

PROJECT NO.

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Characterization of Tile Drainage Systems in the Jewett Brook Watershed

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Cover Photo: Installing a pipe trap and monitoring manhole at the end of one of the tile drains to be monitored.

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# Introduction

This report is intended to document the detailed data collected on the 12 tile-drained fields selected for monitoring, as well as present summary level data on field conditions throughout the Jewett Brook watershed. Data describing the monitored tile-drained fields were obtained through field reconnaissance, interviews with participating farmers, review of nutrient management plans, and analysis of the USDA-NRCS SSURGO soils dataset. However, at this time summary level data on field conditions throughout the Jewett Brook watershed are not available.

In Task 2, Stone will use data describing the monitored fields to evaluate associations between agronomic factors and measured nutrient concentrations and loads in tile drain flow. These data will also be used in Task 3 in extrapolating phosphorus loading rate estimates from the 12 monitored tile drains to the scale of the Jewett Brook watershed. This extrapolation will also require certain watershed-scale data, including estimates of the tile-drained acreage among various crops, soil types, and soil test phosphorus classes. For example, to scale up from unit-area phosphorus loading at study fields in silage corn production with clay soils and “optimum” soil-test phosphorus, we require tile drainage, cropping, soils, and soil test phosphorus information at the watershed scale. These watershed-scale data will also be important in determining how representative the monitored tile-drained fields are to conditions in the watershed as a whole.

Stone is currently in discussions with the Vermont Agency of Agriculture, Food, and Markets (AAFM) concerning access to data AAFM obtained in preparing a *2015 Cropland Inventory of St. Albans Bay*. This cropland inventory includes critical data on the distributions and types of tile drainage systems throughout the watershed from AAFM’s interpretation of aerial imagery collected under ideal springtime conditions. AAFM classified fields in the watershed as tile-drained or not tile-drained, and then further characterized tile drainage systems as either systematic or dendritic. AAFM also recorded soil test phosphorus concentrations for a majority of fields in the watershed by reviewing nutrient management plans for nine farms. Because of restrictions on dissemination of personally protected information, AAFM cannot provide Stone with the relevant spatial data layers; therefore we have asked AAFM to perform certain GIS analyses and provide the needed summary data. By providing only summary statistics, neither AAFM nor Stone would disseminate any protected information. It is unclear whether AAFM will be able to provide the requested summary data. It would be outside the scope of the present project for Stone to conduct the mapping and analyses necessary to reproduce these data, and at the present time we would likely be unsuccessful in obtaining as many nutrient management plans as AAFM was able to review.

# Characterization of Study Fields

Data describing the monitored tile-drained fields were obtained through field reconnaissance, interviews with participating farmers, review of nutrient management plans, and analysis of the USDA-NRCS SSURGO soils dataset. All six participating farmers provided information about the fields and tile drainage systems we are investigating. Data related to the selected tile drainage systems are presented in Table 1. Agronomic data for the study fields are presented in Table 2.

Table : Construction of the Selected Tile Drainage Systems

| **Farmer** | **Site** | **Year installed** |  | **Outfall diam. (in.)** | **Outfall position** | **Depth (ft)** | **Nominal spacing (feet)** | **Surface inlet type** | **Comment** |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Farmer1 | JBT01 | ~2012 |  | 6 | will surcharge | 3-5 | 25 | None known |  |  |
| Farmer1 | JBT02 | ~2012 |  | 4 | underwater | 3-5 | 25 | None known |  |  |
| Farmer1 | JBT04 | ~2012 |  | 4 | will surcharge | 3-5 | 25 | None known |  |  |
| Farmer2 | JBT05 | 2011 |  | 8 | will surcharge | 3-4 | 35 | None known | Majority of field outside Jewett Brook watershed |  |
| Farmer2 | JBT06 | ? |  | 12 | will surcharge | ? | ? | 3 visible standpipes | Significant erosion (gulley) |  |
| Farmer3 | JBT07 | 2011 |  | 4 | may surcharge | 3-4 | 40 | None known | Tile exposed ~6’ |  |
| Farmer3 | JBT11 | 2010 |  | 8 | will surcharge | 3-4 | 40 | None known | Water control structure near outlet: depth=60”, pipe=18” off bottom |  |
| Farmer4 | JBT13 | 2013 |  | 6 | will surcharge | 3 | 40 | None known | |  |
| Farmer4 | JBT14 | 2013 |  | 8 | will surcharge | 3 | 40 | Two inlet pipes in ditches (one clogged) | |  |
| Farmer5 | JBT16 | ~2004 |  | 4 | may surcharge | 3-4 | Dendritic | Surface inlet at northern property boundary, 100 yards into field from road | Cropped to edge of bank |  |
| Farmer6 | JBT18 | 2006 |  | 6 | will surcharge | 3 | 80 | None known |  |  |
| Farmer6 | JBT19 | 2006 |  | 6 | will surcharge | 3 | 80 | None known |  |  |

