FINAL REPORT

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ASSESSMENT OF TILE DRAINAGE SYSTEMS IN ADDISON COUNTY AND THE JEWETT BROOK WATERSHED

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Executive Summary

In Vermont and across the Lake Champlain Basin, the extent of tile drainage systems and their potential impacts on water quality have not been adequately assessed. A previous study by Stone Environmental (Stone) for the Lake Champlain Basin Program in the Jewett Brook watershed in Franklin County (Braun et al. 2019) revealed that subsurface drainage systems in agricultural fields can discharge significant quantities of phosphorus (P). This project adds to the previous work by measuring nutrient and sediment concentrations and loads in tile drainage water in a second agricultural area, Addison County, and comparing these values with nutrient and sediment concentrations and loads measured in tile drains in the Jewett Brook watershed.

Ten agricultural tile drains were selected for monitoring, five in Addison County and five in the Jewett Brook watershed in Franklin County. Four out of five of the Addison County tile drains drain silage cornfields, and the fifth (ACT4) drains a hayfield. In the Jewett Brook watershed, monitoring begun in 2017 (described in Braun et al. 2019) was extended at five tile drains for an additional 16 months. Four of the Jewett Brook tile drains drain silage cornfields and one (JBT11) drains an alfalfa hayfield with low P inputs. All ten tile drainage systems are constructed of standard, perforated, corrugated drainpipe, installed 3-5 feet below the ground surface, arrayed in a pattern of parallel laterals. All were installed since 2006.

Flow-proportional composite samples were processed approximately weekly and analyzed for total phosphorus (TP), total dissolved phosphorus (TDP), total nitrogen (TN), and total suspended solids (TSS) concentrations. Across the 10 tile drains, median TP concentrations ranged from 20 – 570 µg/L (mean = 189 µg/L) and median TDP concentrations ranged from 9 – 208 µg/L (mean 81 µg/L). Concentrations in individual composite samples reveal even greater variability than do these site medians: across all sites, TP concentrations ranged from 11 – 3,193 µg/L (median = 120 µg/L) and TDP concentrations ranged from 6 – 1,735 µg/L (median 56 µg/L) in individual samples. These P concentrations are more comparable to ranges observed in Ontario (20 – 9,700 µg/L; Miller 1979), Ohio (110 – 300 µg/L; King 2014), and Wisconsin (80 – 1,780 µg/L; Madison et al. 2014) than to the few Lake Champlain Basin studies available (Benoit 1973, Young 2015, and Klaiber 2015).

The five Addison County tile drains selected for this monitoring study had significantly higher TP and TSS concentrations than the five Jewett Brook watershed tile drains, when grouped by county/watershed. Differences in TDP and TN concentrations were not significant. TP, TDP, TN, and TSS loads were all significantly higher in the Addison County tile drains than in the Jewett Brook watershed tile drains. The greater TP concentrations and TP and TDP loading from the Addison County tile drains could have resulted from a variety of factors (for example, differences in tile drain construction, agronomic history, and storm intensity and timing relative to nutrient application) that were not analyzed in detail in this study, given the relatively small number of tile drains representing each county/watershed. The overriding conclusion is that substantial P concentrations and loads in tile drainage water in the Lake Champlain Basin occur in Addison County and are not confined to tile drains in the Jewett Brook watershed.

An interesting exception to the pattern of nutrient and sediment concentrations and loading in the Addison County tile drains was the ACT1 tile drain, which drains a cornfield with loamy sand soils. The ACT1 tile drain delivered significantly lower concentrations and loads of TP, TDP, and TSS and higher concentrations of total nitrogen (TN) than the other Addison County tile drains, which have clay soils. We attribute these differences to differing soil texture.

P filters composed of reactive media have been shown to be effective in reducing total and dissolved P loading from agricultural tile drains prior to discharge to receiving waters (Braun 2017, McDowell et al. 2008, Penn et al. 2012, Bryant et al. 2012). Widespread adoption of tile drain P filters has the potential to reduce P loading to Lake Champlain and improve its water quality. For this project, Stone designed, constructed, and monitored two large, up-flow, gravity P filters in trenches excavated near the outlet of one of the monitored tile drains—JBT05—in St. Albans. The JBT05 P filters were constructed in October-November 2019, after the Addison County/Jewett Brook watershed tile drain monitoring program was completed. These P filters were able to treat substantial volumes of water, with flow rates up to approximately 250 L/min. Filter A contained only crushed Swanton black shale and reduced TP and TDP concentrations by about 40%, while Filter B contained crushed Swanton black shale, zero-valent iron shavings, and activated alumina beads and achieved ~60% reduction in TP and ~65% reduction in TDP concentrations and ~60% reductions in TP and TDP loads. The TP and TDP reduction efficiencies of both filters improved with increasing TP and TDP inflow concentrations.

Analysis of paired inflow/outflow data over 38 weeks of automated, flow-proportional, composite sample collection indicates a combined removal between the two filters of approximately 1.6 kg (3.5 lb.) of TP and 1.1 kg (2.4 lb.) of TDP. Since 2020 had an exceptionally dry summer and fall, with no tile drain flow for extended periods, greater P removal should be possible in most years. Furthermore, because the filters discharge to an agricultural ditch that was frequently backwatered, substantial bypass flow occurred. Similar filters constructed in less flood prone locations should treat a higher proportion of tile drain flow and remove more P.

We believe this project demonstrated that Stone's basic concept of developing large, in-ground, up-flow, gravity filters containing a coarse (~1/2-inch diameter) aggregate amended with one or more P sorbing materials to remove P from tile drainage water is sound. The analysis of P reduction efficiency indicated that reasonably consistent dissolved P removal occurred at inflow concentrations above 60 µg/L of TDP. This threshold may be a useful guide in selecting tile drains for implementation of P filters, until a more complete benefit-cost analysis is completed for the tile drain P filter evaluation Stone is now conducting in Lake Carmi watershed in Franklin, Vermont.

Assessment of Tile Drainage Systems in Addison County and the Jewett Brook Watershed

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1. Introduction

1.1. Background

Lake Champlain (Vermont – New York – Quebec) continues to suffer from the effects of excessive phosphorus (P) loading from sources in the Lake Champlain Basin (LCB). One factor that may contribute to the slow pace of progress in attaining 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. Vadas et al. (2007), Sims et al. (1998), Kleinman et al. (2003), Beauchemin et al. (2003), and King et al. (2014) all demonstrated that a considerable amount of P can be transported beneath the surface in tile drained fields.

Phosphorus concentrations in tile drainage water reported in the literature frequently exceed the U.S. EPA threshold of 100 µg/L for eutrophication in surface waters (U.S. EPA 1994). In the UK, total phosphorus (TP) concentrations exceeding 1000 µg/L have been observed in tile drainage water, with up to roughly 90% in dissolved form (Heckrath et al. 1995, Gardner et al. 2002). Algoazany et al. (2007) reported annual mean dissolved P concentrations of 86–194 µg/L in drainage water in Illinois. Kinley et al. (2007) reported mean concentrations of 230 µg/L TP and 60 µg/L dissolved P in drainage samples from cropland fields in Nova Scotia. Madison et al. (2014) measured average annual TP concentrations of 21–1300 µg/L in tile drainage from Wisconsin field sites.

Phosphorus exported from agricultural fields in tile drainage water can represent a significant component of overall nonpoint source P loads. In southern Quebec, Eastman (2008, 2010) reported TP loss in drainage water of 1.2 to 4.0 kg/ha, the same order of magnitude reported in surface runoff from agricultural fields. King et al. (2014) reported that tile drainage from an Ohio watershed contributed 0.48 kg/ha of TP, compared to an average annual watershed TP export of 0.98 kg/ha. Drainage water accounted for 47% of the dissolved P and 40% of the TP exported from the watershed. In Wisconsin, Madison et al. (2014) reported annual TP loads in tile drainage of 0.24–2.73 kg/ha, contributing 17 to 41% of all TP loss and up to 72% of dissolved P loss. Smith et al. (2015) documented that 49% of dissolved P and 48% of TP losses from Indiana research fields occurred via tile discharge.

Subsurface tile drainage is an essential agronomic practice on many agricultural fields, enabling timely equipment access, reduced soil compaction, and increased crop yields in fields otherwise too wet to efficiently farm. Tile drainage can provide significant environmental benefits, from reduced soil erosion to more efficient nutrient uptake by crops to enabling more timely application of conservation measures, because producers face fewer delays due to wet field conditions. By drawing down the water table and providing rapid conveyance of subsurface water to an outlet, tile drainage can significantly change the hydrologic behavior of a field, reducing surface runoff by enhancing infiltration and ground water transmission. We now know that, management remaining equal, the net result of reduced surface runoff P losses and increased subsurface P losses may be positive or negative, depending on the field and the year.

Although research is not yet conclusive on the factors driving P export via tile drains, characteristics that appear to enhance P loss include: the presence of macropores (e.g., soil cracks and worm holes), especially on clay soils (Beauchemin et al. 1998, Kleinman et al. 2003, Eastman 2010); high drainage flows associated with precipitation or snowmelt events (Gentry et al. 2007); excessive accumulations of P in soils (Beauchemin et al. 2003, Kinley et al. 2007, Toor and Sims 2015); and high nutrient inputs, especially manure applications to soils with high or excessive soil test P (Sims et al. 1998, Kinley et al. 2007).

In Vermont, as in much of the nation, the pace of tile drain installation has accelerated in recent years. As the area of systematically drained cropland rises, concern regarding nutrient losses and other water quality impacts related to tile drainage has increased. In the LCB, the extent of tile drainage systems and the potential impacts of tile drainage systems on water quality have not been adequately assessed. Recent research, including a previous study by Stone Environmental (Stone) for the Lake Champlain Basin Program (LCBP) in the Jewett Brook watershed in Franklin County (Braun et al. 2019), has revealed that subsurface drainage systems in agricultural fields can discharge significant quantities of P, and should thus be considered in management strategies seeking to minimize nonpoint source pollution of surface waters.

Beginning in the 1930’s, the USDA Soil Conservation Service, now the Natural Resources Conservation Service (NRCS), began developing conservation practices to reduce soil erosion and nutrient losses from cropland. Today we have 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. Currently, there is no national NRCS practice standard addressing phosphorus losses via tile drainage, although Vermont NRCS has a relevant standard (Phosphorus Removal System, Code 782), adopted in 2013.

Phosphorus removal systems installed at the outlets of tile drains that direct flow through filtering media can significantly reduce P loads to drainage ditches and receiving waters (Braun 2017, McDowell et al. 2008, Penn et al. 2012, Bryant et al. 2012). Widespread adoption of tile drain treatment systems has the potential to reduce P loading to Lake Champlain and improve its water quality.

1.2. Current Project

This tile drainage project had two parts. The first part was a monitoring program to improve our understanding of tile drainage system nutrient losses in the Lake Champlain Basin. We monitored five representative tile drainage systems in the Jewett Brook watershed in Franklin County and five in Addison County to measure nutrient and sediment concentrations and estimate nutrient and sediment mass loads in tile drainage water. The five tile drains monitored in the Jewett Brook watershed were selected from among 12 tile drains monitored from April

2017–April 2018 by Braun and others (2019), extending the monitoring period at these tile drains through August 2019.

The second part of this project involved the design, construction, and monitoring of tile drainage water treatment systems (or “P filters”). Such P filters can reduce P loading from agricultural tile drains prior to discharge to receiving waters. Stone has been working to develop suitable P filters for the last seven years. In this project, two large P filters containing reactive media were constructed near the outlet of one of the monitored tile drains—JBT05—in St. Albans. The JBT05 P filters were constructed in October-November 2019, after the Addison County/Jewett Brook watershed tile drain monitoring program was finished, and monitored through December 2020.

1.3. Project Objectives

The objectives of this project were:

- To characterize field areas drained by tile drainage systems selected for monitoring in Addison County and in the Jewett Brook watershed in Franklin County.
- To measure total and dissolved P concentrations and flow and calculate P loads from representative tile drainage systems in Addison County and in the Jewett Brook watershed in Franklin County.
- To characterize the distributions of total nitrogen and total suspended solids concentrations in drain flow from representative tile drainage systems in Addison County and in the Jewett Brook watershed in Franklin County.
- To design and construct two P filters and evaluate their performance in reducing total and dissolved P loading from an agricultural tile drain.

2. Tasks Completed

The following tasks were accomplished to meet the study objectives.

Project Review Committee: A Project Review Committee (PRC) was assembled to advise Stone in execution of this project. The PRC included representatives from LCBP, the University of Vermont, the University of Vermont Extension Service, the Vermont Agency of Agriculture, Food & Markets, and the Vermont Agency of Natural Resources. At an April 24, 2019 PRC meeting, Stone presented the selection and characterization of the Addison County tile drain sites as well as draft engineering plans for the tile drain P filters to be installed at the JBT05 site in St. Albans. Constructive feedback was received from PRC members regarding the P filter designs.

Prepare Quality Assurance Project Plan (QAPP): A primary data QAPP addressing the monitoring phases of the project was approved on November 21, 2018. This QAPP was amended to incorporate the P filter experiment. The amended QAPP (Version 2.0, Amendment 1) was approved on March 26, 2019. This QAPP is included as Appendix A.

Select and Characterize Tile Drainage Systems: In the Jewett Brook Watershed, 5 of the 12 tile drainage systems monitored during the original tile drainage assessment (Braun et al. 2019) were selected for continued monitoring in this project.

In Addison County, Stone conducted a comprehensive outreach effort to farmers and agricultural agents to identify tile drainage systems suitable for monitoring. Considering location, access, drainage area, and crop type, five tile drained fields were selected for monitoring that best met the objectives of the study. Stone submitted a report describing the selection and characterization of the Addison County tile drains, portions of which are incorporated in this final report. The tile drainage systems selected for monitoring are described in Section 3.

Collect Agronomic Data: Stone interviewed the participating farmers and recorded direct observations regarding farming activities. These results are presented in Section 3.

Install Monitoring Systems: Stone completed installation of the tile drain monitoring stations at the five Addison County sites. The stations were operational as of November 21, 2018. In the months prior, Stone made any repairs needed at the five continuing Jewett Brook watershed stations. This task is discussed in more detail in Section 4.

Perform Monitoring Activities: Stone monitored the selected tile drainage systems according to the project workplan and the approved primary data QAPP. The methods and results of this task are presented in Section 4 and Section 7. We estimate that field technicians made about 800 visits to the tile drain monitoring stations over the course of this project. A great deal of effort was expended collecting and processing flow data. The resulting tile drain hydrographs are included in Appendix B.

Sample Analysis: The Vermont Agriculture and Environmental Laboratory (VAEL) completed analysis of all water samples submitted in this study. The Agricultural and Environmental Testing Lab (AETL) at the University of Vermont and the Maine Agricultural and Forestry Experiment Station (MAFES) Lab at the University of Maine, Orono, completed analysis of all submitted soil samples. Approved water quality data are presented in Appendix C. Results of sol sample analyses are presented in Section 3.

Design and Construct P Filters: Stone designed and oversaw construction of two P filters at the JBT05 site in St. Albans. This task is described in Section 5. The as-built filter drawings are presented in Appendix D.

Maintain Facilities: Stone maintained the tile drain monitoring stations throughout the monitoring period and decommissioned the stations when monitoring was complete.

Prepare Reports: Stone submitted quarterly progress reports throughout this project. Stone also submitted an interim report describing the selection and characterization of the Addison County tile drains, the design and construction of the P filters, and the installation of the monitoring systems.

This final report covers aspects of site characterization, monitoring station installation and maintenance, design and construction of the P filters, monitoring activities, tile drain monitoring data, and an evaluation of the P filters.

3. Tile Drain Characterization

3.1. Selection of Jewett Brook Watershed Tile Drains for Continued Monitoring

Among the 12 tile drainage systems monitored during the original Jewett Brook watershed tile drainage assessment project (Braun et al. 2019), 5 were selected for continued monitoring. The Jewett Brook tile drains (“JBT”) where monitoring was extended were JBT05, JBT06, JBT07, JBT11, and JBT18. These tile drains and fields were described by Braun and others (2019) in LCBP Technical Report Number 92: https://lcbp-089519.s3.us-east-2.amazonaws.com/techreportPDF/92_20190830-Jewett-Brook-Tile-Drain-Assessment-Final-Report-Approved_web.pdf.

In most cases the decision to extend monitoring was based on the continued cooperation of the participating farmer. Three of the original study participants, accounting for six of the original JBT sites, declined to participate further. One monitoring station, JBT19, was eliminated from consideration due to heaving of soil into the monitoring manhole.

Although we had very little choice in which Jewett Brook watershed tile drains to select for continued monitoring, the selected set represent an interesting range of conditions. One permanent hay site (JBT11) was included and differences in the management of the four remaining crop fields provided representative agronomic variation.

3.2. Selection of Addison County Tile Drains and Study Fields

Stone conducted a comprehensive outreach effort to farmers and agricultural agents operating in Addison County to identify tile drainage systems suitable for monitoring. A meeting was organized in May 2018 with six Addison County farmers with tile drained cropland. During the meeting three farmers expressed a willingness to participate. These farmers were interviewed to identify specific tile drained fields under their management and site visits were then made to 11 fields. Considering location, access, drainage area, and crop type, five Addison County tile drainage systems, “ACT1” through “ACT5” (Figures 1 – 5), were selected for monitoring that best met the objectives of the study The ACT study fields included four cornfields and one hayfield. Stone secured access agreements with the three farmers managing the selected study fields.


Figure 1. ACT1 outlet


Figure 2. ACT2 outlet


Figure 3. ACT3 outlet


Figure 4. ACT4 outlet


Figure 5. ACT5 outlet

3.3. Characterization of Tile Drains and Study Fields

Data describing the tile drained fields selected for monitoring in Addison County and in the Jewett Brook watershed were obtained through field reconnaissance, interviews with participating farmers, review of nutrient management plans, and analysis of the USDA-NRCS SSURGO soils dataset. The extent of the drained area, the tile drain lateral spacing and depth, and the system construction and age were recorded from information provided by the participating farmer, as was information about the cropping system and inputs of manure and fertilizer. Soil type and slope class data were acquired from the SSURGO database. Soil test P data were assembled from nutrient management plans. Data describing the monitored tile drainage systems and study fields are presented in Table 1.

Table 1. Tile drainage system construction

Site	Year installed	Area (A)	Outlet diam. (in.)	Outlet position	Tile drain depth (ft)	Tile drain spacing (ft)	Surface inlets	Soil survey data % of area, soil type, slope, hydrologic group	Soil test P (ppm)
JBT05	2011	94	8	usually underwater	3-4	35	none known	30%: Kingsbury clay, 0-3%, D 30%: Massena stony loam, 0-3%, C/D 29%: Covington clay, D 10%: Georgia stony loam, 3-8%, C	2
JBT06	2014	91	12	surcharges	unknown	unknown	3 standpipes plus diversion inlet from neighboring field	51%: Covington clay, D 36%: Massena stony loam, 0-3%, C/D 7%: Kingsbury clay, 0-3%, D 6%: Georgia stony loam, 3-8%, C	n.d.
JBT07	2011	28	4	surcharges	3-4	40	none known	53%: Covington clay, D 37%: Kingsbury clay, 0-3%, D 10%: Massena stony loam, 0-3%, C/D	12
JBT11	2010	51	8	surcharges	3-4	40	none known	58%: Massena stony loam, 0-3%, C/D 16%: Georgia stony loam, 3-8%, C 15%: Georgia stony loam, 0-3%, C 11%: Covington clay, D	4
JBT18	2006	11	6	surcharges	3	80	none known	43%: Kingsbury clay, 0-3%, D 25%: Massena stony loam, 0-3%, C/D 17%: Georgia stony loam, 0-3%, C 15%: Covington clay, D	n.d.
ACT1	~2015	~40	6	on slope	3-5	25	none known	100%: Swanton FS loam, 0-3%, C/D	7
ACT2	~2013	~30	8	in ditch, will surcharge	3-5	25	none known	95%: Vergennes clay, 2-6%, D 5% Covington silty clay, 0-3%, D	3
ACT3	2017	~35	8	ditch	3-5	25	none known	90% Covington silty clay, 0-3%, D 10%: Vergennes clay, 2-6%, D	3
ACT4	2014	~25	6	in ditch, will surcharge	3-5	20	none known	90% Covington silty clay, 0-3%, D 10%: Vergennes clay, 2-6%, D	8
ACT5	~2014	~15	6	on slope	3-5	20	none known	80%: Vergennes clay, 2-6%, D 20% Vergennes clay, 12-25%, D	2

n.d. = no data available

The following sections describe critical aspects of the construction of the tile drainage systems as well as agronomic factors in the study fields. These sections refer to data presented in Tables 1 and 2.

3.4. Tile Drainage System Construction

3.4.1. Jewett Brook Watershed

The five JBT tile drains selected for continued monitoring are constructed of standard, perforated, corrugated drainpipe arrayed in a pattern of parallel laterals. They were installed since 2006 (Table 1). The outlets of these systems range in diameter from 4–12 inches.

The selected Jewett Brook watershed tile drains discharge to drainage ditches, close to the bottom of the ditch such that submergence of the outlet is common. The depths of the tile drains generally range from 3–4 feet below ground surface. The spacing of the laterals is in the typical range of 25–40 feet, except for JBT18, which has unusually wide, 80-foot spacing.

Surface water may enter subsurface drainage systems in a variety of ways, including standpipe inlets and rock inlets (French drains) constructed in field depressions, blind inlets, and diversions of concentrated flow from ditches, culverts, and roof drains into tile drain mains. Vermont’s Required Agricultural Practices (VAAFM 2018) distinguish between surface inlets and diversion structures. There are no known surface inlets or diversions to tile drains JBT05, JBT07, JBT11, or JBT18. However, JBT06 has a cluster of three standpipes connected to the underlying drainage system in a wet area at the south end of the field. It was recently revealed that there is another inlet at the southern end of the JBT06 field, a diversion which conveys both surface runoff and tile drain flow from a large, adjacent field in corn production.

3.4.2. Addison County

All five Addison County tile drainage systems selected for monitoring are constructed of standard, perforated, corrugated drainpipe arrayed in a pattern of parallel laterals. Tile drains were installed in all the study fields since 2013 (Table 1). The depths of the tile drains generally range from 3–5 feet below ground surface, with most in the 3–4-foot range. There do not appear to be any exceptionally shallow or deep tile drains. All five ACT tile drains have closely spaced laterals; the 20-foot lateral spacing in the ACT4 and ACT5 fields is unusually close in Vermont. The outlets of the ACT tile drains range in diameter from 6–8 inches; there are three 6-inch and two 8-inch diameter outlets. The ACT2 and ACT4 tile drains (Figures 2 and 4) discharge close to the bottom of drainage ditches, such that submergence is common. Submergence is not likely at the outlets of the remaining three tile drains.

There are no known surface inlets into any of the five tile drainage systems monitored in Addison County. In the ACT2 field there are several piped runoff diversions near the downslope end of the field; however, these discharge directly into the ditch, bypassing the tile drainage system.

3.5. Study Field Soil Types

3.5.1. Jewett Brook Watershed

Two soil complexes comprise most of the area of the Jewett Brook watershed study fields. These complexes are the Kingsbury-Covington clays and the Massena-Lyons stony loams. Kingsbury-Covington clays are the principal soils in four of the five fields (Table 1). Massena and Georgia stony loams are the principal soils in the JBT11 field.

Clays in the Kingsbury-Covington complex are deep and somewhat poorly drained to poorly drained (Flynn and Joslin 1979). They formed in water laid deposits of clay on old lake plains. Kingsbury soils are at a higher position in the landscape than Covington soils. Both soils have a seasonal high water table. Without drainage, crop production on Kingsbury-Covington soils may be limited by wetness due to their slow permeability.

Massena-Lyons soils are deep, level to gently sloping, somewhat poorly drained and poorly drained, loamy soils in depressional areas (Flynn and Joslin 1979). These soils formed in glacial till. Massena-Lyons soils have a seasonal high water table. Without drainage, crop production on Massena-Lyons soils may be limited by wetness and a high water table.

Georgia stony loam comprises 31 percent of field JBT11, 17 percent of JBT18, and 10 percent of JBT05. Georgia stony loams are moderately well drained (Flynn and Joslin 1979), in contrast to the predominant soils among the study fields. They formed in glaciated uplands in western Franklin County and are deep and stony or extremely stony.

3.5.2. Addison County

Three soil series comprise most of the area of the Addison County study fields. These soils are Vergennes clay, Covington silty clay, and Swanton fine sandy loam. Vergennes clay is the principal soil in two fields (ACT2 and ACT5), Covington silty clay in two fields (ACT3 and ACT4), and Swanton fine sandy loam in one field, ACT1 (Table 1). Vergennes and Covington clays in Addison County are deep and somewhat poorly drained to poorly drained (Griggs, 1971). As with the Kingsbury-Covington complex in Franklin County, Vergennes and Covington soils formed in water-laid deposits of clay on old lake plains. Covington soils are at a higher position in the landscape and are less sloped than Vergennes soils. Both soils have a seasonal high-water table. Without drainage, crop production on Vergennes and Covington soils may be limited by wetness due to their slow permeability.

ACT1 is the exception in this group of fields due to its sandy textured soils. Despite its sandy surface texture, the ACT1 field is considered somewhat poorly to poorly drained, because Swanton fine sandy loams form in depressional areas and are usually underlain by a layer of heavy clay. Tile drainage can increase crop production in these soils and prevent crop loss due to wetness.

3.6. Crop Production in Study Fields

Seven of the ten study fields (JBT05, JBT06, JBT07, ACT1, ACT2, ACT3, and ACT5) were in continuous silage corn production between 2017 and 2019 (Table 2). Two study fields, JBT11 and ACT4, were in continuous hay production: alfalfa/grass at JBT11 and grass at ACT4. The JBT18 field was seeded in 2016 for clover hay production, but was converted to organic corn production in 2018, then soybeans in 2019.

3.7. Soil Test Phosphorus Levels in Study Fields

The available soil test phosphorus concentration data presented in Table 1 were taken from nutrient management plans. The JBT07 field had a soil test P value of 12 ppm, in the high range but not considered excessive (University of Vermont Extension, 2020). The JBT05 and JBT11 fields had low to medium soil test P values.

The Addison County study field with the highest reported available phosphorus concentration was ACT4, the field in hay production. However, this concentration, 8 ppm, is not especially high, falling near the low end of the high soil test P range. Fields ACT2, ACT3, and ACT5 all had low to medium soil test P concentrations, and the P concentration at ACT1 is considered optimum from an agronomic standpoint.

3.8. Manure and Fertilizer Applications in Study Fields

Table 2 presents the available fertilizer and manure application data for the study fields for the period 2017-2019.

3.8.1. Jewett Brook Watershed

Liquid manure was usually injected in the JBT05 and JBT06 fields in the fall after the corn was chopped. However, manure was spread and incorporated in the spring of 2018 on both fields and again on JBT06 in 2019. At the JBT07 field, manure was apparently spread in the fall in 2016, not at all in 2017, both fall and spring in 2018, and only in spring in 2019.

Since the field was seeded in 2015 no manure was applied on the JBT11 hayfield until 2019.

3.8.2. Addison County

A small amount of starter fertilizer containing P was applied at planting on all the cornfields. The manure application methods of the three participating farmers on the study fields differed considerably. Manure application methods on the cornfields included fall surface application (ACT2 and ACT3) and fall injection (ACT5). To the best of our knowledge, these practices remained consistent between 2017 and 2019. At the ACT1 field, manure was spread in the spring of 2017, the fall of 2018, and the spring of 2019.

The one hayfield (ACT4) received three surface applications of manure in 2017; however, the participating farmer started injecting manure on this field in 2018.

Table 2. Agronomic data for the study fields

Site	Year	Crop	Fertilizer application	Manure application	Cover crop
JBT05	2016	silage corn	pop-up at plant	fall manure injection	winter rye
	2017	silage corn	pop-up at plant	fall manure spread ~10/10/17 and injected ~10/24/17 on portion	winter rye
	2018	silage corn	may have spread N ~6/20-29/18	spring manure incorporated	unknown
	2019	silage corn	unknown	fall manure spread ~12/15/19	NA
JBT06	2016	silage corn	pop-up at plant	fall manure injection	winter rye
	2017	silage corn	pop-up at plant	fall manure injection	winter rye
	2018	silage corn	N spread 6/20/18	spring manure ~4/24/18 - 5/1/18; fall manure on portion ~10/4-12/18	unknown
	2019	silage corn	unknown	spring manure ~6/11/19	NA
JBT07	2016	silage corn	5 gal/A pop-up at plant; 300 lb./A urea-ammonium sulfate-potash spread 7/4/16	fall: 6,000 gal/A spread	none
	2017	silage corn	10 gal/A starter + potash at plant; liquid N+P applied in summer	none	none
	2018	silage corn	200 lb./A urea applied 6/20/18	6,000 gal/A spread 5/16/18; fall manure spread before 12/2/18	none
	2019	silage corn	200 lb./A urea applied 7/10/19	6,000 gal/A manure spread ~6/5//19	none
JBT11	2016	continuous alfalfa hay	200 lb./A potash-ammonia sulfate-boron after 1st and 2nd cuts	none	NA
	2017	continuous alfalfa hay	250 lb./A potash-ammonia sulfate-boron after 1st and 2nd cuts	none	NA
	2018	continuous alfalfa hay	200 lb./A urea applied 7/6/18	none	NA
	2019	continuous alfalfa hay	200 lb./A urea applied 7/13/19	5,000 gal/A manure spread 7/15/18 & ~8/22/19	NA
JBT18	2016	hay (grass/clover)	no P	12 ton/A liquid in mid-May	NA
	2017	hay (grass/clover)	no P	none	NA

Site	Year	Crop	Fertilizer application	Manure application	Cover crop
	2018	silage corn	100 lb./A urea applied 7/13/18	0.5 -1.0 ton/A composted chicken manure spread 5/20/18	none
	2019	soybeans	none	none	NA
ACT1	2017	silage corn	starter at plant	spring manure	winter rye
	2018	silage corn	unknown	fall manure	grass
	2019	silage corn	unknown	spring manure before 4/10/19	NA
ACT2	2017	silage corn	starter at plant	fall spread, no-till	winter rye
	2018	silage corn	unknown	fall spread before 11/29/18 (multiple dates?)	grass
	2019	silage corn	unknown	fall spread before 10/16/19 (multiple dates?)	NA
ACT3	2017	silage corn	starter at plant	fall spread, no-till	winter rye
	2018	silage corn	unknown	fall manure?	grass
	2019	silage corn	unknown	fall (~10/8/19)	NA
ACT4	2017	hay (grass)	none	fall: 3 applications	NA
	2018	hay (grass)	urea in spring	injected	NA
	2019	hay (grass)	urea in spring	injected ~7/18/19	NA
ACT5	2017	silage corn	starter at plant	fall injection	triticale
	2018	silage corn	starter at plant	fall injection	winter wheat
	2019	silage corn	starter at plant	fall injection	NA

3.9. JBT05 Field Soil Characterization

Further characterization of the JBT05 field in St. Albans was warranted because the JBT05 tile drainage system was chosen as the site of the tile drain P filters. At the JBT05 field, soil physical and chemical properties data were obtained through soil sample collection and analysis. Soil samples were collected on June 19, 2019. The study field was sectioned in two portions, a lower section comprised of clay soils (mapped as Covington and Kingsbury clays) and an upland section comprised of loam soils (mapped as Massena and Georgia stony loams). A representative composite sample was collected from each section.

Soil samples from the 0–15 cm depth were collected at nodes in a sampling grid (Figure 6) using a stainless-steel soil probe. Individual soil samples were blended in a bucket using a garden trowel. The trowel was used to transfer approximately two cups (0.5 L) of the composited sample into a labelled polyethylene bag. Soil samples were held under ambient conditions and transported to the Agricultural and Environmental Testing Laboratory at UVM in Burlington, VT. Samples were analyzed for pH and cation exchange capacity. Available macronutrients and micronutrients were analyzed following extraction in modified Morgan solution. Organic matter was quantified by the loss on ignition method and reported in Walkley-Black method equivalents. Soil particle size was analyzed by wet sieving and the hydrometer method.

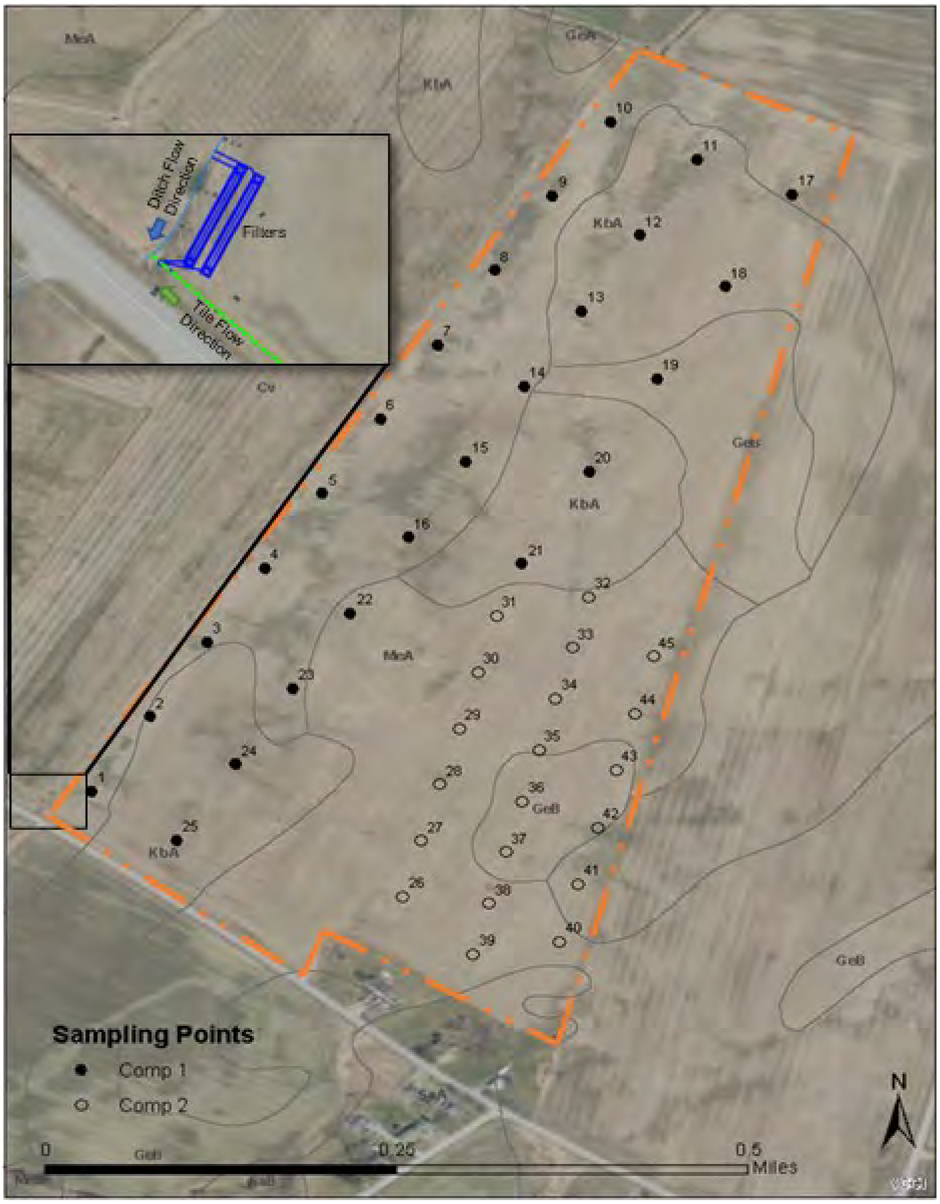


Figure 6. Soil sampling locations in the JBT05 study field

Soils data for the JBT05 study field are presented in Table 3.

Table 3. Soil characterization of the JBT05 study field

	Optimum range or Average value[1]	Composite 2 sample	Composite 1 sample	Composite 1 (dupe)	Composite 1 (mean)
Texture class	NA	Loam	Clay loam	Clay loam	Clay loam
Particle size analysis					
Sand %	NA	36.1	25.0	25.2	25.1
Silt %	NA	38.7	37.5	37.7	37.6
Clay %	NA	25.2	37.5	37.1	37.3
Soil pH (2:1, water)		6.4	6.9	6.9	6.9
Macronutrients					
Phosphorus (ppm)	4 - 7	16.6	19.4	15.6	17.5
Potassium (ppm)	100-130	408	277	288	283
Calcium (ppm)	**	2029	2988	2923	2956
Magnesium (ppm)	50-100	330	520	522	521
Sulfur (ppm)	11*	15	16	19	18
Micronutrients					
Iron (ppm)	7.0*	2.8	4.3	5.1	4.7
Manganese (ppm)	8.0*	6.6	6.1	6.6	6.4
Boron (ppm)	0.3*	0.5	0.5	0.5	0.5
Copper (ppm)	0.3*	1.7	1.5	1.7	1.6
Zinc (ppm)	2.0*	1.5	1.8	1.6	1.7
Sodium (ppm)	20*	45.0	45.0	46.0	45.5
Aluminum (ppm)	35*	11	12	13	12.5
Soil Organic Matter (%)	**	4.5	4.8	5.1	5.0
Effective CEC (meq/100g)	**	13.9	20.0	19.7	19.9
Base Saturation					
Calcium Saturation (%)	40-80	68.8	74.8	74.2	74.5
Potassium Saturation (%)	2.0-7.0	7.1	3.6	3.7	3.7
Magnesium Saturation (%)	10-30	18.7	21.7	22.1	21.9

1. From *Nutrient Recommendations for Field Crops in Vermont* (University of Vermont Extension, 2020)

* Micronutrient and sulfur deficiencies are rare in Vermont and optimum ranges are not defined; thus, average values in Vermont soils are shown instead.

** Ranges shown are for Field Crops; Vegetable ranges are higher. Ranges for calcium, organic matter, and effective CEC vary with soil type and crop.

4. Tile Drain Monitoring Methods

4.1. Installation of Monitoring Systems

The Jewett Brook watershed and Addison County tile drain monitoring stations were nearly identical. The only important exceptions were the flow monitoring systems at JBT06 and ACT3. Aside from these exceptions, which are described in Sections 4.1.1 and 4.1.2, the following general description applies to all the JBT and ACT stations.

Monitoring manholes, instrument shelters, and solar panels were installed at each site. Manholes were constructed by excavating to a depth ~2 feet below the tile drain line, cutting out a section of the existing pipe, attaching a rigid pipe trap on the incoming tile line, and installing a 36-inch diameter, double walled culvert vertically over the pipe trap. The vertical culvert was notched to fit over the incoming and outgoing pipes. The outgoing pipe is the existing tile line, which remains at its pre-construction elevation. The pipe trap ensures that water flows into the manhole under full-pipe conditions. Drainage stone and soil were backfilled around the manhole up to grade. A plywood cover was placed over the manhole for safety purposes.

Figure 7. 8-inch Waterflux 3000 flowmeter in JBT11 manhole

All stations except JBT06 and ACT3 were equipped with Waterflux 3000 electromagnetic flowmeters (Figure 7). Each Waterflux 3000 flowmeter was cabled to a Krohne IFC-100W signal converter, which processes electrical signals into meaningful flow data. The signal converter was connected to an ISCO 2105ci datalogger/modem for continuous storage and transmission of flow data and to an ISCO 6712 autosampler for collection of flow-paced composite water samples. The wiring and programming of these instruments were highly customized for this monitoring application.

In each monitoring shelter (Figure 8), an ISCO 6712 autosampler was mounted on a custom manifold consisting of funnels and hoses to dispense water to a carousel of four 10-L carboys. Sample lines were run into the monitoring manhole. The flowmeters were programmed to transmit an electrical pulse to the autosampler for every 100 liters that passed through the tile line. The autosamplers were programmed to dispense 95-mL aliquots of sample to the carboys upon receiving a specific number of electrical pulses. The sampling interval was set with the goal of collecting between 2 L and 20 L of sample at each station during a week-long sampling period.

Figure 8. JBT11 monitoring station

ISCO 2105ci modems were programmed to transit flow and sampling data to a computer server at Stone's office in Montpelier. Each modem has a static IP address, allowing two-way communication and remote control of the autosampler. These data were checked periodically to assess whether the monitoring systems were working as intended.

The ACT stations were installed and operational as of November 21, 2018. Any repairs and maintenance needed at the five continuing JBT stations were performed in the months prior.

4.1.1. JBT06 flow monitoring

Due to the large (12-inch) diameter of the JBT06 tile drain main, it was not feasible to install a pipe trap for an electromagnetic flowmeter or a manhole over the pipeline. Therefore, a different type of access structure was designed, a large plywood box (8 ft. long x 4 ft. x 4 ft.) containing a 90-degree V weir. The long dimension of the box was installed in-line with the tile drain. A 6-ft. long section of the tile drain was cut out and the box was constructed to span the gap. The end walls of the box were notched to accommodate the ends of the pipe. A plywood, 90-degree V weir plate was installed in the box and sheet metal strips were affixed to it to form a sharp crested, 90-degree V weir. The notch in the weir was approximately 3 inches (8 cm) higher than the invert of the outgoing pipe. A hatch was constructed on the top of the weir box for access and installation of monitoring instruments.

An ISCO 2110 ultrasonic flowmeter was installed for continuous measurement of water level. The stated accuracy of this instrument is the greater of ±0.00396 m or 0.00256 m per foot (0.305 m) from the calibration point. The sensor for this flowmeter was installed on a bracket on the upstream side of the weir, over the water surface. The flowmeter computes discharge from measured water level using a rating equation developed for this structure. Based on 32 paired, manual measurements of stage and flow rate made between 2017-2019, a rating equation was developed to compute flow rate from continuously recorded stage data. This rating provides a slightly improved estimate of flow rate as compared with the standard equation for a 90°V weir. The rating equation was programmed in the 2110 flowmeter to enable accurate computation of flow. The standard 90°V weir equation (from Teledyne ISCO, 2013) and our empirically derived rating equation are:

90°V weir equation: Flow rate (L/s) = $(\text{stage in cm}/5.5469)^{2.5}$
Rating equation: Flow rate (L/s) = $(\text{stage in cm}/5.072)^{2.7367}$

The ISCO 2110 flowmeter was connected to an ISCO 2105ci datalogger/modem for continuous recording and transmission of flow data. The 2105ci modem/logger was also wired to an ISCO 6712 autosampler enabling collection of flow-paced composite samples.

4.1.2. ACT3 flow monitoring

ACT3 was monitored differently because the outlet does not become submerged. At ACT3, flow was measured using a 15-inch Thelmar weir and an ISCO 2110 ultrasonic level sensor mounted within the monitoring manhole. The sensor was installed on a bracket on the upstream side of the weir, over the water surface. The ISCO 2110 flowmeter computes discharge from measured water level using a weir equation, while an ISCO 2105ci datalogger/modem transmits flow data to Stone and enables a connected ISCO 6712 autosampler to collect flow-paced composite samples.

4.2. Monitoring Activities

Monitoring activities were performed in accordance with the project Quality Assurance Project Plan, Version 2.0, Amendment 1 (Appendix A). At the Jewett Brook watershed sites, monitoring continued from May 2018 through August 2019 (16 months). Monitoring of the Addison County tile drain sites was initiated in November 2018 and continued through November 2019.

Flow-proportional sampling is challenging because flow rates are highly variable and difficult to predict. If sample aliquot collection is too infrequent (e.g., in small flow events), insufficient sample volume may be collected to perform the intended analyses. If sample aliquots are collected too frequently (e.g., in an unexpectedly large flow event), the bulk sample container may not have the capacity to contain samples over the entire event, resulting in a non-representative sample. To minimize the occurrence of under-sampling and overfilling, a two-part program was used whereby the autosampler pumps sample aliquots to two sets of containers at different intervals of accumulated flow. Each bottle set consisted of two 10-L polyethylene carboys. The first bottle set (Set A) was intended to capture a representative sample at low flow rates and the second bottle set (Set B) was intended to capture a representative sample at high flow rates. Set B was filled at approximately one tenth the frequency of Set A. The second bottle in each set was filled only after the first became full, at the same frequency as the first.

Sampling personnel selected either Set A or Set B for analysis, but not both sets. Any sample in the bottle set not chosen was discarded. If the combined volume of Set A was less than ~14 L, Set A was processed, and Set B was discarded. If the combined volume of Set A was greater than 14 L, Set B was processed, and Set A was discarded.

In most events, only the first bottle in the selected bottle set contained sample. However, if both bottles #1 and #2 in the selected set contained sample, the sample volumes were combined in the large capacity (14-L) churn splitter used to obtain sample splits (Figure 9), unless doing so would exceed the capacity of the churn splitter. If greater than 14 L was collected in total in the selected bottle set, then bottles #1 and #2 were processed independently. Split samples from both bottles were submitted for analysis to allow calculation of total P flux.

Adjustments to the autosampler programs to increase or decrease the sampling frequency were made either directly or via remote access. Failure of the system to collect at least three sample aliquots in bottle Set A during a weekly period or exceeding the capacity of all sample bottles in Set B typically resulted in rejection of the sample as non-representative.

At each of the monitored tile drains, flow was recorded continuously, and flow-proportional composite water samples were collected approximately weekly to provide TP, TDP, TN, and TSS concentration data representing the preceding period.

Over the winter months, grab samples were collected approximately weekly from December 2018 until early April 2019, at which time flow-paced composite sampling was resumed.

Collected water samples were transported on ice to VAEL within the stated holding times for each analyte. Samples were tracked using a Chain of Custody form that was completed by the sampler and accompanied all water samples delivered to VAEL. Once the water samples were accepted by VAEL, they were subject to the lab's internal tracking system.

Figure 9. Processing a composite water sample

4.2.1. Challenges Encountered

Short days, cold temperatures, and snow accumulation on the solar panels caused periodic low voltage problems and power outages at ACT2 from November 21–29, 2018 and at JBT11 from December 1–7, 2018. A second battery and extra solar panel were installed at JBT11 and the solar panel at ACT2 was relocated. No power outages occurred after these adjustments. After heavy snowfall, additional site visits were required to clear the solar panels.

The flowmeter at the JBT05 site began malfunctioning on February 2, 2019. The cause of the periodic, erratic readings was not readily apparent. Ultimately, we needed to wait until water levels in the monitoring manhole dropped enough to allow removal of the submerged flow tube. The flow tube was removed on March 21, 2019 and found to be irrevocably damaged. Delivery of a replacement flow tube from the Netherlands was slow. In the interim, an ISCO 2150 Area-Velocity flowmeter was installed in the manhole outlet pipe to record flow velocity. In evaluating the resulting JBT05 flow dataset, we determined that enough of the data were either missing or potentially erroneous that the JBT05 flow data should be excluded from the analyses.

The ground surrounding the JBT18 monitoring manhole eroded badly in the winter of 2018-2019. Despite our repeated visits to shore up the manhole by hand, the farmer ultimately removed the manhole and the instrument shelter and regraded the edge of the field, prematurely ending monitoring of this site.

4.3. Water Sample Analysis

Water samples were analyzed according to VAEL's standard methods. These methods and relevant data quality objectives, assessment procedures, and reporting limits are described in VAEL's Quality Systems Manual, Revision 23, dated December 18, 2015. The methods of analysis are summarized in Table 4.

Table 4. Water analysis methods

Analyte	Lab	Method
TP	VAEL	4500-P H
TDP	VAEL	4500-P H
TN	VAEL	4500-N C-modified
TSS	VAEL	2540-D

References: Standard Methods for the Examination of Water and Wastewater; 21st Ed. 2005.

Approved analytical data for the ACT and JBT tile drain monitoring stations are included in Appendix C.

4.4. Monitoring Station Maintenance

Regular maintenance of the monitoring stations and instruments minimized the incidence of instrument malfunctions and other problems. Certain basic maintenance activities were conducted after each sampling event, to clean bulk sample containers, churn splitters, and sampler lines and to reset the autosampler. Routine maintenance included checking/replacing instrument desiccant and clearing vegetation from around the stations.

Monitoring station readiness was assessed through routine (minimum of twice weekly) review of flowmeter, autosampler, and battery voltage data transmitted in near real-time to Stone’s computer server. Several important and not uncommon problems may be detected remotely and quickly using these data, for example, sampler error messages, erroneous autosampling attempts, and low battery voltage. Early detection of these problem conditions enabled timely response by sampling technicians to visit the monitoring station in question and correct the problem. Non-routine maintenance included clearing snow from solar panels, swapping in charged batteries when necessary, resetting autosampler programs, and troubleshooting cellular modems.

5. P Filter Design, Construction, and Monitoring

The proposed design for the P filters to be constructed at the JBT05 site were distributed to the PRC in April 2019. These designs were informed by literature review, discussions with other scientists and engineers, and benchtop experiments conducted by Stone, which are described below. Several design changes were made in response to feedback from the PRC. The P filters were installed in October-November 2019. As-built design drawings for the P filters are included as Appendix D.

5.1. Summary of Benchtop Experiments

5.1.1. Model P Filter Testing

A benchtop experiment was conducted using heavy duty gear sleds filled with porous media to model P filter trenches. Three benchtop filters were assembled. Short sections of 4-inch diameter perforated drainpipe were placed at either end of the sleds to distribute water and collect it at the opposite end after passage through the media. These pipes spanned the “length” of the filter, 73 cm. The sections of 4-inch diameter pipe in each sled were parallel and at the same elevation, allowing water to flow laterally through the media to the collection pipe. The filter “width” between the distribution and collection pipes (center to center) was 81 cm. A collection barrel was placed at the outlet of each filter and a pump was used to recirculate water from the collection barrel up to the distribution pipe. Figure 10 shows the constructed filters.

200 L of Montpelier tapwater was added to each collection barrel and circulated through the filter. The P concentration of the added water was negligible (<10 µg/L), and its pH was approximately neutral. A float switch in each collection barrel turned on the pump when the water level rose above a preset level. The pumps have a flow rate of 18.5 L per minute. A gate valve on the outlet pipe was partially closed during normal operation to restrict the flow rate of each filter to approximately 3 L per minute. With the pump shut off and the outlet valve open, each filter retained approximately 40 L of water below the level of the outlet pipe, leaving 160 L in the barrel. The filters were covered with plastic sheeting to reduce evaporation; however small water volumes were occasionally added to maintain the volume in each filter system (filter plus barrel) at approximately 200 L.

The volume of saturated media between the distribution and collection pipes (the effective media volume) was approximately 3.9 cubic feet (0.11 m^3). The media used in each filter was as follows:

1. PEA filter: washed ½-inch diameter pea gravel (the control)
2. AA filter: washed ½-inch diameter pea gravel with ~5% (by volume) activated alumina beads

3. SGB filter: crushed Swanton black shale screened to ¾ inch minus and rescreened by hand using ¼-inch hardware cloth to remove fines

The porosity (0.34) and hydraulic conductivity of the pea gravel were tested to aid in design of the full-scale filters. The hydraulic conductivity was high, 3.9 cm/s (0.15 ft/s), which indicated that ½-inch diameter stone should be suitable for use in subsurface P filters.

Figure 10. Three filter sleds recirculating P solution

5.1.1.1. P removal

On April 28, 2019, the filter sled experiment was begun by adding P to the collection barrel for each filter. Between April 28 and May 26, a target P concentration of 350 µg/L was maintained through regular additions of P. The 350 µg/L influent P concentration was intended to simulate a slightly elevated, but not unreasonably high, tile drainage water P concentration. For comparison, the annual flow-weighted average TP concentration of tile drainage water from the JBT05 tile drain was 197 µg/L during the 2017-2018 monitoring period.

Daily or twice daily P additions were made to bring the concentration of the recirculating water back to approximately 350 µg/L. The P concentration in the collection barrel was measured using a HACH DR 900 Multiparameter Colorimeter and PhosVER3 reagent. Note that the P fraction measured according to this method is total (unfiltered) reactive P. The mass of P required to return the P concentration to 350 µg/L was calculated based on the instantaneous P concentration in the collection barrel (assuming a system water volume of 200 L), and the appropriate amount of 316.0 mg/L, or later 2,686 mg/L, P solution was weighed and added to the collection barrel. Note that on May 7, 2019, a more concentrated stock solution was mistakenly added; the P additions on this date were approximately eight times the intended additions.

Beginning on May 26, 2019, a target P concentration of 3,000 µg/L was used. This higher concentration was used to gain a better understanding of the sorption capacities of the media within a reasonable period of time. Figure 11 shows the cumulative addition of P to each filter.

Our findings from this experiment were:

1. The PEA control filter removed essentially all the first addition of P (68 mg P) within the first 16 hours of operation, as did the AA and SGB filters. However, although the PEA filter continued to remove some P even six weeks into the experiment, its performance was poor. After the second day of the experiment, the concentration of the PEA filter outflow never fell below 230 µg/L. The total P mass removed over the experiment was less than 2 g.
2. The AA and SGB filters continued to sorb P for the duration of the experiment. P removal by the AA and SGB filters was similar though the first month of the experiment; however, the removal rates diverged in the second half of the experiment, with the AA filter removing more P mass than the SGB filter. The total amount of P sorbed by the AA filter (7.0 g) exceeded the amount sorbed by the SGB filter (5.2 g).
3. While the P sorption capacities of the SGB and AA media were not exhausted, the P removal efficiencies of both media declined over the course of the experiment. Following P additions on May 26, it took less than 24 hours for P concentrations to decline from 3,000 µg/L to 500–600 µg/L. Whereas, following P additions on June 17, it took 18 days of continuous recirculation for P concentrations to decline from 3,000 µg/L to 300–400 µg/L.

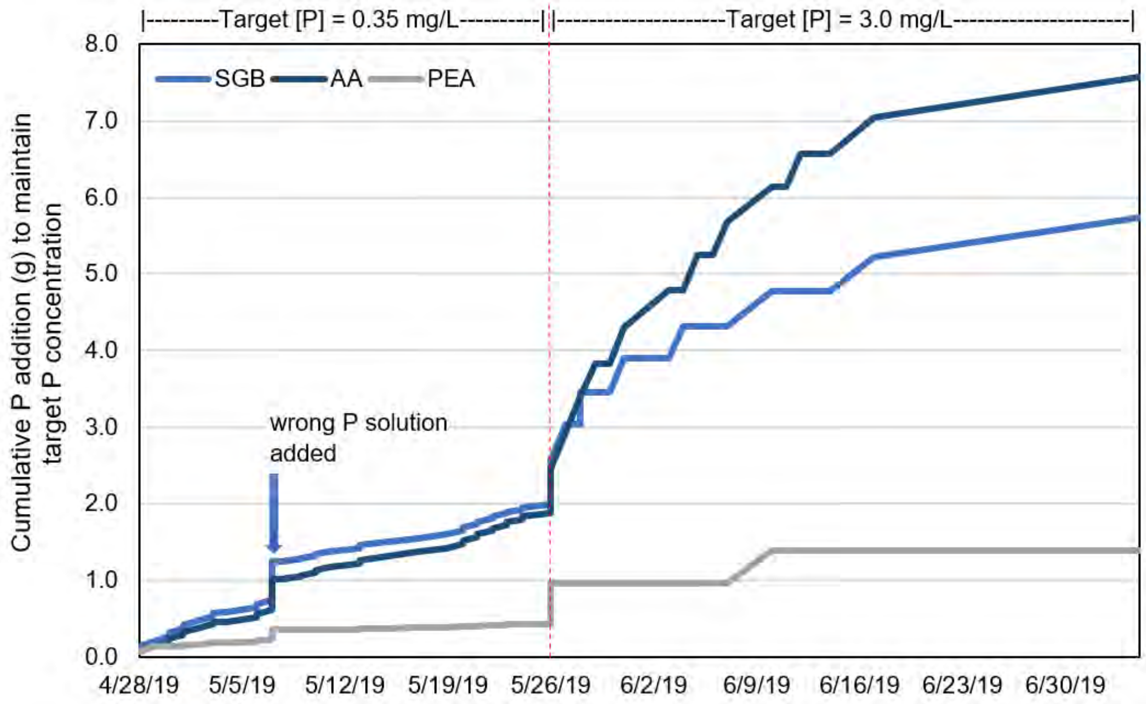


Figure 11. Cumulative P additions to benchtop media filters

5.1.1.2. pH and Conductivity

The pH of the recirculating P solution was tested periodically to identify any substantial effects of the media. The pH of the SGB water was slightly lower (range 7.1–8.1) than the pH of the AA water (7.9–8.4) and the PEA water (8.1–8.4). None of these readings suggested a concern for receiving water quality. Specific conductance was measured on one date, June 19, 2019, after water had cycled through the filters continuously for 52 days. The specific conductance of the

PEA water (366 µS/cm) and the AA water (301 µS/cm) were low; however, water in the SGB filter had substantially elevated specific conductance, 2,430 µS/cm. The Swanton black shale appears to confer greater electrical conductivity on water passing through it.

5.1.2. Jar Testing of Drinking Water Treatment Residuals

Drinking water treatment residuals (DWTR) produced by the Champlain Water District have been shown to have impressive P sorption potential (ex., Braun 2017). From our experience, the difficulty with this material is that its fine particle size precludes its use in filters with high flow rates, such as the tile drain filters designed in this study. Therefore, we have begun to examine ways to combine this material with more conductive aggregates. Jar testing was conducted to provide relative information on the amount of P retained by different combinations of aggregate type, binding agent, and amount of DWTR. We found that 1) DWTR alone, 2) Portland cement coated on pea gravel aggregate, and 3) Portland cement and DWTR coated on pea gravel aggregate all appeared to provide rapid removal of dissolved P. An adhesive product we tested to bind DWTR to stone reduced the effectiveness of the DWTR and was difficult to use. Even applied sparingly, the adhesive drained to the bottom of the jar and set in a hard mass.

In this study we were not able to solve the problem of how to produce a suitable media incorporating DWTR in quantities sufficient for use in full-scale filters. However, Stone recently constructed a P filter to treat stormwater pond outflow that consists of 8% DWTR (by volume) mixed in well-graded ½-inch Swanton black shale. The DWTR adhered adequately to the wet stone during mixing and installation. Data describing performance of this stormwater pond outflow P filter are in development.

5.2. P Filter Design and Construction

Stone designed two large, in-ground filters to remove P from tile drainage water at the JBT05 site, one filter (“Filter A”) containing Swanton black shale and a second, nearly identical filter (“Filter B”) containing Swanton black shale amended with activated alumina beads and elemental (zero-valent) iron shavings (Appendix D). Tile drain flow was split between the two filters. This side-by-side comparison provided information about the performance of Swanton black shale by itself and whether the addition of P sorbing amendments to Swanton black shale can be a cost-effective strategy for removing P from drainage waters.

Anticipated flow rates, media hydraulic conductivity, water residence time, and practical filter size were fundamental considerations in the filter design process. The filters needed to be large because the JBT05 system drains a very large field, approximately 94 acres. Flow rates at the JBT05 tile drain outlet ranged from zero to 1,800 L/min over the year-long monitoring period (April 2017-April 2018) in the original Jewett Brook watershed tile drain study (Braun et al. 2019). The filter dimensions we ultimately specified were the practical upper size limit we could construct in this study. We assumed a design flow rate of 250 L/min per filter, or 500 L/min total, beyond which water would begin to bypass the filters. Approximately 67% of the cumulative flow volume during the April 2017–April 2018 monitoring period occurred at flow rates of 500 L/min or less. At the 250 L/min per filter design flow rate, the estimated contact time of water in the filter media was 20 minutes.

Each filter was constructed in a 5-ft. wide trench excavated ~3.0 ft. below the elevation of the tile drain invert (Figure 12). The filter trenches were excavated perpendicular to the tile drain main line and parallel with a drainage ditch and with each other. The trenches were lined with

10-mil plastic. A 6-inch diameter, perforated pipe running along the bottom of the trench was installed as a sediment collector, to enable cleanout of sediments using a pump or sewer jet.

Drainage water was diverted from the JBT05 tile drain at the existing monitoring manhole, located immediately upstream of the existing tile drain outlet. In this manhole, tile drain flow was split between Filter A, Filter B, and a normally dry bypass pipe. The bypass pipe was the existing 8-inch diameter tile drain outlet to the receiving ditch. A 45-degree fitting, oriented upwards, was attached to the outflow pipe, which raised the elevation of the overflow about eight inches.

Parallel, 6-inch diameter perforated pipes installed near the bottom of each filter close to either trench wall distribute the drainage water. These distribution pipes were set ~2.3 ft. below the elevation of the tile drain invert. The distribution pipes were covered with 2.1 ft. of media. Two parallel, 6-inch diameter perforated collection pipes were installed over the media bed, and more media was added to cover the collection pipes. The filter was covered in 10-mil plastic and the trenches were backfilled with native soil, mounding excess soil to avoid surface runoff and ponding over the filters.

Drainage water flows out the perforations in the distribution pipes, up through the media bed, and into the collection pipes, which discharge to a monitoring manhole at the end of the filter (Figure 14). Treated water then flows from the monitoring manhole through a pipe to the receiving ditch. Both filter outlets and the bypass pipe from the JBT05 manhole are typically submerged in the receiving ditch.

Figure 12. Excavating trench for Filter B

Figure 13. Spreading and raking in activated alumina and iron

The rate of flow through the filter can be controlled by opening and closing valves installed at the outlets of the collection pipes.

Figure 14. View down filter outlet manhole

5.2.1. Filter Media

We used crushed Swanton black shale in both JBT05 filters because it is a locally available, inexpensive stone with acceptable hydraulic properties and the capacity to remove some P. This material was generously donated from the Swanton Limestone quarry by Rock Dust Local, a private company based in Bridport, Vermont. While our benchtop testing suggested that the P sorption capacity of a filter composed only of Swanton black would be inadequate to achieve substantial P reductions over the long term, we concluded that good P removal might be achieved at reasonable cost by amending Swanton black shale with complementary materials with higher P sorption rates.

The Swanton black shale used in both filters was graded to ~1/2-inch by screening the crushed stone between 9/16-inch and 7/16-inch screens, removing most fines. Filter A contains 100% Swanton black shale. In Filter B, the Swanton black shale was mixed with 3/16-inch activated alumina beads and ground, zero-valent (elemental) iron shavings. The P sorption achieved by the activated alumina in our benchtop testing was impressive considering the relatively small quantity used (5% by volume). Zero-valent iron has been shown to be a strong P sorbent in stormwater bioretention area media, although two designers cautioned me to use it sparingly to avoid hardening of the media mixture. In Filter B, the activated alumina and iron were added to the stone in successive lifts and raked in (Figure 13). Table 5 summarizes the composition of the filters by volume.

Table 5. Filter media

	Filter A	Filter B
Media	100% Swanton black shale (60 tons)	90% Swanton black shale (55 tons) 8% activated alumina (2,700 lb.) 2% elemental iron (2,000 lb.)

5.2.2. Filter Construction Cost

The total cost of construction, excluding engineering, was $5,000 for Filter A and $11,000 for Filter B (Table 6). The $6,000 cost difference between the filters was the cost of the iron and activated alumina.

Table 6. P filter construction cost

Component	Filter A		Filter B	
Filter media	Swanton black shale	$0	Swanton black shale Activated alumina Zero valent iron	$0 $4,270 $1,740
Pipe and fittings		$1,810		$1,810
Excavation/construction		$3,210		$3,210
Total		**$5,020**		**$11,030**

5.3. Monitoring the P Filters

Upon completion of the JBT05 P filters in November 2019, monitoring of the JBT05 tile drain resumed and monitoring of the P filter outlets began and continued through December 2020. Monitoring activities were consistent with the tile drain monitoring methods described in Section 4, except for modifications we made to extend the period of flow-proportional composite sampling into the winter months. These included installing custom racks to suspend the autosamplers inside the monitoring manholes to take advantage of ground heat (Figure 15). The autosampler racks fit two carboys. Thus, while two-part sampling programs were still used, there was only one 10-L carboy per set rather than two.

Figure 15. Custom autosampler rack in monitoring manhole

Continuous autosampling was attempted at the JBT05 site and both filter outlets through the winter of 2019-2020. Despite insulating the monitoring manholes and deploying low power heaters inside them, multiple weeks in January and February were not consistently sampled due to ice in the manholes and in the autosampler lines. However, these efforts certainly did extend the automated sampling window much longer than would otherwise have been possible.

There was a period in March–April 2020 during the COVID-19 state of emergency during which we held samples for later analysis because the VAEL laboratory was effectively closed.

The P filter monitoring results are presented in Section 8 and Appendix C.

6. Quality Assurance Tasks Completed

The project data-quality objective was to collect, provide, maintain, analyze, display, and document valid water quantity and quality data. Field quality assurance measures included adherence to the QAPP, Version 2.0, Amendment 1, approved March 2019 (Appendix A).

The analytical laboratory for the water samples was VAEL. VAEL is accredited by New Hampshire under the National Environmental Laboratory Accreditation Program (NELAP) for the specified water quality parameters. Sample analyses by VAEL were conducted according to the laboratory's established procedures, which are described in VAEL's Quality Systems Manual, Revision 23, dated December 18, 2015. This manual identifies the analytical methods and relevant data quality objectives, assessment procedures, and reporting limits applied.

For the QC samples, field duplicates were collected of TP, TDP, TN, and TSS samples. Duplicates were collected on a rotating basis among stations. Grab samples collected during the winter months were collected in duplicate according to the same scheme used for the composite sample splits. Field quality control sampling consisted of the following:

- Approximately 10% of composite water sample splits were duplicated in the field by collecting a second aliquot from the churn splitter for delivery to the lab.
- One of two composite soil sample splits was duplicated in the field by collecting a second aliquot from the sample bucket for delivery to the lab.

Data from field duplicates were accepted if the RPD was less than or equal to 20%; in such cases, the mean of the field duplicates was used to represent data from the sample involved.

Sampling QC excursions were evaluated by the Project Manager. Field duplicate sample results were used to assess the entire sampling process, including environmental variability; therefore, the arbitrary rejection of results based on predetermined limits was not practical. The professional judgment of the Project Manager was relied upon in evaluating results.

The primary reason for rejecting certain sample results was determination that samples were not representative due to a malfunction with the flowmeter or autosampler, an extreme environmental condition affecting sample quality (such as flooding), or an error on the part of the technician. Data and observations describing such malfunctions, extreme conditions, and errors were recorded in the field and are distilled in notes included in Appendix C in the following fields: "Sample Quality Notes", "Processing Comments", and "Additional Comments from Field".

7. Tile Drain Monitoring Results

Constituent concentrations in flow-proportional composite samples represent mean concentrations over the approximately weeklong sampling periods. The flow volumes and constituent concentrations for individual flow-proportional composite sampling periods are presented in Appendix C. Appendix C also includes concentration data for grab samples collected during winter periods; however, these data are for reference only. Only data from flow-proportional composite samples are analyzed in this report. Appendix C also includes data for the JBT01 tile drain, but these data are not analyzed because the record is insufficient since sampling was discontinued when the farmer ceased participation.

Constituent loads are calculated as the product of constituent concentration and the tile drainage flow volume over the corresponding sampling period. These loads were then divided by the duration of the sampling period (in days) and by the area drained by the tile drainage system (in hectares) to express loading as mass per day per hectare. These loading data are tabulated in Appendix C.

Tables 7 through 16 present descriptive statistics for flow volumes and constituent concentrations and loads in tile drainage water sampled at individual Jewett Brook watershed and Addison County tile drains. No descriptive statistics for flow volumes and constituent loads are presented for the JBT05 site (Table 7) due to missing flow data, as discussed in Section 4.2.1.

Table 7. Descriptive statistics for concentrations at JBT05 (pre-filter period)

	Concentration			
	TP (µg/L)	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**
Count	50	50	30	23
Min	31	18	2.2	2
Max	443	385	42.0	28
Mean	108	79	24.1	13
Median	82	58	24.1	14
St. Dev.	90	72	9.9	8

Table 8. Descriptive statistics for flow volumes, concentrations, and loads at JBT06

		Concentration				Load			
	Flow (m^3)	**TP (μg/L)**	**TDP (μg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	32	31	31	20	17	31	31	20	17
Min	23.2	36	17	0.1	2	0.0084	0.0040	0.00055	0.0049
Max	17700	1100	348	63.6	125	28	22	4.8	0.96
Mean	4360	206	117	33.6	22	4.0	2.8	0.66	0.16
Median	1390	145	108	34.2	14	1.1	0.68	0.12	0.069
St. Dev.	5320	208	78	15.1	30	6.4	4.6	1.1	0.24

Table 9. Descriptive statistics for flow volumes, concentrations, and loads at JBT07

		Concentration				Load			
	Flow (m^3)	**TP (μg/L)**	**TDP (μg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	30	30	30	15	17	30	30	15	17
Min	0.3	20	13	0.6	3	0.000077	0.000064	0.0000079	0.00060
Max	1760	3190	1740	22.5	200	47	25	0.33	2.9
Mean	388	353	217	10.7	41	3.2	2.0	0.073	0.38
Median	131	241	98	10.0	28	0.27	0.12	0.024	0.058
St. Dev.	509	570	332	6.4	49	8.7	4.9	0.11	0.83

Table 10. Descriptive statistics for flow volumes, concentrations, and loads at JBT11

		Concentration				Load			
	Flow (m^3)	**TP (μg/L)**	**TDP (μg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	32	32	32	18	20	32	32	18	20
Min	0.0	11	6	0.2	2	0	0	0	0
Max	5440	159	68	13.2	67	2.7	1.5	0.53	1.4
Mean	1145	43	21	2.3	17	0.35	0.19	0.043	0.091
Median	153	31	16	1.4	12	0.014	0.0087	0.00092	0.010
St. Dev.	1650	35	15	3.0	17	0.59	0.33	0.12	0.32

Table 11. Descriptive statistics for flow volumes, concentrations, and loads at JBT18

		Concentration				Load			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	32	28	28	16	17	28	28	16	17
Min	0.3	39	16	0.9	15	0.0013	0.0012	0.000047	0.0032
Max	1300	580	370	66	314	9.7	2.4	0.41	3.8
Mean	233	190	61	10.2	66	1.7	0.39	0.063	0.67
Median	61	154	50	3.9	43	0.35	0.093	0.011	0.29
St. Dev.	325	128	68	16.1	87	2.5	0.59	0.11	1.0

Table 12. Descriptive statistics for flow volumes, concentrations, and loads at ACT1

		Concentration				Loading			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	26	26	26	12	24	26	26	12	24
Min	1.5	13	6	12.8	2	0.0007	0.0002	0.0009	0.0001
Max	2530	52	31	70.8	18	0.81	0.40	1.8	0.13
Mean	655	21	11	42.0	3	0.13	0.072	0.34	0.022
Median	599	20	9	38.9	2	0.12	0.063	0.20	0.015
St. Dev.	581	8	5	18.6	3	0.16	0.083	0.49	0.027

Table 13. Descriptive statistics for flow volumes, concentrations, and loads at ACT2

		Concentration				Load			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	34	34	34	18	33	34	34	18	33
Min	2.1	46	15	0.4	4	0.0075	0.0019	0.0000	0.0011
Max	4540	1490	760	37.6	494	170	85	2.0	55
Mean	1690	304	139	15.4	115	13	6.8	0.58	4.3
Median	913	164	81	17.2	71	2.2	1.1	0.36	0.28
St. Dev.	1680	321	169	12.3	116	30	16	0.70	10

Table 14. Descriptive statistics for flow volumes, concentrations, and loads at ACT3

		Concentration				**Load**			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	24	24	23	14	24	24	23	14	24
Min	3.6	54	19	2.9	36	0.012	0.0029	0.0015	0.0046
Max	1850	1600	838	35.4	1730	36	16	1.2	45
Mean	707	629	218	24.3	376	7.0	2.4	0.28	4.3
Median	568	570	171	22.5	242	3.6	1.4	0.17	1.1
St. Dev.	580	339	164	8.3	358	9.8	3.5	0.34	9.7

Table 15. Descriptive statistics for flow volumes, concentrations, and loads at ACT4

		Concentration				**Load**			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	33	33	33	15	32	33	33	15	32
Min	3.0	199	89	1.4	18	0.024	0.011	0.00020	0.0021
Max	843	1020	673	4.0	278	7.0	5.1	0.040	0.61
Mean	174	405	232	2.5	45	1.3	0.80	0.012	0.11
Median	55	388	206	2.5	35	0.46	0.34	0.0062	0.040
St. Dev.	211	153	112	0.8	45	1.8	1.2	0.015	0.15

Table 16. Descriptive statistics for flow volumes, concentrations, and loads at ACT5

		Concentration				**Load**			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
Count	28	28	28	14	28	28	28	14	28
Min	3.2	21	9	6.4	9	0.0021	0.0009	0.0008	0.010
Max	1320	600	56	36.2	1090	22	2.1	0.96	40
Mean	384	125	21	17	125	2.0	0.31	0.24	2.3
Median	359	99	18	14.4	84	0.86	0.15	0.15	0.41
St. Dev.	388	113	11	8.2	198	4.4	0.49	0.32	7.6

Median values from Tables 7-16 are tabulated in Table 17 for ease of reference. Minimums, maximums, and means of the median values are also included. Among the 10 Addison County and Jewett Brook watershed tile drains sampled, median TP concentrations ranged from a low of 20 µg/L at ACT1 to 570 µg/L at ACT3, and averaged 189 µg/L. Median TDP concentrations ranged from a low of 9 µg/L at ACT1 to 206 µg/L at ACT4, and averaged 81 µg/L.

Table 17. Median flow volumes, concentrations, and loads by site

		Concentration				Load			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
JBT05 (pre-filter)		82	58	24.1	14				
JBT06	1390	145	108	34.2	14	1.1	0.68	0.12	0.069
JBT07	131	241	98	10.0	28	0.27	0.12	0.024	0.058
JBT11	153	31	16	1.4	12	0.014	0.0087	0.00092	0.010
JBT18	61.2	154	49	3.9	43	0.35	0.093	0.011	0.29
ACT1	599	20	9	38.9	2	0.12	0.063	0.20	0.015
ACT2	913	164	81	17.2	71	2.2	1.1	0.36	0.28
ACT3	568	570	171	22.5	242	3.6	1.4	0.17	1.1
ACT4	55.0	388	206	2.5	35	0.46	0.34	0.0062	0.040
ACT5	359	99	18	14.4	84	0.86	0.15	0.15	0.41
Minimum	55.0	20	9	1.4	2	0.014	0.0087	0.00092	0.010
Maximum	1390	570	206	38.9	242	3.6	1.4	0.36	1.1
Mean	470	189	81	16.9	55	1.0	0.44	0.12	0.25

Figures 16 through 23 present box plots of TP, TDP, TN, and TSS concentration and loading data from flow-proportional composite samples collected from the Jewett Brook watershed and Addison County tile drains. All data are presented on log scale. The top and bottom of the vertical box indicate the 75th and 25th percentiles, respectively, of the data distribution for the category, defining the interquartile range. The horizontal line across each box indicates the median (50th percentile) of the data distribution. The top and bottom vertical lines (“whiskers”) for each box define the [3rd quartile + 1.5 x interquartile range] and the [1st quartile – 1.5 x interquartile range], respectively. Points beyond each whisker represent outliers.

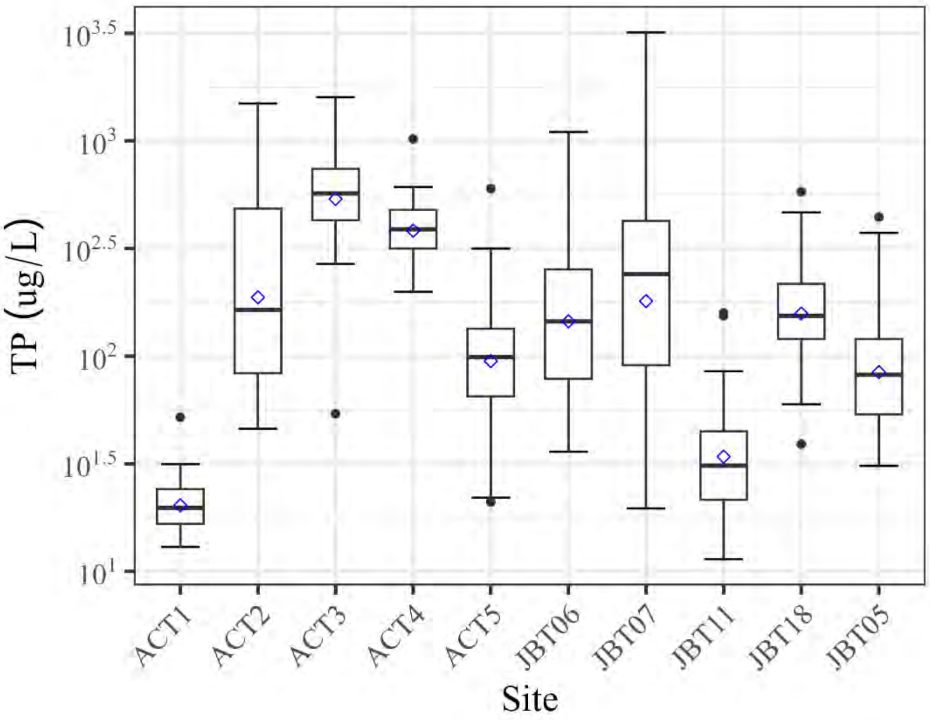


Figure 16. TP concentration distributions by site

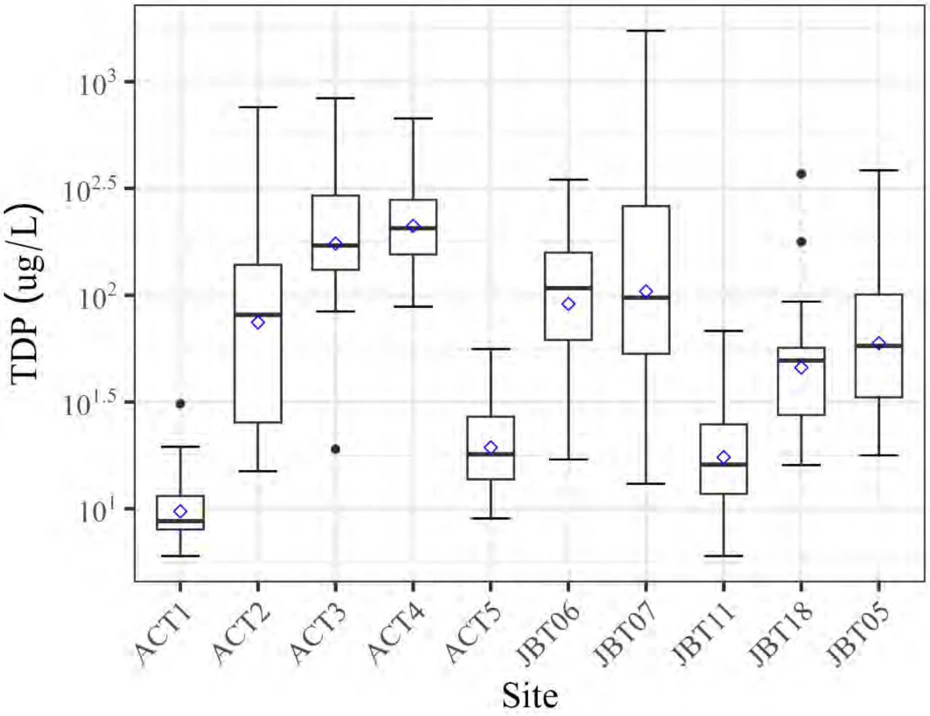


Figure 17. TDP concentration distributions by site

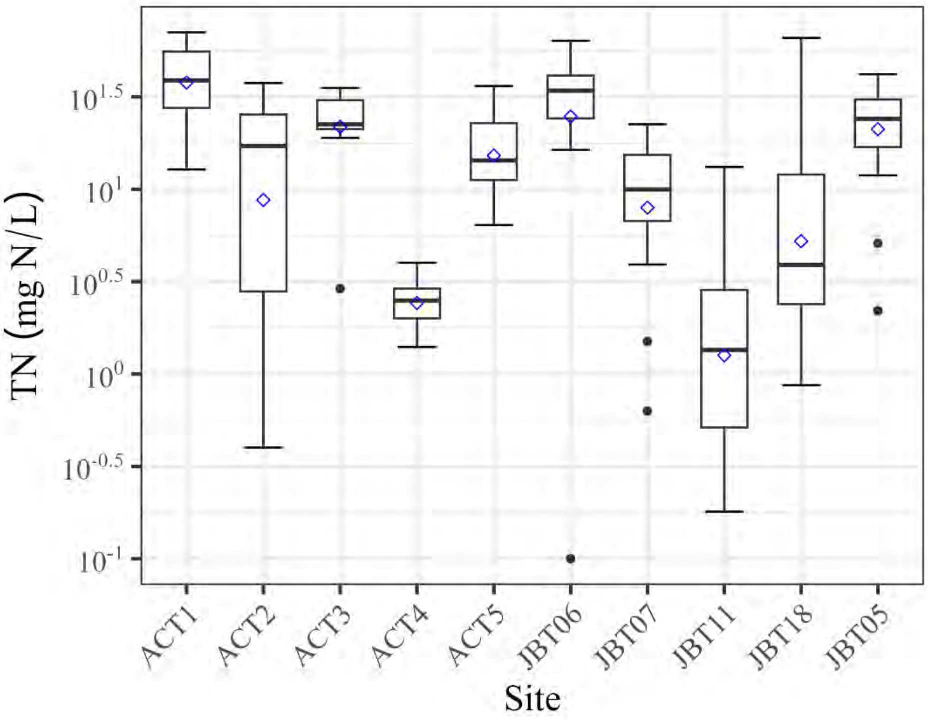


Figure 18. TN concentration distributions by site

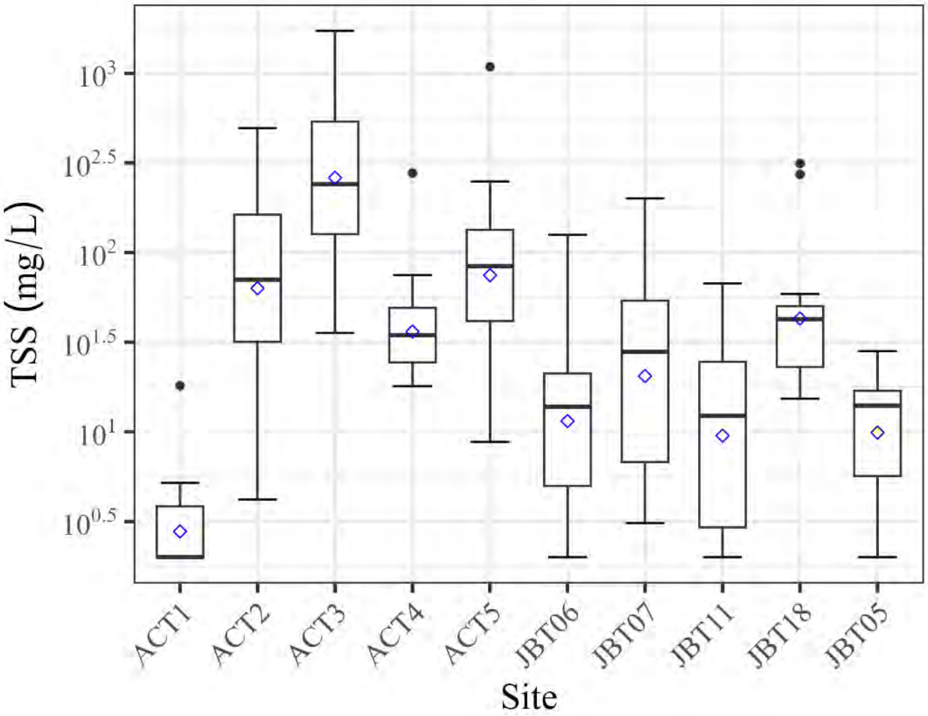


Figure 19. TSS concentration distributions by site

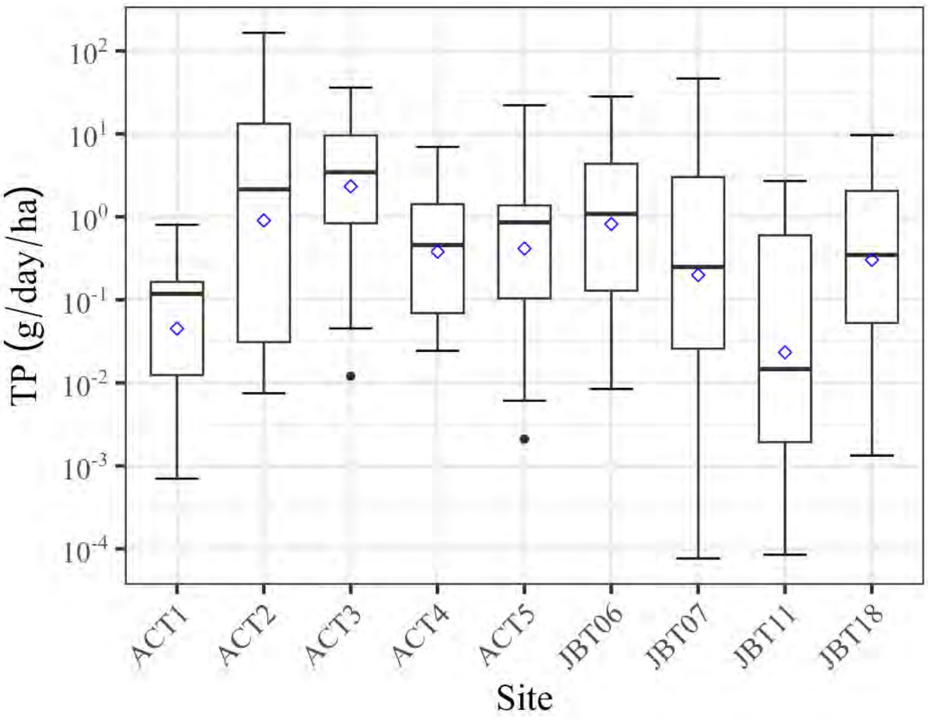


Figure 20. TP load distributions by site

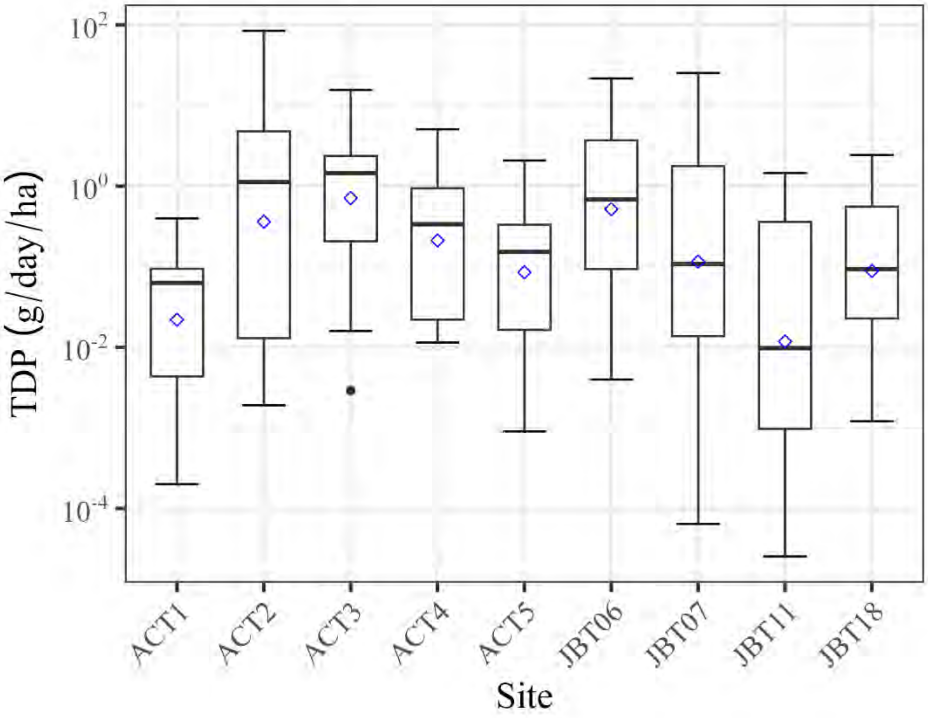


Figure 21. TDP load distributions by site

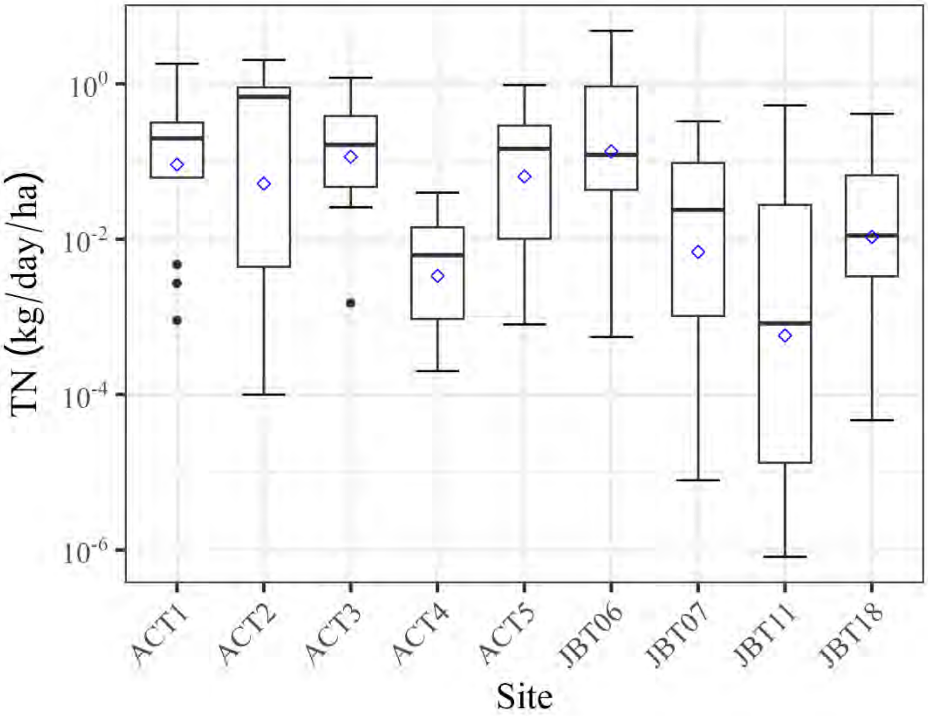


Figure 22. TN load distributions by site

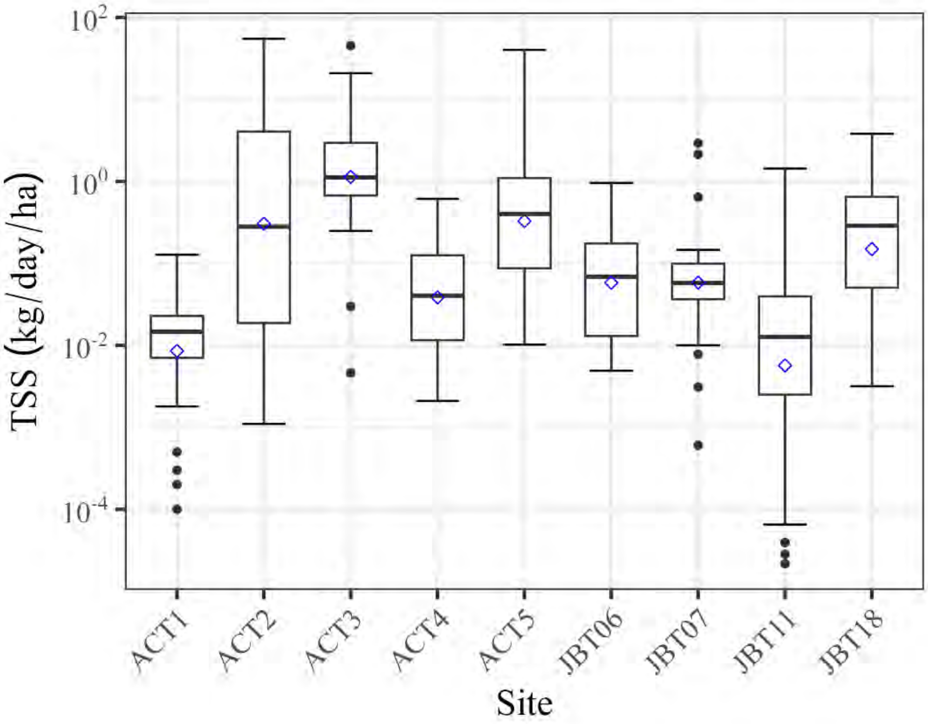


Figure 23. TSS load distributions by site

Tile effluent phosphorus concentrations in Addison County and Jewett Brook watershed tile drainage were higher than those previously reported from similar land uses in the LCB region (Stone 2016). Benoit (1973) reported all tile drainage samples from corn silage and hay plots in Franklin, VT contained less than 20 µg/L TP, the detection limit. More recently, Young (2015) reported TP concentrations of 23 – 175 µg/L (mean 98 µg/L) and dissolved reactive P concentrations of 9 – 41 µg/L (mean 11 µg/L) in tile drainage water on five farms in Clinton and St. Lawrence Counties, NY. In the same region, Klaiber (2015) reported a mean TP concentration of 29 µg/L and a mean dissolved reactive P concentration of 12 µg/L in tile drainage from seven events over a year. Note that all these data were reported from seasonal or multi-event data, not from samples collected throughout the year.

