discharge was measured at three points: within the Agri-drain water control structure, and at Filter A and Filter B outflows. The inflow is monitored using a pressure transducer installed within the control structure. Total discharge at the inflow will be the sum of inflow to Filter A, inflow to Filter B, and bypass flow over the top plate in the water control structure. Each of these flow components will be calculated using the stage data from the pressure transducer in conjunction with orifice and weir equations specific to each filter inlet and to the water control structure.

Water passing through the filter media flows via a system of underdrains into an open chamber in the same tank. The internal dimensions of this chamber are: 6.0 ft long, 1.5 ft wide, and 2.5 feet high. A 4-inch (10 cm) diameter Flout® manufactured by Rissy Plastics are installed in this chamber to periodically flush water from the chamber. A downward facing ultrasonic sensor installed in the Flout® chamber of each filter records continuous stage data. Each discharge cycle of the Flout® is recorded as a rapid decrease in the water level in the chamber. The outflow rate from each filter is calculated by multiplying the number of Flout® cycles in a given period of time by the average volume of each cycle.

All water samples were collected using ISCO 6712 autosamplers. The autosamplers are programmed to pump sample aliquots on a flow-proportional basis, sequentially filling four 10-L polyethylene carboys. When the first carboy is filled, the autosampler will begin dispensing sample aliquots to the second carboy, and so on until either the fourth carboy is filled or the sampling program is stopped. The bulk composite samples will be split in the field using a 14-L polyethylene churn splitter to obtain aliquots for chemical analysis. Each filled or partially filled carboy will be processed into sample splits, unless it contains insufficient sample, in which case the sample may be combined in the churn splitter with the volume of the previous carboy.

Each autosampler is connected to an ISCO 2105ci Interface Modules (a combination datalogger and modem). These modules record the time every sample aliquot is collected and transmit the sampling, stage, discharge, and other data to a computer server located at Stone's office in Montpelier, Vermont.

Results

Analytical Results

11/19/15	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	TN (ug/L)
IN	11.2	164	143	9.12
A	17.89	64.8	41.7	8.44
B	15.8	118	105	8.21
12/2/15				
IN	19.2	144	121	8.63
A	4.6	70.3	56.6	8.03
A2	4.6	44.2	18	8.6
B	6.2	115	97.8	8.29
B2	5.6	112	100	8.69
12/10/15				
IN	2.6	93.2	84	7.74
A	4.6	31.4	26.3	7.9
B	5.2	91.5	84	7.65
12/16/15				
IN1	28	197	120	6.69
IN2	44	271.5	193	4.72
IN3	16	167.8	143	5.24
IN4	6.2	153	127	6.72
A	6.4	64.4	35.7	7.81
B	2	89.9	83	7.07

Table 1. These are the raw data for the first sampling rounds. IN = inflow station; A = Filter A (Drinking water residuals); B = Filter B (limestone bedding). NOTE this data has not accounted for flow.

Event Mean Concentration

	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	TN (ug/L)
11/19/15				
A	17.9	65	42	8.4
B	15.8	118	105	8.2
12/2/15				
IN	19.2	144	121	8.6
A	4.6	59	40	8.3
B	5.9	114	99	8.5
12/10/15				
IN	2.6	93	84	7.7
A	4.6	31	26	7.9
B	5.2	92	84	7.7
12/16/15				
IN	26.1	204	149	5.7
A	6.4	64	36	7.8
B	2	90	83	7.1

Table 2. Concentration data adjusted for flow. IN = Inflow station; A = Filter A (Drinking water residuals); B = Filter B (limestone bedding). NOTE no adjusted concentration for IN on 11/19/15 due to the fact that only 50% of event was sampled.

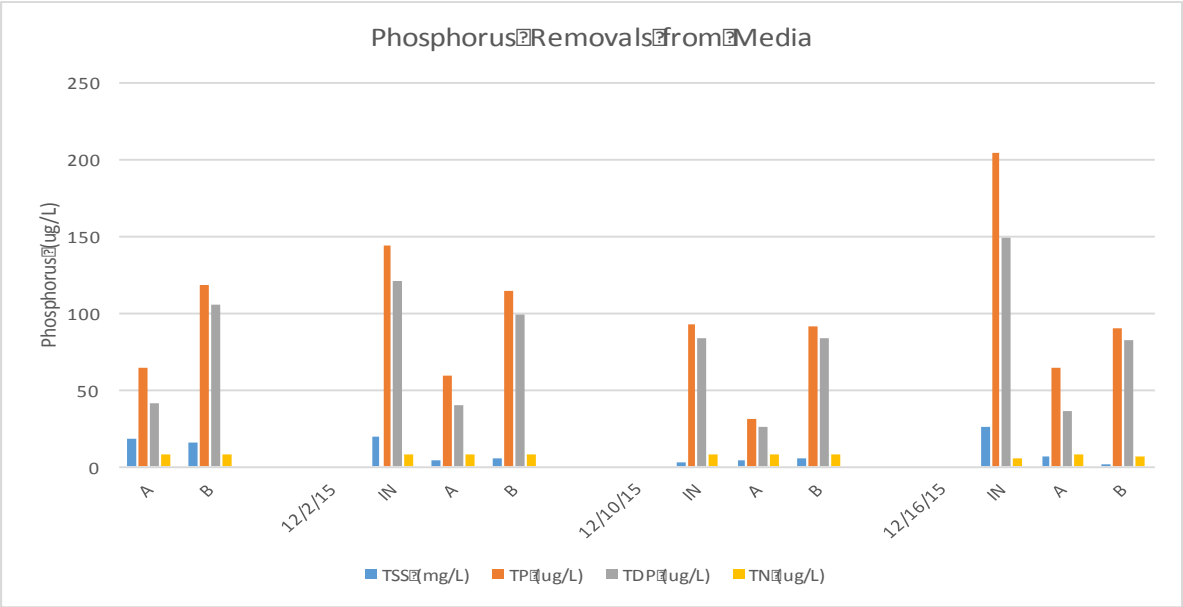

Figure 2. Flow proportional concentration data for: Inlet (IN), Drinking Water Residuals (A), and Limestone Bedding (B).

Percent Removals

	TSS (mg/L)	TP (ug/L)	TDP (ug/L)	TN (ug/L)
12/2/15				
A	76	59	67	4
B	69	21	18	2
12/10/15				
A	-77	66	69	-2
B	-100	2	0	1
12/16/15				
A	76	68	76	-37
B	92	56	44	-24

Table 3. Percent removal of phosphorus for each filter. NOTE: a negative sign indicates and increase.

As one can see from the figures above, Filter A (drinking water residuals) is more effective at removing phosphorus than Filter B (limestone bedding). Both media are showing promising results and we hope to gain a clearer picture with continued sampling efforts.