Table . Agronomic Data for the Study Fields

| Farmer | Site | Area (A) | Crop | Soil Survey Data % of field, type, slope class, hydrologic group | Soil Test P | Fertilizer Application | Manure Application | Cover Crop | 2017 Dates |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Farmer1 | JBT01 | 25 | 2016: Silage corn  2017: Soybean | 82%: Kingsbury clay, 0 to 3%, D  10%: Massena stony loam, 0 to 3%, C/D  8%: Kingsbury clay, 3 to 8%, D | 7.2 | 2016: starter at plant; urea in June or July  2017: starter at plant | 2016: None  Fall 2017: spread | 2016: None  2017: None | SB harvested ~10/3/17  Plowed ~ 10/24/17  Manure spread ~11/15/17 |
| Farmer1 | JBT02 | 4.7 | 2016: Silage corn  2017: Soybean | 69%: Kingsbury clay, 3 to 8%, D  31%: Kingsbury clay, 0 to 3%, D | 9.3 | 2016: starter at plant; urea in June or July  2017: starter at plant | 2016: None  Fall 2017: spread | 2016: None  2017: None | SB harvested ~10/3/17  Plowed ~ 10/24/17  Manure spread ~11/15/17 |
| Farmer1 | JBT04 | 5.7 | 2016: Silage corn  2017: Silage corn | 100%: Kingsbury clay, 0 to 3%, D | 4.5 | 2016: starter at plant  2017: starter at plant | 2016: None  2017: None | 2016: None  2017: None | Corn chopped, field plowed ~11/20/17 |
| Farmer2 | JBT05 | 94 | 2016: Silage corn  2017: Silage corn | 30%: Kingsbury clay, 0 to 3%, D  30%: Massena stony loam, 0 to 3%, C/D  29%: Covington clay, D  10%: Georgia stony loam, 3 to 8%, C | ? | 2016: pop-up at plant  2017: pop-up at plant | Fall 2016: inject  Fall 2017: inject | 2016: Winter rye  2017: Winter rye | Corn harvested ~10/10/17  Manure spread ~10/10/17  Manure injected on part of field ~10/24/17 |
| Farmer2 | JBT06 | 91 | 2016: Silage corn  2017: Silage corn | 51%: Covington clay, D  36%: Massena stony loam, 0 to 3%, C/D  7%: Kingsbury clay, 0 to 3%, D  6%: Georgia stony loam, 3 to 8%, C | ? | 2016: pop-up at plant  2017: pop-up at plant | Fall 2016: inject  Fall 2017: inject | 2016: Winter rye  2017: Winter rye | Corn harvested ~10/10/17  Manure injected ~10/24/17 |
| Farmer3 | JBT07 | 28 | Continuous silage corn | 53%: Covington clay, D  37%: Kingsbury clay, 0 to 3%, D  10%: Massena stony loam, 0 to 3%, C/D | 12 | 2016: 5 gal/A pop-up at plant  2017: 5 gal/A pop-up at plant | Fall 2016: 6,000 gal/A  Fall 2017: None | 2016: None  2017: None | Corn harvested ~10/17/17  Manure injected ~10/24/17  Plowed ~ 11/20/17 |
| Farmer3 | JBT11 | 51 | Continuous alfalfa hay | 58%: Massena stony loam, 0 to 3%, C/D  16%: Georgia stony loam, 3 to 8%, C  15%: Georgia stony loam, 0 to 3%, C  11%: Covington clay, D | 4 | 2016: No P  2017: No P | 2016: None  2017: None | 2016: NA  2017: NA | Hay cut ~7/5/17  Hay cut ~8/30/17  Hay cut ~10/24/17 |