Figure 24. Foam in ACT4 manhole, Dec. 3, 2018

P concentrations observed in ACT and JBT tile drainage were more comparable to the range observed in Ontario (20 – 9,700 µg/L; Miller 1979), Ohio (110 – 300 µg/L; King 2014), and in Wisconsin (80 – 1,780 µg/L; Madison et al. 2014) than to the few LCB studies available (Benoit 1973, Young 2015, and Klaiber 2015).

Occasional high TP and TDP concentrations were measured in the ACT and JBT tile drain flow following manure application. On several events, we observed foam (Figure 24) or discolored water indicating manure had leached into the tile drain.

7.1. Comparing Jewett Brook Watershed and Addison County Tile Drains

Figures 25 through 29 illustrate the TP, TDP, TN, and TSS concentration distributions grouped by county/watershed.

The Addison County tile drains had higher 25th percentile, median, and 75th percentile TP concentrations than the Jewett Brook watershed sites (Figure 25). Median and 75th percentile TDP concentrations (Figure 26) were higher across the Addison County sites than at the Jewett Brook watershed sites, but the 25th percentile TDP concentration was lower, reflecting a larger TDP concentration interquartile range at the ACT sites.

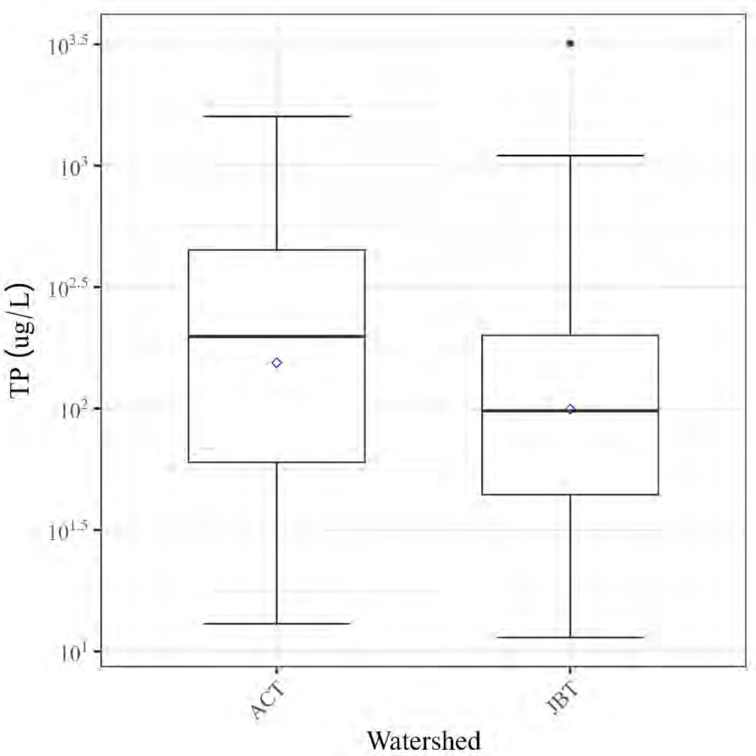


Figure 25. Comparing TP concentration distributions at ACT and JBT sites

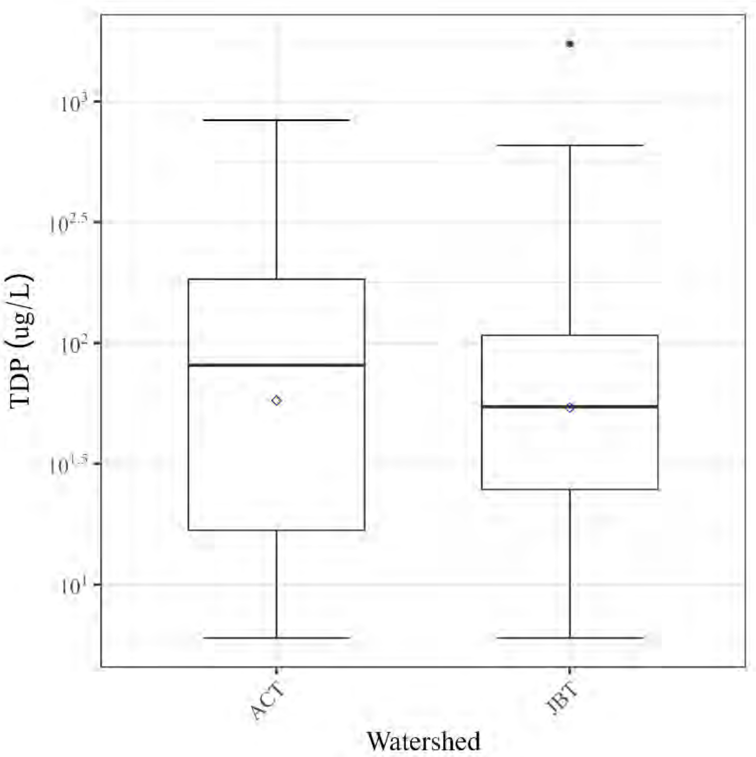
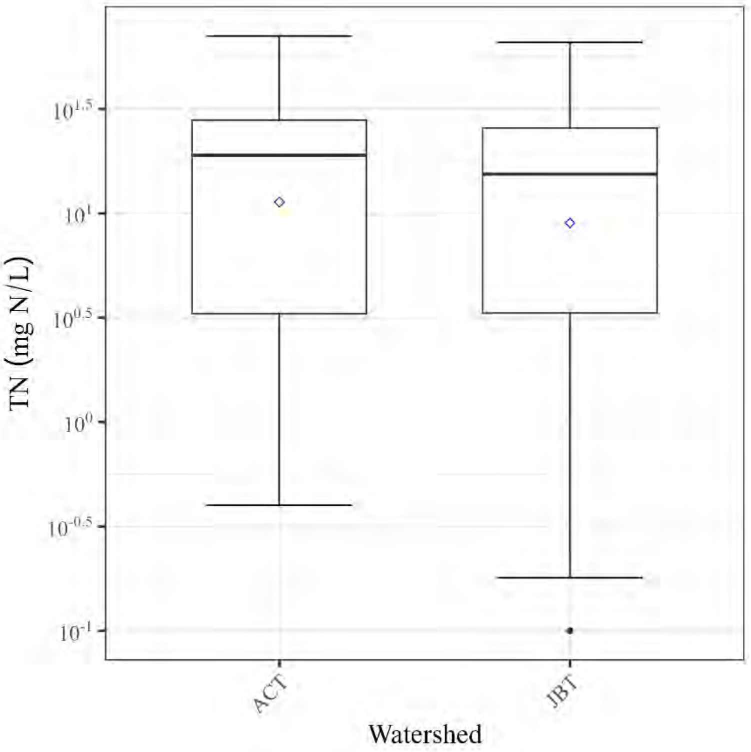
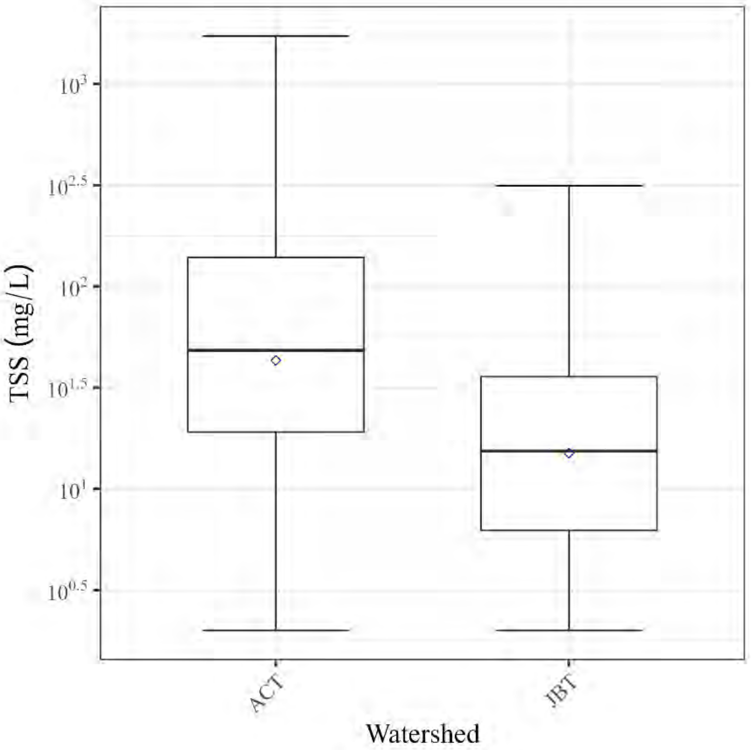


Figure 26. Comparing TDP concentration distributions at ACT and JBT sites



The TN concentration distributions were similar at the ACT and JBT sites (Figure 27).

Figure 27. Comparing TN concentration distributions at ACT and JBT sites



As with the TP concentration comparison, grouped ACT sites had substantially higher 25th percentile, median, and 75th percentile TSS concentrations than the JBT sites (Figure 28).

Figure 28. Comparing TSS concentration distributions at ACT and JBT sites

Table 18 compares minimum, maximum, and median concentrations and loads grouped by county/watershed. For each constituent, the Addison County sites had higher median concentrations and loads. Median TP concentrations were approximately twice as high at the Addison County sites and TSS concentrations were a factor of three greater. Median TP, TDP, TN, and TSS loads were between 4X (TN load) and 20X (TP load) higher at the Addison County sites than the Jewett Brook watershed sites. The primary reason for the dramatic differences in loading was likely differences in rainfall. Between March and August 2019, most of Addison County had surplus rainfall, 125-150% of normal, while most of Franklin County had a rainfall deficit, 75-100% of normal (Northeast Climate Data Center 2023).

Table 18. Concentrations and loads grouped by county/watershed

		Concentration				Load			
Sites	**Statistic**	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
ALL	min	11	6	0.1	2	0	0	0	0
	max	3193	1735	70.8	1726	166	85	4.8	55
	median	120	56	16.4	31	0.16	0.073	0.027	0.050
ACT	min	13	6	0.4	2	0.00070	0.00020	0	0.00010
	max	1595	838	70.8	1726	166	85	2.0	55
	median	198	81	19.0	48	0.62	0.15	0.053	0.12
JBT	min	11	6	0.1	2	0	0	0	0
	max	3193	1735	66.0	314	47	25	4.8	3.8
	median	98	55	15.4	15	0.030	0.017	0.014	0.015

Two-sided Wilcoxon rank sum tests were performed to evaluate the significance of differences between constituent concentrations at the Addison County tile drains and Jewett Brook watershed tile drains. The results in Table 19 demonstrate that the tile drains monitored in Addison County had significantly higher TP and TSS concentrations than the Jewett Brook watershed sites. There were no significant differences in TDP or TN concentrations between the Addison County and Jewett Brook watershed sites.

TP, TDP, TN, and TSS loads were statistically greater at Addison County sites than at Jewett Brook watershed sites, after normalizing by tile drainage area (Table 19). Particularly with respect to TDP and TN loads, these results suggest that higher flow volumes contributed to significantly greater loading across ACT sites than at JBT sites.

Table 19. Results of Wilcoxon rank sum tests between ACT and JBT concentrations and loading[1]

	Concentration				Load			
	TP (µg/L)	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d/ha)**	**TDP (g/d/ha)**	**TN (kg/d/ha)**	**TSS (kg/d/ha)**
p-value	**<0.01**	0.60	0.50	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**

1. Statistically significant differences in bold

7.2. Comparing Addison County Tile Drains by Soil Type

Since the outset of monitoring, P concentrations measured at the ACT1 tile drain (Figure 29) in Addison County were surprisingly low. The most obvious difference between ACT1 and the other ACT study fields is in soil type. The ACT2, ACT3, ACT4, and ACT5 fields have predominantly clay or silty clay soil. The ACT1 field is unique in this study in having light textured, fine loamy sand soil. Therefore, the ACT sites were grouped and analyzed according to soil type. Distributions of TP, TDP, TSS, and TN concentration data by soil type are presented in Figures 30 through 33.

The TP concentrations (Figure 30) and TDP concentrations (Figure 31) at ACT1 were consistently very low relative to the other ACT sites.

Figure 29. ACT1 tile drain outlet

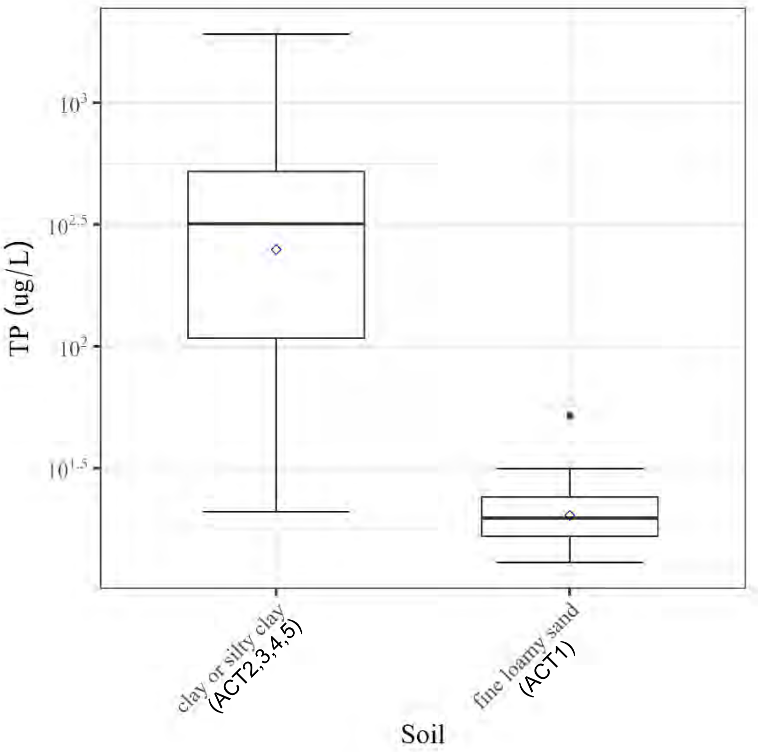


Figure 30. TP concentration distributions at ACT sites by soil texture

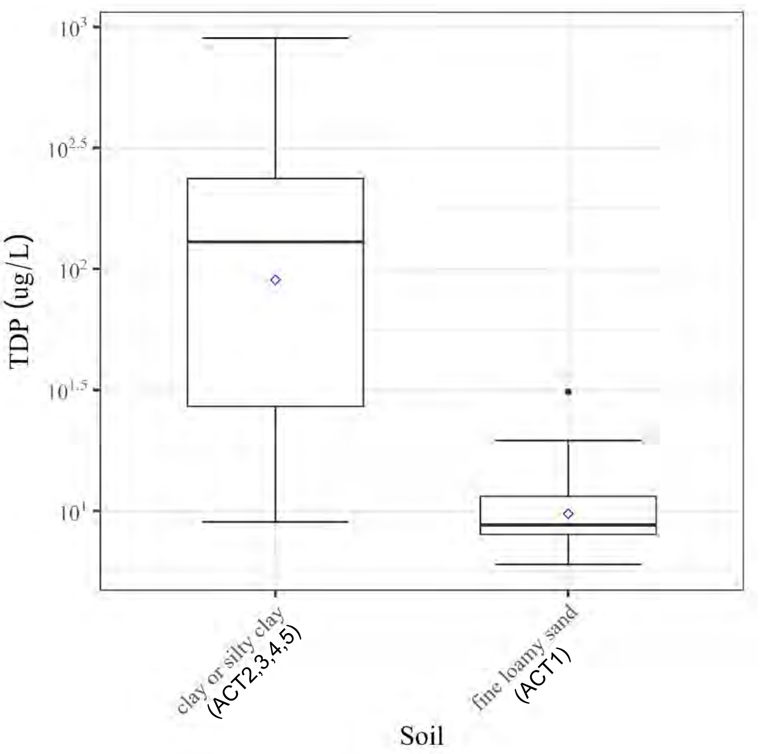
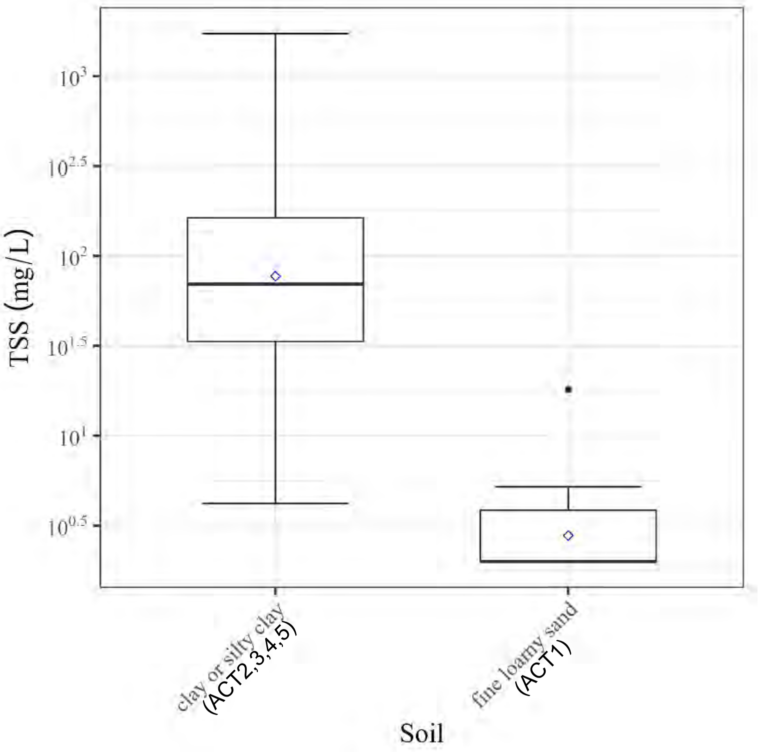


Figure 31. TDP concentration distributions at ACT sites by soil texture



As with the TP and TDP concentrations, TSS concentrations (Figure 32) were similarly dramatically lower at ACT1 than at the other ACT sites.

Figure 32. TSS concentration distributions at ACT sites by soil texture

Conversely, TN concentrations were higher at ACT1 than at the other ACT tile drains (Figure 33).

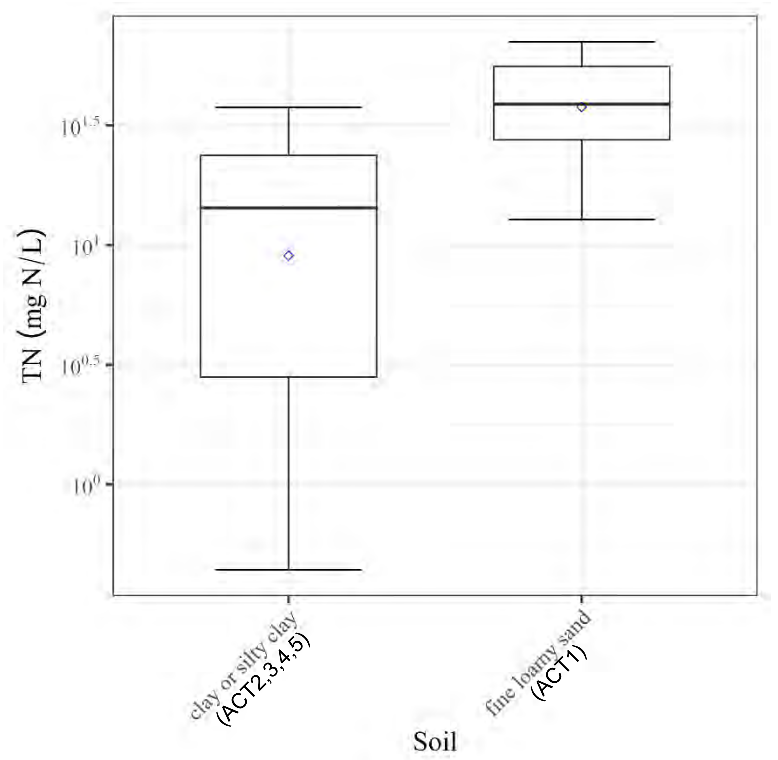


Figure 33. TN concentration distributions at ACT sites by soil texture

The statistical significance of the apparent differences between the ACT sites with clay/silty clay soils and ACT1 with loamy fine sand was assessed using two-sided Wilcoxon rank sum tests (Table 20). TP, TDP, and TSS concentrations were significantly lower, and TN concentrations were significantly higher, at the ACT1 site than at the ACT sites with clay soils. A similar pattern is apparent in the loading data, with significantly lower TP, TDP, and TSS loads at ACT1 than at the other ACT sites, except that the difference in TN loading was non-significant.

While we recognize evaluating a category (sandy soil) represented by only one site (ACT1) necessitates cautious interpretation of these results, the fact that the water quality at this tile drainage system is markedly different from the other ACT sites, and indeed the Jewett Brook watershed sites as well, deserves special mention. Given that the ACT1 field is in continuous corn under conventional management, we attribute ACT1's lower TP, TDP, and TSS concentrations and loading and higher TN concentrations to its sandy soil.

Table 20. Results of Wilcoxon rank sum tests between ACT sites with clay soils and ACT1[1]

	Concentration				Load			
	TP (µg/L)	TDP (µg/L)	TN (mg/L)	TSS (mg/L)	TP (g/d/ha)	TDP (g/d/ha)	TN (kg/d/ha)	TSS (kg/d/ha)
p-value	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	0.30	**<0.01**

1. Statistically significant differences in bold

8. Tile Drain Phosphorus Filter Results

The JBT05 tile drain (the "inflow" station) and the Filter A and Filter B outflows were monitored between December 2019 and December 2020. Flow-proportional composite samples were collected and processed approximately weekly for as much of the period as was possible. Installing autosamplers within monitoring manholes with insulated covers did extend the time window for automated sampling considerably; however, despite considerable efforts, including an attempt to heat the manholes with low-power electric heaters, consistent operation through January and February was not possible. During the coldest weeks, grab samples were collected (Appendix C).

8.1. Water Quality at the JBT05 Tile Drain and Filter Outflows

Tables 21 through 23 present flow volume, concentration, and loading data for samples collected at the filter inflow (JBT05) and outflow stations. Note that the JBT05 data presented in Table 21 do not include data collected in the previous monitoring period, which are summarized in Section 7. Tile drainage water inflows to the filters had TP concentrations ranging from 36 to 1380 µg/L—a large range— and a median concentration of 93 µg/L. TDP concentrations were in a similar range, 21–1410 µg/L, although the median TDP concentration was lower, 55 µg/L. Inflow concentrations of TN were relatively high (range = 2.2–43.5 mg/L; median = 20.4 mg/L). TP, TDP, and TN loads at JBT05 ranged from 0.88–590 g TP per day, 0.41–570 g TDP per day, and 0.087–18 kg TN per day. When the receiving ditch was flooded and during the highest flow events, a portion of the tile drain flow bypassed the P filters, and they received a fraction of these calculated JBT05 loads.

Table 21. Descriptive statistics for flow volumes, concentrations, and loads at JBT05 (filter period)

		Concentration				Load			
	Flow (m^3)	TP (µg/L)	TDP (µg/L)	TN (mg/L)	TSS (mg/L)	TP (g/d)	TDP (g/d)	TN (kg/d)	TSS (kg/d)
Count	48	45	44	45	42	45	44	45	42
Min	61.1	36	21	2.2	3	0.88	0.41	0.087	0.072
Max	6230	1380	1410	43.5	140	590	570	18	45
Mean	1120	183	138	20.0	27	48	40	3.1	4.2
Median	429	93	55	20.4	12	5.2	3.7	1.3	0.92
St. Dev.	1430	244	240	8.2	33	110	100	4.0	8.5

Table 22. Descriptive statistics for flow volumes, concentrations, and loads in Filter A outflow

		Concentration				Load			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d)**	**TDP (g/d)**	**TN (kg/d)**	**TSS (kg/d)**
Count	40	38	38	38	34	38	38	38	34
Min	6.0	23	11	2.0	3	0.022	0.011	0.000	0.028
Max	1180	685	690	36.9	88	41	41	5.3	3.4
Mean	201	110	84	19.4	16	4.0	3.2	0.69	0.41
Median	135	57	38	19.5	6	1.3	0.80	0.28	0.11
St. Dev.	249	137	137	8.5	20	7.7	7.2	1.0	0.75

Table 23. Descriptive statistics for flow volumes, concentrations, and loads in Filter B outflow

		Concentration				Load			
	Flow (m^3)	**TP (µg/L)**	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d)**	**TDP (g/d)**	**TN (kg/d)**	**TSS (kg/d)**
Count	42	40	40	40	37	40	40	40	37
Min	5.6	14	8	1.2	2	0.029	0.029	0.000	0.071
Max	1070	328	265	39.3	78	13	7.6	6.2	8.6
Mean	274	72	49	17.8	15	2.6	1.9	0.91	0.62
Median	214	44	33	18.2	8	1.6	1.1	0.58	0.22
St. Dev.	220	71	52	8.1	19	2.7	1.9	1.1	1.4

Only paired inflow/outflow concentration data are plotted in the boxplots presented in Figures 34 through 37. These figures illustrate lower TP (Figure 34) and TDP (Figure 35) concentrations in outflow from both filters than in inflow. TSS concentrations also appear lower in outflow from both filters than in inflow (Figure 37), although the differences are less dramatic. There is little change in TN concentrations (Figure 36) between the inflows and filter outflows.

Further, the outflow concentrations of TP and TDP from Filter B appear lower than from Filter A (Figures 34 and 35). The median TP (44 µg/L) and TDP (33 µg/L) concentrations in Filter B outflow are lower than in Filter A outflow (57 µg/L TP and 38 µg/L TDP), as are the maximums. Only marginal decreases are seen in TN concentrations, with median concentrations of 20.4 mg/L in the inflow, 19.5 mg/L in Filter A outflow, and 18.2 mg/L in Filter B outflow.

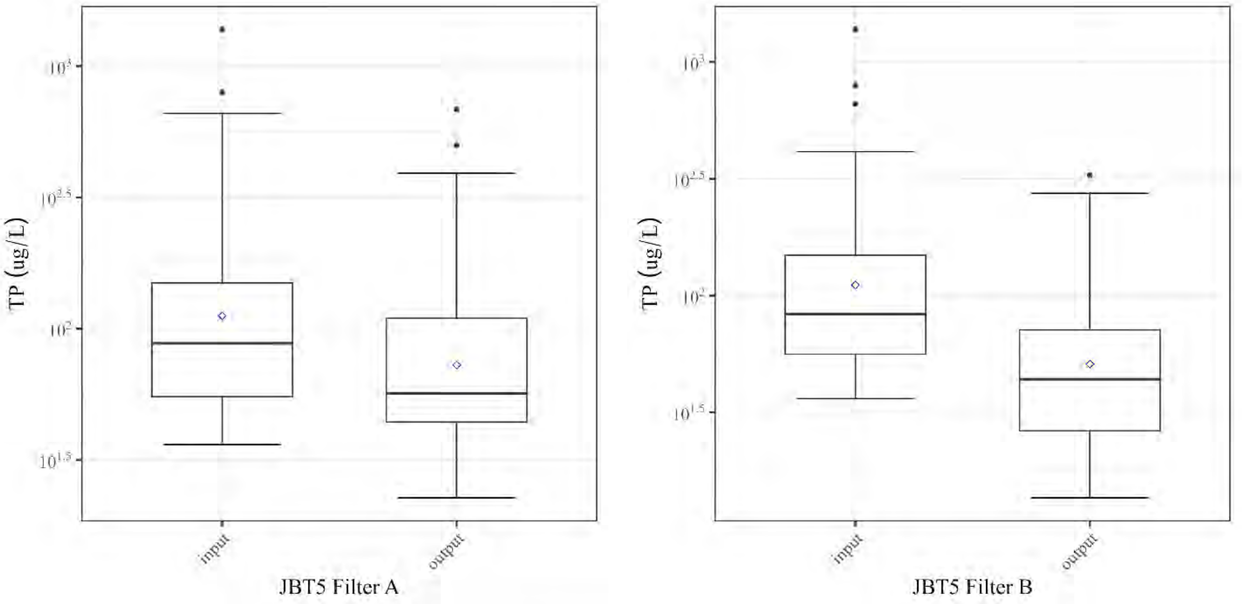


Figure 34. TP concentration distributions in Filter A (left) and Filter B (right) inflows and outflows

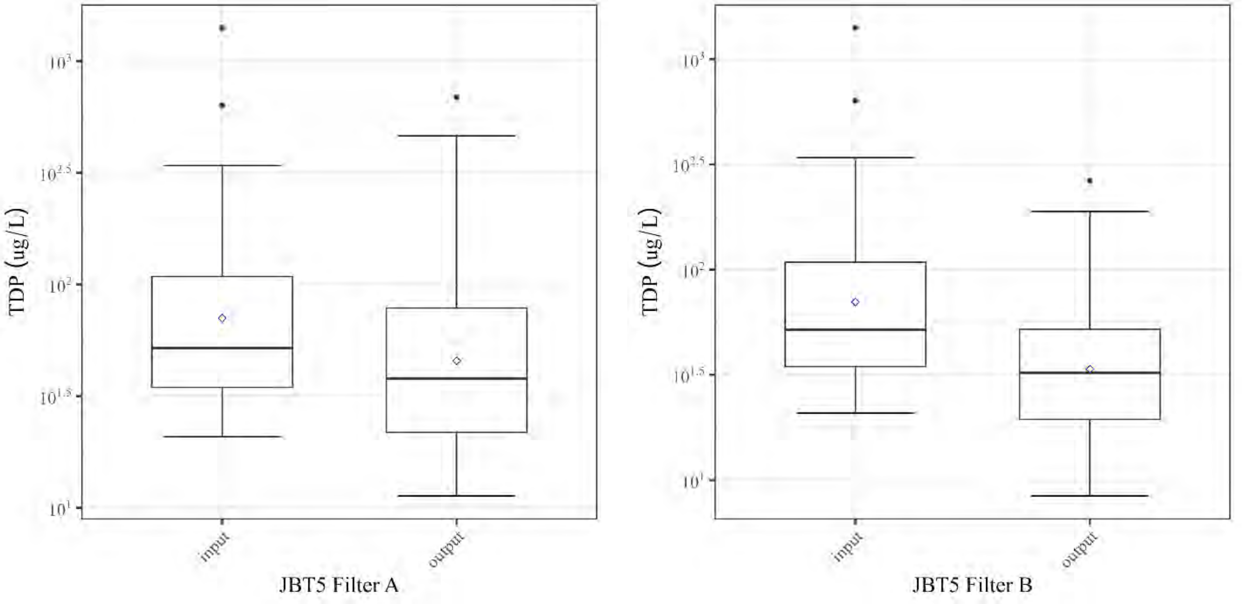


Figure 35. TDP concentration distributions in Filter A (left) and Filter B (right) inflows and outflows

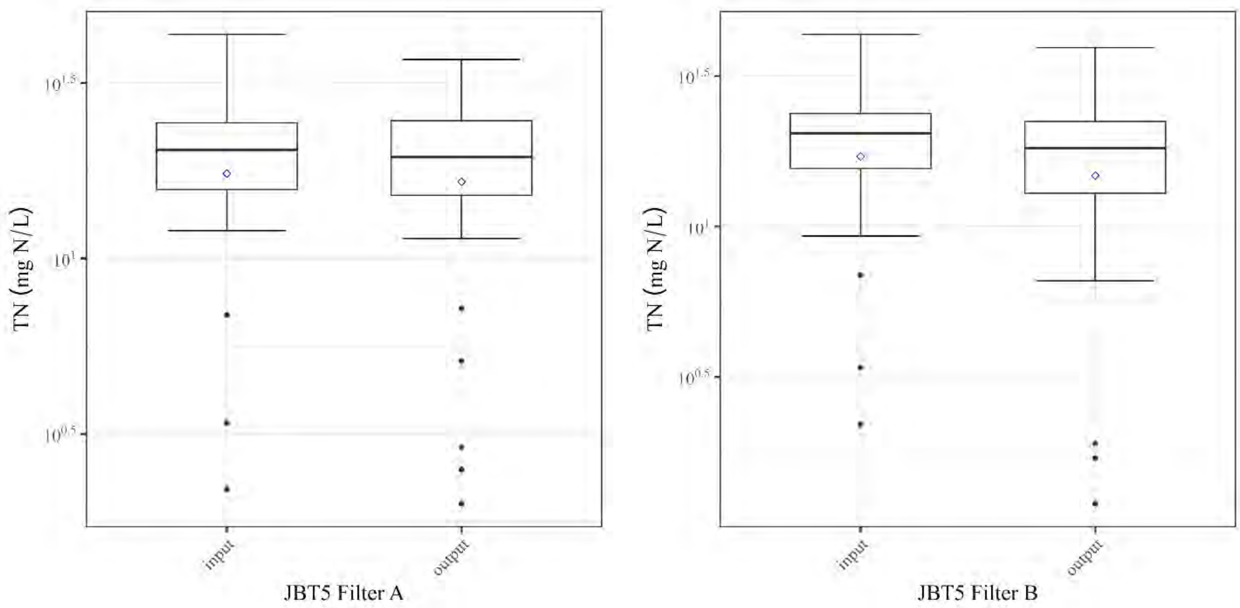


Figure 36. TN concentration distributions in Filter A (left) and Filter B (right) inflows and outflows

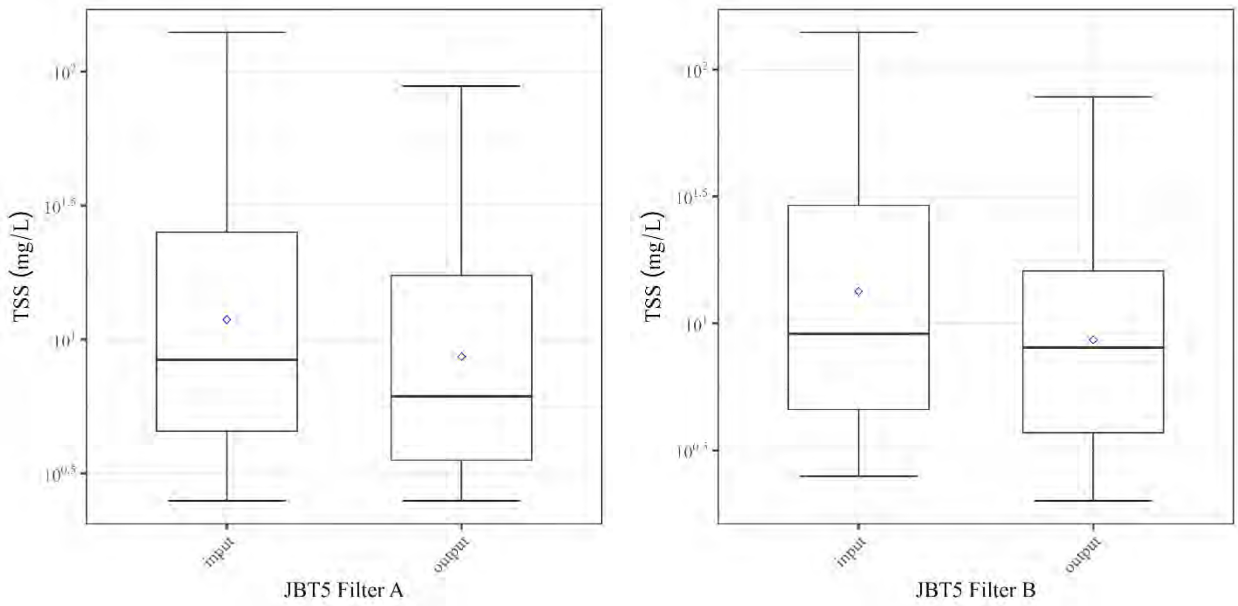


Figure 37. TSS concentration distributions in Filter A (left) and Filter B (right) inflows and outflows

Figures 38 through 41 present distributions of loads in filter inflows and outflows. Only paired inflow/outflow loading data are plotted in these boxplots. Since inflow rates to the filters were not independently measured, we assumed that filter inflow volumes were equivalent to the monitored outflow volumes in this boxplot series and in all subsequent loading comparisons. The filters were constructed in clay soil and are lined in durable plastic; therefore, minimal groundwater exchange should occur. Furthermore, the approximately weeklong duration between sample collection events should ameliorate short-term lag effects through the filters. Filter inflow loads were calculated as the inflow concentration multiplied by the outflow volume. Because tile drain flow is split between the two filters and also bypasses the filters at high flow rates and when the receiving ditch is backwatered, the effective inflow volumes and loads to each filter do not match the JBT05 values in Table 21.

At both Filter A and Filter B, TP loads (Figure 38) and TDP loads (Figure 39) appear lower in the outflow than in the inflow. TSS loads (Figure 41) also appear lower in outflow from both filters than in the inflow, though the differences are less dramatic. There is little change in TN loads (Figure 40) between the inflows and outflows.

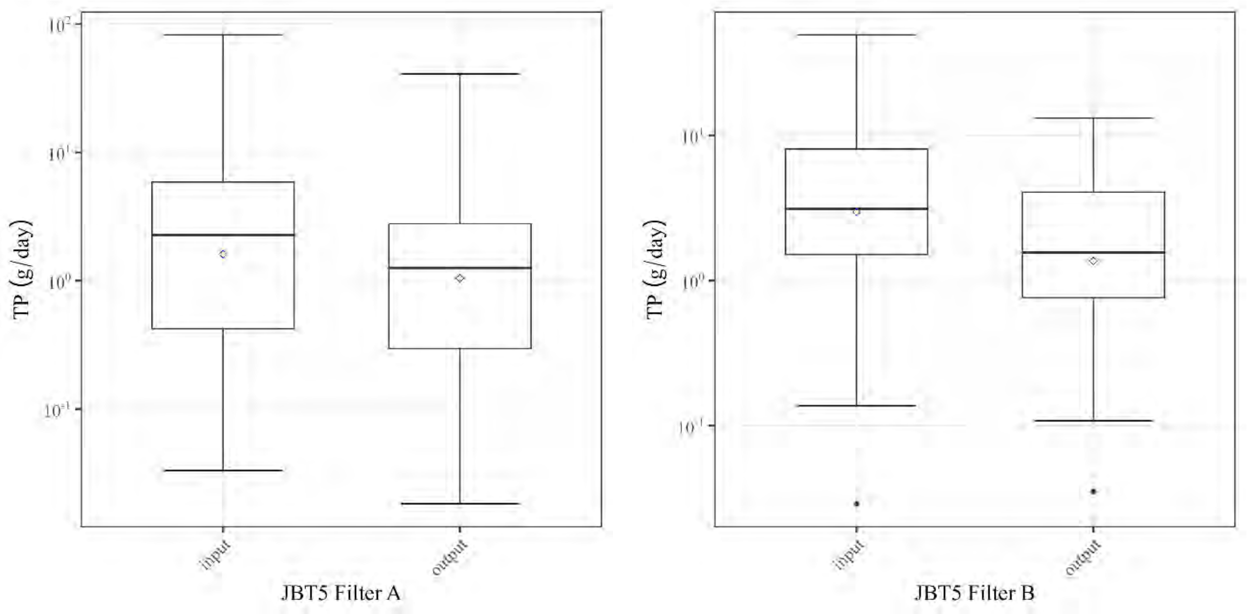


Figure 38. TP load distributions in Filter A (left) and Filter B (right) inflows and outflows

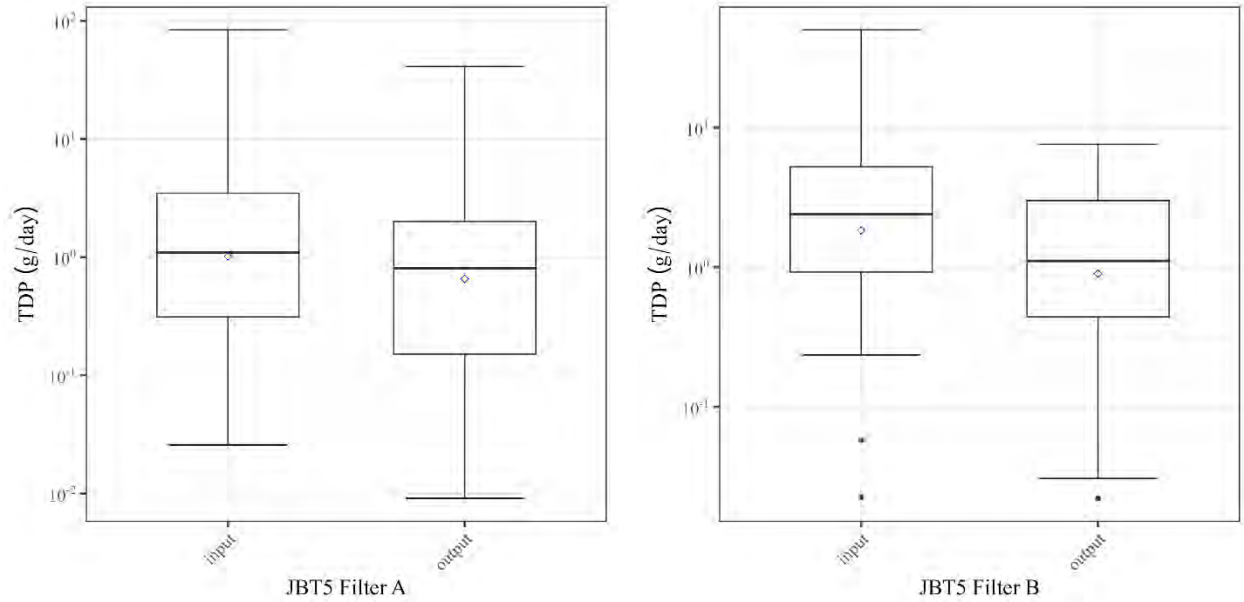


Figure 39. TDP load distributions in Filter A (left) and Filter B (right) inflows and outflows

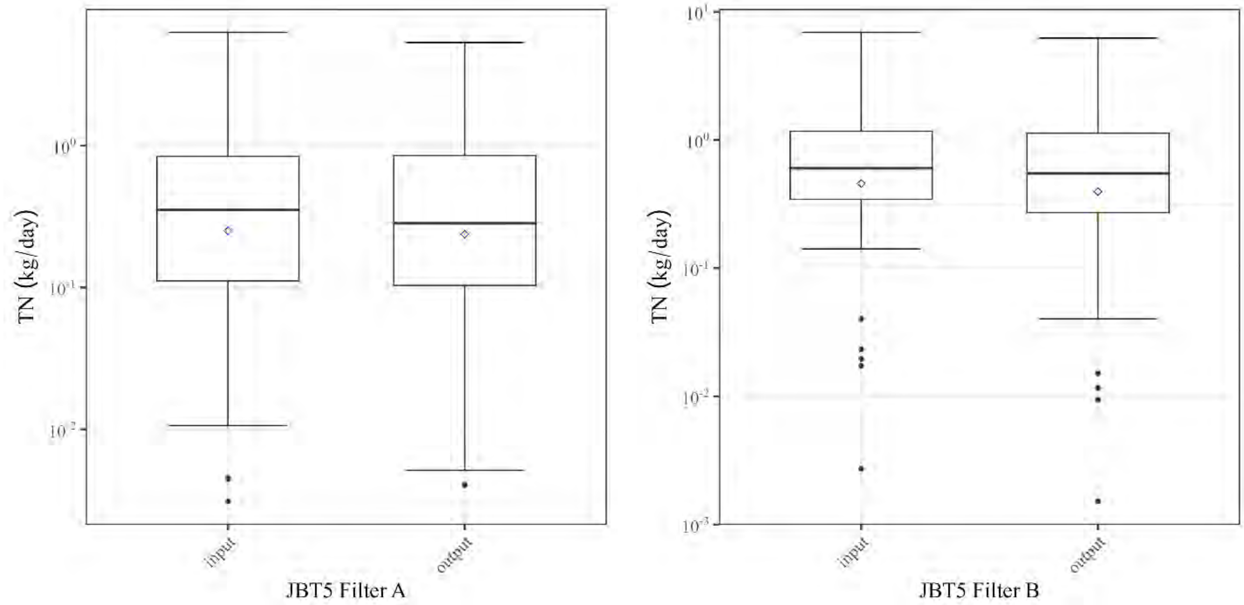


Figure 40. TN load distributions in Filter A (left) and Filter B (right) inflows and outflows

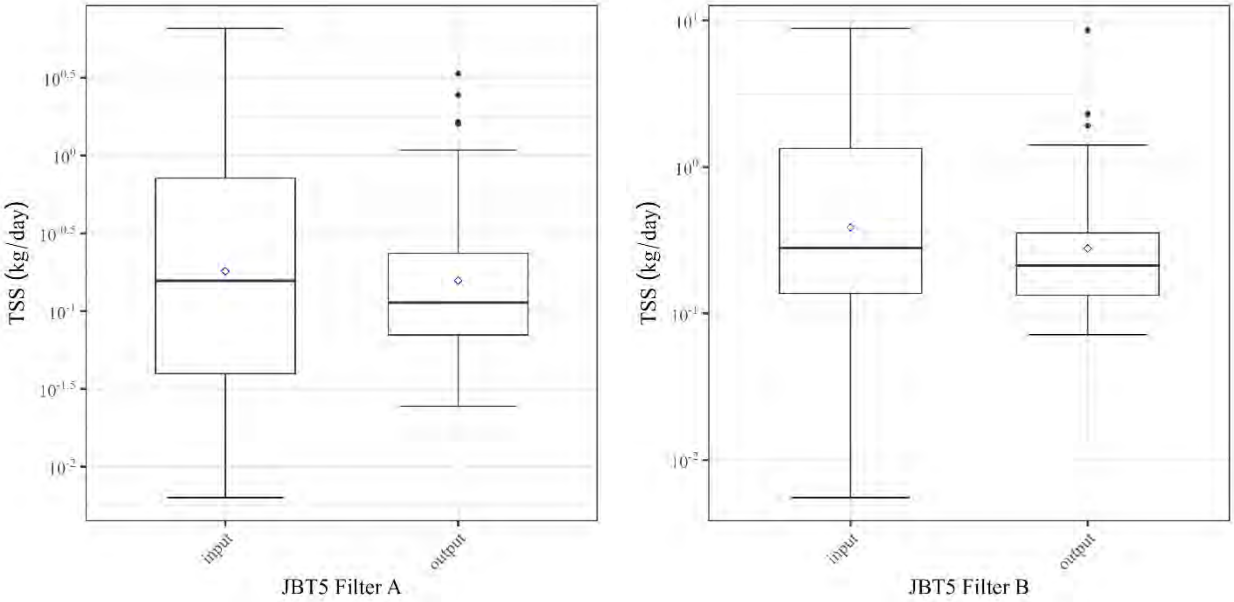


Figure 41. TSS load distributions in Filter A (left) and Filter B (right) inflows and outflows

8.2. Filter Hydraulics

Since the proportion of flow bypassing the filters is a function of both the tile drain flow rate and the water elevation in the receiving ditch, the threshold flow at which bypass occurs is not a constant. During many late winter/early spring events substantial tile drain flow bypassed the filters because the water elevation in the receiving ditch approached the water elevation in the JBT05 manhole. While water continues to flow out the tile drain bypass, there was little flow through the filters under these conditions, because there was negligible hydraulic head difference between the JBT05 manhole and the filter outlets. An extreme example of this is shown in Figure 42, when flood waters inundated the site.

Figure 42. Flooding of the P filters, Nov. 1, 2019

Flow rates from Filter A and Filter B during summer events when the water level in the receiving ditch did not rise substantially provide a reasonable indication of the hydraulic capacity of the filters. For example, on June 3, 2022 in-situ hydraulic conductivity measurements were made between the inflow and outflow manholes of Filters A and B. Flow measurements were 134

L/min (0.079 ft^3/s) for Filter A and 177 L/min (0.104 ft^3/s) for Filter B. Both filter outlets were submerged and there was no bypass flow on this date. The hydraulic head differences between the inflow and outflow manholes were 0.13 ft. for Filter A and 0.10 ft. for Filter B. These differences in head and the minimum distance through the media between the top of the distribution pipes and the inverts of the collection pipes (1.5 ft) were used to calculate the hydraulic gradient. Using the flow rates, hydraulic gradients, and filter dimensions, the hydraulic conductivities of the filters were: k= 0.0036 ft/s for Filter A and k= 0.0063 ft/s for Filter B. A possible explanation for the greater hydraulic conductivity of Filter B is that we did a better job of excluding soil from the Filter B trench during construction. These full-scale, empirically derived hydraulic conductivity values will be useful in designing future P filters.

8.3. P Filter Performance

Statistical analysis of the filter inflow and outflow data was conducted according to EPA guidance for monitoring and evaluating nonpoint source management practices (Dressing et al. 2016) using an “input/output” experimental design. The reduction efficiencies of the tile drain P filters were calculated using the percent reduction in concentrations and loads as well as regression of outflow vs. inflow concentrations and loads, after Dressing et al. (2016).

As described in Section 8.1, the inflow volume to each filter was assumed to equal the monitored outflow volume. Given this assumption, the fraction of a given constituent removed during an individual sampling period should be equivalent whether comparing concentrations or loads. Therefore, in this filter performance comparison, we have emphasized concentration reductions.

Concentration datasets were tested for normality using the Shapiro-Wilks method in R. Apart from TN concentrations in Filter A outflow (p = 0.057) and Filter B outflow (p = 0.13), the data do not follow normal distributions. Therefore, non-parametric Wilcoxon rank sum tests were used to assess significant differences between inflows and outflows. Filter performance was quantified using trimmed datasets with non-paired data removed. There were 38 paired events at both Filter A and Filter B. Eight events with valid inflow concentration data and no or invalid Filter A outflow data were excluded, as were six events with no or invalid Filter B outflow data.

The results of two-sided Wilcoxon rank sum tests are provided in Tables 24 and 25. Using this test, significant differences at $p < 0.1$ were found in TP and TDP concentrations for Filter A (Table 24). For Filter B, significant differences were found in both TP and TDP concentrations and loads (Table 25). No significant differences were found in TN or TSS concentrations or loads.

Table 24. Results of Wilcoxon rank sum tests between Filter A inflows and outflows[1]

	Concentration				**Load**			
	TP (µg/L)	**TDP (µg/L)**	**TN (mg/L)**	**TSS (mg/L)**	**TP (g/d)**	**TDP (g/d)**	**TN (kg/d)**	**TSS (kg/d)**
p-value	**0.03**	**0.03**	0.73	0.25	0.28	0.33	0.87	0.81

1. Statistically significant reductions in bold face

Table 25. Results of Wilcoxon rank sum tests between Filter B inflows and outflows[1]

	Concentration				Load			
	TP (µg/L)	TDP (µg/L)	TN (mg/L)	TSS (mg/L)	TP (g/d)	TDP (g/d)	TN (kg/d)	TSS (kg/d)
p-value	**<0.01**	**<0.01**	0.22	0.13	**<0.01**	**0.04**	0.69	0.39

1. Statistically significant reductions in bold face

Table 26 presents long-term efficiency and load reduction estimates for Filters A and B. Long-term efficiency is determined by calculating the average concentrations for inflows and outflows and using these values to calculate the percent reduction in concentration. Because average concentrations are compared, this estimate does not consider paired data. Similarly, the load reductions in Table 26 compare the sums of all monitored (and paired) inflow and outflow loads.

Table 26. Percent reductions[1] in concentrations and loads between filter inflows and outflows

	Concentration Reduction (%)		Load Reduction (%)		Load Reduction (kg)	
Parameter	Filter A	Filter B	Filter A	Filter B	Filter A	Filter B
TP	**41.3**	**60.8**	36.2	**59.5**	0.57	**1.0**
TDP	**39.6**	**65.1**	32.2	**58.7**	0.38	**0.70**
TN	3.9	10.3	7.0	5.1	15	13
TSS	36.1	46.6	46.9	50.4	77	160

1. Statistically significant reductions in bold face

While the load reduction totals presented in Table 26 provide a reasonable basis for comparing the filters, these values are clearly underestimates for the monitoring year, since paired, flow-proportional composite samples were not obtained during some winter events and several large events in April-May 2020, mainly due to equipment malfunctions complicated by the Covid-19 state of emergency. Also, the summer and early fall of 2020 were exceptionally dry, with little tile drain flow from mid-June through mid-October. In most years, the filters would likely receive greater P loads.

Figures 43 through 46 present simple linear regressions of filter outflow concentrations versus inflow concentrations. The trendlines are forced through the origin. The slopes of the TP, TDP, and TSS concentration regression lines are substantially less than one for both Filter A and Filter B, suggesting reduction of these concentrations through the filters. Conversely, the slopes of the TN concentration regression lines (Figure 45) approach one for both Filter A and Filter B, suggesting little TN removal.

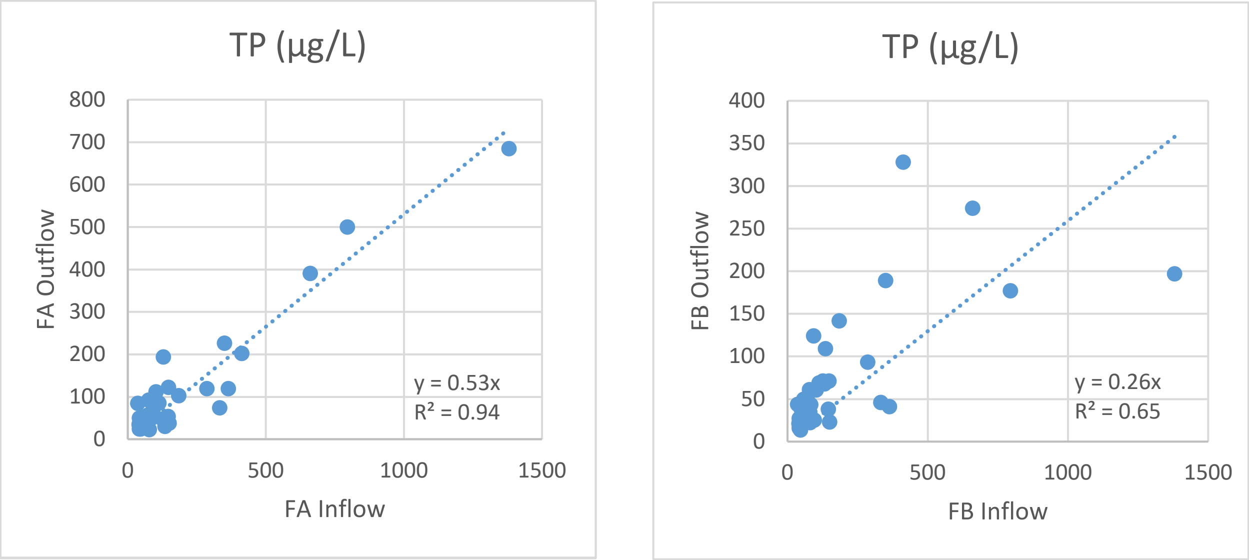


Figure 43. Filter A (left) and Filter B (right) inflow/outflow TP concentration regressions

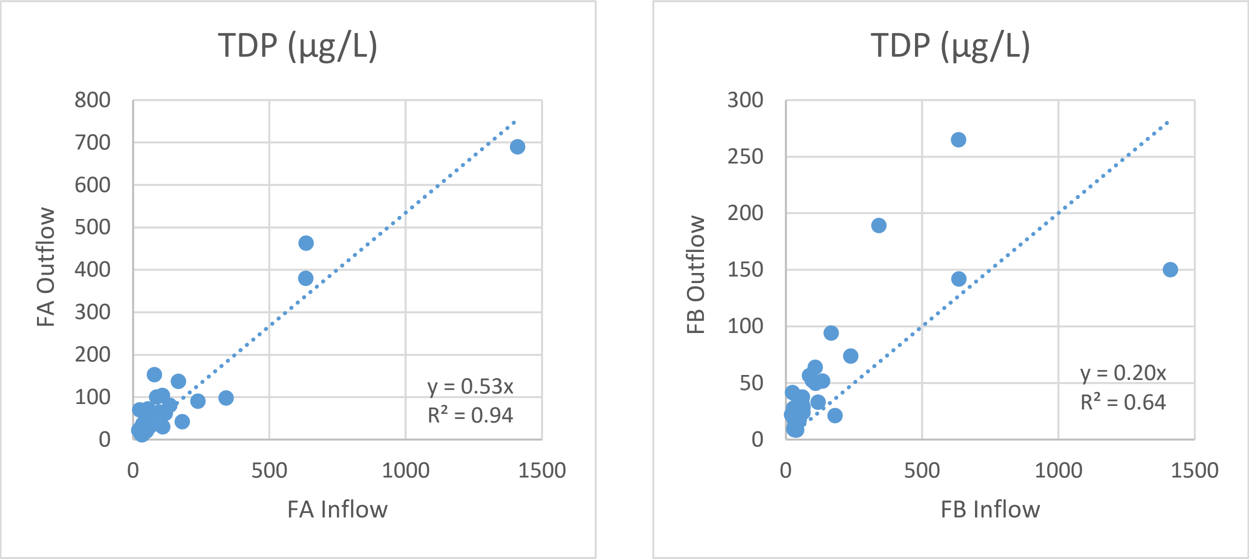


Figure 44. Filter A (left) and Filter B (right) inflow/outflow TDP concentration regressions

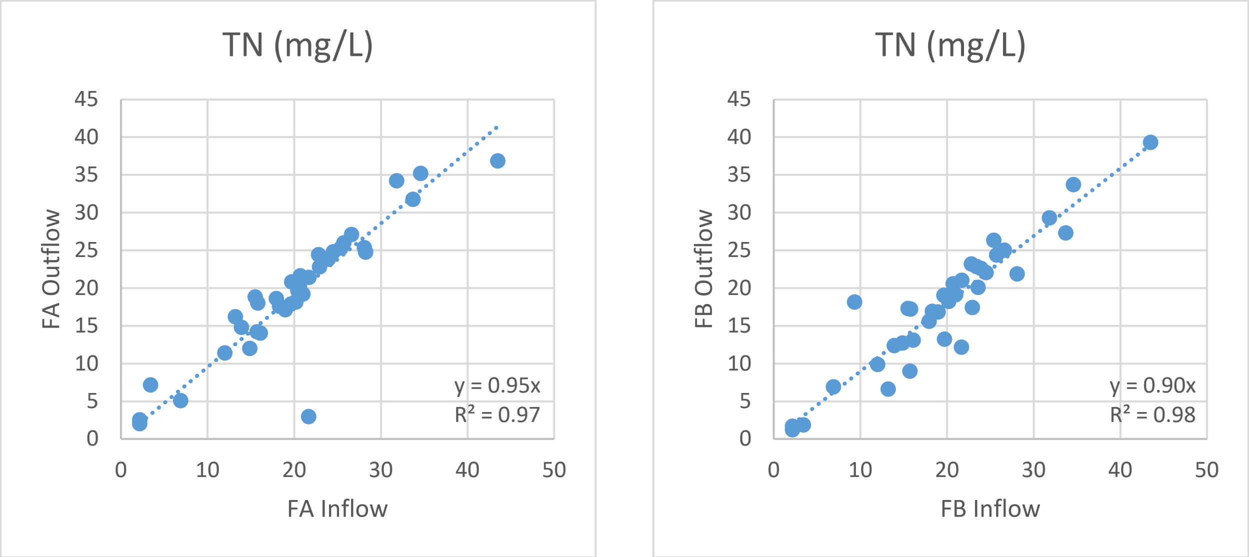


Figure 45. Filter A (left) and Filter B (right) inflow/outflow TN concentration regressions

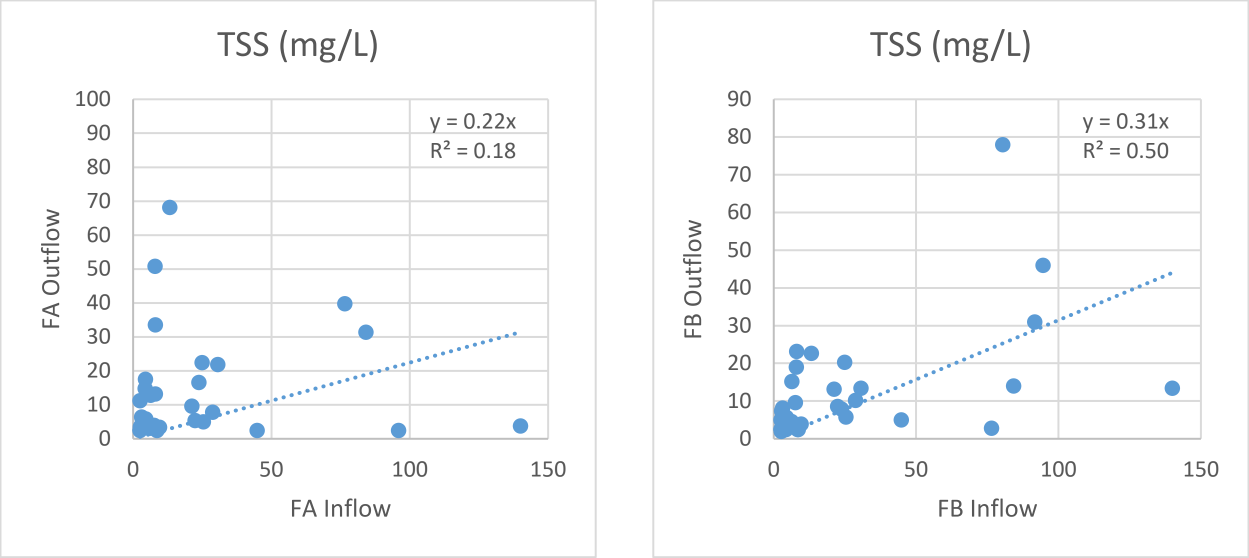


Figure 46. Filter A (left) and Filter B (right) inflow/outflow TSS concentration regressions

Similar patterns are apparent in simple linear regressions of filter outflow loads versus inflow loads (Figures 47-50). Again, the trendlines are forced through the origin. The slopes of the TP, TDP, and TSS load regression lines are substantially less than one for both Filter A and Filter B, suggesting removal through the filters, whereas the TN load regression lines (Figure 49) suggest little TN removal.

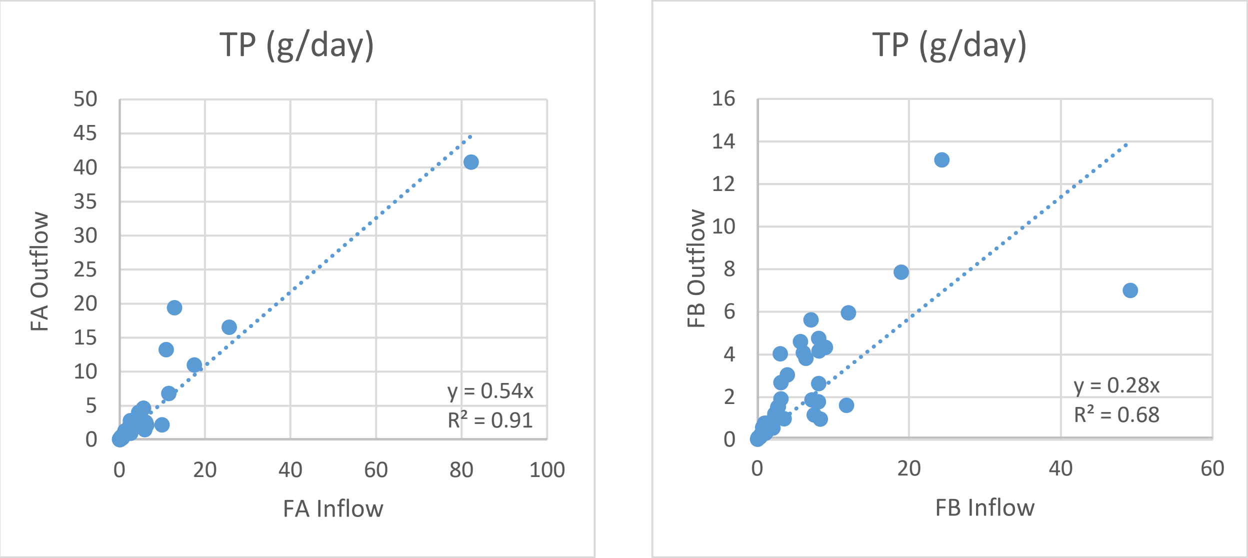


Figure 47. Filter A (left) and Filter B (right) inflow/outflow TP loading regressions

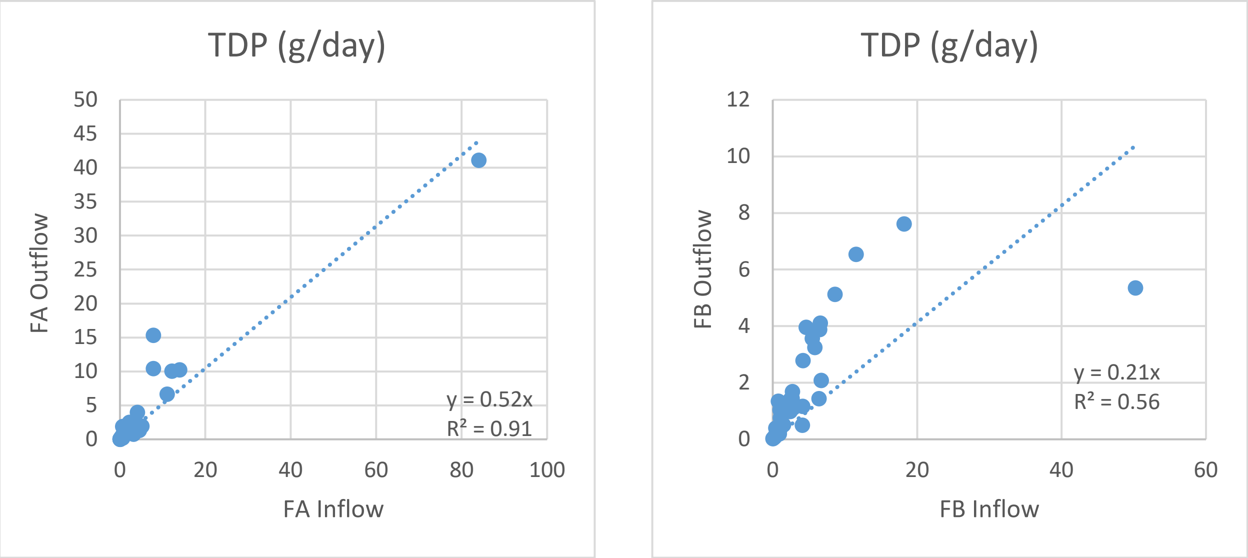


Figure 48. Filter A (left) and Filter B (right) inflow/outflow TDP loading regressions

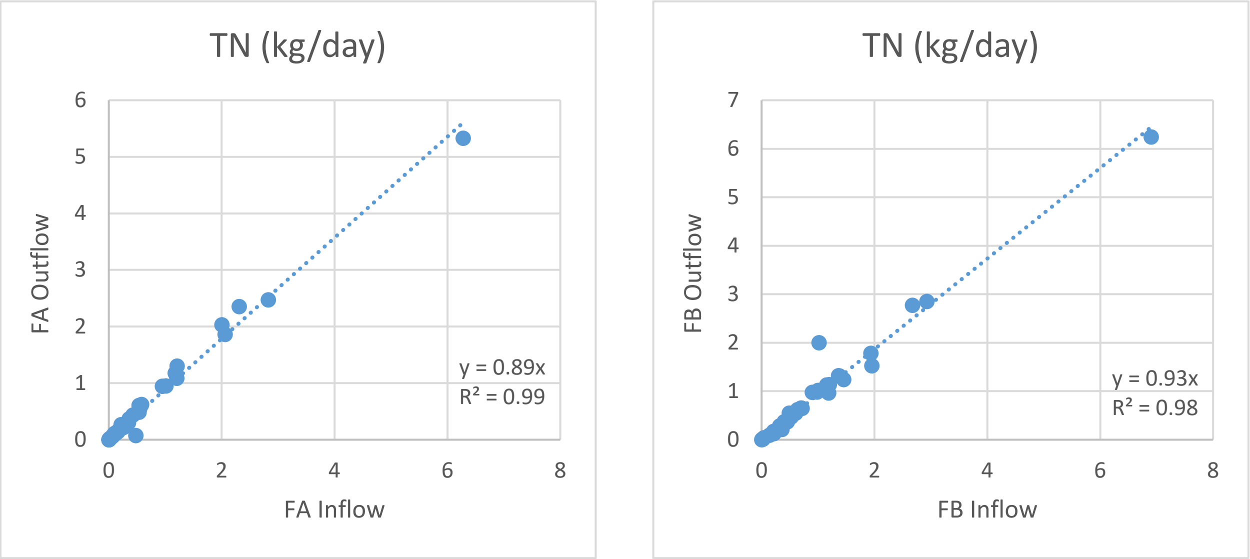


Figure 49. Filter A (left) and Filter B (right) inflow/outflow TN loading regressions

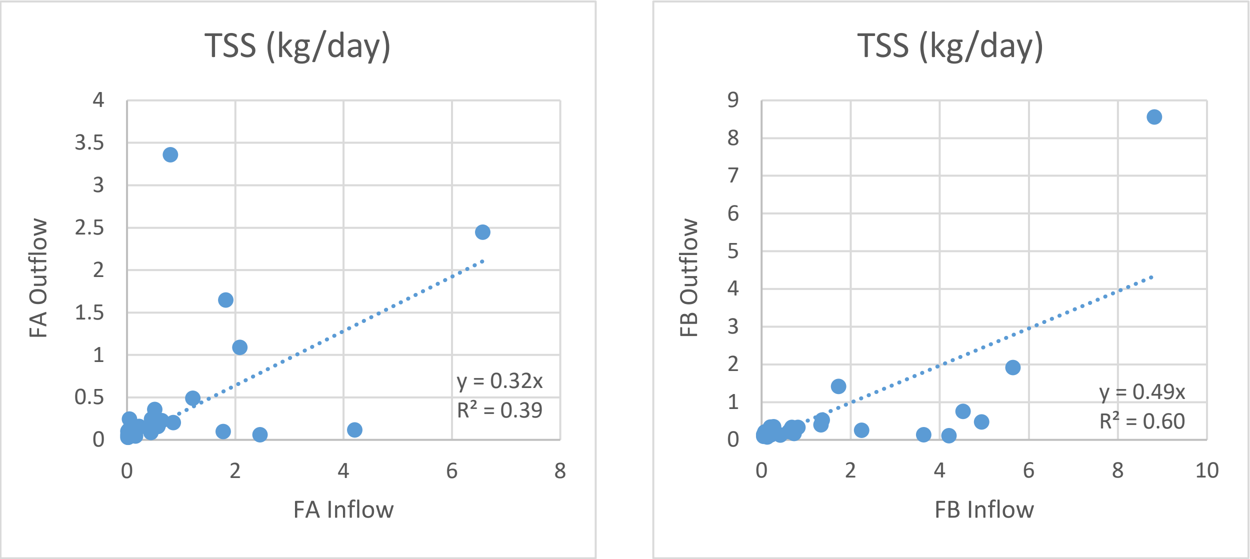


Figure 50. Filter A (left) and Filter B (right) inflow/outflow TSS loading regressions

The slopes of regression equations between inflow and outflow concentrations and loads provide alternate estimates of filter performance (Table 27). These estimates are all higher than the corresponding reduction estimates calculated from the unsorted, concentration and loading data (Table 26). The significance of the differences between inflow and outflow concentrations and loads was previously assessed using Wilcoxon rank sum tests (Tables 24 and 25).

Table 27. Concentration and load reduction estimates[1] derived from linear regression equations

Parameter	Concentration Reduction Estimates from Regression Line Slopes (%)		Load Reduction Estimates from Regression Line Slopes (%)	
	Filter A	Filter B	Filter A	Filter B
TP	**47**	**74**	46	**72**
TDP	**47**	**80**	48	**79**
TN	5	10	11	7
TSS	78	69	68	51

1. Statistically significant reductions in bold face

Among the statistically significant results, Filter A reduced both TP and TDP concentrations by 47%. Filter B was substantially more effective, reducing TP and TDP concentrations by 74% and 80%, with similar reductions in loads. Any effect on TN was marginal and non-significant. Considerable reductions in TSS concentrations in both filters were suggested by the regression equations; however, these were non-significant using the Wilcoxon rank sum tests.

The final type of inflow/outflow analysis we performed was to regress the filter efficiency (percent reduction among paired inflow/outflow concentrations) against inflow concentration. This type of analysis is meaningful because the efficiency with which a filter may remove a given constituent often varies as a function of the constituent's inflow concentration. Establishing the concentration range over which a filter is effective is critical in selecting appropriate locations to install P filters.

As is often the case, there is a great deal of scatter in the removal efficiency data at low influent concentrations. This was true for TP, TDP, TN, and TSS (Figures 51-54).

At the low end of the influent TP concentration range (~40 µg/L), Filter B appears roughly 30-50% efficient, while Filter A performs poorly, with ~0-20% TP reduction (Figure 51). At an inflow TP concentration of 300 µg/L, Filter B appears 50-60% efficient, while Filter A removes ~30-40%. The TP reduction efficiency of both filters improves with increasing inflow TP concentration, with Filter B continuing to outperform Filter A.

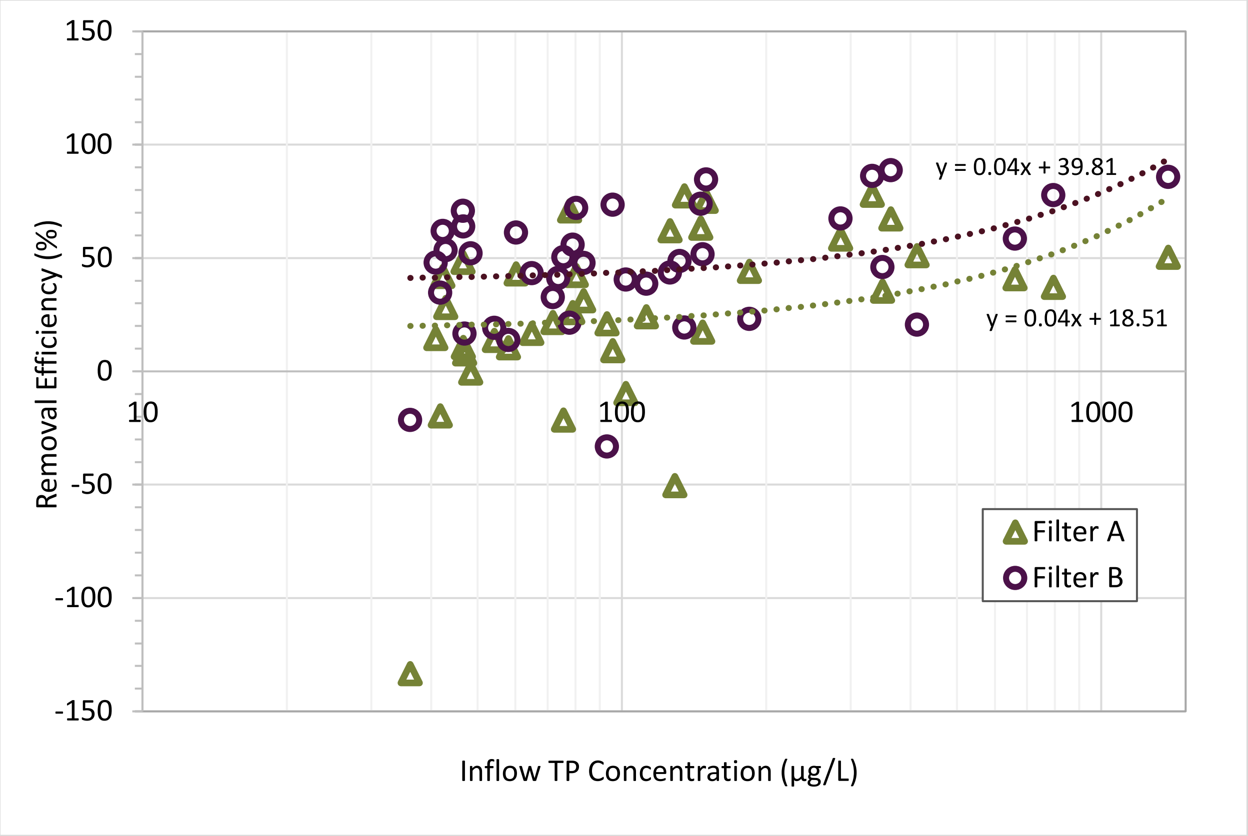


Figure 51. TP removal efficiency versus inflow TP concentration

The relationships between removal efficiency and inflow concentration follow a similar pattern for TDP (Figure 52). Filter B consistently outperforms Filter A over the entire range of inflow TDP concentrations, appears modestly effective at reducing TDP concentrations even at inflow concentrations in the 25-50 µg/L range, and is >50% efficient at inflow TDP concentrations above 300 µg/L.

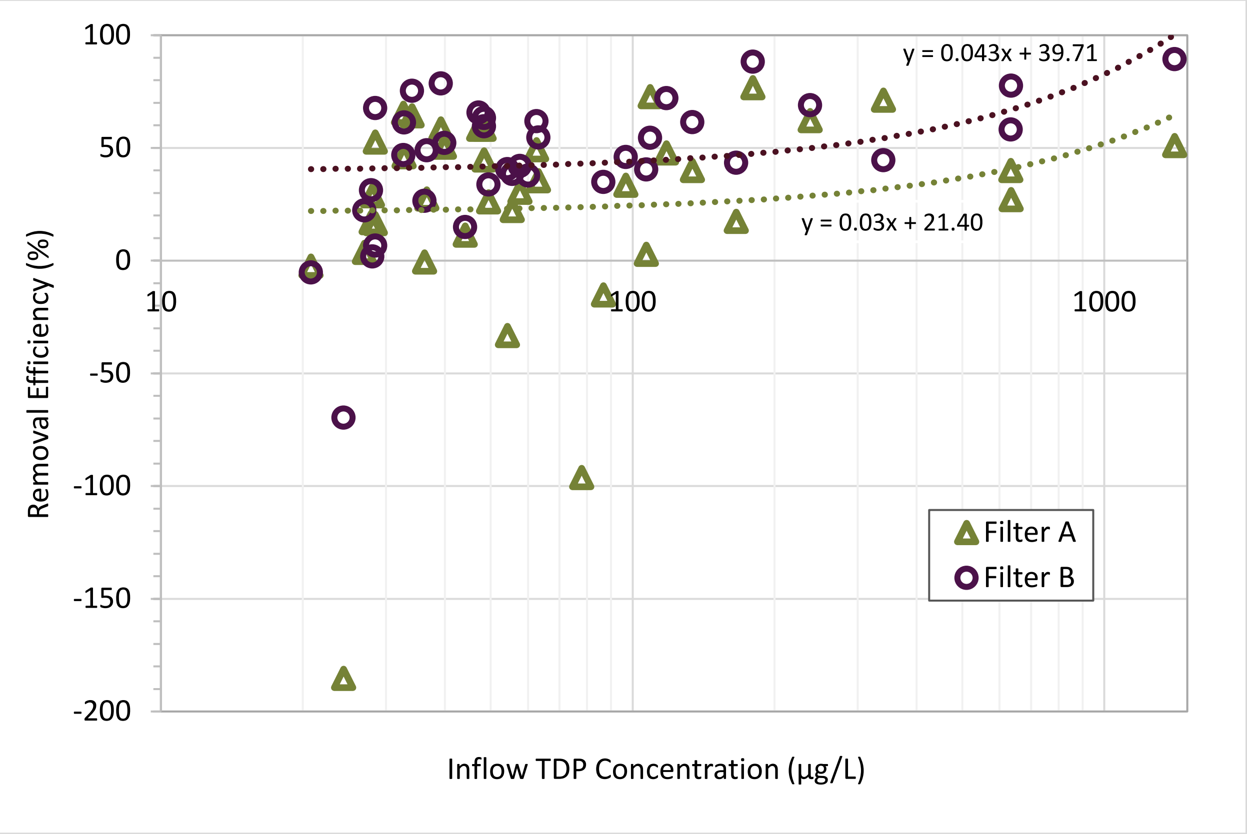


Figure 52. TDP removal efficiency versus inflow TDP concentration

Figure 53 illustrates a lack of TN reduction through the P filters regardless of inflow concentration.