| Farmer4 | JBT13 | 22 | Continuous silage corn | 52%: Massena stony loam, 0 to 3%, C/D  47%: Kingsbury clay, 0 to 3%, D | ? | 2016: No P  2017: No P | 2016: 6,000 gal/A at plant  2017: 6,000 gal/A (5/10-11/17) at plant | 2016: Winter rye  2017: Winter rye | Manure applied 5/10-11/17, approx. 6000 gal/A  Corn harvested ~10/11/17 |
| Farmer4 | JBT14 | 33 | Continuous silage corn | 97%: Massena stony loam, 0 to 3%, C/D  3%: Binghamville silt loam, C/D | ? | 2016: No P  2017: No P | 2016: 6,000 gal/A at plant  2017: 6,000 gal/A (5/10-11/17) at plant | 2016: Winter rye  2017: Winter rye | Manure applied 5/10-11/17, approx. 6000 gal/A  Corn harvested ~10/11/17 |
| Farmer5 | JBT16 | 7.0 | Continuous silage corn | 76%: Massena stony loam, 0 to 3%, C/D  10%: Lyons stony loam, C/D  6%: Covington clay, D  4%: St. Albans slaty loam, 3 to 8%, A  3%: Georgia stony loam, 0 to 3%, C | ? | 2016: pop-up at plant  2017: pop-up at plant | Fall 2016: incorporated  Fall 2017: incorporated | 2016: Winter rye  2017: Winter rye | Plowed ~5/30/17  Harvested corn ~9/26/17  Manure spread between 9/27/17 and 10/1/17 |
| Farmer6 | JBT18 | 11 | 2016: Hay (clover)  2017: Hay (clover) | 43%: Kingsbury clay, 0 to 3%, D  25%: Massena stony loam, 0 to 3%, C/D  17%: Georgia stony loam, 0 to 3%, C  15%: Covington clay, D | ? | 2016: No P  2017: No P | 2016: 12 ton/A in mid-May  2017: None | 2016: NA  2017: NA | Hay cut ~8/30/17  Hay cut ~10/24/17 |
| Farmer6 | JBT19 | 10 | 2016: Hay (clover)  2017: Hay (clover) | 48%: Kingsbury clay, 0 to 3%, D  43%: Lyons stony loam, C/D  7%: Massena stony loam, 0 to 3%, C/D | ? | 2016: No P  2017: No P | 2016: 12 ton/A in mid-May  2017: None | 2016: NA  2017: NA | Hay cut ~8/30/17  Hay cut ~10/24/17 |

While Table 1 and Table 2 provide information about the fields and their respective drainages systems, some data gaps remain. We will attempt to fill in these data gaps with follow-up correspondences with participating farmers and their crop consultants. In particular, soil test phosphorus data are not presented for most of the study fields because we have been unable to review the nutrient management plan for every farm. Crop consultants are currently revising nutrient management plans for two of the farms and have committed to providing us with the updated plans when available. Follow-up farm visits are needed to review the nutrient management plans of two other farms. Additional data on soil test phosphorus concentrations in the study fields will be presented in the final report.



Figure 1. JBT06 Outfall (12-inch diameter)

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 the data presented in Tables 1 and 2.