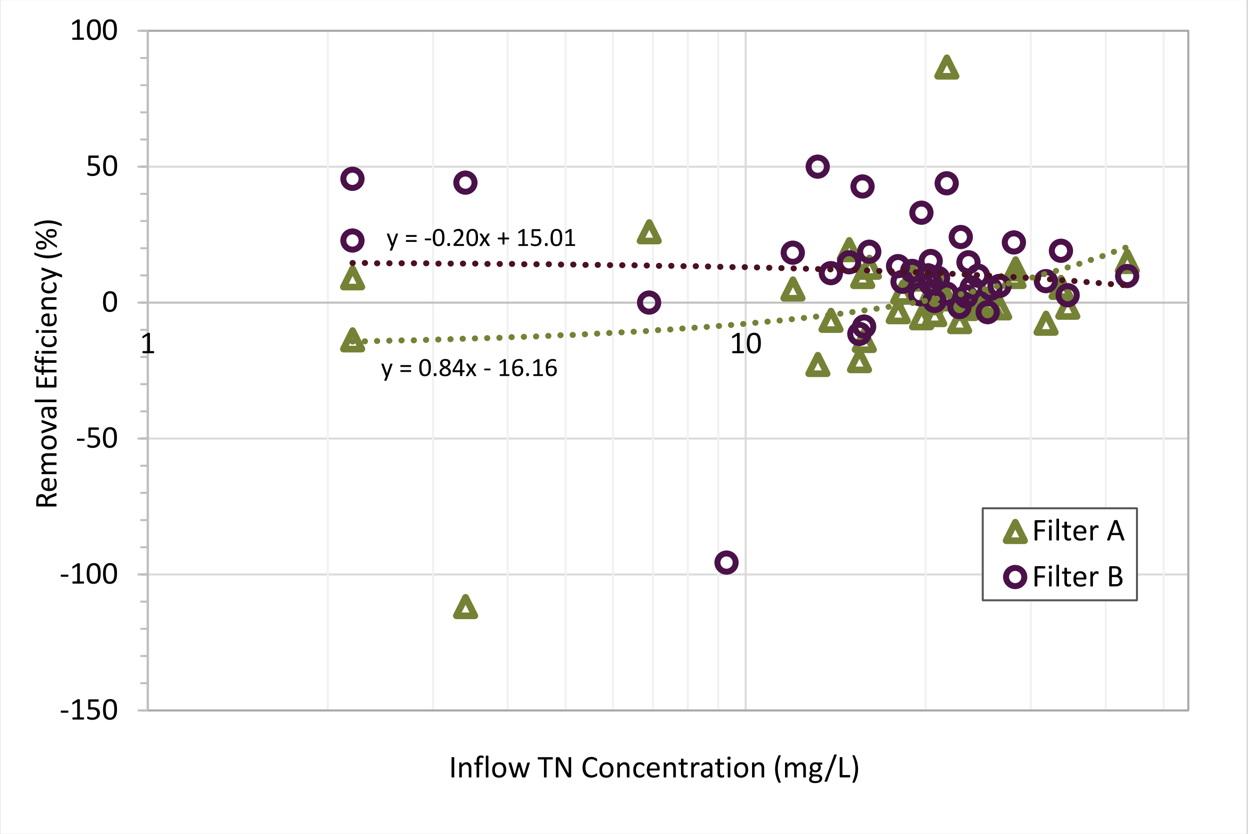


Figure 53. TN removal efficiency versus inflow TN concentration

There is a great deal of scatter in the TSS removal efficiency values at inflow TSS concentrations below about 15 mg/L (Figure 54). The limit of quantitation of TSS is 2 mg/L. At TSS concentrations approaching this limit, minor errors made during sample processing and analysis will become proportionally larger. Above ~15 mg/L of TSS in the inflow, the consistent TSS reduction we would expect to see is apparent.

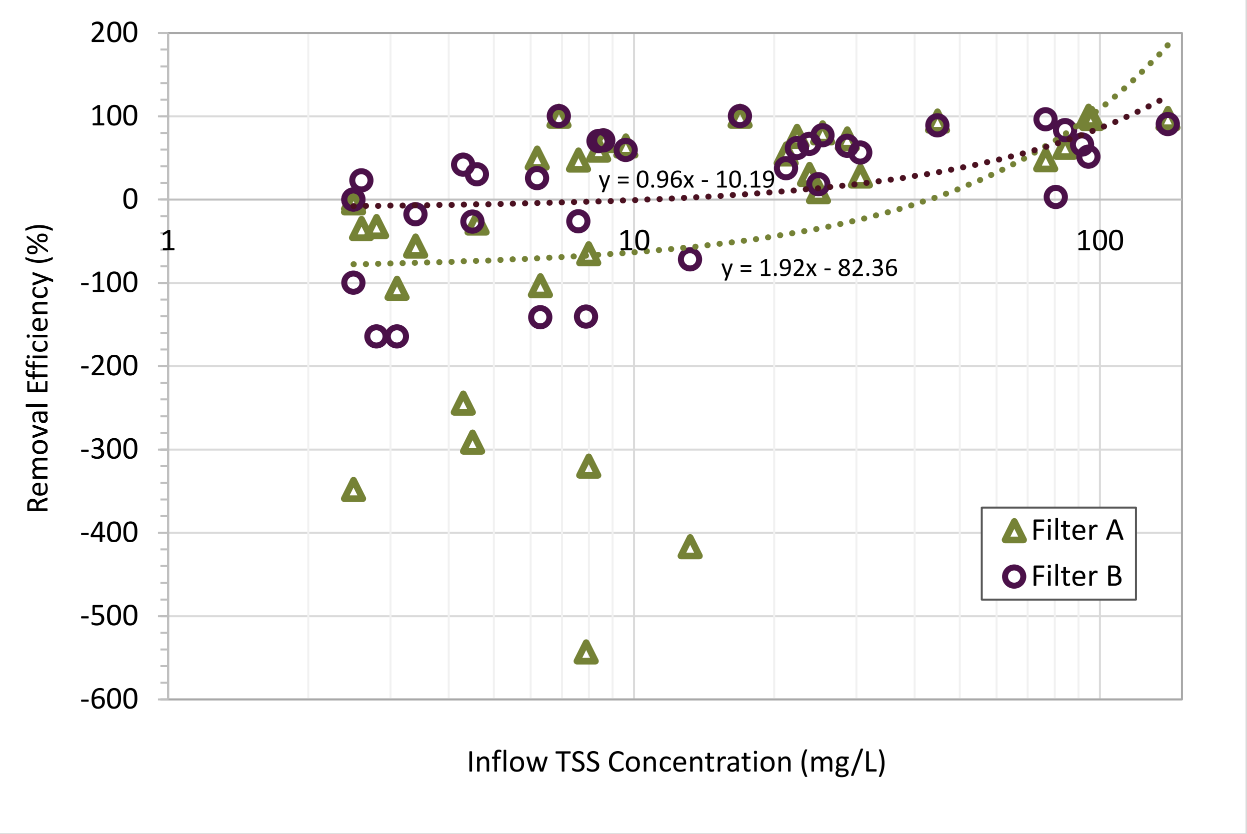


Figure 54. TSS removal efficiency versus inflow TSS concentration

Filter B removed a higher percentage of TP and TDP concentrations and loads than Filter A (Tables 26 and 27). Taken together, the two filters removed about 1.6 kg (3.5 lb.) of TP and 1.1 kg (2.4 lb.) of TDP over approximately 38 weeks between December 9, 2019 and January 5, 2021. The summer of 2020 was exceptionally dry; Jewett Brook stopped flowing and there was no tile drain flow for extended periods. Therefore, greater P removal should be possible in most years.

Substantial bypass flow occurred, which was not unexpected given the very large—94 acre—contributing field area. However, we had not fully appreciated the substantial impact high water levels in the receiving ditch could have on increasing bypass flow in this location. Similar filters constructed in less flood prone locations would treat a higher proportion of tile drain flow and remove more P. Despite this factor and the dry monitoring year, the P removal efficiency and flow rates through the filters were high enough that reasonably good P load reductions were obtained.

We believe this project demonstrated that our basic concept of building large, in-ground, up-flow, gravity filters containing a coarse (~1/2-inch diameter) aggregate amended with one or more P sorbing materials is sound. Filter A with Swanton black shale media significantly reduced TP and TDP concentrations, by about 40% using the more conservative estimates (Table 26). Amending the crushed shale with iron shavings and activated alumina (Filter B) substantially improved P removal relative to Filter A, achieving ~60% reduction in TP and ~65% reduction in TDP concentrations and ~60% reductions in TP and TDP loads, again using the more conservative estimates.

Given the short timeframe of the monitoring program, we were not able to adequately assess the life expectancy of the P filters. It is worth noting, however, that the highest flow rates recorded from Filter B (253 L/min) occurred on December 1, 2020 (Appendix B–Figure 4), more than a year after construction, and that on the final sampling date, January 5, 2021, the TP concentration was 72% lower in the Filter B outflow than in the inflow. The Filter A peak outflow rate on December 1, 2020 was nearly as high, 240 L/min (Appendix B–Figure 3), and the TP concentration reduction on the January 5, 2021 sampling date was reasonably good, 42%. These data suggest that neither the hydraulic function nor the P removal capacity of the filters were diminished one year from construction.

Considering P reduction efficiency as a function of inflow P concentration provides some insight into the relative benefit of constructing P filters at a given tile drain site. At low inflow P concentrations, both the P load available for treatment and the P reduction efficiency are lower. In this context, evaluating TDP removal efficiencies may be more meaningful than TP removal efficiencies because 1) the filters are intended as chemical treatment systems, not simply particle filters, and 2) dissolved phosphorus has greater impact in downstream waterbodies than the particulate fraction of TP, much of which is not biologically available. Figure 52 illustrates that relatively consistent TDP removal occurred in Filter B at inflow concentrations above about 60 µg/L. From this study, we suggest selecting tile drains having median inflow TDP concentrations above ~60 µg/L for construction of P filters. Total loading is a second criteria: if the cumulative P loading is too low, costs may outweigh the benefit of treatment. This is likely the case for tile drainage systems in fields of less than ~5 acres. A more complete benefit-cost analysis will be developed in Stone's upcoming tile drain P filter evaluation in the Lake Carmi watershed.

8.4. P Filter Design and Construction Improvements

Based on the results of this study, there are some refinements we recommend when siting, designing, and constructing P filters:

1. P filters constructed in an agricultural setting are an agricultural conservation practice. Vermont's Required Agricultural Practices (VAAFM, 2018) should be the prevailing regulations. P filters are installed on cropland, typically at the very edge of the field where the tile drain main passes from the cultivated portion of the field into a perennial buffer zone along a ditch or stream. The completed filter becomes a narrow "bump-out" along the edge of the cultivated field. In most tile drained fields, there is little flexibility regarding where a P filter can be sited given the layout of tile drain laterals. Recognizing these constraints, P filters should be set back from streams and ditches as far as possible without compromising their function.
2. While it is possible to design filters with submerged outlets, it is preferable to avoid this where possible. When the water level in the ditch approached the water surface elevation in the JBT05 manhole, the flow rate through the filters decreased and then occasionally stopped entirely (because the hydraulic head in the manhole and the ditch became equal), resulting in excessive bypass flow.

3. Use perforated, rigid pipe for distribution and collection pipes. The flexible tile drainpipe we used, while inexpensive, tends to float up and move as stone is added to the trench.
4. Prepare the filter media by blending materials on level ground before constructing the filters. Filling the filter trenches in lifts while raking in amendments was time consuming and difficult.
5. Simplify the piping to one distribution pipe and one collection pipe. The parallel pipes were likely unnecessary.
6. Replace the heavy plastic liner with geotextile.
7. Replace the distribution manhole with an Agri-drain water level control structure and buried pipes.
8. At some sites, it may be preferable to loop the treated water back to the existing tile drain main, downstream of the water level control structure, rather than creating a separate outlet for the filter. This design could add flexibility in filter siting and avoid some disturbance.

9. Conclusions

The Addison County tile drains selected for this study had significantly higher TP, TDP, and TSS concentrations than the Jewett Brook watershed tile drains. This finding is counter to the frequently expressed opinion that tile drains in the Jewett Brook watershed are likely to contribute more P than elsewhere in the Lake Champlain Basin (such as Addison County)—that, in this respect, the Jewett Brook watershed is essentially a non-representative outlier. We find that substantial P losses through tile drains are not confined to the Jewett Brook watershed but occur in Addison County also.

Our finding that P and TSS concentrations and loads in tile drainage water from the one field with sandy soils, ACT1, were dramatically lower than from the other Addison County fields, despite similar agronomic practices, is informative. While studies in other regions include similar findings (Beauchemin et al., 1998; Kleinman et al., 2003; Eastman, 2010), we are not aware of studies in the Lake Champlain Basin that have demonstrated effects of soil texture on P concentrations in tile drain flow. The earlier Jewett Brook tile drainage study by Braun et al. (2019) did not find significant differences in P concentrations or loads based on soil texture, possibly because differences in soil texture among the study fields were relatively minor.

The P filters Stone designed and constructed were able to treat substantial volumes of water, with flow rates up to approximately 250 L/min (except when the receiving ditch was full). The P filters significantly reduced TP and TDP concentrations in tile drainage water. Filter A containing only Swanton black shale reduced P concentrations by about 40%, while Filter B containing zero-valent iron and activated alumina reduced TP concentrations by approximately 60%, TDP concentrations by 65%, and TP and TDP loads by about 60%. Filter B also appeared to be more effective at removing P at low inflow concentrations than Filter A; under these conditions, the TP concentration in Filter A outflow was typically in the 30-50 µg/L range (minimum 23 µg/L), while the TP concentration in Filter B outflow was lower, in the 15-40 µg/L range (minimum 14 µg/L).

Considering only the 38 events with paired inflow and outflow data, Filter A removed approximately 0.6 kg of TP and 0.4 kg of TDP over the monitoring period, though these loading reductions were not statistically significant using Wilcoxon ranked sum tests. Filter B removed approximately 1 kg of TP and 0.7 kg of TDP, both significant reductions. Substantially higher P reductions would surely have been achieved if most of the tile drain flow did not bypass the filters during large events when the receiving ditch was full.

The analysis of P reduction efficiency indicated that reasonably consistent dissolved P removal occurred at inflow concentrations above 60 µg/L of TDP. This threshold may be a useful guide in selecting tile drains for implementation of P filters, until a more complete benefit-cost analysis is completed for the tile drain P filter evaluation Stone is now conducting in Lake Carmi watershed.

10. Deliverables Completed

Stone prepared quarterly progress reports within 10 days following the end of each calendar quarter. These quarterly reports provided updates on the progress of each task and described any problems encountered.

Stone prepared an interim report following completion of Task 6 of the workplan. This interim report described work performed through site characterization, monitoring station installation, and filter design and construction. The substance of this interim report has been incorporated in this final report.

This final report includes methods and results of both the extended tile drain monitoring and the tile drain P filter evaluation components of this project.

Stone presented its findings to the LCBP technical advisory committee on February 1, 2023, shortly following submission of the draft final report.

This study has been presented at the following events:

- Meeting of the Vermont Agency of Agriculture, Food, and Markets’ Tile Drain Advisory Group, December 17, 2019.
- Finger Lakes Institute, Water Pollution Prevention in the Seneca-Keuka Watershed (webinar series), May 28, 2020.
- Meeting of the Vermont Agricultural Water Quality Partnership, Scientific Advisory Committee, May 2, 2022.

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Appendix A: Quality Assurance Project Plan

Section 1. Project Management

1.1 Title and Approvals

Assessment of Tile Drainage System Impacts to Lake Champlain and Phosphorus Loads in Tile Drainage in the Jewett Brook Watershed of St. Albans Bay and in Addison County

Quality Assurance Project Plan, Version 2.0, Amendment 1
RFA# 19005

Prepared by
Stone Environmental, Inc.
535 Stone Cutters Way
Montpelier, VT 05602

This project is funded through EPA Grant Number LC96187501 and
the Great Lakes Fishery Commission FFY16 allocation to LCBP
End Date: July 30, 2022

Approved 2019-03-21

Dave Braun, Project Manager, Stone Environmental, Inc. — Date

Kim Watson, RQAP-GLP, Project QA/QC Manager, Stone Environmental, Inc. — Date 3/22/19

Mike Winchell, Vice-President, Stone Environmental, Inc. — Date 2019-03-21

Matthew Vaughan, Project Officer LCBP — Date

Peter Zaykoski, QA Program Manager, NEIWPCC — Date 3/26/19

Bryan Dore, Project Officer, EPA — Date 3/26/2019

Nora Conlon, QA Reviewer, EPA — Date

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Mike Winchell, Vice-President, Stone Environmental, Inc. Date

Matthew Vaughan, Project Officer, LCBP Date

Peter Zaykoski, QA Program Manager, NEIWPCC Date

Bryan Dore, Project Officer, EPA Date

Nora Conlon, QA Reviewer, EPA Date

1.2 Table of Contents

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1.4 Project/Task Organization

Table 1 below outlines the primary project participants and their roles in the project. The scope of this QAPP Version 2.0, Amendment 1 includes monitoring and assessment of tile drainage systems and primary data collection related to the design, installation, and monitoring of experimental tile drainage treatment systems.

Stone Environmental, Inc.:

Staff members from Stone Environmental will report to the project manager for technical and administrative direction. Each staff member has responsibility for performance of assigned quality control duties in the course of accomplishing identified sub-tasks. The quality control duties include: completing the assigned task on or before schedule and in a quality manner in accordance with established procedures and documenting and ascertaining that the work performed is technically correct and meets all aspects of the QAPP.

Table 1: Roles and responsibilities

Individual(s) assigned	Responsible for:	Authorized to:
Stone Environmental		
David Braun	Project manager, overall study design, landowner outreach, monitoring station design, treatment system design, treatment system construction oversight, monitoring station construction oversight, monitoring program oversight, non-routine maintenance, primary contact for the Lake Champlain Basin Program.	Coordinate project operations Document and approve all major project changes Develop monitoring station designs Supervise station construction Interim/final report preparation Lead design of treatment systems Oversee construction and monitoring of treatment systems
Serena Matt	Management of routine field operations, data management, computations.	Repair damage/breakdown in field stations Calibrate and maintain monitoring equipment Oversee collection and handling of water samples Conduct routine operation and maintenance of field stations Perform data QA/QC and reduction Provide data reports and outputs
Don Meals	Statistical analysis of monitoring data and interpretation of results.	Conduct statistical data analysis Interpret project findings
Kim Watson, RQAP-GLP	Quality review.	Evaluate all aspects of project operations for compliance with approved QAPP Resolve QA/QC issues
LCBP		
Matthew Vaughan	Maintain and distribute the approved QAPP.	

1.5 Special Training Requirements/Certifications

Personnel with considerable expertise and experience in performing the project tasks will conduct all sampling and analysis for the project. If field data collection is done by subcontracted personnel at certain sites, initial training will be led by the Stone Environmental Project Manager or his designee. The Project Manager or his designee will also be responsible for continued coordination of field operations and maintenance of consistency among field sampling personnel. This consistency will be aided by the use of standard checklists and forms for sample retrieval and station maintenance (see Appendix A, Study Specific Procedure). All personnel performing the project tasks will have documented training in their respective duties and shall have read the applicable SOPs. Stone Environmental maintains training records for all staff that document relevant training and SOP review. Laboratory analysis will occur at the Vermont Agriculture and Environmental Laboratory (VAEL) under the direction of the Laboratory Director. No additional specialized training or certifications are necessary for personnel to conduct the project tasks.

Section 2. Project Definition and Objectives

2.1 Problem Definition/Background

Subsurface drainage is an essential agronomic practice on many agricultural fields in the Lake Champlain Basin (LCB), allowing timely equipment access, reduced soil compaction, and increased crop yields in fields otherwise too wet to efficiently farm. The combined effects of drawing down the water table and providing rapid conveyance of subsurface water to an outlet can significantly change the hydrologic behavior of a field, generally reducing surface runoff by enhancing infiltration and ground water transmission. Until recently, it was widely believed that, despite hydrologic changes caused by installation of subsurface drainage, phosphorus (P) losses from agricultural lands occurred primarily via surface runoff and that very little P was lost through subsurface drainage, such that tiling a field could reasonably be expected to reduce P losses.

Recent research has revealed that subsurface drainage systems in agricultural fields can discharge significant quantities of P under a wide range of soil characteristics and management practices and should be considered in management strategies seeking to minimize nonpoint source pollution of surface waters.

In Vermont and across the LCB, little is known about the extent of tile drainage systems, and the potential impacts of tile drainage systems on water quality have not been assessed. To address this knowledge gap, the Project Team will monitor representative tile drainage systems in the Jewett Brook watershed (JBW) and Addison County, estimate P loading from these tile systems, and assess the significance of this loading to the overall P export from the JBW and similar areas of the LCB.

A promising approach to reducing P loading from agricultural tile drains is the development of media filters to remove P from tile drainage water. Experimental filters to remove P from tile drains will be developed and monitored in this study. This QAPP applies to both the primary and secondary data collection activities involved in monitoring the selected tile drains as well as the development and monitoring of two P filtration systems.

2.2 Project Objectives

The objectives of the tile drainage systems assessment are:

1. To evaluate characteristics of the Jewett Brook Watershed in Franklin County and provide detailed characterization of field areas drained by tile drainage systems selected for monitoring in Franklin County and Addison County.
2. To measure total and dissolved P concentrations and flow and calculate P loads from representative tile drainage systems in the Jewett Brook Watershed in Franklin County and additional sites in Addison County.

3. To characterize the distribution of total nitrogen and total suspended solids concentrations in drain flow from representative tile drainage systems in the Jewett Brook Watershed in Franklin County and additional sites in Addison County.
4. To design and install two P filtration systems and evaluate their performance in reducing soluble and particulate P loading from an agricultural tile drain. Analyses of soil samples collected at the site of the tile drain filters will provide data on soil texture and nutrient concentrations in the study field, which are critical reference values that will be used in comparing this test site to other fields in the Lake Champlain Basin and nationally.

Section 3. Primary Data Collection Activities for Select Tile Drain Systems

3.1 Study Location

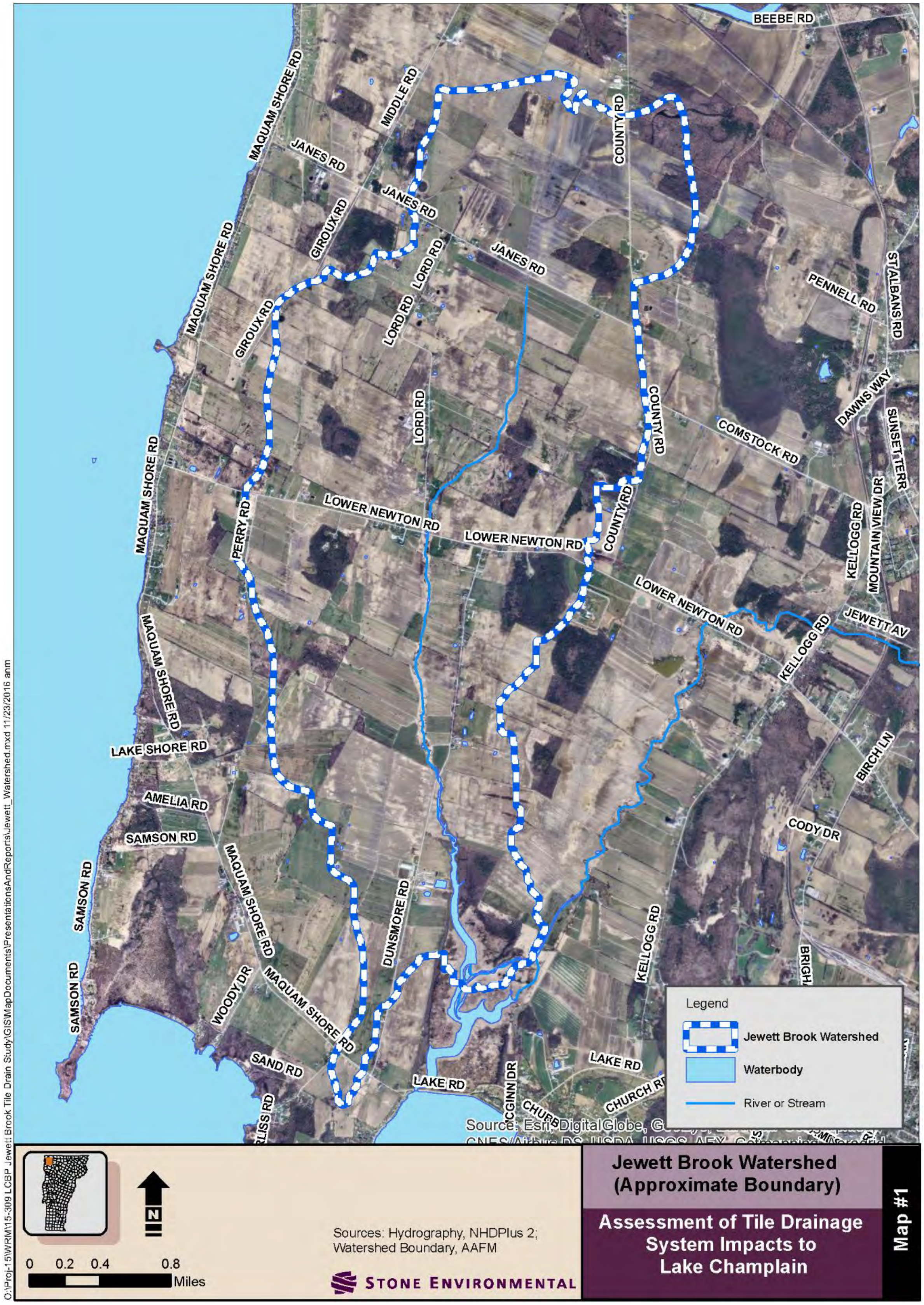
The study will be performed in two areas, the Jewett Brook Watershed (JBW) in the Town of St. Albans, Franklin County, Vermont and at several sites on farms in Addison County, Vermont. Jewett Brook flows to St. Albans Bay, a eutrophic bay of Lake Champlain (see Map 1). In 2017. monitoring stations were constructed near the outfalls of 12 tile drainage systems selected for monitoring in the JBW. Monitoring has continued at five of these sites (JBT05, JBT06, JBT07, JBT11, and JBT18) and will continue until the spring of 2019 under this QAPP Version 2.0. Monitoring commenced at five sites in Addison County upon approval of this QAPP Version 2.0 on November 21, 2018.

The proposed site for the tile drain treatment study is JBT05. JBT05 is among the sites in the Jewett Brook watershed at which monitoring has been extended. It drains a large cornfield and has been shown to discharge significant amounts of P.

3.2 Monitoring Site Selection

Through a comprehensive outreach effort to farmers and agricultural agents operating in the Jewett Brook Watershed (JBW), Stone Environmental secured agreements in 2016 with 6 of the 11 farmers believed to crop tile-drained land in the JBW to allow for monitoring of selected tile drain outlets. Taken together, 18 tile drainage systems were identified across these farmers' managed lands. Several of these tile drains are clearly not suitable for monitoring. The main reason certain tile drains were determined to be unsuitable is that they drain very small areas (<5 acres) and thus produce relatively little drainflow. Most of these tile drains were dry when visited in the summer of 2016. One other tile drain was eliminated from consideration because it was installed primarily to drain barn roof runoff via surface inlets. After excluding these unsuitable tile drains, 15 tile drains that could potentially be monitored were identified, although several of these have obvious drawbacks, including 2 with known surface inlets (standpipes and/or rock inlets). Given that the number of tile drain outlets available for monitoring was only slightly higher than the number to be monitored, no formal site selection criteria were established. Farmer cooperation and practical realities necessarily superseded efforts to intentionally represent a range of field conditions (e.g., cropping system, soil type, hydrologic soil group, soil test P, and age, layout, and depth of tile drain system) in the watershed.

In May and June 2018, meetings were held to identify farmers with tile drained land in Addison County. A total of 11 tile drain outlets were identified on three farms. Considering location,



Sources: Hydrography, NHDPlus 2;
Watershed Boundary, AAFM

access, drainage area, and crop, five sites were selected for monitoring in Addison County that best meet the objectives of the study.

3.3 Characterization of Tile Drained Field Areas

For the JBW sites, the best available geographic data were assembled and reviewed, including cropping patterns and soils data. The source of the soils data was the SSURGO database, maintained by USDA-NRCS. Statistics regarding cropping patterns in the watershed (acreage in permanent corn or hay production or in specific rotations) and dominant soil types and slope classes, for land with and without tile drainage, were summarized for Stone by the Vermont Agency of Agriculture, Food & Markets based on their 2015 *St. Albans Bay Watershed Cropland Inventory* (unpublished) without attribution to individual farmers or land ownership. In characterizing these fields, producer confidentiality was strictly maintained.

Detailed information was obtained for fields served by the 12 tile outlets selected for monitoring. This includes the JBT05 field, the site of the tile drain treatment study. Extent of drained area, drain spacing, tile depth, and system construction and age were defined based on information provided by the landowner, as was information on the cropping system and manure/fertilizer inputs within the drained area. Phosphorus application rates and soil test P data were assembled from nutrient management plans, where accessible, and interviews with the participating farmers and/or their technical service providers. These data are being used to analyze associations among agronomic and water quality variables and in computation of tile drain P loads in the JBW.

For the Addison County sites, soil type and slope class data will be acquired from the SSURGO database. In characterizing these fields, producer confidentiality will be strictly maintained. Detailed information will be obtained for fields served by the five tile outlets selected for monitoring. Extent of drained area, drain spacing, tile depth, and system construction and age will be defined based on information provided by the participating farmer, as will information about the cropping system and manure/fertilizer inputs. Phosphorus application rates and soil test data will be assembled from nutrient management plans, where accessible, and interviews with the participating farmers and/or their technical service providers.

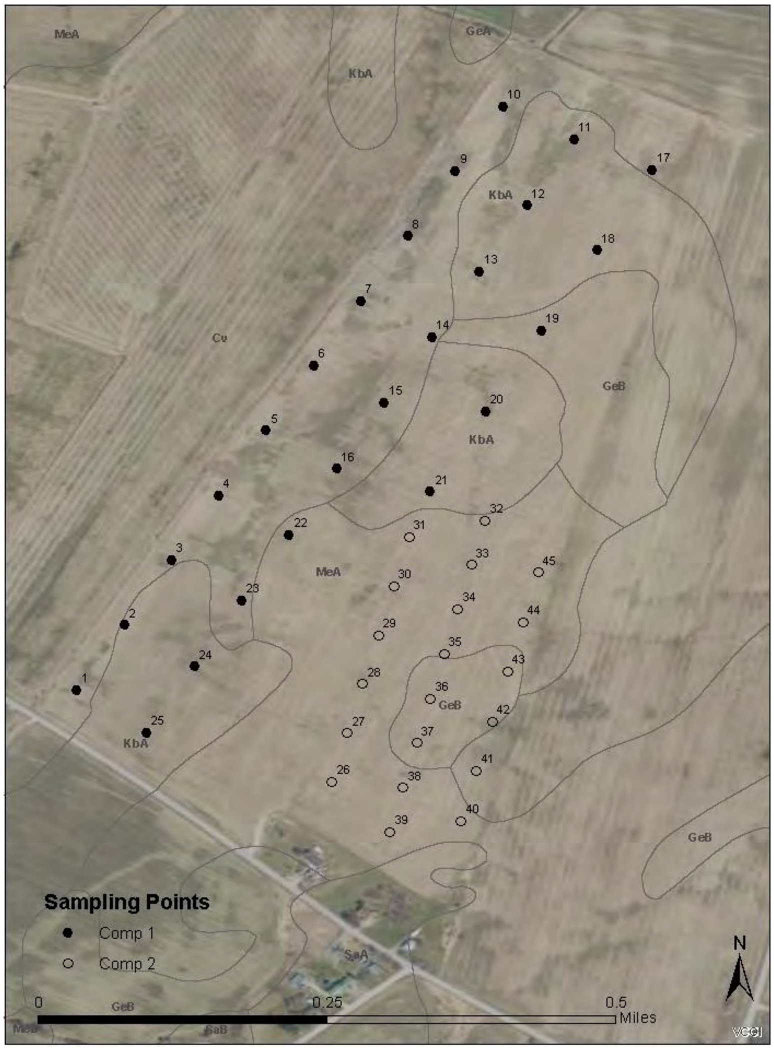


Figure 1. Soil sampling locations in JBT05 study field

At the JBT05 site, soil physical and chemical properties data will be obtained through soil sample collection and analysis. Sampling will be performed in May or June of 2019. The study field will be sectioned in two portions, a lower section comprised of clay soils (mapped as Covington and Kingsbury clays) and an upland section comprised of loam soils (Massena and Georgia stony loams). A representative composite sample will be collected from each section. Soil samples from the 0–15 cm depth will be collected at nodes in a sampling grid (Figure 1) using a stainless steel soil probe. Individual soil samples will be blended in a bucket using a garden trowel. The trowel will be used to transfer approximately two cups (0.5 L) of the composited sample into a labelled polyethylene bag. The remaining soil will be discarded. Soil samples will be held under ambient conditions and transported to the Agricultural and Environmental Testing Laboratory at UVM in Burlington, VT. Samples will be analyzed for pH and available P, K, Mg, Ca, Fe, Mn, and Zn following extraction in modified Morgan solution. Organic matter will be quantified by the loss on ignition method and reported in Walkley-Black method equivalents. Soil particle size will be analyzed by wet sieving and the hydrometer method.

3.4. Design and Installation of P Filters

Stone will design two filters to remove P from tile drain JBT05. Plans and specifications will be prepared that are suitable for construction.

The types of media used in the filters will be determined by Stone scientists in consultation with project advisors. Because no standard operating procedures exist for this task, they will be developed and documented as part of this project. At this time, we are considering several types of medias: 1) activated alumina beads blended in pea stone, 2) iron oxide pellets blended in pea stone, 3) solid drinking water treatment residuals adhered to pea stone, and 4) a porous stone aggregate saturated with aluminum sulfate (alum) or polyaluminum chloride and dried. These candidate medias combine a fine P sorbent with a large (~1 cm) diameter, stable aggregate possessing good flow-through capacity. A fifth option to be considered is a local mineral product (a crushed shale) currently marketed as St. George Black. Any of these medias would need to be prepared in quantity for use in the P filters.

Estimated P sorption capacity, hydraulic properties, cost, and necessary preparations will be considered in reviewing media options. Bench testing of 2-3 candidate medias will be performed to evaluate their P sorption potential in model filters. An artificial P solution containing ~200-400 µg/L P will be recirculated through each media bed. This solution will be sampled daily for orthophosphate concentration using Hach PhosVer 3® (Ascorbic Acid) Method 3 and a Hach DR900 colorimeter. When the orthophosphate concentration in the influent solution falls below 200 µg/L, a known mass of P will be added using a concentrated stock solution to bring the solution concentration up to approximately 300 µg/L. The mass of P removed by the filters over the course of the bench testing will be calculated by summing the known P additions, accounting for the volume and orthophosphate concentration of the solution at the beginning and end of the experiments.

Under normal operation, the pumping rate in the model filter will be set to produce a negligible (<2 cm) difference in hydraulic head between the filter inlet and outlet. To evaluate the hydraulic conductivity of the media, the pumping rate will be increased until a substantial difference (~5 cm) in hydraulic head is seen between the inlet and the outlet. The steady-state pumping rate necessary to achieve this head difference will be measured by filling a container of known volume at the model filter outlet. This pumping rate divided by the area of the saturated cross-section of the model filter will approximate the hydraulic conductivity of the media.

After the conclusion of this evaluation, two types of media will be recommended for use in the filters. Stone will oversee construction of the P filters by a hired contractor. Materials will be assembled on site. Structures will be installed per the approved plans, at predetermined elevations. The media beds will be covered with native soil to the ground surface.

3.5 Monitoring System Design

At each of the selected tile drains and filter outlets, drainflow will be recorded continuously and flow-proportional composite water samples will be collected approximately weekly to provide total phosphorus (TP), total dissolved phosphorus (TDP), and total nitrogen (TN) concentration data representing the preceding period. Weekly discharge and weekly composite sample data will be used to compute weekly P loads; flow, concentration, and load data will be aggregated to calculate flow volume, distributions of TP, TDP, and TN concentrations, and cumulative TP and TDP loads at outflows by month and over the entire monitoring period. Field visits to retrieve and process composite water samples will be conducted per the Study Specific Procedure provided in Appendix A each week when the monitored tile drain is flowing. The sampling schedule may be influenced by weather and agronomic considerations, including collecting more frequent samples during certain farm operations such as manure or fertilizer application.

Subsequent to approval of this QAPP on November 21, 2018, sampling began at the Addison County sites. In addition to TP, TDP, and TN samples, collection of samples for total suspended solids (TSS) analysis was begun at all the monitoring stations, including the original JBW stations.

3.6 Monitoring Duration and Frequency

System operation, sample collection, and sample analysis are continuing at the five original Jewett Brook sites selected for continued monitoring. Construction of the Addison County sites was completed in October-November 2018 and monitoring commenced immediately following approval of this QAPP Version 2.0. Monitoring of the P filter outlets will commence immediately following filter construction, which is anticipated no later than June 2019. Stations will remain operational though dry periods, although samples will obviously not be collected if tile outlets cease flowing. During the winter, autosamplers will be turned off to avoid damage. However, weekly grab samples will be collected from the tile drains when discharge occurs.

Weekly retrieval, processing, and analysis of flow-proportional composite water samples will provide data representing an event mean concentration (EMC) for each constituent for the preceding period. Samples will be retrieved on the same day each week, to the maximum extent practicable.

The sampling schedule will be influenced by weather and agronomic considerations; however, the following general schedule of monitoring activities is expected:

1. Monitoring systems installation completed, and sampling initiated at Addison County sites in November 2018. System operation, sample collection, and sample analysis will continue from November 2018 to November 2019 with the exception of December 2018 – April 2019 when continuous monitoring may be suspended due to freezing conditions.
2. Monitoring continued at Jewett Brook sites JBT06, JBT07, JBT11, and JBT18 through June 2019.
3. Monitoring of site JBT05 and the two P filter outlets is currently scheduled to continue through December 2019.

3.7 Pollutants of Concern

The principal pollutant of concern is phosphorus. In addition to the potential impacts of P on immediate receiving waters, P is the primary cause of eutrophication-related impairments in Lake Champlain. Nitrogen losses are also of concern. Both N and P losses are also undesirable from an agronomic standpoint.

3.7.1 Constituents to be monitored

All water samples collected under QAPP Version 2.0 will be analyzed for TP, TDP, and TSS. Collection of TN samples will occur approximately every two weeks, at the direction of the Vermont DEC.

3.8 Sampling Procedures

This QAPP update (Version 2.0) concerns continuation of monitoring activities at five stations installed in the Jewett Brook watershed and installation, operation, and monitoring of five additional tile drain monitoring stations in Addison County, Vermont.

Monitoring and sampling methods will be consistent for the duration of the study period. Trained personnel will be responsible for satisfactory sampling operations and maintenance of monitoring stations (per the Study Specific Procedure, Appendix A), and processing of field data. Field personnel will be responsible for recording failures of sampling systems and taking corrective actions.

Table 2 summarizes the number and type of samples that are anticipated to be collected under this QAPP Version 2.0, Amendment 1. It is assumed that, on average, tile drains would flow 42 weeks per year (no discharge would be present on 10 weekly sampling visits due to dry or frozen conditions). During most weekly sampling events, it is assumed that a single set of sample splits will be processed. On one in four sampling events, it is assumed two carboys would need to be processed into two sample splits per analyte. A minimum of 10% additional QC samples are included in the sample estimates.

The estimated number of samples at all stations was calculated as:

	JBW	Addison Co.	
	5	5	stations
x	26	42	weeks (assumes tile outlets are not flowing 12 weeks per year)
x	1.25		samples per event per station (assumes a single set of splits will be taken most weeks and two sets of splits will be taken roughly one week out of four)
x	1.1		accounts for 10% field duplicates
=	179	289	Total of 468 samples

Table 2. Sample types to be collected

Matrix	Analytical Parameters	Sample Container	Number of Samples	Sample Preservation	Hold Time (days)
Water	TP[1]	Polyethylene bottle (composite) / 60-mL glass vial (aliquot for lab)	468	None	28
Water	TDP[1]	Polyethylene bottle (composite) / 60-mL glass vial (aliquot for lab)	468	Filtered (0.45 µm) in field	28
Water	TN	Polyethylene bottle (composite) / 50-mL plastic centrifuge tube, blue cap (aliquot for lab)	234	Cool (<6°C), 0.1 mL H_2SO_4	28
Water	TSS	Polyethylene bottle (composite) / 1-L polyethylene bottle (aliquot for lab)	468	Cool (<6°C)	7
Soil	pH	Polyethylene bag	3	None	180
Soil	Available P	Polyethylene bag	3	None	180
Soil	Available K	Polyethylene bag	3	None	180

Matrix	Analytical Parameters	Sample Container	Number of Samples	Sample Preservation	Hold Time (days)
Soil	Available Mg	Polyethylene bag	3	None	180
Soil	Available Ca	Polyethylene bag	3	None	180
Soil	Available Fe	Polyethylene bag	3	None	180
Soil	Available Mn	Polyethylene bag	3	None	180
Soil	Available Zn	Polyethylene bag	3	None	180
Soil	Organic matter	Polyethylene bag	3	None	180
Soil	Particle size	Polyethylene bag	3	None	180

1. VAEL employs an EPA-approved variant of standard methods wherein samples for phosphorus analysis are digested in the same glass storage vial in which they are collected. No acidification is necessary.

3.8.1 Water sampling instrumentation

ISCO 6712 automatic samplers will be used to collect samples of drainage water from each of the monitored tile drains and filter outlets. Sample lines will be inserted into a monitoring manhole or weir box constructed to intercept the buried tile line. Discharge monitoring is discussed in more detail in Section 3.9.

The autosamplers will be programmed to withdraw sample aliquots on a flow-proportional basis, according to the frequency of flow pulses received from the flowmeter. Flow-proportional sampling is challenging because discharge rates are highly variable and difficult to predict. If sample aliquot collection is too infrequent (e.g., in small flow events), insufficient sample volume may be collected to perform the intended analyses. If sample aliquots are collected too frequently (e.g., in an unexpectedly large flow event), the bulk sample container may not have the capacity to contain samples over the entire event, resulting in a non-representative sample. To minimize the occurrence of under-sampling and overfilling, a two-part program will be used whereby the autosampler pumps sample aliquots to two sets of containers at different intervals of accumulated discharge. Each bottle set will consist of two 10-L polyethylene carboys. The first bottle set (Set A) is intended to capture a representative sample at low flow rates and the second bottle set (Set B) is intended to capture a representative sample at high flow rates. Set B will be filled at approximately one tenth the frequency of Set A. The second bottle in each set will be filled only after the first is full, at the same frequency as the first.

Per the Study Specific Procedure (Appendix A), sampling personnel will select either Set A or Set B for analysis, but not both sets. Any sample in the bottle set not chosen will be discarded. If Set B contains sufficient sample volume (approximately 1 L is required) to perform the required analyses, Set B will be processed, and Set A discarded. If Set B does not contain sufficient sample volume, Set A will be used and any sample in Set B will be discarded.

In most events, only the first bottle in the selected bottle set will contain sample. However, if both bottles #1 and #2 in the selected set contain sample, the sample volumes will be combined in the large capacity (14-L) churn splitter used to obtain sample splits, unless doing so would exceed the capacity of the churn splitter. If greater than 14 L is collected in total in the selected bottle set, then bottles #1 and #2 will be processed independently. Split samples from both bottles will be submitted for analysis to allow calculation of total P flux.

Adjustments to the autosampler programs to increase or decrease the sampling frequency will be made either by direct connection or via remote access. Failure of the system to collect at least three sample aliquots in bottle Set A during a weekly period or exceeding the capacity of all sample bottles in Set B may result in rejection of the sample as non-representative.

3.8.2 Collection of water samples

Approximately weekly, field technicians will visit each station to process water samples according to the Study Specific Procedure included as Appendix A. If the tile line has not flowed, no sample will have been collected; this will be noted on the Sample Retrieval Form (Appendix A).

Collected water samples will be transported on ice to VAEL in Burlington, VT within the stated holding times for each analyte. Samples will be tracked using a Chain of Custody form (Appendix A) that will be completed by the sampler and will accompany all water samples delivered to VAEL. The Chain of Custody form includes sample IDs, number of containers of each sample being sent to the lab, and the analyses requested. Once the water samples are accepted by VAEL, they will be subject to the lab's internal tracking system.

3.9 Discharge Measurement

An excavation will be made to install a monitoring manhole accessing the buried tile line. Depending on the elevation of the tile drain and filter outlets relative to the water surface in the receiving ditch or stream, one of two types of flow monitoring systems will be installed within the monitoring manhole. Where submergence of the tile drain outlet is unlikely, an appropriately sized Thel-mar weir with ultrasonic level sensor will be installed in the manhole in the outlet pipe. Where the outlet is likely to become submerged during high water levels, an electromagnetic flowmeter will be installed on the inlet pipe within the manhole.

3.9.1 Discharge measurement at free-flowing outlets

The primary hydraulic device used at free-flowing (not submerged) tile outlets will be an appropriately-sized Thel-mar weir.

An ultrasonic water level sensor (ISCO 2110 Ultrasonic Flow Module) will be mounted immediately upstream of the Thel-mar weir to continuously measure stage (water level). The stated accuracy of this instrument is the greater of ±0.00396 m or 0.00256 m per foot (0.305 m) from the calibration point. Level data will be converted to discharge rate based on the established hydraulic rating of the weir. These data will be used in calculation of discharge corresponding to each weekly sample and in calculation of pollutant export.

3.9.2 Discharge measurement at non-free-flowing outlets

To monitor flow at the tile drain outlets that are submerged or likely to become submerged at high water levels, the flowmeter will be installed on a trap section of pipe to ensure full pipe flow. A short section of pipe will be cut out and replaced with rigid pipe and fittings, forming a trap. A Krohne Waterflux 3000 electromagnetic flowmeter will be installed in the trap section, cabled to a signal converter (Krohne IFC 100) mounted above ground in an instrument enclosure. This sensor has outstanding accuracy at high flow rates (less than +/-0.3% in a 6-inch diameter pipe at flows above 300 gallons per minute) and better accuracy at low flows than any similar pipeline flowmeter (for example, 3% in a 6-inch diameter pipe at 5 gallon per minute). The sensor is rated for full submergence and direct burial.

3.10 Precipitation Monitoring

A simple meteorological station will be used for continuous monitoring of rainfall and air temperature. Air temperature will be recorded as hourly and daily, minimum, maximum and average values throughout the study period. The temperature sensor will be housed in an appropriate solar radiation shield. A tipping bucket rain gage will be installed above the maximum crop canopy level. Every tip, marking accumulation of 0.01-in. (0.254-mm) of rainfall, will be recorded in memory with a time stamp. These precipitation data will enable evaluation of the proportion of incident rainfall expressed as tile drain flow.

3.11 Testing and Measurement Protocols

All water samples will be analyzed by the standard methods of the Vermont Agriculture and Environmental Laboratory (VAEL). These methods and relevant data quality objectives, assessment procedures, and reporting limits are described in the VAEL's Quality Systems Manual, Revision 23, dated December 18, 2015. Methods of analysis for each analyte are summarized in Table 3 and are provided in Appendix B (TP and TDP), Appendix C (TN), and Appendix D (TSS). Soil samples will be handled through the UVM Agricultural and Environmental Testing Lab and analyzed for the methods listed in Table 3.

Table 3. Analytical methods

Sample Matrix	Analytical Parameter	Lab	Method	Reference
Water	TP	VAEL	4500-P H	1
Water	TDP	VAEL	4500-P H	1
Water	TN	VAEL	4500-N C-modified	1
Water	TSS	VAEL	2540-D	1
Soil	pH	AETL	Potentiometric measurement of soil slurry (1:2, V:V) with dilute calcium chloride, using electronic pH meter.	2
Soil	Available aluminum	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2

Sample Matrix	Analytical Parameter	Lab	Method	Reference
Soil	Available boron	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available calcium	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available copper	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available iron	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available magnesium	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available manganese	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available phosphorus	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: Molybdate blue procedure with colorimetric analysis.	2
Soil	Available potassium	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available sulfur	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Available zinc	AETL	Extraction: Modified Morgan solution, 5:1 V:V, shake 15 minutes, filter. Analysis: ICP-AES.	2
Soil	Cation exchange capacity	AETL	CEC at pH 7 with Ammonium Acetate	2
Soil	Organic matter	AETL	Loss of weight on ignition	2
Soil	Particle size	AETL	Wet sieve and hydrometer	3

References:

1. Standard Methods for the Examination of Water and Wastewater; 21st Ed. 2005.
2. Recommended Soil Testing Procedures for the Northeastern United States. 3rd Edition. Northeastern Regional Publication No. 493. Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. Revised July 1, 2011.
3. Gee, G.W. and J.W. Bauder. 1986. Particle-size analysis. p. 383-411. In A. Klute (ed.) Methods of Soil Analysis, Part 1. Physical and Mineralogical Methods. Agronomy Monograph No. 9 (2 ed.). American Society of Agronomy/Soil Science Society of America, Madison, WI.

3.12 Quality Assurance/ Quality Control (QA/QC)

3.12.1 Quality objectives and criteria for measurement data

The project data-quality objective is to collect, provide, maintain, analyze, display, and document valid water quantity and quality data. The monitoring information that will be collected to support project objectives will meet the quality assurance objectives outlined in this section. Data quality will be measured in terms of accuracy and precision, representativeness, comparability, completeness, and traceability.

Table 4 summarizes data quality requirements associated with the water sampling program and the accuracy and precision levels reported by the analytical laboratory for each parameter. The analytical laboratory for the water samples is VAEL, which is currently located on the University of Vermont campus in Burlington. VAEL is accredited by New Hampshire under the National Environmental Laboratory Accreditation Program (NELAP) for the specified water quality parameters. Table 4 also summarizes the data quality requirements associated with meteorological measurements, as stated by the instrument manufacturer.

Discharge measurement will document the rate and total quantity of drain flow over the course of the study. Analysis of flow-proportional water samples will provide mean concentrations of each monitored constituent. Mass of each monitored constituent will be computed from interval and total discharge volumes and constituent concentrations. To ensure data quality objectives are met, all sampling activities will be well-documented and will occur in accordance with the specifications presented in this QAPP.

For the QC samples, field duplicates will be collected of TP, TDP, TN, and TSS samples. Duplicates will be collected on a rotating basis among stations. Samples from one or two stations will be collected in duplicate on every event, such that at least 10% of the total sample load is collected in duplicate. Grab samples collected during the winter months will be collected in duplicate according to the same scheme used for the composite sample splits.

Table 4. Data quality requirements and assessments for water analyses and meteorological measurements

Matrix	Parameter	Units	PQL[1]	Accuracy[2]	Accuracy protocol	Precision Lab/Field[3]	Precision protocol	Method Range
Water	TP	µg/L	5 µg/L	85-115%	Spike recovery	15/20	Field duplicate	5 – 200 µg/L
Water	TDP	µg/L	5 µg/L	85-115%	Spike recovery	15/20	Field duplicate	5 – 200 µg/L
Water	TN	mg/L	0.1 mg-N/L	85-115%	Spike recovery	10/20	Field duplicate	0.05 – 2.0 mg-N/L
Water	TSS	mg/L	1 mg/L	80-120%[4]	N/A	15[4]/20	Field duplicate	1 – 2000 mg/L
Air	Temperature	ºC	N/A	± 0.47°C at 25°C[5]	N/A	N/A	N/A	-20° to 70°C
Space	Precipitation	mm	N/A	±1.0% (up to 20 mm/hr)	N/A	N/A	N/A	0 to 12.7 cm/hr

1. Practical Quantitation Limits (PQL) is the lower limit of quantitation (reporting).
2. Accuracy for analytical parameters is expressed as Percent Recovery of Sample Matrix Spike. Analyte Percent Recovery acceptance criteria are method specified limits or generated from historical laboratory data. Recoveries are matrix/sample dependent.
3. Laboratory Analytical Duplicate Relative Percent Difference (RPD) acceptance criteria/Field Duplicate RPD acceptance criteria.
4. Precision and accuracy for samples high in heavy sediment may be outside listed criteria, if the entire sample volume cannot be filtered and heavy particles settle quickly while decanting an aliquot of sample.
5. Stated accuracy of Onset Hobo Pendant Event and Temperature Data Logger (part UA-003-64)

Table 5 summarizes data quality requirements associated with the soil sample analysis.

Table 5. Data quality requirements for soil analyses

Matrix	Parameter	95% Confidence Interval[1]
Soil	pH	± 0.12 pH units
Soil	Organic Matter	± 0.4 %
Soil	Phosphorus	± 11 % relative error
Soil	Potassium	± 7 % relative error
Soil	Calcium	± 8 % relative error
Soil	Magnesium	± 8 % relative error
Soil	Sulfur	± 8 % relative error
Soil	Boron	± 0.05 ppm
Soil	Copper	± 0,10 ppm
Soil	Iron	± 0.8 ppm
Soil	Manganese	± 10 % relative error
Soil	Zinc	± 0.3 ppm
Soil	Sodium	± 4 ppm

1. Soil Testing Reference Sheet, Maine Soil Testing Service, Orono, ME

3.12.2 Accuracy

Accuracy is defined as a measure of how close a result is to the true value. For physical/chemical parameters, accuracy is generally assessed through the analysis of spiked samples, with results expressed as percent recovery. VAEL's Quality Systems Manual, Revision 23, provides acceptance criteria for spiked water sample results for each analyte tested. VAEL's Quality Systems Manual also describes calibration procedures, blank samples, and sample handling protocols, which provide additional information used to evaluate the accuracy of each analytical procedure.

3.12.3 Precision

Precision is defined as a measure of the reproducibility of individual measurements of the same property under a given set of conditions. Precision is generally assessed through field and laboratory duplicate analyses. In this case, duplicate analysis will be conducted on splits of field-collected composite water samples. The most commonly used measure of precision is the relative percent difference (RPD). The formula for calculating the Relative Percent Difference is:

RPD = 100* Absolute Value(X_1-X_2)/((X_1+X_2)/2)

where X_1 and X_2 are the two measurements being compared.

The method RPD is provided for the key analytical parameters in Table 4. Field duplicates will be prepared and delivered to the laboratory at a minimum rate of 10%.

3.12.4 Representativeness

In the context of this study, representativeness expresses the degree to which the data gathered by the project accurately and precisely represent field conditions. By continuously measuring discharge and collecting flow-proportional water samples for chemical analysis, the data gathered will accurately represent water and pollutant export under true field conditions.

Data representativeness for primary source data for this project will be accomplished through implementing standard sampling procedures and analytical methods which are appropriate for the intended data uses.

3.12.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability of the field measurements is ensured by adhering to consistent standard sampling techniques and protocols. Such consistency will be reinforced by training and supervision of field staff (see Section 1.5). Comparability of laboratory measurements is ensured through following VAEL’s Quality Systems Manual, Revision 23, dated December 18, 2015, and the respective SOP for a given analyte.

3.12.6 Completeness

Completeness is a measure of the percentage of planned samples collected or the percentage of usable data points per measurement, with a usable result defined as one that meets criteria for accuracy, precision, and representativeness. Project specific completeness goals account for all aspects of sample handling, from collection through reporting. The minimum completeness objective for the key parameters measured in tile flow is determined to be 95 percent.

% Completeness = # of Usable Points / Total # of Data Points Collected x 100

A usable result is defined as a result that meets all criteria for accuracy, precision, and representativeness.

3.12.7 Traceability

Traceability is defined as the ability to trace the generation of each analytical result from sample collection through analysis and reporting. To accomplish this, all activities must be fully documented. Specific requirements will be met for documenting operation and maintenance of field instrumentation, sample tracking, analytical methodology including NIST traceable standards, record-keeping, data reduction procedures, and data presentation; these requirements are described elsewhere in this document. The data quality objective for traceability with respect to all primary data analyses for all samples is 100 percent.

3.13 Quality Control Requirements

All data acquired or generated will be fully documented as to original source, quality, and history.

Field quality control sampling will consist of the following:

- At least 10% of composite water sample splits will be duplicated in the field by collecting a second aliquot from the churn splitter for delivery to the lab.
- One of two composite soil sample splits will be duplicated in the field by collecting a second aliquot from the sample bucket for delivery to the lab.
- No travel blanks will be collected because the parameters are not susceptible to cross contamination during shipment.

Data from field duplicates will be accepted if the RPD is less than or equal to 20%; in such cases, the mean of accepted field duplicates will be used to represent data from the sample involved. In cases where the RPD of field duplicates exceeds 20%, the data may be deemed unusable. Sampling QC excursions are evaluated by the Project Manager. Field duplicate sample results are used to assess the entire sampling process, including environmental variability; therefore, the arbitrary rejection of results based on predetermined limits is not practical. The professional judgment of the Project Manager or his designee will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Notations of field duplicate excursions and blank contamination will be noted in the final report.

3.14 Instrument/Equipment Calibration and Frequency

Field analytical equipment that may be used in this project includes instruments for measuring water stage, flow rate, rainfall, and air temperature. Calibration procedures for the equipment will follow manufacturer instructions.

Instrument and equipment calibration for water analysis will be routinely carried out by VAEL under their EPA approved Quality Systems Manual, Revision 23, dated December 18, 2015.

3.15 Data Acquisition Requirements for Non-direct Measurements

Sources of supplementary data considered in this project may include weather data obtained from a local NWS cooperating station. Such data may be used to compare contemporary weather conditions against long-term averages or normals. These data will be accepted as valid if officially published by the NWS. Second, historical soil and manure test data from the farm's nutrient management plan (if available) may be reviewed to help characterize site soils and agronomic management. Soil and manure samples for this purpose are typically collected by certified crop management consultants and analyses are performed through the UVM Agricultural and Environmental Testing Laboratory. The data reported in this manner will be accepted as valid if it is contained in a nutrient management plan recognized by the AAFM. Farm records maintained by the participating farmers will be reviewed for information regarding management of the study fields. Collection of these data by the farmer meets record keeping requirements of Vermont AAFM. Additional supplemental data sources used include published topographic data and soils mapping based on the USDA-NRCS county soil surveys.

The supplementary data will not contribute directly to project decision-making, with the exception of field agronomic practices data recorded by the participating farmer.

3.16 Data Summaries

Summary data tables will be prepared for each station using the procedures described in Section 3.18. These tables will include total discharge, mass export, and mean concentrations of all monitored constituents. Using these summary data tables, descriptive statistics (range, mean, median, standard deviation, coefficient of variation) will be calculated by station. These summary data tables and statistical summaries will be stored electronically on Stone Environmental’s servers, which are backed up daily to a Unitrends backup appliance. Once per week the most recent backup will be written to a drive which is taken to a storage vault offsite.

3.17 Methods for Data Acquisition and Storage

To protect personally identifiable information (PII) in any publications or public discussions of project results, the study site will be identified by an alphanumeric code consisting of the abbreviation “JBT” (Jewett Brook Tile) or “ACT” (Addison County Tile) followed by a number between 1 and 12 (i.e., JBT01 through JBT12). Once data are reported to LCBP, they will be subject to standard measures required to protect participants’ PII.

The Stone Environmental Project Manager or his designee will be responsible for organization and oversight of data generation, disbursement, processing and storage so that the data will be documented, accessible and secure for the foreseeable time period of its use. The VAEL director has the same responsibility for the laboratory data and information s/he generates.

Standard sample retrieval forms (Appendix A) will be used to document sample location, station and field conditions, date and time of collection, and personnel responsible for collection for all samples collected in the field. A Chain of Custody form (Appendix B) will be used by the laboratories to confirm sample delivery. VAEL will complete log-in sheets to document sample receipt and condition. Copies of all field sheets will be maintained in the project file at the offices of Stone Environmental.

Analytical data from VAEL will be transmitted in electronic format to the Project Manager or his designee after all internal review has been completed.

Data from the flowmeters and autosamplers will be automatically pushed to Stone Environmental’s computer server every 30 minutes. These raw electronic data will be maintained on the server for the duration of the project and will be viewable in near real-time through a web user interface. These data will be extracted into Access databases, Excel workbooks, and *R* for manipulation and preparation of data summaries.

All electronic files on Stone Environmental's servers, including raw data pushed from monitoring stations, will be backed up daily to a Unitrends backup appliance. Once per week the most recent backup will be written to a drive which is taken to a storage vault offsite. Paper and electronic files will be archived for a minimum of five years at Stone Environmental following completion of the project.

3.18 Methods of Analyses

Water level, discharge, and sample event mark data will be transmitted automatically to a computer server located at Stone Environmental's offices in Montpelier, VT.

An Access database has been created to import and process analytical data from electronic tables transmitted by VAEL, import and aggregate corresponding event discharge data from the SQL server, and calculate total discharge, constituent mean concentrations, and mass export. This data processing will be performed using a series of database queries that will accomplish the following data manipulations:

1. Analytical results of duplicate samples will be averaged
2. Analytical results will be linked to specific sampling events on a common ID (LabID)
3. The constituent mass corresponding to the collection period of each composite sample (concentration multiplied by associated discharge total) will be calculated
4. Where multiple composite samples are subsampled for analysis (for example, carboys 1 and 2), the partial event constituent masses from #3 will be summed to derive total export for the interval.

There are several common sources of inaccuracy in discharge measurement that will be attempted to minimize through selection of the most appropriate instruments and certain station design innovations. These sources of inaccuracy include submergence of the tile drain outlets, level sensor drift, and debris accumulation on weirs. Submergence of many of the outlets will be addressed by ensuring full pipe flow conditions at all times and installing an appropriate flowmeter for this condition. The Thel-mar weir will be maintained by checking the device every maintenance visit and making appropriate adjustments. In some cases, level and discharge data may warrant adjustments to account for debris or ice accumulation in monitored pipes and on weirs.

The data set used for the primary statistical analyses will include total discharge (m^3) and mean concentration (mg/L) and mass export (kg) for each monitored constituent for each sampling event for each monitored location. Data reported as less than a detection limit will be assigned a value of one-half the detection limit for purposes of data analysis but will be flagged as below detection in reported concentration data tables. All statistical analyses will be done using version

10.0 of JMP statistical software (SAS Institute). Basic descriptive statistics and exploratory data analysis will be conducted on this data set.

Section 4. Assessment and Oversight

It will be the responsibility of the Project QA Officer to ensure that project QA/QC activities, assessments, and responses are conducted according to this QAPP. The QA Officer (or designee) will have the authority to issue a stop work order upon finding a significant condition that would adversely affect the quality and usability of the data. The QA Officer will document, implement, and verify the effectiveness of corrective actions, such as an amendment to the QAPP, and take steps to ensure that everyone on the distribution list is notified.

Monitoring station readiness will be assessed through routine (minimum of twice weekly) review of flowmeter, sampler, and battery voltage data transmitted in near real-time to a server located at Stone Environmental's office. Several important and not uncommon problems may be detected remotely and quickly using these data, for example, sampler error messages, erroneous autosampling attempts, and low battery voltage. Early detection of these problem conditions will enable timely response by sampling teams to visit the monitoring station in question and correct the problem. Regular maintenance of the monitoring station and instruments will minimize the incidence of instrument malfunctions and other problems. Certain basic maintenance activities will be conducted after sampling event, to clean bulk sample containers, churn splitters, sampler lines, and flumes (if necessary) and to reset the autosampler. Site visits will be conducted for more intensive maintenance activities approximately monthly during the monitoring period. A Routine Maintenance Form will be completed during each maintenance visit (Appendix A). Deficiencies noted will be corrected by the responsible personnel. In the event that corrective action is required that is beyond the training of the maintenance personnel, a Stone Environmental project scientist with expertise in the monitoring systems will diagnose and correct the problem.

The effectiveness of monitoring will be assessed by the responsible sampling personnel at each site using data collected at the time of sample retrieval (Appendix A). Section 3.18 describes several common sources of inaccuracy in discharge measurement and how these will be addressed.

Periodically, when summary data tables are prepared for reporting purposes, the Project Manager or his designee will assess the quality of all discharge and analytical data and will be responsible for verifying/validating all sample tracking information and laboratory analysis data. Any deficiencies will be flagged with a qualifying statement in summary data tables and necessary corrective action will be taken. As part of final report preparation, the Project Manager or his designee will also review field and data management operations for the preceding year for consistency with the requirements outlined in this QAPP.

Internal assessments and response actions with regard to laboratory analysis within VAEL will occur under the terms of the lab's approved Quality Systems Manual (Revision 23). Project investigators will examine data reports from the laboratory for problems or conditions of concern noted by analysts, based on *Sample Remark Codes.* Examples of such codes are included in Table 6.

Table 6. Sample remark codes used by VAEL

Sample Remark Code	Description
B	Reported value is associated with a lab blank contamination.
BH	Reported value may be biased high.
BL	Reported value may be biased low.
E	Estimated Value
D	Dilution resulted in instrument concentration below PQL.
H	Hold time exceeded.
I	Matrix Interference
N	Not processed or processed but results not reported.
O	Outside calibration range, estimated value.
OL	Outside Limit
P	Preservation of sample inappropriate, value may be in error.
S	Surrogate recovery outside acceptance limits.
T	Time not provided
W	Sample warm on arrival, no evidence cooling has begun.

If water quality data are suspect (e.g., flagged by the lab, duplicate RPD too high, unusual extreme concentrations), the first response will be to contact the laboratory and verify that no simple errors have been made. If questions cannot be resolved and suspect concentration data remain, the concentration data may be rejected for that constituent for the sampling event in question.

NEIWPCC may implement, at its discretion, various audits or reviews of this project to assess conformance and compliance to the quality assurance project plan in accordance with the NEIWPCC Quality Management Plan.

Quarterly reports will be submitted to LCBP and NEIWPCC, per the standard LCBP reporting process for review and approval. The LCBP Project Officer will be presented with the final project deliverables and a summary of any QA/QC actions taken before providing final approval to the report.

Any limitations and gaps in data included in the analysis will be fully disclosed within the project final report, and it will be noted that these data should be used with caution.

Section 5. Deliverables

Stone Environmental will produce a report detailing the methods and results of the watershed and drainage area characterization. The report will document cropping patterns in the JBW (acreage in permanent corn or hay production or in specific rotations) and dominant soil types and slope classes, for land with and without tile drainage, as well as providing descriptive information for the agricultural areas served by each of the tile drain systems included in the study. In addition, photo-documentation of each monitoring installation will be submitted.

Stone Environmental will also produce a succinct monitoring and assessment report summarizing the methods and results of the watershed and drainage area characterization, and the flow and water quality monitoring. The report will also include an analysis of agronomic and water quality factor associations. GIS layers used or generated to support the analyses will also be provided to LCBP, subject to confidentiality requirements of the Vermont Agency of Agriculture. Total and dissolved P concentrations and loads for each of the monitored tile drainage systems will be summarized in monthly and annual statistics. Monthly and annual summary statistics will also be presented for TN and TSS concentrations in tile drain flow.

Details related to the bench testing and evaluation of the filter media options, filter and monitoring system installation, and filter performance results will be included in the final report. Documentation of the media testing procedure development will also be included in the final report.

In addition to the task-specific deliverables described above, quarterly reports will be submitted to LCBP, per the standard LCBP reporting process for review and approval. Relevant LCBP advisory committees, notably the Technical Advisory Committee, will be presented with the final report deliverables and a summary of any QA/QC actions taken before providing final approval to the report.

Section 6. References

MAFES Analytical Laboratory. 2006. Quality Assurance Plan for MAFES Analytical Laboratory. University of Maine, Orono ME. http://anlab.umesci.maine.edu/soillab_files/qc/anlab-qaplan.PDF (accessed April 27, 2012).

U.S. Environmental Protection Agency. 2003. A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information. Washington, DC: Office of Research and Development, Science Policy Council; Report No. EPA/100/B-03/001.

Vermont Agriculture and Environmental Laboratory. 2016. Quality Systems Manual, Revision No. 23. Burlington, VT. URL: https://agriculture.vermont.gov/sites/ag/files/pdf/lab/VAEL%20QSM%20%20-%202016.pdf. (accessed November 12, 2018).

APPENDIX A:

Sampling Procedures and Routine Maintenance for Assessment of Tile Drainage Systems in the Jewett Brook Watershed and in Addison County, Vermont

STUDY SPECIFIC PROCEDURE

Sampling Procedures and Routine Maintenance for Assessment of Tile Drainage Systems in the Jewett Brook Watershed and in Addison County, Vermont

SSP Number: 1	Date Issued: 11/14/16
Version Number: 2	Date of Revision: NA

OBJECTIVE

To facilitate collection of high-quality water samples, preventative maintenance of monitoring stations and equipment, and accurate recording of monitoring activities and data.

POLICIES

All field staff performing sampling duties for the project must read this SSP and implement the procedures written herein.

HEALTH AND SAFETY

A health and safety plan (HASP) was prepared for this project identifying possible health and safety risks involved in field activities, how these risks are to be managed, and responsibilities of project management and staff. This HASP must be read and signed by every direct employee of Stone Environmental engaged in fieldwork for this project. Contractors assisting Stone with sampling and other field activities are not similarly bound by the HASP, but should nonetheless remain alert and responsive to potential health and safety risks. Stone Environmental assumes no responsibility and will accept no liability for the health and safety of personnel who are not direct employees of Stone Environmental.

There are several common health and safety risks which demand particular attention, as follows:

Insects

Hornets, wasps, bees, and yellow jackets are common in edge-of-field settings in Vermont. These insects may build nests in the monitoring shelters. A spray can of insecticide should be available at each monitoring shelter. Personnel known to be allergic to hornet, wasp, bee, and/or yellow jacket stings should carry with them an Epipen or similar medication as directed by their physician.

Mosquitos may carry dangerous pathogens including West Nile virus and eastern equine encephalitis. Use repellant and appropriate clothing to minimize mosquito bites.

Ticks are common in areas bordering agricultural fields. Tick populations should be reduced by mowing work areas. Long pants, tucked into socks, should be worn when possible. Skin and clothing should be checked for ticks upon leaving the field.

Plants

In addition to poison ivy and stinging nettle, personnel must avoid contact with wild parsnip, a new invasive plant in Vermont that can produce a painful and lasting burning of the skin after exposure of affected areas to sunlight. This plant occurs throughout the study area.

Severe weather

Sampling activities will often take place shortly following storm events. Under no circumstances should personnel visit monitoring stations during lightning storms. Personnel should also be alert to high wind or other conditions and avoid exposure.

Cold/heat stress

Personnel will be working under both very cold and very warm conditions in the course of the monitoring program. Standard recommendation for minimizing the risk of heat stress and hypothermia need to be observed.

FLOW PROPORTIONAL COMPOSITE SAMPLING PROCEDURES

An ISCO 6712 or 3700 autosampler will be operated to collect flow-proportional composite samples during times of the year where conditions are expected to remain above freezing. Approximately weekly, field technicians will visit each station to process the bulk composite samples into appropriate splits.

1. Record information from autosampler display (see attached Sample Retrieval Form). Note that the autosampler may display various error messages, some of which may be important, others not. If the display indicates a warning about excessive pump tubing counts, you may disregard this. If the sampler displays “No Liquid Detected”, this may indicate either that the intake was exposed to air during one or more sampling attempts or that there is a clog in the sampling line. If this warning is displayed, inspect the sampling line for a clog, kink, or ice blockage and otherwise ignore it. For all other warning messages, please contact Stone.
2. Stop the sampling program by pressing the red button to pause the program and then selecting STOP PROGRAM. In certain cases, the sampling program may have been stopped remotely by Stone. Stopping the program remotely can mitigate certain problems and potential risks, such as frozen sampling lines on cold nights.
3. Record approximate sample volumes in each carboy.

4. Select the appropriate set of carboy(s), the As (A1 and A2) or the Bs (B3 and B4). Select the appropriate carboys according to the following logic:
    a. If the combined volume of carboys A1 and A2 is less than 14 liters, use set A.
    b. If there is more than 14 liters in carboy A1+A2 and/or if the sampler display indicates Part A is DONE, use set B, unless carboy B3 contains less than 1 liter. If the combined volume of set A is >14 L or DONE is displayed And the volume of set B volume is <1 L, contact the Stone project manager for direction. We will need to evaluate whether the set A sample is sufficiently representative of the entire event.
    c. If the sampler attempted to collect fewer than three aliquots into carboy A1 or the total volume collected is less than 500 mL, discard the sample. The number of aliquots attempted can be determined by viewing the sampler display. The display will indicate Part A, "2, 100 Bottle 1 after X pulses" if only one aliquot was attempted, or Part A, "3, 100 Bottle 1 after X pulses" if only two aliquots were attempted. In this example, "3" indicates that the next aliquot the sampler will attempt dispense to Bottle 1 is its third; "100" indicates that it will dispense a maximum of 100 aliquots to Bottle 1; "Bottle 1" indicates that the sampling container in use is Bottle 1, which we refer to as carboy A1; and "X pulses" indicates how many flow pulses are remaining before the sampler attempts the next aliquot.
    d. Bottle A1 should also contain a minimum of 500 mL for sample splits to be prepared for analysis. Since the programmed aliquot volume is 100 mL, five aliquots should produce ~500 mL of sample. If five or more sample aliquots were attempted and the volume in carboy A1 is significantly less than 500 mL, then the suction line strainer was likely exposed during pumping, drawing air rather than water. This is to be expected at very low flows. You may also view the sampling report for further information about which sampling attempts were successful.
5. Fill out and affix labels to the appropriate containers. The correct container for each analyte is given in Table 1.

Table 1. Sample containers, preservation, and permissible holding times

Analyte	Container	Preservation	Hold Time (days)
TP	60-mL glass vial	None	28
TDP	60-mL glass vial	Filtered (0.45 µm) in field	28
TN	50-mL plastic centrifuge tube, blue cap	Cool (<6°C), 0.1 mL H_2SO_4	28
TSS	1-L plastic bottle	Cool (<6°C)	7

The Sample ID field is a concatenation of the Site ID (JBT01, JBT02, ACT01, etc.), the collection date (mmddyy), and the carboy(s) from which sample splits are taken [A1, A2, B3, B4, A12 (if the samples from carboys A1 and A2 are added together in the churn splitter), or B34 (if the samples from B3 and B4 are added together in the churn splitter)]. See step 7 regarding the sample splitting procedure. The following examples illustrate the sample IDs syntax:

- A sample collected at JBT07 on May 2, 2017 only from carboy A1: **JBT07-050217-A1**
- A sample collected at JBT07 on September 27, 2017 by combining the contents of carboys A1 and A2 in the churn splitter: **JBT07-092717-A12**

6. Put on lab gloves
7. Pour sample from the selected carboy(s) into the churn splitter. Try to swirl the water to suspend sediment as you pour the sample into the churn splitter. NEVER combine sample from set A and set B in the churn splitter.

   In many cases, only the first carboy in each set (A1 or B3) will contain sample. If the second carboy (A2 or B4) also contains sample, this can be added to the churn splitter so long as the combined volume will not exceed 14 liters, the capacity of the churn splitter. For example, if carboy A1 contains 10 liters and carboy A2 contains 2 liters, these can be composited in the churn splitter; and the resulting sample ID would be in the form: SiteID-mmddyy-A12.

   If the combined volume will exceed 14 L, each carboy in the selected set should be split individually, resulting in two sets of sample splits for analysis. For example, if the set A carboys are split individually, the resulting sample IDs would be in the form SiteID-mmddyy-A1 for the carboy A1 splits and SiteID-mmddyy-A2 for the carboy A2 splits.

8. Operate the churn splitter for 5-10 seconds. With sample containers in hand, open the stopcock and let spill on the ground for 1-2 seconds to clear the line. Then prepare:
   a. TP sample split: While operating the churn splitter, fill the glass vial up to the line.
   b. TN sample split: While operating the churn splitter, fill a blue capped centrifuge tube to the 50 mL line.
   c. TSS sample split: While operating the churn splitter, fill a 1-L plastic bottle half full.
   d. Let the contents of the churn splitter settle for 1-5 minutes.

   e. TDP sample split: Sample splits for TDP analyses will be filtered in the field by dispensing sample from the churn splitter directly into a filtration apparatus containing a 45-mm Durapore® 0.45-µm acetate membrane filter. Use forceps to place a clean filter in the filter holder. Wet the filter with a spray of distilled water. Remove the plunger and attach the filter holder to the syringe. Fill a syringe with settled water from the churn splitter. Squirt approximately 10 mL onto the ground and then fill a glass vial to the 50-mL line. If the filter clogs prematurely, it may be replaced with a new filter and the process repeated.

9. Preservation. Put on safety glasses. Add 1 drop of concentrated sulfuric acid to preserve the TN sample. Place all samples on ice and store on ice or refrigerate until delivery to the laboratory. Clean up acid spills with acid neutralizing solution or copious amounts of water. To use acid neutralizing solution, shake bottle of acid neutralizing solution and cover affected area until bubbling stops.
10. Washing equipment. The standard washing procedure is for three rinses with distilled water. After each event, the churn splitter, filter holder, and carboys should be washed.
11. Reinstall carboys in the following clock positions: A1 at 6:00, A2 at 3:00, B3 at 12h, and B4 at 9:00.
12. Press the red button and select "run program" on the autosampler to ready the station for the next event. Confirm that the sampler program is running.
13. Complete the Chain of Custody form, including sample IDs, number of containers of each sample being sent to the lab, and the analyses to be performed. The Chain of Custody form must be kept with the samples, either by sticking it into the plastic sleeve taped to the underside of the cooler lid or in a ziplock bag with the samples.
14. Samples must be delivered to the laboratory within the holding times indicated in Table 1.

GRAB SAMPLING PROCEDURES

The autosampler programs will be stopped during the winter months when temperatures are expected to remain below freezing. During this period, field technicians will visit each station approximately weekly to collect grab samples if tile lines are flowing.

1. Fill out and affix labels to the appropriate containers. The correct container for each analyte is given in Table 1.
2. For grab samples, the Sample ID field is a concatenation of the Site ID (JBT01, JBT02, ACT01, etc.), the collection date (mmddyy), and the word "GRAB". The following example illustrate the sample IDs syntax:

- A grab sample collected at JBT01 on February 2, 2017: **JBT01-020217-GRAB**

3. Grab sample collection.
   a. Put on lab gloves
   b. If the air temperature is above freezing:
      i. Collect samples for TP, TN, and TSS analysis directly into the sample container. The preferred method is to use the autosampler to pump a sample directly into the sample container, using the manual sample mode. The autosampler pump tubing should be detached from the autosampler housing and a stream of water directed into the sample container. Set the sample volume to 200 mL and dispense the first approximately 5 pump cycles (50 mL) onto the ground, then collect sample up to the fill line on the sample container.
      ii. Samples for TDP analysis may be dispensed directly into the filtration apparatus containing a 45-mm Durapore® 0.45-µm acetate membrane filter. Use forceps to place a clean filter in the filter holder. Wet the filter with a spray of distilled water. Remove the plunger and attach the filter holder to the syringe. Use the autosampler to pump sample into the syringe, using the manual sample mode. The autosampler pump tubing should be detached from the autosampler housing and a stream of water directed into the syringe. Set the sample volume to 200 mL and dispense the first approximately 5 pump cycles (50 mL) onto the ground, then collect approximately 60 mL of sample in the syringe. Squirt approximately 10 mL onto the ground and then fill a glass vial to the 50-mL. If the filter clogs prematurely, it may be replaced with a new filter and the process repeated.
   c. If the air temperature is below freezing:
      i. The autosampler may be damaged by ice accumulation. If the tile line continues flowing under freezing conditions, grab samples may be withdrawn using a portable centrifugal pump inserted into the monitoring manhole. Using this pump, sample should be dispensed directly into the sample containers, dispensing the first approximately 50 mL onto the ground, then collecting sample up to the fill line on the sample containers.
      ii. Because field filtration is not generally successful under freezing conditions, grab samples collected for TDP analysis will be filtered at VAEL. In this case, TDP samples must be brought to VAEL for processing on the day of collection.

4. Preservation. Put on safety glasses. Add 1 drop of concentrated sulfuric acid to preserve the TN sample. Place all samples on ice and store on ice or refrigerate until delivery to the laboratory. Clean up acid spills with acid neutralizing solution or copious amounts of water. To use acid neutralizing solution, shake bottle of acid neutralizing solution and cover affected area until bubbling stops.
5. The filter holder and syringe should be washed by rinsing three times with distilled water after sampling at each station.
6. Complete the Chain of Custody form, including sample IDs, number of containers of each sample being sent to the lab, and the analyses to be performed. The Chain of Custody form must be kept with the samples, either by sticking it into the plastic sleeve taped to the underside of the cooler lid or in a ziplock bag with the samples.
7. Samples must be delivered to the laboratory within the holding times indicated in Table 1.

ROUTINE MAINTENANCE

Tasks to be performed by sampler after each sampling event

1. On the Sample Retrieval Form, record the amount of rainfall collected in any manual gauges and the date and time. Record the amount of rainfall collected in the graduated cylinder to the nearest 0.01 inch then empty it. If water is present in the outer (overflow) cylinder, carefully decant this into the graduated cylinder and add this amount to the first reading. Repeat if necessary until the overflow cylinder is empty.
2. Confirm that the sampler program is running.
3. Confirm that the sampling line and pump tubing are attached.
4. Confirm that the sample carboys are installed properly.
5. Describe field/crop condition.
6. Verify that sufficient sampling supplies (bottles, filters, gloves) remain for at least two sampling events. Notify the Stone project manager if any supplies are low.

Tasks to be performed by Stone approximately monthly

1. Confirm that the sampler program is running.
2. Check the sampling line for any kinks or sags; zip-tie if necessary to maintain a consistent downward slope in the line.
3. Confirm that the sample carboys are installed properly.

4. Check the desiccant cartridges of the flowmeters and 2105ci modules and replace desiccant if necessary.
5. Restock monitoring stations with bottles, sample retrieval forms, labels, filtration supplies, gloves, and distilled water.
6. Refill or replace acid dropper bottles.
7. Cut weeds from around the shelters and flume and along the wingwalls.
8. Describe field/crop condition.

AUTHORIZATION

Written/approved by: ______________________________ Date: __________

Dave Braun, Project Manager, Stone Environmental, Inc.

REVISION HISTORY

None

FORMS

Sample Retrieval Form

Collected by:____ Date:________________________________

Weather:____ Rainfall (if gauge is deployed) ________ in.

	Station JBT07	**Comment**
Station condition	☐ OK Other _________________	
Field/crop condition		
SAMPLE COLLECTION		
Type of sample(s) collected (circle)	Composite split Grab None	
Sampler display	_______, _______ bottle______	
Part A status: (circle one)	1. ACTIVE, DISABLED 2. PART A DONE 3. ACTIVE	
If ACTIVE and enabled, display reads:	PART A ____, ____ bottle__ _ after____ pulses	
Part B status: (circle one)	1. ACTIVE, DISABLED 2. PART B DONE 3. ACTIVE	
If ACTIVE and enabled, display reads:	PART B ____, ____ bottle___ after____ pulses	
Time you stopped the autosampler	_____________ AM or PM	
Carboy volume (L)	A1: A2: B3: B4:	
Carboys split (circle)	A1 A2 A1+A2 composite B3 B4 B3+B4 composite	
Sample ID assigned	JBT07 – __________ – _____ (Station) – (mmddyy) – (carboy(s)) JBT07 – __________ – _____ (Station) – (mmddyy) – (GRAB)	
Splits collected (circle)	TP TDP TSS TN	
Duplicates collected? (circle)	TP TDP TSS TN Carboy ________	
RESETTING STATIONS		
STOP then Re-RUN SAMPLING PROGRAM (circle)	Yes No	
Carboys and churn splitter triple rinsed? (circle)	Yes No NA	
Desiccant good? (circle)	Yes Changed	
Carboys installed properly? (circle)	Yes No	
Additional comments:		

Chain of Custody Form for Water Samples

Stone Project ID: 18-006
Lab Program #: 319
Stone Contact: Dave Braun, 802-272-8819, dbraun@stone-env.com

Collection Date	**Sample ID**	**Total # of Containers**	**Analyses Requested (circle those collected)**
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN
			TP TDP TSS TN

Sampled by: __________________________ ______________________________
print name signature

Routine Maintenance Form

Technician:_____________________________________ Date:_________________________

ACTIVITY	SITE: _________	SITE: _________	SITE: _________	SITE: _________
Sampler program running	☐	☐	☐	☐
Sampler tubing is attached	☐	☐	☐	☐
Sample carboys installed properly	☐	☐	☐	☐
Signal converter desiccant	☐ OK ☐ Replaced ☐ NA	☐ OK ☐ Replaced ☐ NA	☐ OK ☐ Replaced ☐ NA	☐ OK ☐ Replaced ☐ NA
2105ci module desiccant	☐ OK ☐ Replaced ☐ NA	☐ OK ☐ Replaced ☐ NA	☐ OK ☐ Replaced ☐ NA	☐ OK ☐ Replaced ☐ NA
Restock sampling supplies	☐	☐	☐	☐
Restock forms and labels if needed	☐	☐	☐	☐
Mow weeds	☐ ☐ NA	☐ ☐ NA	☐ ☐ NA	☐ ☐ NA
Field Condition:				
Comments:				

APPENDIX B (attached):
Determination of Phosphorus by Flow Injection Analysis 24 8 1-2015
(Acid Persulfate Digestion Method)

Standard Operating Procedure (SOP) for

Determination of Phosphorus by Flow Injection Analysis (Acid Persulfate Digestion Method)

Reviewed by: ______________________ Date: 3/27/15
Candace Barber, Chemist*

Revised by: ______________________ ** Date: 3/27/15

Reviewed and Approved by:

______________________ Date: 03-26-2015
Dan Needham Interim Quality Assurance Officer*

______________________ Date: 03-26-2015
Dan Needham, DEC Laboratory Supervisor*

Vermont Department of Environmental Conservation Laboratory

*Signature implies that the individual has read, understands and agrees to follow this Standard Operating Procedure.

**Signature indicates SOP has been revised.

Table of Contents

1.0 Identification of Test Method

1.1 This SOP is for the analysis of Phosphorus either total or dissolved and is based on Standard Methods for the Examination of Water and Wastewater, 21th Ed. APHA-AWNA/WPCF Method 4500-P H Manual Digestion and Flow Injection Analysis for Total Phosphorus and Determination of Total Phosphorus by Flow Injection Analysis Colorimetry, QuikChem Method 10-115-01-1-F.

1.2 Orthophosphate (SRP) procedure is exactly the same as TP minus digestion. Holding time is 48 hours.

2.0 Applicable Matrix/Matrices

2.1 This method determines the amount of phosphorus in drinking, ground, surface water and soil extracts.

3.0 Method Detection Limit (MDL)/Limit of Quantitation (LOQ)

3.1 The MDL for both Total Phosphorus and Dissolved Phosphorus is 2.5µg P/L.

3.2 The LOQ for both Total Phosphorus and Dissolved Phosphorus is 5µg P/L.

4.0 Scope and Application

4.1 This method covers the determination of total phosphorus in drinking water, non-potable water and laboratory DI water. This method determines total phosphorus in non-filtered samples and total dissolved phosphorus in samples that were filtered through a 0.45µm filter. The difference between the result of a sample determined directly and filtered is termed total insoluble phosphorus.

4.2 The method is based on reactions that are specific for the orthophosphate (PO_4^{-3}) ion.

4.3 The applicable range of the 5 - 200µg P/L.

5.0 Summary of Test Method

5.1 The orthophosphate ion PO_4^{-3} reacts with ammonium molybdate and antimony potassium tartrate under acidic conditions to form a complex. This complex is reduced with ascorbic acid to form a blue complex, which absorbs light at 880nm. The absorbance is proportional to the concentration of orthophosphate in the sample. Polyphosphates may be converted to the orthophosphate form by sulfuric acid digestion and organic phosphorus may be converted to orthophosphate by persulfate digestion.

6.0 Definitions

6.1 Calibration Blank (CB) - A volume of reagent water in the same matrix as the calibration standards, but without the analyte.

6.2 Calibration Standard (CAL) - A solution prepared from the primary dilution standard solution or stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

6.2.1 Continuing Calibration Verifications (CCV and CCB) - Calibration standards analyzed at regular intervals used to monitor the instrument calibration. Refer to section 6.14 for DQM

6.2.2 CCV Mid – The CCV Mid is a mid-level calibration standard that is analyzed at the beginning of analysis, after every 10 samples and at the end of analysis.

6.2.3 CCV Low – The CCV Low is low-level standard that is two times the PQL (6.11). It is analyzed at the beginning of the run.

6.2.4 CCB – A blank calibration standard used to monitor the instrument calibration during analysis. It is analyzed at the beginning of analysis, after every 10 samples and at the end of analysis.

6.3 Method Blank (MB) – A laboratory reagent water blank that is treated exactly as a sample, and is used to monitor lab contamination.

6.4 Laboratory Control Sample (LCS) – A laboratory reagent blank spiked with known amounts of analyte. The LCS is used to assess the performance of all or a portion of the measurement system. The LCS samples are then analyzed and processed exactly as customer samples.

6.4.1 LCS – Mid – The target analyte concentration is at mid-calibration level.

6.4.2 LCS – Low – The target analyte concentration is at or near the PQL.

6.5 Filter Blank (FB) - A laboratory reagent water blank that is treated exactly as a sample, and is used to monitor lab contamination. A filter blank is analyzed only when sample filtration is required at the bench.

6.6 Field Split (FS) Sample – An aliquot of a well-mixed sample is poured into two separate containers by field personnel under field conditions. These Duplicates are processed and analyzed independently either as Duplicates (6.7.1) or Matrix Spikes (6.7.2). One of the FS Samples is logged into the lab data system and its corresponding Lab ID# is written on the label of the second FS Sample. The goal for the fiscal year is for the lab to receive 10% of the total sample TP/DP load as FS Samples.

6.6.1 Duplicate – A routine environmental (FS) sample analyzed to obtain a measure of precision.

6.6.2 Matrix Spike (MS) – A sample prepared by adding a known volume of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used to determine recovery efficiency. The added analyte should have the same concentration as the LCS – Mid (6.5.1).

6.7 Initial Calibration Verification (ICV) – The ICV is obtained from a source other than the calibration standards. The ICV is a sample to assess the performance of all or a portion of the measurement system. The analyte concentration of the ICV is typically at mid-calibration level. The ICV sample is analyzed and processed exactly as customer samples.

6.8 Method Detection Limit (MDL) – The minimum concentration of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

6.9 Limit of Detection (LOD) – The LOD is the lowest concentration level that can be statistically different from a blank. The LOD is approximately equal to MDL.

6.10 Limit of Quantitation – The LOQ is approximately equal to the PQL. A CCV-Low (6.3.2) is included in each analysis at 1-2 times the PQL.

6.11 Practical Quantitation Limit (PQL) – The laboratory reporting limit, which is 2 to 5 times the MDL (6.8).

6.12 Proficiency Evaluation (PE) – A certified solution of method analyte to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

6.13 Digestion Prep Batch – The set of 20 samples, a MB and an LCS all digested at the same time.

6.14 Analytical Batch – Digested Phosphorus samples all analyzed at the same time. An analytical batch can include many digestion prep batches (6.14).

6.15 Data Quality Management (DQM) – The DQM is a Lachat Omnion Software specific term used within a Run Worksheet/Tray by defining properties of the samples DQM Tests, DQM Pass and Fail Messages, and DQM Pass and Fail Actions. DQM sets are defined within the Run Worksheet/Tray. After all customer samples have been entered into the Run Worksheet/Tray, the CCV/CCB (6.3) is defined as the DQM set which is then scheduled to run after 10 samples and at the end of the run. This ensures that all samples are bracketed by the method required CCBs and CCVs. This repeating DQM Set will start at the current row in the Run Worksheet/Tray, so it is important this first occurrence of the DQM Set is in the correct row before setting its schedule.

7.0 Interferences

7.1 Silica forms a pale blue complex, which also absorbs at 880nm. This interference is generally insignificant, as a silicate concentration of approximately 30mg SiO_2/L would be required to produce a 0.005mg P/L positive error in orthophosphate.

7.2 Concentrations of ferric iron greater than 50mg Fe^{+3}/l will cause a negative error due to competition with the complex for the reducing agent ascorbic acid and the subsequent loss of orthophosphate. Samples high in iron can be pretreated with sodium bisulfite to eliminate this interference. Treatment with bisulfite will also remove the interference due to arsenates.

7.3 Arsenates react with the molybdate reagent to produce a blue color similar to that formed with phosphate causing a negative error.

7.4 Glassware contamination is a problem in low level phosphorus determinations. Glassware should be washed with 10% HCl and rinsed with deionized water. Commercial detergents should rarely be needed but, if they are used, use special phosphate-free preparations for lab glassware.

8.0 Safety

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable.

8.2 Material Safety Data Sheets (MSDS) are available to all personnel involved in the chemical analysis. The following chemicals have the potential to be highly toxic:

8.3 Personal Protective Equipment (PPE) should be used where appropriate.

8.4 Maintain working areas in a safe manner, which includes cleaning of bench tops, putting away chemicals and glassware after use, cleaning spills and keeping general clutter to a minimum.

9.0 Equipment and Supplies

9.1 Dedicated Class A glassware that has been acid soaked in 10% HCL and rinsed several times with D.I. H_2O.

9.2 60mL pre-cleaned disposable vessels with PTFE lined screw caps (QEC Item # 2112-60mlC).

9.3 Autoclavable Test Tube Racks.

9.4 Balance - Analytical, capable of accurately weighing to the nearest 0.0001g.

9.5 Lachat QuickChem 8000 Flow Injection Analysis instrument.

9.6 Lachat Omnion 3.0 Software.

9.7 Automatic Pipettes ranging from 100µl to 10ml.

9.8 Autoclave.

10.0 Reagents and Standards

10.1 Reagent preparation must be recorded in the Nutrients Reagent Logbook located next to the analytical balance and must include the following:

10.1.1 Preparation date and chemist's initials (i.e. mmddyyDGM).

10.1.2 Manufacturer with lot number of chemical or prep date (i.e. mmddyyDGM) of chemical being used.

10.2 The prep dates of all reagents used for each sample analysis must be recorded on the TP/DP Standards/QC Spreadsheet found on the Phosphorus computer.

10.3 The preparation dates of all Calibration Standards, Spike Solutions and Quality Control Check Samples are recorded on the TP/DP Standards/QC Spreadsheet. A copy of this spreadsheet is printed and included with the final data package.

10.4 Reagents

10.4.1 Ammonium Persulfate – Sigma Aldrich Cat # 248614-500g

10.4.2 Sulfuric Acid (H_2SO_4) – Fisher Cat # A300Sl-212

10.4.3 Ammonium Molybdate Tetrahydrate – Sigma Aldrich Cat # A7302-500g

10.4.4 Antimony Poltassium Tartrate Trihydrate – Fisher Cat # A867-250

10.4.5 Dodecyl Sulfate Sodium Salt, 99% (SDS) – Acros Cat # 23042-1000

10.4.6 Ascorbic Acid – Fisher Cat # A62-500

10.5 Digestion Reagents

10.5.1 Ammonium Persulfate Digestion Reagent – Prepared daily
40g Ammonium Persulfate (10.4.1) → 100mL in DI H_2O.
Based on the above recipe, prepare enough of the reagent by adding reagent to a graduated cylinder and diluting to volume with DI H_2O. Cover the cylinder with Parafilm and invert to mix. Reagent volume is 1mL per test tube.

10.5.2 11N H_2SO_4 – **Caution: Strong exothermic Reaction…Always add acid to water**
In a 1L volumetric flask, slowly and carefully add 310mL Concentrated

H_2SO_4 (10.4.2) to 600mL DI H_2O. Allow to cool. Dilute to 1L mark with DI H_2O. Expiration date is 1 year from preparation date. Reagent volume is 1mL per 50mL sample.

10.6 Analytical Reagents

10.6.1 Carrier and Diluent Reagent (Acid Wash) – Expiry date of 1 year. Fill a 2L volumetric flask with approximate 1.5 liters of DI H_2O. Add 40mL 11N H_2SO_4 (10.4.2) and 16g Ammonium Persulfate (10.4.1). Dilute to 2L mark with DI H_2O. Pour into an autoclavable polycarbonate container. Digest in the autoclave the Acid Wash for 30 minutes at 121°C and 15psi exposure. Allow to cool before use.

10.6.2 Ascorbic Acid Reagent – Expiry date of 5 days
Fill a 1L volumetric flask with approximately 700mL of DI H_2O. Add 60.0g Ascorbic Acid (10.4.6). Dilute to 1L mark with DI H_2O and invert to mix. Pour into a 1L plastic container and add a stir bar. Add 1.0g of SDS (10.4.5). Place on stir plate and allow to mix for a few minutes. Discard solution if the solution becomes yellow.

10.6.3 Stock Ammonium Molybdate Reagent – Expiry date of 30 days
In a 500mL volumetric flask dissolve 20.0g Ammonium Molybdate Tetrahydrate (10.4.3) in approximately 300mL DI H_2O. Dilute to mark with DI H_2O, cover with parafilm and stir for a minimum of four hours (can be left stirring overnight). Store in plastic and refrigerate.

10.6.4 Stock Antimony Potassium Tartrate Reagent – Expiry date of 30 days
In a 100mL volumetric flask dissolve 0.3g Antimony Potassium Tartrate (10.4.4) in approximately 80mL DI H_2O. Dilute to mark with DI H_2O, cover with parafilm and invert to mix. Store in a dark bottle and refrigerate.

10.6.5 Molybdate Color Reagent – Expiry date of 5 days
Fill a 1L volumetric flask with approximately 500mL DI H_2O. Add 21.0mL H_2SO_4 (10.4.2). Swirl to mix. Add 72.0mL Stock Antimony Potassium Tartrate Reagent (10.4.4). Swirl to mix. Add 213mL Stock Ammonium Molybdate Reagent (10.6.3). Swirl to mix. Dilute to mark with DI H_2O, cover with parafilm and invert to mix.

10.7 Standards and Spike Solutions

10.7.1 All calibration standards and ICVs must be digested as in section 14.0 in the same manner as unknown customer samples.

10.7.2 1000mg/L Phosphate-Phosphorus – Spex CertiPrep Cat # AS-PO4P9-2Y

10.7.3 100µg P/L ICV Standard – Expiry date of 30 days
Measure 50mL DI H_2O in a pre-cleaned 60mL test tube with screw cap (9.2). Add 500µL of 1000mg/L Phosphate (10.6.2). Refer to section 14.0 for digestion.

10.7.4 Intermediate (Int) Calibration (Spex) Stock Standards – Expiry date of 28 days

a) **10mg P/L Int Cal Stock**
1mL (10.7.2) → 100mL in DI H_2O

b) **1mg P/L Int Cal Stock**
100µL (10.7.2) → 100mL in DI H_2O

10.7.5 Working Calibration Standard Prep – Expiry date of 30 days

a) Prepare the calibration by using the following volumes of 10mg/L (10.7.4a) or 1mg/L (10.7.4b). Standards are prepared in DI H_2O.

Table 1

Concentration (µg P/L)	**Recipe**
200µg P/L	4mL of 10mg/L (10.7.3a) → 200mL
100µg P/L	2.5mL of 10mg/L (10.7.3a) → 250mL
50µg P/L	1mL of 10mg/L (10.7.3a) → 200mL
10µg P/L	2mL of 1mg/L (10.7.3b) → 200mL
5µg P/L	1mL of 10mg/L (10.7.3b) → 200mL
0µg P/L	200mL DI H_2O

b) Using a graduated cylinder, measure 50mL aliquots of each standard and pour into pre-cleaned 60mL screw top test tubes (9.2). Refer to section 14.0 for digestion.

10.7.6 1000mg/L Phosphate as P – ERA Cat # 061

10.7.7 Intermediate (ERA) LCS/MS Stock Standards – Expiry date of 28 days

a) **10mg P/L Int LCS/MS Stock**
1mL (10.7.6) → 100mL in DI H_2O

b) **1mg P/L Int LCS/MS Stock**
100µL (10.7.6) → 100mL in DI H_2O

10.7.8 LCS, LCS Low and MS Prep

a) Measure 50mL of DI H_2O in pre-cleaned 60mL test tubes with screw caps (9.2) for the LCS and the LCS Low. Pre-measured samples are provided to the lab by field personnel to use for MS Prep.

Table 2

	Volume of ERA Stock	Volume Matrix	Concentration
LCS Low	250µL 1mg/L (10.7.7b)	50mL DI H_2O	100µg P/L
LCS	500µL 10mg/L (10.7.7a)	50mL DI H_2O	100µg P/L
MS	500µL 10mg/L (10.7.7a)	50mL Sample	100µg P/L

11.0 Sample Collection, Preservation, Shipment and Storage

11.1 Pre-cleaned 60mL test tubes with PTFE lined screw caps (9.2) are to be marked to show the 50mL fill-to line using a sharpie and 'jig' prior to sending the test tube out to samplers by lab personnel. All TP and DP samples are collected in these pre-marked/pre-cleaned 60mL test tubes.

11.2 Samples being analyzed for DP are filtered through a 0.45µm membrane filter by field personnel. Field personnel are to provide and login a filter blank sample for lab analysis.

11.3 Field personnel will provide field split samples which will be used for required laboratory quality control purposes as duplicates and matrix spikes.

11.4 Samples are not preserved prior to digestion. Samples have a hold time of 28 days once digested.

11.5 Samples are received via drop off by field personnel or the mail. 10.8.6 Samples are stored at room temperature. Undigested samples (samples as received into the lab) do not need to be stored in secondary containment. Digested samples, which contain oxidizers and have a pH < 2, must be stored in some form of secondary containment.

12.0 Quality Control

12.1 The laboratory operates a formal Quality Control (QC) program. The minimum requirements of this program consist of an initial demonstration of capability, the analysis of method blanks, LCS's, sample matrix spikes, duplicates, and ICV as checks on the analytical performance. The laboratory maintains records that monitor the quality of data.

12.2 Initial Demonstration of Capability (IDC) – The date and analyst's initials of the following are to be documented on the Demonstration of Capability Certification Statement sheet and filed appropriately in the trainee's training folder:

12.1.1 The review of relevant reference method(s)
12.1.2 The review of the laboratory SOP
12.1.3 Observation of analysis by current analyst
12.1.4 Analysis of samples with little to no supervision
12.1.5 Analysis of four LCS or ICV samples.
12.1.6 The completion date of training
12.1.7 Signatures of the trainee, trainer and the quality assurance officer.

12.3 Calibration

12.3.1 The Initial Calibration must use a minimum of five standards and a blank. All standards are run in replicates of 2 as an Indication of Instrument Precision. The lowest calibration standard should be at the reporting limit and the highest concentration at the upper end of the calibration range ensuring that the calibration range encompasses the expected concentration values of the samples or required dilutions.

a) Indication of Instrument Precision – comparison between replicates of each calibration standard. The acceptance criteria is ≤ 10% RSD between each standard.

12.3.2 Analyses of the CCB and the CCV Mid demonstrate the ongoing precision and recovery and are analyzed on an ongoing basis. They are analyzed at the beginning of the run, again every ten samples and at the end of the run.

a) CCB acceptance criteria is ≤ ½ of the PQL.
b) CCV Mid acceptance criteria is ± 10% recovery of the target value.

12.3.3 Analysis of an ICV verifies the calibration curve through a secondary source. It is analyzed at the beginning of the run. ICV acceptance criteria is ± 10% recovery of the target value

12.3.4 Analysis of a CCV Low demonstrates the ongoing precision and recovery at the low end of the calibration curve. It is analyzed at the beginning of the run. Acceptance criteria for the CCV Low ± 10% recovery of the target value.

12.4 Laboratory Performance

12.4.1 Analyses of a Method Blanks are required to demonstrate freedom from contamination. One Method Blank is required per Digestion Prep Batch of 20 samples. Acceptance criteria for the Method Blank ≤ ½ of the PQL.

12.4.2 Analyses of LCS Mids are required to evaluate laboratory performance and analyte recovery in a blank matrix. One LCS Mid is required per Digestion Prep Batch of 20 samples. Acceptance criteria for the LCS Mid ± 10% recovery of the target value.

12.4.3 Analyses of Matrix Spikes (MS) and Duplicate samples are required to demonstrate method accuracy and precision and to monitor matrix interferences caused by the sample. Field Split Samples are provided to the laboratory by field staff for the use of matrix spikes or duplicates. The yearly goal is for 10% of the total yearly samples to have been analyzed as duplicates and as matrix spikes.

a) MS acceptance criteria ± 15% recovery of the target value.
b) Duplicate acceptance criteria ≤ 10% RPD for samples ≥ the PQL.

12.4.4 Analysis of LCS Low is required to evaluate the laboratory performance of the method and analyte recovery at the reporting limit. One LCS Low is required per daily TP digestion and daily DP digestion. Acceptance criteria ± 30% recovery of the target value.

12.4.5 Proficiency Evaluation – A sample with an unknown amount of analyte is analyzed to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. It is analyzed annually.

13.0 Calibration and Standardization

13.1 Prepare reagents and standards as described in section 10.0.

13.2 Set up manifold as shown in Appendix 1.

13.3 Input data system parameters as shown in Appendix 1.

13.4 Pump DI H_2O through all reagent lines and check for leaks and smooth flow. Switch to reagents and allow the system to equilibrate until a stable baseline is achieved.

13.5 Place standards in the sampler. Input the information required by the data system.

13.6 Calibrate the instrument by injecting the standards. The data system will then associate the concentrations with the peak area for each standard to determine the calibration curve. Acceptance criteria is ≥ 0.995.

13.7 Verify calibration using a CCV Low, CCV Mid and CCB as described in section

13.8 If percent recovery exceeds acceptance criteria as described in section 18.0, the analytical system is judged to be out of control, and the problem must be immediately identified and corrected and the analytical batch reanalyzed.

14.0 Procedure

14.1 Digestion Procedure

Note: Samples may be diluted prior to digest when high concentrations can be predicted.

14.1.1 60mL test tubes with a 'Collect sample for Duplicate or Spike' label are provided to the lab by field personnel for required laboratory duplicate or matrix spike quality control purposes. The analyst will decide at the time of analysis whether to use the sample as a Duplicate or as an MS by clearly marking the label. The samples designated as matrix spikes will be set aside for fortifying with spike solution as per section 10.6.8.

14.1.2 Sample container should contain 50mL as indicated by the black mark on the 60mL test tube. Shake well and decant excess sample if required.

14.1.3 TP Sample Digestion

- **a)** Prepare 1 LCS Low (10.7.8) per daily digestion prep batch.
- **b)** Prepare 1 Method Blank and 1 LCS Mid (10.7.8) per digestion prep batch of 20 samples.

14.1.4 DP Sample Digestion

- **a)** Prepare 1 LCS Low (10.7.8) per daily sample digestion batch.
- **b)** Prepare 1 Method Blank and 1 LCS Mid (10.7.8) per sample digestion batch of 20 samples.

14.1.5 TP/DP Calibration Standards and ICV

- **a)** Prepare calibration standards as per 10.7.

14.1.6 Calibration standards, QC and samples are digested using the following procedure:

- **a)** Set up samples in autoclaveable racks.
- **b)** Uncap all samples.
- **c)** Dispense 1mL Ammonium Persulfate Digestion Reagent to each sample.
- **d)** Dispense 1mL 11N H_2SO_4 (10.5.2) to each sample.
- **e)** Replace caps securely.
- **f)** Label racks with Date of Digestion. Autoclave samples for 30 minutes at 15 psi and 121°C (use the pre-programmed autoclave method P6). Record the sample type (TP, DP, Standards or Acid Wash), digestion date, initials and autoclave program being used.
- **g)** After cycle is complete, remove racks from autoclave and allow to cool before analysis.

14.2 Creating a Run Worksheet and Sample Tray Setup Procedure

14.2.1 Open Omnion 3.0 Icon.

14.2.2 Click on: Run →Open→....Omnion→Data folder.

14.2.3 Select Phosphorus Total for the TP worksheet template or select Dissolved Phosphorus for the DP worksheet template. Three windows will appear on the screen: the Run Worksheet, the Run Properties and one Channel Data Display.

14.2.4 Calibration Standard Tray Setup

- **a)** The Cup No.'s (1st column of the Run Worksheet) used for the standards are identified as S1, S2, S3, etc.

b) The Calibration Standard/Sample Type (3^{rd} column of the Run Worksheet) rows will be highlighted a blue color.

c) The CCB, CCV Mid, CCV Low and ICV Mid Check Standards rows will be highlighted a green color.

d) Uncap and place 60mL test tubes containing digested standards into standards tray that corresponds with the Cup No. on the Run Worksheet.

14.2.5 Sample Tray Setup.

a) The Cup No.'s (1^{st} column of the Run Worksheet) are identified as 1, 2, 3, etc. in the Run Worksheet. The Cup No. refers to the labeled position number in the sample rack.

b) Working with one digested sample at a time, begin scanning or manually entering the samples in the Sample ID column (the 2^{nd} column in the Run Worksheet screen). Once entered, pour an aliquot of sample into a 7mL test tube and place into the tray position that corresponds with the Cup No. (1^{st} column of the Run Worksheet).

1. To delete extra rows, click and drag along the selected rows, then right-click and select Delete.
2. To add new rows to the end of the spreadsheet, select any row, then right-click to get the edit menu. Click on the Append Row, to add one row, or on Append Many, to add more than one row.
3. To insert a row or rows before or above a row, click on the row to select it, right-click, then click on Insert Row or Insert Many.
4. To Auto Number Cups, click and drag on the rows in the spreadsheet in which the Cup No. sequence should appear. The right-click and cling on Columns, Auto Number Cups. All Samples rack Cup Nos., those not in the Standards rack (S1, S2, etc.) will be renumbered sequentially, incrementing by 1, starting with the first non-Standards rack Cup No. of the selection.

c) Place the sample tray in the auto-sampler. Make sure the tray is positioned properly in the auto-sampler tray. Sample trays are placed from left to right in the auto-sampler. Three racks of 90 samples can be placed in the auto-sampler.

d) Place a rack of empty 7mL test tubes last space on the right of the auto-sampler. These are to be used for dilutions by auto-diluter.

14.2.6 Defining DQM

Click and drag the CCB and CCV Mid green Check Standard rows. Right-click and select Define DQM Set. Select "After every N samples". Enter #: 10 in the empty field. Make sure the Close End of Run box is checked. Click OK. The DQM Set is now scheduled to appear at the beginning of the run, every 10 samples and at the end of the run.

14.3 Calibration and Sample Analysis

14.3.1 Setup manifold and manifold pump tubing.

14.3.2 Pump DI water through all reagent lines and check for leaks and smooth flow. Switch to reagents and allow the system to equilibrate.

14.3.3 From the main menu, select Configuration →Autosamplers to open the

Configure Autosamplers window.

a) Click on Initialize Autosampler to initialize communication between the autosampler and the computer.
b) Click on Prime Dilutor to prepare the autodilutor for samples needing dilution.
c) Click Close to return to the Run Worksheet window.

14.3.4 From the main menu, select the Start icon to begin instrument calibration and sample analysis. The data system will then associate the concentrations with the instrument responses for each standard.

14.4 End of Sample Analysis

14.4.1 Remove the TP Color Reagent manifold line from the reagent. Place the line a 0.1N – 0.3N NaOH solution and allow 1-3 inches of the solution to pump through the line. Remove the line out of the NaOH solution and place into a flask containing DI H_2O and allow to pump for a few minutes.

14.4.2 Remove all other manifold lines from their reagents and place into the flack containing DI H_2O and allow to pump for a few minutes.

14.4.3 Remove all manifold lines from the DI H_2O and allow air to pump through the manifold lines for a few minutes.

14.4.4 Turn off the manifold pump and unclamp the manifold pump lines.

14.4.5 Re-cap calibration standards, reagents and waste container. Refer to section 21.0 for sample waste disposal.

14.5 Data Acquisition and Reduction

14.5.1 Export Data to File

a) Once the analysis is complete, insert a thumb drive into the computer's USB port. In the Runs Properties window (upper right of the screen), click on the Run tab. Click on *Export Data to File*. This action will copy the data to a USB thumb drive.

14.5.2 Format and Print Run Report

a) Use the cursor to highlight the Calibration peaks in the Channel Data Display window.
b) In tool bar, click on Report, and Open Format. Choose TP for Phosphorus-Digested or DP for Phosphorus Filtered/Digested format.
c) Click on the Custom Report Format icon (which is the 8th icon (yellow) from the left in the toolbar) to display the Custom Report Format window. Click on the Layout Tab to adjust the look of the report which includes the analyst's name and analysis date. Click Apply once all changes have been made and then click Close. Refer to the Omnion 3.0 Software User Guide if other adjustments to the report need to be made.
d) Print analytical run report. Click on Print icon, 7th from the left. Select *Print*.
e) Save report format. Go to tool bar, click on Report, and Save Format. Choose TP for Phosphorus-Digested or DP for Phosphorus Filtered/Digested and click OK. Close window

14.5.3 Print a copy of the TP/DP Standards/QC spreadsheet to include with the analytical run report.

14.5.4 Save an electronic copy of the TP/DP Standards/QC spreadsheet by clicking on the '*Save*' radio button located on the spreadsheet.

14.5.5 Use the cursor to highlight the Calibration peaks in the Channel Data Display window.

14.6 Parse the Data

14.6.1 Insert the thumb drive into USB port on a DEC Sample Master LIM System networked computer.

14.6.2 Open Windows Explorer. Open the following: Y Drive > LIMS > Instrument Parsers Folder > Lachat Omnion 3 folder > Lachat Omnion 3 Parser.

14.6.3 Enter analyst initials, confirm analysis date and OK. At the prompt, go to the E: / drive and choose the file to be parsed. Parsing will commence. Data will be displayed in a color coded format. Review data, QC numbers, recovery calculations and formulas. Highlight and set the Print Area to be printed. Print a copy. Click on the Save icon. Minimize this screen.

14.6.4 Enter the QC Batch ID (refer to 12.7 for creating a QC Batch) in the window and click OK. Parsing will finish and data will be configured for import into the DEC Sample Master LIM System. Review one last time. Click the Save Icon and close the screen.

14.7 Create a QC Batch

14.7.1 Log in to the DEC Sample Master LIM System. Click on the *'Data Entry'* icon in the Main Menu window. Highlight the '*Create QC batch*' then click on the '*Select*' option.

14.7.2 In the *'Matrix'* drop down box select *'water'*.

14.7.3 In the '*Test*' drop down box select '*Phosphorus-Digested*', or *Phosphorus-Filtered/Digested'*. Make sure that the '*Unassigned Samples'* box is checked. Select '*Retrieve'*.

14.7.4 In the '*QC Batch*' window, check the boxes of the sample numbers to be included in the QC batch.

14.7.5 Click the *'New'* button. A QC Batch ID numbered is automatically generated by the Sample Master LIM System to all the checked samples. This QC Batch ID number is required to complete the parsing process (refer to section 14.6.4). The date of sample digestion is considered the date of analysis. If the date of digestion is different from the date of the QC Batch ID, change it to reflect the date of digestion. Write this QC batch number on the front page of the colored parsed data report.

14.7.6 The '*New QC batch*' window will appear. Click the '*Advanced*' button. The '*New QC batch – Sequence*' window will appear. Move desired type and frequency of QC from left side of window into the run sequence section on the right. After this is done, click '*Close*'. This will return you to the '*QC Batch*' window.

14.7.7 In the '*QC Batch*' window, use the drop down boxes to assign order and sample numbers for each Duplicate(s) and Matrix Spike(s). After this is done, click the '*Add Samples*' button. The check marks in sample boxes will disappear. Click '*Close*'.

14.7 Import Data

14.7.1 In the Sample Master LIM System, click on the red/green icon 2nd from the bottom. Highlight the phrase *Import All Files in One Directory* and click *Select.*

14.7.2 In the dropdown box choose Lachat as the directory to import data from. Click *Import Immediately.* Sample Master will display *Do you wish to delete the completed task?* Click *No.* Close import window. Click on the 2nd icon from top and select Result Entry. Review the imported data.

14.7.3 Forward the analytical run report to another analyst for review and validation. Validated data is then authorized for reporting by the lab supervisor.

15.0 Calculations

15.1 Duplicate Sample – Relative Percent Difference (RPD)

$$\text{RPD} = \left(\frac{|\text{Sample Result} - \text{Duplicate Result}|}{((\text{Sample Result} + \text{Duplicate Result})/2)}\right) 100\%$$

15.2 Matrix Spike (MS) Sample – Percent Recovery

$$\%\ \text{Recovery} = \left(\frac{(\text{MS Sample Result} - \text{Sample Result})}{\text{Known MS added Concentration}}\right) 100\%$$

15.3 LCS, CCV, ICV Samples – Percent Recovery

$$\%\ \text{Recovery} = \left(\frac{\text{Found Value}}{\text{True Value}}\right) 100\%$$

16.0 Method Performance (See section 18.0)

16.1 Method Detection Limit (MDL)

16.1.1 To determine MDL values, seven aliquots of reagent water fortified at approximately half the PQL are processed through the entire analytical method.

16.1.2 Perform all calculations defined in the method and report the concentration values in the appropriate units (µg P/L).

a) $\text{MDL} = (t) \times (s)$

(t) = 3.14 Student (t) value for 7 replicates
(s) = standard deviation of the 7 replicates

16.1.3 The MDL is determined annually, when there is a new operator, or when there is a significant change in the background or instrument response.

16.2 Practical Quantitation Limit (PQL) – The PQL is the lowest concentration level achievable within specified limits during routine laboratory operations. It is typically 2 – 5 times the calculated MDL. The PQL for this method is 5.0 ppb.

16.3 Performance Evaluation (PE) Tests – Participation in periodic PE Tests, such as USGS studies, are analyzed semi-annually. If failures occur, corrective action is taken until acceptable performance is achieved.

17.0 Pollution Prevention

17.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation.

17.2 Laboratory policy is to purchase reagents and standards on an as needed basis and log them into the chemical inventory database and assigning an expiration date, eliminating the need for a stockroom. The database is reviewed on an ongoing basis for expired reagents that can be updated and used for another year

18.0 Table 3 - Data Assessment and Acceptance Criteria for Quality Control Measures

Assessment	QC Procedure	Frequency	Limits	Corrective Action
Calibration Curve Linearity	Correlation coefficient	Each calibration	≥ 0.995	Re-calibrate.
Indication of Instrument Precision	Duplicate measurements of Calibration Standards	All standards	≤ 10% RSD	Re-calibrate.
Assessment of Method Performance against second source standard	ICV Mid	Beginning of analysis	± 10%	Re-analyze. If still out of control, find and correct source of problem. Re-calibrate the instrument if the problem is instrument related. Re-prepare a new ICV Mid if the problem is sample prep related.
Calibration Curve Stability	CCB	Beginning of analysis, every 10 samples and at end of run analysis	≤ 1/2 PQL	Re-analyze. If still out of control, find and correct source of problem. Re-calibrate the instrument if the problem is instrument related. Re-prepare a new CCB if the problem is sample prep related.
Calibration Curve Stability	CCV Mid	Beginning of analysis, every 10 samples and at end of run analysis	± 10%	Re-analyze. If still out of control, find and correct source of problem. Re-calibrate the instrument if the problem is instrument related. Re-analyze any and all samples that are not bracketed by passing CCV Mids. However, if a high CCV is recorded and the samples are non-detects, results may be reported with no remark codes if necessary.
Calibration Curve Stability	CCV Low	Beginning of analysis	± 10%	Re-analyze. If still out of control, find and correct source of problem. Re-calibrate the instrument if the problem is instrument related. Note that the CCV Low is 1-2 times the PQL which is ≅ LOQ
Lab Contamination Monitor	Method Blank	1 per 20 samples	≤ 1/2 PQL	Re-analyze. If still out of control, find and correct source of problem. The PQL for samples not bracketed by two passing Method Blanks will be adjusted to reflect a potential high bias due to lab contamination.

Assessment	QC Procedure	Frequency	Limits	Corrective Action
Assessment of Method Performance	LCS	1 per 20 samples	± 10%	Re-analyze. If still out of control, remark code and comment in sample master.
Sample Matrix Effect on Accuracy of Results	MS	Varies per digestion batch	± 15%	Remark code and comment in sample master.
Assessment of Method Performance at the PQL level	LCS Low	1 per digestion batch	± 30%	Re-analyze. If still out of control, remark code and comment in sample master.
Sample Matrix Effect on Precision of Results	Duplicate	Varies per digestion batch	± 15%	Remark code and comment in sample master.

19.0 Corrective Actions for Out of Control Data (See section 18.0)

19.1 Performing routine instrument maintenance such as changing manifold pump tubing, manifold tubing, and other fittings prior to analysis may correct for baseline issues, flow issues, etc. The Lachat Analyzer used primarily for chlorides, nitrates, etc. can also be used as a backup analytical system.

19.2 Contact the lab supervisor, nutrients technical director, QC officer with any questions and/or concerns.

19.3 For technical assistance, contact Lachat Instruments at 1-800-247-7613, account # 119791.

19.4 Lachat Auto Analyzer Data Backup Procedure – Use CDRW on the instrument computer to back up data. This should be done annually, and noted in the instrument maintenance logbook and the data spreadsheet.

20.0 Contingencies for Handling Out of Control or Unacceptable Data

20.1 Remark Code and Comments – Data and/or samples that do not meet acceptance criteria upon receipt or during analysis need to be either Remark Coded and/or Commented on in the Sample Master LIMS system.

20.1.1 Remark Codes – Remark codes are entered after all data has been parced into Sample Master. To enter a remark code, go to Results Entry. Select QC Batch ID of the data and click Retrieve. In the upper left corner of the View Results window, click on Results to Validate option. Click the "+" box of the sample/QC data needing the remark code and place the appropriate code in the Remark Column. Click the "Close" button on the bottom left of the window (do not click the Validate button) to close the window. All remark codes will be saved. The following codes are to be entered in the appropriate field in Sample Master when necessary:

Table 4

SRM Code ID	Description
B	Reported value is associated with a blank contamination
BH	Reported value may be biased high

BL	Reported value may be biased low
D	Dilution resulted in instrument concentration below PQL
E	Estimated Value
H	Hold time exceeded
I	Matrix Interference
N	Not processed
O	Outside calibration range, estimated value
OL	Outside Limit

20.1.2 Comments – Additional analyst comments can be entered when more detail information is needed. To enter a comment, go to Results Entry. Select QC Batch ID of the data and click Retrieve. In the upper left corner of the View Results window, click on Results to Validate option. Click the "C" box of the sample/QC data needing the comment to open the Comment window. Enter the comment into the field and click OK when finished. Click the "Close" button on the bottom left of the window (do not click the Validate button) to close the window. All comments will be saved.

20.2 Method Blank contamination – Acceptance criteria for Method Blanks ≤ ½ the PQL. Samples must be bracketed by passing Method Blanks to report samples at the PQL. If a Method Blank fails > ½ the PQL, the PQL will be adjusted and remark coded "BH" (section 20.1.1) for samples with results between the 5 – 10ppb. Samples with results > 10ppb within the same bracket will not need a remark code.

20.3 Duplicate – RPD acceptance criteria for Duplicate analysis ≤ 15% for samples > ½ the PQL. The sample result for the Duplicate sample is remark coded "OL" (section 20.1.1) if the Duplicate RPD is ≥ 15%. If a Duplicate RPD fails, the sample result of the Duplicate is remark coded "OL" (section 20.1.1). If the sample result ≤ ½ the PQL, the Duplicate RPD does not need to be remark coded.

20.4 MS – MS recovery acceptance criteria ± 15%. The MS result is remark coded "OL" (section 20.1.1) if the MS recovery is ≥ 15%.

21.0 Waste Management

21.1 Phosphorus and Dissolved Phosphorus are first digested in individual sample collection vessels using Ammonium Persulfate and Sulfuric Acid. The automated analysis system utilizes several reagents containing toxics and corrosives such as Ammonium Molybdate, Ammonium Persulfate, and Sulfuric Acid. Because of their toxic and corrosive characteristics, sample analysis waste is collected into a 20 liter waste container and disposed through ESF. A "waste tag" is filled out by the employee generating waste, and submitted to the LSO who then enters tag information on line, for pickup.

21.2 Because the sample is digested in each individual sample collection vessel, the unused sample (in this case, digestate) is poured into analysis waste container and disposed through ESF in the manner stated above.

21.2 See Appendix II of Department of Environmental Conservation Laboratory Final Laboratory Waste Management Plan, September 3, 2012.

22.0 References

22.1 Standard Methods for the Examination of Water and Wastewater, 21th Ed. APHA-AWNA/WPCF Method 4500-P H Manual Digestion and Flow Injection Analysis for Total Phosphorus.

22.2 Determination of Total Phosphorus by Flow Injection Analysis Colorimetry, QuikChem Method 10-115-01-1-F, 27Aug03/csv.

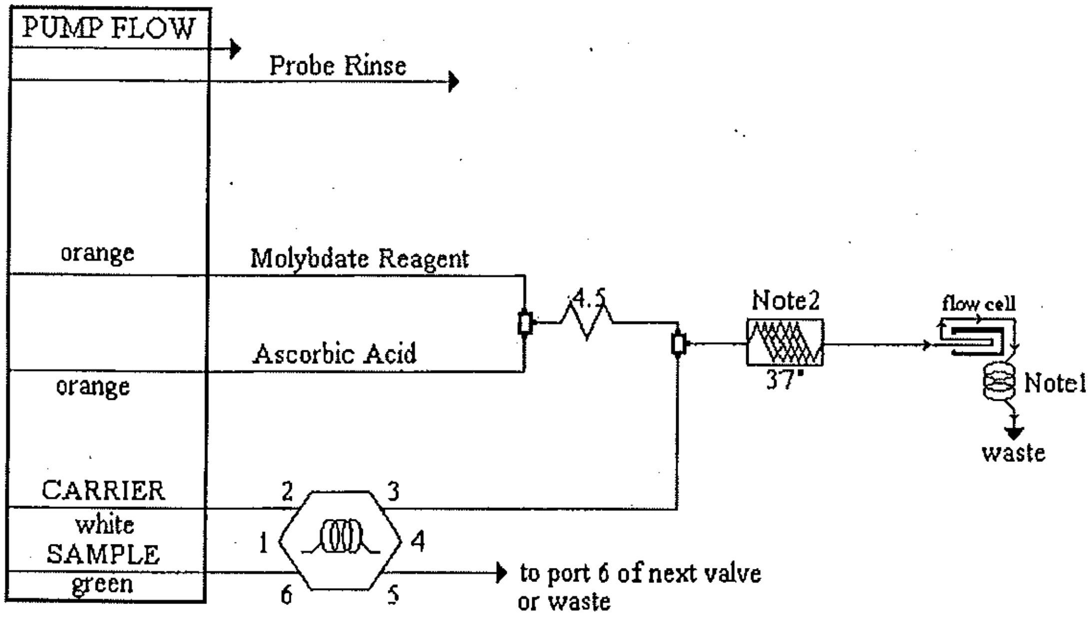
22.3 QuikChem FIA+ Automated Ion Analyzer User Manual, Lachat Instruments, Hach Company, 2003.

22.4 Omnion 3.0 Software User Guide, Lachat Instruments, Hach Company, 2003.

23.0 Tables, Diagrams, Flowcharts and Validation Data

APPENDIX 1

Total Phosphorus Manifold Diagram



Carrier:	**0.13 M sulfuric acid**
Manifold Tubing:	**0.8 mm (0.032 in) i.d. This is 5.2 μL/cm.**
AE Sample Loop:	100 cm
QC8000 Sample Loop:	100 cm
Interference Filter:	880 nm

Apparatus: An injection valve, a 10 mm path length flow cell, and a colorimetric detector module is required. The ▨ shows 175 cm of tubing wrapped around the heater block at the specified temperature.

4.5: 70 cm of tubing on a 4.5 cm coil support

Note 1: 200 cm back pressure loop, 0.52 mm (0.022 in.) i.d.
Note 2: 175 cm of 0.8 mm i.d. tubing on the heater.

Appendix 2

23.1 Data System Parameters for Quikchem 8000

Under **Analyte** tab, Channel 1

Property	**Value**
Description	Phosphorus-Digested
Channel OFF	(box not checked)
Method	FIA

Under **Analyte** tab, Channel 1, Phosphorus-Digested

Property	**Value**
Analyte Name	Phosphorus-Digested
Concentration Units	ug/l
Calibration Fit Type	Second Order
Clear Calibration	Yes
Force Through Zero	No
Calibration Weighting	None
Auto Dilution Trigger	Yes
% of High Standard	100
Quick Chem Method	10-115-01-1-F
Chemistry:	Direct/Bipolar
Calibration by Height	No

Under **Timing** tab, Run

Property	**Value**
Method Cycle Period(s)	60
Sample Period (s)	23
Min. Probe in Wash Period	10
Pump standby active	Yes
Use minutes	No
Channel in minutes	No
Analyte in minutes	No
Pump idle before standby	0
Pump at speed before analysis	0

Under **Timing** tab, Run, Channel 1

Property	**Value**
Load period (s)	18
Inject period (s)	42
Time to valve (s)	26
Use retention time	No

Under **Timing** tab, Run, Channel 1, Phosphorus-Digested

Property	**Value**
Expected inject to peak start (s)	6
Expected peak base width (s)	65

Under **Rack** tab, choose 3x60 rack configuration

Under **Run** tab, the drop down boxes should show the following

Instrument:	Instrument 1 (Flow Injection Analysis)
Autosampler:	Autosampler 1 (ASX 500 / DRD)

Data configuration for export are set from tool bar. Go to *Configuration* and open *Options*. Choose **Data Export** tab. Under *File Export*, the following boxes should be checked

Export to CSV File Enabled

Include Column Headers

Export in Omnion 2.0 Format

Click on *Data Items*. This will open *Export Data* window. The following items should be entered in the following order. The order is important.

Location (to export) F:\ drive

For Channel Independent Data, the Selected Items are (in order shown)

Sample ID
Sample Type
Replicate Number
Detection Date
User Name
Detection Time
Manual Dilution Factor
Auto Dilution Factor

For Channel Dependent Data, the Selected Items are (in order shown)

Channel Number
Analyte Name
Peak Concentration
Concentration Units

24.0 Additional Notes:

Date:	Revision #:	Summary of Changes:	Submitted By/Date:	Approved By:	Effective Date:
1/28/2015	7	This SOP was rewritten to include NELAC required format and informational points. Where guidance is not applicable or would be redundant, an N/A, or another section within the SOP is referenced.	DGM/CMB 1/28/2015		

Standard Operating Procedure Signature Page

The signatures below indicate the analyst has read, understands, and will follow the SOP.

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

APPENDIX C (attached): Standard Operating Procedure for Total Nitrogen 24 7 1-2015 (Persulfate Digestion Method)

Standard Operating Procedure (SOP) for

Standard Operating Procedure (SOP) For Total Nitrogen

Reviewed by: Daniel McAvinney Date: 3/26/15
Daniel McAvinney, Environmental Scientist*

Revised by: Daniel McAvinney Date: 3/26/15
Daniel McAvinney, Environmental Scientist **

Reviewed and Approved by:

Date: 03-26-2015
Dan Needham Interim Quality Assurance Officer*

Date: 03-26-2015
Dan Needham, DEC Laboratory Supervisor*

Vermont Department of Environmental Conservation Laboratory

*Signature implies that the individual has read, understands and agrees to follow this Standard Operating Procedure.

**Signature indicates SOP has been revised.

Table of Contents

1.0 Identification of Test Method:

1.1 This SOP for VTDEC is based on Hach/Lachat method 10-107-04-1-C for the analysis of nitrate/nitrite as nitrogen in water, with reference to Standard Method SM 4500-N C Modified.

2.0 Applicable matrix or matrices:

2.1 This method determines the amount of total nitrogen in drinking, ground, and surface water and in saline, domestic and industrial wastewater, and soil extracts.

3.0 Method detection limit (MDL) / Limit of quantitation (LOQ):

3.1 Method Detection Limit (MDL) is approximately equal to the LOQ, and is used to calculate the Practical Quantitation Limit (PQL). This information is summarized in section 23.0

3.2 The PQL for is Total Nitrogen 0.10 mg/l.

4.0 Scope and application, including components to be analyzed:

4.1 This method determines nitrate/nitrite as nitrogen in water in liquid matrices by automated flow injection analysis.

4.2 The applicable range is 0.05 to 2.0 mg N/l.

5.0 Summary of test method:

5.1 A small sample volume is combined with an alkaline persulfate solution, and digested at 121 C / 15 psi. This process digests ammonia, nitrite and nitrogenous organic materials, oxidizing them to form nitrate.

5.2 Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is read at 520nm. Nitrite alone also can be determined by removing the cadmium column.

6.0 Definitions:

6.1 Calibration Blank (CB) - A volume of reagent (0.2 % sulfuric acid) in the same matrix as the calibration standards, but without the analyte.

6.2 Calibration Standard (CAL) - A solution prepared from the primary dilution standard solution or stock standard solutions. The CAL solutions are used to calibrate the instrument.

6.3 Method Blank (MB) – A laboratory reagent (0.2 % sulfuric acid) blank that is treated exactly as a sample, and is used to monitor lab contamination. Digested sample and QC results are corrected for blank contamination using the averaged Method Blank results from an analytical run.

6.4 Filter Blank (FB) - A laboratory reagent (0.2 % sulfuric acid wash) blank that is treated exactly as a sample, and is used to monitor lab contamination. A filter blank is analyzed only when sample filtration is required at the bench.

6.5 Laboratory Duplicate (LD) - Two aliquots of the same environmental sample treated identically throughout a laboratory analytical procedure. The lab duplicates are treated exactly as the samples. Analysis of laboratory duplicates indicates precision associated with laboratory procedures but not with sample collection, preservation or storage procedures.

6.6 Matrix Spike (MS) - A routine environmental sample with a known concentration of analyte added. The added analyte should have the same concentration as the Laboratory Control Sample (LCS), and be treated exactly as the samples.

6.7 Laboratory Control Sample (LCS) - A laboratory reagent blank with a known amount of analyte added. The added analyte should have the same concentration used for the Matrix Spike (MS), and be treated exactly as the samples.

6.8 Laboratory Control Sample – Low (LCS-Low) - A laboratory reagent blank with a known amount of analyte added. The added analyte should have a concentration at or near the PQL, and be treated exactly as the samples.

6.9 Initial Calibration Verification (ICV) - The ICV is obtained from a source other than the calibration standards, and treated exactly as the calibration standards.

6.10 Method Detection Limit (MDL) - The lowest level at which an analyte can be detected with 99 percent confidence that the analyte concentration is greater than zero.

6.11 Limit of Detection (LOD) – The LOD is the lowest concentration level that can be statistically different from a blank. The LOD is approximately equal to MDL.

6.12 Limit of Quantitation (LOQ) – The LOQ is approximately equal to the PQL. A CCV Low is included in each analysis at 1-2 times the PQL.

6.13 Practical Quantitation Limit (PQL) - The laboratory's reporting limit, which is 2 to 5 times the minimum detection limit.

6.14 Continuing Calibration Verification Solution (CCV) - A calibration standard used to monitor instrument performance.

6.15 Continuing Calibration Blank (CCB) - A calibration blank standard used to monitor instrument performance.

6.16 Proficiency Evaluation (PE) – Certified solution of method analyte that is unknown to the analyst.

6.17 Data Quality Management (DQM) – Defines various quality control samples or sample sets within a tray protocol. These can be CCB/CCV Mid after a calibration curve and every ten samples, at the end of an analytical run; a Method Blank/LCS, a sample and its duplicate / MS.

7.0 Interferences:

7.1 Sulfide can rapidly and significantly reduce cadmium column efficiency.

7.2 Residual chlorine can oxidize the cadmium column.

7.3 High concentrations of iron, copper or other metals can give low results. EDTA is added to the buffer to reduce this interference.

7.4 Turbidity / sediment can interfere, and can be removed by filtration through a 0.45 µm pore diameter membrane filter prior to analysis.

7.5 Oil and grease in high concentrations can coat the surface of the cadmium. Eliminate this by pre-extracting the sample with an organic solvent.

8.0 Safety:

8.1 Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) are stored online at www.thermofisher.com, and with the Lab Safety Officer (LSO).

8.2 The Laboratory Safety Plan is available for review as a hardcopy, and on the State of Vermont intranet (Y drive) and used by personnel involved in the analysis.

8.3 The following reagents are known to be toxic or hazardous. For more detailed explanations consult the MSDS/SDS information, and Lab Safety Plan.

  8.3.1 Sulfuric acid
  8.3.2 Ammonium hydroxide
  8.4.3 Sodium hydroxide
  8.4.4 Phosphoric acid
  8.4.5 Ammonium chloride
  8.4.6 Cadmium
  8.4.7 Sulfanilamide
  8.4.8 Potassium persulfate

9.0 Equipment and Supplies:

9.1 Balance(s) - Analytical, capable of accurately weighing to the nearest 0.001g

9.2 Class 'A' volumetric flasks and lab ware as needed.

9.3 Rainin EDP pipette w/ disposable tips.

9.4 Flow injection analysis instrumentation designed to deliver and react sample and reagents in required order and proportion.

  9.4.1 Auto sampler.
  9.4.2 Auto dilutor.
  9.4.3 Multi-channel peristaltic pump with at least 4 channels.
  9.4.4 Reaction unit or mixing manifold.
  9.4.5 Colorimetric detector, including 80µl flow cell with 10mm path length.
  9.4.6 Interference filter 480nm ± 10nm band pass.
  9.4.7 Cadmium reduction column
  9.4.8 Data handling system

9.5 50ml polyethylene screw-top centrifuge tubes as needed

9.6 16 x 125 mm glass screw top tubes with marking spot, threaded polypropylene (liner less) caps.

9.7 16 x 100 mm glass test tubes as needed

9.8 Filters as needed.

10.0 Reagents and standards:

10.1 Carrier/Diluent 0.2 % Sulfuric acid. In a 2L volumetric flask with 1800 ml D.I. water, add 4ml low nitrogen sulfuric acid (Fluka #84727) and dilute to volume. Prepare daily.

10.2 Digestion Reagent-Each sample needs 5ml digestion reagent. Prepare volume according to Table A.

Volume	**Potassium Persulfate ($K_2S_2O_8$)**	**Sodium Hydroxide (NaOH)**
1 L	20.0 g	6.0 g
500 ml	10.0 g	3.0 g
250 ml	5.0 g	1.5 g
100 ml	2.0 g	0.6 g

10.3 Ammonium Chloride Buffer-In a 2 L volumetric flask dissolve 170.0g ammonium chloride (NH4Cl) and 2.0g disodium EDTA (Na2-EDTA•2H2O) in approximately 1800ml D.I. water. Add 16.0ml ammonium hydroxide (NH4OH). Dilute to 1L with D.I. water and mix on magnetic stir plate until dissolved. Adjust pH to 8.50 ± 0.05 with ammonium hydroxide. Hold time is one month.

10.4 Sulfanilamide Color Reagent-To a 1L volumetric flask add 40.0g sulfanilamide, and enough D.I. water to wet. Then add 100ml of 85% phosphoric acid (H_3PO_4) and swirl to mix, add 500 ml D.I. water and mix until dissolved. Add 1.0g N-(1-naphthyl) ethylenediamine dihydrochloride (NED). Dilute to volume and mix on magnetic stir plate until dissolved. Store in a dark bottle. Hold time is 1 month.

10.5 Primary standard, Nitrate as N 1000mg/l (Spex #AS-NH3N9-2Y). Expiration date is given by the manufacturer or one year from date opened.

10.6 Secondary standard, Nitrate as N 1000 mg/l (ERA #052), Expiration date is one year from ship date.

10.7 Reduction efficiency standard, Nitrite as N 1000 mg/l, either of the following can be used: Spex #AS-NO2N9-2Y or ERA #053.

11.0 Sample collection, preservation, shipment and storage:

11.1 Samples are collected in pre-cleaned, disposable 50ml polyethylene screw top centrifuge tubes.

11.2 Samples are delivered to the lab by field personnel or courier.

11.3 Samples are acidified w/ low nitrogen sulfuric acid and stored at ≤ 6 C.

11.4 Sample hold time is 28 days.

12.0 Quality control:

12.1 The laboratory operates a formal quality control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability, determination of minimum detection limit, periodic analysis of laboratory reagent blanks (method blanks), laboratory control samples, sample (matrix) spikes and duplicates, initial calibration verification solutions as checks on analytical performance and meeting a minimum correlation coefficient for the calibration curve. The laboratory maintains and monitors the data in the Lab Information Management System (LIMS). Definitions below may refer to a Data Quality Management (DQM) set, defined as one or more QC samples analyzed concurrently to monitor instrument performance.

12.2 Method Detection Limit (MDL) - MDLs are determined/verified annually, when a new operator begins work, or whenever there is a significant change in the method procedure. The MDL is determined by analyzing 7 samples at 0.1 mg/L, yielding a PQL of 0.1 mg/L.

12.3 Linear Dynamic Range (LDR) - The LDR must be determined initially or whenever a significant change in instrument response is observed or expected.

12.4 Initial demonstration of Ability (IDA) – An IDA is required by new analysts before reporting results. The reference method and lab SOP must be reviewed. The new analyst must observe the current analyst running at least one analytical batch, then analyze an analytical batch under current analysts supervision, and finally analyze and meet QC criteria for four replicates of LCS or ICV.

12.5 Proficiency Evaluation (PE) – Successful analysis of a PE sample at a minimum of one concentration must be completed prior to reporting results. Results should be within the test limits established by USEPA for the category of sample being tested.

12.6 Lab Reagent Blank aka Method Blank (MB) – are analyzed to determine if reagents contribute contamination to the process. An MB is paired with an LCS and referred to as a DQM set. This DQM set is analyzed with each analytical batch of 20 or fewer samples. Results should be less than ½ the PQL. If the result is greater than ½ the PQL, sample results in the corresponding analytical batch that are between the PQL and 2x the value of the Method Blank are given a remark code 'BH' (result may be Biased High).

12.7 Laboratory Control Samples (LCS) – A laboratory reagent blank with a known amount of analyte added. The added analyte should have the same concentration used for the Matrix Spike (MS), and be treated exactly as the samples. An LCS is paired with an MB and referred to as a DQM set. This DQM set is analyzed with each analytical batch of 20 or fewer samples. LCS recovery of 90 – 110 % is expected. Minimum frequency is 5%, or 1 LCS per analytical batch, whichever is greater.

12.8 Laboratory Control Sample - Low (LCS Low) – A laboratory reagent blank with a known amount of analyte added at or near the PQL. The added analyte should be treated exactly as the samples. An LCS Low is run once during the analysis with an expected recovery of 75 – 125 %.

12.9 Matrix Spike (MS) - A routine environmental sample with a known concentration of analyte added, and is paired with an unspiked sample. The added analyte should have the same concentration as the Laboratory Control Sample (LCS), and be treated exactly as unspiked samples. Recovery of 85 – 115% is expected. Minimum frequency is 5%, or 1 LCS per analytical batch, whichever is greater.

12.10 Lab Duplicate - Two portions of the same environmental sample treated identically throughout the analytical procedure, and treated exactly as the samples. Analysis of laboratory duplicates indicates precision associated with laboratory procedures but not with sample collection, preservation or storage procedures.

12.11 Initial Calibration Verification (ICV) - The ICV is obtained from a source other than the calibration standards, and treated exactly as the calibration standards. The frequency is once per analysis, immediately after the calibration is acquired. Expected recovery is within 10 % of the true value. Re-prepare and rerun if the ICV recovery is outside expected limits.

12.12 Continuing Calibration Verification (CCV) – are calibration standards used to monitor instrument precision and performance. Data is kept in LIMS and monitored by the QC Officer.

12.12.1 CCB - Continuing Calibration Blank is analyzed after the calibration and every ten samples thereafter. It is paired with the CCV Mid and referred to as a Date Quality Management (DQM) set. CCB results should be less than ½ the PQL. If the CCB fails, the analysis must be stopped, the cause determined and the instrument recalibrated. The CCB data must be kept on file with the sample analysis data.

12.12.1 CCV Low - is a low level calibration standard near or at the PQL, and is analyzed once during the run after the calibration. The expected recovery for the CCV Low is within 70 -130% of the true value. If the CCV Low fails, re-run once. If still unacceptable, the analysis must be stopped, the cause determined and the instrument recalibrated. The CCV Low data must be kept on file with the sample analysis data.

12.12.2 CCV Mid - is a midlevel calibration standard analyzed after the calibration is complete and every ten samples thereafter. It is paired with the CCB and referred to as a DQM set. The expected recovery for the CCV Mid is ±10% of its true value. If the CCV Mid fails, the analysis must be stopped, the cause determined and the instrument recalibrated. The CCV Mid data must be kept on file with the sample analysis data.

12.13 Correlation Coefficient – The minimum correlation coefficient for Chloride is 0.995 or greater.

12.14 % Residual for Calibration Standards – The expected % residual for duplicate calibration standards is ≤ 10%.

13.0 Calibration and standardization:

13.1 Intermediate standard –Nitrate as N 10 mgN/l. Dilute 1.0 ml of 1000 mg/l primary stock to 100 ml with DI water.

13.2 Working standards - Use intermediate nitrate standard to prepare 100 ml volumes of working standards as noted in table below. Bring to volume with D.I. water then acidify with 200µl low nitrogen sulfuric acid. Dispense into 50 ml plastic screw top centrifuge tubes. Hold time is 28 days.

Volume (ml) of **10** mg/l Nitrate Stock	Concentration mg/l
20	2.0
10	1.0
5	0.5
1	0.10
0.5	0.05
0.0 (100 ml D.I. water)	0.0

13.3 Prepare (NO3-N) Nitrate as N ICV at a mid-calibration level using other than primary stock solution. Bring to 100 ml volume with D.I. water then acidify 200µl low nitrogen sulfuric acid. Dispense into 50 ml plastic screw top centrifuge tube. Hold time is 28 days.

13.4 Prepare (NO2-N) Nitrite as N reduction efficiency standard. Dispense 100µl nitrite stock 1000 mg/l to 100 ml volumetric flask. Dilute to volume. Do not acidify.

13.5 Prepare (NO3-N) lab control sample (LCS and MS) standard, 100 mg/l NO_3. Use Rainin pipet to make a 1:10 dilution of the primary stock solution into a test tube. The lab uses 100µl of 100mg/l stock + 10 ml volume to yield a concentration of 1 mg/l.

13.6 Prepare TN lab control sample (LCS and MS) stock standard, 100 mgN/l. Dissolve 0.2627 mg of L-Glutamic acid in 250 ml volumetric flask with D.I. water. The lab uses 25 µl of 100mg/l stock + 5 ml volume to yield a concentration of 0.5 mg/l TN.

13.7 Prepare TN LCS Low stock. Dilute an aliquot of ERA Simple Nutrient QC (Item #505) to create an intermediate spiking solution. The final concentration of a blank spiked with this solution should be should be at or near the PQL of 0.1 mg/l.

13.8 Record the following information on the TN QC spreadsheet: Standards and QC prep, instrument model, Standard Method reference, test, analyst, test date, color reagent lot number and expiration date, primary and secondary standards with their respective concentrations, lot numbers, expiration dates. Information is updated with each date of analysis and saved in a folder on the instrument computer by clicking on the 'Save' radio button.

14.0 Procedure:

14.1 Sample Digestion-Prepare digestion reagent according to Section 10.2, Table A.

14.1.1 Remove samples from the refrigerator and bring them to room temperature. Check each sample to ensure that the pH is ≤ 2.
Note: If sample pH is greater than 2 and the sample is within 24 hours of receipt then add 0.1 ml per 50 ml of sample. If after 24 hours, acidify and analyze sample including the proper remark code.

14.1.2 Write sample number on glass test tubes with a permanent marker. There are 2 method blanks, an LCS, and an LCS Low at the beginning of the digestion run. A digestion run can contain many batches (a batch consists of 20 samples) with each batch containing a method blank and an LCS. End the digestion run with 2 method blanks.

14.1.3 Add the following to each test tube:
Method Blank. Use 5 ml of acid wash for method blanks.
LCS. Add 25 µl of the 100 mgN/l spike standard to 5 ml of the 0.2% acid wash to the tubes marked LCS.
LCS Low. Dispense a small volume of a second source QC standard to 5 ml of 0.2% acid wash to achieve a concentration at or near the PQL. Include 1 LCS Low per digestion batch.
Matrix Spike. Dispense 25 µl of the 100 mgN/l spike standard to empty marked tube, then add 5 ml of well-mixed sample.

14.1.4 Use 'dilution' function on 10 ml Rainin pipet to draw / mix 5 ml digestion reagent and 5 ml of 'WELL shaken' sample. Dispense this mixed volume into a labelled glass tube and **cap immediately** and firmly. Ammonia can be lost if sample is not capped immediately upon addition of digestion reagent. Include a minimum of 5% spikes and duplicates.

14.1.5 Place racks in the autoclave and digest for 30 minutes at 121°C and 15 psi. Record digestion in autoclave log book. After cycle is complete, remove samples from autoclave, and let the samples cool to room temperature before analysis.

14.2 Prepare standards (Section 10.0) and reagents for analysis (Section 13.0). Install manifold, sample loop and filter. Turn on power to instrument via power strip. Turn on computer and log onto instrument. Double click on the Omnion icon.

14.3 Click on Run, Open and open Data folder. Select Total Nitrogen method and choose TN template.omn.

14.4 0.2 % sulfuric acid (Section 10.1) is used as carrier in 1 liter Erlenmeyer flask. Place auto dilutor tubing into this container. Begin pumping carrier and reagents through manifold. Tubing should be clearly labeled. Waste stream is saved and disposed of according to the Laboratory hazardous waste plan.

14.5 Initialize the auto sampler by clicking on *Configuration* and *Auto samplers*. Choose *Autosampler 1* tab and click *Initialize Autosampler*. After this is done, click on *Prime Auto dilutor*. Close dialog box.

14.6 Calibration standards. Place each prepared standard in its respective standard rack slot. Each standard is run in duplicate.

14.6.1 The method timing and acquisition parameters should already be entered and optimized in the tray template. The calibration standards and QC elements and reduction efficiency standard should have been entered with their assigned values, acceptance limits and failure actions. See Lachat method #10-107-04-1-C for guidance.

14.7 Enter sample ID numbers via bar code scanner into the empty slots in the tray template. Place samples and QC into corresponding tray locations. Press 'Enter' to save entry and advance cursor.

14.7.1 For samples diluted prior to digestion, check box in MDF column and enter dilution factor. It's helpful to include the dilution factor with the sample ID in the tray template.

As sample ID numbers are being scanned in, use the QC menu sheet on the bench to scan MB/LCS/MS into the tray template. Sample batches of ≤ 20 samples are bracketed by a method blank (MB), and lab control sample (LCS). Highlight and delete the remaining empty tray slots.

14.8 Enter DQM sets within the tray template. Move cursor into the gray *Sample No* column to the left of the *Cup No* column. Left click and drag cursor so that the rows with the CCB and CCV Mid are highlighted. Right click and select *Define DQM Set*. In the '*User Defined DQM Set*' box under '*Scheduling Options*' select '*After every N samples*'. The DQM set is run after every 10 samples, (enter 10), and uncheck '*Close end of run*' box. Click OK.

14.9 Press the '*Start*' icon to begin the run.

14.10 Once analysis is complete, export data. Insert a thumb drive into the USB port. In top right corner of screen, go to *Run Properties* window and click on the *Run* tab. Click on *Export Data to file* to copy run data to thumb drive. Use cursor to highlight the Calibration curve peaks on the screen.

See section 14.3 for parsing instructions.
See section 14.4 for creating a QC batch.
See section 14.5 for data importing instructions.

14.11 Format and print the run report. Go to the tool bar and click on *Tools* and *Custom Report.* In tool bar, click on Report, and Open Format. Choose TN report format. Click to open the 8th icon (yellow) from the left. There are five tabs used to format the report.

- 14.11.1 Click on the *Sample* tab. Uncheck the *calibration standards* boxes. Click *Apply* in lower right of window.
- 14.11.2 Click on *Table* tab. Check the *cup number* box. If the run included any instrument duplicates, auto or manual dilutions, check the boxes that pertain. Click *Apply* in lower right of window.
- 14.11.3 Click on *Layout* tab. Check header information, change date of analysis. Click *Apply* in lower right of window.
- 14.11.4 Click on *Calculations* tab. Under *Sample Preparation* check the boxes that apply so that results are multiplied by the auto or manual dilution factor. Click *Apply* in lower right of window.
- 14.11.5 Click on the *Charts* tab. In the *Options* section, check *Calibration* and *Channel Data Display* boxes. In the Channel Data Display section, under Select Channel(s) for Report, #1 should be checked. Under Display Options, click on *Show ___ Peaks per Chart for All Peaks*. Enter 10. Click *Apply* then *Close* in lower right of window.
- 14.11.6 Print analytical run report. On top of the screen, Click on Print icon, 7th from the left. Select *Print*. Save report format. Go to tool bar, click on Report, and Save Format. Choose TN, and OK. Close window. Print a copy of the Standards/QC spreadsheet to include with the analytical run report.
- 14.11.7 Save an electronic copy of the Standards/QC spreadsheet to the folder by clicking on the '*Save*' radio button located on the spreadsheet. Save the desktop copy by clicking the 'Save' icon at top left of screen.

14.12 Calculate TN results on instrument computer

- 14.12.1 Click on Icon 'Calculate TN results' on lower toolbar to open macro. Enable macro, click on 'Calculate' radio button.
- 14.12.2 Navigate to thumb drive and open TN file to be calculated. Calculating will commence.
- 14.12.3 Type in header info, and any sample dilution factors from the tray template. Check all formulas and cell references for accuracy.
- 14.12.4 Set 'Print Area' and print. Close this window without saving and remove thumb drive.

14.13 Create a QC Batch on LIMS networked computer

- 14.13.1 Log in to Sample Master. Click on the *'Data Entry'* icon in the Main Menu window. Highlight the *'Create QC batch'* then click on the *'Select'* option.
- 14.13.2 In the *'Matrix'* drop down box select *'Water'*.
- 14.13.3 In the *'Test'* drop down box select *'Nitrogen-Total Persulfate'* Make sure that the *'Unassigned Samples'* box is checked. Select *'Retrieve'*.
- 14.13.4 In the *'QC Batch'* window, check the boxes of the sample numbers to be included in the QC batch, by referencing the TN (Calculated) Data sheet.
- 14.13.5 Click the *'New'* button to assign a QC batch ID to the checked samples. If the date of analysis is different from the date of the QC Batch ID, change it to reflect the date of analysis. Write this QC batch number on the front page of the TN data sheet.
- 14.13.6 The *'New QC batch'* window will appear. Click the *'Advanced'* button. The *'New QC batch – Sequence'* window will appear. Move desired type and frequency of QC from left side of window into the run sequence section on the right. After this is done, click *'Close'*. This will return you to the *'QC Batch'* window.
- 14.13.7 In the *'QC Batch'* window, use the drop down boxes to assign order and sample ID to the Duplicate(s) and Matrix Spike(s). After this is done, click the *'Add Samples'* button. The check marks in sample boxes will disappear. Click *'Close'*. Minimize Sample Master.

14.14 Parse the data on LIMS networked computer

- 14.14.1 Insert the thumb drive into a USB port on LIMS networked computer.
- 14.14.2 Open Windows Explorer. Open the following. Y drive, LIMS folder, Instrument Parsers Folder, Lachat Omnion 3 folder, TN Parser.xls.
- 14.14.3 Enter QC Batch, analyst initials, analysis date and OK. At the prompt, find and choose the file to be parsed. Click OK to commence parsing. Data will be displayed in Excel. Review results and QC numbers.

- 14.14.4 Delete any spaces or typed characters associated with sample ID's.
- 14.14.5 Data outside of calibration range cannot be reported. This should be deleted by row so as not to import it into the LIMS.
- 14.14.6 'Save' this spreadsheet, and close. Data will be saved in the *'Data2import'* folder.

14.15 Import Data into LIMS

14.15.1 Maximize Sample Master. Click on the Electronic Data Transfer (Green arrow) icon, second from the bottom. Highlight the phrase *Import All Files in One Directory* and click *Select.*

14.15.2 In the dropdown box choose TN as the directory to import data from. Click *Import Immediately.* Sample Master will display *Do you wish to delete the completed task?* Click *No.* Close import window. Click on second icon from top, choose Result Entry, and select. Review the imported data.

14.15.3 Forward imported data to another analyst for review and validation.

14.16 Data Validation - Data is peer reviewed for errors or omissions by a chemist familiar with the method.

14.16.1 The calibration curve correlation, MS, LCS, CCV, ICV recoveries and RPD values should all be within control limits. The interval of the DQM set(s) is checked.

14.16.2 Sample Master is opened and the QC batch is retrieved by clicking on the second icon from the top. Select *Result Entry.* Select the desired QC batch from the QC batch drop down box.

14.16.3 Select the *Data to be validated* radio button. Data in Sample Master and the analytical report should agree. All relevant data should be included and should be within acceptable limits. Any out of control values should be properly flagged and/or commented.

14.16.4 Values to be validated should have their respective boxes checked. Once this has been done, click *Validate* then *Close.*

14.16.5 The analyst will initial and note the date that the data was validated on the front page of the analytical run report. The report is filed.

15.0 Calculations:

15.1 Total Nitrogen sample results are calculated using a macro on the instrument computer (Section 14.12). To calculate manually, subtract the average method blank value from the obtained result and multiply by 2. This accounts for the known contamination added to each sample by the digestion reagent, as well as the dilution of the sample.

[Raw Result – Avg. MB] x2

15.1 Calculate the MS percent recovery using the following equation:

$$[(C_s - C_u)/ C]*100$$

$C =$ spike (stock) concentration (mg/l)
$C_u =$ unspiked concentration (mg/l)
$C_s =$ spiked concentration (mg/l)

If the recovery of the analyte falls outside the designated MS recovery range and the laboratory performance for that analyte is shown to be in control, the recovery problem with the MS is judged to be either matrix or solution related, not system related.

15.2 Calculate Relative Percent Difference (RPD). Analytical duplicate results are used to calculate a Relative Percent Difference (RPD). If the determined RPD values are not within established control limits, the source of the problem is identified and corrected before results can be submitted.

$$\frac{|(D_1 - D_2)|}{(D_1 + D_2)/2} *100 = RPD$$

$D_1 =$ larger duplicate value $D_2 =$ smaller duplicate value

15.3 Laboratory Control Sample (LCS) – The Laboratory analyzes at least one LCS with each batch of 20 samples. Accuracy is calculated as percent recovery.

15.4 Laboratory Control Sample - Low (LCS Low) – The Laboratory analyzes at least one LCS Low with each digested batch of samples. Accuracy is calculated as percent recovery.

16.0 Method performance:

16.1 Continuing Calibration Verification (Mid-level) - For all determinations the laboratory must analyze a mid-range continuing calibration verification standard (CCV Mid) and a continuing calibration blank (CCB) following daily calibration, after every tenth sample, and at the end of the analytical run. The result of the CCV Mid must be within 10% of its true value. If the calibration cannot be verified within the specified limits, reanalyze the CCV Mid solution. If the second analysis of the CCV Mid confirms the calibration to be outside control limits, sample analysis must be discontinued, the cause determined and the instrument recalibrated. All samples following the last acceptable CCV Mid result must be reanalyzed. The results of the calibration blank and CCV Mid solution must be kept on file with sample analyses data.

16.2 Continuing Calibration Verification (Low level) – the CCV Low is a low range calibration standard with a value 1 to 2 times the Practical Quantitation Limit (PQL). The PQL is approximately equal to the Limit of Quantitation (LOQ). A CCV Low must be run once during the analytical run, and its recovery must be within 30% of its true value.

16.3 Initial Calibration Verification (ICV) - A mid-range ICV is prepared from a source other than the calibration standards, and run after the calibration standards and before any samples are analyzed. The value must be within 10% of the true value or the run is stopped, and the cause determined before analyzing any samples.

16.4 Matrix Spike (MS) - The analyst must add a known amount of analyte to a minimum of 5 % of routine samples. In each case the MS aliquot must be a duplicate of the aliquot used for sample analysis. The analyte concentration must be high enough to be detected above the original sample and should not be less than four times the MDL. The added analyte concentration and source should be the same as that used in the laboratory-control sample. If the recovery of the analyte falls outside the control limits of 85-115%, the MS is judged out of control, and the source of the problem is identified and resolved before continuing analysis.

17.0 Pollution prevention:

17.1 Laboratory policy is to purchase reagents and standards on an as needed basis. Reagents and standards are logged into the chemical inventory database with an associated expiration date, eliminating the need for a stockroom. The database is reviewed on an ongoing basis for expired reagents, which are disposed of through UVM Environmental Safety Facility.

18.0 Data assessment and acceptance criteria for quality control measures

Summary Table of Quality Control Procedures, Limits and Corrective Actions

Assessment	QC Procedure	Frequency	Limits	Corrective Action
Linearity of Calibration Curve	Correlation coefficient	Each calibration	≥ 0.995	Recalibrate
Indication of instrument precision.	Duplicate measurements	All standards	< 10% residual	Re-analyze. If still out of control, find source of problem then re-calibrate.
Verification of calibration curve against second source standard	ICV Mid	After each calibration	90 – 110%	Prepare again and recalibrate
Stability of the low end of the calibration	CCB	After ICV , every 10 samples and at end of run	< ½ the PQL	Identify and correct problem
Stability of Calibration Curve	CCV Mid	After ICV , every 10 samples and at end of run	90 – 110%	Rerun CCV. If still out, recalibrate and rerun all samples not bracketed by an acceptable CCV
Stability of Calibration Curve	CCV Low	Once during the run	90 – 110%	Identify and correct the problem. Note that the CCV Low is 1-2 times the PQL which is ≅ LOQ
Determine if methodology is in control	LCS	1 per batch	85 – 115%	Identify problem and correct, or prepare again and rerun sample
Indication of the effect of the sample matrix on the accuracy of the results	MS	5 % of all samples or 1 per batch, whichever is greater	85 – 115%	Prepare again and rerun
Indication of the effect of the sample matrix on the precision of the results	LD	5 % of all samples or 1 per batch, whichever is greater	10% RPD	Prepare again and rerun
Efficiency of column	Reduction/Efficiency standard	At the beginning and end of analytical run	± 10%	Re-analyze. If still out of control replace cadmium column
Reagent water contamination	MB	1 per batch	< ½ the PQL	Identify problem and correct.

Note: If sample values are reported from an analysis where any of the above limit criteria are exceeded, an appropriate remark code or sample note should be entered to justify reporting the results.

19.0 Corrective actions for out of control data:

19.1 See section 18.0

20.0 Contingencies for handling out of control data:

20.1 If a quality control measure is found to be out-of-control, and the data is to be reported, all samples associated with the failed quality control measure are reported with the appropriate data qualifying remark code found in Section 5.0 of laboratory QA Plan. In addition, final reports may include Order Comment written by analyst and/or supervisor, further qualifying data.

Sample Remark Codes *

Remark Code	Description
B	Reported value is associated with a lab blank contamination.
BH	Reported value may be biased high.
BL	Reported value may be biased low.
E	Estimated Value
D	Dilution resulted in instrument concentration below PQL.
H	Hold time exceeded.
I	Matrix Interference
O	Outside calibration range, estimated value.
OL	Outside Limit
P	Preservation of sample inappropriate, value may be in error.
S	Surrogate recovery outside acceptance limits.
T	Time not provided
W	Sample warm on arrival, no evidence cooling has begun.

21.0 Waste Management:

21.1 Waste generated from this analysis is disposed through ESF. A “waste tag” is filled out by the employee generating waste, which is then entered online for pickup. See Appendix II of Department of Environmental Conservation Laboratory, Final Laboratory Waste Management Plan.

22.0 References:

22.1 Standard Methods for Examination of Water and Wastewater, AWWA, APHA, 21th Ed. SM 4500-N C Modified.

23.0 Tables, diagrams, flowcharts and validation data:

23.1 Instrument Parameters

Under **Analyte** tab, Channel 1

Property	Value
Description	(none)
Channel OFF	(box not checked)
Method	FIA

Under **Analyte** tab, Channel 1,

Property	Value
Analyte Name	Nitrate- Nitrite Nitrogen
Concentration Units	mg/l
Calibration Fit Type	First Order
Clear Calibration	Yes
Force Through Zero	No
Calibration Weighting	None
Auto Dilution Trigger	Yes
% of High Standard	100
QuickChem Method	10-107-04-1-C
Chemistry:	Direct/Bipolar
Calibration by Height	No

Under **Timing** tab, Run

Property	Value
Method Cycle Period(s)	45
Sample Period (s)	15
Min. Probe in Wash Period	5
Pump standby active	No
Use minutes	No
Channel in minutes	No
Analyte in minutes	No
Pump idle before standby	0
Pump at speed before analysis	0

Under **Timing** tab, Run, Channel 1

Property	**Value**
Load period (s)	10
Inject period (s)	35
Time to valve (s)	24
Use retention time	No

Under **Timing** tab, Run, Channel 1, Nitrate-Nitrite Nitrogen

Property	**Value**
Expected inject to peak start (s)	26
Expected peak base width (s)	40

Under **Rack** tab, choose 3x60 rack configuration

Under **Run** tab, the drop down boxes should show the following

Instrument:	Instrument 1 (Flow Injection Analysis)
Autosampler:	Autosampler 1 (ASX 500 / DRD)

Data configuration for export are set from tool bar. Go to *Configuration* and open *Options*. Choose **Data Export** tab.Under *File Export*, the following boxes should be checked

Export to CSV File Enabled
Include Column Headers
Export in Omnion 2.0 Format

Click on *Data Items*. This will open *Export Data* window. The following items should be entered in the following order. The order is important.

Location (to export) F: / drive

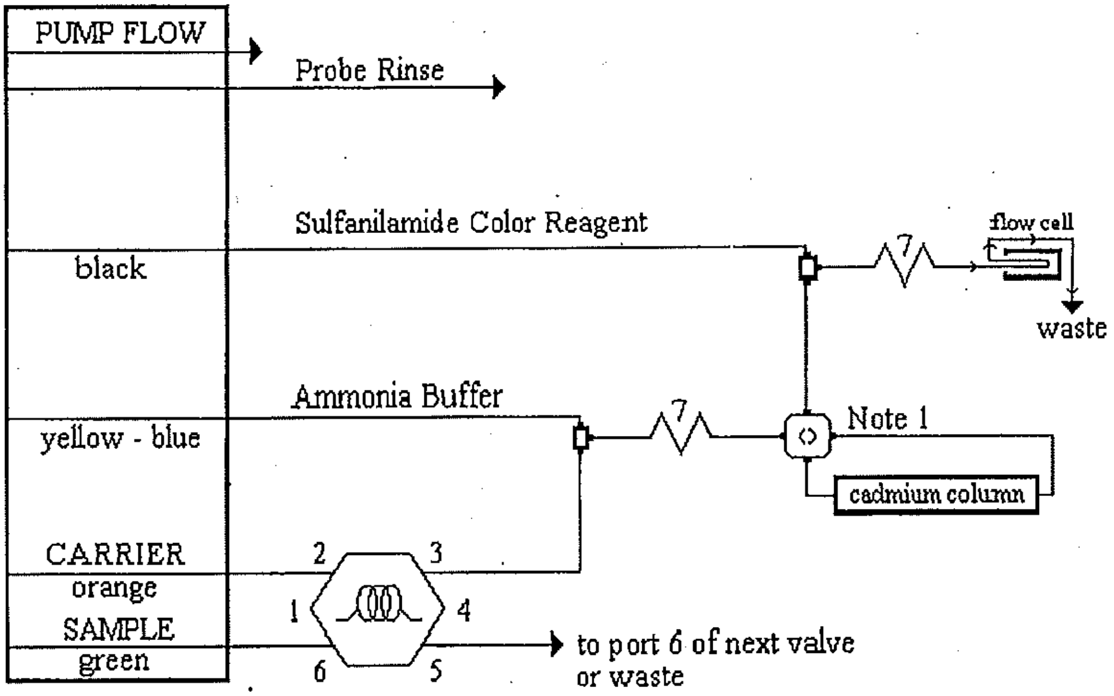
For Channel Independent Data, the Selected Items are (in order shown)

Sample ID
Sample Type
Replicate Number
Detection Date
User Name
Detection Time
Manual Dilution Factor
Auto Dilution Factor

For Channel Dependent Data, the Selected Items are (in order shown)

Channel Number
Analyte Name
Peak Concentration
Concentration Units

Nitrate Manifold Diagram

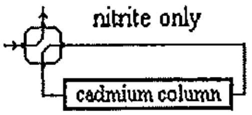


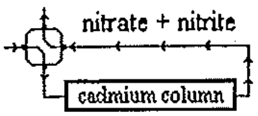
Carrier: Helium Degassed DI water
Manifold Tubing: 0.8 mm (0.032 in) i.d. This is 5.2 µL/cm.
AE Sample Loop: 17 cm x 0.8 mm i.d.
QC8000 Sample Loop: 22.5 cm x 0.8 mm i.d.
Interference Filter: 520 nm

Apparatus: An injection valve, a 10 mm path length flow cell , and a colorimetric detector module is required.

7: 135 cm of tubing on a 7 cm coil support

Note 1: This a 2 state switching valve used to place the cadmium column in-line with the manifold





24.0 Additional notes:

Troubleshooting

24.1 Trouble is often traced to either mechanical or chemical sources. The following are suggestions to help prevent problems. For more detailed troubleshooting guidance, consult the Lachat training manual or call Lachat tech support at 800-247-7613

24.2 Mechanical problems can show up as air spikes, misshapen peaks or an unstable or noisy baseline. To minimize these potential problems, prior to beginning a test, do the following.

24.3 Reagents should be at room temperature prior to the run. Sparging reagents with helium is not needed.

24.4 Make sure all mixing manifold tubing connections are snug, but not tight enough to impede reagent flow.

24.5 While reagents are pumping through the manifold make sure there are no air bubbles in the flow cell. Remove the cell from the colorimeter and tap gently with finger to dislodge any bubbles.

24.6 Confirm that timing parameters are correct.

24.7 Chemical problems can show up as poorly shaped peaks, lower than expected peak areas or as an elevated baseline. Properly made and stored reagents can minimize these potential problems, and using reagents before the recommended expiration date.

24.8 Rainin EDP pipette is used to make standards, QC check samples and sample spikes. This pipette and attachments are serviced and calibrated annually. Calibration is verified quarterly.

24.9 Septic samples may have hydrogen sulfide present as well as high NH_3 and low NO_3. If a strong rotten egg odor is noticed, dilute with acid wash 1:10. Hydrogen Sulfide will rapidly degrade column efficiency.

24.10 Nitrate/Nitrite samples without previous data or site history should be screened using EM QUANT Nitrate test strips (VWR Scientific 1-800-932-5000) and diluted prior to analysis.

24.11 ACS grade ammonium chloride can occasionally contain a small concentration of nitrate. Check the reagent assay prior to purchase. An alternative buffer recipe is provided in the Lachat Nitrate/Nitrite method.

24.12 Lachat Technical Support 1-800-247-7613.

24.13 Data backup to CD should be done annually, and noted in the instrument maintenance logbook and the data spreadsheet.

Rev. Date:	Revision #:	Summary of Changes:	Submitted By/Date:	Approved By:	Effective Date:
1/15/2015	7	This SOP was rewritten to include NELAC required format and informational points. Where guidance is not applicable or would be redundant, an N/A, or another section within the SOP is referenced.	DGM 1/15/2015		

Standard Operating Procedure Signature Page

The signatures below indicate the analyst has read, understands, and will follow the SOP.

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date

X Date:

X Date:

APPENDIX D (attached):
Standard Operating Procedure (SOP) for Total Suspended Solids (TSS) 14 11 03-2015

Standard Operating Procedure (SOP) for Total Suspended Solids (TSS)

Author: ____ Date: _____________
Megan Phillips, Environmental Scientist

Revised: Date: 01-2015

Reviewed and Approved by:

____ Date: _____________
Dan Needham, Quality Assurance Officer

Vermont Agriculture and Environmental Laboratory

Table of Contents

Total Suspended Solids

1.0 Identification of Test Method:

1.1 This SOP is based upon the Standard Method 2540D for the analysis of total suspended solids in water samples, with reference to Standard Methods 21st Edition, 2005.

2.0 Applicable Matrix or Matrices:

2.1 The applicable matrix for this analysis is water.

3.0 Method Detection Limit (MDL)/Limit of Quantitation (LOQ):

3.1 The Reporting limit is 2.00mg/L, with a minimum residue of 0.002g

3.2 This method does not have an MDL, but a standard at 1 to 2 times the reporting limit is analyzed at least annually. Results are filed with QA/QC Officer.