## Construction of Tile Drainage Systems

All twelve tile drainage systems selected for monitoring are constructed of standard, perforated, corrugated drain pipe. Tile drains were installed in most of the study fields within the last decade. The outfalls of these systems range in diameter from 4–12 inches; there are four 4-inch, four 6-inch, three 8-inch, and one 12-inch diameter outfalls (Figure 1). Nine of the 12 tile drains discharge to drainage ditches, generally close to the bottom of the ditch such that submergence is common. The remaining three, JBT01, JBT02 (Figure 2), and JBT04, drain contiguous fields and discharge directly to Jewett Brook. 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 but one of the study fields has patterned tile drainage. Only JBT16 has a dendritic (branching) system. Drain spacing among the patterned tile drain systems is in the typical range of 25–40 feet, with the exception of JBT18 and JBT19, which have 80-foot spacing that is unusually wide.



JBT02 outfall

Figure 2. Submerged Outlet of JBT02 Discharging Directly to Jewett Brook

## Surface Inlets to Tile Drains

There are no known surface inlets into ten of the twelve tile drainage systems selected for this study. In field JBT06, there is a cluster of three standpipes in a wet area that are connected to the underlying tile lines. Field JBT16 has one surface inlet, which receives runoff from an adjacent residential property and overflow from a pond. It is locatedalong the property boundary on the north side of the field, approximately 300 feet into the field from the road. There are also two connected standpipes in ditches bordering the JBT14 field. One appears to receive little, if any, runoff from field areas. The second was plugged but appears to receive runoff from cropped areas.

## Crop Production in Study Fields

Nine of the twelve study fields were in silage corn production in 2016. Two of these—JBT01 and JBT02—were planted in soybeans in 2017, while the remaining seven remained in corn. Three fields—JBT11, JBT18, and JBT19—are in continuous hay production. JBT11 was seeded in 2015 in alfalfa hay and JBT18 and JBT19 were seeded in 2016 for clover hay production.

Five of the corn fields being monitored were seeded with a cover crop of winter rye in 2016. At least four of these same fields are expected to be seeded in winter rye again in 2017, whereas the fifth (JBT16) may be seeded in triticale.

## Study Field Soil Types

Two soil complexes comprise most of the area of the study fields. These complexes are the Massena-Lyons stony loams and Kingsbury-Covington clays. Kingsbury-Covington clays are the principle soils in seven of the twelve study fields. Massena-Lyon stony loams are the principle soils in four fields. The remaining field, JBT19, has a roughly equal acreage in both soil complexes.

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. The Massena soils are at a slightly higher position in the landscape than the Lyons soils. Both 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.

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.

Georgia stony loam is also a significant soil in several of the study fields. Georgia stony loam comprises 31 percent of field JBT11, 17 percent of JBT18, 10 percent of JBT05, and lesser percentages of fields JBT06 and JBT16. Georgia stony loams are deep and moderately well drained, in contrast to the other dominant soils among the study fields (Flynn and Joslin 1979). They are stony or extremely stony and they formed in glaciated uplands in western Franklin County.

## Soil Test Phosphorus Levels in Study Fields

At this time, we lack sufficient soil test phosphorus data for the study fields to make any generalizations or comparisons.

## Manure and Fertilizer Applications in Study Fields

In 2016, the manure and fertilizer application methods of the six participating farmers on the study fields differed dramatically. Manure application methods on the cornfields included fall surface application (JBT07), fall incorporation (JBT16), fall injection (JBT05 and JBT06), and spring application at planting (JBT13 and JBT14). A small amount of “pop-up” or starter fertilizer containing P was applied at planting on all the cornfields except JBT13 and JBT14.

On the three hay fields, no commercial fertilizer containing P was applied. Manure was applied to the two clover hay fields, JBT18 and JBT19, in mid-May. Field JBT11 apparently received no P in any form.

Actual manure and fertilizer applications in 2017 will be documented for inclusion in the final report and in the agronomic factors association analysis.

# References

Flynn, D.J. and R.V. Joslin. 1979. Soil Survey of Franklin County, Vermont. USDA Soil Conservation Service.