4.0 Scope and Application, including components to be analyzed:

4.1 This method is used to determine the amount of total suspended solids in water samples by filtering a known sample volume through and pre-weighed filter, drying the filter in an oven, and using the difference of the original filter weight from the weight of the filter plus dry solids to determine total suspended solids of water sample.

5.0 Summary of Test Method:

5.1 Samples of water are filtered under vacuum through a 55-mm diameter glass fiber filter, which have been washed and dried to constant weight. The suspended solids are retained on the filter.

6.0 Definitions:

6.1 Total Suspended Solids (TSS) - The portion of total solids retained by a glass fiber filter after a water sample has been filtered.

6.2 Laboratory Control Sample (LCS) - laboratory reagent water or clean matrix spiked with a known amount of analyte; prepared and analyzed as a sample to assess the performance of the measurement system.

6.3 Duplicate Sample – a second aliquot of the sample prepared and analyzed in the laboratory as a sample to obtain a measure of precision.

6.4 Method Blank – laboratory reagent water or clean matrix prepared and analyzed as a sample to monitor lab contamination.

6.5 Proficiency Evaluation (PE) – Semi-annual analysis of Proficiency Evaluation samples are run to ensure accuracy of the procedure. Samples are obtained through a NELAC Certified PE provider.

6.6 LOQ – The minimum concentration of a target analyte which can be reported with a method-specific degree of confidence.

6.7 Prep Batch – Samples prepared and/or analyzed together with the same method, personnel and reagent lots. Not to exceed 20 samples.

7.0 Interferences:

7.1 A sample may contain too many solids that do not allow for the entire sample to be used for filtration. In these cases, measure enough representative sample to get between 2.0 and 200 mg dried residue.

7.2 The solids will begin to settle out as soon as the sample is not being shaken, it is important to measure the sample volume and begin filtration as quickly as possible after the sample has been shaken.

7.3 A hole in a filter will compromise results. This can be detected by sound or possibly by the color of the filtrate.

7.4 Non-representative particulates such as leaves, sticks, and other non-homogenizable solids should be excluded and a sample note recorded.

8.0 Safety:

8.1 There are no special precautions required for this analysis that would be considered above and beyond good laboratory practices.

9.0 Equipment and Supplies:

9.1 Buchner funnel and vacuum filtration set up
9.2 Graduated cylinders (varying sizes)
9.3 55mm, ProWeigh Filters, Environmental Express, F93455MM. Pre-weighed glass micro fiber filters
9.4 Oven at 103-105°C with certified thermometer
9.5 Aluminum dishes
9.6 Tweezers
9.7 Desiccator

9.8 DI water/rinse bottle
9.9 Laptop computer.
9.10 Balance (± .0002g sensitivity)
9.11 Laboratory Control Sample (LCS) Solution.

10.0 Reagents and Standards:

10.1 Laboratory Control Standard (LCS) Solution – peCHECK Solids Level 2, SCP Science, Cat. # 140-702-102. Made up in a one liter batch, lot number of standard and preparation and expiration dates noted on bench and on bottle reagent label.

11.0 Sample Collection, Preservation, Shipment, and Storage:

11.1 Samples are taken in various sizes of plastic sample bottles (250mL-1.0L)
11.2 No preservation necessary other than refrigeration.
11.3 Samples are generally brought to the laboratory on ice on the same day or following day of sampling.
11.4 Hold time: 7 days at ≤6°C

12.0 Quality Control:

12.1 Duplicates are run at least once per run, and on 10% of all samples when sufficient volume is available. Duplicate samples are analyzed by filtering two aliquots from the same sample container. Acceptance criteria is ± 15%
12.2 A method blank (DI water) sample is run at least once per twenty samples. A method blank is 500mL of DI Water filtered and treated as a regular sample. Blank results must be <1.0mg/L.
12.3 A Laboratory Control Sample (LCS) of known value is run at least once with each batch of samples, and every 20 samples after. An acceptance criterion for an LCS sample is +/- 10% of the true value. Refer to manufacturer’s instructions for preparation of LCS standard and true value amounts.
12.4 Oven temperature recorded each day oven is in use. Acceptance range 103-105°C.
12.5 All sample/filter weights must be within +/- 0.0005g difference between the first time weighed and second time weighed to be valid. If the weights are out of range, the filters should be put into the oven again, and then re-weighed until two subsequent weights are within the acceptable range.
12.6 Analytical balance must be verified annually for accuracy of 1 mg weight (LOQV)

13.0 Calibration and Standardization:

13.1 Laboratory balances are checked daily (when laboratory is open) with 1.0 g and 100g weights to ensure accuracy.
13.2 Balances are calibrated annually by a third party calibration service..
13.3 Thermometers are calibrated annually using NIST trace-able thermometers to ensure accuracy.

14.0 Procedure:

14.1 Set up spreadsheet on laptop. For detailed directions on how to do this, see Section 18.2
14.2 Sample filtration:
  14.2.1 Allow samples to warm to room temperature before filtration.
  14.2.2 Using tweezers, place 55mm filter in Buchner funnel.
  14.2.3 Turn filter pump on and seat the filter using small amount of DI water.
  14.2.4 Shake sample well and quickly pour volume into a graduated cylinder (volume should allow for 2.0 to 200 mg dry solids). To run a Method Blank, filter 500mL of DI water through a filter. To run the LCS standard, homogenize the standard solution completely and filter 100mLs.
  14.2.5 Quickly pour sample into filter funnel and allow filtering. Record volume of sample filtered on laptop spreadsheet. If an entire sample is filtered, rinse the sample container with DI water and filter the rinse water as well. (Less volume is to be filtered only when the entire volume will not allow filtration because of too many solids).
  14.2.6 Rinse the graduated cylinder with three successive rinses of DI water of at least 10mL each and pour these rinses through the filter. Note: If there is visible residue on the sides of the filter funnel, it can be rinsed with DI water. After final rinse, continue to apply vacuum for 3 minutes.
  14.2.7 After sample volumes are filtered, use tweezers to replace filter back into aluminum dish and put into the oven for drying.
  14.2.8 When the waste/filtered water flask is full, empty down the sink.

14.3 Drying of Filters:
  14.3.1 Place filters/aluminum dishes inside 104° (±1°C) oven. Record oven temperature and date on laptop spreadsheet.
  14.3.2 Dry filters overnight.

14.4 Initial Weighing of Filters:

14.4.1 Transfer oven dried filters/dishes into desiccator and allow filters to cool. When removing filters from oven, record date and temperature of oven, to laptop spreadsheet.
14.4.2 Bring laptop and filters to balance room for weighing.
14.4.3 Plug in data cable from balance to laptop. Open appropriate spreadsheet file. (Place cursor on laptop spreadsheet into the box that weight will be recorded).
14.4.4 Tare balance. Carefully remove filter from dish using tweezers being careful not to lose dried residue, and place on balance. Press "print" on balance when weight is steady (this will insert weight in correct box on laptop spreadsheet).
14.4.5 After weighing each filter, replace filter into aluminum dish and return dish to desiccator.
14.4.6 When all samples have been weighed and recorded, save spreadsheet.
14.4.7 Place filters/dishes back in 104°C oven and leave overnight.
14.4.8 Repeat process of first weighing again, adding required information to laptop spreadsheet.
14.4.9 After second weighing, both weights for any given sample must agree within ± 0.0005g to be considered valid.
14.4.10 Parse sample data and add to the LIMS system. For details on parsing data and using LIMS, see Section 18.3
14.4.11 Note: Method required drying time at 103 -105° C is <u>one</u> hour. VAEL lab method dries samples overnight.

15.0 Calculations:

15.1 To calculate TSS:

A = Weight of dried filter/sample (mg)
B = Original weight of filter (mg)
C = Volume of sample filtered (mL)

$$\frac{(A-B) \times 1000}{C} = \text{mg/L}$$

15.2 Relative Percent Difference (RPD) – For Duplicate Samples:

D1 = Larger duplicate value
D2 = Smaller duplicate value
Average = Mean of D1 and D2

$$\frac{D1 - D2}{\text{Average}} \times 100 = \text{RPD}$$

15.3 LCS Recovery:

$$\frac{\text{Measured Value (mg/L)}}{\text{True Value (mg/L)}} \times 100 = \text{\% Recovery}$$

16.0 Method Performance:

Assessment	QC procedure	Frequency	Limits	Corrective Action
Routine low level check	Method Blank	1 per batch and every 20 samples	< 1 mg/L	Review data sheet for data entry error.
Precision	Duplicate	At least once per batch, and on 10% of samples when available	±15% RPD	Flag data. Improve technique.
Routine performance check	Laboratory Control Sample (LCS)	Once at the beginning of every batch, and then once every 20 samples.	± 10 %	Check data sheet for possible data recording errors. Improve technique.
Annual performance check	Limit of Quantification Verification (LOQV)	Annually	± 30 %	Check data sheet for possible data recording errors. Improve technique.

17.0 Pollution Prevention:

17.1 No part of this analysis is associated with being harmful to the environment. See section 21.0 for more information on Waste Management for this parameter.

17.2 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation.

17.3 Laboratory policy is to purchase reagents and standards on an as needed basis and log them into the chemical inventory database and assign them an expiration date. This eliminates the need for a stockroom. The reagent database is reviewed on an ongoing basis for expired reagents that can be disposed of or updating the expiration date and using for another year.

18.0 Data Assessment and Acceptance Criteria for Quality Control Measures:

See Section 12.0

19.0 Corrective Actions for Out of Control Data:

See 16.0

20.0 Contingencies for Handling Out of Control or Unacceptable Data:

20.1 Out of control data shall be remark coded. If continually out of control, corrective action shall be initiated.

21.0 Waste Management:

21.1 Any unused sample volumes may go down the drain, along with any filtered water in the waste flasks. Any unused or expired standard (LCS) may also be disposed of down the sink.

22.0 References:

22.1 Standard Methods for the Examination of Water and Wastewater, 21st Edition, 2005. Method 2540D - Total Suspended Solids Dried at 103-105°C. Page 2-5 through 2-58.

23.0 Any Tables, Diagrams, Flowcharts, and Validation Data:

23.1 Setting up Spreadsheet
- 23.1.1 Arrange samples on bench in order to be entered on spreadsheet.
- 23.1.2 With power cord plugged in, turn on laptop computer.
- 23.1.3 Log onto laptop - Username: labman1, Password: report
- 23.1.4 Double click "Spreadsheet" desk top, "Enable Macro", and click "TSS."
- 23.1.5 Fill in header at top of spreadsheet as appropriate (analyst, date, time, etc).
- 23.1.6 With cursor in "Lab ID" column and scanner plugged into port on notebook, scan sample ID's in order previously determined, being sure to include method blank(s), LCS, and duplicates.
- 23.1.7 Once samples are scanned in, move cursor to top of "Filter #" column and scan in appropriate # of filters.
- 23.1.8 With cursor at top of "Volume" column, you are ready to manually enter the volumes of each sample that is filtered.
- 23.1.9 When all samples are filtered, save spreadsheet and close. (Note: Spreadsheet is automatically saved by test parameter and date analyzed).

23.2 Parsing / Importing / LIMS:
- 23.2.1 Creating a QC Batch
- 23.2.2 After the second filter weighing, bring laptop into office and attach to Ethernet cord, then log into sample master on the office computer, and select:
  - "Data Entry" Icon
  - From that menu choose "Create QC Batch"
  - Under "Test" scroll down to "Solids, Total Suspended" and click "Retrieve."
- 23.2.3 All samples that have not been run yet in that have been logged into the system should be shown. Right click "Sample ID" to arrange samples in numerical order.
  - 23.2.3.1 Next select all samples analyzed in the run by clicking the box to the right of sample. A check mark should appear in box.
  - 23.2.3.2 Once entire run is selected, click "new" at top of page.
  - 23.2.3.3 Under instrument select NA, insert correct date, and click "Advanced."
  - 23.2.3.4 Select all required QC parameters for the run, select "Okay," in main menu select "Add Samples."
  - 23.2.3.5 Add the new QCBatch# to the laptop spreadsheet, and save.

23.2.3.6 Print spreadsheet.

23.2.4 Parsing Data:
- 23.2.4.1 After printing spreadsheet, click the “Parse” button.
- 23.2.4.2 Close spreadsheet.

23.2.5 Importing Data:
- 23.2.5.1 Back in Sample Master, select the “Electronic Data Transfer” icon, and double click “Import All Files In One Directory.”
- 23.2.5.2 Select the directory for WetLab.
- 23.2.5.3 Click “Import Immediately.”
- 23.2.5.4 When asked “Do you wish to delete this completed task?” - Select “No.”
- 23.2.5.5 Select “Close.”
- 23.2.5.6 Take spreadsheet printout to be reviewed/validated.

VALIDATION ☐ Alkalinity ☐ TSS Jan 2017

Raw Data

☐ Analyst / Date / Time recorded on Bench Sheet.

☐ All standards/reagents lot # recorded and within expiration date.

Alkalinity	TSS
☐ Slope % between 92 and 102.	☐ Method Blank <0.5 mg/l
☐ If <20 mg/l result, sample correctly calculated using formula titrant value “A” X 2- “B” X 10 = mg/l $CaCO_3$	☐ Sample weighing at least 4 hour between weighings.
☐ If >20 mg/l result, sample correctly calculated using formula titrant value “A” x 10 = mg/l $CaCO_3$	☐ Sample weights, between weighings agree ± 0.5 mg
☐ Final pH endpoint between 4.45 and 4.55 when more than 2 ml titrant added.	
☐ If < 2ml titrant is added, final pH begins between 4.3 and 4.7	

LIMS

☐ Date / Time of analysis correctly entered in LIMS.

☐ Analyst name recorded in LIMS.

☐ Analysis parameter correctly recorded in LIMS.

☐ Result correctly reported for each sample in LIMS.

☐ Analysis QC (Method Blank, CCV’s, ICV correctly reported in LIMS and are Remark Coded if outside limits).

☐ Sample QC (Duplicates) are correctly reported in LIMS and Remark Coded if outside limits.

☐ All tabs have been marked and validation button selected.

QC Acceptance Criteria - Alkalinity	**QC Acceptance Criteria - TSS**
Slope Percent 92-102% CCV Low 3.95 – 4.05 CCV Mid ICV Mid Method Blank <0.5 mg/l Duplicates >20 mg/l <5% RPD <20 mg/l <15% RPD LOQ Analyzed Annually ±30% Recovery	Method Blank <0.5 mg/l LCS TV = 323 mg/l, 90-110% Duplicate 0-15% RPD

Follow-Up

______________________________Date / Time analysis returned to analyst for clarification / correction.

______________________________Date / Time returned to validation.

______________________________Date Initial validation complete.

24.0 Additional Notes:

N/A

Summary of Changes/Revisions to newest version of SOP:

Date	Revision #	Summary of Changes	Submitted By	Approved By/Date	Effective Date
1-12-15	11	Sections 16-18 and 23 edited	MBP	3/12/2015 DEN	3/12/2015 DEN
01-16-2014	#10	Reformatted SOP to include 23 requirements	MBP	02-27-2014 DEN	Same

Standard Operating Procedure Signature Page
The signatures below indicate the analyst has read, understands, and will follow the SOP, and serves as documentation for annual review.

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

X Date:

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X Date:

X Date:

Appendix B: Tile Drain Hydrographs

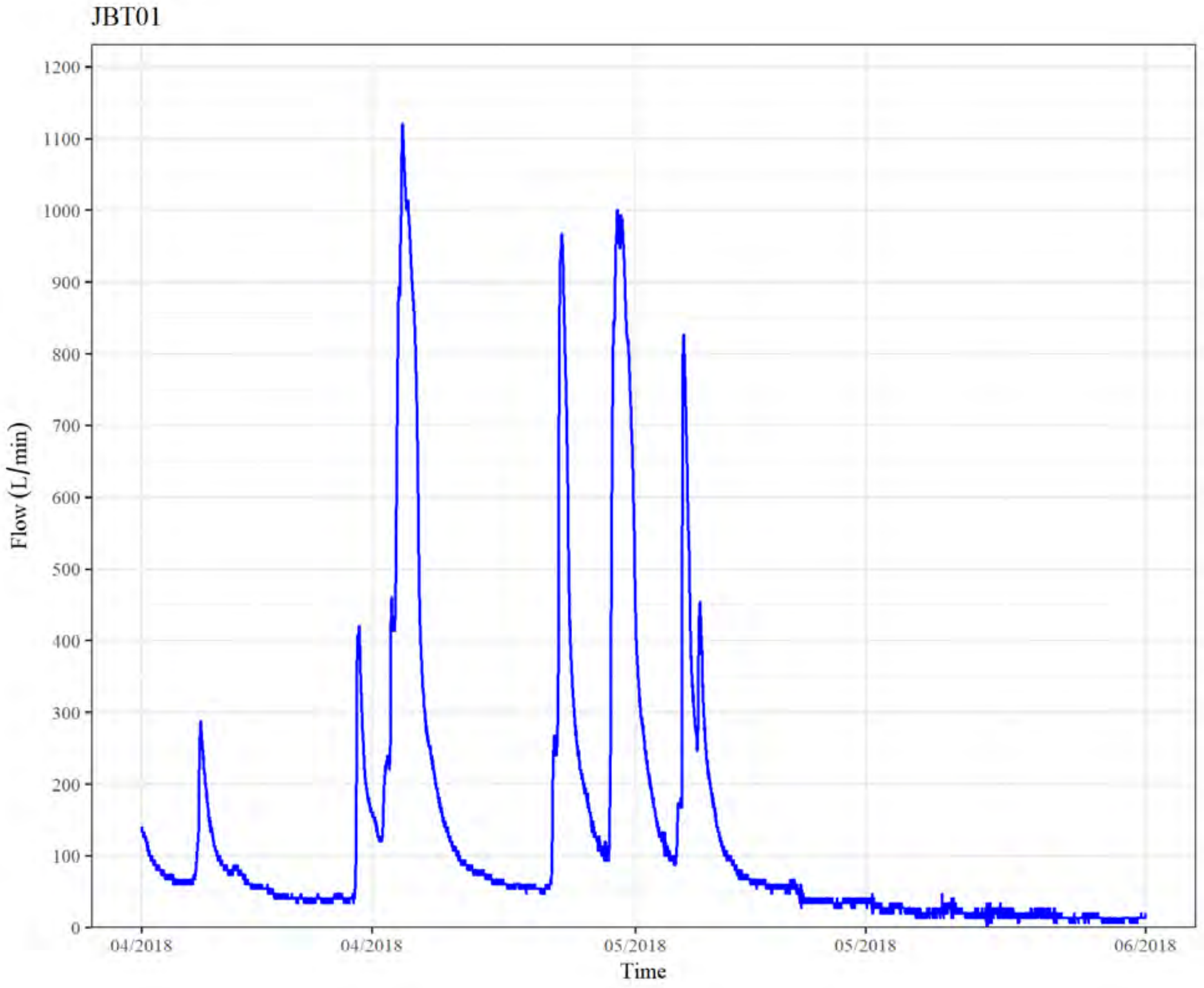


Figure 1. Flow rate at the JBT01 tile drain monitoring station

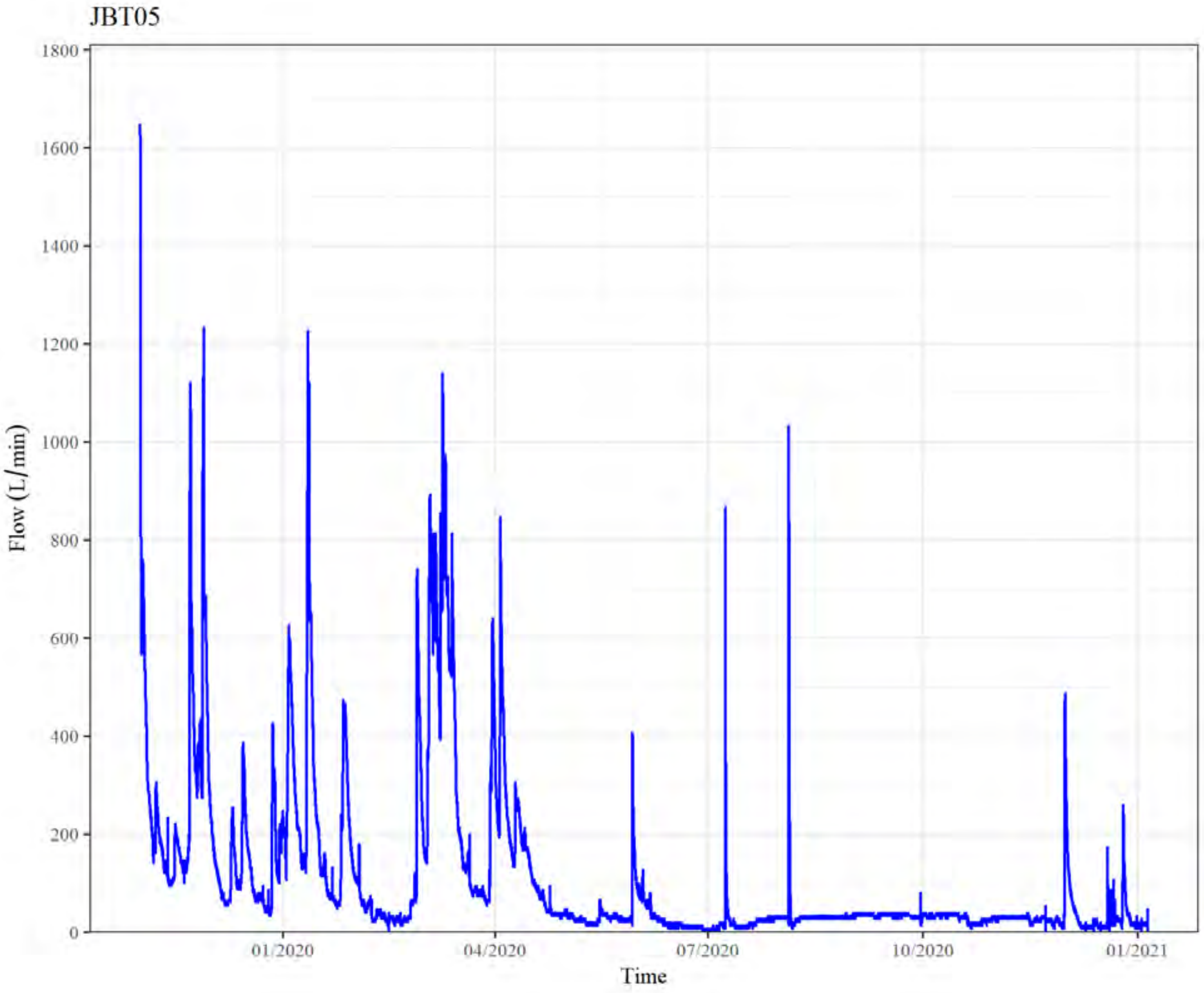


Figure 2. Flow rate at the JBT05 tile drain monitoring station

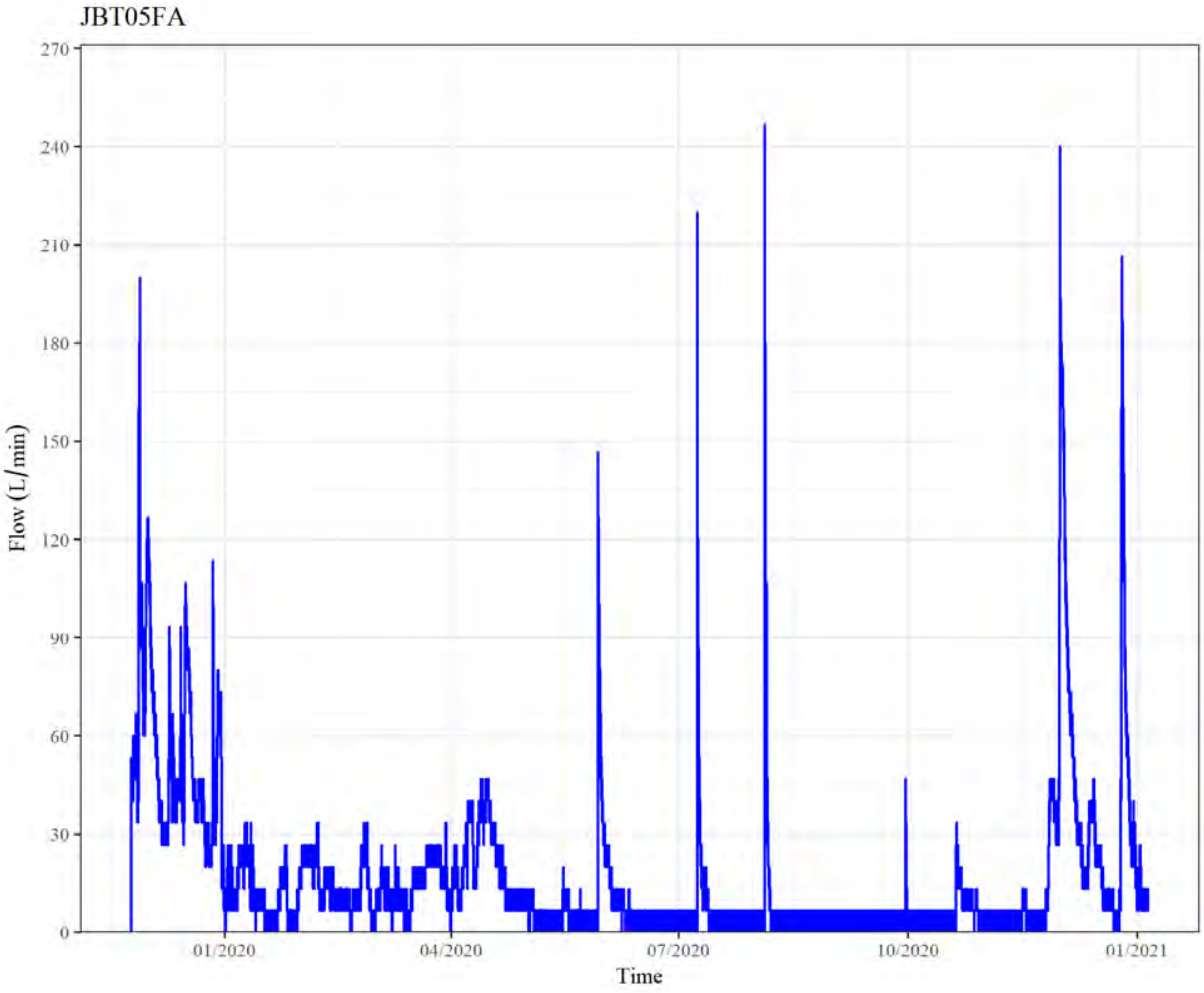


Figure 3. Flow rate at the JBT05 Filter A tile drain monitoring station

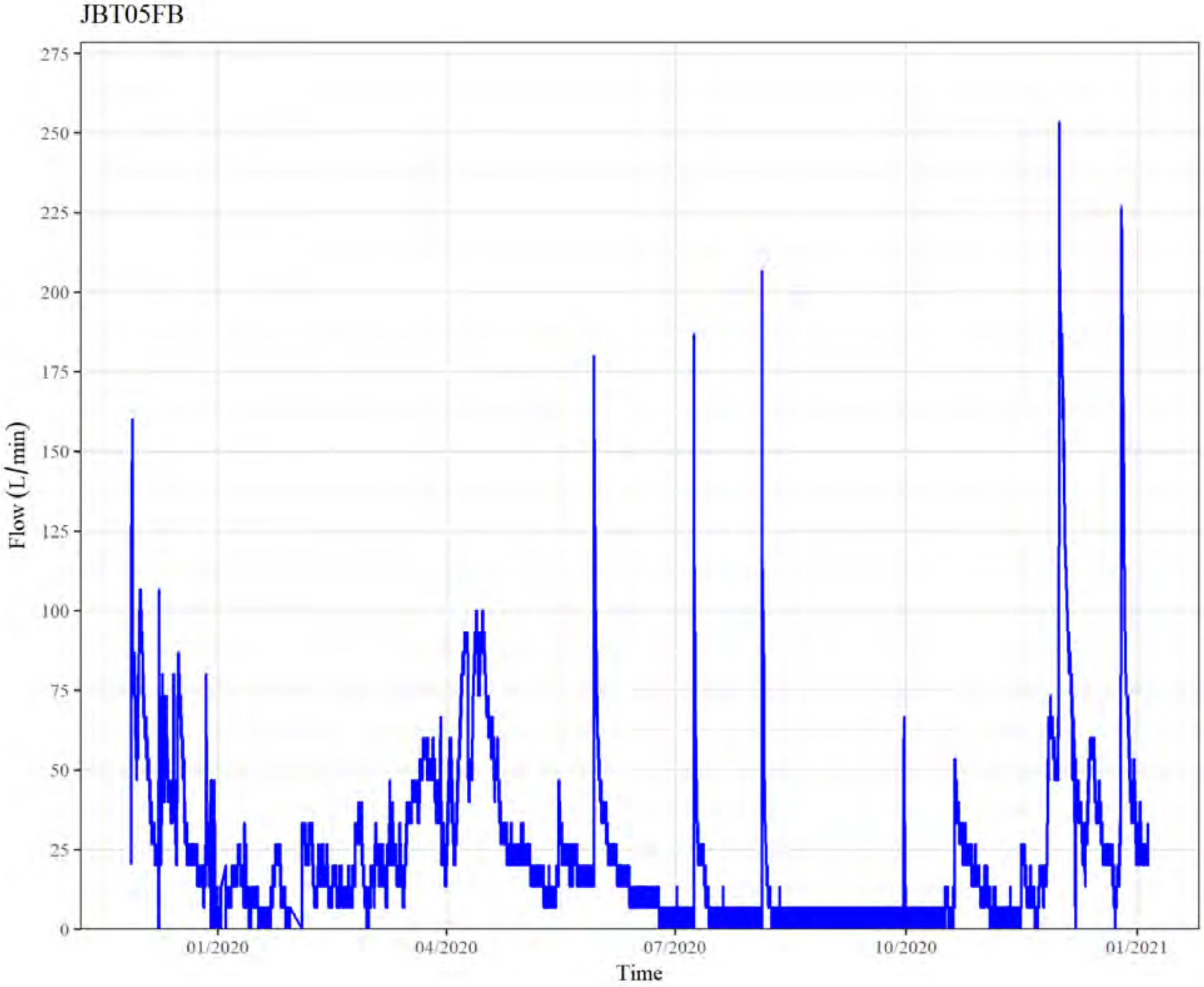


Figure 4. Flow rate at the JBT05 Filter B tile drain monitoring station

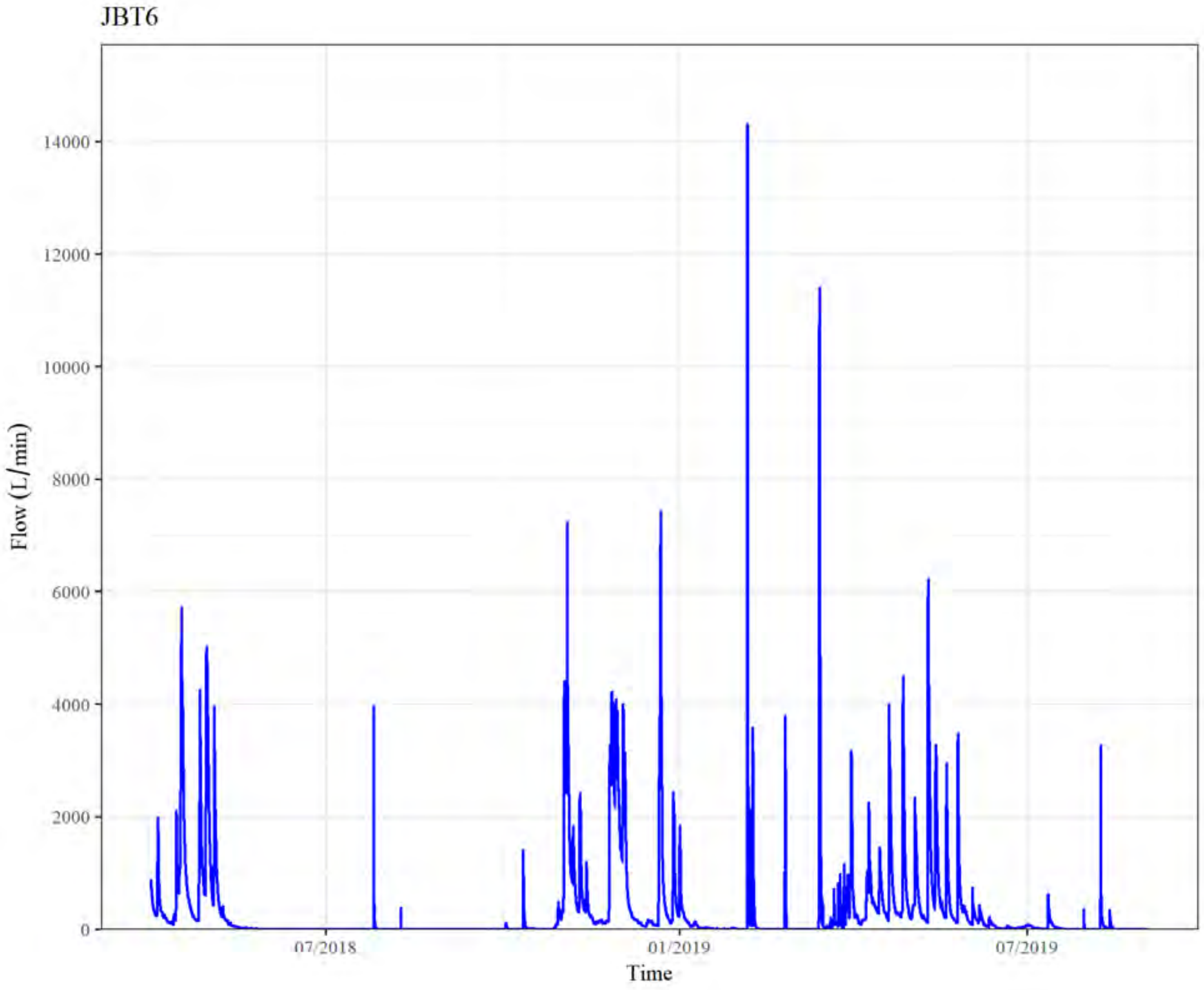


Figure 5. Flow rate at the JBT06 tile drain monitoring station

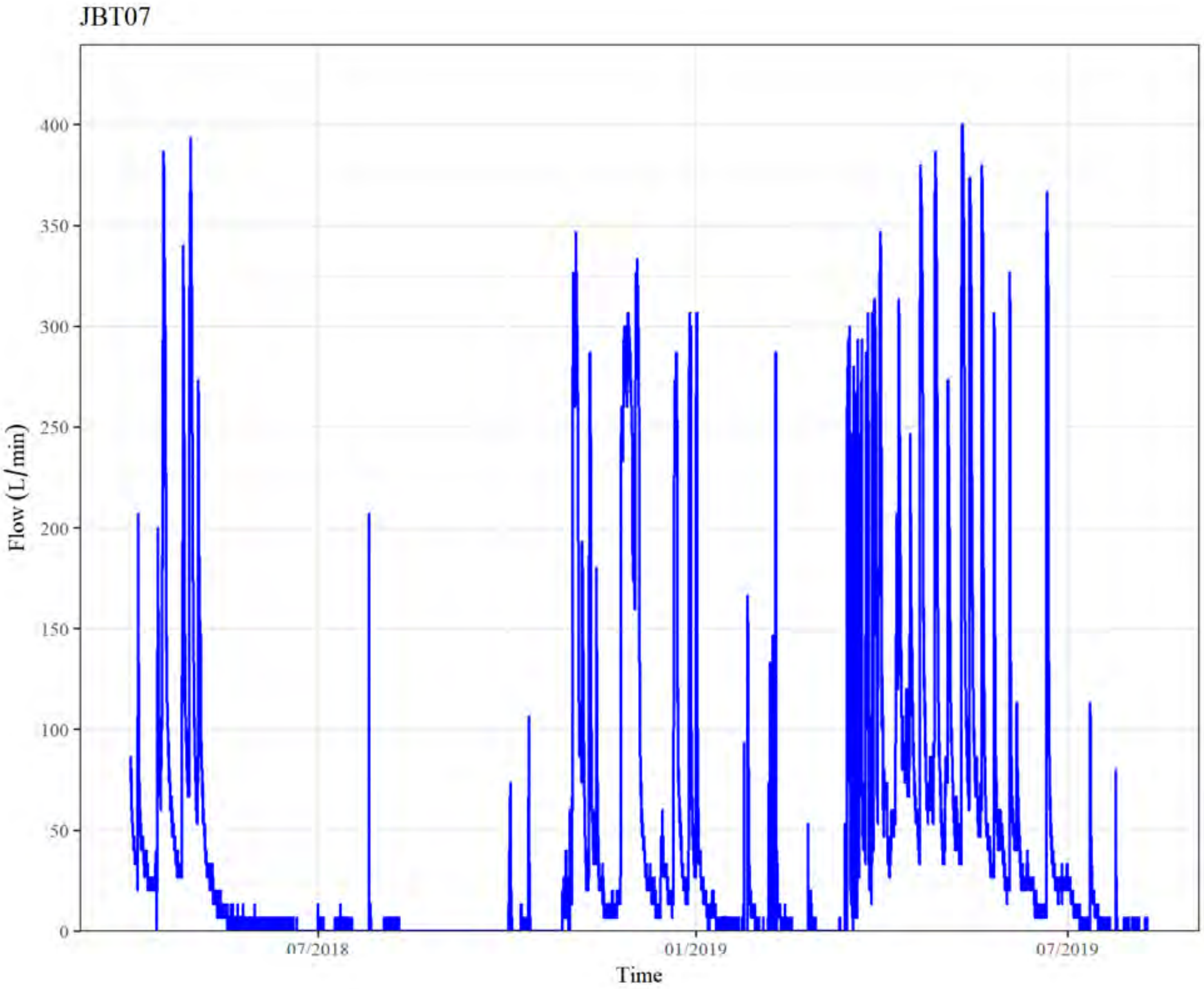


Figure 6. Flow rate at the JBT07 tile drain monitoring station

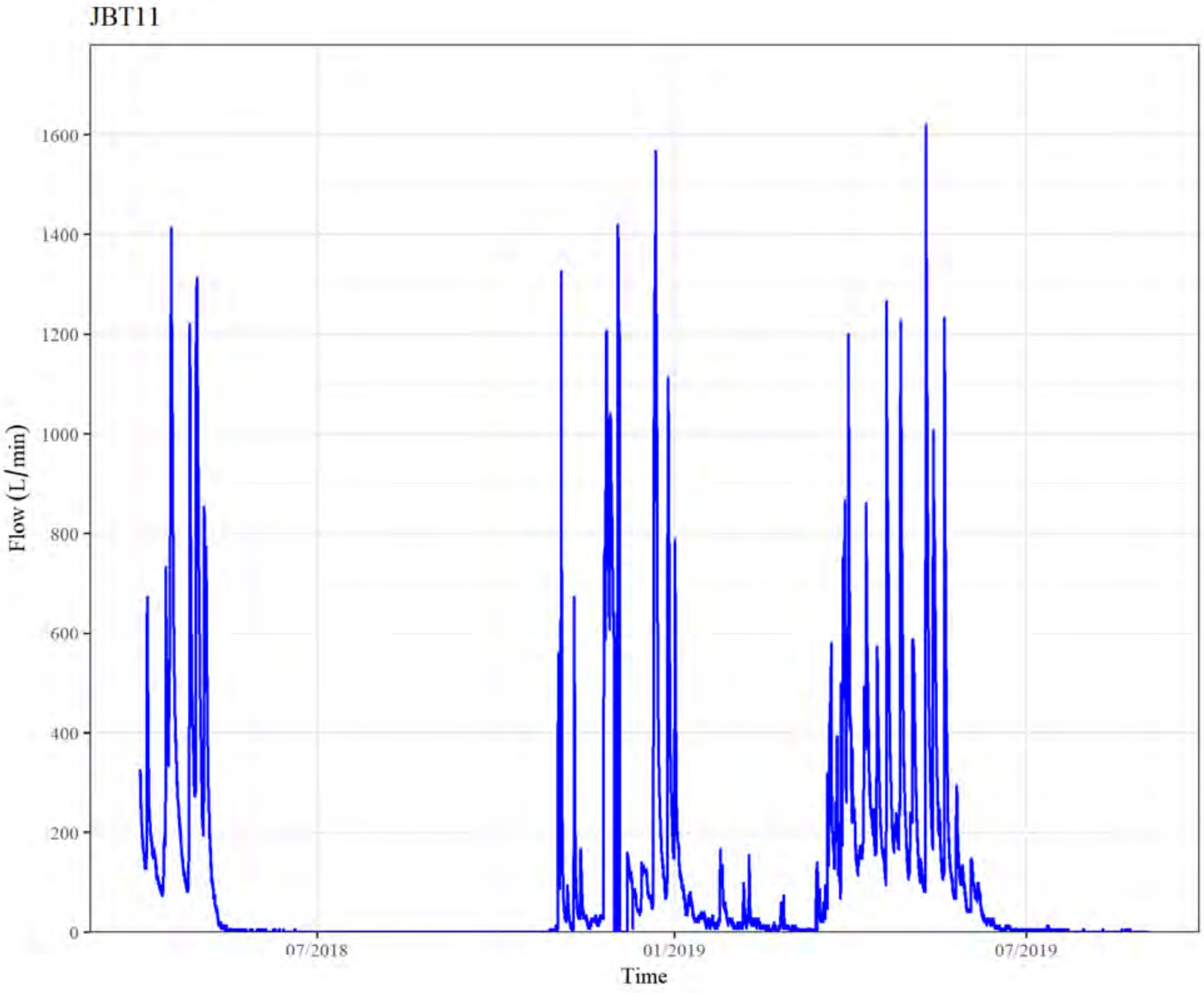


Figure 7. Flow rate at the JBT11 tile drain monitoring station

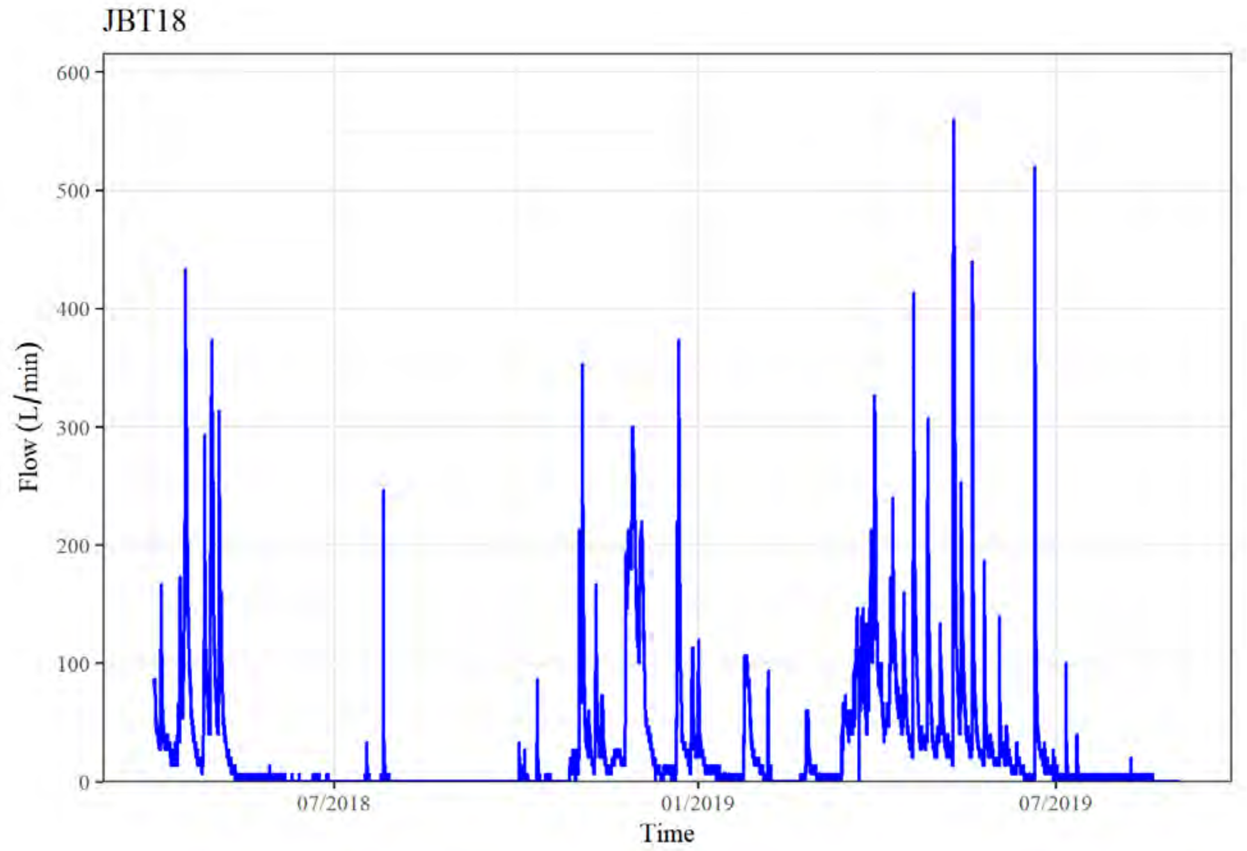


Figure 8. Flow rate at the JBT18 tile drain monitoring station

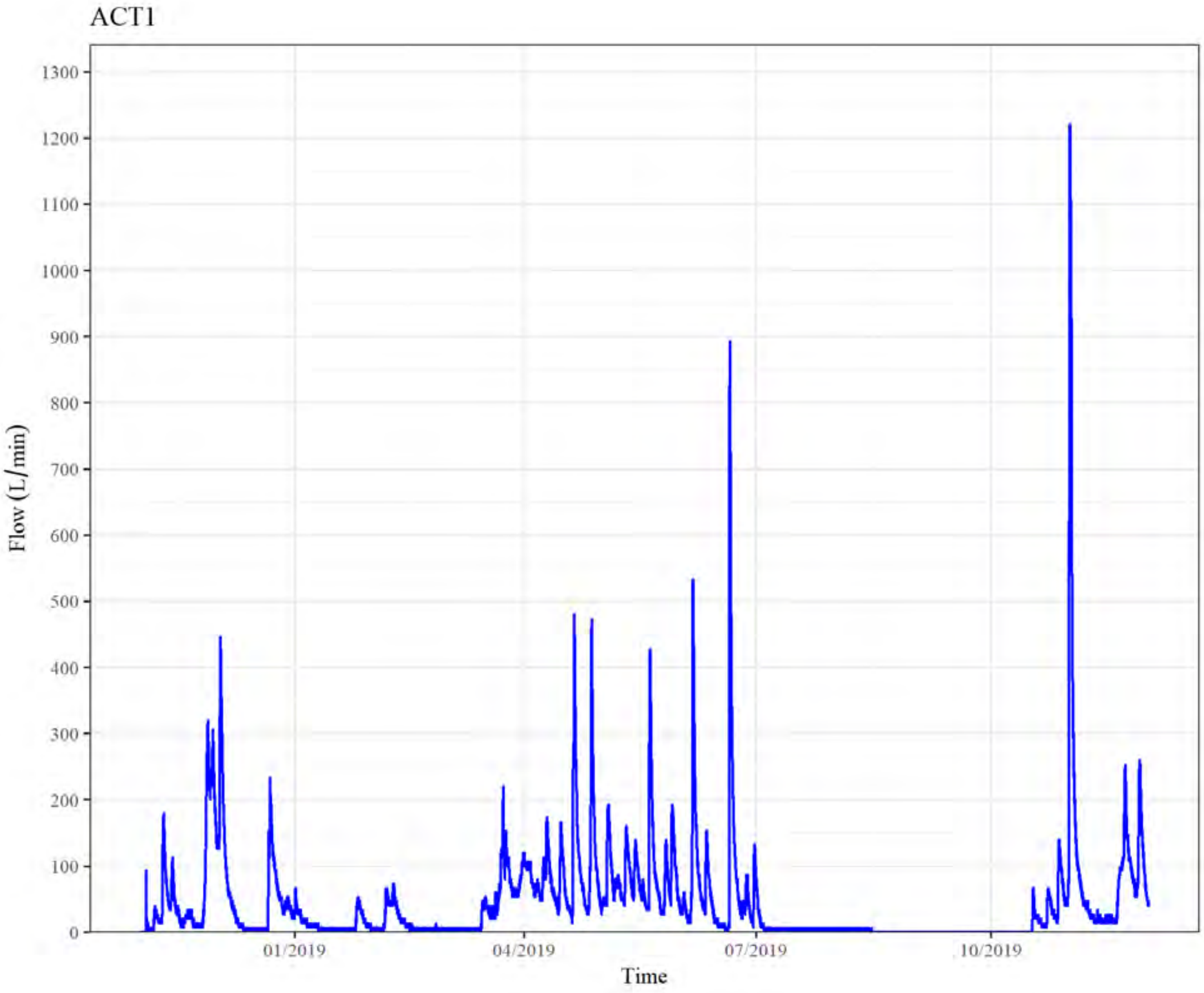


Figure 9. Flow rate at the ACT1 tile drain monitoring station

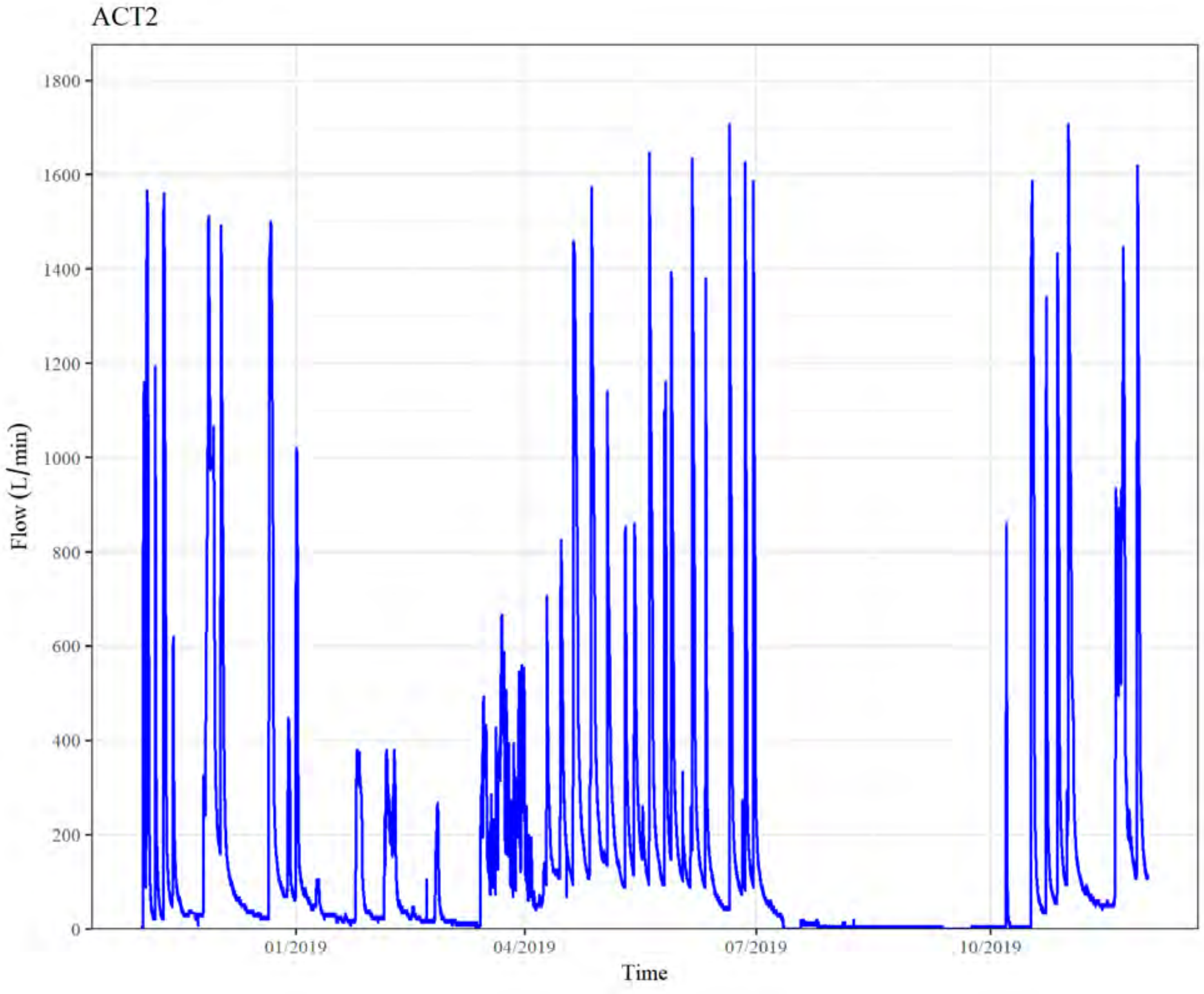


Figure 10. Flow rate at the ACT2 tile drain monitoring station

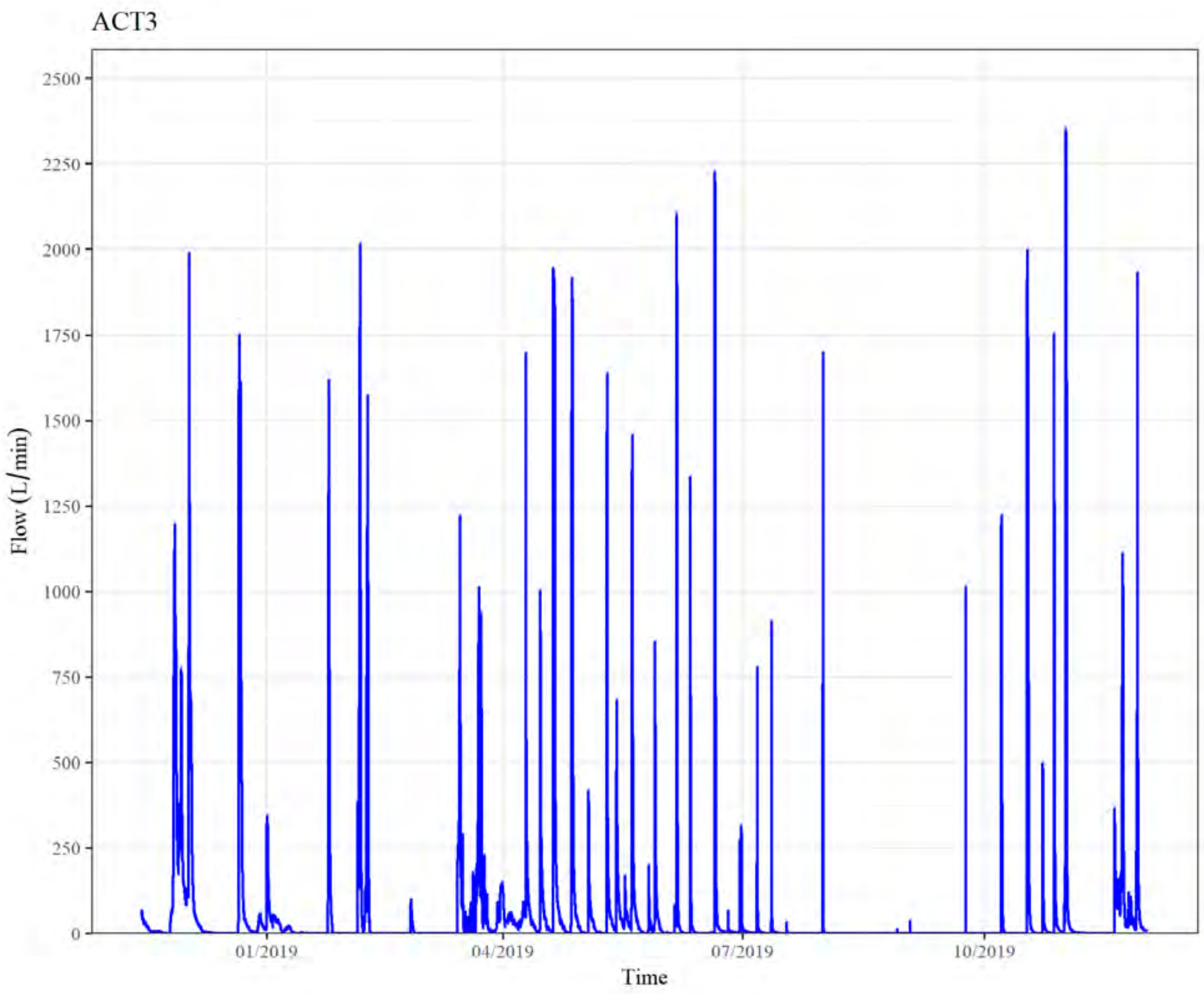


Figure 11. Flow rate at the ACT3 tile drain monitoring station

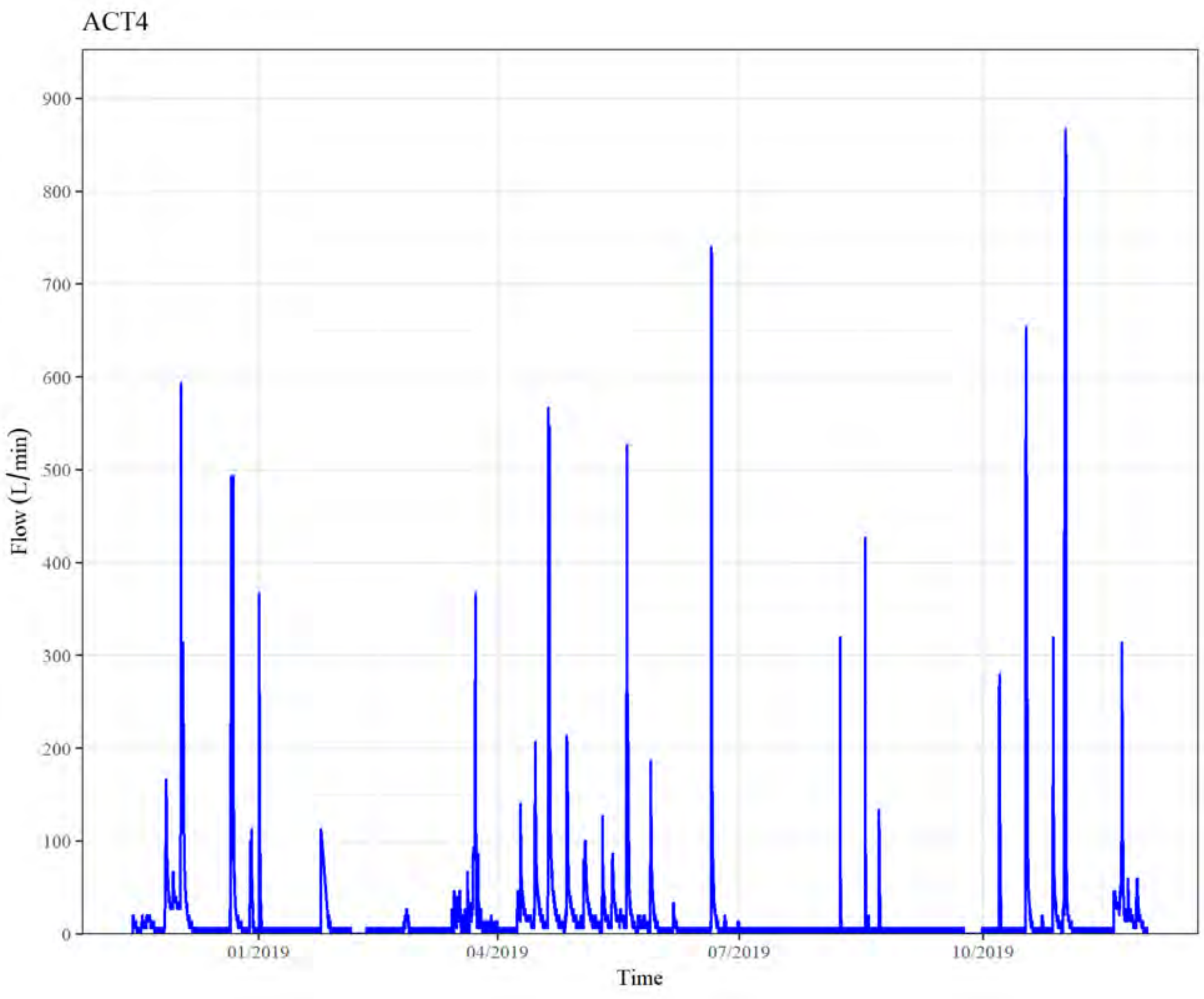


Figure 12. Flow rate at the ACT4 tile drain monitoring station

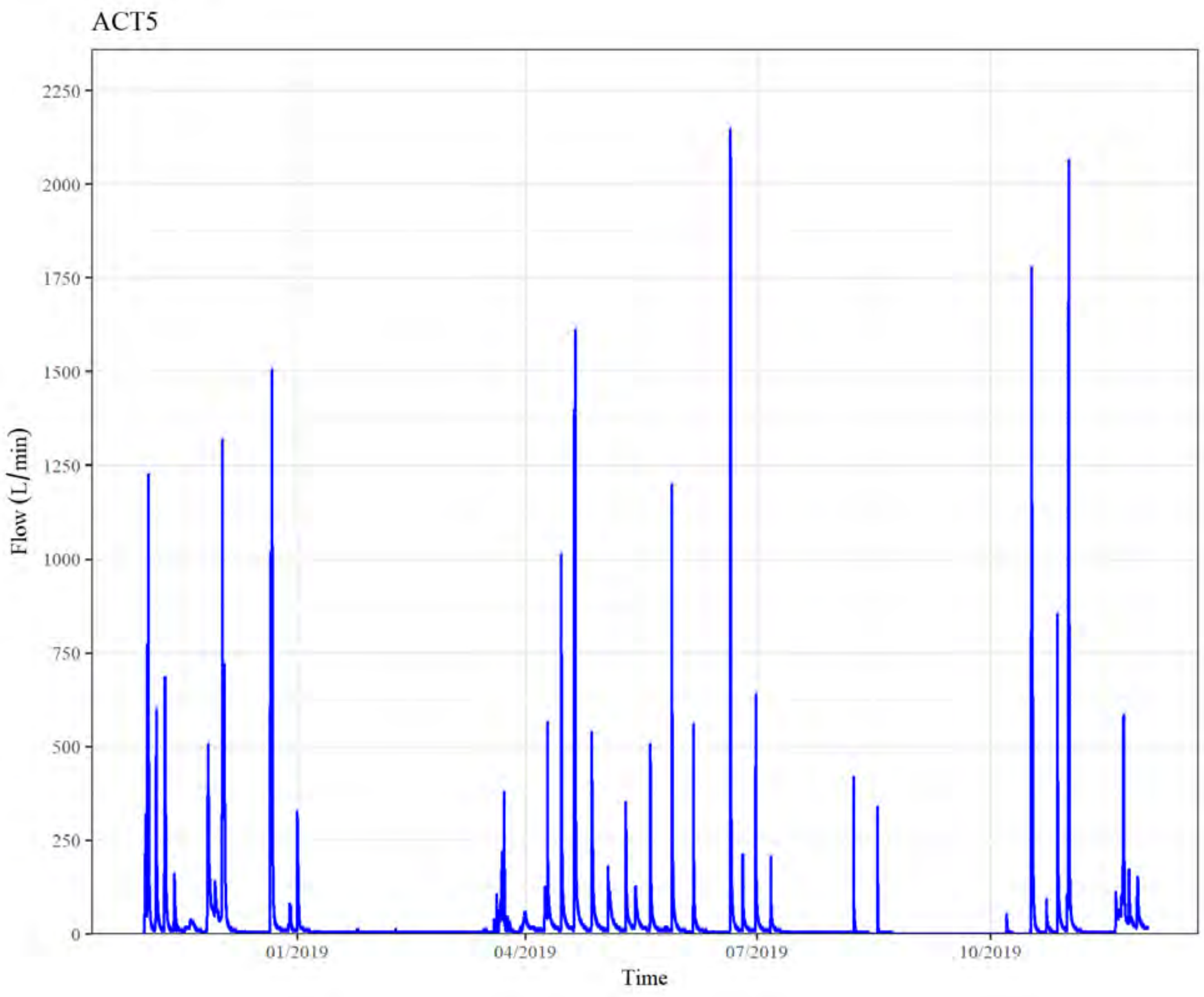


Figure 13. Flow rate at the ACT5 tile drain monitoring station

Appendix C: Flow and Water Quality Monitoring Data

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
ACT1	ACT1-112918-G	G	6,800	11/29/2018	15	13	57.5	2	0.1	0.1	0.39	0.01	11/29/2018 10:15	11/29/2018 10:30	NA	16.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT1	ACT1-120318-G	G	1,411,400	12/3/2018	16	15	NA	2	22.7	21.2	NA	2.82	11/29/2018 10:45	12/3/2018 16:30	NA	16.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT1	ACT1-121418-G	G	655,700	12/14/2018	10	8	53.7	2	6.4	5.5	35.21	1.31	12/3/2018 16:45	12/14/2018 16:00	NA	16.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Signs of manure spreading, but not fresh
ACT1	ACT1-121818-G	G	16,100	12/18/2018	10	10	NA	2	0.2	0.2	NA	0.03	12/14/2018 16:15	12/18/2018 9:45	NA	16.19	NA	NA	NA	NA	NA	NA	Y	1.9	NA	NA	NA	NA	NA	NA
ACT1	ACT1-122318-G	G	471,000	12/23/2018	42	37	39.7	2	19.9	17.2	18.71	0.94	12/18/2018 10:00	12/23/2018 17:30	NA	16.19	NA	NA	NA	NA	NA	NA	Y	114.8	NA	NA	NA	NA	NA	NA
ACT1	ACT1-010319-G	G	712,600	1/3/2019	20	17	NA	2	14.1	11.9	NA	1.43	12/23/2018 17:45	1/3/2019 14:30	NA	16.19	NA	NA	NA	NA	NA	NA	Y	19.7	NA	NA	NA	NA	NA	Snow covered. Manure odor but no sign on ground
ACT1	ACT1-011019-G	G	105,900	1/10/2019	13	11	43.2	2	1.3	1.1	4.58	0.21	1/3/2019 14:45	1/10/2019 13:45	NA	16.19	NA	NA	NA	NA	NA	DCB	Y	5.2	NA	NA	NA	NA	NA	NA
ACT1	ACT1-011619-G	G	34,900	1/16/2019	9	8	NA	2	0.3	0.3	NA	0.07	1/10/2019 14:00	1/16/2019 13:30	NA	16.19	NA	NA	NA	NA	NA	NA	Y	3.2	NA	NA	NA	NA	Outlet is flowing	NA
ACT1	ACT1-012419-G	G	26,200	1/24/2019	10	8	46.0	2	0.3	0.2	1.21	0.05	1/16/2019 13:45	1/24/2019 16:15	NA	16.19	NA	NA	NA	NA	NA	NA	Y	2.2	NA	NA	NA	NA	Outlet is flowing	NA
ACT1	ACT1-020819-G	G	478,800	2/8/2019	18	16	10.5	8	8.6	7.4	5.01	3.72	1/24/2019 16:30	2/8/2019 16:30	NA	16.19	NA	NA	NA	NA	NA	NA	Y	70.2	NA	NA	NA	NA	Outlet is flowing	Patchy snow
ACT1	ACT1-022119-G	G	270,500	2/21/2019	10	9	36.6	7	2.7	2.3	9.91	1.81	2/8/2019 16:45	2/21/2019 15:15	NA	16.19	NA	NA	NA	NA	NA	NA	Y	3.8	NA	NA	NA	NA	Outlet is flowing	NA
ACT1	ACT1-030419-G	G	58,100	3/4/2019	9	9	39.0	4	0.5	0.5	2.27	0.23	2/21/2019 15:30	3/4/2019 19:00	NA	16.19	NA	NA	NA	NA	NA	NA	Y	2.5	NA	NA	NA	NA	NA	NA
ACT1	ACT1-031519-G	G	49,100	3/15/2019	17	13	7.1	2	0.8	0.6	0.35	0.10	3/4/2019 19:15	3/15/2019 18:00	NA	16.19	NA	NA	NA	NA	NA	NA	Y	46	NA	NA	NA	NA	Outlet is flowing	Field has patchy ice
ACT1	ACT1-032319-G	G	525,500	3/23/2019	154	114	13.5	2	80.9	59.9	7.07	1.05	3/15/2019 18:15	3/23/2019 12:00	NA	16.19	NA	NA	NA	NA	NA	NA	Y	115.2	NA	NA	NA	NA	Visible flow, no carboys, took dupe for TDP.	NA
ACT1	ACT1-040119-G	G	1,197,200	4/1/2019	44	31	NA	2	52.7	37.1	NA	2.39	3/23/2019 12:15	4/1/2019 16:45	NA	16.19	NA	NA	NA	NA	NA	SM	Y	104.2	NA	NA	NA	NA	Outlet is flowing, manhole clear, water level low	Field is bare
ACT1	ACT1-040519-NS	NS	466,000	4/5/2019	NA	NA	NA	NA	NA	NA	NA	NA	4/1/2019 17:00	4/5/2019 14:00	NA	16.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT1	ACT1-041019-1	1	583,900	4/10/2019	26	20	NA	2	14.9	11.4	NA	1.20	4/5/2019 14:15	4/10/2019 9:00	4.78	16.19	0.192	0.147	NA	0.015	9:25 AM	CAG	Y	137.4	31/100 bottle 1	11/100 bottle 3	NA	NA	Some foam	Green grass sprouting
ACT1	ACT1-041719-1	1	811,900	4/17/2019	22	14	NA	2	17.9	11.4	NA	1.60	4/10/2019 9:15	4/17/2019 11:30	7.09	16.19	0.156	0.099	NA	0.014	1:30 PM	CAG	Y	50.2	42/100 bottle 1	15/100 bottle 3	NA	NA	NA	Green cover crop among corn stubble
ACT1	ACT1-042419-1	1	1,232,700	4/24/2019	20	13	28.0	2	24.7	15.4	34.50	2.50	4/17/2019 11:45	4/24/2019 16:45	7.21	16.19	0.211	0.132	0.296	0.021	7:15 PM	CAG	Y	42.1	63/100 bottle 1	22/100 bottle 3	NA	NA	NA	Green cover crop among corn stubble
ACT1	ACT1-043019-1	1	1,017,200	4/30/2019	17	10	NA	2	17.3	9.7	NA	2.00	4/24/2019 17:00	4/30/2019 10:15	5.72	16.19	0.187	0.104	NA	0.022	12:01 PM	CAG	Y	53.9	69/100 bottle 1	22/100 bottle 3	NA	NA	NA	Green grass
ACT1	ACT1-050719-1	1	817,700	5/7/2019	13	9	25.8	2	10.6	7.4	21.10	1.60	4/30/2019 10:30	5/7/2019 13:00	7.10	16.19	0.092	0.064	0.183	0.014	1:15 PM	SM	Y	71.5	56/100 bottle 1	18/100 bottle 3	NA	NA	NA	Tilled. No obvious signs of manure application
ACT1	ACT1-051519-1	1	1,010,000	5/15/2019	15	10	NA	2	15.2	9.6	NA	2.00	5/7/2019 13:15	5/15/2019 16:15	8.13	16.19	0.115	0.073	NA	0.015	5:10 PM	CAG	Y	96.3	69/100 bottle 1	22/100 bottle 3	NA	NA	Lab duplicates too	Field plowed, bare
ACT1	ACT1-052219-1+2	1+2	1,104,300	5/22/2019	20	12	26.3	2	21.5	13.3	29.00	2.20	5/15/2019 16:30	5/22/2019 10:00	6.73	16.19	0.198	0.122	0.267	0.020	10:50 AM	CAG	Y	83.1	39/100 bottle 2	38/100 bottle 3	NA	NA	NA	Bare soil
ACT1	ACT1-053119-1+2	1+2	1,063,200	5/31/2019	17	9	NA	2	18.1	9.0	NA	2.10	5/22/2019 10:15	5/31/2019 14:00	9.16	16.19	0.122	0.061	NA	0.014	3:17 PM	RD	Y	49.6	34/100 bottle 2	37/100 bottle 3	NA	NA	Very clear. Lab duplicates too	3" corn
ACT1	ACT1-060619-1	1	526,000	6/6/2019	25	9	29.2	3	13.1	4.7	15.40	1.50	5/31/2019 14:15	6/6/2019 9:15	5.79	16.19	0.140	0.051	0.164	0.016	9:21 AM	RD	Y	530	47/100 bottle 1	19/100 bottle 3	NA	NA	NA	No change
ACT1	ACT1-061219-1+2	1+2	1,030,400	6/12/2019	16	8	NA	2	16.0	7.7	NA	2.50	6/6/2019 9:30	6/12/2019 8:45	5.97	16.19	0.165	0.080	NA	0.026	8:38 AM	RD	Y	89.1	15/100 bottle 2	42/100 bottle 3	NA	Sampled @8:54	NA	Healthy
ACT1	ACT1-062119-1+2	1+2	1,030,900	6/21/2019	23	10	55.1	18	23.7	9.8	56.80	18.70	6/12/2019 9:00	6/21/2019 10:30	9.06	16.19	0.162	0.067	0.387	0.127	10:42 AM	RD	Y	370	16/100 bottle 2	43/100 bottle 3	NA	NA	NA	1' corn
ACT1	ACT1-062519-1	1	613,200	6/25/2019	17	7	NA	4	10.4	4.3	NA	2.30	6/21/2019 10:45	6/25/2019 10:15	3.98	16.19	0.162	0.067	NA	0.036	10:50 AM	RD	Y	22.5	88/100 bottle 1	26/100 bottle 3	NA	NA	Erosion at outfall	1.5' corn
ACT1	ACT1-070319-1	1	541,200	7/3/2019	17	8	51.4	2	8.9	4.3	27.80	1.10	6/25/2019 10:30	7/3/2019 11:30	8.04	16.19	0.069	0.033	0.214	0.008	1:40 PM	CAG	Y	8.9	79/100 bottle 1	23/100 bottle 3	NA	Duplicate bottle cracked	NA	Thigh-high green corn
ACT1	ACT1-071119-1	1	42,400	7/11/2019	22	7	NA	5	0.9	0.3	NA	0.20	7/3/2019 11:45	7/10/2019 23:00	7.47	16.19	0.008	0.003	NA	0.002	11:09 AM	RD	Y	1.6	10/100 bottle 1	3/100 bottle 3	NA	NA	Outlet trickling	1-6' corn
ACT1	ACT1-071819-1	1	14,700	7/18/2019	25	8	39.8	4	0.4	0.1	0.60	0.10	7/10/2019 23:15	7/18/2019 15:15	7.67	16.19	0.003	0.001	0.005	0.001	4:26 PM	RD	N	0.5	5/100 bottle 1	2/100 bottle 3	NA	NA	NA	6' corn
ACT1	ACT1-072419-1	1	6,700	7/24/2019	22	8	NA	4	0.1	0.1	NA	0.00	7/18/2019 15:30	7/24/2019 0:30	5.38	16.19	0.002	0.001	NA	0.000	2:10 PM	RD	N	0.0-0.6	5/100 bottle 1	2/100 bottle 3	TSS sample is under volume	Switched TP and TDP results	NA	8' corn
ACT1	ACT1-080119-1	1	9,300	8/1/2019	20	8	37.9	2	0.2	0.1	0.40	0.00	7/24/2019 0:45	8/1/2019 4:00	8.14	16.19	0.001	0.001	0.003	0.000	10:32 AM	RD	N	0.2-0.9	16/100 bottle 1	3/100 bottle 3	NA	NA	NA	Tall corn
ACT1	ACT1-080819-1	1	8,300	8/8/2019	18	8	NA	2	0.1	0.1	NA	0.00	8/1/2019 4:15	8/8/2019 13:45	7.40	16.19	0.001	0.001	NA	0.000	2:25 PM	RD	N	(-)0.1-0.1	18/100 bottle 1	3/100 bottle 3	NA	NA	NA	Tall corn
ACT1	ACT1-081319-1	1	6,000	8/13/2019	25	9	12.8	NA	0.1	0.1	0.10	NA	8/8/2019 14:00	8/13/2019 18:30	5.19	16.19	0.002	0.001	0.001	NA	6:47 PM	CAG	N	0.2	14/100 bottle 1	3/100 bottle 3	NA	NA	NA	20' tall corn
ACT1	ACT1-081919-1	1	1,500	8/19/2019	26	6	NA	NA	0.0	0.0	NA	NA	8/13/2019 18:45	8/17/2019 4:30	3.41	16.19	0.001	0.000	NA	NA	3:45 PM	RD	N	0	5/100 bottle 1	2/100 bottle 3	Insufficient volume for TSS	NA	Low volume in manhole. Spilled carboy - not enough volume for TSS	Tall corn
ACT1	ACT1-082619-NS	NS	-	8/26/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/17/2019 4:45	8/26/2019 12:15	NA	16.19	NA	NA	NA	NA	12:21 PM	RD	N	0	2/100 bottle 1	2/100 bottle 3	Insufficient volume for sample	Dry or nearly dry	NA	Tall corn
ACT1	ACT1-090419-NS	NS	-	9/4/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/26/2019 12:30	9/4/2019 14:00	NA	16.19	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry	Wet inside manhole, but no flow	NA
ACT1	ACT1-091119-NS	NS	-	9/11/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/4/2019 14:15	9/11/2019 13:00	NA	16.19	NA	NA	NA	NA	1:00 PM	CAG	N	0	NA	NA	Insufficient volume for sample	Dry or nearly dry	Not flowing - standing water around rocks below outlet	Tall corn
ACT1	ACT1-091819-NS	NS	-	9/18/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/11/2019 13:15	9/18/2019 12:00	NA	16.19	NA	NA	NA	NA	NA	CAG	NA	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry	NA	NA
ACT1	ACT1-092419-NS	NS	-	9/24/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/18/2019 12:15	9/24/2019 12:00	NA	16.19	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry	Manhole dry	NA
ACT1	ACT1-100319-NS	NS	-	10/3/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/24/2019 12:15	10/3/2019 16:30	NA	16.19	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry	White crust all round outlet pipe - photo taken. 3" standing water in manhole below pipe outlet	Corn
ACT1	ACT1-100819-NS	NS	-	10/8/2019	NA	NA	NA	NA	NA	NA	NA	NA	10/3/2019 16:45	10/8/2019 16:30	NA	16.19	NA	NA	NA	NA	4:30 PM	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry	White crust all round outlet pipe - photo taken. 3" standing water in manhole below pipe outlet	Corn
ACT1	ACT1-101719-NS	NS	-	10/17/2019	NA	NA	NA	NA	NA	NA	NA	NA	10/8/2019 16:45	10/17/2019 9:45	NA	16.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry	No visit	NA
ACT1	ACT1-102119-3	3	146,300	10/21/2019	52	31	69.1	2	7.6	4.5	10.10	0.30	10/17/2019 10:00	10/21/2019 16:00	4.25	16.19	0.111	0.066	0.147	0.004	4:39 PM	CAG	Y	12.3	23/100 bottle 1	14/100 bottle 3	NA	NA	Crystal clear and all bottles are clear	Corn stubble, bare ground. Corn has been chopped
ACT1	ACT1-102919-3	3	541,000	10/29/2019	17	10	NA	2	8.9	5.4	NA	1.10	10/21/2019 16:15	10/29/2019 12:45	7.85	16.19	0.070	0.043	NA	0.009	2:00 PM	CAG	Y	67.4	DONE	47/100 bottle 3	NA	NA	NA	Corn stubble
ACT1	ACT1-110419-3+4	3+4	2,528,201	11/4/2019	32	16	70.8	2	79.6	39.2	178.90	5.10	10/29/2019 13:00	11/4/2019 15:30	6.10	16.19	0.806	0.397	1.811	0.051	4:53 PM	CAG	Y	93.3	DONE	7/100 bottle 4	NA	NA	NA	Corn stubble, small amount of green cover crop
ACT1	ACT1-111319-1+2	1+2	435,200	11/13/2019	16	7	NA	3	7.0	3.0	NA	1.40	11/4/2019 15:45	11/12/2019 22:15	8.27	16.19	0.052	0.023	NA	0.011	10:40 AM	CAG	Y	17	12/100 bottle 2	20/100 bottle 3	Thawed sample-processed next day	End time is last wet squirt. Subsequent squirts were dry and sampler was shut off due cold.	Took carboys 1, 2 and 3 home to thaw	Snow-covered, ice in intake hole (could not get out)
ACT1	ACT1-112019-G	G	256,400	11/20/2019	15	14	61.4	2	3.8	3.6	15.74	0.51	11/12/2019 22:30	11/20/2019 13:00	NA	16.19	NA	NA	NA	NA	NA	CAG	NA	84.6	NA	NA	NA	NA	Sampler left off due to cold temperatures	NA
ACT1	ACT1-112319-1	1	635,800	11/23/2019	20	15	NA	4	12.4	9.5	NA	2.70	11/20/2019 13:15	11/23/2019 17:15	3.17	16.19	0.242	0.186	NA	0.053	5:28 PM	CAG	Y	142	81/100 bottle 1	23/100 bottle 3	NA	NA	NA	Patches of snow
ACT1	ACT1-120419-1+2	1+2	1,269,600	12/2/2019	13	7	57.6	4	16.5	8.3	73.20	5.50	11/23/2019 17:30	12/1/2019 23:45	8.26	16.19	0.123	0.062	0.547	0.041	3:44 PM	CAG	Y	31	31/100 bottle 2	27/100 bottle 3	Thawed sample-processed next day	Bottle 2 squirts 15-20 were dry so ended it on the 14th squirt	Carboys frozen solid, ice in both lines	Snow
ACT2	ACT2-012419-G	G	-	1/24/2018	309	249	2.9	16	0.0	0.0	0.00	0.00	1/16/2019 13:30	1/24/2018 15:45	NA	12.14	NA	NA	NA	NA	NA	NA	Y	178.4	NA	NA	NA	NA	Outlet submerged. Lots of snow accumulated around it	NA
ACT2	ACT2-112918-G	G	30,170	11/29/2018	560	315	22.5	52	16.9	9.5	0.68	1.57	11/29/2018 12:45	11/29/2018 13:00	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Evidence of manure spreading
ACT2	ACT2-120318-G	G	3,250,889	12/3/2018	471	242	NA	62	1531.2	786.7	NA	201.56	11/29/2018 13:15	12/3/2018 15:30	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT2	ACT2-121418-G	G	1,370,600	12/14/2018	43	30	16.2	2	59.3	41.5	22.18	2.74	12/3/2018 15:45	12/14/2018 13:30	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT2	ACT2-121718-G	G	145,900	12/17/2018	36	31	NA	2	5.2	4.4	NA	0.29	12/14/2018 13:45	12/17/2018 17:00	NA	12.14	NA	NA	NA	NA	NA	NA	Y	31.1	NA	NA	NA	NA	NA	Appears to have recently spread manure
ACT2	ACT2-122318-G	G	3,409,903	12/23/2018	287	196	23.9	11	976.9	668.3	81.33	38.98	12/17/2018 17:15	12/23/2018 13:00	NA	12.14	NA	NA	NA	NA	NA	NA	Y	258	NA	NA	NA	NA	Flowing	NA
ACT2	ACT2-010319-G	G	2,919,500	1/3/2019	98	65	NA	5	284.7	190.6	NA	14.60	12/23/2018 13:15	1/3/2019 13:45	NA	12.14	NA	NA	NA	NA	NA	NA	Y	83.5	NA	NA	NA	NA	NA	Snow on field. Don't see manure
ACT2	ACT2-010919-G	G	516,300	1/9/2019	258	224	8.4	5	133.2	115.4	4.36	2.37	1/3/2019 14:00	1/9/2019 9:45	NA	12.14	NA	NA	NA	NA	NA	NA	Y	92.3	NA	NA	NA	NA	NA	NA
ACT2	ACT2-011619-G	G	406,000	1/16/2019	69	39	NA	2	28.2	15.6	NA	0.81	1/9/2019 10:00	1/16/2019 13:15	NA	12.14	NA	NA	NA	NA	NA	NA	Y	26.8	NA	NA	NA	NA	Outlet flowing	NA
ACT2	ACT2-020819-G	G	26,917,962	2/8/2019	256	206	2.9	26	6891.0	5545.1	77.25	699.87	1/24/2018 16:00	2/8/2019 14:45	NA	12.14	NA	NA	NA	NA	NA	NA	Y	330	NA	NA	NA	NA	Outlet flowing	Some patchy snow
ACT2	ACT2-022119-G	G	921,000	2/21/2019	84	50	7.0	58	77.4	46.0	6.43	53.42	2/8/2019 15:00	2/21/2019 14:15	NA	12.14	NA	NA	NA	NA	NA	NA	Y	16	NA	NA	NA	NA	Outlet flowing	NA
ACT2	ACT2-030419-G	G	684,800	3/4/2019	73	54	6.7	43	50.0	37.0	4.62	29.45	2/21/2019 14:30	3/4/2019 16:00	NA	12.14	NA	NA	NA	NA	NA	NA	Y	13.1	NA	NA	NA	NA	Visible flow	NA
ACT2	ACT2-031519-G	G	577,900	3/15/2019	465	385	3.9	6	268.7	222.5	2.27	3.66	3/4/2019 16:15	3/15/2019 17:15	NA	12.14	NA	NA	NA	NA	NA	NA	Y	450	NA	NA	NA	NA	Outlet fully submerged under ditch water. Sample water a little turbid	Patchy ice/mainly clear
ACT2	ACT2-032319-G	G	3,146,399	3/23/2019	620	473	8.7	23	1950.8	1488.2	27.31	72.37	3/15/2019 17:30	3/23/2019 12:30	NA	12.14	NA	NA	NA	NA	NA	NA	Y	448.1	NA	NA	NA	NA	Visible flow	NA
ACT2	ACT2-040119-G	G	3,630,999	4/1/2019	398	230	NA	24	1445.1	835.1	NA	87.14	3/23/2019 12:45	4/1/2019 16:00	NA	12.14	NA	NA	NA	NA	NA	SM	Y	257	NA	NA	NA	NA	Outlet is flowing, partially submerged. Manhole murky	Field is bare, residue from last year
ACT2	ACT2-040619-NS	NS	580,000	4/6/2019	NA	NA	NA	NA	NA	NA	NA	NA	4/1/2019 16:15	4/6/2019 9:45	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT2	ACT2-041019-1	1	975,600	4/10/2019	168	94	NA	10	163.9	91.7	NA	9.60	4/6/2019 10:00	4/10/2019 10:45	4.03	12.14	3.349	1.874	NA	0.195	11:15 AM	CAG	Y	301.4	34/100 bottle 1	12/100 bottle 3	NA	NA	NA	Corn stubble and mud
ACT2	ACT2-041719-1	1	2,424,200	4/17/2019	83	55	NA	4	201.2	133.3	NA	10.20	4/10/2019 11:00	4/17/2019 11:30	7.02	12.14	2.361	1.564	NA	0.120	11:30 AM	CAG	Y	169.8	82/100 bottle 1	22/100 bottle 3	NA	NA	NA	No change - corn stubble
ACT2	ACT2-042419-1+2	1+2	4,542,703	4/24/2019	133	90	37.6	18	604.2	408.8	170.80	82.70	4/17/2019 11:45	4/24/2019 10:45	6.96	12.14	7.152	4.840	2.022	0.979	12:25 PM	CAG	Y	156.1	15/100 bottle 2	39/100 bottle 3	NA	NA	NA	Corn stubble, small amount of green grass
ACT2	ACT2-043019-1+2	1+2	4,021,402	4/30/2019	166	84	NA	48	667.6	337.8	NA	194.40	4/24/2019 11:00	4/30/2019 13:15	6.09	12.14	9.023	4.566	NA	2.627	1:30 PM	CAG	Y	193.7	2/100 bottle 2	42/100 bottle 3	NA	NA	NA	Corn stubble
ACT2	ACT2-050719-1	1	2,889,100	5/7/2019	57	37	25.5	8	164.7	106.9	73.50	23.10	4/30/2019 13:30	5/7/2019 11:45	6.93	12.14	1.958	1.271	0.874	0.275	12:29 PM	SM	Y	139.5	74/100 bottle 1	30/100 bottle 3	NA	NA	NA	No activity, grass over corn stubble
ACT2	ACT2-051519-1	1	3,065,400	5/15/2019	91	32	NA	33	279.0	98.1	NA	100.70	5/7/2019 12:00	5/15/2019 15:30	8.15	12.14	2.821	0.992	NA	1.019	4:20 PM	CAG	Y	255.7	78/100 bottle 1	32/100 bottle 3	NA	NA	NA	Sparse grass, corn stubble
ACT2	ACT2-052219-1+2	1+2	3,771,302	5/22/2019	322	72	32.3	196	1214.4	271.5	121.80	739.20	5/15/2019 15:45	5/22/2019 10:45	6.79	12.14	14.728	3.293	1.477	8.965	11:40 AM	CAG	Y	204.4	9/100 bottle 2	43/100 bottle 3	NA	NA	NA	Sparse green/yellow grass and weeds
ACT2	ACT2-053119-3	3	4,542,202	5/31/2019	615	380	NA	187	2793.5	1726.0	NA	847.90	5/22/2019 11:00	5/31/2019 14:00	9.13	12.14	25.216	15.580	NA	7.654	2:29 PM	RD	Y	148.5	83/100 bottle 2	52/100 bottle 3	NA	NA	NA	Fresh planting of corn. No obvious signs of manure
ACT2	ACT2-060619-1	1	2,171,301	6/6/2019	515	212	25.8	252	1118.2	460.3	55.90	547.20	5/31/2019 14:15	6/6/2019 10:00	5.82	12.14	15.818	6.511	0.791	7.740	10:12 AM	RD	Y	1100	64/100 bottle 1	23/100 bottle 3	NA	NA	Carboy 3 more turbid. Tile outlet submerged	No change
ACT2	ACT2-061219-1	1	2,703,701	6/12/2019	262	140	NA	89	708.4	378.5	NA	240.60	6/6/2019 10:15	6/12/2019 8:45	5.94	12.14	9.827	5.251	NA	3.338	9:38 AM	RD	Y	176	99/100 bottle 1	28/100 bottle 3	NA	NA	NA	No change
ACT2	ACT2-062119-1	1	2,513,502	6/21/2019	318	136	29.8	151	799.3	341.8	75.00	380.40	6/12/2019 9:00	6/21/2019 11:45	9.11	12.14	7.223	3.089	0.677	3.437	11:46 AM	RD	Y	667.1	93/100 bottle 1	27/100 bottle 3	NA	NA	NA	6" corn
ACT2	ACT2-062519-1	1	849,800	6/25/2019	46	15	NA	16	39.1	12.7	NA	13.40	6/21/2019 12:00	6/25/2019 10:45	3.95	12.14	0.816	0.266	NA	0.280	12:15 PM	RD	Y	85.3	39/100 bottle 1	11/100 bottle 3	NA	NA	Flowmeter reading was 115 L/min by the time I left after 8 minutes of heavy rain	Spotty 10" corn
ACT2	ACT2-070319-3	3	3,590,002	7/3/2019	402	114	25.1	307	1443.2	409.3	90.00	1100.90	6/25/2019 11:00	7/3/2019 11:45	8.03	12.14	14.801	4.197	0.923	11.291	12:48 PM	CAG	Y	81	61/100 bottle 2	41/100 bottle 3	NA	NA	NA	Short, yellow, sparse corn
ACT2	ACT2-071119-1	1	516,900	7/11/2019	57	17	NA	46	29.5	8.8	NA	23.80	7/3/2019 12:00	7/11/2019 10:00	7.92	12.14	0.307	0.091	NA	0.247	12:10 PM	RD	Y	14.5	31/100 bottle 1	8/100 bottle 3	NA	NA	Slow flow	Spotty 1-3' corn

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
ACT2	ACT2-071819-3	3	27,200	7/18/2019	65	30	21.1	30	1.8	0.8	0.60	0.80	7/11/2019 10:15	7/19/2019 14:45	8.19	12.14	0.018	0.008	0.006	0.008	1:37 PM	RD	NA	NA	Done	Done	Many false squirts due to malfunctioning flowmeter. Sampled anyways and took additional grab. Sample is NOT flow proportional. ISCO was not turned on until 7/19 by CG due to overheating on day flowmeter replaced	Accept concentration data--consistent with bounding concentrations. Zeroed out garbage flow 7/11/19 10:30 PM - 7/18/19 3:00 PM.	Malfunctioning flowmeter replaced 7/19/2019	1-6' corn (spotty)
ACT2	ACT2-071819-G	G	27,200	7/18/2019	115	83	13.7	9	3.1	2.3	0.37	0.23	7/11/2019 10:15	7/19/2019 14:45	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Disregard grab. Composite sample concentrations look more consistent than grab	NA	NA
ACT2	ACT2-072419-1	1	66,800	7/24/2019	84	18	NA	139	5.6	1.2	NA	9.30	7/19/2019 15:00	7/24/2019 0:30	4.40	12.14	0.105	0.023	NA	0.175	1:29 PM	RD	Y	6.4-7.9	6/100 bottle 1	2/100 bottle 3	TSS sample is under volume (accept)	NA	Tile outlet flowing very slightly	Spotty corn 1-6'
ACT2	ACT2-080119-1	1	59,900	8/1/2019	63	20	7.3	52	3.8	1.2	0.40	3.10	7/24/2019 0:45	8/1/2019 2:45	8.08	12.14	0.039	0.012	0.004	0.032	11:23 AM	RD	Y	2.5-3.4	15/100 bottle 1	3/100 bottle 3	NA	NA	NA	2-10' corn
ACT2	ACT2-080819-1	1	26,300	8/8/2019	97	24	NA	112	2.6	0.6	NA	3.00	8/1/2019 3:00	8/8/2019 12:00	7.38	12.14	0.029	0.007	NA	0.033	1:20 PM	RD	Y	2.8-4.3	10/100 bottle 1	2/100 bottle 3	NA	NA	NA	2-12' corn
ACT2	ACT2-081319-1	1	12,600	8/13/2019	60	24	2.2	86	0.8	0.3	0.00	1.10	8/8/2019 12:15	8/13/2019 11:30	4.97	12.14	0.013	0.005	0.000	0.018	1:22 PM	CAG	N	0.8	10/100 bottle 1	2/100 bottle 3	NA	NA	NA	NA
ACT2	ACT2-081919-1	1	9,300	8/19/2019	60	19	NA	71	0.6	0.2	NA	0.70	8/13/2019 11:45	8/19/2019 14:15	6.10	12.14	0.008	0.002	NA	0.009	3:04 PM	RD	Y	(-)0.1-1.0	9/100 bottle 1	2/100 bottle 3	NA	NA	Tile outlet trickling	No change
ACT2	ACT2-082619-1	1	9,200	8/26/2019	83	17	0.4	44	0.8	0.2	0.00	0.40	8/19/2019 14:30	8/26/2019 7:45	6.72	12.14	0.009	0.002	0.000	0.005	12:56 PM	RD	N	0.4-1.2	12/100 bottle 1	3/100 bottle 3	NA	NA	NA	6-10' corn, deep cracks in soil
ACT2	ACT2-090319-1	1	11,700	9/3/2019	191	43	NA	159	2.2	0.5	NA	1.90	8/26/2019 8:00	9/3/2019 12:30	8.19	12.14	0.023	0.005	NA	0.019	2:10 PM	CAG	N	0.5	18/100 bottle 1	3/100 bottle 3	NA	NA	NA	Corn
ACT2	ACT2-091119-1	1	10,700	9/11/2019	96	47	1.4	10	1.0	0.5	0.00	0.10	9/3/2019 12:45	9/11/2019 10:30	7.91	12.14	0.011	0.005	0.000	0.001	1:10 PM	CAG	N	0.5	17/100 bottle 1	3/100 bottle 3	NA	NA	Lab dupe for TDP	NA
ACT2	ACT2-091819-NS	NS	1,400	9/18/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/11/2019 10:45	9/18/2019 13:45	NA	12.14	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	Insufficient volume for sample	Flow gap 9/12/19 2:45 AM - 9/23/19 8:00 PM. Flow zeroed	Outlet is dry	NA
ACT2	ACT2-092419-1	1	2,100	9/24/2019	650	107	2.6	287	1.4	0.2	0.00	0.60	9/18/2019 14:00	9/24/2019 15:15	6.05	12.14	0.019	0.003	0.000	0.008	4:50 PM	CAG	N	1.9	8/100 bottle 1	2/100 bottle 3	NA	NA	NA	NA
ACT2	ACT2-100319-1	1	13,900	10/3/2019	224	113	NA	41	3.1	1.6	NA	0.60	9/24/2019 15:30	10/3/2019 1:45	8.43	12.14	0.030	0.015	NA	0.006	11:49 AM	CAG	Y	1.2	13/100 bottle 1	3/100 bottle 3	NA	NA	Very light trickle	Corn has been chopped
ACT2	ACT2-100819-3	3	452,300	10/8/2019	710	214	3.5	192	321.1	96.8	1.60	86.80	10/3/2019 2:00	10/8/2019 12:45	5.45	12.14	4.855	1.463	0.024	1.313	3:40 PM	CAG	Y	8.7	DONE	47/100 bottle 3	NA	NA	NA	Corn has been chopped 1+ week. Fair vegetation on field. Corn was sparse near station prior to chopping
ACT2	ACT2-101619-1	1	19,800	10/16/2019	162	125	2.6	7	3.2	2.5	0.10	0.10	10/8/2019 13:00	10/16/2019 14:00	8.04	12.14	0.033	0.025	0.001	0.002	6:30 PM	CAG	Y	1.5	17/100 bottle 1	33/100 bottle 3	NA	NA	NA	Corn chopped, manure recently spread
ACT2	ACT2-102119-NS	NS	622,800	10/18/2019	NA	NA	NA	NA	NA	NA	NA	NA	10/18/2019 9:00	10/21/2019 14:30	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Program complete before end of event. Gap between end of program and sampler restart. Average bounding concentrations.	NA	NA
ACT2	ACT2-102119-3/4	3/4	2,393,503	10/21/2019	1492	760	18.0	494	3570.0	1818.2	43.00	1182.80	10/16/2019 14:15	10/18/2019 8:45	1.77	12.14	166.053	84.573	2.002	55.017	2:35 PM	CAG	Y	41.1	DONE	DONE	NA	NA	Two full sets. Partially submerged outlet pipe. Outflow visible. Lots of sediment	Corn stubble, recent manure spreading or plowing?
ACT2	ACT2-102919-3	3	3,352,502	10/29/2019	795	474	NA	118	2665.2	1589.1	NA	394.30	10/21/2019 14:45	10/29/2019 15:00	8.01	12.14	27.406	16.340	NA	4.054	4:30 PM	CAG	Y	145.5	DONE	69/100 bottle 3	NA	NA	NA	Corn stubble, plowed
ACT2	ACT2-110419-3	3	3,945,302	11/4/2019	750	310	16.4	347	2959.0	1223.0	64.60	1367.00	10/29/2019 15:15	11/4/2019 13:30	5.93	12.14	41.121	16.997	0.898	18.998	3:14 PM	CAG	Y	130.9	DONE	51/100 bottle 3	NA	NA	NA	Corn stubble, possibly fresh manure
ACT2	ACT2-111219-1	1	641,700	11/12/2019	110	78	NA	32	70.6	50.1	NA	20.40	11/4/2019 13:45	11/9/2019 14:30	5.03	12.14	1.156	0.819	NA	0.334	NA	CAG	Y	NA	NA	NA	Autosampler power failure on 11/9/19. Thawed sample-processed next day	Accepted	Ice in line - was able to disable and get out. Took carboy 1 home to thaw.	Snow
ACT2	ACT2-111219-NS	NS	255,200	11/12/2019	NA	NA	NA	NA	NA	NA	NA	NA	11/9/2019 14:45	11/12/2019 14:45	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Gap created by autosampler power failure	Likely we can apply average of bounding concentrations depending on values.	NA	NA
ACT2	ACT2-112019-1	1	160,600	11/20/2019	108	18	6.0	NA	17.3	2.9	1.00	NA	11/12/2019 15:00	11/14/2019 21:00	2.25	12.14	0.635	0.106	0.035	NA	NA	CAG	Y	500.8	STOPPED	STOPPED	Autosampler stopped working 11/14 at 21:00.	NA	Sampler had stopped. Brought frozen carboy home - restarted program.	NA
ACT2	ACT2-112019-NS	NS	1,479,500	11/20/2019	NA	NA	NA	NA	NA	NA	NA	NA	11/14/2019 21:15	11/20/2019 12:00	NA	12.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Gap created by powering autosampler off due to ice. Turned on once it had thawed and very large event began.	This sampling gap includes large flows (first rise of big thaw event)	NA	NA
ACT2	ACT2-112319-3	3	3,714,702	11/23/2019	635	436	NA	60	2358.8	1619.6	NA	221.40	11/20/2019 12:15	11/23/2019 13:00	3.03	12.14	64.097	44.010	NA	6.016	1:10 PM	CAG	Y	311.5	87/100 bottle 1	32/100 bottle 3	NA	NA	NA	Snowy
ACT2	ACT2-120419-1	1	3,833,802	12/2/2019	660	366	18.9	163	2530.3	1403.2	72.60	624.10	11/23/2019 13:15	12/1/2019 23:45	8.44	12.14	24.701	13.698	0.709	6.093	5:09 PM	CAG	Y	96.8	100/100 bottle 1	26/100 bottle 3	Last 7 of 100 squirts were dry--sample may not be fully flow-proportional. Thawed sample-processed next day.	Accepted	Errors occurred, ice in lines. See notes in field form.	Snow
ACT3	ACT3-012419-G	G	-	1/24/2018	224	135	16.0	58	0.0	0.0	0.00	0.00	1/16/2019 12:15	1/24/2018 15:00	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Outlet flowing	NA
ACT3	ACT3-112918-G	G	8,155	11/29/2018	366	185	55.9	14	3.0	1.5	0.46	0.12	11/29/2018 14:15	11/29/2018 14:30	NA	14.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT3	ACT3-120318-G	G	2,343,108	12/3/2018	505	266	NA	2	1183.3	623.3	NA	4.69	11/29/2018 14:45	12/3/2018 14:00	NA	14.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT3	ACT3-121418-G	G	409,727	12/14/2018	31	28	19.2	2	12.7	11.5	7.86	0.82	12/3/2018 14:15	12/14/2018 15:00	NA	14.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT3	ACT3-121718-G	G	-	12/17/2018	27	27	NA	2	0.0	0.0	NA	0.00	12/14/2018 15:15	12/17/2018 16:00	NA	14.16	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	NA	No flow. Water 1" below weir notch	NA
ACT3	ACT3-122318-G	G	1,782,455	12/23/2018	106	72	41.1	12	188.0	127.5	73.17	21.75	12/17/2018 16:15	12/23/2018 13:45	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Heavy flow	NA
ACT3	ACT3-010319-G	G	624,460	1/3/2019	43	34	NA	3	26.6	21.1	NA	1.80	12/23/2018 14:00	1/3/2019 12:15	NA	14.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Snow on field
ACT3	ACT3-010919-G	G	210,137	1/9/2019	32	26	20.2	3	6.8	5.4	4.25	0.64	1/3/2019 12:30	1/9/2019 10:30	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Water level slightly above weir notch	NA
ACT3	ACT3-011619-G	G	32,569	1/16/2019	23	21	NA	2	0.8	0.7	NA	0.07	1/9/2019 10:45	1/16/2019 12:00	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Barely flowing over notch, water is frozen in outlet pipe. Flowing out under culvert	NA
ACT3	ACT3-020819-G	G	11,143,511	2/8/2019	525	193	8.2	180	5850.3	2150.7	91.27	2005.83	1/24/2018 15:15	2/8/2019 14:00	NA	14.16	NA	NA	NA	NA	NA	NA	NA	Depth = 1'11 10/16"	NA	NA	NA	NA	NA	NA
ACT3	ACT3-022119-NS	NS	384,330	2/21/2019	NA	NA	NA	NA	NA	NA	NA	NA	2/8/2019 14:15	2/21/2019 12:45	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Water below notch. Small flow coming from inlet pipe, but not enough to sample. Sample intake exposed. No flow from the outlet pipe, but some water coming under pipe. Outlet pipe sealed w/ putty and stamped down perimeter of manhole. Still leaking ~1 L/min but level seems to be coming up.	NA
ACT3	ACT3-030419-G	G	72,918	3/4/2019	43	24	4.8	54	3.1	1.7	0.35	3.93	2/21/2019 13:00	3/4/2019 15:15	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Flow visible under tile (not coming through pipe).	NA
ACT3	ACT3-031519-G	G	594,452	3/15/2019	399	188	10.7	168	237.2	111.8	6.35	99.87	3/4/2019 15:30	3/15/2019 16:30	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Outlet flowing heavily. Water is turbid.	Field is mostly clear with small patches of ice
ACT3	ACT3-032319-G	G	1,387,879	3/23/2019	346	112	22.0	52	479.5	155.4	30.56	72.52	3/15/2019 16:45	3/23/2019 10:45	NA	14.16	NA	NA	NA	NA	NA	NA	Y	NA	NA	NA	NA	NA	Visible flow	NA
ACT3	ACT3-040119-G	G	1,014,219	4/1/2019	101	60	NA	2	102.4	60.9	NA	2.03	3/23/2019 11:00	4/1/2019 13:45	NA	14.16	NA	NA	NA	NA	NA	SM	Y	NA	NA	NA	NA	Switched TP and TDP results	Outlet is flowing	Field is bare
ACT3	ACT3-041019-G	G	1,035,341	4/10/2019	93	69	NA	5	96.3	71.4	NA	4.97	4/1/2019 14:00	4/10/2019 10:30	NA	14.16	NA	NA	NA	NA	10:45 AM	CAG	Y	NA	NA	NA	NA	NA	NA	Small amount of green cover crop poking up among corn stubble
ACT3	ACT3-041319-NS	NS	192,911	4/13/2019	NA	NA	NA	NA	NA	NA	NA	NA	4/10/2019 10:45	4/13/2019 11:00	NA	14.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT3	ACT3-041719-1	1	542,655	4/17/2019	268	131	NA	120	145.4	71.1	NA	65.30	4/13/2019 11:15	4/17/2019 11:00	3.99	14.16	2.574	1.258	NA	1.156	12:38 PM	CAG	Y	NA	20/100 bottle 1	8/100 bottle 3	NA	NA	NA	NA
ACT3	ACT3-042419-1	1	1,848,775	4/24/2019	446	NA	35.4	82	824.6	NA	65.40	151.60	4/17/2019 11:15	4/23/2019 22:30	6.47	14.16	8.999	NA	0.714	1.655	11:35 AM	CAG	Y	NA	63/100 bottle 1	22/100 bottle 3	TDP sample lost while filtering (inadequate volume)	NA	NA	Green grass, corn stubble
ACT3	ACT3-043019-1	1	1,421,347	4/30/2019	585	153	NA	207	831.5	217.5	NA	294.20	4/23/2019 22:45	4/30/2019 5:30	6.28	14.16	9.346	2.444	NA	3.307	2:00 PM	CAG	Y	NA	72/100 bottle 1	19/100 bottle 3	NA	NA	NA	Green grass, corn stubble
ACT3	ACT3-050719-1	1	294,701	5/7/2019	358	122	22.5	175	105.5	36.0	6.60	51.60	4/30/2019 5:45	5/6/2019 16:15	6.44	14.16	1.157	0.394	0.073	0.566	11:37 AM	SM	Y	NA	16/100 bottle 1	5/100 bottle 3	NA	NA	Water is quite brown. Opened lid @12:07, just barely flowing over v-notch 30"/16". Closed lid @12:09	Green grass, corn stubble
ACT3	ACT3-051519-1+2	1+2	1,143,702	5/15/2019	645	159	NA	107	737.7	181.8	NA	122.00	5/6/2019 16:30	5/15/2019 15:00	8.94	14.16	5.827	1.437	NA	0.964	3:47 PM	CAG	Y	NA	16/100 bottle 2	19/100 bottle 3	NA	NA	NA	Yellow grass, corn stubble
ACT3	ACT3-052219-1+2	1+2	1,042,982	5/22/2019	474	143	20.9	129	494.4	149.1	21.80	134.50	5/15/2019 15:15	5/22/2019 11:30	6.84	14.16	5.100	1.539	0.225	1.388	12:15 PM	CAG	Y	NA	32/100 bottle 2	22/100 bottle 3	NA	NA	NA	Brown, dead grass and corn stubble (took picture)
ACT3	ACT3-053119-1	1	592,999	5/31/2019	595	312	NA	220	352.8	185.0	NA	130.50	5/22/2019 11:45	5/31/2019 12:30	9.03	14.16	2.758	1.446	NA	1.020	1:28 PM	RD	Y	NA	76/100 bottle 1	13/100 bottle 3	NA	NA	Some dirty water found in carboy 4	NA
ACT3	ACT3-060619-3	3	1,063,724	6/6/2019	877	322	35.1	529	932.9	342.5	37.30	562.70	5/31/2019 12:45	6/6/2019 10:30	5.91	14.16	11.151	4.094	0.446	6.727	11:05 AM	RD	Y	NA	DONE	23/100 bottle 3	NA	NA	Very turbid	No change
ACT3	ACT3-061219-1	1	403,152	6/12/2019	565	300	NA	213	227.8	120.9	NA	85.90	6/6/2019 10:45	6/12/2019 6:00	5.80	14.16	2.772	1.472	NA	1.045	10:20 AM	RD	Y	NA	67/100 bottle 1	11/100 bottle 3	NA	NA	Very turbid	No change
ACT3	ACT3-062119-3	3	899,025	6/21/2019	735	212	29.4	407	660.8	190.6	26.40	365.90	6/12/2019 6:15	6/21/2019 11:15	9.21	14.16	5.066	1.461	0.203	2.805	12:33 PM	RD	Y	NA	80/100 bottle 2	24/100 bottle 3	NA	NA	Repaired leak 6/19/2019. Flow out weir.	6" corn
ACT3	ACT3-062519-1	1	45,297	6/25/2019	54	19	NA	36	2.4	0.9	NA	1.60	6/21/2019 11:30	6/25/2019 7:00	3.81	14.16	0.045	0.016	NA	0.030	12:59 PM	RD	Y	NA	14/100 bottle 1	3/100 bottle 3	NA	Far falling limb of 6/20 event	Flows and turbidity increase approx. 8 minutes after heavy rain.	1' corn
ACT3	ACT3-070319-1	1	157,457	7/3/2019	760	171	19.0	799	119.7	26.9	3.00	125.80	6/25/2019 7:15	7/3/2019 12:00	8.20	14.16	1.031	0.232	0.026	1.084	12:10 PM	CAG	Y	NA	63/100 bottle 1	8/100 bottle 3	NA	NA	NA	NA
ACT3	ACT3-071119-1	1	108,559	7/11/2019	555	165	NA	641	60.3	17.9	NA	69.60	7/3/2019 12:15	7/10/2019 10:00	6.91	14.16	0.616	0.183	NA	0.711	1:03 PM	RD	Y	NA	62/100 bottle 1	8/100 bottle 3	NA	NA	Carboy 3 full of ants. Tile outlet trickling.	3-5' corn
ACT3	ACT3-071819-1	1	126,498	7/18/2019	435	132	28.0	387	55.0	16.7	3.50	49.00	7/10/2019 10:15	7/18/2019 7:30	7.89	14.16	0.493	0.150	0.032	0.438	12:28 PM	RD	Y	NA	72/100 bottle 1	9/100 bottle 3	NA	NA	Tile outlet trickling. Sprayed ants again.	5-6' corn
ACT3	ACT3-072419-NS	NS	316	7/24/2019	NA	NA	NA	NA	NA	NA	NA	NA	7/18/2019 7:45	7/24/2019 12:30	NA	14.16	NA	NA	NA	NA	12:41 PM	RD	Y	NA	2/100 bottle 1	2/100 bottle 3	NA	Can flow be zeroed?	Leaking under outlet, but not enough to sample. Dumped the last sample and restarted program.	NA
ACT3	ACT3-080119-3	3	162,635	8/1/2019	575	98	30.7	554	93.5	15.9	5.00	90.00	7/24/2019 12:45	8/1/2019 8:00	7.80	14.16	0.846	0.144	0.045	0.815	12:13 PM	RD	Y	NA	DONE	29/100 bottle 3	NA	NA	Tile outlet trickling over weir. Sample in carboy 4 is from inaccurate delivery of sample. Distributer arm adjusted.	10' corn, developing deep surface cracks.
ACT3	ACT3-080819-NS	NS	96	8/8/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/1/2019 8:15	8/8/2019 12:00	NA	14.16	NA	NA	NA	NA	NA	RD	N	NA	2/100 bottle 1	2/100 bottle 3	NA	Can flow be zeroed?	Water in manhole ~0.5" below v-notch. Left carboys with original squirts. Ants in manhole lid.	Tall corn
ACT3	ACT3-081319-NS	NS	-	8/13/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/8/2019 12:15	8/13/2019 12:00	NA	14.16	NA	NA	NA	NA	12:02 PM	CAG	N	NA	NA	NA	NA	Can flow be zeroed?	No sample. Rinsed, dumped, restarted. Bottles almost dry.	NA

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
ACT3	ACT3-081919-NS	NS	-	8/19/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/13/2019 12:15	8/19/2019 12:00	NA	14.16	NA	NA	NA	NA	2:18 PM	RD	N	NA	2/100 bottle 1	2/100 bottle 3	NA	Can flow be zeroed?	No flow	Tall corn
ACT3	ACT3-082619-NS	NS	-	8/26/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/19/2019 12:15	8/26/2019 12:00	NA	14.16	NA	NA	NA	NA	1:46 PM	RD	N	NA	2/100 bottle 1	2/100 bottle 3	Not enough volume to sample	Can flow be zeroed?	NA	8-10' corn
ACT3	ACT3-090319-1	1	3,608	9/3/2019	362	88	NA	139	1.3	0.3	NA	0.50	8/26/2019 12:15	9/3/2019 5:15	7.71	14.16	0.012	0.003	NA	0.005	1:30 PM	CAG	N	NA	5/100 bottle 1	2/100 bottle 3	Insufficient volume for TSS	NA	Poured from carboy #1 (shaken well) to bottles, churn splitter not used.	Corn
ACT3	ACT3-091119-NS	NS	-	9/11/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/3/2019 5:30	9/11/2019 12:45	NA	14.16	NA	NA	NA	NA	12:45 PM	CAG	N	NA	NA	NA	NA	Can flow be zeroed?	Outlet not flowing, standing water in manhole.	NA
ACT3	ACT3-091819-NS	NS	-	9/18/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/11/2019 13:00	9/18/2019 12:00	NA	14.16	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	Can flow be zeroed?	Insufficient volume for sample. Outlet is dry.	NA
ACT3	ACT3-092419-1	1	41,967	9/24/2019	523	84	2.9	540	21.9	3.5	0.10	22.70	9/18/2019 12:15	9/24/2019 7:45	5.81	14.16	0.266	0.043	0.002	0.275	5:30 PM	CAG	NA	NA	54/100 bottle 1	7/100 bottle 3	NA	NA	NA	Corn
ACT3	ACT3-100319-NS	NS	46	10/3/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/24/2019 8:00	10/3/2019 12:00	NA	14.16	NA	NA	NA	NA	NA	CAG	NA	NA	NA	NA	NA	Can flow be zeroed?	NA	NA
ACT3	ACT3-100819-3	3	487,337	10/8/2019	1595	838	19.3	432	777.3	408.1	9.40	210.50	10/3/2019 12:15	10/8/2019 14:00	5.07	14.16	10.818	5.680	0.131	2.930	2:30 PM	CAG	Y	Depth = 2' 6 1/8"	DONE	42/100 bottle 3	NA	NA	Thick white frothy foam at outlet. Took photo. Bracket top - water level.	Corn has been chopped, stubble and bare ground
ACT3	ACT3-101619-NS	NS	651	10/16/2019	NA	NA	NA	NA	NA	NA	NA	NA	10/8/2019 14:15	10/17/2019 1:15	NA	14.16	NA	NA	NA	NA	NA	CAG	NA	NA	NA	NA	NA	Can flow be zeroed?	NA	NA
ACT3	ACT3-102119-3/4	3/4	1,658,059	10/21/2019	932	402	30.7	537	1545.4	666.3	51.00	891.10	10/17/2019 1:30	10/20/2019 2:00	3.02	14.16	36.119	15.573	1.191	20.827	1:40 PM	CAG	Y	NA	2/100 bottle 1	12/100 bottle 4	NA	NA	Trickle of flow. Lots of sediment. Two full sets of samples taken.	Corn stubble
ACT3	ACT3-102919-1/2	1/2	833,863	10/29/2019	682	293	NA	264	568.4	244.1	NA	219.80	10/20/2019 2:15	10/29/2019 8:45	9.27	14.16	4.329	1.859	NA	1.674	3:12 PM	CAG	Y	Depth = 2' 5.75"	31/100 bottle 2	DONE	NA	NA	Part B had program error and only collected one squirt total. Fixed issue.	Flat corn stubble, bare ground
ACT3	ACT3-110419-3	3	1,756,093	11/4/2019	1380	294	22.1	1726	2423.4	516.3	38.80	3031.00	10/29/2019 9:00	11/3/2019 2:30	4.73	14.16	36.179	7.708	0.579	45.250	3:40 PM	CAG	Y	Depth = 2' 7.25"	DONE	26/100 bottle 3	NA	NA	NA	Corn stubble
ACT3	ACT3-111319-NS	NS	17,009	11/12/2019	NA	NA	NA	NA	NA	NA	NA	NA	11/3/2019 2:45	11/12/2019 15:15	NA	14.16	NA	NA	NA	NA	3:35 PM	CAG	Y	NA	2/100 bottle 1	2/100 bottle 3	NA	Pacing set too high to obtain sample. Should be labeled 111219	Insufficient volume for sample.	Snow covered
ACT3	ACT3-112019-1+2	1+2	261,610	11/20/2019	348	184	22.3	105	91.0	48.1	5.80	27.50	11/12/2019 15:30	11/20/2019 11:30	7.83	14.16	0.821	0.434	0.053	0.248	11:35 AM	CAG	Y	NA	32/100 bottle 2	15/100 bottle 3	NA	NA	NA	NA
ACT3	ACT3-112319-3	3	1,056,207	11/23/2019	405	184	NA	117	427.8	194.3	NA	123.60	11/20/2019 11:45	11/23/2019 9:15	2.90	14.16	10.429	4.738	NA	3.013	1:55 PM	CAG	Y	NA	DONE	28/100 bottle 3	Final squirt was dry	Accepted	NA	Patches of snow
ACT3	ACT3-120419-1+2	1+2	1,018,503	12/2/2019	945	210	22.5	556	962.5	213.9	22.90	566.30	11/23/2019 9:30	11/30/2019 0:00	6.60	14.16	10.289	2.287	0.245	6.054	4:47 PM	CAG	Y	NA	32/100 bottle 2	16/100 bottle 3	Last portion of sample not fully flow-proportional. Thawed sample-processed next day.	Last 27 squirts were dry (27 out of 32). Last wet squirt occurred 11/29 at 22:26. Ending 11/30 at midnight.	Intake line frozen, carboys frozen solid. Error in program detected.	Snow
ACT4	ACT4-012419-G	G	-	1/24/2018	440	401	2.9	14	0.0	0.0	0.00	0.00	1/16/2019 11:00	1/24/2018 13:45	NA	10.12	NA	NA	NA	NA	NA	NA	NA	38.5	NA	NA	NA	Flow estimated 1/24/19 6:30 PM - 1/27/19 8:30 AM	Outlet buried	NA
ACT4	ACT4-112918-G	G	1,600	11/29/2018	325	253	2.1	5	0.5	0.4	0.00	0.01	11/29/2018 17:15	11/29/2018 17:30	NA	10.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT4	ACT4-120318-G	G	501,800	12/3/2018	939	840	NA	10	471.2	421.5	NA	5.18	11/29/2018 17:45	12/3/2018 11:30	NA	10.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT4	ACT4-121418-G	G	244,100	12/14/2018	214	195	6.3	5	52.2	47.6	1.53	1.22	12/3/2018 11:45	12/14/2018 11:00	NA	10.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT4	ACT4-121718-G	G	3,200	12/17/2018	216	196	NA	7	0.7	0.6	NA	0.02	12/14/2018 11:15	12/17/2018 14:00	NA	10.12	NA	NA	NA	NA	NA	NA	N	0.1	NA	NA	NA	NA	No visible flow	NA
ACT4	ACT4-122218-G	G	426,600	12/22/2018	831	715	3.3	12	354.5	305.0	1.42	5.12	12/17/2018 14:15	12/22/2018 17:45	NA	10.12	NA	NA	NA	NA	NA	NA	Y	75.3	NA	NA	NA	NA	NA	NA
ACT4	ACT4-010319-G	G	383,500	1/3/2019	300	249	NA	10	115.0	95.5	NA	3.83	12/22/2018 18:00	1/3/2019 10:45	NA	10.12	NA	NA	NA	NA	NA	NA	NA	1.5	NA	NA	NA	NA	Outlet submerged	Dusting of snow in field. No manure observed.
ACT4	ACT4-010919-G	G	7,900	1/9/2019	234	215	13.2	2	1.8	1.7	0.10	0.02	1/3/2019 11:00	1/9/2019 11:30	NA	10.12	NA	NA	NA	NA	NA	NA	NA	0.3	NA	NA	NA	NA	NA	NA
ACT4	ACT4-011619-G	G	7,300	1/16/2019	258	224	NA	2	1.9	1.6	NA	0.01	1/9/2019 11:45	1/16/2019 10:45	NA	10.12	NA	NA	NA	NA	NA	NA	NA	0.5	NA	NA	NA	NA	Outlet buried	NA
ACT4	ACT4-020819-G	G	2,246,600	2/8/2019	262	206	2.9	10	588.6	462.8	6.49	21.34	1/24/2018 14:00	2/8/2019 12:15	NA	10.12	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	Flow estimated 2/5/19 4:00 PM - 2/9/19 1:00 PM	Ditch submerged. Manhole clear of ice. Outlet doesn't seem blocked. Some sediment.	Patchy snow
ACT4	ACT4-022119-G	G	22,100	2/21/2019	266	202	2.5	20	5.9	4.5	0.05	0.45	2/8/2019 12:30	2/21/2019 11:30	NA	10.12	NA	NA	NA	NA	NA	NA	NA	3.2	NA	NA	NA	NA	Outlet iced. Sample from manhole. Water looked pretty stagnant	NA
ACT4	ACT4-030419-G	G	60,800	3/4/2019	402	348	4.5	11	24.4	21.2	0.28	0.69	2/21/2019 11:45	3/4/2019 17:15	NA	10.12	NA	NA	NA	NA	NA	NA	NA	0-1	NA	NA	NA	NA	Grabbed sample from manhole using TSS bottle (not pumped).	NA
ACT4	ACT4-031519-G	G	37,000	3/15/2019	645	580	4.1	10	23.9	21.5	0.15	0.38	3/4/2019 17:30	3/15/2019 15:30	NA	10.12	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	Zero flow probably due to high ditch level. Sample water clear.	Some patchy ice
ACT4	ACT4-032319-G	G	273,500	3/23/2019	1630	1420	5.9	9	445.8	388.4	1.60	2.46	3/15/2019 15:45	3/23/2019 10:15	NA	10.12	NA	NA	NA	NA	NA	NA	NA	83.7	NA	NA	NA	NA	No flow visible (snow-covered)	NA
ACT4	ACT4-040119-G	G	277,600	4/1/2019	472	302	NA	10	131.0	83.8	NA	2.87	3/23/2019 10:30	4/1/2019 14:15	NA	10.12	NA	NA	NA	NA	NA	NA	Y	4	NA	NA	NA	NA	Outlet submerged by a couple inches. Water looks a bit stagnant in manhole but appears to be flowing	Field is bare
ACT4	ACT4-041019-1	1	143,800	4/10/2019	410	258	NA	26	59.0	37.1	NA	3.70	4/5/2019 14:30	4/10/2019 12:15	4.91	10.12	1.188	0.747	NA	0.075	?	CAG	Y	36.8	9/100 bottle 1	4/100 bottle 3	NA	NA	Turbid plume in ditch where tile outlet enters	Brown grass
ACT4	ACT4-041719-1	1	316,300	4/17/2019	336	240	NA	20	106.3	75.9	NA	6.30	4/10/2019 12:30	4/17/2019 12:45	7.01	10.12	1.498	1.070	NA	0.089	3:15 PM	CAG	N	NA	33/100 bottle 1	7/100 bottle 3	NA	NA	Ditch was stagnant, water in carboy was brown	Brown stubble
ACT4	ACT4-042419-1	1	605,700	4/24/2019	454	322	4.0	26	275.0	195.0	2.40	15.40	4/17/2019 13:00	4/24/2019 10:15	6.89	10.12	3.948	2.800	0.035	0.222	1:40 PM	CAG	N	10.5	62/100 bottle 1	12/100 bottle 3	NA	NA	NA	Green grass
ACT4	ACT4-043019-1	1	314,100	4/30/2019	406	258	NA	21	127.5	81.0	NA	6.60	4/24/2019 10:30	4/30/2019 14:00	6.15	10.12	2.051	1.303	NA	0.106	3:40 PM	CAG	N	12.1	31/100 bottle 1	8/100 bottle 3	NA	NA	NA	Green grass
ACT4	ACT4-050719-1	1	250,700	5/7/2019	336	188	2.7	48	84.2	47.1	0.70	11.90	4/30/2019 14:15	5/7/2019 5:45	6.65	10.12	1.253	0.701	0.010	0.177	10:28 AM	SM	Y	10.5	31/100 bottle 1	8/100 bottle 3	NA	NA	Tile outlet submerged and barely flowing. Water not that turbid but very brown	Grass
ACT4	ACT4-051519-1	1	276,700	5/15/2019	336	171	NA	31	93.0	47.3	NA	8.60	5/7/2019 6:00	5/15/2019 12:15	8.26	10.12	1.113	0.566	NA	0.103	2:35 PM	CAG	Y	24.1	38/100 bottle 1	9/100 bottle 3	NA	NA	NA	Thick green grass
ACT4	ACT4-052219-1	1	462,400	5/22/2019	450	280	3.0	60	208.1	129.5	1.40	27.70	5/15/2019 12:30	5/22/2019 9:30	6.88	10.12	2.992	1.861	0.020	0.399	1:42 PM	CAG	N	9.7	78/100 bottle 1	17/100 bottle 3	NA	NA	NA	Lush green grass
ACT4	ACT4-053119-1	1	240,900	5/31/2019	340	220	NA	42	81.9	53.0	NA	10.00	5/22/2019 9:45	5/31/2019 9:30	8.99	10.12	0.901	0.583	NA	0.110	12:20 PM	RD	Y	6.8	81/100 bottle 1	13/100 bottle 3	NA	NA	Tile outlet submerged and barely flowing.	Grass
ACT4	ACT4-060619-1	1	38,300	6/6/2019	222	138	1.8	32	8.5	5.3	0.10	1.20	5/31/2019 9:45	6/6/2019 11:30	6.07	10.12	0.138	0.086	0.001	0.020	12:50 PM	RD	Cannot tell	23.3	9/100 bottle 1	3/100 bottle 3	NA	NA	Tile outlet not visible: submerged and very turbid	Grass
ACT4	ACT4-061219-1	1	31,000	6/12/2019	270	151	NA	48	8.4	4.7	NA	1.50	6/6/2019 11:45	6/11/2019 22:00	5.43	10.12	0.152	0.085	NA	0.027	11:41 AM	RD	N	0.2	13/100 bottle 1	3/100 bottle 3	Partial TSS sample	NA	NA	No change
ACT4	ACT4-062119-3	3	458,800	6/21/2019	317	363	2.0	53	145.4	166.5	0.90	24.30	6/11/2019 22:15	6/21/2019 11:45	9.56	10.12	1.503	1.722	0.010	0.251	1:49 PM	RD	Y	46.5	DONE	32/100 bottle 3	NA	NA	NA	No change, tall grass
ACT4	ACT4-062519-1	1	59,300	6/25/2019	284	181	NA	29	16.8	10.7	NA	1.70	6/21/2019 12:00	6/25/2019 11:45	3.99	10.12	0.417	0.266	NA	0.043	2:04 PM	RD	N	4	54/100 bottle 1	7/100 bottle 3	Water stagnant in manhole with film	NA	No discernable flow, tile outlet too turbid and submerged.	No change
ACT4	ACT4-070319-1	1	39,900	7/3/2019	270	206	2.2	27	10.8	8.2	0.10	1.10	6/25/2019 12:00	7/3/2019 6:15	7.76	10.12	0.137	0.105	0.001	0.014	11:06 AM	CAG	NA	2.2	41/100 bottle 1	6/100 bottle 3	NA	NA	NA	Tall grass, perimeter mowed
ACT4	ACT4-071119-1	1	11,100	7/11/2019	212	125	NA	278	2.4	1.4	NA	3.10	7/3/2019 6:30	7/11/2019 8:00	8.06	10.12	0.029	0.017	NA	0.038	2:17 PM	RD	N	0	10/100 bottle 1	2/100 bottle 3	Not enough volume for splitter; sample direct from carboy	NA	Not enough volume for splitter; sampled direct from carboy	Freshly cut
ACT4	ACT4-071819-1	1	8,100	7/18/2019	320	152	1.4	59	2.6	1.2	0.00	0.50	7/11/2019 8:15	7/18/2019 8:00	6.99	10.12	0.037	0.017	0.000	0.007	11:25 AM	RD	N	0.3	9/100 bottle 1	2/100 bottle 3	Partial TSS sample	NA	No visible flow. Not enough volume for splitter; sampled direct from carboy	Cut last week. Tractor with dragline parked on field.
ACT4	ACT4-072419-1	1	7,000	7/24/2019	379	170	NA	56	2.7	1.2	NA	0.40	7/18/2019 8:15	7/24/2019 6:30	5.93	10.12	0.044	0.020	NA	0.007	11:29 AM	RD	N	0.0-1.0	13/100 bottle 1	3/100 bottle 3	NA	NA	Not flowing, so did not take grab.	6" grass
ACT4	ACT4-080119-1	1	9,500	8/1/2019	610	165	2.0	36	5.8	1.6	0.00	0.30	7/24/2019 6:45	8/1/2019 13:00	8.26	10.12	0.069	0.019	0.000	0.004	2:42 PM	RD	N	0.0-0.3	25/100 bottle 1	4/100 bottle 3	NA	NA	NA	Other half of field cut
ACT4	ACT4-080819-1+2	1+2	46,100	8/8/2019	1020	673	NA	57	47.0	31.0	NA	2.60	8/1/2019 13:15	8/8/2019 11:15	6.92	10.12	0.672	0.443	NA	0.038	11:21 AM	RD	Y	16.2-17.1	16/100 bottle 2	13/100 bottle 3	NA	NA	Water highly stained	No change
ACT4	ACT4-081319-1	1	10,400	8/13/2019	396	279	3.8	19	4.1	2.9	0.00	0.20	8/8/2019 11:30	8/13/2019 9:30	4.92	10.12	0.083	0.058	0.001	0.004	10:28 AM	CAG	N	0.1-0.0	27/100 bottle 1	4/100 bottle 3	NA	NA	Brought carboy home and put in sample bottles @11:15am	NA
ACT4	ACT4-081919-3	3	54,600	8/19/2019	515	376	NA	38	28.1	20.5	NA	2.10	8/13/2019 9:45	8/19/2019 11:00	6.05	10.12	0.459	0.335	NA	0.034	1:07 PM	RD	N	1.0-2.4	38/100 bottle 2	15/100 bottle 3	NA	NA	No visible flow	No change
ACT4	ACT4-082619-3	3	52,000	8/26/2019	316	128	2.2	24	16.4	6.6	0.10	1.30	8/19/2019 11:15	8/25/2019 17:00	6.24	10.12	0.260	0.105	0.002	0.020	2:43 PM	RD	N	0.5-1.2	DONE	74/100 bottle 3	NA	Flow estmated 8/22/19 due to flowmeter malfunction	No visible flow	No change
ACT4	ACT4-090419-1	1	14,800	9/4/2019	444	142	NA	NA	6.6	2.1	NA	NA	8/25/2019 17:15	9/4/2019 9:45	9.69	10.12	0.067	0.021	NA	NA	11:20 AM	CAG	N	0.6	35/100 bottle 1	5/100 bottle 3	NA	NA	NA	Green grass
ACT4	ACT4-091119-1	1	10,100	9/11/2019	305	156	1.7	19	3.1	1.6	0.00	0.20	9/4/2019 10:00	9/11/2019 11:30	7.06	10.12	0.043	0.022	0.000	0.003	11:50 AM	CAG	N	1.9	27/100 bottle 1	4/100 bottle 3	NA	NA	NA	NA
ACT4	ACT4-091819-1	1	10,700	9/18/2019	295	89	NA	18	3.2	0.9	NA	0.20	9/11/2019 11:45	9/18/2019 16:15	7.19	10.12	0.043	0.013	NA	0.003	4:22 PM	CAG	N	0.1	28/100 bottle 1	4/100 bottle 3	NA	NA	NA	Short grass - recently mowed
ACT4	ACT4-093019-NS	NS	4,800	9/30/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/18/2019 16:30	9/30/2019 18:45	NA	10.12	NA	NA	NA	NA	1:30 PM	CAG	NA	NA	NA	NA	Flowmeter malfunction. Non-representative samples dumped. Flowmeter replaced 9/30/2019	Flowmeter noise zeroed--No flow at ACT5 during period	Flowmeter replaced 9/30/2019	NA
ACT4	ACT4-100319-1	1	3,000	10/3/2019	478	176	NA	19	1.4	0.5	NA	0.10	9/30/2019 19:00	10/3/2019 13:15	2.76	10.12	0.051	0.019	NA	0.002	1:30 PM	CAG	N	0.2	7/100 bottle 1	2/100 bottle 3	NA	NA	Tile outlet half submerged, appears still. Standing water inside manhole	Green grass - recently mowed?
ACT4	ACT4-100819-3	3	129,000	10/8/2019	520	342	3.3	42	67.1	44.1	0.40	5.40	10/3/2019 13:30	10/8/2019 5:00	4.65	10.12	1.427	0.939	0.009	0.115	12:30 PM	CAG	Y	2.5	DONE	27/100 bottle 3	NA	NA	Outlet mostly submerged, but could see some flow out of tile.	Short grass
ACT4	ACT4-101619-1	1	10,500	10/16/2019	199	93	NA	34	2.1	1.0	NA	0.40	10/8/2019 5:15	10/16/2019 16:00	8.45	10.12	0.024	0.011	NA	0.004	5:30 PM	CAG	NA	0.1	21/100 bottle 1	3/100 bottle 3	NA	NA	Tile outlet partially submerged	Short grass
ACT4	ACT4-102119-3/4	3/4	556,300	10/21/2019	490	356	2.8	36	272.7	198.1	1.50	19.90	10/16/2019 16:15	10/20/2019 13:00	3.86	10.12	6.975	5.066	0.040	0.508	11:30 AM	CAG	NA	1.1	2/100 bottle 1	14/100 bottle 4	NA	NA	Outlet submerged. Carboys 3 and 4 both sampled separately. Adjusted pacing.	Short grass
ACT4	ACT4-102919-1+2	1+2	211,700	10/29/2019	585	304	NA	22	123.8	64.4	NA	4.70	10/20/2019 13:15	10/29/2019 15:30	9.09	10.12	1.346	0.700	NA	0.051	4:50 PM	CAG	N	10.5	6/100 bottle 2	DONE	NA	NA	Submerged - no visible flow. Part B program was incorrect - changed from 1 to 100 samples per bottle.	Grass
ACT4	ACT4-110419-3	3	842,900	11/4/2019	436	248	2.5	41	367.5	209.0	2.10	34.90	10/29/2019 15:45	11/4/2019 7:00	5.64	10.12	6.446	3.666	0.038	0.612	2:30 PM	CAG	N	3.4	DONE	30/100 bottle 3	NA	NA	Outlet partially submerged. No visible flow.	Grass
ACT4	ACT4-111219-1	1	20,700	11/12/2019	388	260	NA	75	8.0	5.4	NA	1.50	11/4/2019 7:15	11/12/2019 17:15	8.42	10.12	0.094	0.063	NA	0.018	NA	CAG	NA	0.1	6/100 bottle 1	2/100 bottle 3	Insufficient sample volume due to frozen line.	NA	Took carboy 1 home to thaw, rinsed #3, no spare carboy for next time, rest station off.	NA
ACT4	ACT4-112019-G	G	70,500	11/20/2019	657	358	3.0	37	46.3	25.2	0.21	2.61	11/12/2019 17:30	11/20/2019 13:30	NA	10.12	NA	NA	NA	NA	NA	CAG	NA	30.3	NA	NA	Sampler off due to cold temperatures. Submerged	NA	NA	NA
ACT4	ACT4-112319-3	3	271,700	11/23/2019	550	280	NA	25	149.4	76.1	NA	6.70	11/20/2019 13:45	11/23/2019 14:15	3.02	10.12	4.890	2.489	NA	0.218	3:04 PM	CAG	NA	18.5	37/100 bottle 2	15/100 bottle 3	Sample not flow proportional due to autosampler malfunction	Accepted. Compares well with grab	Submerged	NA
ACT4	ACT4-112319-G	G	271,700	11/23/2019	464	192	NA	12	126.1	52.2	NA	3.35	11/20/2019 13:45	11/23/2019 14:15	NA	10.12	NA	NA	NA	NA	NA	CAG	NA	NA	NA	NA	NA	NA	NA	NA

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
ACT4	ACT4-120419-1	1	212,500	12/2/2019	480	182	2.5	65	102.0	38.7	0.50	13.80	11/23/2019 14:30	12/1/2019 23:45	8.39	10.12	1.202	0.456	0.006	0.163	2:55 PM	CAG	NA	2.6	73/100 bottle 1	9/100 bottle 3	Last 5 squirts out of 73 are dry--sample not fully flow-proportional. Thawed sample processed next day.	Accept	Ice in both lines. Carboy frozen solid.	Snow covered
ACT5	ACT5-012419-G	G	-	1/24/2018	33	19	5.7	10	0.0	0.0	0.00	0.00	1/16/2019 11:30	1/24/2018 12:00	NA	6.07	NA	NA	NA	NA	NA	NA	Y	5.8	NA	NA	NA	NA	Outlet is buried. Replaced ISCO temporarily to fix internal battery	NA
ACT5	ACT5-112918-G	G	3,900	11/29/2018	135	71	32.9	13	0.5	0.3	0.13	0.05	11/29/2018 18:00	11/29/2018 18:15	NA	6.07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT5	ACT5-120318-G	G	978,600	12/3/2018	201	94	NA	57	196.7	92.1	NA	55.78	11/29/2018 18:30	12/3/2018 10:45	NA	6.07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT5	ACT5-121418-G	G	399,400	12/14/2018	26	21	8.4	2	10.5	8.4	3.35	0.80	12/3/2018 11:00	12/14/2018 12:30	NA	6.07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT5	ACT5-121718-G	G	11,800	12/17/2018	21	21	NA	2	0.3	0.2	NA	0.02	12/14/2018 12:45	12/17/2018 13:15	NA	6.07	NA	NA	NA	NA	NA	NA	Y	3.1	NA	NA	NA	NA	NA	NA
ACT5	ACT5-122218-G	G	904,900	12/22/2018	173	82	22.5	49	156.5	73.8	20.39	44.34	12/17/2018 13:30	12/22/2018 18:15	NA	6.07	NA	NA	NA	NA	NA	NA	Y	107.9	NA	NA	NA	NA	NA	NA
ACT5	ACT5-010319-G	G	512,900	1/3/2019	29	21	NA	2	15.1	11.0	NA	1.03	12/22/2018 18:30	1/3/2019 11:15	NA	6.07	NA	NA	NA	NA	NA	NA	Y	12.6	NA	NA	NA	NA	NA	Snow on cut corn, ice underneath. Cannot see any manure.
ACT5	ACT5-010919-G	G	58,300	1/9/2019	20	17	6.5	2	1.2	1.0	0.38	0.12	1/3/2019 11:30	1/9/2019 12:15	NA	6.07	NA	NA	NA	NA	NA	DCB	Y	5.6	NA	NA	NA	NA	Visible flow	NA
ACT5	ACT5-011619-G	G	28,600	1/16/2019	20	17	NA	2	0.6	0.5	NA	0.06	1/9/2019 12:30	1/16/2019 11:15	NA	6.07	NA	NA	NA	NA	NA	NA	Y	2.6	NA	NA	NA	NA	Outlet flowing	NA
ACT5	ACT5-020819-G	G	NA	2/8/2019	22	17	5.3	21	NA	NA	NA	NA	1/24/2018 12:15	2/8/2019 11:45	NA	6.07	NA	NA	NA	NA	NA	NA	Y	2	NA	NA	NA	NA	Ditch and bottom of hill has lots of water.	Ice, patchy snow
ACT5	ACT5-022119-G	G	20,400	2/21/2019	19	16	4.3	23	0.4	0.3	0.09	0.48	2/8/2019 12:00	2/21/2019 10:45	NA	6.07	NA	NA	NA	NA	NA	NA	Y	2	NA	NA	NA	NA	Outlet trickling	NA
ACT5	ACT5-030419-G	G	12,800	3/4/2019	15	16	4.2	32	0.2	0.2	0.05	0.40	2/21/2019 11:00	3/4/2019 18:15	NA	6.07	NA	NA	NA	NA	NA	NA	Y	1.2	NA	NA	NA	NA	Visible flow	NA
ACT5	ACT5-031519-G	G	10,500	3/15/2019	53	30	6.5	8	0.6	0.3	0.07	0.08	3/4/2019 18:30	3/15/2019 14:45	NA	6.07	NA	NA	NA	NA	NA	NA	Y	2.5	NA	NA	NA	NA	Outlet flowing but not as much as surface runoff. Ditch is flooded. Sample water was clear.	Field muddy, patchy ice
ACT5	ACT5-032319-G	G	291,900	3/23/2019	180	82	13.0	37	52.5	23.9	3.78	10.80	3/15/2019 15:00	3/23/2019 8:45	NA	6.07	NA	NA	NA	NA	NA	NA	Y	33	NA	NA	NA	NA	Visible flow. Bad erosion around manhole	NA
ACT5	ACT5-040119-G	G	330,600	4/1/2019	24	50	NA	2	7.9	16.5	NA	0.66	3/23/2019 9:00	4/1/2019 10:30	NA	6.07	NA	NA	NA	NA	NA	SM	Y	28.7	NA	NA	NA	NA	Outlet flowing, just a trickle of flow in ditch. Inside manhole looks good. Removed back.	Field bare
ACT5	ACT5-040519-NS	NS	105,800	4/5/2019	NA	NA	NA	NA	NA	NA	NA	NA	4/1/2019 10:45	4/5/2019 14:15	NA	6.07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACT5	ACT5-041019-1	1	384,000	4/10/2019	93	33	NA	9	35.7	12.7	NA	3.40	4/5/2019 14:30	4/10/2019 13:30	4.96	6.07	1.187	0.421	NA	0.112	2:30 PM	CAG	Y	55.4	21/100 bottle 1	8/100 bottle 3	NA	NA	Clear water	Corn stubble
ACT5	ACT5-041719-1	1	546,900	4/17/2019	74	27	NA	38	40.5	14.8	NA	20.70	4/10/2019 13:45	4/17/2019 13:45	7.00	6.07	0.952	0.348	NA	0.487	4:05 PM	CAG	Y	21.3	38/100 bottle 1	11/100 bottle 3	NA	NA	NA	Bare
ACT5	ACT5-042419-1	1	1,038,900	4/24/2019	114	20	36.2	85	118.4	20.8	37.60	88.00	4/17/2019 14:00	4/24/2019 13:30	6.98	6.07	2.796	0.490	0.888	2.076	2:20 PM	CAG	Y	15.6	71/100 bottle 1	19/100 bottle 3	NA	NA	NA	Corn stubble, small amount of green grass
ACT5	ACT5-043019-1	1	540,700	4/30/2019	80	22	NA	49	43.3	11.9	NA	26.30	4/24/2019 13:45	4/30/2019 14:15	6.02	6.07	1.184	0.326	NA	0.719	4:30 PM	CAG	Y	16.2	45/100 bottle 1	11/100 bottle 3	NA	NA	NA	Corn stubble
ACT5	ACT5-050719-1	1	346,900	5/7/2019	102	17	23.9	12	35.4	5.9	8.30	4.20	4/30/2019 14:30	5/7/2019 6:30	6.67	6.07	0.874	0.146	0.204	0.103	9:48 AM	SM	Y	14.5	33/100 bottle 1	8/100 bottle 3	NA	NA	NA	No activity
ACT5	ACT5-051519-1	1	456,200	5/15/2019	62	18	NA	36	28.3	8.2	NA	16.40	5/7/2019 6:45	5/15/2019 12:30	8.24	6.07	0.566	0.164	NA	0.328	1:55 PM	CAG	Y	37	47/100 bottle 1	11/100 bottle 3	NA	NA	NA	Green grass, corn stubble
ACT5	ACT5-052219-1	1	371,600	5/22/2019	96	18	20.1	91	35.7	6.7	7.50	33.70	5/15/2019 12:45	5/22/2019 11:00	6.93	6.07	0.848	0.159	0.178	0.803	2:15 PM	CAG	Y	14.9	45/100 bottle 1	11/100 bottle 3	NA	NA	NA	Green grass, corn stubble
ACT5	ACT5-053119-1	1	557,000	5/31/2019	123	20	NA	105	68.5	11.1	NA	58.40	5/22/2019 11:15	5/31/2019 10:00	8.95	6.07	1.261	0.205	NA	1.075	11:31 AM	RD	Y	13.3	67/100 bottle 1	15/100 bottle 3	NA	NA	Turbid	Grass - not disced
ACT5	ACT5-060619-1	1	240,400	6/6/2019	184	27	10.9	145	44.2	6.5	2.60	34.70	5/31/2019 10:15	6/6/2019 13:45	6.15	6.07	1.186	0.174	0.070	0.931	1:44 PM	RD	Y	81.4	30/100 bottle 1	7/100 bottle 3	NA	NA	NA	No change
ACT5	ACT5-061219-1	1	110,800	6/12/2019	33	10	NA	43	3.7	1.1	NA	4.70	6/6/2019 14:00	6/12/2019 7:30	5.73	6.07	0.105	0.032	NA	0.136	12:37 PM	RD	Y	4.4	26/100 bottle 1	5/100 bottle 3	NA	NA	NA	No change
ACT5	ACT5-062119-3	3	1,198,699	6/21/2019	316	34	15.2	249	378.8	40.8	18.20	298.50	6/12/2019 7:45	6/21/2019 13:30	9.24	6.07	6.754	0.727	0.325	5.322	2:42 PM	RD	Y	68.5	DONE	36/100 bottle 3	NA	NA	NA	Cut and tilled
ACT5	ACT5-062519-1	1	106,900	6/25/2019	60	16	NA	30	6.4	1.7	NA	3.20	6/21/2019 13:45	6/25/2019 9:15	3.81	6.07	0.277	0.074	NA	0.137	3:23 PM	RD	Y	157.3	43/100 bottle 1	6/100 bottle 3	NA	NA	NA	No change
ACT5	ACT5-070319-1+2	1+2	484,200	7/3/2019	96	32	20.4	70	46.5	15.5	9.90	33.80	6/25/2019 9:30	7/3/2019 8:45	7.97	6.07	0.961	0.320	0.204	0.699	10:17 AM	CAG	Y	11.8	54/100 bottle 2	18/100 bottle 3	NA	NA	NA	NA
ACT5	ACT5-071119-1	1	182,400	7/11/2019	66	14	NA	240	12.0	2.6	NA	43.80	7/3/2019 9:00	7/11/2019 12:00	8.13	6.07	0.244	0.052	NA	0.888	3:09 PM	RD	Y	6.1	62/100 bottle 1	9/100 bottle 3	NA	NA	NA	1' corn
ACT5	ACT5-071819-1	1	36,200	7/18/2019	161	20	11.2	83	5.8	0.7	0.40	3.00	7/11/2019 12:15	7/18/2019 9:45	6.90	6.07	0.139	0.017	0.010	0.072	10:24 AM	RD	Y	1.8	12/100 bottle 1	3/100 bottle 3	Not enough volume for splitter; sampled directly from carboy. TSS under volume	NA	NA	2-3' corn
ACT5	ACT5-072419-1	1	17,300	7/24/2019	108	13	NA	75	1.9	0.2	NA	1.30	7/18/2019 10:00	7/24/2019 8:30	5.94	6.07	0.052	0.006	NA	0.036	10:42 AM	RD	Y	1.4-2.0	12/100 bottle 1	3/100 bottle 3	Not enough volume for splitter; sampled directly from carboy	NA	NA	3' corn
ACT5	ACT5-080119-1	1	11,500	8/1/2019	25	12	25.1	120	0.3	0.1	0.30	1.40	7/24/2019 8:45	8/1/2019 3:00	7.76	6.07	0.006	0.003	0.006	0.029	3:22 PM	RD	Y	0.6-(-0.3)	11/100 bottle 1	2/100 bottle 3	NA	NA	Tile outlet trickling	5-6' corn
ACT5	ACT5-080819-1	1	40,700	8/8/2019	126	16	NA	138	5.1	0.7	NA	5.60	8/1/2019 3:15	8/8/2019 10:30	7.30	6.07	0.116	0.015	NA	0.126	10:42 AM	RD	Y	24.0-26.0	42/100 bottle 1	6/100 bottle 3	NA	NA	NA	3-6' corn
ACT5	ACT5-081319-1	1	26,300	8/13/2019	21	13	13.5	18	0.6	0.3	0.40	0.50	8/8/2019 10:45	8/13/2019 8:45	4.92	6.07	0.019	0.012	0.012	0.016	9:40 AM	CAG	N	0.9	66/100 bottle 1	8/100 bottle 3	NA	NA	Working in field above - see pic from road	Tall corn
ACT5	ACT5-081919-1	1	39,300	8/19/2019	96	15	NA	86	3.8	0.6	NA	3.40	8/13/2019 9:00	8/19/2019 10:00	6.04	6.07	0.102	0.016	NA	0.093	12:00 PM	RD	Y	0.8-1.7	58/100 bottle 1	7/100 bottle 3	NA	NA	NA	6-8' corn
ACT5	ACT5-082619-1	1	3,200	8/26/2019	22	9	8.1	105	0.1	0.0	0.00	0.30	8/19/2019 10:15	8/24/2019 20:00	5.41	6.07	0.002	0.001	0.001	0.010	3:52 PM	RD	N	0	6/100 bottle 1	2/100 bottle 3	TSS sample under volume	NA	NA	6-10' corn
ACT5	ACT5-090419-NS	NS	-	9/4/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/24/2019 20:15	9/4/2019 12:00	NA	6.07	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry. Can flow be zeroed?	Totally dry inside manhole	NA
ACT5	ACT5-091119-NS	NS	-	9/11/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/4/2019 12:15	9/11/2019 12:00	NA	6.07	NA	NA	NA	NA	11:30 AM	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry. Can flow be zeroed?	Dry	NA
ACT5	ACT5-091819-NS	NS	-	9/18/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/11/2019 12:15	9/18/2019 12:00	NA	6.07	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry. Can flow be zeroed?	Outlet is dry	NA
ACT5	ACT5-092419-NS	NS	-	9/24/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/18/2019 12:15	9/24/2019 12:00	NA	6.07	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry. Can flow be zeroed?	NA	NA
ACT5	ACT5-100319-NS	NS	-	10/3/2019	NA	NA	NA	NA	NA	NA	NA	NA	9/24/2019 12:15	10/3/2019 12:00	NA	6.07	NA	NA	NA	NA	NA	CAG	N	NA	NA	NA	Insufficient volume for sample	Dry or nearly dry. Can flow be zeroed?	NA	NA
ACT5	ACT5-100819-1	1	22,500	10/8/2019	107	22	6.4	60	2.4	0.5	0.10	1.40	10/3/2019 12:15	10/8/2019 8:45	4.85	6.07	0.082	0.017	0.005	0.046	11:20 AM	CAG	Y	0.2	34/100 bottle 1	5/100 bottle 3	NA	NA	White flakes in sample water source? Mold on tubing in bottle.	Corn yellowish, dried out
ACT5	ACT5-101619-NS	NS	1,800	10/16/2019	NA	NA	NA	NA	NA	NA	NA	NA	10/8/2019 9:00	10/16/2019 17:00	NA	6.07	NA	NA	NA	NA	5:00 PM	CAG	N	0	4/100 bottle 1	Program frozen	NA	Program malfunction resulted in no sample.	Part B program frozen. Unplugged and restarted.	Corn has been chopped
ACT5	ACT5-102119-3	3	1,153,401	10/21/2019	198	33	23.7	133	228.4	38.1	27.30	153.20	10/16/2019 17:15	10/21/2019 9:30	4.68	6.07	8.044	1.341	0.962	5.395	10:25 AM	CAG	Y	3.2	14/100 bottle 1	12/100 bottle 3	NA	NA	NA	Corn stubble, bare ground
ACT5	ACT5-102919-1+2	1+2	472,400	10/29/2019	193	18	NA	157	91.2	8.5	NA	74.20	10/21/2019 9:45	10/29/2019 16:45	8.29	6.07	1.811	0.169	NA	1.474	5:20 PM	CAG	Y	19.3	20/100 bottle 2	13/100 bottle 3	NA	NA	NA	Corn stubble, bare ground
ACT5	ACT5-110419-3	3	1,318,100	11/4/2019	600	56	11.3	1088	790.9	73.8	14.80	1434.10	10/29/2019 17:00	11/4/2019 13:45	5.86	6.07	22.215	2.073	0.417	40.284	1:00 PM	CAG	Y	9.3	66/100 bottle 2	23/100 bottle 3	NA	NA	NA	Corn stubble
ACT5	ACT5-111219-1	1	49,800	11/12/2019	53	12	NA	53	2.6	0.6	NA	2.60	11/4/2019 14:00	11/12/2019 7:30	7.73	6.07	0.056	0.013	NA	0.056	4:52 PM	CAG	Y	2.8	14/100 bottle 1	3/100 bottle 3	Thawed sample processed next day	NA	Took carboy 1 home to thaw, rinsed #3 in field.	Snow
ACT5	ACT5-112019-G	G	128,600	11/20/2019	52	21	13.4	4	6.7	2.6	1.72	0.54	11/12/2019 7:45	11/20/2019 12:00	NA	6.07	NA	NA	NA	NA	NA	CAG	Y	48.9	NA	NA	No composite sample due to ice	Grab sample useful for reference	NA	NA
ACT5	ACT5-112319-3	3	577,300	11/23/2019	114	40	NA	39	65.8	23.1	NA	22.30	11/20/2019 12:15	11/23/2019 15:30	3.14	6.07	3.458	1.213	NA	1.171	4:08 PM	CAG	Y	43.5	44/100 bottle 2	16/100 bottle 3	NA	NA	NA	Bare
ACT5	ACT5-120419-1	1	429,100	12/2/2019	184	13	11.9	143	79.0	5.6	5.10	61.40	11/23/2019 15:45	11/30/2019 16:45	7.04	6.07	1.847	0.131	0.120	1.438	2:30 PM	CAG	Y	11.5	79/100 bottle 1	11/100 bottle 3	Thawed sample processed next day	NA	Carboy frozen solid. Sample line plugged. Errors occurred - no liquid detected (11/30/2019 4:50 pm).	NA
JBT05	JBT5-041718-3	3	3,273,200	4/17/2018	332	193	27.0	NA	0.0	0.0	88.40	NA	4/11/2018 18:55	4/17/2018 9:45	5.62	38.04	0.000	0.000	0.414	NA	9:32 AM	SM	NA	NA	DONE	67/100 bottle 3	NA	NA	NA	Cut corn from last year, field is wet
JBT05	JBT5-042418-1	1	824,000	4/24/2018	374	333	30.9	NA	0.0	0.0	25.50	NA	4/17/2018 10:00	4/18/2018 3:30	0.73	38.04	0.000	0.000	0.919	NA	?	KP	NA	NA	NA	NA	NA	NA	NA	NA
JBT05	JBT5-042418-2+3	2+3	2,740,999	4/24/2018	108	130	25.3	NA	0.0	0.0	69.30	NA	4/18/2018 3:45	4/24/2018 9:00	6.22	38.04	0.000	0.000	0.293	NA	?	KP	NA	NA	DONE	?/100 bottle 3	Mistakenly combined carboys 2 & 3	Mistakenly combined carboys 2+3. Judged this sample to be the best representation available. All in falling limb of big storm.	NA	No tillage, no manure applied yet
JBT05	JBT5-050118-3+4	3+4	5,250,101	5/1/2018	317	193	26.7	NA	0.0	0.0	140.40	NA	4/24/2018 9:15	5/1/2018 9:30	7.01	38.04	0.000	0.000	0.526	NA	9:20 AM	SM	NA	NA	DONE	6/100 bottle 4	NA	NA	NA	No tillage, manure? Observed flies and caked on woody debris with no odor-maybe applied last year?
JBT05	JBT5-050918-3	3	4,293,699	5/9/2018	124	89	NA	NA	0.0	0.0	NA	NA	5/1/2018 9:45	5/9/2018 11:00	8.05	38.04	0.000	0.000	NA	NA	1:00 PM	KP	NA	NA	DONE	92/100 bottle 3	NA	NA	Changed part A pacing to 100	No tillage or manure
JBT05	JBT5-051618-1	1	811,400	5/16/2018	35	33	23.6	NA	0.0	0.0	19.20	NA	5/9/2018 11:15	5/16/2018 7:15	6.83	38.04	0.000	0.000	0.074	NA	8:26 AM	SM	NA	45	81/100 bottle 1	18/100 bottle 3	NA	NA	NA	No tillage or manure
JBT05	JBT5-052318-1	1	395,200	5/23/2018	35	29	NA	NA	0.0	0.0	NA	NA	5/16/2018 7:30	5/23/2018 14:30	7.29	38.04	0.000	0.000	NA	NA	3:22 PM	SM	NA	33.4	41/100 bottle 1	10/100 bottle 3	NA	NA	Outlet submerged, can't tell if flowing	Tilled
JBT05	JBT5-053118-1	1	276,500	5/31/2018	98	35	17.7	NA	0.0	0.0	4.90	NA	5/23/2018 14:45	5/31/2018 6:15	7.65	38.04	0.000	0.000	0.017	NA	7:51 AM	KP	NA	20.5	36/100 bottle 1	?	NA	NA	NA	Tilled and planted to corn. Assume manure was incorporated.
JBT05	JBT5-060718-1	1	208,700	6/7/2018	41	42	NA	NA	0.0	0.0	NA	NA	5/31/2018 6:30	6/7/2018 4:30	6.92	38.04	0.000	0.000	NA	NA	7:40 AM	KP	NA	13.8	31/100 bottle 1	6/100 bottle 3	NA	NA	NA	6" corn, no noticeable activity
JBT05	JBT5-061318-1	1	134,700	6/13/2018	36	18	16.4	NA	0.0	0.0	2.20	NA	6/7/2018 4:45	6/13/2018 15:00	6.43	38.04	0.000	0.000	0.009	NA	2:25 PM	SM	NA	18.1	20/100 bottle 1	4/100 bottle 3	NA	NA	Changed pump tubing, reset counter	4" corn
JBT05	JBT5-062018-1	1	162,300	6/20/2018	53	41	NA	NA	0.0	0.0	NA	NA	6/13/2018 15:15	6/20/2018 7:45	6.69	38.04	0.000	0.000	NA	NA	NA	KP	N	31	25/100 bottle 1	6/100 bottle 3	NA	NA	No visible flow at outlet	12" corn, no visible activity
JBT05	JBT5-062918-1	1	282,100	6/29/2018	31	26	24.0	NA	0.0	0.0	6.80	NA	6/20/2018 8:00	6/29/2018 9:15	9.05	38.04	0.000	0.000	0.020	NA	9:35 AM	KP	Y	16	42/100 bottle 1	10/100 bottle 3	NA	NA	Some flow at end of pipe	2' corn, no activity observed, may have spread N fertilizer on surface
JBT05	JBT5-070618-1	1	115,900	7/6/2018	31	27	NA	NA	0.0	0.0	NA	NA	6/29/2018 9:30	7/6/2018 3:45	6.76	38.04	0.000	0.000	NA	NA	8:17 AM	KP	N	~10	18/100 bottle 1	5/100 bottle 3	NA	NA	No visible flow from outlet	3' corn
JBT05	JBT5-071318-1	1	55,400	7/13/2018	36	28	16.7	NA	0.0	0.0	0.90	NA	7/6/2018 4:00	7/12/2018 15:30	6.48	38.04	0.000	0.000	0.004	NA	7:45 AM	KP	Y	~2.5	9/100 bottle 1	3/100 bottle 3	NA	NA	Water in manhole, minimal flow	4' corn
JBT05	JBT5-072018-1	1	18,000	7/20/2018	44	35	NA	NA	0.0	0.0	NA	NA	7/12/2018 15:45	7/19/2018 18:30	7.11	38.04	0.000	0.000	NA	NA	8:40 AM	KP	Y	1.2	5/100 bottle 1	2/100 bottle 3	NA	NA	Minimal flow at end of pipe	5' corn
JBT05	JBT5-072718-1	1	416,400	7/27/2018	151	105	24.2	NA	0.0	0.0	10.10	NA	7/19/2018 18:45	7/27/2018 6:15	7.48	38.04	0.000	0.000	0.036	NA	9:17 AM	KP	Y	30	Missed	Missed	NA	NA	Water in manhole flowing into outlet pipe	5-6' corn
JBT05	JBT5-080218-1	1	161,300	8/2/2018	78	25	NA	NA	0.0	0.0	NA	NA	7/27/2018 6:30	8/2/2018 4:45	5.93	38.04	0.000	0.000	NA	NA	8:31 AM	KP	?	5	24/100 bottle 1	6/100 bottle 3	NA	NA	Outflow submerged, no visible flow	6-7' corn
JBT05	JBT5-080918-1	1	24,500	8/9/2018	59	22	13.9	NA	0.0	0.0	0.30	NA	8/2/2018 5:00	8/7/2018 4:00	4.96	38.04	0.000	0.000	0.002	NA	9:29 AM	SM	?	32.5	4/100 bottle 1	2/100 bottle 3	Sampler stops 8/4 due to low battery. Small flow uptick on 8/8 is missed. Splitting the difference between last and first squirt.	NA	Submerged, could not discern flow	tall corn
JBT05	JBT5-081618-1	1	86,400	8/16/2018	55	27	NA	NA	0.0	0.0	NA	NA	8/7/2018 4:15	8/15/2018 12:30	8.34	38.04	0.000	0.000	NA	NA	8:30 AM	TAR	?	~1-3	11/100 bottle 1	3/100 bottle 3	Poured directly from carboy (not enough for splitter)	NA	Partially submerged, flow difficult to determine	7' corn
JBT05	JBT5-082218-1	1	4,700	8/22/2018	73	58	NA	NA	0.0	0.0	NA	NA	8/15/2018 12:45	8/22/2018 2:30	6.57	38.04	0.000	0.000	NA	NA	1:30 PM	TAR	Y	NA	4/100 bottle 1	2/100 bottle 3	NA	NA	Little flow, partially submerged	7' corn
JBT05	JBT5-083118-NS	NS	-	8/31/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/22/2018 2:45	8/31/2018 9:30	NA	38.04	NA	NA	NA	NA	9:39 AM	KP	N	NA	4/100 bottle 1	2/100 bottle 3	NA	Some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	No flow. Some standing water in manhole.	8-10' corn
JBT05	JBT5-090718-NS	NS	-	9/7/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/31/2018 9:45	9/7/2018 9:30	NA	38.04	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	NA	Zero flow	Dry	NA
JBT05	JBT5-091218-NS	NS	-	9/12/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/7/2018 9:45	9/12/2018 9:30	NA	38.04	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	Al squirts were dry	Zero flow	No flow at outlet	NA

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT05	JBT5-092018-NS	NS	-	9/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/12/2018 9:45	9/20/2018 9:30	NA	38.04	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	NA	Zero flow	Manhole totally dry	NA
JBT05	JBT5-092718-NS	NS	-	9/27/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/20/2018 9:45	9/27/2018 9:30	NA	38.04	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	Al squirts were dry	Zero flow	Manhole totally dry	NA
JBT05	JBT5-100218-NS	NS	-	10/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/27/2018 9:45	10/2/2018 11:30	NA	38.04	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	NA	Zero flow	Just noise	NA
JBT05	JBT5-100418-1	1	37,800	10/4/2018	226	143	11.9	NA	0.0	0.0	0.50	NA	10/2/2018 11:45	10/4/2018 1:45	1.58	38.04	0.000	0.000	0.008	NA	9:05 AM	KP	N	~4	7/100 bottle 1	3/100 bottle 3	NA	NA	Standing water in manhole. Does not appear to be flowing at outlet.	NA
JBT05	JBT5-101218-1	1	232,400	10/12/2018	81	72	36.3	NA	0.0	0.0	8.40	NA	10/4/2018 2:00	10/12/2018 8:45	8.28	38.04	0.000	0.000	0.027	NA	9:29 AM	KP	Y	~90	36/100 bottle 1	8/100 bottle 3	NA	NA	Outlet flowing	Corn not cut yet
JBT05	JBT5-101918-1	1	116,400	10/19/2018	98	75	2.2	NA	0.0	0.0	0.30	NA	10/12/2018 9:00	10/19/2018 9:15	7.01	38.04	0.000	0.000	0.001	NA	~9:30	KP	Y	NA	NA	NA	NA	NA	Flowing a little bit	NA
JBT05	JBT5-102618-1	1	18,500	10/26/2018	132	111	5.1	NA	0.0	0.0	0.10	NA	10/19/2018 9:30	10/25/2018 20:15	6.45	38.04	0.000	0.000	0.000	NA	9:40 AM	KP	N	~3.1	5/100 bottle 1	2/100 bottle 3	NA	NA	Standing water in manhole. Outlet not flowing.	Remaining corn being cut
JBT05	JBT5-110218-3	3	1,042,029	11/2/2018	67	58	34.5	NA	0.0	0.0	35.90	NA	10/25/2018 20:30	11/2/2018 5:15	7.36	38.04	0.000	0.000	0.128	NA	9:20 AM	KP	Y	NA	NA	NA	Unrepresentative sample. Ends 11/1 23:00 due to power loss but flow continues to rise until visit on 11/2.	Accepted	Flowing. Power losses in program	Corn cut with residue on ground
JBT05	JBT5-110818-1	1	5,737,343	11/8/2018	85	66	40.8	NA	0.0	0.0	233.90	NA	11/2/2018 5:30	11/8/2018 7:45	6.09	38.04	0.000	0.000	1.009	NA	10:22 AM	SM	Y	276	21/100 bottle 1	15/100 bottle 3	Unrepresentative sample. Is interrupted by power failure and then stops sampling for an extended period due to low battery.	Accepted	Flowing	Corn cut
JBT05	JBT5-112618-1	1	3,832,099	11/16/2018	77	42	NA	NA	0.0	0.0	NA	NA	11/8/2018 8:00	11/16/2018 12:00	8.17	38.04	0.000	0.000	NA	NA	NA	KP	NA	NA	60/100 bottle 1	36/100 bottle 3	Last 6 squirts of 59 were missed due to distributor arm jam. Picked up 11/20 (frozen). Thawed and sampled 11/26. DB not concerned about freeze thaw.	Accepted	NA	NA
JBT05	JBT5-112718-G	G	-	11/27/2018	221	120	30.3	NA	0.0	0.0	0.00	NA	11/16/2018 12:15	11/27/2018 9:45	NA	38.04	NA	NA	NA	NA	9:50 AM	KP	NA	NA	NA	NA	NA	Ditch flooded, manhole almost full, no freezing	Emptied carboys 1 and 3 and replaced. Ditch flooded, manhole almost full, no freezing.	NA
JBT05	JBT5-120318-G	G	-	12/2/2018	249	142	NA	13	0.0	0.0	NA	0.00	11/27/2018 10:00	12/2/2018 11:00	NA	38.04	NA	NA	NA	NA	10:55 AM	KP	NA	700	NA	NA	NA	NA	Manhole and ditch are full	Field has no snow on it
JBT05	JBT5-121018-G	G	-	12/10/2018	30	31	26.4	2	0.0	0.0	0.00	0.00	12/2/2018 11:15	12/10/2018 18:00	NA	38.04	NA	NA	NA	NA	6:00 PM	SM	NA	NA	NA	NA	NA	NA	NA	NA
JBT05	JBT5-122118-G	G	-	12/21/2018	392	188	NA	56	0.0	0.0	NA	0.00	12/10/2018 18:15	12/21/2018 12:45	NA	38.04	NA	NA	NA	NA	12:50 PM	KP	NA	625	NA	NA	NA	NA	Ditch and culvert nearly full of water	No snow or manure on field
JBT05	JBT5-122918-G	G	-	12/29/2018	191	127	21.9	18	0.0	0.0	0.00	0.00	12/21/2018 13:00	12/29/2018 12:30	NA	38.04	NA	NA	NA	NA	12:35 PM	KP	NA	526	NA	NA	NA	NA	Ditch full of water	No snow on field
JBT05	JBT5-011019-G	G	-	1/10/2019	33	27	19.1	32	0.0	0.0	0.00	0.00	12/29/2018 12:45	1/10/2019 11:00	NA	38.04	NA	NA	NA	NA	11:08 AM	SM	NA	63.4	NA	NA	NA	NA	Outlet is submerged	NA
JBT05	JBT5-011719-G	G	-	1/17/2019	46	34	NA	4	0.0	0.0	NA	0.00	1/10/2019 11:15	1/17/2019 12:00	NA	38.04	NA	NA	NA	NA	NA	KP	NA	30	NA	NA	NA	NA	Restarting modem at JBT18!	Field with light snow cover
JBT05	JBT5-012219-G	G	-	1/22/2019	40	30	14.9	5	0.0	0.0	0.00	0.00	1/17/2019 12:15	1/22/2019 12:00	NA	38.04	NA	NA	NA	NA	12:05 PM	KP	NA	12	NA	NA	NA	NA	Some ice in manhole	Snow covered field. Snow in field ~1 ft
JBT05	JBT5-012419-G	G	-	1/24/2019	180	142	10.9	19	0.0	0.0	0.00	0.00	1/22/2019 12:15	1/24/2019 13:00	NA	38.04	NA	NA	NA	NA	1:00 PM	KP	NA	556	NA	NA	NA	NA	Ditch flooded	Most of snow in field melted
JBT05	JBT5-020819-G	G	-	2/8/2019	163	129	7.2	NA	0.0	0.0	0.00	NA	1/24/2019 13:15	2/8/2019 9:15	NA	38.04	NA	NA	NA	NA	9:20 AM	KP	NA	7000	NA	NA	NA	NA	Water level above culvert inlet. Water 1 ft below top of manhole.	Entire area is flooded
JBT05	JBT5-022219-G	G	-	2/22/2019	45	36	8.1	59	0.0	0.0	0.00	0.00	2/8/2019 9:30	2/22/2019 12:00	NA	38.04	NA	NA	NA	NA	12:05 PM	KP	NA	0.7-2.1	NA	NA	NA	NA	Some loose ice in manhole. After chopping ice in ditch, flow=22.5-40.0 L/min	Snow in field. Ditch partially frozen over.
JBT05	JBT5-030419-G	G	-	3/4/2019	51	36	8.2	39	0.0	0.0	0.00	0.00	2/22/2019 12:15	3/4/2019 14:00	NA	38.04	NA	NA	NA	NA	2:05 PM	KP	NA	7	NA	NA	NA	NA	4-in of water to top of meter. Sampled from manhole	Snow in field and ditch
JBT05	JBT5-031519-G	G	-	3/15/2019	392	338	2.7	14	0.0	0.0	0.00	0.00	3/4/2019 14:15	3/15/2019 9:45	NA	38.04	NA	NA	NA	NA	9:46 AM	KP	NA	~2-20	NA	NA	NA	NA	NA	Area around station flooded. Culvert under road appears plugged.
JBT05	JBT5-032319-G	G	-	3/23/2019	658	476	6.5	21	0.0	0.0	0.00	0.00	3/15/2019 10:00	3/23/2019 14:15	NA	38.04	NA	NA	NA	NA	2:20 PM	KP	NA	NA	NA	NA	NA	Removed bad flowmeter 3/21/19	Ditch partially full of water	Some new snow on field
JBT05	JBT5-033019-G	G	-	3/30/2019	258	202	NA	2	0.0	0.0	NA	0.00	3/23/2019 14:30	3/30/2019 14:00	NA	38.04	NA	NA	NA	NA	2:05 PM	KP	NA	NA	NA	NA	NA	NA	Ditch partially full of water	All snow gone from field
JBT05	JBT5-041219-G	G	-	4/12/2019	100	67	22.8	14	0.0	0.0	0.00	0.00	3/30/2019 14:15	4/12/2019 10:30	NA	38.04	NA	NA	NA	NA	NA	KP	NA	NA	NA	NA	NA	NA	Manhole looks clear and good. No leakage or erosion around manhole.	Field clear of snow and ice, no activity. Ditch partially full.
JBT05	JBT5-041719-1	1	-	4/17/2019	71	55	NA	2	0.0	0.0	NA	0.00	4/12/2019 10:45	4/17/2019 10:45	5.00	38.04	0.000	0.000	NA	0.000	10:46 AM	KP	Y	NA	89/100 bottle 1	36/100 bottle 3	NA	NA	Ditch partially full of water	No activity in field
JBT05	JBT5-042419-1	1	-	4/24/2019	93	69	24.0	5	0.0	0.0	0.00	0.00	4/17/2019 11:00	4/24/2019 9:45	6.95	38.04	0.000	0.000	0.000	0.000	10:12 AM	KP	Y	NA	78/100 bottle 1	28/100 bottle 3	NA	Switched TP and TDP results	Ditch partially full of water	No activity in field
JBT05	JBT5-050319-1	1	-	5/3/2019	74	67	NA	2	0.0	0.0	NA	0.00	4/24/2019 10:00	5/3/2019 10:15	9.01	38.04	0.000	0.000	NA	0.000	11:20 AM	KP	Y	NA	78/100 bottle 1	32/100 bottle 3	NA	NA	NA	No activity in field
JBT05	JBT5-050919-1	1	-	5/9/2019	58	50	23.2	5	0.0	0.0	0.00	0.00	5/3/2019 10:30	5/9/2019 8:15	5.91	38.04	0.000	0.000	0.000	0.000	10:35 AM	KP	Y	NA	50/100 bottle 1	22/100 bottle 3	NA	NA	Ditch partially full of water	No activity in field
JBT05	JBT5-051519-1+2	1+2	-	5/15/2019	228	123	NA	28	0.0	0.0	NA	0.00	5/9/2019 8:30	5/15/2019 12:00	6.15	38.04	0.000	0.000	NA	0.000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT05	JBT5-052219-1	1	-	5/22/2019	114	69	14.5	27	0.0	0.0	0.00	0.00	5/15/2019 12:15	5/22/2019 9:30	6.89	38.04	0.000	0.000	0.000	0.000	9:40 AM	KP	Y	NA	61/100 bottle 1	28/100 bottle 3	NA	NA	Ditch partially full of water	No activity in field
JBT05	JBT5-053019-3	3	-	5/30/2019	443	385	NA	14	0.0	0.0	NA	0.00	5/22/2019 9:45	5/30/2019 10:45	8.04	38.04	0.000	0.000	NA	0.000	11:30 AM	RD	Y	NA	Done	70/100 bottle 3	NA	NA	Tile outlet submerged	No activity in field
JBT05	JBT5-060519-1	1	-	6/5/2019	143	108	22.3	14	0.0	0.0	0.00	0.00	5/30/2019 11:00	6/5/2019 11:45	6.03	38.04	0.000	0.000	0.000	0.000	11:36 AM	RD	Y	NA	80/100 bottle 1	31/100 bottle 3	NA	NA	Tile outlet submerged	No activity in field
JBT05	JBT5-061119-1	1	-	6/11/2019	110	88	NA	5	0.0	0.0	NA	0.00	6/5/2019 12:00	6/11/2019 9:30	5.90	38.04	0.000	0.000	NA	0.000	9:45 AM	RD	Y	NA	70/100 bottle 1	27/100 bottle 3	NA	NA	Fairly clear	No activity in field
JBT05	JBT5-061719-1	1	-	6/17/2019	70	58	24.5	3	0.0	0.0	0.00	0.00	6/11/2019 9:45	6/17/2019 8:15	5.94	38.04	0.000	0.000	0.000	0.000	10:17 AM	RD	Y	NA	64/100 bottle 1	25/100 bottle 3	NA	NA	Tile outlet submerged and barely flowing	No-till corn planted, fresh parallel tractor tracks
JBT05	JBT5-062619-1	1	-	6/26/2019	106	77	NA	12	0.0	0.0	NA	0.00	6/17/2019 8:30	6/26/2019 10:15	9.07	38.04	0.000	0.000	NA	0.000	10:34 AM	RD	Y	NA	68/100 bottle 1	26/100 bottle 3	NA	NA	Tile outlet submerged	3" corn
JBT05	JBT5-070119-1	1	-	7/1/2019	70	52	25.7	6	0.0	0.0	0.00	0.00	6/26/2019 10:30	7/1/2019 9:30	4.96	38.04	0.000	0.000	0.000	0.000	10:08 AM	RD	Y	NA	52/100 bottle 1	22/100 bottle 3	NA	NA	NA	8" corn
JBT05	JBT5-071019-1	1	-	7/10/2019	89	44	NA	27	0.0	0.0	NA	0.00	7/1/2019 9:45	7/10/2019 12:00	9.09	38.04	0.000	0.000	NA	0.000	12:04 PM	RD	Y	NA	52/100 bottle 1	22/100 bottle 3	Squirts 47-52 all dry. Ultrasonic submerged. Adjusted suction intake below water level.	Accepted	Tile outlet barely flowing and submerged in manhole	8" corn
JBT05	JBT5-071719-1	1	-	7/17/2019	85	66	34.7	15	0.0	0.0	0.00	0.00	7/10/2019 12:15	7/17/2019 9:00	6.86	38.04	0.000	0.000	0.000	0.000	12:10 PM	RD	Y	NA	58/100 bottle 1	13/100 bottle 3	NA	NA	NA	3-4" corn
JBT05	JBT5-072219-1	1	-	7/22/2019	33	25	NA	14	0.0	0.0	NA	0.00	7/17/2019 9:15	7/22/2019 11:00	5.07	38.04	0.000	0.000	NA	0.000	11:25 AM	RD	Y	NA	14/100 bottle 1	4/100 bottle 3	NA	NA	Tile outlet trickling	4' corn
JBT05	JBT5-073119-1	1	-	7/31/2019	46	30	20.0	14	0.0	0.0	0.00	0.00	7/22/2019 11:15	7/31/2019 10:15	8.96	38.04	0.000	0.000	0.000	0.000	11:10 AM	RD	Y	NA	30/100 bottle 1	7/100 bottle 3	NA	NA	Manhole wet and flowing	3-6' corn
JBT05	JBT5-080719-1	1	-	8/7/2019	83	49	NA	19	0.0	0.0	NA	0.00	7/31/2019 10:30	8/8/2019 0:15	7.57	38.04	0.000	0.000	NA	0.000	1:29 PM	RD	N	NA	31/100 bottle 1	6/100 bottle 3	NA	NA	RD forgot to turn sampler on, KP turned on at 8/8/19 a little after level rise	6-8' corn
JBT05	JBT5-081519-1	1	-	8/15/2019	89	70	29.9	13	0.0	0.0	0.00	0.00	8/8/2019 0:30	8/15/2019 8:15	7.32	38.04	0.000	0.000	0.000	0.000	10:58 AM	KP	Y	NA	70/100 bottle 1	12/100 bottle 3	NA	NA	NA	7' corn
JBT05	JBT5-082219-1	1	-	8/22/2019	39	21	NA	19	0.0	0.0	NA	0.00	8/15/2019 8:30	8/22/2019 9:45	7.05	38.04	0.000	0.000	NA	0.000	10:39 AM	RD	Y	NA	20/100 bottle 1	4/100 bottle 3	NA	NA	Tile outlet trickling. Manhole looks good, intake is approx. mid-depth of water level	8-10' corn
JBT05	JBT5-082919-1	1	-	8/29/2019	36	23	13.3	17	0.0	0.0	0.00	0.00	8/22/2019 10:00	8/29/2019 11:15	7.05	38.04	0.000	0.000	0.000	0.000	11:10 AM	RD	Y	NA	29/100 bottle 1	5/100 bottle 3	NA	NA	Very slight flow. Tile outlet trickling. Sampler turned off 9/4/19.	6-8' corn
JBT05	JBT-100219-NS	NS	-	10/2/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/29/2019 11:30	10/2/2019 12:00	NA	38.04	NA	NA	NA	NA	NA	DCB	NA	NA	NA	NA	NA	NA	NA	NA
JBT05	JBT5-101019-3	3	-	10/10/2019	143	146	32.7	6	0.0	0.0	0.00	0.00	10/2/2019 12:15	10/10/2019 12:30	8.01	38.04	0.000	0.000	0.000	0.000	NA	KP	Y	193	Done	28/100 bottle 3	NA	NA	NA	Standing corn
JBT05	JBT5-101719-1+2	1+2	-	10/17/2019	163	109	38.6	17	0.0	0.0	0.00	0.00	10/10/2019 12:45	10/17/2019 12:00	6.97	38.04	0.000	0.000	0.000	0.000	NA	DCB	Y	NA	2/100 bottle 2	13/100 bottle 3	NA	NA	Ditch starting to flood	Standing corn
JBT05	JBT5-102419-3	3	-	10/24/2019	122	107	42.0	8	0.0	0.0	0.00	0.00	10/17/2019 12:15	10/24/2019 12:00	6.99	38.04	0.000	0.000	0.000	0.000	NA	KP	NA	NA	NA	NA	NA	NA	NA	NA
JBT06	JBT6-041718-3+4	3+4	11,320,194	4/17/2018	287	158	23.4	NA	3250.0	1788.6	264.33	NA	4/11/2018 18:00	4/17/2018 12:30	5.77	36.83	15.293	8.416	1.244	NA	12:37 PM	SM	NA	NA	Done	30/100 bottle 4	NA	NA	NA	Cut corn from last year, wet and muddy
JBT06	JBT6-042418-3	3	7,861,092	4/24/2018	111	108	25.6	NA	872.6	849.0	201.40	NA	4/17/2018 12:45	4/24/2018 9:45	6.88	36.83	3.446	3.353	0.795	NA	9:50 AM	KP	NA	NA	Done	?/100 bottle 3	NA	NA	Changed part B pulse to 525	No tillage, no manure applied yet
JBT06	JBT6-050118-4	3/4	17,746,172	5/1/2018	255	159	24.5	NA	4531.4	2812.8	434.29	NA	4/24/2018 10:00	5/1/2018 10:00	7.00	36.83	17.578	10.911	1.685	NA	10:09 AM	SM	Y	NA	Done	93/100 bottle 4	NA	NA	Upstream stage: 4 13/16"	Maybe spread (flies, very muddy)
JBT06	JBT6-050918-3+4	3+4	9,962,994	5/9/2018	145	119	NA	NA	1444.6	1185.6	NA	NA	5/1/2018 10:15	5/9/2018 12:15	8.08	36.83	4.853	3.983	NA	NA	12:25 PM	KP	NA	NA	Done	14/100 bottle 4	NA	NA	Changed part a pacing to 200	No tillage or manure
JBT06	JBT6-051618-1	1	822,631	5/16/2018	38	18	25.1	NA	30.8	14.9	20.63	NA	5/9/2018 12:30	5/16/2018 9:15	6.86	36.83	0.122	0.059	0.082	NA	9:15 AM	SM	NA	NA	31/100 bottle 1	13/ 100 bottle 3	NA	NA	NA	No tillage or manure. Dry (mud cracks)
JBT06	JBT6-052318-1	1	176,055	5/23/2018	65	23	NA	NA	11.5	4.1	NA	NA	5/16/2018 9:30	5/23/2018 14:15	7.20	36.83	0.043	0.016	NA	NA	2:18 PM	SM	NA	NA	12/100 bottle 1	4/100 bottle 3	NA	NA	Bolt in the way of measurement, not as accurate	Tilled
JBT06	JBT6-053118-NS	1	23,182	5/31/2018	NA	NA	NA	NA	NA	NA	NA	NA	5/23/2018 14:30	5/31/2018 8:45	7.76	36.83	NA	NA	NA	NA	8:55 AM	KP	NA	NA	4/100 bottle 1	NA	TP collected only due to low volume (<100 mL)	NA	NA	Tilled and planted to corn. Assume manure was incorporated.
JBT06	JBT6-060718-NS	NS	3,249	6/7/2018	NA	NA	NA	NA	NA	NA	NA	NA	5/31/2018 9:00	6/7/2018 8:15	NA	36.83	NA	NA	NA	NA	8:15 AM	KP	NA	NA	2/100 bottle 1	2/100 bottle 3	Insufficient volume for sample	NA	NA	6" corn, no recent activity
JBT06	JBT6-061318-NS	NS	-	6/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/7/2018 8:30	6/13/2018 13:30	NA	36.83	NA	NA	NA	NA	1:30 PM	SM	Y	NA	2/100 bottle 1	2/100 bottle 3	Insufficient volume for sample	NA	Water below v-notch but outlet flowing, indicating leak. Patching did not seem to reduce leak, no obvious place of seepage.	4" corn
JBT06	JBT6-062018-NS	NS	-	6/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/13/2018 13:45	6/20/2018 9:00	NA	36.83	NA	NA	NA	NA	9:12 AM	KP	Y	NA	2/100 bottle 1	2/100 bottle 3	Insufficient volume for sample	NA	Measured leak on 6/20/18. Minimal outflow and water below v-notch. Leak repaired with plumber's putty. Water above v-notch measured. By 6/22/18 water once again below v notch.	12" corn, no visible activity, N fertilizer applied later in day.
JBT06	JBT6-062918-NS	NS	436	6/29/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/20/2018 9:15	6/29/2018 12:00	NA	36.83	NA	NA	NA	NA	?	KP	Y	NA	2/100 bottle 1	2/100 bottle 3	Insufficient volume for sample	NA	No flow over weir, flow out end of pipe (still leaking).	NA
JBT06	JBT6-070618-NS	NS	-	7/6/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/29/2018 12:15	7/6/2028 8:45	NA	36.83	NA	NA	NA	NA	8:48 AM	KP	Y	NA	2/100 bottle 1	2/100 bottle 3	No water in carboys	NA	No flow over weir, small amount of flow at end of pipe	2-3' corn
JBT06	JBT6-071318-NS	NS	-	7/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/6/2028 9:00	7/13/2018 8:15	NA	36.83	NA	NA	NA	NA	8:15 AM	KP	N	NA	2/100 bottle 1	2/100 bottle 3	Insufficient volume for sample	NA	Weir box almost dry. No flow out of pipes. Carboys dry	3' corn, cracks developing in soil
JBT06	JBT6-072018-NS	NS	-	7/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/13/2018 8:30	7/20/2018 9:00	NA	36.83	NA	NA	NA	NA	9:10 AM	KP	N	NA	3/100 bottle 1	1/100 bottle 3	NA	NA	Weir box completely dry	5' corn
JBT06	JBT6-072718-3	3	891,067	7/27/2018	170	124	23.4	NA	151.0	110.5	20.88	NA	7/20/2018 9:15	7/27/2018 10:00	7.03	36.83	0.583	0.427	0.081	NA	10:07 AM	KP	Y	NA	77/100 bottle 2	15/100 bottle 3	NA	NA	Flow over weir	4-5' corn
JBT06	JBT6-080218-NS	NS	2,433	8/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/27/2018 10:15	8/2/2018 8:45	NA	36.83	NA	NA	NA	NA	8:59 AM	KP	N	NA	2/100 bottle 1	2/100 bottle 3	NA	NA	Weir box almost dry	6-7' corn
JBT06	JBT6-080918-1	1	52,955	8/9/2018	287	102	16.3	NA	15.2	5.4	0.87	NA	8/2/2018 9:00	8/9/2018 10:00	7.04	36.83	0.059	0.021	0.003	NA	10:11 AM	SM	Y	depth 11 3/16", v=2ft/7s	13/100 bottle 1	2/100 bottle 3	NA	NA	Flow not measurable, small sheet over v-notch	Tall corn
JBT06	JBT6-083118-NS	NS	107	8/31/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/9/2018 10:15	8/31/2018 9:45	NA	36.83	NA	NA	NA	NA	9:52 AM	KP	N	NA	2/100 bottle 1	2/100 bottle 3	NA	NA	Weir box dry	8-10' corn
JBT06	JBT6-092518-NS	NS	-	9/25/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/31/2018 10:00	9/25/2018 12:00	NA	36.83	NA	NA	NA	NA	NA	KP	NA	NA	NA	NA	NA	NA	NA	Corn being cut

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT06	JBT6-100218-NS	NS	3,549	10/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/25/2018 12:15	10/2/2018 11:45	NA	36.83	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	NA	Restarted sampler remotely 10/2/18 12:06 PM, standing water	NA
JBT06	JBT6-100418-1	1	79,414	10/4/2018	484	108	28.7	NA	38.4	8.6	2.28	NA	10/2/2018 12:00	10/4/2018 9:30	1.90	36.83	0.551	0.123	0.033	NA	9:34 AM	KP	N	NA	21/100 bottle 1	3/100 bottle 3	NA	NA	No flow, standing water in box	Corn cut, no manure or tillage
JBT06	JBT6-101218-3	3	589,668	10/12/2018	1100	236	49.4	NA	648.6	139.2	29.11	NA	10/4/2018 9:45	10/12/2018 10:00	8.01	36.83	2.199	0.472	0.099	NA	10:13 AM	KP	NA	NA	24/100 bottle 1	11/100 bottle 3	NA	NA	Water flowing over weir	Manure spread on portion of field
JBT06	JBT6-101918-1	1	159,294	10/19/2018	354	183	36.7	NA	56.4	29.1	5.85	NA	10/12/2018 10:15	10/19/2018 12:00	7.07	36.83	0.216	0.112	0.022	NA	?	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT06	JBT6-102618-NS	NS	2,845	10/26/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/19/2018 12:15	10/26/2018 12:00	NA	36.83	NA	NA	NA	NA	?	KP	N	NA	2/100 bottle 1	2/100 bottle 3	NA	NA	No flow	Remaining corn being cut
JBT06	JBT6-110218-3	3	4,132,446	11/2/2018	495	348	55.8	NA	2045.6	1438.1	230.43	NA	10/26/2018 12:15	11/2/2018 9:45	6.90	36.83	8.055	5.663	0.907	NA	9:45 AM	KP	Y	NA	Done	63/100 bottle 3	NA	NA	Good flow over weir, pacings adjusted	Corn cut, heavy crop residue
JBT06	JBT6-110818-1	1	17,267,607	11/8/2018	375	287	63.6	NA	6479.7	4955.8	1098.91	NA	11/2/2018 10:00	11/8/2018 15:00	6.21	36.83	28.341	21.676	4.806	NA	3:02 PM	SM	Y	NA	97/100 bottle 1	49/100 bottle 3	NA	NA	NA	Corn cut, wet
JBT06	JBT6-112618-1	1	6,977,549	11/16/2018	216	180	NA	NA	1503.7	1256.0	NA	NA	11/8/2018 15:15	11/16/2018 11:15	7.83	36.83	5.212	4.354	NA	NA	11:16 AM	NA	NA	NA	58/100 bottle 1	23/100 bottle 3	NA	NA	NA	NA
JBT06	JBT6-112718-G	G	10,798,260	11/27/2018	540	266	58.8	NA	5831.1	2870.2	634.51	NA	11/16/2018 11:30	11/27/2018 10:15	NA	36.83	NA	NA	NA	NA	10:15 AM	KP	Y	NA	NA	NA	NA	NA	Emptied carboys 1 and 3 and replaced. Water flowing over weir, no freezing.	NA
JBT06	JBT6-120318-G	G	18,556,611	12/2/2018	452	333	NA	15	8387.6	6179.4	NA	282.06	11/27/2018 10:30	12/2/2018 11:15	NA	36.83	NA	NA	NA	NA	11:15 AM	KP	Y	NA	NA	NA	NA	NA	Good flow over weir	No snow on field
JBT06	JBT6-121018-G	G	10,776,706	12/10/2018	69	39	46.8	2	744.7	419.2	503.92	21.55	12/2/2018 11:30	12/10/2018 17:00	NA	36.83	NA	NA	NA	NA	5:00 PM	SM	NA	NA	NA	NA	NA	Switched TP and TDP results	NA	NA
JBT06	JBT6-122118-G	G	2,039,312	12/21/2018	603	369	NA	53	1228.7	751.7	NA	108.42	12/10/2018 17:15	12/21/2018 13:15	NA	36.83	NA	NA	NA	NA	1:17 PM	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir	No snow on field
JBT06	JBT6-122918-G	G	13,587,110	12/29/2018	254	191	37.0	9	3451.1	2597.9	502.86	116.85	12/21/2018 13:30	12/29/2018 12:45	NA	36.83	NA	NA	NA	NA	12:52 PM	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir. Some water in ditch.	No snow on field
JBT06	JBT6-011019-G	G	5,126,663	1/10/2019	169	39	35.4	2	866.4	197.9	181.23	10.25	12/29/2018 13:00	1/10/2019 15:30	NA	36.83	NA	NA	NA	NA	3:34 PM	KP	NA	NA	NA	NA	NA	NA	Not enough depth for flow meter	NA
JBT06	JBT6-011719-G	G	227,889	1/17/2019	29	31	NA	2	6.7	7.1	NA	0.46	1/10/2019 15:45	1/17/2019 12:00	NA	36.83	NA	NA	NA	NA	?	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir. Pump line appears to be frozen	Some snow on field
JBT06	JBT6-012219-G	G	37,613	1/22/2019	102	40	37.8	105	3.8	1.5	1.42	3.93	1/17/2019 12:15	1/22/2019 12:45	NA	36.83	NA	NA	NA	NA	12:50 PM	KP	N	NA	NA	NA	NA	NA	Standing water and ice in weir box. No water flowing over weir.	NA
JBT06	JBT6-012419-G	G	1,605	1/24/2019	176	117	6.4	40	0.3	0.2	0.01	0.06	1/22/2019 13:00	1/24/2019 13:30	NA	36.83	NA	NA	NA	NA	1:25 PM	KP	NA	NA	NA	NA	NA	NA	Flooded weir. Water level close to sensor. Appears higher than ditch. Tried to clear ice from outlet in ditch. No ice in weir box.	NA
JBT06	JBT6-020819-G	G	8,532,455	2/8/2019	196	149	2.1	22	1672.4	1271.3	18.26	187.71	1/24/2019 13:45	2/8/2019 9:45	NA	36.83	NA	NA	NA	NA	9:55 AM	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir. Some water in ditch.	Ice/snow and flowing water in field
JBT06	JBT6-022219-NS	NS	1,041,903	2/22/2019	NA	NA	NA	NA	NA	NA	NA	NA	2/8/2019 10:00	2/22/2019 12:30	NA	36.83	NA	NA	NA	NA	12:30 PM	KP	N	NA	NA	NA	NA	NA	Water in weir box frozen. No flow over weir	Snow in field. Ditch covered with snow and ice.
JBT06	JBT6-030419-NS	NS	2,446,525	3/4/2019	NA	NA	NA	NA	NA	NA	NA	NA	2/22/2019 12:45	3/4/2019 14:45	NA	36.83	NA	NA	NA	NA	2:45 PM	KP	N	NA	NA	NA	NA	NA	Ice on surface of water in weir box. No water flowing over weir.	Ice and snow on field and in ditch.
JBT06	JBT6-031519-G	G	8,536,046	3/15/2019	NA	490	2.6	33	NA	4182.7	22.02	281.69	3/4/2019 15:00	3/15/2019 10:00	NA	36.83	NA	NA	NA	NA	10:14 AM	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir. Ditch partially full.	Water running in field
JBT06	JBT6-032319-G	G	2,367,300	3/23/2019	444	324	10.2	13	1051.1	767.0	24.22	30.77	3/15/2019 10:15	3/23/2019 14:45	NA	36.83	NA	NA	NA	NA	2:45 PM	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir	A few inches of snow in field
JBT06	JBT6-033019-G	G	3,489,915	3/30/2019	302	218	NA	14	1054.0	760.8	NA	47.11	3/23/2019 15:00	3/30/2019 14:15	NA	36.83	NA	NA	NA	NA	2:25 PM	KP	Y	NA	NA	NA	NA	NA	Water flowing over weir. Some water in ditch. Forgot to check carboys.	All snow gone from field. Still partially frozen.
JBT06	JBT6-041219-G	G	10,584,765	4/12/2019	77	67	34.6	2	815.0	709.2	366.13	21.17	3/30/2019 14:30	4/12/2019 11:15	NA	36.83	NA	NA	NA	NA	11:30 AM	KP	NA	NA	NA	NA	NA	NA	Weir box looks good, no obvious leakage or erosion. Ditch partially full.	No snow or ice in field
JBT06	JBT6-041719-1	1	4,027,275	4/17/2019	80	68	NA	2	322.2	273.9	NA	8.05	4/12/2019 11:30	4/17/2019 9:30	4.92	36.83	1.779	1.512	NA	0.044	11:20 AM	KP	Y	NA	39/100 bottle 1	15/100 bottle 3	NA	NA	Water flowing over weir. Ditch partially full	No activity in field
JBT06	JBT6-042419-1	1	8,317,966	4/24/2019	104	82	42.4	11	865.1	682.1	352.93	91.50	4/17/2019 9:45	4/24/2019 8:00	6.93	36.83	3.391	2.674	1.384	0.359	10:45 AM	KP	Y	NA	74/100 bottle 1	27/100 bottle 3	NA	NA	Ditch partially full of water	No activity in field
JBT06	JBT6-050319-1	1	9,253,794	5/3/2019	167	144	NA	5	1545.4	1332.5	NA	46.27	4/24/2019 8:15	5/3/2019 11:30	9.14	36.83	4.594	3.961	NA	0.138	11:50 AM	KP	Y	NA	97/100 bottle 1	33/100 bottle 3	NA	NA	NA	No activity in field
JBT06	JBT6-050919-1	1	5,401,070	5/9/2019	114	103	39.6	3	615.7	556.3	214.04	15.12	5/3/2019 11:45	5/9/2019 11:00	5.97	36.83	2.801	2.531	0.974	0.069	11:05 AM	KP	Y	NA	59/100 bottle 1	21/100 bottle 3	NA	NA	Bottom of ditch has water	No activity in field
JBT06	JBT6-051519-1+2	1+2	15,153,809	5/15/2019	192	131	NA	14	2909.5	1985.1	NA	212.15	5/9/2019 11:15	5/15/2019 12:00	6.03	36.83	13.100	8.938	NA	0.955	est	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT06	JBT6-052219-1	1	6,625,166	5/22/2019	119	84	18.2	14	788.4	556.5	120.45	91.43	5/15/2019 12:15	5/22/2019 8:15	6.83	36.83	3.133	2.211	0.479	0.363	10:10 AM	KP	Y	NA	74/100 bottle 1	26/100 bottle 3	NA	NA	Ditch has low water levels	No activity in field
JBT06	JBT6-053019-1+2	1+2	5,673,788	5/30/2019	218	180	NA	9	1236.9	1021.3	NA	52.20	5/22/2019 8:30	5/30/2019 11:15	8.11	36.83	4.139	3.418	NA	0.175	12:45 PM	RD	Y	NA	5/100 bottle 2	27/100 bottle 3	NA	NA	NA	No activity in field
JBT06	JBT6-060519-1	1	1,683,180	6/5/2019	136	88	34.4	22	228.9	148.1	57.88	37.70	5/30/2019 11:30	6/5/2019 9:45	5.93	36.83	1.049	0.679	0.265	0.173	12:44 PM	RD	Y	NA	31/100 bottle 1	9/100 bottle 3	NA	NA	NA	No activity in field
JBT06	JBT6-061119-1	1	1,254,768	6/11/2019	95	86	NA	3	119.2	107.9	NA	4.02	6/5/2019 10:00	6/11/2019 10:30	6.02	36.83	0.538	0.487	NA	0.018	10:34 AM	RD	Y	NA	36/100 bottle 1	10/100 bottle 3	NA	NA	Foam in box	No activity in field
JBT06	JBT6-061719-1	1	508,805	6/17/2019	56	51	36.6	2	28.5	25.9	18.62	1.02	6/11/2019 10:45	6/17/2019 2:00	5.64	36.83	0.137	0.125	0.090	0.005	11:04 AM	RD	Y	NA	15/100 bottle 1	5/100 bottle 3	NA	NA	NA	Freshly planted
JBT06	JBT6-062619-1	1	208,327	6/26/2019	46	30	NA	17	9.6	6.2	NA	3.55	6/17/2019 2:15	6/25/2019 20:00	8.74	36.83	0.030	0.019	NA	0.011	3:20 PM	RD	Y	NA	8/100 bottle 1	3/100 bottle 3	Partial TSS sample, insufficient volume for splitter	NA	NA	3" corn
JBT06	JBT6-070119-1	1	287,311	7/1/2019	77	56	34.0	8	22.1	16.1	9.77	2.18	6/25/2019 20:15	7/1/2019 10:30	5.59	36.83	0.107	0.078	0.047	0.011	11:03 AM	RD	Y	NA	27/100 bottle 1	4/100 bottle 3	NA	NA	NA	5" corn
JBT06	JBT6-071019-1	1	362,290	7/10/2019	51	31	NA	15	18.5	11.2	NA	5.58	7/1/2019 10:45	7/10/2019 0:30	8.57	36.83	0.059	0.036	NA	0.018	12:49 PM	RD	Y	NA	68/100 bottle 1	9/100 bottle 3	NA	NA	Weir box leaking in multiple spots, water below v-notch	14" corn
JBT06	JBT6-071719-3	3	1,011,744	7/17/2019	53	34	41.0	21	53.6	34.4	41.50	21.45	7/10/2019 0:45	7/17/2019 13:00	7.51	36.83	0.194	0.124	0.150	0.078	12:57 PM	RD	Y	NA	48/100 bottle 2	20/100 bottle 3	NA	NA	Weir box leaking	2-3" corn
JBT06	JBT6-072219-1	1	31,877	7/22/2019	36	17	NA	52	1.1	0.5	NA	1.64	7/17/2019 13:15	7/21/2019 6:00	3.70	36.83	0.008	0.004	NA	0.012	1:17 PM	RD	Y	NA	7/100 bottle 1	2/100 bottle 3	NA	NA	Weir box still leaking, not flowing over weir	2-4' corn
JBT06	JBT6-072219-G	G	31,877	7/22/2019	NA	NA	NA	5	NA	NA	NA	0.15	7/17/2019 13:15	7/21/2019 6:00	NA	36.83	NA	NA	NA	NA	1:17 PM	RD	Y	NA	NA	NA	NA	NA	Weir box still leaking, not flowing over weir	2-4' corn
JBT06	JBT6-073119-1	1	40,381	7/31/2019	250	109	53.5	125	10.1	4.4	2.16	5.07	7/21/2019 6:15	7/31/2019 19:45	10.56	36.83	0.026	0.011	0.006	0.013	4:27 PM	RD	Y	NA	12/100 bottle 1	3/100 bottle 3	NA	NA	Weir box is leaking, SM turned on 8/1/19, didn't seem to miss any flow	4-7' corn
JBT06	JBT6-080719-NS	NS	-	8/7/2019	NA	NA	NA	NA	NA	NA	NA	NA	7/31/2019 20:00	8/7/2019 12:30	NA	36.83	NA	NA	NA	NA	12:40 PM	RD	N	NA	NA	NA	Insufficient volume for sample	NA	Not flowing	NA
JBT06	JBT6-081519-3	3	1,528,767	8/15/2019	197	189	0.1	50	301.2	288.9	0.15	76.13	8/7/2019 12:45	8/15/2019 1:45	7.54	36.83	1.084	1.040	0.001	0.274	12:00 PM	KP	Y	NA	Not displayed	38/100 bottle 3	NA	NA	NA	6' corn
JBT06	JBT6-082219-NS	NS	3,632	8/22/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/15/2019 2:00	8/22/2019 12:00	NA	36.83	NA	NA	NA	NA	?	RD	N	NA	2/100 bottle 1	2/100 bottle 3	NA	NA	No flow	8-10' corn
JBT06	JBT6-082919-NS	NS	-	8/29/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/22/2019 12:15	8/29/2019 11:45	NA	36.83	NA	NA	NA	NA	11:49 AM	RD	N	NA	NA	NA	Sampler is off. Insufficient volume for sample.	NA	Weir box almost dry, no flow	8' corn
JBT07	JBT7-052318-1	1	68,700	5/23/2018	40	20	NA	NA	2.7	1.3	NA	NA	5/16/2018 13:00	5/23/2018 8:45	6.82	11.33	0.035	0.017	NA	NA	?	SM	Y	5.9	20/100 bottle 1	8/100 bottle 3	Needed volume calibration ~half of what was expected in carboys. Changed pump tubing.	NA	Changed part A program to 20	Cut corn from last year
JBT07	JBT7-053118-1	1	57,500	5/31/2018	25	28	6.0	NA	1.4	1.6	0.34	NA	5/23/2018 9:00	5/31/2018 11:45	8.11	11.33	0.016	0.018	0.004	NA	11:58 AM	KP	NA	4.5	29/100 bottle 1	8/100 bottle 3	NA	NA	NA	Tilled and planted to corn. Assume manure was incorporated.
JBT07	JBT7-060718-1	1	35,400	6/7/2018	20	14	NA	NA	0.7	0.5	NA	NA	5/31/2018 12:00	6/7/2018 9:30	6.90	11.33	0.009	0.006	NA	NA	9:48 AM	KP	NA	2	25/100 bottle 1	5/100 bottle 3	NA	NA	NA	4" corn, no activity
JBT07	JBT7-061318-1	1	17,500	6/13/2018	26	13	8.2	NA	0.5	0.2	0.14	NA	6/7/2018 9:45	6/13/2018 11:45	6.08	11.33	0.007	0.003	0.002	NA	4:12 PM	SM	Y	2.5	17/100 bottle 1	4/100 bottle 3	NA	NA	Outlet flowing	4" corn
JBT07	JBT7-062018-1	1	7,500	6/20/2018	83	22	NA	NA	0.6	0.2	NA	NA	6/13/2018 12:00	6/20/2018 2:15	6.59	11.33	0.008	0.002	NA	NA	9:48 AM	KP	Y	0.4	8/100 bottle 1	3/100 bottle 3	NA	NA	Small steady flow at end of pipe	10" corn, no evidence of activity in field. On 6/22/18 DCB observed field plowed.
JBT07	JBT7-062918-1	1	300	6/29/2018	25	21	7.6	NA	0.0	0.0	0.00	NA	6/20/2018 2:30	6/28/2018 14:00	8.48	11.33	0.000	0.000	0.000	NA	12:07 PM	KP	N	~0.1	5/100 bottle 1	2/100 bottle 3	NA	NA	No flow from pipe	2' corn, no activity
JBT07	JBT7-070618-1	1	11,300	7/6/2018	22	24	NA	NA	0.2	0.3	NA	NA	6/28/2018 14:15	7/6/2018 6:00	7.66	11.33	0.003	0.003	NA	NA	9:50 AM	KP	N	~0.2	19/100 bottle 1	3/100 bottle 3	NA	NA	No flow out pipe	2-3' corn
JBT07	JBT7-071318-EST	NS	8,500	7/13/2018	22	24	NA	NA	0.2	0.2	NA	NA	7/6/2018 6:15	7/13/2018 7:15	NA	11.33	NA	NA	NA	NA	9:30 AM	KP	N	NA	15/100 bottle 1	3/100 bottle 3	Insufficient volume for sample	Used concentration from prior sampling week. Did not use bounding concentrations because following week had higher flows and elevated concentrations.	Water in manhole, no flow out of pipe	4' corn
JBT07	JBT7-072018-1	1	11,300	7/20/2018	186	91	NA	NA	2.1	1.0	NA	NA	7/13/2018 7:30	7/20/2018 10:30	7.13	11.33	0.026	0.013	NA	NA	10:28 AM	KP	N	~0.1	25/100 bottle 1	4/100 bottle 3	NA	NA	Water in manhole, no flow out of pipe. Sample intake looks OK. Water looks clear.	5-6' corn
JBT07	JBT7-072718-1	1	41,600	7/27/2018	225	105	9.8	NA	9.4	4.4	0.41	NA	7/20/2018 10:45	7/27/2018 3:15	6.69	11.33	0.124	0.058	0.005	NA	11:53 AM	KP	Y	0.0-0.3	74/100 bottle 1	8/100 bottle 3	NA	NA	Minimal flow out pipe	5-6' corn
JBT07	JBT7-080218-NS	NS	-	8/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/27/2018 3:30	8/2/2018 6:15	NA	11.33	NA	NA	NA	NA	10:21 AM	KP	N	NA	6/100 bottle 1	2/100 bottle 3	NA	Some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	Manhole almost dry, no flow, water looks clear	7-8' corn
JBT07	JBT7-080918-1	1	12,200	8/9/2018	255	70	1.5	NA	3.1	0.9	0.02	NA	8/2/2018 6:30	8/9/2018 12:00	7.23	11.33	0.038	0.010	0.000	NA	12:15 PM	SM	N	0.0-0.1	21/100 bottle 1	3/100 bottle 3	NA	NA	Submerged, no visible flow	Tall corn
JBT07	JBT7-081618-NS	NS	-	8/16/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/9/2018 12:15	8/16/2018 8:30	NA	11.33	NA	NA	NA	NA	9:30 AM	TAR	N	0	11/100 bottle 1	2/100 bottle 3	NA	Intermittent flow zeroed it out. Had some flow even after noise removal and zero filter. Zeroed it out because it was negligible.	No flow, meter not submerged	8' corn
JBT07	JBT7-082218-NS	NS	-	8/22/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/16/2018 8:45	8/22/2018 14:00	NA	11.33	NA	NA	NA	NA	2:00 PM	TAR	N	(-2) - (+2)	19/100 bottle 1	3/100 bottle 3	NA	Zero flow	Totally dry	8' corn
JBT07	JBT7-083118-NS	NS	-	8/31/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/22/2018 14:15	8/31/2018 11:15	NA	11.33	NA	NA	NA	NA	11:05 AM	KP	N	NA	32/100 bottle 1	4/100 bottle 3	NA	Zero flow	Manhole dry	8-10' corn
JBT07	JBT7-090718-NS	NS	-	9/7/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/31/2018 11:30	9/7/2018 10:00	NA	11.33	NA	NA	NA	NA	10:00 AM	KP	N	NA	NA	NA	Checked remotely. Squirts confirm it's dry.	Zero flow	NA	NA
JBT07	JBT7-091318-NS	NS	-	9/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/7/2018 10:15	9/13/2018 9:30	NA	11.33	NA	NA	NA	NA	9:30 AM	KP	N	NA	NA	NA	NA	Zero flow	No flow	NA
JBT07	JBT7-092018-NS	NS	-	9/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/13/2018 9:45	9/20/2018 9:30	NA	11.33	NA	NA	NA	NA	9:30 AM	KP	N	NA	NA	NA	NA	Zero flow	No flow	NA
JBT07	JBT7-092718-NS	NS	-	9/27/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/20/2018 9:45	9/27/2018 3:00	NA	11.33	NA	NA	NA	NA	9:30 AM	KP	N	NA	NA	NA	10 dry squirts 2 wet squirts	Zeroed flow. Although it looks like it could be real, it doesn't line up with events at any other sites. More likely there is a little real flow in there but it is not the rise.	No flow	NA
JBT07	JBT7-100218-NS	NS	-	10/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/27/2018 3:15	10/1/2018 23:45	NA	11.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Zeroed flow. Had some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	NA	NA
JBT07	JBT7-100418-EST	NS	39,800	10/4/2018	328	66	15.3	NA	13.1	2.6	0.61	NA	10/2/2018 0:00	10/3/2018 22:45	NA	11.33	NA	NA	NA	NA	11:15 AM	KP	N	0.1	42/100 bottle 1	5/100 bottle 3	Pump issue results in no sample but many squirts	Back applying concentration from program start at 11:58 to beginning of flow at 00:00. Using concentration from 11/2 sample which is the closest available in time and in flow regime.	No flow out of pipe, standing water in manhole	Corn cut, no manure or tillage.

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT07	JBT7-101218-EST	NS	57,300	10/12/2018	328	66	15.3	NA	18.8	3.8	0.88	NA	10/3/2018 23:00	10/12/2018 11:30	NA	11.33	NA	NA	NA	NA	11:35 AM	NA	Y	NA	20/100 bottle 1	12/100 bottle 3	Pump issue results in no sample but many squirts	Using concentration from 11/2 sample which is the closest available in time and in flow regime. Will be worth revisiting and comparing to winter grab regressions when that data is processed.	Some flow out of pipe	Corn cut, no manure or tillage.
JBT07	JBT7-101518-NS	NS	-	10/15/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/12/2018 11:45	10/15/2018 2:30	NA	11.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT07	JBT7-101918-NS	NS	-	10/19/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/15/2018 2:45	10/19/2018 9:30	NA	11.33	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	NA	Zero flow	No flow	NA
JBT07	JBT7-102618-NS	NS	26,700	10/26/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/19/2018 9:45	10/29/2018 10:15	NA	11.33	NA	NA	NA	NA	11:17 AM	KP	N	NA	NA	NA	NA	Zero flow	Manhole dry	Corn cut, no manure
JBT07	JBT7-110218-1	1	261,500	11/2/2018	328	66	15.3	NA	85.8	17.2	4.00	NA	10/29/2018 10:30	11/2/2018 8:00	3.90	11.33	1.943	0.390	0.091	NA	11:15 AM	KP	Y	NA	NA	NA	Power failure, restarted	NA	Flow out pipe	Corn cut, no manure
JBT07	JBT7-110218-EST	NS	261,500	11/2/2018	394	112	NA	NA	102.9	29.3	NA	NA	10/29/2018 10:30	11/2/2018 8:00	NA	11.33	NA	NA	NA	NA	8:00 AM	KP	NA	NA	NA	NA	Extremely unrepresentative sample. Only captured some flow on 10/29 than sampler shut off due to battery outage for bulk of flow on 11/1-11/2. Using average of 11/2 and 11/26 sample. This are the closest bounding concentrations that contain similar flow regime.	Back applying concentration from program start at 10/29/19 10:34 to beginning of flow at 00:00 on 10/28. Using average of 11/2 and 11/26 sample. This are the closest bounding concentrations that contain similar flow regime.	NA	NA
JBT07	JBT7-110818-EST	NS	1,547,100	11/8/2018	459	158	NA	NA	710.1	244.4	NA	NA	11/2/2018 8:15	11/8/2018 13:30	NA	11.33	NA	NA	NA	NA	12:35 PM	KP	Y	36	NA	NA	Battery problem resulted in no samples	Using 11/26 concentration as it is the closest and most similar in flow.	Outlet flowing	Cut corn, not tilled
JBT07	JBT7-112618-1	1	788,400	11/16/2018	459	158	NA	NA	361.9	124.6	NA	NA	11/8/2018 13:45	11/16/2018 12:00	7.93	11.33	4.029	1.387	NA	NA	NA	KP	NA	NA	NA	NA	Sampler stopped 11/14 due to bad batteries. Picked up on 11/16 and sampled and filtered on 11/26/18. 4 of 25 squirts were missed due to power failures so not a purely representative sample.	Accept	NA	NA
JBT07	JBT7-112718-G	G	968,600	11/27/2018	1805	1235	23.8	NA	1748.3	1196.2	23.09	NA	11/16/2018 12:15	11/27/2018 13:00	NA	11.33	NA	NA	NA	NA	NA	KP	NA	-	NA	NA	NA	NA	No freezing. Carboys set at 1 and 3 positions.	NA
JBT07	JBT7-120318-G	G	1,801,700	12/2/2018	1794	1376	NA	60	3232.2	2479.1	NA	108.10	11/27/2018 13:15	12/2/2018 12:30	NA	11.33	NA	NA	NA	NA	NA	KP	NA	315	NA	NA	NA	NA	NA	No snow in field. A lot of water in manhole and ditch. Manure spread--was under snow!
JBT07	JBT7-121018-G	G	1,220,000	12/10/2018	120	148	7.5	2	146.4	180.6	9.13	2.44	12/2/2018 12:45	12/10/2018 16:00	NA	11.33	NA	NA	NA	NA	NA	NA	NA	-	NA	NA	NA	Grab sampling time estimated	NA	NA
JBT07	JBT7-122118-G	G	431,600	12/21/2018	3390	2970	NA	69	1463.1	1281.9	NA	29.78	12/10/2018 16:15	12/21/2018 13:45	NA	11.33	NA	NA	NA	NA	NA	KP	NA	-	NA	NA	NA	NA	NA	Water flowing in ditch. No snow in field.
JBT07	JBT7-122918-G	G	1,306,700	12/29/2018	1590	1278	12.0	76	2077.7	1670.0	15.62	98.66	12/21/2018 14:00	12/29/2018 14:15	NA	11.33	NA	NA	NA	NA	NA	NA	NA	232	NA	NA	NA	NA	NA	Ditch partially full of water. No snow in field
JBT07	JBT7-011019-G	G	728,700	1/10/2019	122	112	5.9	2	88.9	81.6	4.31	1.46	12/29/2018 14:30	1/10/2019 14:00	NA	11.33	NA	NA	NA	NA	NA	NA	NA	8.2	NA	NA	NA	NA	NA	Outlet is covered
JBT07	JBT7-011719-G	G	47,300	1/17/2019	83	85	NA	8	3.9	4.0	NA	0.38	1/10/2019 14:15	1/17/2019 12:00	NA	11.33	NA	NA	NA	NA	NA	KP	Y	2.04	NA	NA	Pump line appears frozen. Sampled from manhole.	NA	Some ice in manhole. Flow out pipe.	Some snow in field
JBT07	JBT7-012219-G	G	14,700	1/22/2019	159	151	6.9	28	2.3	2.2	0.10	0.41	1/17/2019 12:15	1/22/2019 13:15	NA	11.33	NA	NA	NA	NA	NA	KP	NA	1.5	NA	NA	NA	NA	Cleared snow from manhole. Some ice in manhole.	NA
JBT07	JBT7-012419-G	G	17,600	1/24/2019	585	412	1.3	149	10.3	7.2	0.02	2.61	1/22/2019 13:30	1/24/2019 15:00	NA	11.33	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	Water backed up in manhole. Big slab of snow over outlet in ditch. Tried to clear snow off outlet in ditch. No icing in manhole.	NA
JBT07	JBT7-020819-G	G	208,100	2/8/2019	892	813	1.3	2	185.6	169.2	0.28	0.42	1/24/2019 15:15	2/8/2019 11:30	NA	11.33	NA	NA	NA	NA	NA	NA	N	0	NA	NA	NA	NA	Ditch nearly full. No flow out of manhole. Height of water in manhole appears higher than ditch.	NA
JBT07	JBT7-022219-G	G	228,400	2/22/2019	650	595	2.8	82	148.5	135.9	0.65	18.73	2/8/2019 11:45	2/22/2019 14:00	NA	11.33	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	Sampled from manhole	NA	Ice on surface of water in manhole	Snow in ditch and field
JBT07	JBT7-030419-G	G	16,100	3/4/2019	1010	944	2.7	45	16.3	15.2	0.04	0.72	2/22/2019 14:15	3/4/2019 15:45	NA	11.33	NA	NA	NA	NA	NA	NA	Y	0.2	NA	NA	Sampled from manhole	NA	Appears to be some flow out pipe	Snow in ditch and field
JBT07	JBT7-031519-G	G	2,900	3/15/2019	1895	1776	2.7	18	5.5	5.2	0.01	0.05	3/4/2019 16:00	3/15/2019 11:30	NA	11.33	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	Ditch running nearly full. Water flowing thru field	NA
JBT07	JBT7-032319-G	G	1,551,800	3/23/2019	1460	1310	9.0	29	2265.6	2032.9	13.90	44.23	3/15/2019 11:45	3/23/2019 16:00	NA	11.33	NA	NA	NA	NA	NA	NA	NA	49	NA	NA	NA	NA	Ditch open, partially full	Snow in field
JBT07	JBT7-033019-G	G	1,459,800	3/30/2019	1160	978	NA	26	1693.4	1427.7	NA	37.95	3/23/2019 16:15	3/30/2019 15:30	NA	11.33	NA	NA	NA	NA	NA	NA	NA	168	NA	NA	NA	NA	Missing #1 carboy. Ditch partially full.	Most snow gone from field
JBT07	JBT7-041219-G	G	2,143,800	4/12/2019	142	125	8.3	8	304.4	268.0	17.75	18.01	3/30/2019 15:45	4/12/2019 15:00	NA	11.33	NA	NA	NA	NA	NA	KP	NA	84	NA	NA	NA	NA	Manhole looks good, no erosion, water flowing. Ditch partially full.	No snow or ice in field, no activity.
JBT07	JBT7-041719-1	1	757,600	4/17/2019	119	66	NA	4	90.2	50.0	NA	3.18	4/12/2019 15:15	4/17/2019 12:15	4.88	11.33	1.632	0.905	NA	0.058	1:25 PM	KP	Y	71.4	50/100 bottle 1	17/100 bottle 3	NA	NA	Ditch partially full	No activity in field
JBT07	JBT7-042419-1	1	1,314,900	4/24/2019	262	232	18.1	9	344.5	305.1	23.73	11.57	4/17/2019 12:30	4/24/2019 12:00	6.98	11.33	4.356	3.857	0.300	0.146	1:05 PM	KP	Y	65.5	89/100 bottle 1	26/100 bottle 3	NA	NA	Ditch partially full	No activity in field
JBT07	JBT7-050319-1+2	1+2	1,507,500	5/3/2019	226	189	NA	7	340.7	284.9	NA	10.25	4/24/2019 12:15	5/3/2019 14:45	9.10	11.33	3.303	2.762	NA	0.099	2:45 PM	KP	Y	262	2/100 bottle 2	32/100 bottle 3	NA	NA	NA	No activity in field
JBT07	JBT7-050919-1	1	791,800	5/9/2019	81	66	15.4	3	63.7	51.9	12.22	2.45	5/3/2019 15:00	5/9/2019 13:30	5.94	11.33	0.947	0.771	0.182	0.036	2:20 PM	KP	Y	37	65/100 bottle 1	17/100 bottle 3	NA	NA	NA	No activity in field
JBT07	JBT7-051519-1+2	1+2	1,764,199	5/15/2019	578	370	NA	81	1018.8	652.8	NA	142.51	5/9/2019 13:45	5/15/2019 11:00	5.89	11.33	15.277	9.788	NA	2.137	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT07	JBT7-052219-1	1	1,145,300	5/22/2019	3193	1735	22.5	200	3656.4	1987.1	25.78	229.44	5/15/2019 11:15	5/22/2019 9:45	6.94	11.33	46.513	25.278	0.328	2.919	11:32 AM	KP	Y	50	78/100 bottle 1	23/100 bottle 3	Sample very brown, with manure odor	NA	NA	Spreading manure in field today!
JBT07	JBT7-053019-1	1	729,500	5/30/2019	665	660	NA	6	485.1	481.5	NA	4.09	5/22/2019 10:00	5/30/2019 13:45	8.16	11.33	5.249	5.210	NA	0.044	2:43 PM	RD	Y	40.2	74/100 bottle 1	16/100 bottle 3	NA	NA	NA	No activity in field
JBT07	JBT7-060519-1	1	520,300	6/5/2019	665	570	12.5	12	346.0	296.6	6.50	6.14	5/30/2019 14:00	6/5/2019 7:45	5.74	11.33	5.320	4.560	0.100	0.094	9:33 AM	RD	Y	41.3	43/100 bottle 1	12/100 bottle 3	Lots of life in carboy 1	NA	NA	No activity in field
JBT07	JBT7-061119-1	1	345,800	6/11/2019	464	384	NA	9	160.5	132.8	NA	3.11	6/5/2019 8:00	6/11/2019 10:45	6.11	11.33	2.316	1.917	NA	0.045	12:45 PM	RD	Y	30.5	29/100 bottle 1	8/100 bottle 3	NA	NA	NA	Freshly disced
JBT07	JBT7-061719-1	1	157,500	6/17/2019	154	130	10.0	4	24.3	20.5	1.57	0.66	6/11/2019 11:00	6/17/2019 7:00	5.83	11.33	0.367	0.310	0.024	0.010	1:23 PM	RD	Y	8.4	17/100 bottle 1	5/100 bottle 3	NA	NA	NA	Tilled
JBT07	JBT7-062619-1	1+2	839,200	6/26/2019	510	386	NA	79	428.0	323.9	NA	66.46	6/17/2019 7:15	6/26/2019 10:15	9.13	11.33	4.139	3.133	NA	0.643	1:43 PM	RD	Y	20.4	6/100 bottle 2	20/100 bottle 3	NA	NA	NA	4" corn
JBT07	JBT7-070119-1	1	166,600	7/1/2019	128	64	10.9	28	21.3	10.7	1.82	4.66	6/26/2019 10:30	7/1/2019 11:15	5.03	11.33	0.374	0.187	0.032	0.082	1:00 PM	RD	Y	21.7	22/100 bottle 1	6/100 bottle 3	NA	NA	Re-dug ditch	1' corn
JBT07	JBT7-071019-1	1	123,700	7/10/2019	138	50	NA	39	17.1	6.2	NA	4.87	7/1/2019 11:30	7/10/2019 7:45	8.84	11.33	0.170	0.062	NA	0.049	2:36 PM	RD	Y	2.7	32/100 bottle 1	5/100 bottle 3	NA	NA	NA	2-3" corn, spreading something but can't make out what it is
JBT07	JBT7-071719-1	1	137,700	7/17/2019	276	158	18.4	46	38.0	21.8	2.53	6.31	7/10/2019 8:00	7/17/2019 12:15	7.18	11.33	0.467	0.268	0.031	0.078	3:24 PM	RD	Y	3.7	36/100 bottle 1	5/100 bottle 3	NA	NA	NA	3-4" corn
JBT07	JBT7-072219-1	1	10,500	7/22/2019	328	80	NA	NA	3.4	0.8	NA	NA	7/17/2019 12:30	7/21/2019 2:45	3.59	11.33	0.085	0.021	NA	NA	4:38 PM	RD	Y	0.2	4/100 bottle 1	2/100 bottle 3	NA	NA	Tile outlet trickling	3-5' corn
JBT07	JBT7-072219-G	G	-	7/22/2019	NA	NA	NA	9	NA	NA	NA	0.00	7/21/2019 2:45	7/21/2019 2:45	NA	11.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT07	JBT7-073119-1	1	15,300	7/31/2019	298	149	3.9	60	4.6	2.3	0.06	0.92	7/21/2019 3:00	7/31/2019 13:30	10.44	11.33	0.039	0.019	0.001	0.008	1:01 PM	RD	Y	0.8-0.9	26/100 bottle 1	4/100 bottle 3	NA	NA	Turbid in manhole, tile outlet trickling	6' corn
JBT07	JBT7-080719-1	1	4,400	8/7/2019	452	317	NA	54	2.0	1.4	NA	0.24	7/31/2019 13:45	8/7/2019 8:15	6.77	11.33	0.026	0.018	NA	0.003	12:40 PM	RD	N	0.7-0.8	14/100 bottle 1	3/100 bottle 3	NA	NA	Little water in manhole	5-8' corn
JBT07	JBT7-081519-1	1	1,100	8/15/2019	354	272	0.6	48	0.4	0.3	0.00	0.05	8/7/2019 8:30	8/15/2019 3:15	7.78	11.33	0.004	0.003	0.000	0.001	1:30 PM	KP	N	NA	17/100 bottle 1	3/100 bottle 3	NA	NA	NA	7' corn
JBT11	JBT11-041718-G	G	23,700	4/17/2018	66	39	3.5	NA	1.6	0.9	0.08	NA	4/17/2018 16:30	4/17/2018 16:45	NA	20.64	NA	NA	NA	NA	NA	SM	NA	NA	NA	NA	NA	NA	Started 2 part autosampling program, pulse settings 60/150	Last year's cut hay
JBT11	JBT11-042418-4	3/4	2,573,400	4/24/2018	64	21	2.9	NA	163.9	54.6	7.51	NA	4/17/2018 16:45	4/24/2018 11:00	6.76	20.64	1.175	0.391	0.054	NA	11:25 AM	KP	NA	NA	DONE	84/100 bottle 4	Samples carboys 3 and 4 separately	NA	Reset part A pulse to 70 and part B pulse to 250	Hay, no manure
JBT11	JBT11-050118-4	3/4	5,437,702	5/1/2018	68	36	13.2	NA	369.9	198.1	71.79	NA	4/24/2018 11:15	5/1/2018 2:00	6.61	20.64	2.710	1.451	0.526	NA	8:22 AM	SM	NA	NA	DONE	DONE	NA	NA	NA	Hay, no evidence of manure spreading
JBT11	JBT11-050918-3+4	3+4	3,773,700	5/9/2018	39	21	NA	NA	148.3	80.4	NA	NA	5/1/2018 2:15	5/9/2018 7:00	8.20	20.64	0.877	0.475	NA	NA	10:05 AM	KP	NA	NA	DONE	DONE	NA	NA	NA	Alfalfa growing, no manure
JBT11	JBT11-051618-1	1	179,600	5/16/2018	11	8	1.0	NA	2.0	1.4	0.18	NA	5/9/2018 7:15	5/16/2018 1:30	6.76	20.64	0.015	0.010	0.001	NA	11:44 AM	SM	Y	3.2	27/100 bottle 1	7/100 bottle 3	NA	NA	Outlet barely flowing	Alfalfa growing, no manure
JBT11	JBT11-052318-1	1	29,600	5/23/2018	19	14	NA	NA	0.6	0.4	NA	NA	5/16/2018 1:45	5/23/2018 8:45	7.29	20.64	0.004	0.003	NA	NA	11:13 AM	SM	Y	1.7	11/100 bottle 1	2/100 bottle 3	NA	NA	Outlet flowing gently, Changed part a to 20	Alfalfa growing, no manure
JBT11	JBT11-053118-1	1	5,800	5/31/2018	38	19	0.3	NA	0.2	0.1	0.00	NA	5/23/2018 9:00	5/31/2018 0:15	7.64	20.64	0.001	0.001	0.000	NA	10:15 AM	KP	NA	1	10/100 bottle 1	?	NA	NA	NA	Alfalfa waist high. Smells like manure was injected. I believe this was the smell from the manure storage pit at the front end of the field by the barn.
JBT11	JBT11-060718-1	1	5,200	6/7/2018	22	16	NA	NA	0.1	0.1	NA	NA	5/31/2018 0:30	6/7/2018 8:00	7.31	20.64	0.001	0.001	NA	NA	10:29 AM	KP	NA	2	17/100 bottle 1	2/100 bottle 3	NA	NA	Reset pacing Part A to 10, Part B to 250	Unmowed alfalfa
JBT11	JBT11-061318-1	1	700	6/13/2018	33	13	0.3	NA	0.0	0.0	0.00	NA	6/7/2018 8:15	6/11/2018 18:15	4.42	20.64	0.000	0.000	0.000	NA	5:16 PM	SM	N	-0.8	NA	NA	Errors occurred during program 7-14 out of 15 squirts were dry. Last wet squirt at 6/9 19:02.	Accepted	Outlet is dry. Meter barely submerged. Lowered sample intake slightly.	Shoulder high alfalfa
JBT11	JBT11-062018-1	1	900	6/20/2018	30	24	NA	NA	0.0	0.0	NA	NA	6/11/2018 18:30	6/20/2018 10:15	8.66	20.64	0.000	0.000	NA	NA	11:17 AM	KP	N	~0.5	16/100 bottle 1	2/100 bottle 3	NA	NA	No flow through manhole	Hay being mowed today
JBT11	JBT11-062918-NS	NS	-	6/29/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/20/2018 10:30	6/29/2018 13:00	NA	20.64	NA	NA	NA	NA	12:55 PM	KP	N	~0.5	22/100 bottle 1	2/100 bottle 3	Insufficient volume	All squirts dry, intake line was dry assume intake line was out of the water. Zeroed flow. Had some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	No flow in pipe	Alfalfa cut, manure applied to a portion of the field
JBT11	JBT11-070618-NS	NS	-	7/6/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/29/2018 13:15	7/6/2018 10:15	NA	20.64	NA	NA	NA	NA	10:27 AM	KP	N	~0.5	65/100 bottle 1	4/100 bottle 3	Insufficient volume	All dry squirts, false flow triggered dry samples. Flow can be zeroed. Zeroed flow. Had some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	Manhole dry, no flow	Alfalfa cut, manure applied
JBT11	JBT11-071318-NS	NS	-	7/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/6/2018 10:30	7/13/2018 9:45	NA	20.64	NA	NA	NA	NA	9:53 AM	KP	N	NA	32/100 bottle 1	3/100 bottle 3	Insufficient volume	Flow is zero. All dry squirts no water in carboys	Manhole dry, no samples	1' alfalfa, dry
JBT11	JBT11-072018-NS	NS	-	7/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/13/2018 10:00	7/20/2018 12:00	NA	20.64	NA	NA	NA	NA	12:13 PM	KP	N	NA	NA	NA	NA	NA	Manhole is dry, no water in carboys	2' alfalfa

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT11	JBT11-072718-EST	NS	-	7/27/2018	30	24	NA	NA	0.0	0.0	NA	NA	7/20/2018 12:15	7/27/2018 12:30	NA	20.64	NA	NA	NA	NA	12:32 PM	KP	N	1.5-2.0	48/100 bottle 1	3/100 bottle 3	Insufficient volume	#1 carboy nearly empty dry squirts. Only 1 wet squirt. What to do? Use concentration from 6/20 (closest low flow period)	No flow out pipe	2' alfalfa
JBT11	JBT11-080218-NS	NS	-	8/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/27/2018 12:45	8/2/2018 10:45	NA	20.64	NA	NA	NA	NA	10:46 AM	KP	N	1	32/100 bottle 1	3/100 bottle 3	NA	NA	Manhole dry, no flow	Alfalfa recently cut
JBT11	JBT11-080918-NS	NS	-	8/9/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/2/2018 11:00	8/9/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	SM	N	NA	67/100 bottle 2	8/100 bottle 3	NA	NA	Manhole completely dry	Shin high clover
JBT11	JBT11-081618-NS	NS	-	8/16/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/9/2018 9:45	8/16/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	Flow is zero. No visit	NA	NA
JBT11	JBT11-082218-NS	NS	-	8/22/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/16/2018 9:45	8/22/2018 15:15	NA	20.64	NA	NA	NA	NA	3:15 PM	TAR	N	-14	30/100/bottle 1	7/100 bottle 3	NA	NA	Totally dry	2-3' alfalfa
JBT11	JBT11-083118-NS	NS	-	8/31/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/22/2018 15:30	8/31/2018 11:15	NA	20.64	NA	NA	NA	NA	11:25 AM	KP	N	NA	NA	NA	No samples	Program not running	Manhole dry	Alfalfa recently cut, no manure
JBT11	JBT11-090718-NS	NS	-	9/7/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/31/2018 11:30	9/7/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	NA	All sites shut down	NA	NA
JBT11	JBT11-091318-NS	NS	-	9/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/7/2018 9:45	9/13/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	All stations shut off @ 9:30	NA	NA
JBT11	JBT11-092018-NS	NS	-	9/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/13/2018 9:45	9/20/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	NA	NA	NA
JBT11	JBT11-092718-NS	NS	-	9/27/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/20/2018 9:45	9/27/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	NA	NA	NA
JBT11	JBT11-100418-NS	NS	-	10/4/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/27/2018 9:45	10/4/2018 11:30	NA	20.64	NA	NA	NA	NA	11:38 AM	NA	N	NA	NA	NA	False flow (all squirts dry)	NA	Manhole almost dry, no flow, solar panel off	12" alfalfa
JBT11	JBT11-101918-NS	NS	-	10/19/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/12/2018 12:30	10/19/2018 9:30	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	Flow is zero	Missing field sheets	NA
JBT11	JBT11-102618-NS	NS	-	10/26/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/19/2018 9:45	10/26/2018 12:00	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	NA	Manhole dry, no samples	Alfalfa cut, no manure
JBT11	JBT11-102818-NS	NS	200	10/28/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/26/2018 12:15	10/28/2018 17:15	NA	20.64	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	NA	Flow is zero. Extending to include zero flow until flow resumes on 10/29	NA	NA
JBT11	JBT11-110218-3	3	376,400	11/2/2018	159	64	3.8	NA	59.7	24.1	1.41	NA	10/28/2018 17:30	11/2/2018 12:15	4.78	20.64	0.605	0.244	0.014	NA	12:15 PM	NA	Y	349	Done	14/100 bottle 3	NA	NA	Good flow through pipe	Alfalfa cut, no manure
JBT11	JBT11-112618-1	1	844,300	11/26/2018	39	11	NA	NA	33.2	9.1	NA	NA	11/8/2018 14:15	11/15/2018 13:15	6.96	20.64	0.231	0.063	NA	NA	NA	NA	NA	NA	44/100 bottle 1	15/100 bottle 3	NA	NA	NA	NA
JBT11	JBT11-112718-G	G	2,996,602	11/27/2018	90	59	2.9	NA	268.5	175.9	8.63	NA	11/15/2018 13:30	11/27/2018 12:45	NA	20.64	NA	NA	NA	NA	NA	KP	Y	NA	NA	NA	NA	NA	Water flowing out pipe, no freezing. Carboys set at 1 and 3 positions.	NA
JBT11	JBT11-120318-G	G	3,967,402	12/2/2018	128	115	NA	9	507.8	456.3	NA	34.56	11/27/2018 13:00	12/2/2018 13:30	NA	20.64	NA	NA	NA	NA	NA	KP	Y	1198	NA	NA	NA	NA	Water flowing thru manhole and in ditch	No snow on field
JBT11	JBT11-121018-G	G	2,564,302	12/10/2018	18	14	1.9	2	46.2	36.9	4.74	5.13	12/2/2018 13:45	12/10/2018 12:15	NA	20.64	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT11	JBT11-122118-G	G	2,074,401	12/21/2018	156	117	NA	18	324.0	242.7	NA	36.92	12/10/2018 12:30	12/21/2018 15:00	NA	20.64	NA	NA	NA	NA	NA	KP	NA	171	NA	NA	NA	NA	No power to sampler. Battery charged and flow meter is on. Checked all connections.	No snow on field
JBT11	JBT11-122918-G	G	5,147,103	12/29/2018	48	51	2.6	2	248.6	263.0	13.28	10.29	12/21/2018 15:15	12/29/2018 14:45	NA	20.64	NA	NA	NA	NA	NA	NA	NA	486	NA	NA	NA	NA	Ditch partially full of water	No snow on field
JBT11	JBT11-011019-G	G	2,614,600	1/10/2019	19	15	1.5	2	49.5	40.3	3.97	5.23	12/29/2018 15:00	1/10/2019 14:45	NA	20.64	NA	NA	NA	NA	NA	NA	Y	34.5	NA	NA	NA	NA	Outlet flowing	NA
JBT11	JBT11-011719-G	G	262,400	1/17/2019	23	24	NA	2	6.0	6.2	NA	0.52	1/10/2019 15:00	1/17/2019 12:00	NA	20.64	NA	NA	NA	NA	NA	KP	NA	15	NA	NA	NA	NA	NA	Light snow cover over field
JBT11	JBT11-012219-G	G	127,200	1/22/2019	27	22	0.8	13	3.4	2.8	0.10	1.67	1/17/2019 12:15	1/22/2019 16:30	NA	20.64	NA	NA	NA	NA	NA	KP	NA	8.5	NA	NA	NA	NA	No ice in manhole	NA
JBT11	JBT11-012419-G	G	128,400	1/24/2019	55	66	1.1	7	7.1	8.4	0.13	0.92	1/22/2019 16:45	1/24/2019 15:30	NA	20.64	NA	NA	NA	NA	NA	NA	NA	157	NA	NA	NA	NA	Ditch partially full	Some snow still in field
JBT11	JBT11-020819-G	G	740,500	2/8/2019	44	61	1.3	2	32.6	45.2	0.94	1.48	1/24/2019 15:45	2/8/2019 12:00	NA	20.64	NA	NA	NA	NA	NA	NA	NA	8.9	NA	NA	NA	NA	Ditch flowing with some water	NA
JBT11	JBT11-022219-G	G	275,800	2/22/2019	21	39	0.4	86	5.8	10.8	0.11	23.72	2/8/2019 12:15	2/22/2019 14:30	NA	20.64	NA	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	Snow in field and ditch
JBT11	JBT11-030419-G	G	181,800	3/4/2019	22	45	0.3	48	4.0	8.2	0.06	8.73	2/22/2019 14:45	3/4/2019 16:15	NA	20.64	NA	NA	NA	NA	NA	NA	NA	10	NA	NA	NA	NA	Ditch partially clear	Snow in field
JBT11	JBT11-031519-G	G	148,900	3/15/2019	NA	NA	NA	NA	NA	NA	NA	NA	3/4/2019 16:30	3/15/2019 14:45	NA	20.64	NA	NA	NA	NA	NA	NA	NA	110	NA	NA	Invalid. Flooding from ditch suspected on 3/15/19	Sample collected shortly after ditch flooding event (flow dropped to 0)	Ditch partially full	Standing water/ice in field
JBT11	JBT11-032319-G	G	1,569,900	3/23/2019	136	112	2.2	2	213.5	175.8	3.52	3.14	3/15/2019 15:00	3/23/2019 16:45	NA	20.64	NA	NA	NA	NA	NA	NA	NA	178	NA	NA	NA	NA	Ditch partially full	Snow in field
JBT11	JBT11-033019-G	G	3,362,100	3/30/2019	80	91	NA	2	269.0	306.0	NA	6.72	3/23/2019 17:00	3/30/2019 16:00	NA	20.64	NA	NA	NA	NA	NA	NA	NA	418	NA	NA	NA	NA	Ditch partially full, carboy #1 missing.	Most snow gone from field, still frozen
JBT11	JBT11-041219-G	G	6,315,400	4/12/2019	31	27	2.1	2	192.6	167.4	13.39	12.63	3/30/2019 16:15	4/12/2019 15:45	NA	20.64	NA	NA	NA	NA	NA	KP	Y	230	NA	NA	NA	NA	Ditch partially full. Manhole clear and water flowing	No snow or ice in field. No activity.
JBT11	JBT11-041719-1	1	1,903,400	4/17/2019	47	19	NA	2	89.5	36.2	NA	3.81	4/12/2019 16:00	4/17/2019 13:30	4.90	20.64	0.885	0.358	NA	0.038	2:10 PM	KP	Y	185.7	97/100 bottle 1	33/100 bottle 3	NA	NA	Ditch partially full	No activity in field
JBT11	JBT11-042419-1	1	3,345,801	4/24/2019	24	15	3.4	2	80.3	50.2	11.41	6.69	4/17/2019 13:45	4/24/2019 7:15	6.73	20.64	0.578	0.361	0.082	0.048	1:40 PM	KP	Y	195	87/100 bottle 1	44/100 bottle 3	NA	NA	Ditch partially full	No activity in field
JBT11	JBT11-050319-1+2	1+2	4,336,601	5/3/2019	28	16	NA	2	121.4	69.4	NA	8.67	4/24/2019 7:30	5/3/2019 15:15	9.32	20.64	0.631	0.361	NA	0.045	3:20 PM	KP	Y	576	21/100 bottle 2	61/100 bottle 3	NA	NA	NA	No activity in field
JBT11	JBT11-050919-1	1	1,880,900	5/9/2019	16	14	2.3	2	30.1	26.3	4.27	3.76	5/3/2019 15:30	5/9/2019 13:15	5.91	20.64	0.247	0.216	0.035	0.031	1:50 PM	KP	Y	90	63/100 bottle 1	30/100 bottle 3	NA	NA	NA	No activity in field
JBT11	JBT11-051519-1+2	1+2	4,988,002	5/15/2019	36	27	NA	35	179.6	134.7	NA	175.58	5/9/2019 13:30	5/15/2019 12:00	5.94	20.64	1.465	1.099	NA	1.433	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT11	JBT11-052219-1	1	2,953,500	5/22/2019	29	20	1.4	5	85.7	59.1	3.99	14.92	5/15/2019 12:15	5/22/2019 11:15	6.96	20.64	0.596	0.411	0.028	0.104	12:20 PM	KP	Y	155	89/100 bottle 1	44/100 bottle 3	NA	NA	NA	No activity in field
JBT11	JBT11-053019-1	1	1,394,600	5/30/2019	18	11	NA	2	25.1	15.3	NA	2.79	5/22/2019 11:30	5/30/2019 13:30	8.08	20.64	0.150	0.092	NA	0.017	2:10 PM	RD	Y	80.5	58/100 bottle 1	22/100 bottle 3	NA	NA	NA	NA
JBT11	JBT11-060519-1	1	612,000	6/5/2019	20	14	0.7	4	12.2	8.6	0.41	2.69	5/30/2019 13:45	6/5/2019 7:30	5.74	20.64	0.103	0.072	0.003	0.023	8:41 AM	RD	Y	68.4	24/100 bottle 1	10/100 bottle 3	NA	NA	NA	NA
JBT11	JBT11-061119-1	1	399,100	6/11/2019	19	9	NA	13	7.6	3.6	NA	5.19	6/5/2019 7:45	6/11/2019 8:30	6.03	20.64	0.061	0.029	NA	0.042	11:38 AM	RD	Y	20.5	18/100 bottle 1	7/100 bottle 3	NA	NA	NA	No activity in field
JBT11	JBT11-061719-1	1	127,100	6/17/2019	13	7	0.5	12	1.7	0.9	0.06	1.47	6/11/2019 8:45	6/17/2019 0:15	5.65	20.64	0.014	0.008	0.001	0.013	12:28 PM	RD	Y	7.8	10/100 bottle 1	4/100 bottle 3	Partial TSS sample	NA	NA	3' alfalfa, 5' grass
JBT11	JBT11-062619-1	1	85,400	6/26/2019	21	9	NA	13	1.8	0.8	NA	1.13	6/17/2019 0:30	6/25/2019 23:15	8.95	20.64	0.010	0.004	NA	0.006	2:31 PM	RD	Y	3.1	11/100 bottle 1	3/100 bottle 3	NA	NA	Tile outlet trickling	No activity in field
JBT11	JBT11-070119-1	1	24,700	7/1/2019	31	6	0.2	24	0.8	0.1	0.00	0.59	6/25/2019 23:30	7/1/2019 5:30	5.25	20.64	0.007	0.001	0.000	0.005	12:13 PM	RD	Y	2.7	7/100 bottle 1	2/100 bottle 3	Not enough volume to use splitter, poured from carboy	NA	NA	No change, 6' grass
JBT11	JBT11-071019-1	1	24,800	7/10/2019	31	9	NA	9	0.8	0.2	NA	0.22	7/1/2019 5:45	7/10/2019 11:15	9.23	20.64	0.004	0.001	NA	0.001	2:01 PM	RD	Y	0.5	19/100 bottle 1	3/100 bottle 3	NA	NA	Tile outlet trickling	Fresh cut
JBT11	JBT11-071719-1	1	34,800	7/17/2019	29	18	0.3	27	1.0	0.6	0.01	0.93	7/10/2019 11:30	7/17/2019 14:00	7.10	20.64	0.007	0.004	0.000	0.006	2:49 PM	RD	Y	2.5	25/100 bottle 1	4/100 bottle 3	NA	NA	NA	Cut last week, fresh manure
JBT11	JBT11-072219-1	1	11,300	7/22/2019	24	12	NA	67	0.3	0.1	NA	0.76	7/17/2019 14:15	7/22/2019 10:30	4.84	20.64	0.003	0.001	NA	0.008	12:25 PM	RD	N	0.00-1.0	11/100 bottle 1	2/100 bottle 3	NA	NA	NA	1' alfalfa
JBT11	JBT11-073119-1	1	500	7/31/2019	31	13	1.1	24	0.0	0.0	0.00	0.01	7/22/2019 10:45	7/31/2019 6:45	8.83	20.64	0.000	0.000	0.000	0.000	12:16 PM	RD	N	0.5-1.6	17/100 bottle 1	3/100 bottle 3	NA	NA	NA	18" alfalfa
JBT11	JBT11-080719-1	1	-	8/7/2019	44	31	NA	36	0.0	0.0	NA	0.00	7/31/2019 7:00	8/7/2019 10:15	7.14	20.64	0.000	0.000	NA	0.000	11:59 AM	RD	N	0.0-0.4	16/100 bottle 1	3/100 bottle 3	NA	NA	Manhole wet, outlet dry	2' alfalfa
JBT11	JBT11-081519-1	1	100	8/15/2019	154	42	1.4	36	0.0	0.0	0.00	0.00	8/7/2019 10:30	8/15/2019 11:15	8.03	20.64	0.000	0.000	0.000	0.000	2:10 PM	KP	N	1.1	22/100 bottle 1	4/100 bottle 3	NA	NA	NA	Hay being baled in field
JBT11	JBT11-082219-1	1	200	8/22/2019	67	31	2.4	19	0.0	0.0	0.00	0.00	8/15/2019 11:30	8/22/2019 2:45	6.64	20.64	0.000	0.000	0.000	0.000	12:07 PM	RD	N	(-)0.5 - 0.5	19/100 bottle 1	3/100 bottle 3	NA	NA	NA	Cut last week - fresh manure
JBT11	JBT11-082919-1	1	1,800	8/29/2019	85	68	3.4	3	0.2	0.1	0.01	0.01	8/22/2019 3:00	8/29/2019 12:15	7.39	20.64	0.001	0.001	0.000	0.000	12:10 PM	RD	N	0	6/100 bottle 1	2/100 bottle 3	Sampler OFF, limited volume for splits	NA	Manhole dry	No change
JBT11	JBT11-101218-NS	NS	-	10/122018	NA	NA	NA	NA	NA	NA	NA	NA	10/4/2018 11:45	10/12/2018 12:15	NA	20.64	NA	NA	NA	NA	12:22 PM	NA	N	NA	NA	NA	Flow is zero. All squirts dry	NA	Some standing water in manhole, not enough water in carboy to sample	Alfalfa being cut
JBT11	JBT11-110818-1	1	1,286,700	11/8/208	78	36	2.7	NA	100.9	46.3	3.41	NA	11/2/2018 12:30	11/8/2018 14:00	6.06	20.64	0.806	0.370	0.027	NA	2:00 PM	SM	Y	14.2	55/100 bottle 1	22/100 bottle 3	NA	NA	Outlet flowing	Grass cut
JBT18	JBT18-051519-1+2	1+2	1,300,500	5/15/2018	204	51	NA	37	265.3	66.3	NA	48.64	5/9/2019 8:30	5/15/2019 12:00	6.15	4.45	9.697	2.424	NA	1.778	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT18	JBT18-060718-1	1	9,200	6/7/2018	NA	NA	NA	NA	NA	NA	NA	NA	5/31/2018 13:15	6/7/2018 2:15	6.54	4.45	NA	NA	NA	NA	9:00 AM	KP	NA	0.6	NA	NA	Severe erosion to base of manhole. Sample could be compromised	Invalid due to possible surface runoff	NA	Field changed from hay to corn this year. Tilled, manured, and planted to corn observed 5/31/18. 6" on 6/7/18.
JBT18	JBT18-061318-1	1	300	6/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/7/2018 2:30	6/13/2018 10:15	6.32	4.45	NA	NA	NA	NA	9:24 AM	SM	NA	0-0.4	9/100 bottle 1	3/100 bottle 3	Manhole water looks stagnant/not flowing. Sample dirty. Manhole erosion issue fixed with sandbags and backfill. Sample may be compromised	Invalid due to possible surface runoff	Maintenance. Shored up manhole. Gap at bottom ran almost around entire circumference. Water disturbed during this process. Delayed turning sampler on until 20:00. Finished work around 13:00	6" corn
JBT18	JBT18-062018-1	1	700	6/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/13/2018 10:30	6/21/2018 4:00	7.73	4.45	NA	NA	NA	NA	10:20 AM	KP	N	~0.1	9/100 bottle 1	3/100 bottle 3	Manhole shored up by DCB on 6/22 so don't use this either	Invalid due to possible surface runoff	No flow at end of pipe or through manhole	0-10" corn, no activity
JBT18	JBT18-062218-NS	NS	300	6/22/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/21/2018 4:15	6/22/2018 10:00	NA	4.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT18	JBT18-062918-1	1	700	6/29/2018	60	54	2.1	NA	0.0	0.0	0.00	NA	6/22/2018 10:15	6/29/2018 11:00	7.03	4.45	0.001	0.001	0.000	NA	11:22 AM	KP	N	0.4	14/100 bottle 1	3/100 bottle 3	6/20 to 6/22 gap due to DCB dumping 5 turbid squirts from carboy and continuing to shore up manhole. Sample is still probably adequately representative. We ended up zeroing this anyways.	Zeroed flow	No flow in pipe	Sparse 1' corn
JBT18	JBT18-070618-NS	NS	-	7/6/2018	NA	NA	NA	NA	NA	NA	NA	NA	6/29/2018 11:15	7/6/2018 9:15	NA	4.45	NA	NA	NA	NA	9:24 AM	KP	N	~0.5	NA	NA	All squirts dry. False flow pulses. Zeroing period 7/2 based on field notes. Had some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	All squirts were dry (false flow)	No flow in pipe, manhole dry	Variable height corn has been cultivated between rows
JBT18	JBT18-071318-NS	NS	-	7/13/2018	NA	NA	NA	NA	NA	NA	NA	NA	7/6/2018 9:30	7/13/2018 8:45	NA	4.45	NA	NA	NA	NA	8:50 AM	KP	N	NA	Done	28/100 bottle 4	Flow is zero. All squirts dry due to false flow pulses	All squirts were dry (false flow)	Manhole dry, stopped program until tile starts flowing again	1-3' corn, very dry
JBT18	JBT18-072018-1	1	6,300	7/20/2018	140	79	NA	NA	0.9	0.5	NA	NA	7/13/2018 9:00	7/20/2018 5:30	6.85	4.45	0.029	0.016	NA	NA	9:55 AM	KP	N	NA	NA	NA	NA	NA	Standing water, no flow	1-4' corn
JBT18	JBT18-072718-3	3	56,600	7/27/2018	218	93	66.0	NA	12.3	5.3	3.74	NA	7/20/2018 5:45	7/27/2018 2:45	6.88	4.45	0.402	0.173	0.122	NA	11:05 AM	KP	Y	1.9	35/100 bottle 2	18/100 bottle 3	NA	NA	Minimal flow out pipe	1-5' corn
JBT18	JBT18-080218-1	1	1,500	8/2/2018	146	45	NA	NA	0.2	0.1	NA	NA	7/27/2018 3:00	8/2/2018 4:30	6.06	4.45	0.008	0.002	NA	NA	9:42 AM	KP	N	0.4	11/100 bottle 1	3/100 bottle 3	NA	NA	No flow, manhole almost dry	4-6' corn
JBT18	JBT18-080918-NS	NS	-	8/9/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/2/2018 4:45	8/9/2018 9:30	NA	4.45	NA	NA	NA	NA	NA	SM	N	0.3	39/100 bottle 1	6/100 bottle 3	NA	Zeroed flow. Had some flow even after noise removal and zero filter. Zeroed it out due to the fact that it was negligible.	No flow	Tall corn
JBT18	JBT18-081618-NS	NS	-	8/16/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/9/2018 9:45	8/16/2018 9:30	NA	4.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Flow is zero	NA	NA	NA
JBT18	JBT18-082218-NS	NS	-	8/22/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/16/2018 9:45	8/22/2018 9:30	NA	4.45	NA	NA	NA	NA	2:35 PM	TAR	N	-6	37/100 bottle 1	6/100 bottle 3	Flow is zero. All dry squirts.	NA	Totally dry	8-10' corn, lots of weeds
JBT18	JBT18-083118-NS	NS	-	8/31/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/22/2018 9:45	8/31/2018 9:30	NA	4.45	NA	NA	NA	NA	10:33 AM	NA	N	NA	NA	NA	Flow is zero	NA	Manhole dry, carboys empty	Corn 6-8'
JBT18	JBT18-090718-NS	NS	-	9/7/2018	NA	NA	NA	NA	NA	NA	NA	NA	8/31/2018 9:45	9/7/2018 9:30	NA	4.45	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	Flow is zero	NA	NA	NA

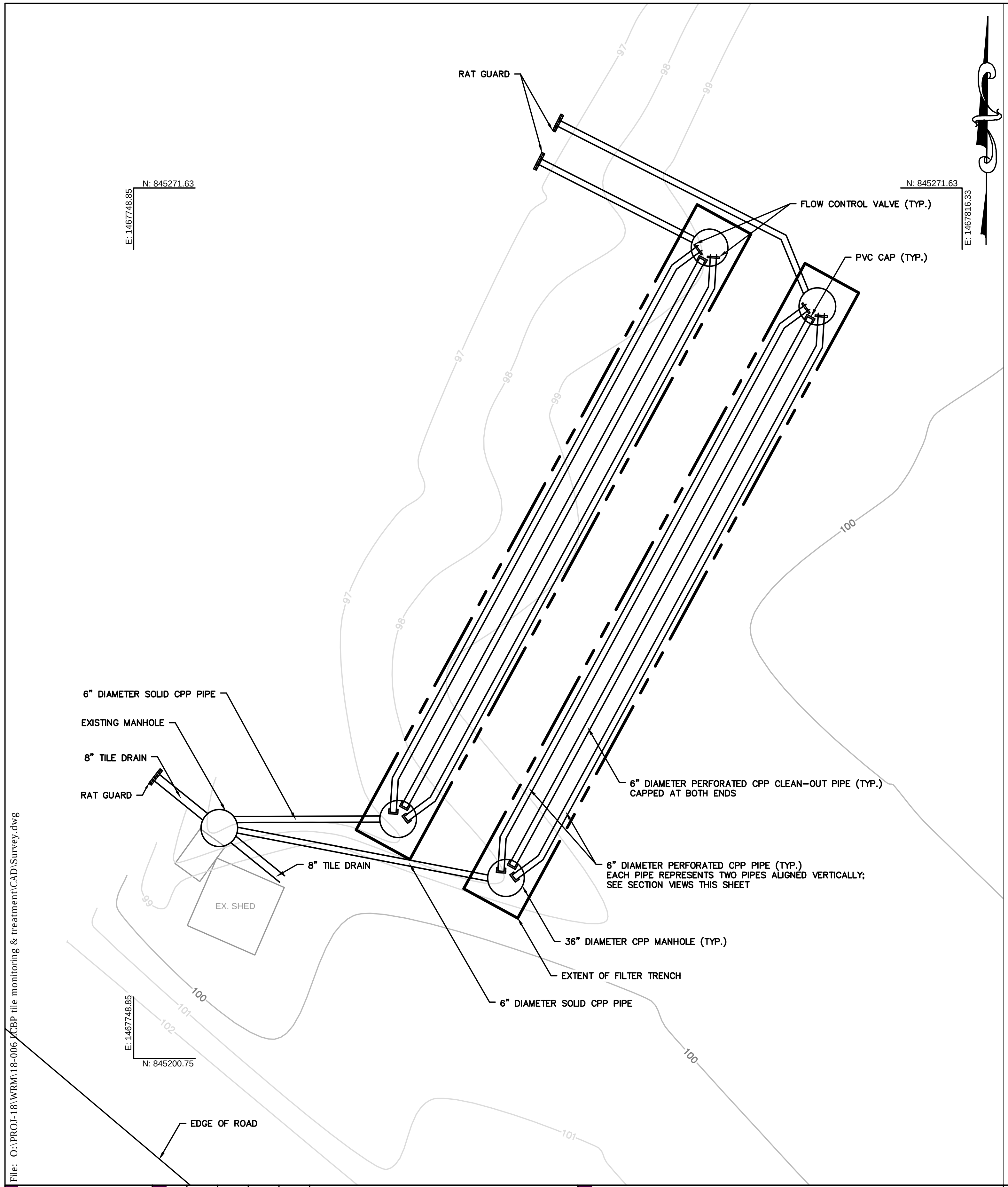
Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d/ha)	TDP Load (g/d/ha)	TN Load (kg/d/ha)	TSS Load (kg/d/ha)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT18	JBT18-091218-NS	NS	-	9/12/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/7/2018 9:45	9/12/2018 9:30	NA	4.45	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	Flow is zero	NA	NA	NA
JBT18	JBT18-092018-NS	NS	-	9/20/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/12/2018 9:45	9/20/2018 9:30	NA	4.45	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	Flow is zero	NA	NA	NA
JBT18	JBT18-092718-NS	NS	-	9/27/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/20/2018 9:45	9/27/2018 9:30	NA	4.45	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	Flow is zero	NA	NA	NA
JBT18	JBT18-100218-NS	NS	-	10/2/2018	NA	NA	NA	NA	NA	NA	NA	NA	9/27/2018 9:45	10/2/2018 9:15	NA	4.45	NA	NA	NA	NA	NA	NA	N	NA	NA	NA	Flow is zero	NA	NA	NA
JBT18	JBT18-100418-1	1	13,700	10/4/2018	258	60	6.9	NA	3.5	0.8	0.09	NA	10/2/2018 9:30	10/4/2018 8:15	1.95	4.45	0.407	0.094	0.011	NA	10:27 AM	NA	N	NA	NA	NA	NA	NA	Standing water in manhole. No flow	Corn not cut
JBT18	JBT18-101218-1	1	33,400	10/12/2018	278	79	12.2	NA	9.3	2.6	0.41	NA	10/4/2018 8:30	10/12/2018 10:45	8.09	4.45	0.258	0.073	0.011	NA	10:50 AM	NA	N	NA	NA	NA	NA	NA	No flow, manhole has standing water	Corn not cut
JBT18	JBT18-101918-1	1	4,200	10/19/2018	153	55	12.0	NA	0.6	0.2	0.05	NA	10/12/2018 11:00	10/19/2018 7:00	6.83	4.45	0.021	0.008	0.002	NA	NA	NA	NA	NA	NA	NA	NA	Missing field sheets	NA	NA
JBT18	JBT18-102618-NS	NS	-	10/26/2018	NA	NA	NA	NA	NA	NA	NA	NA	10/19/2018 7:15	10/27/2018 23:45	NA	4.45	NA	NA	NA	NA	NA	NA	N	0	NA	NA	NA	Flow is zero. Extend period beyond field visit to 10/28 at which point flow finally becomes real and samplers are turned on shortly thereafter	Manhole dry	Corn not cut
JBT18	JBT18-110218-3	3	204,500	11/2/2018	160	53	22.2	NA	32.7	10.8	4.54	NA	10/28/2018 0:00	11/2/2018 10:30	5.44	4.45	1.352	0.445	0.187	NA	10:30 AM	NA	Y	185	Done	47/100 bottle 3	NA	NA	Pipe flowing	Corn not cut
JBT18	JBT18-110818-4	4	658,200	11/8/2018	217	50	16.2	NA	142.5	32.8	10.65	NA	11/2/2018 10:45	11/8/2018 6:45	5.83	4.45	5.488	1.265	0.410	NA	11:08 AM	NA	Y	18	NA	18/100 bottle 4	NA	Only sampled to bottle 4. 3 false squirts due to program checks	Outlet barely flowing	Corn not cut
JBT18	JBT18-112618-1	1	433,100	11/26/2018	131	18	NA	NA	56.6	7.7	NA	NA	11/8/2018 7:00	11/16/2018 12:00	8.21	4.45	1.548	0.210	NA	NA	NA	NA	NA	NA	NA	NA	Picked up samples 11/20 (frozen). Thawed and sampled 11/26.	Turned off remotely	NA	NA
JBT18	JBT18-112718-G	G	796,500	11/27/2018	187	177	11.5	NA	148.5	141.0	9.14	NA	11/16/2018 12:15	11/27/2018 11:45	NA	4.45	NA	NA	NA	NA	NA	KP	Y	-	NA	NA	NA	NA	Water flowing out of pipe, no freezing. Carboys set at 1 and 3 positions.	NA
JBT18	JBT18-120318-G	G	1,647,800	12/3/2018	213	113	NA	10	351.0	186.2	NA	16.48	11/27/2018 12:00	12/3/2018 12:00	NA	4.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JBT18	JBT18-121018-G	G	652,300	12/10/2018	226	125	7.3	15	147.4	81.5	4.79	9.78	12/3/2018 12:15	12/10/2018 13:30	NA	4.45	NA	NA	NA	NA	NA	NA	NA	-	NA	NA	NA	Switched TP and TDP results	NA	NA
JBT18	JBT18-122118-G	G	170,500	12/21/2018	269	197	NA	58	45.9	33.5	NA	9.89	12/10/2018 13:45	12/21/2018 14:15	NA	4.45	NA	NA	NA	NA	NA	KP	Y	-	NA	NA	NA	NA	Pipe running about 1/3 full	No snow in field
JBT18	JBT18-122918-G	G	869,800	12/29/2018	239	121	6.3	30	207.9	105.2	5.51	26.09	12/21/2018 14:30	12/29/2018 13:30	NA	4.45	NA	NA	NA	NA	NA	NA	Y	88	NA	NA	NA	NA	Pipe flowing about 1/4 full. Cannot get ISCO to stay on. Grab sample at end of pipe.	No snow in field
JBT18	JBT18-011019-G	G	401,000	1/10/2019	204	145	7.9	14	81.8	58.1	3.18	5.45	12/29/2018 13:45	1/10/2019 12:30	NA	4.45	NA	NA	NA	NA	NA	NA	NA	9.8	NA	NA	NA	NA	Outlet covered in snow. Lid open, door broken off, shed filled with snow. Cleaned out and put cinderblock on lid	Corn cut
JBT18	JBT18-011719-G	G	55,000	1/17/2019	161	83	NA	21	8.9	4.6	NA	1.16	1/10/2019 12:45	1/17/2019 12:00	NA	4.45	NA	NA	NA	NA	NA	KP	Y	3	NA	NA	NA	NA	No power to ISCO. Sampled from manhole. Small flow out of manhole. Reset modem.	Some snow in field
JBT18	JBT18-012219-G	G	18,200	1/22/2019	NA	NA	NA	NA	NA	NA	NA	NA	1/17/2019 12:15	1/22/2019 14:00	NA	4.45	NA	NA	NA	NA	NA	KP	NA	1.5	NA	NA	NA	Invalid due to stirring of manhole	Surface of water in manhole frozen. Created some turbidity by breaking ice.	NA
JBT18	JBT18-012419-G	G	23,500	1/24/2019	171	55	4.2	50	4.0	1.3	0.10	1.17	1/22/2019 14:15	1/24/2019 14:15	NA	4.45	NA	NA	NA	NA	NA	NA	NA	82	NA	NA	NA	NA	Outlet drifted in	Most of snow melted from field
JBT18	JBT18-020819-G	G	632,600	2/8/2019	214	161	1.8	36	135.4	101.8	1.11	22.77	1/24/2019 14:30	2/8/2019 10:45	NA	4.45	NA	NA	NA	NA	NA	NA	NA	90	NA	NA	NA	NA	Lots of water flowing around manhole. No power at ISCO. Sampled from manhole.	Ice and water in field
JBT18	JBT18-022219-G	G	3,200	2/22/2019	705	236	6.9	64	2.3	0.8	0.02	0.20	2/8/2019 11:00	2/22/2019 13:15	NA	4.45	NA	NA	NA	NA	NA	NA	Y	4	NA	NA	NA	NA	Some flow out of pipe. No water from pump, appears frozen. Sampled from manhole.	Snow in field
JBT18	JBT18-030419-G	G	201,400	3/4/2019	NA	NA	NA	NA	NA	NA	NA	NA	2/22/2019 13:30	3/4/2019 15:00	NA	4.45	NA	NA	NA	NA	NA	NA	N	2	NA	NA	NA	NA	Restarted modem. No flow out pipe. No samples.	Snow in field
JBT18	JBT18-031519-G	G	53,900	3/15/2019	635	248	2.0	1264	34.2	13.4	0.11	68.13	3/4/2019 15:15	3/15/2019 11:00	NA	4.45	NA	NA	NA	NA	NA	NA	NA	35	NA	NA	NA	NA	Water flowing off field around manhole	NA
JBT18	JBT18-032319-G	G	794,300	3/23/2019	378	151	2.4	406	300.2	119.9	1.93	322.49	3/15/2019 11:15	3/23/2019 15:30	NA	4.45	NA	NA	NA	NA	NA	NA	NA	88	NA	NA	NA	NA	NA	Some snow in field. Ditch snowed over
JBT18	JBT18-033019-G	G	1,064,900	3/30/2019	459	120	NA	332	488.8	127.8	NA	353.55	3/23/2019 15:45	3/30/2019 15:00	NA	4.45	NA	NA	NA	NA	NA	NA	NA	125	NA	NA	NA	NA	Ditch partially full of water.	Most snow gone from field, soil still partially frozen.
JBT18	JBT18-041219-G	G	1,961,600	4/12/2019	NA	NA	NA	NA	NA	NA	NA	NA	3/30/2019 15:15	4/12/2019 12:15	NA	4.45	NA	NA	NA	NA	NA	KP	NA	55	NA	NA	NA	Invalid due to surface runoff	Manhole has additional erosion around it. Some surface water entering. Also sediment accumulation in bottom of manhole. Samples have some sediment in them.	All snow and ice gone from field
JBT18	JBT18-041719-1	1	475,900	4/17/2019	NA	NA	NA	NA	NA	NA	NA	NA	4/12/2019 12:30	4/17/2019 10:45	4.93	4.45	NA	NA	NA	NA	12:10 PM	KP	Y	42.5	33/100 bottle 1	13/100 bottle 3	NA	Invalid due to sediment	Moved sample intake to bottom of outlet--was buried in sediment. Small amount of sediment in bottom of carboys.	No activity in field
JBT18	JBT18-042419-1	1	834,800	4/24/2019	174	59	4.4	24	145.3	49.3	3.63	20.04	4/17/2019 11:00	4/24/2019 9:45	6.95	4.45	4.696	1.592	0.117	0.648	NA	KP	Y	37	68/100 bottle 1	22/100 bottle 3	NA	NA	Low flow out pipe	No activity in field
JBT18	JBT18-050319-1	1	781,000	5/3/2019	155	56	NA	23	121.1	43.7	NA	17.71	4/24/2019 10:00	5/3/2019 13:30	9.15	4.45	2.973	1.074	NA	0.435	1:58 PM	KP	Y	131	64/100 bottle 1	21/100 bottle 3	NA	NA	NA	No activity in field
JBT18	JBT18-050919-1	1	379,700	5/9/2019	123	38	3.5	20	46.7	14.4	1.33	7.75	5/3/2019 13:45	5/9/2019 8:15	5.77	4.45	1.818	0.562	0.052	0.302	11:52 AM	KP	Y	20	39/100 bottle 1	11/100 bottle 3	NA	NA	NA	No activity in field
JBT18	JBT18-052219-1	1	684,800	5/22/2019	185	41	2.4	53	126.7	28.1	1.67	36.29	5/15/2019 12:15	5/22/2019 8:45	6.85	4.45	4.152	0.920	0.055	1.190	10:53 AM	KP	Y	39	71/100 bottle 1	19/100 bottle 3	NA	NA	Tile flowing	No activity in field
JBT18	JBT18-053019-1	1	415,800	5/30/2019	145	49	NA	32	60.3	20.4	NA	13.47	5/22/2019 9:00	5/30/2019 15:30	8.27	4.45	1.638	0.553	NA	0.366	3:34 PM	RD	Y	20.3	65/100 bottle 1	15/100 bottle 3	NA	NA	NA	Not planted, ditched to run to manhole
JBT18	JBT18-060519-1	1	213,200	6/5/2019	431	44	2.5	273	91.9	9.4	0.52	58.20	5/30/2019 15:45	6/5/2019 8:45	5.71	4.45	3.616	0.369	0.021	2.290	10:24 AM	RD	Y	19.6	30/100 bottle 1	9/100 bottle 3	Heavy sediment in carboy 1	NA	Leak under manhole left side. Stuffed clay around outside, flow seems to have stopped. Cover to manhole opened at 10:53.	No activity in field
JBT18	JBT18-061119-1	1	167,000	6/11/2019	160	42	NA	47	26.7	7.0	NA	7.90	6/5/2019 9:00	6/11/2019 13:00	6.17	4.45	0.973	0.256	NA	0.288	1:28 PM	RD	Y	25.9	34/100 bottle 1	8/100 bottle 3	NA	NA	NA	No activity in field
JBT18	JBT18-061719-1	1	86,800	6/17/2019	70	26	2.2	15	6.1	2.3	0.19	1.33	6/11/2019 13:15	6/17/2019 11:30	5.93	4.45	0.230	0.086	0.007	0.050	2:25 PM	RD	Y	3.2	19/100 bottle 1	5/100 bottle 3	NA	NA	Tile outlet trickling	Recently sprayed with weed killer, manure spreading in fields nearby, spot burning
JBT18	JBT18-062619-1+2	1+2	487,500	6/26/2019	580	56	NA	314	282.7	27.3	NA	153.07	6/17/2019 11:45	6/26/2019 12:15	9.02	4.45	7.041	0.680	NA	3.812	11:47 AM	RD	Y	14.3	41/100 bottle 2	21/100 bottle 3	Turbid sample	NA	Adjusted sampling arm, was missing holes	2-3" soybean
JBT18	JBT18-070119-1	1	74,300	7/1/2019	91	28	2.3	22	6.8	2.1	0.17	1.60	6/26/2019 12:30	7/1/2019 13:45	5.05	4.45	0.301	0.093	0.007	0.071	1:56 PM	RD	Y	8.5	23/100 bottle 1	4/100 bottle 3	NA	Switched TP and TDP results	NA	3" soybean
JBT18	JBT18-071019-1	1	65,700	7/10/2019	117	16	NA	59	7.7	1.1	NA	3.86	7/1/2019 14:00	7/10/2019 8:45	8.78	4.45	0.197	0.027	NA	0.099	3:14 PM	RD	Y	0.8	38/100 bottle 1	6/100 bottle 3	NA	NA	Tile outlet trickling	8" soybean
JBT18	JBT18-071719-1	1	39,300	7/17/2019	87	20	3.3	50	3.4	0.8	0.13	1.98	7/10/2019 9:00	7/17/2019 7:30	6.94	4.45	0.111	0.025	0.004	0.064	4:00 PM	RD	Y	1.7	23/100 bottle 1	4/100 bottle 3	NA	NA	NA	1' soybean
JBT18	JBT18-072219-1	1	4,900	7/22/2019	39	16	NA	NA	0.2	0.1	NA	NA	7/17/2019 7:45	7/21/2019 20:15	4.52	4.45	0.009	0.004	NA	NA	3:45 PM	RD	N	0.2-0.6	4/100 bottle 1	2/100 bottle 3	NA	NA	Not enough flow for TSS	1' soybean
JBT18	JBT18-073119-1	1	7,700	7/31/2019	72	18	0.9	48	0.6	0.1	0.01	0.37	7/21/2019 20:30	7/31/2019 10:45	9.59	4.45	0.013	0.003	0.000	0.009	3:14 PM	RD	N	0.6-0.8	16/100 bottle 1	3/100 bottle 3	NA	NA	NA	1' soybean
JBT18	JBT18-080719-1	1	5,800	8/7/2019	121	26	NA	43	0.7	0.2	NA	0.25	7/31/2019 11:00	8/7/2019 6:00	6.79	4.45	0.023	0.005	NA	0.008	11:11 AM	RD	N	-0.7	13/100 bottle 1	3/100 bottle 3	NA	NA	Manhole dry	2' soybean
JBT18	JBT18-081519-1	1	9,400	8/15/2019	354	178	4.9	43	3.3	1.7	0.05	0.40	8/7/2019 6:15	8/15/2019 12:15	8.25	4.45	0.091	0.046	0.001	0.011	12:40 PM	KP	N	0	33/100 bottle 1	5/100 bottle 3	NA	NA	Reset modem	Soybeans 2-3', field cultivated between rows
JBT18	JBT18-082219-1	1	3,300	8/22/2019	465	370	NA	23	1.5	1.2	NA	0.08	8/15/2019 12:30	8/20/2019 21:30	5.38	4.45	0.064	0.051	NA	0.003	2:39 PM	RD	N	0	13/100 bottle 1	3/100 bottle 3	NA	NA	NA	3' soybean
JBT18	JBT18-082919-NS	NS	-	8/29/2019	NA	NA	NA	NA	NA	NA	NA	NA	8/20/2019 21:45	8/29/2019 13:00	NA	4.45	NA	NA	NA	NA	1:02 PM	RD	N	0	NA	2/100 bottle 3	NA	NA	Dry manhole, modem reset, sampler is OFF	No change

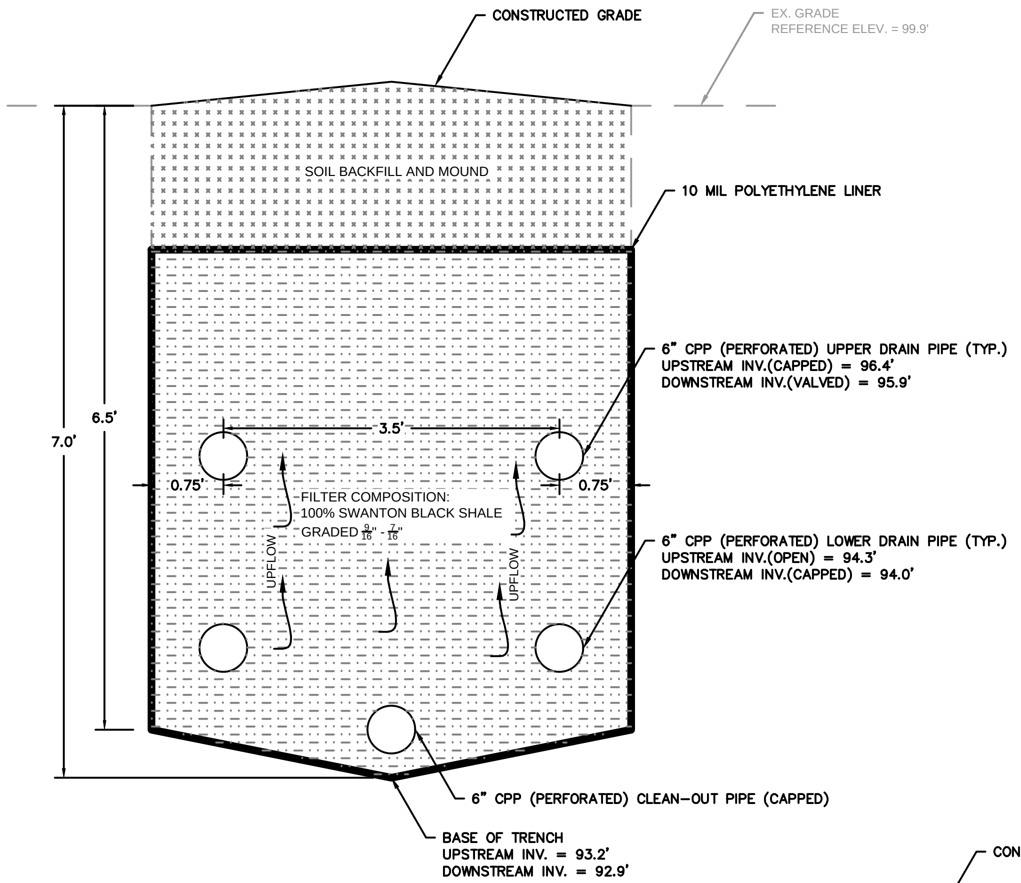
Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d)	TDP Load (g/d)	TN Load (kg/d)	TSS Load (kg/d)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT05	JBT5-120919	1	4,028,601	12/9/2019	129	78	28.3	8	519.7	314.2	113.80	32.20	11/27/2019 18:45	12/9/2019 13:15	11.77	38.04	44.155	26.695	9.669	2.736	1:25 PM	KP	NA	NA	16/100 bottle 1	4/100 bottle 3	NA	NA	NA	NA
JBT05	JBT5-121619-1	1	1,814,600	12/16/2019	350	166	28.1	25	635.1	301.2	51.00	45.20	12/9/2019 13:30	12/16/2019 13:15	6.99	38.04	90.858	43.090	7.296	6.466	1:20 PM	KP	Y	193	33/100 bottle 1	6/100 bottle 3	NA	NA	Reset pacing to 300/2000. Site OK, no freezing	Manure spread on field
JBT05	JBT5-122319-1	1	988,700	12/23/2019	58	27	25.7	84	57.3	26.7	25.40	83.20	12/16/2019 13:30	12/23/2019 13:15	6.99	38.04	8.197	3.820	3.634	11.903	1:20 PM	KP	Y	62	34/100 bottle 1	6/100 bottle 3	NA	NA	A little ice in carboy 3. Reconnected sample line at bottom of sampler. Part A pacing set to 120.	No activity
JBT05	JBT5-123019-1	1	1,114,345	12/30/2019	1380	1410	20.2	8	1537.8	1571.2	22.50	8.50	12/23/2019 13:30	12/30/2019 13:30	7.00	38.04	219.686	224.457	3.214	1.214	1:15 PM	KP	Y	90	53/100 bottle 1	NA	NA	Significant sampling gap	Power loss 12/28/19, sampler stopped at 29 counts.	No activity, ~1-2" snow/ice
JBT05	JBT5-010620-2	2	2,756,299	1/6/2020	795	635	21.7	21	2191.3	1750.3	59.70	58.40	12/30/2019 13:45	1/6/2020 14:15	7.02	38.04	312.151	249.330	8.504	8.319	2:22 PM	KP	Y	273	33/100 bottle 1	15/100 bottle 2	NA	NA	Some ice in carboys. Part A pacing changed from 210 to 450. Part B still 2000.	1-2" snow on field
JBT05	JBT5-011320-1+2	1+2	3,681,701	1/13/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/6/2020 14:30	1/13/2020 12:30	6.92	38.04	NA	NA	NA	NA	12:15 PM	KP	Y	524	NA	NA	Carboys overturned	NA	Water-ice up around shelter over weekend. Both carboys overturned in manhole, both still have ice in them.	Light covering of snow
JBT05	JBT5-012020-1	1	2,009,400	1/20/2020	185	109	24.7	16	371.7	219.0	49.60	31.70	1/13/2020 12:45	1/20/2020 12:00	6.97	38.04	53.329	31.420	7.116	4.548	NA	KP	Y	79	NA	NA	NA	Significant sampling gap	Samplers stopped on 1/16 due to freezing. Filter A still flowing but no flow to frozen outlets. Moved working heater to JBT05. Took grab sample at JBT05. All samplers powered off.	6-8" snow on field. Ditch frozen over
JBT05	JBT5-012020-G	G	2,009,400	1/20/2020	149	129	22.5	2	299.4	259.2	45.21	4.42	1/13/2020 12:45	1/20/2020 12:00	NA	38.04	NA	NA	NA	NA	NA	KP	NA	NA	NA	NA	NA	NA	NA	6-8" snow on field. Ditch frozen over
JBT05	JBT5-012820-1	1	1,892,099	1/28/2020	413	341	20.4	17	781.4	644.3	38.60	32.00	1/20/2020 12:15	1/28/2020 13:15	8.04	38.04	97.189	80.137	4.801	3.980	1:20 PM	KP	Y	329	35/100 bottle 1	9/100 bottle 2	NA	NA	No freezing in manhole	2-3" snow cover
JBT05	JBT5-020320-1	1	1,297,000	2/3/2020	200	159	21.1	10	259.4	206.2	27.40	13.00	1/28/2020 13:30	2/3/2020 14:00	6.02	38.04	43.090	34.252	4.551	2.159	2:05 PM	KP	Y	72	30/100 bottle 1	8/100 bottle 2	NA	NA	No freezing in manhole, some freezing in carboys.	1-3" snow
JBT05	JBT5-021020-1	1	458,500	2/10/2020	93	24	19.6	NA	42.7	11.2	9.00	NA	2/3/2020 14:15	2/10/2020 14:00	6.99	38.04	6.109	1.602	1.288	NA	2:00 PM	KP	Y	39	12/100 bottle 1	4/100 bottle 2	NA	NA	Sample partially frozen. Water in manhole not frozen, sample line unfrozen.	6-8" snow
JBT05	JBT5-021720-1	1	270,200	2/17/2020	364	180	15.7	NA	98.4	48.6	4.20	NA	2/10/2020 14:15	2/16/2020 13:00	5.95	38.04	16.538	8.168	0.706	NA	9:55 AM	KP	Y	23	8/100 bottle 1	3/100 bottle 2	Sampler line frozen, sampling adequate	NA	Sample line frozen. Stop program.	6-8" snow
JBT05	JBT5-022420-NS	NS	289,300	2/24/2020	NA	NA	NA	NA	NA	NA	NA	NA	2/16/2020 13:15	2/24/2020 13:00	NA	38.04	NA	NA	NA	NA	1:10 PM	KP	Y	28.5	NA	NA	NA	NA	No samples collected. Restart sampler. Pacing 225/1,000. Batteries good. No ice in manhole.	3-6" snow
JBT05	JBT5-030220-3	3	2,313,400	3/2/2020	286	238	16.1	24	661.6	550.6	37.20	55.10	2/24/2020 13:15	3/2/2020 13:45	7.02	38.04	94.245	78.433	5.299	7.849	1:40 PM	KP	Y	136	5/100 bottle 1	25/100 bottle 3	NA	NA	No ice in manhole, some ice in carboys. Increased pacing to 450/2,000	1-3" snow and ice
JBT05	JBT5-030920-3	3	6,232,501	3/9/2020	661	634	14.9	25	4116.6	3948.3	92.60	158.30	3/2/2020 14:00	3/9/2020 13:30	6.98	38.04	589.771	565.659	13.266	22.679	1:25 PM	KP	Y	1130	40/100 bottle 1	33/100 bottle 2	NA	NA	Carboy 1 overflowing. Changed pacing to 700/3,000. Ditch full	No snow
JBT05	JBT5-031620-1	1	5,780,301	3/16/2020	407	362	22.3	14	2352.6	2092.5	128.90	78.60	3/9/2020 13:45	3/16/2020 14:30	7.03	38.04	334.651	297.653	18.336	11.181	2:30 PM	KP	Y	216	84/100 bottle 1	21/100 bottle 3	NA	NA	Some ice in carboy	Bare ground
JBT05	JBT5-032320-1	1	1,279,800	3/23/2020	102	87	21.7	3	130.5	111.1	27.80	3.30	3/16/2020 14:45	3/23/2020 13:00	6.93	38.04	18.831	16.032	4.012	0.476	1:10 PM	KP	Y	80	20/100 bottle 1	6/100 bottle 3	NA	NA	Changed pacing 350/2,000	No activity
JBT05	JBT5-033120-1	1	1,822,500	3/31/2020	NA	NA	NA	NA	NA	NA	NA	NA	3/23/2020 13:15	3/31/2020 14:15	8.04	38.04	NA	NA	NA	NA	Remotely: 3/26/20 1:45 pm	KP	Y	495	12/100 bottle 1	3/100 bottle 3	Invalid. Sampling inadequate	NA	Had been remotely stopped on 3/26. Restarted 3/31 at 1:45 pm	No activity
JBT05	JBT5-040720-3	3	3,436,799	4/7/2020	132	NA	23.6	92	453.7	NA	81.10	314.80	3/31/2020 14:30	4/7/2020 12:30	6.92	38.04	65.564	NA	11.720	45.491	1:10 PM	KP	Y	180	1/100 bottle 1	19/100 bottle 3	NA	NA	Looks OK, carboy 1 overflowing. Used #3	No activity
JBT05	JBT5-041420-1	1	2,028,300	4/14/2020	74	60	9.3	80	149.5	121.9	18.90	163.10	4/7/2020 12:45	4/14/2020 13:15	7.02	38.04	21.296	17.365	2.692	23.234	2:30 PM	KP	Y	170	60/100 bottle 1	12/100 bottle 3	NA	NA	NA	No activity
JBT05	JBT5-042020-1	1	936,700	4/20/2020	54	44	25.4	3	50.8	41.4	23.80	2.30	4/14/2020 13:30	4/20/2020 8:15	5.78	38.04	8.789	7.163	4.118	0.398	9:10 AM	KP	Y	67	28/100 bottle 1	6/100 bottle 3	NA	NA	Changed pacing to 300/2000. All flow diverted to filters.	No activity
JBT05	JBT5-042720-1	1	510,400	4/27/2020	146	56	23.4	9	74.5	28.4	11.90	4.40	4/20/2020 8:30	4/27/2020 12:00	7.15	38.04	10.420	3.972	1.664	0.615	12:50 PM	KP	N	37	19/100 bottle 1	4/100 bottle 3	NA	NA	Changed pacings to 100/750. No flow from bypass.	No activity
JBT05	JBT5-050420-1	1	350,300	5/4/2020	79	63	20.4	5	27.7	22.1	7.10	1.60	4/27/2020 12:15	5/4/2020 12:00	6.99	38.04	3.963	3.162	1.016	0.229	1:00 PM	KP	N	32	37/100 bottle 1	6/100 bottle 3	NA	NA	Pacings unchanged. No flow out bypass	No activity
JBT05	JBT5-051120-1	1	229,700	5/11/2020	126	109	18.3	5	28.9	25.0	4.20	1.00	5/4/2020 12:15	5/11/2020 11:45	6.98	38.04	4.140	3.582	0.602	0.143	12:40 PM	KP	N	19	24/100 bottle 1	5/100 bottle 3	NA	NA	Left all pacings unchanged. No flow out bypass	Spreading manure in upper part of field using dragline (injector?). Some surface applied near shelters.
JBT05	JBT5-051820-1	1	276,600	5/18/2020	113	97	19.0	3	31.1	26.8	5.20	0.80	5/11/2020 12:00	5/18/2020 12:45	7.03	38.04	4.424	3.812	0.740	0.114	1:45 PM	KP	N	33.4	29/100 bottle 1	5/100 bottle 3	NA	NA	No flow out bypass. No change to pacings	Tilled and planted
JBT05	JBT5-052520-1	1	297,900	5/25/2020	42	36	21.0	4	12.5	10.8	6.30	1.30	5/18/2020 13:00	5/25/2020 13:00	7.00	38.04	1.786	1.543	0.900	0.186	2:10 PM	KP	N	26	100/100 bottle 1	5/100 bottle 3	NA	NA	No flow out bypass. Pacings 100/750	No activity
JBT05	JBT5-060120-1	1	764,100	6/1/2020	148	107	31.8	22	112.7	81.8	24.30	17.10	5/25/2020 13:15	6/1/2020 11:30	6.93	38.04	16.263	11.804	3.506	2.468	12:35 PM	KP	N	78	78/100 bottle 1	12/100 bottle 3	NA	NA	No change to pacings. No flow out bypass	Corn ~4"
JBT05	JBT5-060820-1	1	546,000	6/8/2020	65	58	26.6	3	35.4	31.5	14.50	1.80	6/1/2020 11:45	6/8/2020 8:00	6.84	38.04	5.175	4.605	2.120	0.263	9:10 AM	KP	N	32	56/100 bottle 1	9/100 bottle 3	NA	NA	No flow out bypass. No change to pacings	Corn ~6"
JBT05	JBT5-061520-1	1	203,200	6/15/2020	96	48	24.5	31	19.5	9.8	5.00	6.20	6/8/2020 8:15	6/15/2020 8:00	6.99	38.04	2.790	1.402	0.715	0.887	9:05 AM	KP	N	13	22/100 bottle 1	4/100 bottle 3	NA	NA	No flow out bypass. No change to pacings	Corn ~10"
JBT05	JBT5-062220-1	1	130,600	6/22/2020	47	29	22.9	13	6.1	3.7	3.00	1.70	6/15/2020 8:15	6/22/2020 6:45	6.94	38.04	0.879	0.533	0.432	0.245	7:45 AM	KP	Y	10	15/100 bottle 1	3/100 bottle 3	NA	NA	No flow out bypass. No change to pacings	Corn ~14"
JBT05	JBT5-062920-1	1	94,200	6/29/2020	135	33	19.7	95	12.7	3.1	1.90	8.90	6/22/2020 7:00	6/29/2020 13:15	7.26	38.04	1.749	0.427	0.262	1.226	2:05 PM	KP	Y	6	11/100 bottle 1	3/100 bottle 3	NA	NA	No change to pacings. No flow out bypass	Corn ~16-24"
JBT05	JBT5-070520-1+3	1+3	61,100	7/5/2020	NA	NA	NA	NA	NA	NA	NA	NA	6/29/2020 13:30	7/6/2020 7:45	6.76	38.04	NA	NA	NA	NA	8:40 AM	KP	Y	16	8/100 bottle 1	2/100 bottle 3	Invalid. Negligible sample. Combined 1+3 by mistake	NA	No change to pacings. No flow out bypass	Corn 3-4 ft
JBT05	JBT5-071320-1	1	399,500	7/13/2020	333	118	33.7	140	133.0	47.1	13.50	55.90	7/6/2020 8:00	7/13/2020 6:30	6.94	38.04	19.164	6.787	1.945	8.055	7:30 AM	KP	Y	4	41/100 bottle 1	7/100 bottle 3	NA	NA	No change to pacings. No flow out bypass	Corn ~5 ft
JBT05	JBT5-072420-1	3	222,100	7/24/2020	59	29	16.2	26	13.2	6.5	3.60	5.70	7/13/2020 6:45	7/24/2020 7:30	11.03	38.04	1.197	0.589	0.326	0.517	8:30 AM	KP	N	-26	24/100 bottle 1	4/100 bottle 3	NA	NA	No flow out bypass. Flow meter negative	Corn ~6 ft
JBT05	JBT5-073020-1	1	224,300	7/30/2020	61	37	15.8	26	13.7	8.2	3.50	5.80	7/24/2020 7:45	7/30/2020 9:15	6.06	38.04	2.261	1.353	0.578	0.957	10:20 AM	KP	N	-25	24/100 bottle 1	5/100 bottle 3	NA	NA	Water level ~ 1 ft below bypass. No flowing water visible	Corn ~6-7 ft
JBT05	JBT5-080820-1	1	655,300	8/8/2020	185	134	18.0	29	120.9	87.8	11.80	18.80	7/30/2020 9:30	8/8/2020 8:45	8.97	38.04	13.478	9.788	1.315	2.096	9:42 AM	KP	N	-22	67/100 bottle 1	10/100 bottle 3	NA	NA	No flow out bypass. No visual evidence of flow. Pacings 100/750	Corn ~8 ft
JBT05	JBT5-081720-1	1	376,500	8/17/2020	78	33	13.2	NA	29.3	12.3	5.00	NA	8/8/2020 9:00	8/17/2020 10:30	9.06	38.04	3.234	1.358	0.552	NA	11:20 AM	KP	N	34	39/100 bottle 1	7/100 bottle 3	NA	NA	No visible flow	Corn ~8 ft
JBT05	JBT5-082520-NS	NS	366,600	8/25/2020	NA	NA	NA	NA	NA	NA	NA	NA	8/17/2020 10:45	8/25/2020 13:00	NA	38.04	NA	NA	NA	NA	2:05 PM	KP	N	28	38/100 bottle 1	6/100 bottle 3	Insufficient sample	NA	No visible flow	Corn 8-10 ft
JBT05	JBT5-090120-NS	NS	309,000	9/1/2020	NA	NA	NA	NA	NA	NA	NA	NA	8/25/2020 13:15	9/1/2020 10:15	NA	38.04	NA	NA	NA	NA	11:10 AM	KP	N	30	32/100 bottle 1	6/100 bottle 3	No samples collected	NA	No visible flow	Corn 9-10 ft
JBT05	JBT5-091420-NS	NS	632,900	9/14/2020	NA	NA	NA	NA	NA	NA	NA	NA	9/1/2020 10:30	9/14/2020 8:15	NA	38.04	NA	NA	NA	NA	9:10 AM	KP	N	32	65/100 bottle 1	10/100 bottle 3	No samples collected	NA	No visible flow	Corn ~10 ft
JBT05	JBT5-092820-NS	NS	678,200	9/28/2020	NA	NA	NA	NA	NA	NA	NA	NA	9/14/2020 8:30	9/28/2020 8:30	NA	38.04	NA	NA	NA	NA	9:20 AM	KP	N	33	NA	NA	No samples collected	NA	No visible flow	Corn harvested, no manure
JBT05	JBT5-100520-1	1	329,100	10/5/2020	83	63	6.9	8	27.4	20.6	2.30	2.60	9/28/2020 8:45	10/5/2020 9:00	7.01	38.04	3.909	2.939	0.328	0.371	9:55 AM	KP	N	30	34/100 bottle 1	6/100 bottle 3	NA	NA	No visible flow	No manure
JBT05	JBT5-101220-1	1	339,400	10/12/2020	36	28	3.4	7	12.3	9.5	1.20	2.30	10/5/2020 9:15	10/12/2020 9:00	6.99	38.04	1.760	1.359	0.172	0.329	9:55 AM	KP	N	32	35/100 bottle 1	6/100 bottle 3	NA	NA	No visible flow. Water level below bypass	No manure
JBT05	JBT5-101720-NS	NS	252,600	10/17/2020	NA	NA	NA	NA	NA	NA	NA	NA	10/12/2020 9:15	10/17/2020 16:00	NA	38.04	NA	NA	NA	NA	NA	DCB	N	NA	NA	NA	Sample dumped 10/17, sampler not reset	NA	NA	NA
JBT05	JBT5-102620-1	1	260,900	10/26/2020	60	47	15.5	6	15.7	12.3	4.00	1.60	10/17/2020 16:15	10/26/2020 9:00	8.70	38.04	1.805	1.414	0.460	0.184	9:50 AM	KP	N	14	53/100 bottle 1	8/100 bottle 3	NA	NA	No visible flow	No manure
JBT05	JBT5-110220-1	1	239,300	11/2/2020	47	39	13.9	3	11.2	9.4	3.30	0.70	10/26/2020 9:15	11/2/2020 10:30	7.05	38.04	1.589	1.333	0.468	0.099	11:25 AM	KP	N	29	26/100 bottle 1	5/100 bottle 3	NA	NA	No visible flow	No manure
JBT05	JBT5-110920-1	1	303,700	11/9/2020	43	29	2.2	8	13.0	8.6	0.70	2.40	11/2/2020 10:45	11/9/2020 10:30	6.99	38.04	1.860	1.230	0.100	0.343	11:25 AM	KP	N	32	82/100 bottle 1	6/100 bottle 3	NA	NA	No visible flow	No manure
JBT05	JBT5-111620-1	1	300,000	11/16/2020	47	34	2.2	6	14.0	10.2	0.60	1.90	11/9/2020 10:45	11/16/2020 8:45	6.92	38.04	2.023	1.474	0.087	0.275	9:35 AM	KP	N	14	31/100 bottle 1	5/100 bottle 3	NA	NA	No flow from outlet	No manure
JBT05	JBT5-112320-1	1	251,400	11/23/2020	42	40	12.0	3	10.6	10.0	3.00	0.60	11/16/2020 9:00	11/23/2020 10:00	7.04	38.04	1.506	1.420	0.426	0.085	11:00 AM	KP	N	25	27/100 bottle 1	5/100 bottle 3	NA	NA	NA	No manure
JBT05	JBT5-113020-1	1	202,400	11/30/2020	41	37	15.8	3	8.3	7.4	3.20	0.50	11/23/2020 10:15	11/30/2020 8:15	6.92	38.04	1.199	1.069	0.462	0.072	9:05 AM	KP	N	12	22/100 bottle 1	4/100 bottle 3	NA	NA	NA	No manure
JBT05	JBT5-120720-3	3	978,800	12/7/2020	76	54	43.5	8	74.0	53.1	42.60	8.20	11/30/2020 8:30	12/7/2020 2:15	6.74	38.04	10.979	7.878	6.320	1.217	3:15 AM	KP	N	26	100/100 bottle 1	15/100 bottle 3	NA	NA	Water level 3-in. below bypass	No manure
JBT05	JBT5-121420-1	1	85,700	12/14/2020	150	48	23.9	45	12.9	4.1	2.00	3.80	12/7/2020 2:30	12/14/2020 10:00	7.31	38.04	1.765	0.561	0.274	0.520	11:00 AM	KP	N	20	10/100 bottle 1	3/100 bottle 3	NA	NA	Water level 6-in. below overflow	No manure
JBT05	JBT5-122120-1	1	140,500	12/21/2020	48	21	20.7	77	6.8	2.9	2.90	10.70	12/14/2020 10:15	12/21/2020 12:15	7.08	38.04	0.960	0.410	0.410	1.511	12:05 PM	KP	N	17	15/100 bottle 1	3/100 bottle 3	NA	NA	Water level 8-in. below overflow	No manure
JBT05	JBT5-122920-1	1	565,500	12/29/2020	72	50	34.6	10	40.6	28.0	19.60	5.40	12/21/2020 12:30	12/29/2020 11:15	7.95	38.04	5.107	3.522	2.465	0.679	12:15 PM	KP	N	8	58/100 bottle 1	9/100 bottle 3	NA	NA	Water level 9-in. below overflow	No manure
JBT05	JBT5-010521-1	1	146,700	1/5/2021	80	28	22.8	96	11.8	4.1	3.30	14.10	12/29/2020 11:30	1/5/2021 9:15	6.91	38.04	1.708	0.593	0.478	2.041	10:00 AM	KP	N	NA	19/100 bottle 1	4/100 bottle 3	NA	NA	Water level 9-in. below overflow	No manure
JBT5FA	JBT5A-120919	1	1,176,800	12/9/2019	194	153	24.8	34	228.3	180.1	29.10	39.50	11/27/2019 18:45	12/9/2019 13:15	11.77	38.04	19.397	15.302	2.472	3.356	1:25 PM	KP	NA	NA	18/100 bottle 1	6/100 bottle 3	NA	NA	NA	NA
JBT5FA	JBT5A-121619-1	1	512,300	12/16/2019	226	137	25.4	23	115.8	70.2	13.00	11.50	12/9/2019 13:30	12/16/2019 13:15	6.99	38.04	16.567	10.043	1.860	1.645	1:20 PM	KP	Y	100	21/100 bottle 1	7/100 bottle 3	NA	NA	Pacing reset to 140/500. Some freezing in carboy	Manure spread on field
JBT5FA	JBT5A-122319-1	1	545,100	12/23/2019	52	26	26.0	31	28.3	14.2	14.20	17.10	12/16/2019 13:30	12/23/2019 13:15	6.99	38.04	4.049	2.031	2.031	2.446	1:20 PM	KP	Y	40	NA	NA	NA	Minor sampling gap--disregard	Sampler program stopped (low battery). Some ice in both carboys. Part A pacing set to 100.	No activity
JBT5FA	JBT5A-123019-1	1	417,000	12/30/2019	685	690	18.2	4	285.6	287.7	7.60	1.70	12/23/2019 13:30	12/30/2019 13:30	7.00	38.04	40.800	41.100	1.086	0.243	1:30 PM	KP	Y	67	43/100 bottle 1	10/100 bottle 1	NA	NA	NA	No activity
JBT5FA	JBT5A-010620-1	1	154,600	1/6/2020	500	463	2.9	10	77.3	71.6	0.50	1.50	12/30/2019 13:45	1/6/2020 14:15	7.02	38.04	11.011	10.199	0.071	0.214	2:35 PM	KP	Y	20	17/100 bottle 1	5/100 bottle 2	NA	NA	Pacings set to 80/500. Some ice in carboys	1-2" snow on field
JBT5FA	JBT5A-011320-G	G	212,900	1/13/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/6/2020 14:30	1/13/2020 12:30	NA	38.04	NA	NA	NA	NA	1:46 PM	KP	Y	6.3	NA	NA	Carboys overturned	NA	Locks and doors all frozen. Both carboys overturned in bottom of manhole	Ice and snow
JBT5FA	JBT5A-012020-NS	NS	52,800	1/20/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/13/2020 12:45	1/20/2020 12:00	NA	38.04	NA	NA	NA	NA	NA	KP	N	NA	NA	NA	NA	NA	Filter outlets frozen	6-8" snow on field. Ditch frozen over
JBT5FA	JBT5A-012820-1+2	1+2	107,200	1/28/2020	202	98	19.7	NA	21.7	10.5	2.10	NA	1/20/2020 12:15	1/28/2020 13:15	8.04	38.04	2.699	1.306	0.261	NA	1:25 PM	KP	N?	NA	9/100 bottle 1	3/100 bottle 1	NA	NA	Outlet may be frozen. Some ice in manhole and samples	2-3" snow cover
JBT5FA	JBT5A-020320-NS	NS	131,800	2/3/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/28/2020 13:30	2/3/2020 14:00	NA	38.04	NA	NA	NA	NA	2:15 PM	KP	Y	26	NA	NA	Power failed after 3 samples. No sample in carboy.	NA	No freezing manhole. Carboys frozen. Restarted sampler	1-3" snow
JBT5FA	JBT5A-021020-1	1	191,800	2/10/2020	74	70	17.9	4	14.1	13.3	3.40	0.80	2/3/2020 14:15	2/10/2020 14:00	6.99	38.04	2.017	1.903	0.486	0.114	2:10 PM	KP	Y	16	25/100 bottle 1	5/100 bottle 2	Sampler line frozen	NA	Water in manhole frozen on surface. Sample partially frozen. Sample line frozen, thawed and replaced.	6-8" snow
JBT5FA	JBT5A-021720-1	1	104,300	2/17/2020	119	42	14.2	88	12.4	4.4	1.50	9.20	2/10/2020 14:15	2/16/2020 9:00	5.78	38.04	2.145	0.761	0.260	1.592	10:05 AM	KP	Y	8	NA	NA	NA	NA	NA	6-8" snow

Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d)	TDP Load (g/d)	TN Load (kg/d)	TSS Load (kg/d)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT5FA	JBT5A-022420-NS	NS	109,200	2/24/2020	NA	NA	NA	NA	NA	NA	NA	NA	2/16/2020 9:15	2/24/2020 13:00	NA	38.04	NA	NA	NA	NA	1:15 PM	KP	Y	11	NA	NA	NA	NA	Restarted sampler. No ice in manhole. No samples collected.	3-6" snow
JBT5FA	JBT5A-030220-1	1	151,000	3/2/2020	119	90	14.0	17	18.0	13.6	2.10	2.50	2/24/2020 13:15	3/2/2020 13:45	7.02	38.04	2.564	1.937	0.299	0.356	2:00 PM	KP	Y	17	20/100 bottle 1	5/100 bottle 3	NA	NA	Some ice in manhole. Sample frozen. No change to pacing	1-3" snow and ice
JBT5FA	JBT5A-030920-1	1	121,700	3/9/2020	391	380	12.0	5	47.6	46.2	1.50	0.60	3/2/2020 14:00	3/9/2020 13:30	6.98	38.04	6.819	6.619	0.215	0.086	1:35 PM	KP	Y	23	17/100 bottle 1	4/100 bottle 3	NA	NA	Looks Ok. Water just below carboys	No snow
JBT5FA	JBT5A-031620-NS	NS	96,000	3/16/2020	NA	NA	NA	NA	NA	NA	NA	NA	3/9/2020 13:45	3/16/2020 14:30	NA	38.04	NA	NA	NA	NA	2:40 PM	KP	Y	14	2/100 bottle 1	1/100 bottle 3	NA	NA	May not have restarted program. Some ice in carboy	Bare ground
JBT5FA	JBT5A-032320-1	1	173,700	3/23/2020	112	100	21.4	4	19.5	17.4	3.70	0.60	3/16/2020 14:45	3/23/2020 13:00	6.93	38.04	2.814	2.511	0.534	0.087	1:20 PM	KP	Y	27	23/100 bottle 1	5/100 bottle 3	NA	NA	Changed pacing 70/500	No activity
JBT5FA	JBT5A-033120-1+3	1+3	228,700	3/31/2020	NA	NA	NA	NA	NA	NA	NA	NA	3/23/2020 13:15	3/31/2020 14:15	8.04	38.04	NA	NA	NA	NA	2:10 PM	KP	Y	10	?	?	Invalid. Sampler malfunction. Combined carboys 1+3.	NA	No power at sampler. Will not turn on.	No activity
JBT5FA	JBT5A-040720-NS	NS	170,000	4/7/2020	NA	NA	NA	NA	NA	NA	NA	NA	3/31/2020 14:30	4/7/2020 12:30	NA	38.04	NA	NA	NA	NA	NA	KP	Y	32	NA	NA	NA	NA	Fuse to sampler blown, also plug burned	No activity
JBT5FA	JBT5A-041420-NS	NS	322,400	4/14/2020	NA	NA	NA	NA	NA	NA	NA	NA	4/7/2020 12:45	4/14/2020 13:15	NA	38.04	NA	NA	NA	NA	2:10 PM	KP	Y	37	NA	NA	NA	NA	Replaced power cord. Restarted sampler	No activity
JBT5FA	JBT5A-042020-1	1	268,000	4/20/2020	47	39	25.3	3	12.5	10.5	6.80	0.70	4/14/2020 13:30	4/20/2020 8:15	5.78	38.04	2.163	1.817	1.176	0.121	9:20 AM	KP	Y	18	40/100 bottle 1	7/100 bottle 3	NA	NA	Opened gates a little further. Did not have any effect on flow rate. Changed pacing to 50/400.	No activity
JBT5FA	JBT5A-042720-1	1	130,200	4/27/2020	54	43	23.9	3	7.0	5.6	3.10	0.30	4/20/2020 8:30	4/27/2020 12:00	7.15	38.04	0.979	0.783	0.434	0.042	1:00 PM	KP	Y	9	34/100 bottle 1	4/100 bottle 3	NA	NA	Changed pacings to 20/250	No activity
JBT5FA	JBT5A-050420-1	1	77,400	5/4/2020	59	41	20.4	6	4.5	3.2	1.60	0.50	4/27/2020 12:15	5/4/2020 12:00	6.99	38.04	0.644	0.458	0.229	0.072	1:10 PM	KP	Y	8	40/100 bottle 1	5/100 bottle 1	NA	NA	No change to pacings	No activity
JBT5FA	JBT5A-051120-1	1	39,800	5/11/2020	48	30	17.6	18	1.9	1.2	0.70	0.70	5/4/2020 12:15	5/11/2020 11:45	6.98	38.04	0.272	0.172	0.100	0.100	12:50 PM	KP	Y	3	21/100 bottle 1	3/100 bottle 3	NA	NA	Left all pacings unchanged	Spreading manure in upper part of field using dragline (injector?). Some surface applied near shelters.
JBT5FA	JBT5A-051820-1	1	46,500	5/18/2020	85	64	17.1	4	4.0	3.0	0.80	0.20	5/11/2020 12:00	5/18/2020 12:45	7.03	38.04	0.569	0.427	0.114	0.028	1:55 PM	KP	Y	6.4	25/100 bottle 1	3/100 bottle 3	NA	NA	No change to pacings	Tilled and planted
JBT5FA	JBT5A-052520-1	1	53,300	5/25/2020	50	36	19.2	15	2.7	1.9	1.00	0.80	5/18/2020 13:00	5/25/2020 13:00	7.00	38.04	0.386	0.271	0.143	0.114	2:15 PM	KP	Y	7	28/100 bottle 1	4/100/ bottle 3	NA	NA	Pacings 20/250	No activity
JBT5FA	JBT5A-060120-1	1	263,500	6/1/2020	122	104	34.2	5	32.1	27.4	9.00	1.40	5/25/2020 13:15	6/1/2020 11:30	6.93	38.04	4.632	3.954	1.299	0.202	12:40 PM	KP	Y	27	83/100 bottle 1	12/100 bottle 3	NA	NA	No change to pacings	Corn ~4"
JBT5FA	JBT5A-060820-1	1	140,400	6/8/2020	54	40	27.1	5	7.6	5.6	3.80	0.70	6/1/2020 11:45	6/8/2020 8:00	6.84	38.04	1.111	0.819	0.556	0.102	9:15 AM	KP	Y	6	72/100 bottle 1	7/100 bottle 3	NA	NA	No change to pacings	Corn ~6"
JBT5FA	JBT5A-061520-1	1	50,400	6/15/2020	87	20	24.8	22	4.4	1.0	1.20	1.10	6/8/2020 8:15	6/15/2020 8:00	6.99	38.04	0.629	0.143	0.172	0.157	9:10 AM	KP	NA	2	27/100 bottle 1	4/100 bottle 3	NA	NA	No change to pacings	Corn ~10"
JBT5FA	JBT5A-062220-1	1	25,200	6/22/2020	43	24	22.8	68	1.1	0.6	0.60	1.70	6/15/2020 8:15	6/22/2020 6:45	6.94	38.04	0.159	0.086	0.086	0.245	7:50 AM	KP	Y	2.5	14/100 bottle 1	3/100 bottle 3	NA	NA	No change to pacings	Corn ~14"
JBT5FA	JBT5A-062920-1	1	9,800	6/29/2020	31	18	20.8	NA	0.3	0.2	0.20	NA	6/22/2020 7:00	6/29/2020 13:15	7.26	38.04	0.041	0.028	0.028	NA	2:20 PM	KP	N	0	8/100 bottle 1	3/100 bottle 3	Insufficient sample for TSS. No dupes either.	NA	No change to pacings	Corn ~16-24"
JBT5FA	JBT5A-070520-1+3	1+3	6,000	7/5/2020	NA	NA	NA	NA	NA	NA	NA	NA	6/29/2020 13:30	7/6/2020 7:45	6.76	38.04	NA	NA	NA	NA	9:00 AM	KP	Y	1	4/100 bottle 1	2/100 bottle 3	Invalid. Negligible sample. Combined 1+3 by mistake	NA	No change to pacings. No dupes, not enough sample.	Corn 3-4 ft
JBT5FA	JBT5A-071320-1	1	208,300	7/13/2020	74	62	31.8	4	15.4	12.8	6.60	0.80	7/6/2020 8:00	7/13/2020 6:30	6.94	38.04	2.219	1.844	0.951	0.115	7:35 AM	KP	Y	6	106/100 bottle 1	10/100 bottle 3	NA	NA	No change in pacings	Corn ~5 ft
JBT5FA	JBT5A-072420-NS	NS	16,400	7/24/2020	NA	NA	NA	NA	NA	NA	NA	NA	7/13/2020 6:45	7/24/2020 7:30	NA	38.04	NA	NA	NA	NA	8:35 AM	KP	N	-1	10/100 bottle 1	2/100 bottle 3	NA	NA	Flow meter negative. No samples collected.	Corn ~6 ft
JBT5FA	JBT5A-073020-NS	NS	3,800	7/30/2020	NA	NA	NA	NA	NA	NA	NA	NA	7/24/2020 7:45	7/30/2020 9:15	NA	38.04	NA	NA	NA	NA	10:25 AM	KP	N	0	3/100 bottle 1	1/100 bottle 3	NA	NA	No samples, no flow. Water level ~ 6 in. above inflow pipes, no evidence of flow.	Corn ~6-7 ft
JBT5FA	JBT5A-080820-1	1	178,700	8/8/2020	103	81	18.6	8	18.4	14.4	3.30	1.40	7/30/2020 9:30	8/8/2020 8:45	8.97	38.04	2.051	1.605	0.368	0.156	9:50 AM	KP	NA	1.5	91/100 bottle 1	9/100 bottle 3	NA	NA	Pacings: 20/250	Corn ~8 ft
JBT5FA	JBT5A-081720-1	1	7,300	8/17/2020	23	11	16.2	NA	0.2	0.1	0.10	NA	8/8/2020 9:00	8/17/2020 10:30	9.06	38.04	0.022	0.011	0.011	NA	11:25 AM	KP	N	0.5	5/100 bottle 1	2/100 bottle 3	NA	NA	No visible flow	Corn ~8 ft
JBT5FA	JBT5A-082520-NS	NS	4,200	8/25/2020	NA	NA	NA	NA	NA	NA	NA	NA	8/17/2020 10:45	8/25/2020 13:00	NA	38.04	NA	NA	NA	NA	2:10 PM	KP	N	3	4/100 bottle 1	2/100 bottle 3	Insufficient sample	NA	No visible flow	Corn 8-10 ft
JBT5FA	JBT5A-090120-NS	NS	6,300	9/1/2020	NA	NA	NA	NA	NA	NA	NA	NA	8/25/2020 13:15	9/1/2020 10:15	NA	38.04	NA	NA	NA	NA	11:15 AM	KP	N	0.5	5/100 bottle 1	2/100 bottle 3	No samples collected	NA	No visible flow	Corn 9-10 ft
JBT5FA	JBT5A-091420-NS	NS	8,500	9/14/2020	NA	NA	NA	NA	NA	NA	NA	NA	9/1/2020 10:30	9/14/2020 8:15	NA	38.04	NA	NA	NA	NA	9:15 AM	KP	N	0.5	6/100 bottle 1	2/100 bottle 3	No samples collected	NA	No visible flow	Corn ~10 ft
JBT5FA	JBT5A-092820-NS	NS	7,600	9/28/2020	NA	NA	NA	NA	NA	NA	NA	NA	9/14/2020 8:30	9/28/2020 8:30	NA	38.04	NA	NA	NA	NA	9:30 AM	KP	N	0	NA	NA	No samples collected	NA	No visible flow	Corn harvested, no manure
JBT5FA	JBT5A-100520-1	1	19,900	10/5/2020	57	32	5.1	13	1.1	0.6	0.10	0.30	9/28/2020 8:45	10/5/2020 9:00	7.01	38.04	0.157	0.086	0.014	0.043	10:05 AM	KP	N	0	11/100 bottle 1	2/100 bottle 3	NA	NA	No visible flow	No manure
JBT5FA	JBT5A-101220-1	1	6,400	10/12/2020	85	20	7.2	NA	0.5	0.1	0.00	NA	10/5/2020 9:15	10/12/2020 9:00	6.99	38.04	0.072	0.014	0.000	NA	10:05 AM	KP	N	0.4	5/100 bottle 1	2/100 bottle 3	NA	NA	No visible flow	No manure
JBT5FA	JBT5A-101720-NS	NS	6,800	10/17/2020	NA	NA	NA	NA	NA	NA	NA	NA	10/12/2020 9:15	10/17/2020 16:00	NA	38.04	NA	NA	NA	NA	NA	DCB	Y	NA	NA	NA	Sample dumped 10/17, sampler not reset	NA	NA	NA
JBT5FA	JBT5A-102620-1	1	123,600	10/26/2020	34	20	18.8	3	4.2	2.4	2.30	0.40	10/17/2020 16:15	10/26/2020 9:00	8.70	38.04	0.483	0.276	0.264	0.046	10:10 AM	KP	Y	8	67/100 bottle 1	7/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-110220-1	1	54,200	11/2/2020	24	16	14.8	6	1.3	0.9	0.80	0.30	10/26/2020 9:15	11/2/2020 10:30	7.05	38.04	0.184	0.128	0.113	0.043	11:30 AM	KP	Y	2	29/100 bottle 1	4/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-110920-1	1	14,400	11/9/2020	31	14	2.5	51	0.4	0.2	0.00	0.70	11/2/2020 10:45	11/9/2020 10:30	6.99	38.04	0.057	0.029	0.000	0.100	11:30 AM	KP	Y	0.5	9/100 bottle 1	2/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-111620-1	1	14,000	11/16/2020	42	12	2.0	13	0.6	0.2	0.00	0.20	11/9/2020 10:45	11/16/2020 8:45	6.92	38.04	0.087	0.029	0.000	0.029	9:45 AM	KP	Y	10	9/100 bottle 1	2/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-112320-1	1	38,200	11/23/2020	25	20	11.4	11	0.9	0.8	0.40	0.40	11/16/2020 9:00	11/23/2020 10:00	7.04	38.04	0.128	0.114	0.057	0.057	11:05 AM	KP	Y	4.5	20/100 bottle 1	3/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-113020-1	1	233,500	11/30/2020	35	27	18.0	3	8.2	6.2	4.20	0.60	11/23/2020 10:15	11/30/2020 8:15	6.92	38.04	1.185	0.896	0.607	0.087	9:15 AM	KP	Y	30	99/100 bottle 1	11/100 bottle 3	NA	NA	Changed pacings to 60/500	No manure
JBT5FA	JBT5A-120720-3	3	973,400	12/7/2020	92	72	36.9	3	89.4	70.3	35.90	3.30	11/30/2020 8:30	12/7/2020 2:15	6.74	38.04	13.264	10.430	5.326	0.490	3:20 AM	KP	Y	38	69/100 bottle 1	22/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-121420-1	1	290,000	12/14/2020	38	27	23.8	3	10.9	7.8	6.90	0.70	12/7/2020 2:30	12/14/2020 10:00	7.31	38.04	1.491	1.067	0.944	0.096	11:25 AM	KP	Y	40	45/100 bottle 1	7/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-122120-1	1	193,100	12/21/2020	49	21	21.6	40	9.4	4.1	4.20	7.70	12/14/2020 10:15	12/21/2020 12:15	7.08	38.04	1.328	0.579	0.593	1.088	12:15 PM	KP	Y	9	33/100 bottle 1	5/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-122920-1	1	531,300	12/29/2020	56	37	35.2	3	29.9	19.4	18.70	1.80	12/21/2020 12:30	12/29/2020 11:15	7.95	38.04	3.761	2.440	2.352	0.226	12:20 PM	KP	Y	30	90/100 bottle 1	12/100 bottle 3	NA	NA	NA	No manure
JBT5FA	JBT5A-010521-1	1	176,800	1/5/2021	46	23	24.4	3	8.2	4.1	4.30	0.40	12/29/2020 11:30	1/5/2021 9:15	6.91	38.04	1.187	0.593	0.622	0.058	10:10 AM	KP	Y	8.8	31/100 bottle 1	5/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-120919	NA	968,300	12/9/2019	57	29	23.7	11	55.2	28.1	22.90	10.65	11/27/2019 18:45	12/9/2019 13:15	NA	38.04	NA	NA	NA	NA	1:25 PM	KP	NA	NA	NA	NA	NA	NA	NA	NA
JBT5FB	JBT5B-121619-1	1	486,000	12/16/2019	189	94	21.9	20	91.9	45.7	10.60	9.90	12/9/2019 13:30	12/16/2019 13:15	6.99	38.04	13.147	6.538	1.516	1.416	1:20 PM	KP	Y	82	23/100 bottle 1	8/100 bottle 3	NA	NA	Pacing reset to 120/400	Manure spread on field
JBT5FB	JBT5B-122319-1	1	375,500	12/23/2019	50	21	24.4	14	18.8	7.9	9.20	5.30	12/16/2019 13:30	12/23/2019 13:15	6.99	38.04	2.690	1.130	1.316	0.758	1:20 PM	KP	Y	26	33/100 bottle 1	11/100 bottle3	NA	NA	Part A pacing set to 90	No activity
JBT5FB	JBT5B-123019-1	1	249,400	12/30/2019	197	150	18.2	10	49.1	37.4	4.50	2.40	12/23/2019 13:30	12/30/2019 13:30	7.00	38.04	7.014	5.343	0.643	0.343	1:45 PM	KP	Y	41	29/100 bottle 1	8/100 bottle 1	NA	NA	NA	No activity
JBT5FB	JBT5B-010620-1	1	71,000	1/6/2020	177	142	12.2	13	12.6	10.1	0.90	0.90	12/30/2019 13:45	1/6/2020 14:15	7.02	38.04	1.795	1.439	0.128	0.128	2:45 PM	KP	Y	13	No data	No data	Only about 250 mL for TSS sample	NA	Pacings set to 70/500	1-2" snow on field
JBT5FB	JBT5B-011320-1	1	165,400	1/13/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/6/2020 14:30	1/13/2020 12:30	6.92	38.04	NA	NA	NA	NA	2:10 PM	KP	NA	NA	NA	NA	Carboys overturned	NA	Both carboys overturned, one still had sample in it. Battery dead. Sampler not pumping, replaced sample hose on 1/14 1:30 PM and restarted.	Light snow cover
JBT5FB	JBT5B-012020-NS	NS	52,000	1/20/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/13/2020 12:45	1/20/2020 12:00	NA	38.04	NA	NA	NA	NA	NA	KP	NA	NA	NA	NA	NA	NA	Filter outlets frozen	6-8" snow on field. Ditch frozen over
JBT5FB	JBT5B-012820-1+2	1+2	138,100	1/28/2020	328	189	17.3	NA	45.3	26.1	2.40	NA	1/20/2020 12:15	1/28/2020 13:15	8.04	38.04	5.634	3.246	0.299	NA	1:35 PM	KP	Y	4.2	12/100 bottle 1	3/100 bottle 2	NA	NA	Some ice in manhole and sample	2-3" snow cover
JBT5FB	JBT5B-020320-NS	NS	5,400	2/3/2020	NA	NA	NA	NA	NA	NA	NA	NA	1/28/2020 13:30	2/3/2020 14:00	NA	38.04	NA	NA	NA	NA	2:25 PM	KP	Y	30	NA	NA	No sample, sampler malfunction	NA	All lights on relay blinking. Powered off and back on. Reprogrammed and sampled.	1-3" snow
JBT5FB	JBT5B-021020-1	1	227,500	2/10/2020	124	41	19.0	70	28.2	9.4	4.30	16.00	2/3/2020 14:15	2/10/2020 14:00	6.99	38.04	4.034	1.345	0.615	2.289	2:25 PM	KP	Y	20	34/100 bottle 1	5/100 bottle 1	NA	NA	NA	6-8" snow
JBT5FB	JBT5B-021720-1	1	135,500	2/17/2020	41	21	9.0	55	5.6	2.9	1.20	7.40	2/10/2020 14:15	2/16/2020 9:00	5.78	38.04	0.969	0.502	0.208	1.280	10:25 AM	KP	Y	10	NA	NA	NA	NA	NA	6-8" snow
JBT5FB	JBT5B-022420-NS	NS	150,200	2/24/2020	NA	NA	NA	NA	NA	NA	NA	NA	2/16/2020 9:15	2/24/2020 13:00	NA	38.04	NA	NA	NA	NA	1:25 PM	KP	Y	14	NA	NA	NA	NA	No samples collected. Restarted sampler. No ice in manhole. Batteries good.	3-6" snow
JBT5FB	JBT5B-030220-1	1	198,300	3/2/2020	93	74	13.1	8	18.5	14.6	2.60	1.60	2/24/2020 13:15	3/2/2020 13:45	7.02	38.04	2.635	2.080	0.370	0.228	2:10 PM	KP	Y	18	30/100 bottle 1	5/100 bottle 3	NA	NA	Some ice in manhole. Sample frozen	1-3" snow and ice
JBT5FB	JBT5B-030920-1	1	200,500	3/9/2020	274	265	12.7	6	54.9	53.1	2.50	1.20	3/2/2020 14:00	3/9/2020 13:30	6.98	38.04	7.865	7.607	0.358	0.172	1:45 PM	KP	Y	44	10/100 bottle 1	6/100 bottle 3	NA	NA	Looks Ok. Water just below carboys.	No snow
JBT5FB	JBT5B-031620-NS	NS	223,900	3/16/2020	NA	NA	NA	NA	NA	NA	NA	NA	3/9/2020 13:45	3/16/2020 14:30	NA	38.04	NA	NA	NA	NA	2:55 PM	KP	Y	36	NA	NA	NA	NA	May not have restarted program. No ice.	Bare ground
JBT5FB	JBT5B-032320-1	1	436,100	3/23/2020	61	57	21.0	2	26.5	24.6	9.20	0.90	3/16/2020 14:45	3/23/2020 13:00	6.93	38.04	3.824	3.550	1.328	0.130	1:30 PM	KP	Y	55	63/100 bottle 1	10/100 bottle 3	NA	NA	Pacing 70/500 (no change)	No activity
JBT5FB	JBT5B-033120-1	1	512,300	3/31/2020	57	52	19.8	4	29.3	26.8	10.10	2.10	3/23/2020 13:15	3/31/2020 14:15	8.04	38.04	3.644	3.333	1.256	0.261	2:20 PM	KP	Y	22	36/100 bottle 1	6/100 bottle 3	NA	NA	NA	No activity
JBT5FB	JBT5B-040720-1	1	426,300	4/7/2020	68	58	20.1	31	28.9	24.5	8.60	13.20	3/31/2020 14:30	4/7/2020 12:30	6.92	38.04	4.176	3.540	1.243	1.908	1:35 PM	KP	Y	82	63/100 bottle 1	10/100 bottle 3	NA	NA	NA	No activity
JBT5FB	JBT5B-041420-1	1	770,300	4/14/2020	43	37	18.2	78	33.4	28.8	14.00	60.10	4/7/2020 12:45	4/14/2020 13:15	7.02	38.04	4.758	4.103	1.994	8.561	2:20 PM	KP	Y	84	127/100 bottle 1	17/100 bottle 3	NA	NA	NA	No activity
JBT5FB	JBT5B-042020-1	1	608,500	4/20/2020	44	38	26.3	3	26.7	22.9	16.00	1.50	4/14/2020 13:30	4/20/2020 8:15	5.78	38.04	4.619	3.962	2.768	0.260	9:30 AM	KP	Y	46	80/ 100 bottle 1	4/100 bottle 3	NA	NA	No change to pacings	No activity
JBT5FB	JBT5B-042720-1	1	352,100	4/27/2020	38	34	22.9	3	13.5	12.0	8.00	0.90	4/20/2020 8:30	4/27/2020 12:00	7.15	38.04	1.888	1.678	1.119	0.126	1:10 PM	KP	Y	25	52/100 bottle 1	9/100 bottle 3	NA	NA	Changed pacings to 50/250. Closed valve gates to ~1/4 open, which did not change flows at A or B significantly. Will leave at this until see how they compare at higher flows.	No activity
JBT5FB	JBT5B-050420-1	1	240,100	5/4/2020	35	29	19.0	3	8.4	6.9	4.60	0.80	4/27/2020 12:15	5/4/2020 12:00	6.99	38.04	1.202	0.987	0.658	0.114	1:15 PM	KP	Y	18	50/100 bottle 1	11/100 bottle 3	NA	NA	No change to pacings	No activity
JBT5FB	JBT5B-051120-1	1	153,200	5/11/2020	71	50	16.9	6	10.9	7.6	2.60	0.90	5/4/2020 12:15	5/11/2020 11:45	6.98	38.04	1.562	1.089	0.372	0.129	12:55 PM	KP	Y	12	32/100 bottle 1	8/100 bottle 3	NA	NA	Left all pacings unchanged	Spreading manure in upper part of field using dragline (injector?). Some surface applied near shelters.
JBT5FB	JBT5B-051820-1	1	195,100	5/18/2020	69	52	16.8	7	13.5	10.2	3.30	1.40	5/11/2020 12:00	5/18/2020 12:45	7.03	38.04	1.920	1.451	0.469	0.199	2:05 PM	KP	Y	24.6	41/100 bottle 1	9/100 bottle 3	NA	NA	NA	Tilled and planted
JBT5FB	JBT5B-052520-1	1	200,500	5/25/2020	27	27	19.1	3	5.5	5.3	3.80	0.50	5/18/2020 13:00	5/25/2020 13:00	7.00	38.04	0.786	0.757	0.543	0.071	2:20 PM	KP	Y	16	42/100 bottle 1	10/100 bottle 3	NA	NA	Pacings 50/250	No activity
JBT5FB	JBT5B-060120-1	1	421,600	6/1/2020	71	64	29.3	9	30.1	26.9	12.40	3.60	5/25/2020 13:15	6/1/2020 11:30	6.93	38.04	4.343	3.882	1.789	0.519	12:45 PM	KP	Y	44	86/100 bottle 1	18/100 bottle 3	NA	NA	No change to pacings	Corn ~4"
JBT5FB	JBT5B-060820-1	1	285,700	6/8/2020	37	34	25.0	4	10.5	9.6	7.10	1.10	6/1/2020 11:45	6/8/2020 8:00	6.84	38.04	1.535	1.404	1.038	0.161	9:20 AM	KP	Y	17	59/100 bottle 1	13/100 bottle 3	NA	NA	No change to pacings	Corn ~6"
JBT5FB	JBT5B-061520-1	1	151,500	6/15/2020	25	18	22.1	13	3.8	2.7	3.30	2.00	6/8/2020 8:15	6/15/2020 8:00	6.99	38.04	0.544	0.386	0.472	0.286	9:15 AM	KP	NA	9	32/100 bottle 1	8/100 bottle 3	NA	NA	No change to pacings	Corn ~10"
JBT5FB	JBT5B-062220-1	1	102,900	6/22/2020	39	27	17.4	23	4.0	2.7	1.80	2.30	6/15/2020 8:15	6/22/2020 6:45	6.94	38.04	0.576	0.389	0.259	0.331	7:55 AM	KP	Y	8	22/100 bottle 1	6/100 bottle 3	NA	NA	No change to pacings	Corn ~14"
JBT5FB	JBT5B-062920-1	1	52,100	6/29/2020	109	13	13.2	46	5.7	0.7	0.70	2.40	6/22/2020 7:00	6/29/2020 13:15	7.26	38.04	0.785	0.096	0.096	0.331	2:25 PM	KP	Y	1	12/100 bottle 1	4/100 bottle 3	NA	NA	No change to pacings	Corn ~16-24"
JBT5FB	JBT5B-070520-1+3	1+3	19,900	7/5/2020	NA	NA	NA	NA	NA	NA	NA	NA	6/29/2020 13:30	7/6/2020 7:45	6.76	38.04	NA	NA	NA	NA	9:10 AM	KP	NA	1	5/100 bottle 1	2/100 bottle 3	Invalid. Negligible sample. Combined 1+3 by mistake	NA	No change to pacings. No dupes, not enough sample.	Corn 3-4 ft
JBT5FB	JBT5B-071320-1	1	244,900	7/13/2020	46	33	27.3	13	11.3	8.1	6.70	3.30	7/6/2020 8:00	7/13/2020 6:30	6.94	38.04	1.628	1.167	0.965	0.476	7:40 AM	KP	Y	13	50/100 bottle 1	11/100 bottle 3	NA	NA	No change in pacings	Corn ~5 ft
JBT5FB	JBT5B-072420-NS	NS	39,800	7/24/2020	NA	NA	NA	NA	NA	NA	NA	NA	7/13/2020 6:45	7/24/2020 7:30	NA	38.04	NA	NA	NA	NA	8:40 AM	KP	N	0	9/100 bottle 1	3/100 bottle 3	NA	NA	Flow meter zero. No samples collected.	Corn ~6 ft

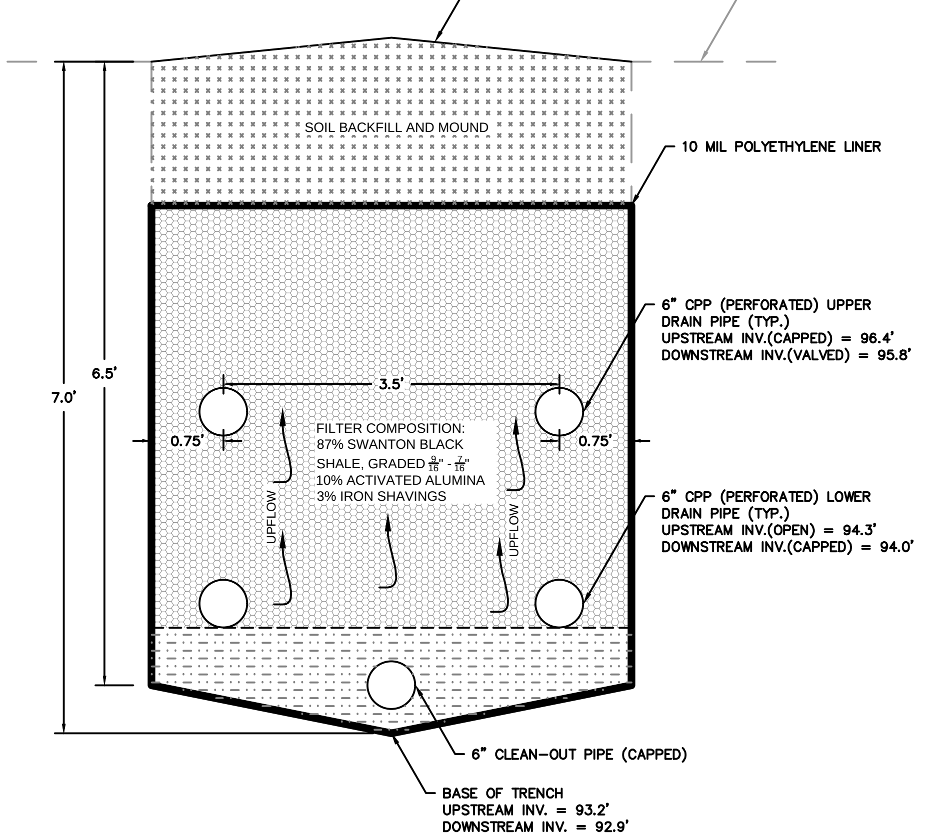
Site ID	Sample ID	Carboy	Flow Total (L)	Sample Date	TP (ug P/L)	TDP (ug P/L)	TN (mg N/L)	TSS (mg/L)	TP Load (g)	TDP Load (g)	TN Load (kg)	TSS Load (kg)	Sample Begin	Sample End	Elapsed Time (d)	Area (ha)	TP Load (g/d)	TDP Load (g/d)	TN Load (kg/d)	TSS Load (kg/d)	Time Autosampler Stopped	Tech.	Outlet flowing?	Flowmeter Display (L/min)	PART A	PART B	Sample Quality Notes	Processing Comments	Additional Comments from field	Field Condition Notes
JBT5FB	JBT5B-073020-NS	NS	3,800	7/30/2020	NA	NA	NA	NA	NA	NA	NA	NA	7/24/2020 7:45	7/30/2020 9:15	NA	38.04	NA	NA	NA	NA	10:30 AM	KP	NA	1	NA	NA	NA	NA	No samples, no flow. Water level ~ 6 in. above inflow pipes, no evidence of flow.	Corn ~6-7 ft
JBT5FB	JBT5B-080820-1	1	192,300	8/8/2020	142	52	15.6	10	27.3	10.0	3.00	2.00	7/30/2020 9:30	8/8/2020 8:45	8.97	38.04	3.043	1.115	0.334	0.223	9:55 AM	KP	NA	6.9	40/100 bottle 1	9/100 bottle 3	NA	NA	Pacings: 50/250	Corn ~8 ft
JBT5FB	JBT5B-081720-1	1	16,000	8/17/2020	61	17	6.6	NA	1.0	0.3	0.10	NA	8/8/2020 9:00	8/17/2020 10:30	9.06	38.04	0.110	0.033	0.011	NA	11:30 AM	KP	N	0.3	5/100 bottle 1	2/100 bottle 3	NA	Switched TP and TDP results	No visible flow	Corn ~8 ft
JBT5FB	JBT5B-082520-NS	NS	5,700	8/25/2020	NA	NA	NA	NA	NA	NA	NA	NA	8/17/2020 10:45	8/25/2020 13:00	NA	38.04	NA	NA	NA	NA	2:15 PM	KP	N	0.5	3/100 bottle 1	2/100 bottle 3	Insufficient sample	NA	No visible flow	Corn 8-10 ft
JBT5FB	JBT5B-090120-NS	NS	7,400	9/1/2020	NA	NA	NA	NA	NA	NA	NA	NA	8/25/2020 13:15	9/1/2020 10:15	NA	38.04	NA	NA	NA	NA	11:20 AM	KP	N	0.5	3/100 bottle 1	2/100 bottle 3	No samples collected	NA	No visible flow	Corn 9-10 ft
JBT5FB	JBT5B-091420-NS	NS	7,100	9/14/2020	NA	NA	NA	NA	NA	NA	NA	NA	9/1/2020 10:30	9/14/2020 8:15	NA	38.04	NA	NA	NA	NA	9:20 AM	KP	N	0	3/100 bottle 1	2/100 bottle 3	No samples collected	NA	No visible flow	Corn ~10 ft
JBT5FB	JBT5B-092820-NS	NS	6,800	9/28/2020	NA	NA	NA	NA	NA	NA	NA	NA	9/14/2020 8:30	9/28/2020 8:30	NA	38.04	NA	NA	NA	NA	9:35 AM	KP	N	0.5	NA	NA	No samples collected	NA	No visible flow	Corn harvested, no manure
JBT5FB	JBT5B-100520-1	1	40,900	10/5/2020	43	24	6.9	23	1.8	1.0	0.30	0.90	9/28/2020 8:45	10/5/2020 9:00	7.01	38.04	0.257	0.143	0.043	0.128	10:10 AM	KP	N	0.6	10/100 bottle 1	3/100 bottle 3	NA	NA	No visible flow	No manure
JBT5FB	JBT5B-101220-1	1	5,600	10/12/2020	44	28	1.9	NA	0.2	0.2	0.00	NA	10/5/2020 9:15	10/12/2020 9:00	6.99	38.04	0.029	0.029	0.000	NA	10:10 AM	KP	N	0.6	3/100 bottle 1	2/100 bottle 3	NA	NA	No visible flow	No manure
JBT5FB	JBT5B-101720-NS	NS	19,900	10/17/2020	NA	NA	NA	NA	NA	NA	NA	NA	10/12/2020 9:15	10/17/2020 16:00	NA	38.04	NA	NA	NA	NA	NA	DCB	Y	NA	NA	NA	Sample dumped 10/17, sampler not reset	NA	NA	NA
JBT5FB	JBT5B-102620-1	1	275,400	10/26/2020	23	16	17.3	5	6.4	4.5	4.80	1.30	10/17/2020 16:15	10/26/2020 9:00	8.70	38.04	0.736	0.517	0.552	0.149	10:20 AM	KP	Y	21	61/100 bottle 1	12/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-110220-1	1	162,300	11/2/2020	14	8	12.4	8	2.2	1.4	2.00	1.30	10/26/2020 9:15	11/2/2020 10:30	7.05	38.04	0.312	0.199	0.284	0.184	11:35 AM	KP	Y	17	34/100 bottle 1	8/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-110920-1	1	62,000	11/9/2020	20	9	1.7	19	1.2	0.6	0.10	1.20	11/2/2020 10:45	11/9/2020 10:30	6.99	38.04	0.172	0.086	0.014	0.172	11:35 AM	KP	Y	4	14/100 bottle 1	4/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-111620-1	1	54,300	11/16/2020	17	8	1.2	15	0.9	0.5	0.10	0.80	11/9/2020 10:45	11/16/2020 8:45	6.92	38.04	0.130	0.072	0.014	0.116	9:50 AM	KP	Y	23	13/100 bottle 1	4/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-112320-1	1	124,300	11/23/2020	16	19	9.8	5	2.0	2.4	1.20	0.60	11/16/2020 9:00	11/23/2020 10:00	7.04	38.04	0.284	0.341	0.170	0.085	11:10 AM	KP	Y	14	26/100 bottle 1	6/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-113020-1	1	392,700	11/30/2020	21	19	17.2	3	8.4	7.3	6.80	1.00	11/23/2020 10:15	11/30/2020 8:15	6.92	38.04	1.214	1.055	0.983	0.145	9:20 AM	KP	Y	47	80/100 bottle 1	14/100 bottle 3	NA	NA	Changed pacings to 100/500	No manure
JBT5FB	JBT5B-120720-3	3	1,069,900	12/7/2020	38	32	39.3	3	40.2	34.6	42.00	2.70	11/30/2020 8:30	12/7/2020 2:15	6.74	38.04	5.964	5.134	6.231	0.401	3:25 AM	KP	Y	50	100/100 bottle 1	22/100 bottle 3	NA	NA	No power, replaced batteries	No manure
JBT5FB	JBT5B-121420-1	1	366,400	12/14/2020	23	20	22.6	5	8.5	7.2	8.30	1.80	12/7/2020 2:30	12/14/2020 10:00	7.31	38.04	1.163	0.985	1.135	0.246	11:30 AM	KP	Y	57	37/100 bottle 1	9/100 bottle 3	NA	NA	Batteries changed 12/11/20 after outage	No manure
JBT5FB	JBT5B-122120-1	1	336,800	12/21/2020	23	22	20.6	3	7.8	7.4	6.90	0.90	12/14/2020 10:15	12/21/2020 12:15	7.08	38.04	1.102	1.045	0.975	0.127	12:20 PM	KP	Y	22	35/100 bottle 1	8/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-122920-1	1	672,600	12/29/2020	48	33	33.7	4	32.5	22.1	22.70	2.60	12/21/2020 12:30	12/29/2020 11:15	7.95	38.04	4.088	2.780	2.855	0.327	12:30 PM	KP	Y	43	69/100 bottle 1	15/100 bottle 3	NA	NA	NA	No manure
JBT5FB	JBT5B-010521-1	1	302,700	1/5/2021	23	19	23.2	3	6.8	5.8	7.00	0.80	12/29/2020 11:30	1/5/2021 9:15	6.91	38.04	0.984	0.839	1.013	0.116	10:20 AM	KP	Y	19.1	32/100 bottle 1	8/100 bottle 3	NA	NA	NA	No manure

Appendix D: As-built P Filter Drawings





FILTER A



FILTER B

File: O:\PROJ-18\WRM\18-006 LCBP tile monitoring & treatment\CAD\Survey.dwg

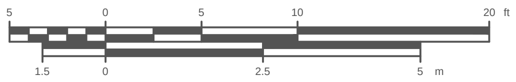
DRAWING CREDITS
Drawn On: 07/14/2021
Drawn By: MLS
Checked On: 07/15/2021
Checked By: DCB
Project No.: 18-006

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17



1 inch = 5 feet
(1 : 60)

LCBP TILE MONITORING & TREATMENT
ST. ALBANS P FILTER
AS-BUILT PLAN

ST. ALBANS VERMONT

SHEET NO.
1